Stormwater Integrated Resource Plan (SIRP) – Capital and Operational Plan Alternatives

Recommendation:
Utility Committee is asked to provide feedback on the preferred timeline for implementation of the SIRP capital and operational changes. EPCOR recommends implementing Scenario 2, with a 20 year focus for implementation. The implementation would commence this year and would then be incorporated into subsequent rate filings in successive five-year periods, for review and approval by Utility Committee and City Council.

EWSI intends to apply for approval of a Non-Routine Adjustment ("NRA") to stormwater rates beginning January 1, 2020 to recover the increase in its stormwater revenue requirement to begin implementation of the flood mitigation priorities identified as part of the Stormwater Integrated Resource Plan (SIRP).

Report Purpose:

This report provides an overview of the recommended capital and operational program investments for the Drainage Utility to reduce the flooding risks within the City of Edmonton for urban and riverine flooding events. Three scenarios for the spreading of capital investments over the next 30 years have been developed, along with the additional manpower resources required to support the SIRP implementation.

The subsequent sections of this report provide more detail on how the capital investments and operational cost impacts were developed for each of the investment category types and the revenue requirements over the subsequent PBR periods for each of the three scenarios.

Revenue Requirements and Non-Routine Adjustment Summary

EPCOR is recommending Scenario 2, with a 20-year focus for implementation.

To begin implementation immediately, an NRA is required to provide bridge funding until the next PBR renewal. Prior to end of 2019, EWSI intends to file an application seeking a Non-Routine Adjustment ("NRA") to stormwater rates beginning January 1, 2020 to recover the required funding. If scenario 2 of the SIRP strategy is accepted as currently defined, the average annual increase in the stormwater revenue requirement is approximately $2.4 million per year for the remaining three years of the current PBR term (2019-2021). The NRA increases

the average monthly bill for the residential stormwater customer by $0.56 per month beginning January 1, 2020. If the Utility Committee advises alternative timing for the mitigation components is preferable, the revenue requirement and associated rate increase will be adjusted to the spending requirements for that timing.

Future SIRP revenue requirements and detailed business cases for the proposed capital projects for the following five year term will be incorporated into future PBR rate filings based on the Scenario preferred by Utility Committee.

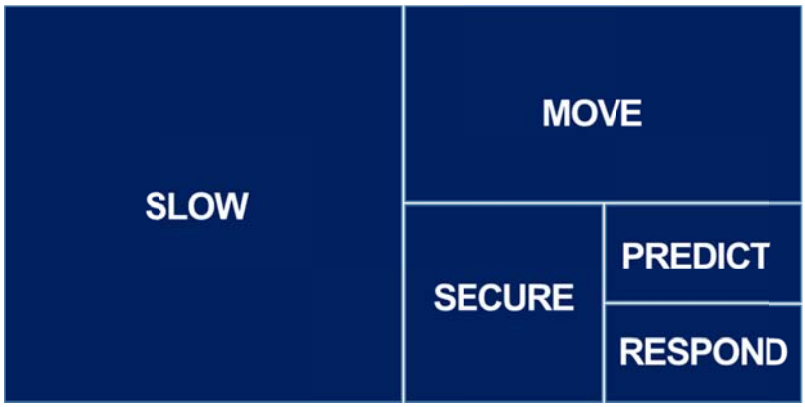
Background:
In our report to Utility Committee on February 23rd, EPCOR proposed a risk methodology aligned with the vulnerability risk analysis underway through the City of Edmonton's Climate Change Resiliency and Adaptation initiative being led by the City Environmental Strategies group. At the June 8th Utility Committee meeting EPCOR provided information on the data that would be included in the risk analysis and obtained confirmation from the Utility Committee that the four perspectives of risk consequences —Health and Safety, Environment, Social and Financial — met the expectations of the committee. At the October 25th EPCOR presented the results of the risk ranking assessment and a recommendation to prioritize the stormwater sub-basins for flood mitigation efforts with a focus that provided additional emphasis on flood mitigation to reduce the health and safety and social risk of flooding.

This report presents the proposed capital and operational program investments to mitigate flood risks across the City. The SIRP approach allows for a lower overall capital investment than seen with traditional engineering approaches through the inclusion of operational programs that support the overall community in responding to flooding events. Both the capital and operational investments proposed in this report are necessary to achieve the overall risk mitigation in the community.

Estimated Total Capital Costs (20-year)

EPCOR developed the investment recommendations considering a mix of grey and green infrastructure components installed within the public right-of-way or within City- or EPCOR-owned parcels. The $1.6 Billion capital program proposed through the SIRP can be classified into five themes of investment described below along with the estimated capital program recommended for each of these theme areas.

Slow: We slow the entry of stormwater into the drainage network by absorbing it in green infrastructure and holding it in ponds, creating space in the collection system during storm events.



- Ponds ($470M) and Low Impact Development - LID ($470M)

Move: We move excess water away from areas at risk, quickly and efficiently.

- Tunnels Trunks and Sewer Separation ($300M)

Secure: We help secure individual properties in higher risk areas against sewer backups, inflow infiltration and overland flooding and river flooding.

- Inflow and Infiltration Reduction ($100M), Enhanced Flood Proofing ($60M), Outfalls and Control Gates ($30M)

Predict: We predict and manage the movement of stormwater through smart sensors and technologies that integrate into the collection system.

- Monitoring and Controls ($70M)

Respond: We respond through fast rollout of flood barriers, traffic diversions, and public communications to protect life, safety and property.

- Emergency Response Equipment ($45M)

Appendix A contains a summary of the previous City Wide Flood Mitigation capital cost Scenarios based on storm intensities with mitigation primarily through grey infrastructure. The previous scenarios would be classified as predominantly Move options with some Slow through the additional of large dry ponds throughout the City.

Human Resource Requirements

EPCOR is also recommending the addition of 18 staff positions to support the implementation of the SIRP plan.

These positions include:

- Four management positions to support the concept design and community engagement requirements for Dry Ponds, LID, Monitoring and Controls and Building Flood Proofing initiatives.
- Six technologists to support LID, Monitoring and Controls, Emergency Response and Building Flood Proofing analysis.
- Four field labour positions to support the operations of overland drainage including LID and ditches and swales maintenance.
- Four specialized field operators to support the mechanical, electrical and controls maintenance for the new outfall gates and additional monitoring and controls proposed throughout the City.

The annual operating cost impact for these positions is $2.2M per year starting in 2020.

Expansion of the Backwater Valve Subsidy Program

EPCOR also recommends that the backwater valve subsidy program increase to support the targeted installation of an additional 40,000 backwater valves in homes immediately adjacent to localized sag areas where stormwater will continue to pool due to the topography of the City.

The current program has approximately 300 homes per year installing the backwater valve and claiming the subsidy. A ten year timing scenario to complete this targeted backwater valve installation is recommended for this program in all three scenarios. Four of the manpower positions proposed above are to support this program and will no longer be required once the program is completed.

This report has been structured into the following sections

Part 1 – Provides a background on the methodology used to develop the SIRP proposed capital and operational plans based on the SIRP Risk Framework. Included in this section is a more

detailed comparison of the capital costs determined using the previous City Wide Flood Mitigation approach vs. the SIRP approach for the Downtown major stormwater basin.

Part 2 – Is organized by the eight types of investments identified for flood mitigation through the SIRP approach. This includes Dry Ponds, Low Impact Development, Tunnels and Sewer Separation, Outfalls and Control Gates, Maintenance and Inflow\Infiltration for local sewer pipes, Enhanced Building Flood Proofing, Monitoring and Controls and Emergency Response support.

Part 3 – Summarizes the capital and operational investments to support the SIRP plan and provide an overview of the expected revenue requirements to support the entire plan implementation and the requirements for a Non-Routine Adjustment for the period 2019 to 2021 until the next PBR period.

Part 4 – Provides a summary of the work activities that will be completed by EPCOR over the next two years, including activities that are required to be completed as part of the next PBR submission to Utility Committee and City Council.

The appendices contain additional information on previous City Wide Flood Mitigation Plan, the correlation of overland ponding and basement flooding, and an outline of the public consultation process that will be used by EPCOR for the proposed new dry ponds.

Table of Contents

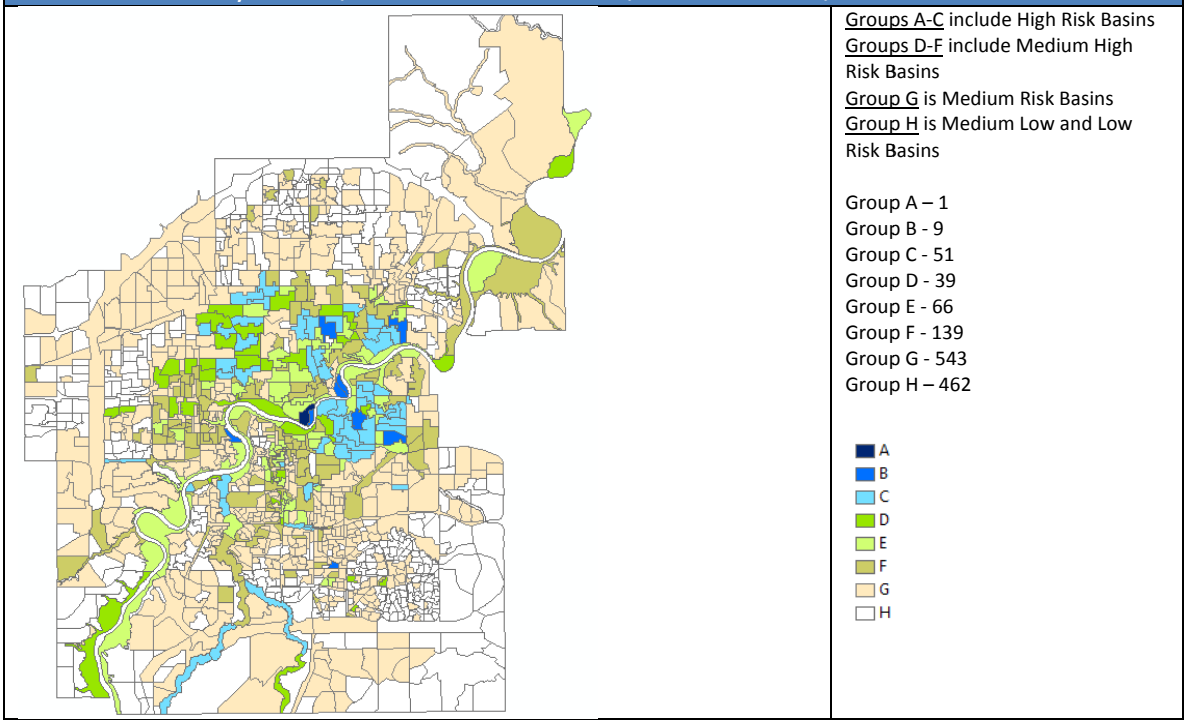
Part 1 – Methodology

1.1 Overview of the Risk Framework

In the October 25th, 2018 Utility Committee meeting, EPCOR presented the methodology and results of the risk ranking of the stormwater sub-basins within Edmonton. The risk ranking considered the impacts to the community for five storm scenarios (1:20 / 1:50 / 1:75 / 1:100 and 1:200) from four aspects of risk (Health and Safety, Environment, Social Impact and Financial).

Utility Committee provided direction to EPCOR to develop the capital and operational cost impacts based on the Scenario 2 risk weighting presented at the October meeting for the priority risk basins (A to E). This scenario places a higher emphasis on the risks driven by Health and Safety and Social Impacts of flooding, as recommended by the public engagement completed to support the project. The figure below illustrates the priority sub-basins (risk ranked A to E) from this analysis.

Scenario 2 – Public Opinion Survey Preference
Health and Safety – 30% / Environment – 15% / Social – 30 % / Financial 25%



All previous SIRP reports are available at the following EPCOR website https://www.epcor.com/products-services/drainage/Pages/flood-mitigation.aspx

1.2 SIRP Methodology to Determine Capital and Operational Costs

Subsequent to the Utility Committee meeting, EPCOR reviewed each of the high risk sub-basins in closer detail to determine the types of flood mitigation investments that would be required to reduce the risk levels in these basins. This review was completed for each of the major stormwater basins through a series of workshops with representatives from Drainage Planning, Engineering, Construction and Operations to determine the mix of projects for each location. The workshops referenced previous engineering studies and the additional data sets compiled as part of the SIRP risk analysis.

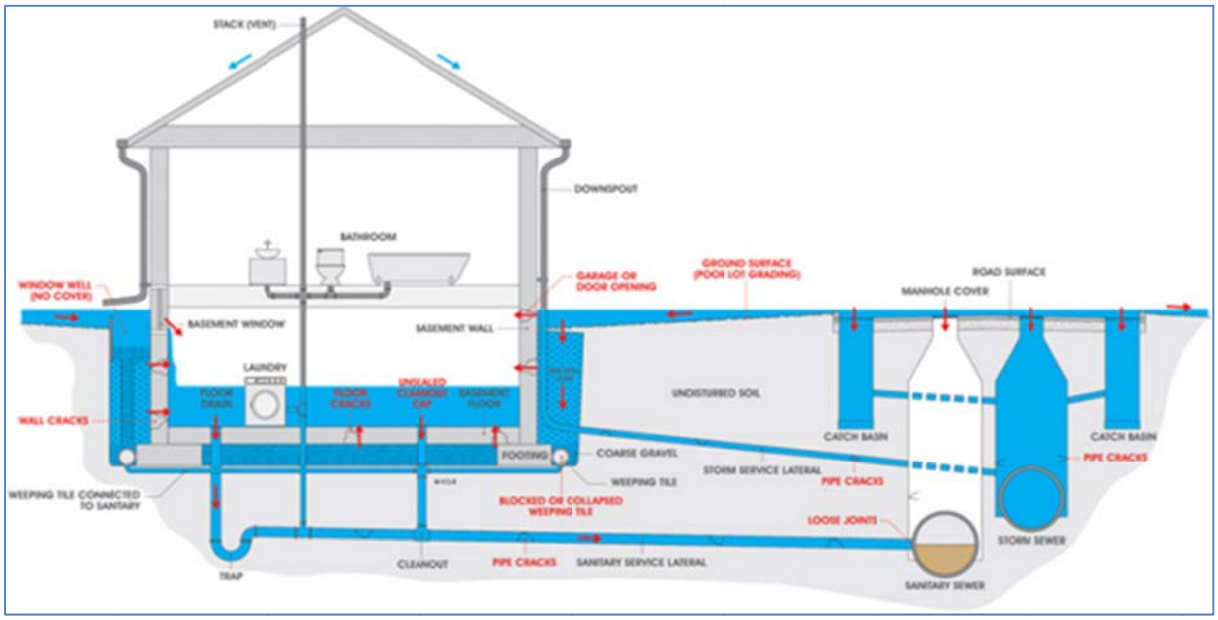
EPCOR developed the investment recommendations considering a mix of grey and green infrastructure components installed within the public right-of-way or within City- or EPCOR-owned parcels. The previous City Wide Flood Mitigation alternatives presented to Utility Committee in June 2017 primarily focused on grey infrastructure options along with large dry ponds. Appendix A contains a summary of the previous City Wide Flood Mitigation Plan.

Two aspects in particular drove the SIRP choice to broaden the mix of capital or operational investments within a community to include additional green infrastructure and flood proofing of properties most at risk of flooding:

- The impact of ponding on road after a storm event, and
- The convective storm patterns that are experienced in the Edmonton area.

The higher risk of ponding to properties was evident from the risk analysis of the stormwater sub basins where water was predicted to pond on the roads after a storm event. Historical basement flooding records for Edmonton confirmed this increased risk level.

The higher flood risk in localized sag areas is illustrated in the figure below from the CSA Standard Z800-18 – Guideline on Basement Flood Protection and Risk Reduction. The figure illustrated the different paths where storm water can enter a property during a flooding event. The longer the duration that the water pools on the road surface the higher the risk that the water will access the sanitary pipes and/or foundation drains of properties without adequate flood proofing and enter the building. Hence the focus for SIRP on programs to reduce the risk of water ponding in these localized sag areas during a storm event. Appendix B of this report provides more background on this finding.



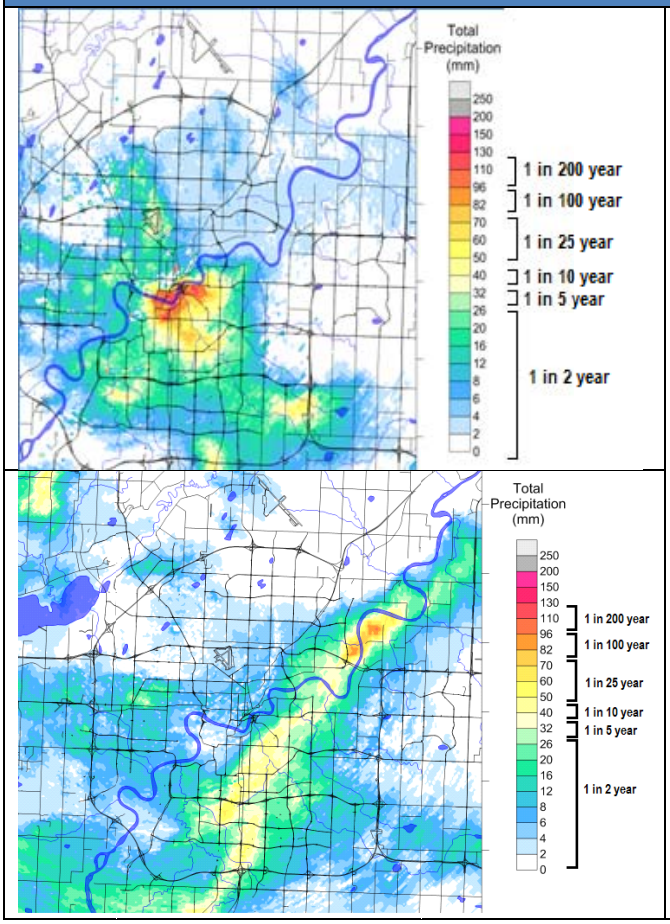
The figure above shows that stormwater can enter a home either via a backup through the sanitary sewer, risk mitigated by installation of a backwater valve and via foundation drains and/or window wells, risk mitigated by proper lot grading and repairs to service lines pipes to reduce risk from infiltration of water ponding on the surface. The Enhanced Flood Proofing components proposed as part of the SIRP address these different flooding risks.

Storm patterns in the Edmonton region were also reviewed. The types of storms experienced in Edmonton are primarily driven by convective processes or unstable atmospheric conditions. Convective storm events are more localized events with less continuous rainfall over a shorter time frame. Extreme convective storms events result in high localized rainfall over a short duration surrounded with less intense rainfall around the core of the storm.

Although one area of the City may be experiencing an extreme 1:100 or 1:200 year storm event the surrounding areas will be experiencing rainfall at a much lower intensity.

The following chart also provides an illustration on how these storm patterns vary across the City during two recent intense storm events in Edmonton.

Storm Precipitation Patterns – Total Precipitation by location vs. Storm Return period



The adjacent charts from the Drainage Radar service provider show how the storms and return period experienced by a particular location varies by the storm pattern

From a community perspective storm events have a range of storm intensities depending on how the storm develops and the speed that the storm travels across the City.

For the most recent major storms on July 27th, 2016 (top chart) and August 5th, 2017 (lower chart) the storm intensity experienced by a particular property varied depending on location of the property.

The SIRP approach to managing stormwater

The risk of flooding within the community is impacted by the methods used to manage these volumes of water across the City. The previous City Wide Flood Mitigation approach focused on building a large pipe and tunnel network to move these volumes rapidly to the creeks and river.

The SIRP approach is to capture the stormwater volumes in dry ponds *prior* to reaching the storm trunk network to provide additional capacity in the pipes in the immediate path of the storm. The addition of Low Impact Development throughout the catchment area will further

retain these volumes and reduce the impact on the entire pipe network as storms travel across the community. The plan does include tunnels, trunks and sewer separation in locations where due to configuration of the community there is limited space to install additional ponds or LID components to fully capture the expected water volumes during a major storm event.

The SIRP capital plan in this report includes a focus on sag locations and the reduction of the potential for water to pool in these locations during major storm events through the redirection of stormwater to dry ponds and installation of LID to hold back the peak flows from the sag areas. The plan also focuses on the rehabilitation of the infrastructure in these locations to reduce inflow and infiltration and on sewer separation where there are combined sewers adjacent to localized sag areas.

Enhanced Building Flood Proofing Program for the properties adjacent to these localized sag areas is also included to further protect the property from damage.

Monitoring and real time controls are also proposed to transition the entire City storm pipe and pond network into a "smart" system to improve situational awareness of the system response during major events and enable the ability for future real time management of flow volumes between adjacent stormwater retention locations within a major stormwater basin.

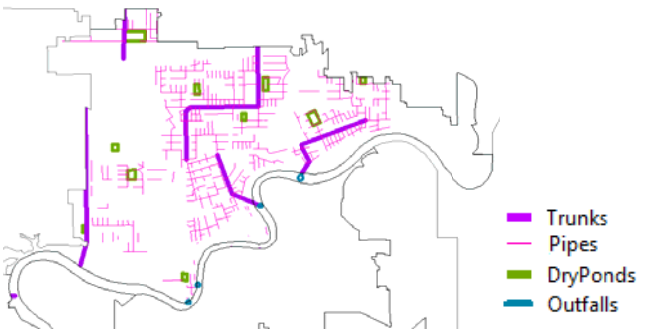
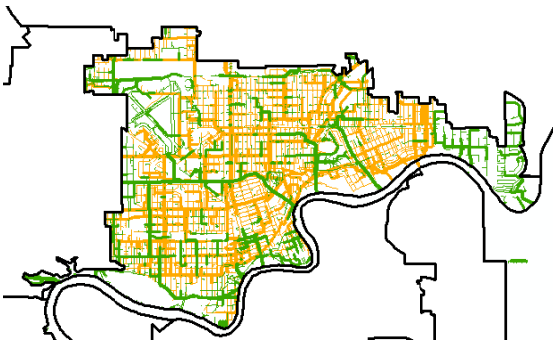
Finally the plan includes the development of 15 emergency response stations located throughout the City. These stations will be outfitted with emergency response equipment such as portable flood barriers, pumps and hoses to allow for efficient deployment during a major flooding event. The locations for these stations will be selected jointly by EPCOR and the Office of Emergency Management with support from the City of Edmonton Climate Change Adaptation team.

1.3 Downtown Major Basin – Comparison City Wide to SIRP

To provide a comparison of how the SIRP methodology results in a lower overall capital expense to provide flood mitigation, the following section shows how the different approaches result in a lower overall cost for the downtown major stormwater basin.

The City Wide Flood Mitigation Program previously developed four capital investment scenarios based on the size of storm to be mitigated. Appendix A contains a summary of the City Wide program for the entire City. The table below summarizes the forecasted capital expenses in the downtown major stormwater basin for these 4 storm scenarios considering the four types of capital investments proposed under the City Wide Flood Mitigation Plan.

Downtown Stormwater Basin - City Wide Flood Mitigation
Estimated total Capital Cost -$600 M - $1600M

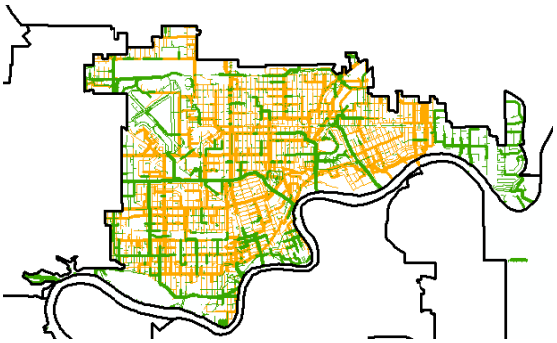
Major Basin Group Existing Pipe Network	Downtown Proposed Project Locations 
	

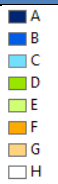
Capital Investment Type	1:100 Large	1: 50 Large	1:100 Small	1:50 Small
Storm Tunnels and Outfalls	$ 543,148,000	$ 543,148,000	$ 115,657,000	$ 115,657,000
Local Pipe Upgrades	$ 49,070,000	$ 46,507,000	$ 45,351,000	$ 42,788,000
Large Ponds	$ 111,830,000	$ 98,286,000	$ 98,286,000	$ 98,286,000
Sewer Separation	$ 944,949,000	$ 409,898,000	$ 432,324,000	$ 339,796,000
Total	$1,648,997,000	$1,097,839,000	$ 691,618,000	$ 596,527,000

The SIRP approach includes the type of capital investments identified above, but also expands the options to include smaller ponds, more green infrastructure to capture water at the property, an increased focus on Inflow\Infiltration reduction to the sanitary system, and enhanced flood proofing of properties to reduce the risk over a spectrum of storms ranging from the 1:20 to 1:200 storm level. The subsequent sections of this report provide more detail in the capital investments and operational cost impacts that were developed for each of the investment category type.

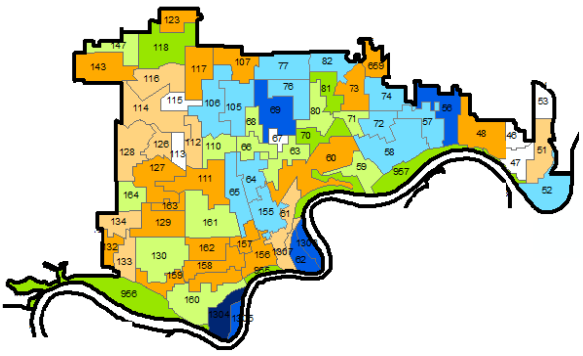
Downtown Stormwater Basin – SIRP Proposed Flood Mitigation
Estimated total Capital Cost -$ 326M

Major Basin Group Number of Sub-basins - 71	Downtown





Weighting Map for Major Basin



Risk Rank	Sub-Basin Number(s)	Proposed Improvements
A/B	1304/1305	Outfall Gates Building Flood Proofing Rossdale Dry Pond Emergency Management Plan
B	62, 1306	Outfall Gates Emergency Management Plan
B/C	55,56, 57, 58, 69, 72, 74, 75,76, 77,82, 105, 106	Sewer Separation Dry Ponds (Bellevue, Newton, Alberta Avenue, Eastwood, Parkdale) LID, Small Storage Ponds, I & I Reduction, Building Flood Proofing
D	955, 956, 957, 118	Sewer Separation Lauderdale Dry Pond Emergency Management Plan
E	130, 160, 161, 164	LID, Small Storage Ponds, I & I Reduction, Building Flood Proofing
F	Remaining Basins 22.5% of Area	LID in conjunction with BGN Home Flood Proofing
G	Remaining Basins 16.9% of Area	LID in conjunction with BGN Home Flood Proofing
H	Remaining Basins 8.5% of Area	Maintenance programs review Home Flood proofing

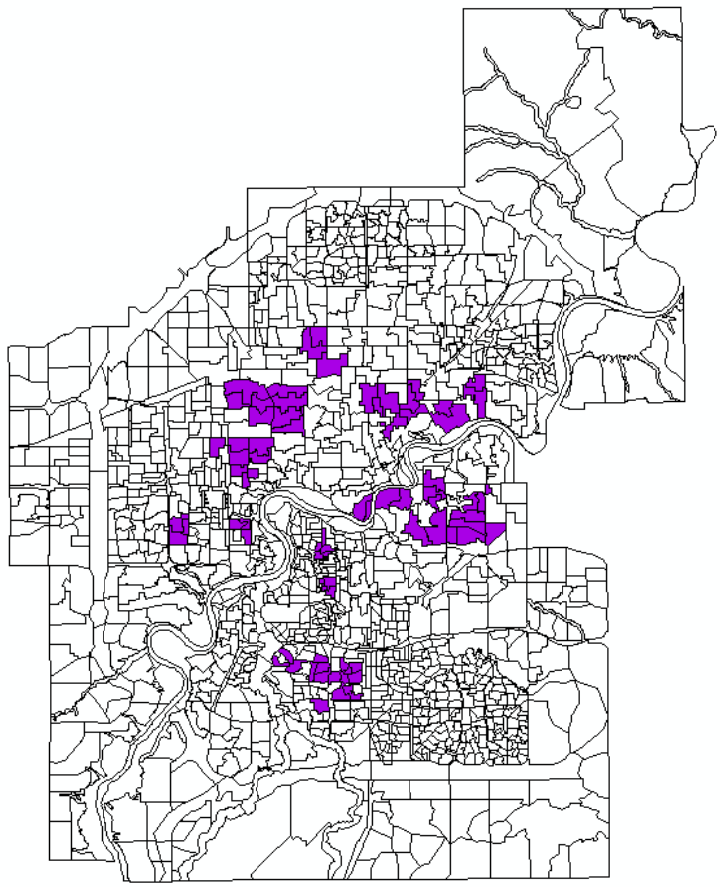
Capital Investment Type	Estimated SIRP Capital Cost
SLOW - Dry Ponds	$ 24,580,000
SLOW - Low Impact Development	$ 79,580,000
MOVE - Tunnels, Trunks, Sewer Separation	$ 131,322,000
SECURE - Outfalls and Control Gates	$ 34,480,000
SECURE - Maintenance Rehabilitation I\I Reduction	$ 22,500,000
SECURE - Enhanced Building Flood Proofing	$ 7,930,000
PREDICT - Monitoring and Controls	$ 16,104,000
RESPOND - Emergency Response Stations	$ 9,060,000
Total	$ 325,556,000

Part 2 – SIRP Investment Categories

2.1 SLOW - Dry Ponds

The previous City Wide Flood Mitigation analysis completed by the City of Edmonton had reviewed 71 parcels located throughout the City to determine if they were hydraulically feasible to be converted to dry pond location. This review was limited to parcels with a minimum of 1 hectare in size. Through the City's review, 51 locations were determined to have the hydraulic characteristics suitable for conversion to a dry pond. The SIRP team further evaluated these locations as compared to the high risk stormwater sub-basins, and identified approximately 31 of these locations that should move to the next stage of discussions. The map below shows which basins are recommended for flood risk mitigated through the addition of a dry pond.

Stormwater Sub-basins and Neighbourhoods with recommended Dry Ponds



Active
- Parkallen
- Steinhauer/Erminskin

Future
- Alberta Avenue
- Aspen Gardens
- Bellevue
- Blue Quill
- Calder
- Cloverdale
- Dovercourt
- Duggan
- Eastwood
- Forest Heights
- Greenfield
- Grovenor
- High Park
- Idylwylde
- Inglewood
- Kenilworth
- Kensington
- Lambton Industrial
- Lauderdale West
- McQueen
- Newton
- Ottewell
- Parkdale
- Parkview
- Rossdale
- Sherbrook
- University of Alberta
- West Meadowlark Park
- Woodcroft

Through our discussions with other communities across Canada it was determined that the previous limitation on the size of the pond was not consistent with the direction being taken in other cities who were also installing smaller localized "pocket ponds" to serve a localized flooding risk. This approach has been considered in the development of our recommendation for additional dry ponds for the community and will allow for more variation in pond design to meet the unique community objectives for the open space within their community.

The risk analysis review also identified a few existing wet ponds that have a greater depth differential due to the volumes of water collected during a major storm event. EPCOR is also recommending that additional depth monitoring be installed at these locations and additional safety measures, such as fencing, be added to protect the public during major events. These components have been added to the pond capital investment assumptions and are recommended to be completed in the first 10 years of the plan.

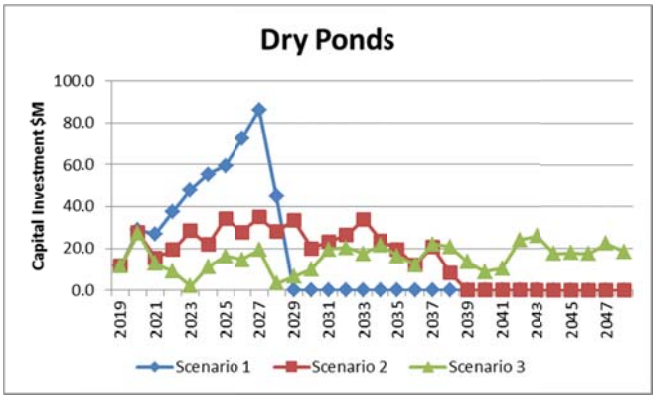
Coordination with Open Spaces Process and Public Engagement

In many neighbourhoods, the installation of dry ponds for flood mitigation is one of several potential land use options. While EPCOR has identified 31 locations where dry ponds could contribute to flood mitigation, the actual siting, sizing and design will be part of a coordinated discussion through the City of Edmonton Open Spaces team.

EPCOR's objective is to work closely with each of the communities identified above and the Open Spaces team to create the optimal design for each of these ponds, or to identify alternative flood mitigation measures in locations where other land uses would be more appropriate. In addition, some sites can be designed in a way that achieves multiple objectives: for example, pairing affordable housing with a smaller dry pond and recreational or environmental amenities.

EPCOR's public and stakeholder engagement programs will work to design and deliver critical flood protection infrastructure in a way that is aligned with the interests and priorities of the local community, supports the achievement of the Open Spaces policies, and meets the needs of the broader community including ratepayers.

Capital Investment Scenarios – Dry Ponds $M Estimated Total Investment $500M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	11.5	28.8	27.0	37.6	47.9	54.0	59.5	72.4	86.1	44.8
Scenario 2	11.5	27.7	15.5	19.3	28.5	21.8	33.0	27.9	34.9	28.0
Scenario 3	11.5	27.3	12.7	9.1	2.2	11.1	16.3	14.7	19.4	3.3
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	33.6	20.1	23.3	26.3	33.9	23.7	19.6	11.9	20.7	8.5
Scenario 3	8.1	8.7	19.6	20.3	17.6	21.6	16.4	12.1	22.1	20.9
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	13.5	8.9	10.6	24.2	26.0	17.3	17.6	17.4	22.3	18.3
Grant Contributions captured in the above cost estimates for all Scenarios in the next 10 years										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
DMAF		3.2	9.8	4.8	7.7	6.2	6.3	5.1	0.6	-



EPCOR recommends Scenario 2 as the preferred approach for dry ponds. This recommendation is based on the level of community involvement that will be required during the design phase for each of these ponds and assumes that 6 ponds per year are being developed (2 in planning, 2 in design and 2 in construction). This timing aligns with the recently approved Federal Government Disaster Mitigation and Adaptation Fund (DMAF) grant of $43.6 Million supporting construction of 13 dry ponds over the next 10 years. The grant amounts have been included in the cost estimates included in the table above.

Dry Pond Operational Cost Impacts

The manpower costs of the maintenance of these additional dry ponds, including debris clean up after a flooding event; have been captured as part of the operational costs identified for the Low Impact Development and Outfall and Control Gates in subsequent sections of this report.

The additional manpower to support the increased monitoring equipment is captured in the operational costs within the Outfall and Control gate section of this report.

One additional engineering resource is recommended for Drainage Planning and Engineering team to support the conceptual design and modeling of pond configuration in each area through the community consultation phases prior to initiating the capital construction project. Once the project moves into detailed design and construction, public consultation will continue and be funded through the capital project budget.

The extensive community consultation to finalize the exact location and configuration of the proposed new dry ponds (including the selection of recreational amenities or inclusion of naturalized landscape elements) will be funded through the capital budgets for these proposed new ponds. This process is outlined in later this report.

2.2 SLOW - Low Impact Development

EPCOR is proposing that the SIRP program include the investment by EPCOR in the wide scale implementation of Low Impact Development (LID) throughout the entire City to reduce the peak stormwater flows that are entering the storm pipe network and pooling at low areas on the City streets.

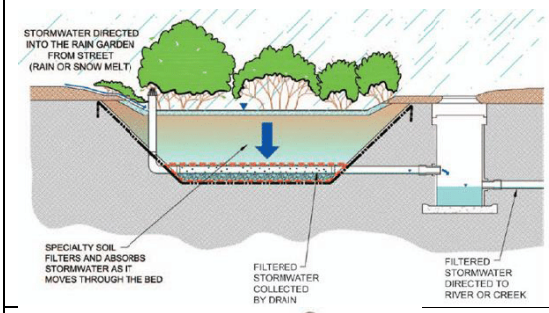
The City of Edmonton prior to the transition to EPCOR had completed a feasibility study of the potential locations that would be suitable for installation of LID across the City. This study looked at all open space including public lands and privately owned residential and commercial/institutional/industrial lands. Through this review over 80,000 potential locations were identified as locations where LID could be installed to control stormwater runoff.

The study also reviewed the 12 types of LID that are being used across North America and assessed each for their ability to support improved water quality and stormwater management, with a primary focus on their ability to function during minor storm events that occur more frequently.

12 LID Types Assessed in City of Edmonton LID Location Study 2017		
1. Bioretention Basins	5. Permeable Pavement	**9. Rain Gardens**
2. Bioswales\ Vegetated Swales	6. Naturalized Drainage Ways	**10. Tree Trenches**
3. Box Planters	7. Rainwater Harvesting for Reuse	11. Conversion of Turf Grass to Native Prairie Grass
4. Green Roofs	8. Rain Barrels	12. Conversion of Pavement to Native Prairie Grass

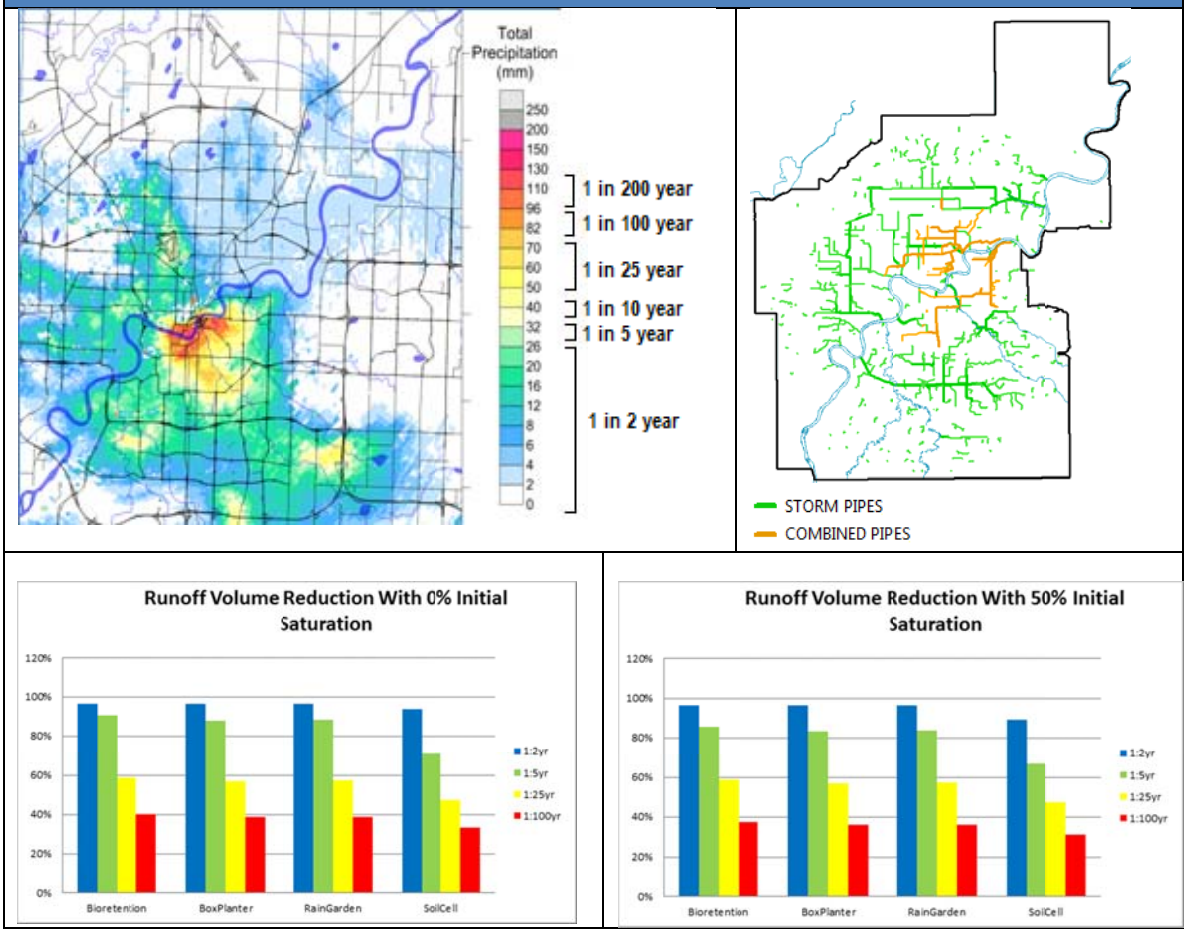
The SIRP team reviewed this previous work and identified that four of the LID types (in bold type above) also have the ability to support the capture, detention and retention of large stormwater events. These types are Rain Garden, Box Planter, Bioretention Basin and Tree Trench (or Tree Soil Cell).

Additional engineering analysis was completed to determine the runoff volume reduction estimated from these types for a range of storm scenarios considering the first storm and a second storm if these assets had not yet drained their excess stormwater volumes.

4 LID Types selected for Stormwater Mitigation of Large Storm events	
	<u>Rain Garden</u> Rain water collects in the depressed area and evaporates or is absorbed into the soil Requires minimum distance from building foundations
	<u>Bioretention Basin</u> Similar to Rain Garden with the addition of an underdrain system connected to the piped stormwater network to transport excess flows Additional underground storage can be installed to increase stormwater retention capacity.
	<u>Box Planter</u> Similar to Bioretention basin but contained within a concrete structure. Ideal for parking lots and where there is tight space between road and building structure.
	<u>Tree Soil Cell</u> Structured components installed around trees and under adjacent sidewalks and parking areas. Provides looser soil to capture higher volumes of water and promotes greater tree health due to larger growth area for roots.

It is also important to provide context on storm cell patterns and how the volume of rainwater that reaches the ground varies across the community during a storm. The figure below shows the variation in water volumes during a 6 hour period over the City of Edmonton during a recent extreme storm event in July 2016. LID is particularly effective in capturing the lower volumes of water on the periphery of the intense storm cell and retaining the water to allow for more capacity in the pipes and ponds in the direct path of the intensive portion of the storm.

Storm Patterns and LID Volume Reduction Assessment

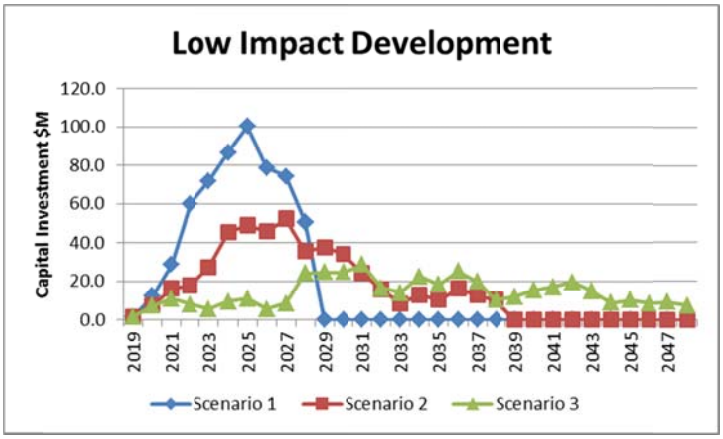


To determine the quantity of LID to be installed within each stormwater sub-basin the SIRP team first reviewed the extent of the localized ponding depths to determine whether a dry pond or piped solution was the best option for the volumes of water being accumulated over the range of different storms. For locations where the ponding was localized, LID, Maintenance

Rehabilitation and Flood Proofing of properties are recommended to reduce the overall capital cost to implement. The Building Great Neighbourhoods Program schedule of neighbourhood renewal was also reviewed to identify opportunities to reduce overall cost to implement through the sharing of sidewalk and road restoration activities.

Capital Investment Scenarios – Low Impact Development $M Estimated Total Investment $420M to $560M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	1.8	12.3	28.7	60.1	72.0	86.7	100.3	87.7	74.2	50.5
Scenario 2	1.8	7.7	16.3	17.8	27.4	45.4	49.1	46.0	52.4	35.7
Scenario 3	1.8	7.5	11.0	8.2	5.8	9.8	11.2	5.8	8.6	24.2
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	37.7	34.0	24.1	15.9	8.6	13.0	10.4	16.2	12.8	10.5
Scenario 3	24.7	24.7	28.8	16.7	14.1	22.4	18.2	25.2	19.8	10.4
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	12.1	15.4	17.0	19.4	15.0	8.9	10.4	8.7	9.4	7.6

EPCOR recommends that the LID be implemented over the 30 year scenario to allow for optimal cost coordination with the Building Great Neighbourhoods construction.



Also included in the proposed capital plan is to have EPCOR develop a full scale LID testing and demonstration site focused on the four selected LID types to provide testing ability to refine the installation performance through alternative soil media and to provide a facility to train individuals on the required maintenance practices, in particular for the types with underdrain systems.

Currently approximately 25 LID pilot facilities have been installed throughout the City to date. These pilot sites have passive monitoring to determine performance, but are not set up to allow simulation of multiple storms or alternative maintenance and repair techniques. This testing facility will assist EPCOR and the City of Edmonton in developing the Design and Construction

Standards for this class of infrastructure to further improve the certainty to developers and builders when selecting this infrastructure during green field or redevelopment of properties.

To be fully successful with the LID implementation the SIRP team recognizes that we also need to broaden our options for installation to encourage the installation of these components on private property. This will require EPCOR to work closely with the City of Edmonton Land Zoning and Lot Grading review teams to ensure this aspect is covered in the development of parcels that are undergoing redevelopment. For parcels that are not undergoing redevelopment, but are interested in supporting EPCOR by providing land space for LID, additional easement or land parcel caveats may be required to ensure the stormwater components remain functional.

EPCOR believes a communal LID approach within the Commercial\Industrial areas and as part of the Building Great Neighbourhoods planning would be successful in Edmonton to allow for more innovative management of stormwater across the City.

EPCOR will also be proposing a future PBR performance measure of a Greened Acre as part of the PBR renewal for Drainage in 2022. This performance measure also used in Philadelphia provides an indication of the success of implementation of LID features in the community.

Credit Valley Conservation Authority in Mississauga, Ontario have been piloting communal LID approaches working with a group of land owners and providing the engineering resource support to develop LID implementations that work for a group of properties and allow for cross lot drainage flows that do not interfere with the operations of the individual parcel owners.

They also provide a wealth of resources to promote LID within their community

https://cvc.ca/low-impact-development/

An increase in LID through the City of Edmonton will also result in improved performance on the total loadings to the river and the combined sewer overflow reduction strategies. LID has also been shown to reduce the impacts of drought and heat wave, two other climate scenarios that Edmonton will be required to adapt to in the coming years.

Low Impact Development Operational Cost Impacts

The LID focus will be supported on the technical side through the Drainage Planning team. One additional engineering resource is recommended to support this increased focus on LID and ensures alignment of these installations to also meet the Total Loadings Strategy obligations to the Province. One additional technical/educational resource is proposed to conduct outreach into the community and support the public engagement components to implement a communal LID approach for the BGN and commercial\industrial areas.

The increase in LID features with underdrains does require the addition of a specialized maintenance crew with flushing equipment suitable for the underdrain configuration. A two person crew with specially outfitted flushing vehicle is proposed. Longer term additional inspection and underdrain clean out may be required as the systems age. It is assumed that these resources are captured in the resources identified to support ditches and swales maintenance described further in this report.

2.3 MOVE - Tunnels, Trunks and Sewer Separation

The previous City Wide Flood Mitigation analysis had proposed significant construction of stormwater tunnels, local pipe upgrades and combined sewer separation ranging in capital costs of $2-$4 Billion over a 60 to 80 year time horizon. The expenditure level variation depended on the chosen design storm to target for mitigation.

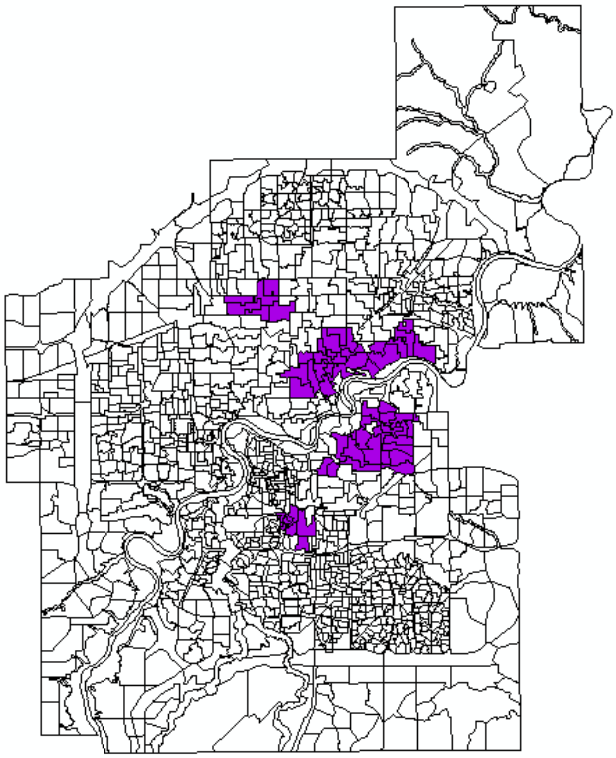
The SIRP proposed investment in tunnels, trunks and sewer separation is considerably less, with an estimate of $300 Million over a 10, 20 or 30 year time frame. The primary difference between the SIRP vs. the previous proposed alternatives is the expansion of the flood mitigation alternatives to include the addition of Low Impact Development, real time operational controls, and Flood Proofing of high risk property locations to reduce the risk of internal building flooding.

The proposed capital investment in tunnels, trunks and sewer separation was developed by first assessing the flood mitigation that would be obtained by investing in dry ponds and Low Impact Development as an initial option in the communities at higher risk of flooding. Depending on the volumes of water to be managed over the range of storm scenarios and volumes of water that could be diverted to either a dry pond or LID in the neighbourhood, this determined the residual amount of water that needed to be managed using a piped network solution of tunnels, trunks and sewer separation. The previous analysis completed through the City Wide Flood Mitigation work completed by Drainage was then referenced to determine the pipe network required to manage the remaining water volumes in these locations.

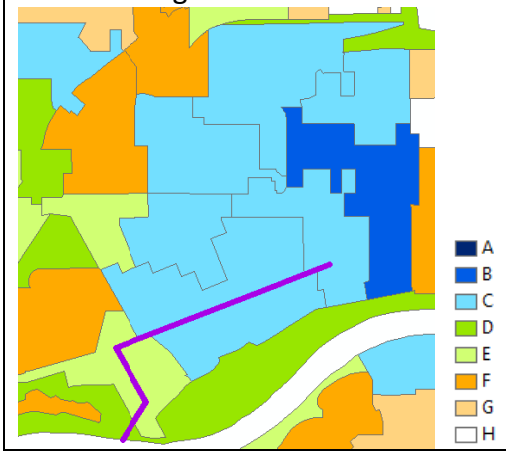
> The SIRP approach aligns with the direction taken by leading utilities around the world to incorporate green infrastructure into their flood mitigation efforts. Two examples are Philadelphia' Green City, Clean Waters Plan and Copenhagen's Cloud Burst Strategy.
>
> http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan
>
> https://www.citylab.com/design/2016/01/copenhagen-parks-ponds-climate-change-community-engagement/426618/

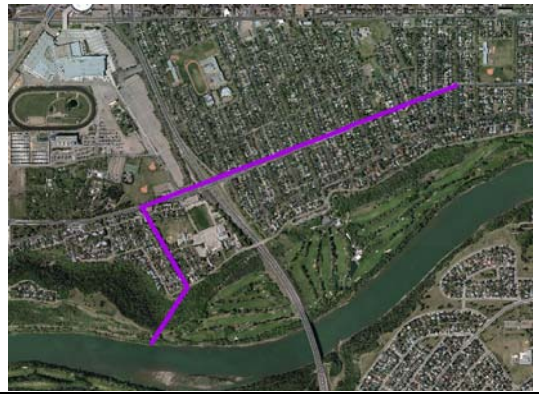
The map below shows the sub-basins where investments in tunnels, trunks and sewer separation are recommended in addition to the ponds and LID which will also be implemented where feasible to mitigate peak flows.

Stormwater Sub-basins with flood risk mitigation through Tunnels, Trunks and Sewer Separation



Potential alignment of new Storm Tunnel to reduce high risk Sub-basins north of River

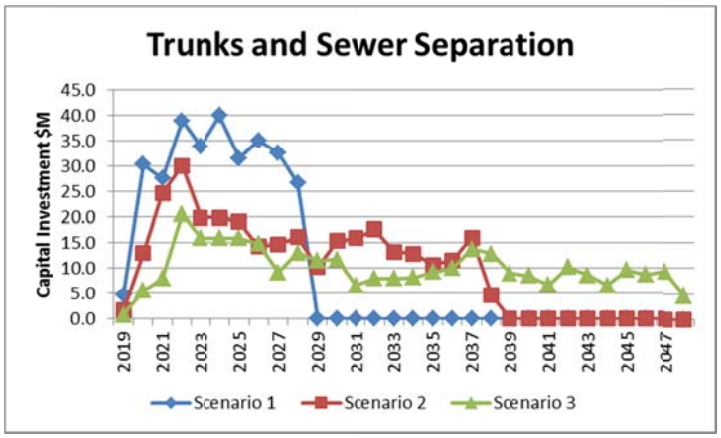




Three timing scenarios for these investments are proposed below. EPCOR recommends that the investment scenario matches the one chosen for the implementation of the proposed dry ponds, as some of the proposed pipes will need to be constructed to interact with the dry pond proposed in the stormwater sub-basin.

The earliest start for the proposed tunnel investments is 2022 due to timing to obtain the necessary approvals for environmental construction of a new or enhanced outfall to the river and due to resources being committed to other tunnel relocation projects supporting the expansion of the Valley Line West LRT to west Edmonton.

Capital Investment Scenarios – Tunnels, Trunks and Sewer Separation $M Estimated Total Investment $300M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	4.7	30.4	27.6	39.0	33.9	40.0	31.6	35.1	32.6	26.7
Scenario 2	1.7	12.9	24.7	30.1	19.9	19.9	19.1	14.3	14.7	16.1
Scenario 3	0.8	5.6	8	20.7	15.9	15.9	15.9	14.8	9.2	13.0
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	10.2	15.3	15.9	17.6	13.3	12.9	10.7	11.6	16.0	4.7
Scenario 3	11.5	11.8	6.6	8.0	8.0	8.2	9.3	10.0	13.8	12.8
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	9.0	8.5	6.7	10.2	8.6	6.6	9.7	8.7	9.3	4.7



There is a low probability that these costs could increase depending on whether the dry pond or LID components for the proposed location are not able to be constructed due to unforeseen conflicts with the land utilization and community needs. This will be confirmed during the detailed design phase for these flood mitigation components and updated to Utility Committee during the regular PBR capital budget updates.

Tunnels, Trunks, Sewer Separation Operational Cost Impacts

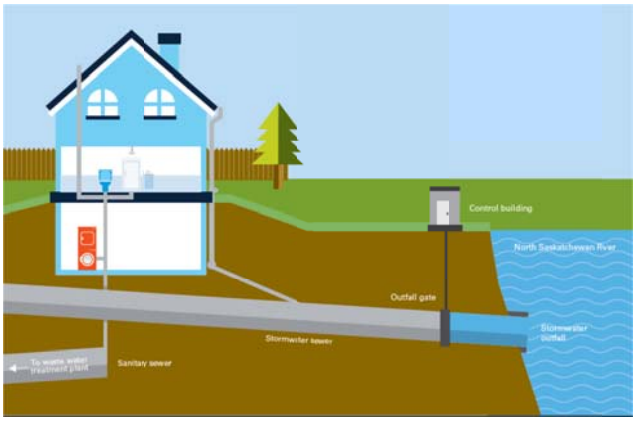
The operational cost impacts of the proposed tunnels, trunks and sewer separation will be absorbed through operational efficiencies within the Drainage Construction and Drainage Planning and Engineering groups.

2.4 SECURE - Outfalls and Control Gates

EPCOR is recommending through the SIRP risk review that additional control gates be added to the existing outfalls located within the river valley to provide additional protection to the residential homes located within these areas from river water backing up through the pipe network.

EPCOR is also recommending the conversion of the existing gates to automatic controls vs. manual operation and to install the automatic controls on all new gates installed. This is to improve the overall response time to close the gates prior to a flooding event and to open them once the river levels have receded to allow the storm network to return to normal operation.

River Valley and Creek Outfall – Control Gates Proposed locations

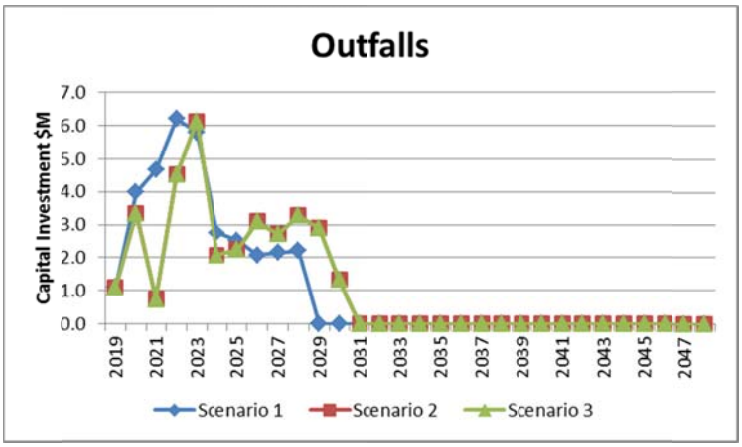


Dry ponds, costs captured in the previous section, are also recommended in the river valley neighbourhoods of Rossdale and Cloverdale to capture stormwater when the outfall gates are closed and there is an urban rainfall event occurring concurrently with high river water levels.

EPCOR is recommending that the proposed outfall control gates be installed over the next 12 years due to the higher damage risk exposure for these river valley neighbourhoods. Exact timing for installation will be dependent on obtaining the necessary regulatory approvals for construction and completion of the archaeological assessments and indigenous consultations required when constructing within the River Valley.

Capital Investment Scenarios – Outfalls and Control Gates $M Estimated Total Investment $30M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	1.1	4.0	4.7	6.2	5.8	2.8	2.5	2.1	2.2	2.2
Scenario 2	1.1	3.4	0.8	4.5	6.1	2.1	2.2	3.1	2.7	3.3
Scenario 3	1.1	3.4	0.8	4.5	6.1	2.1	2.2	3.1	2.7	3.3
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	2.9	1.3	-	-	-	-	-	-	-	-
Scenario 3	2.9	1.3	-	-	-	-	-	-	-	-
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	-	-	-	-	-	-	-	-	-	-
Grants and Contributions										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
DMAF	-	0.8	1.2	1.2	0.9	-	-	-	-	-

The installation of these additional outfall control gates was included in the grant applications to the Federal DMAF programs. $4.15 Million of grant funding was announced recently and is included in the above forecast of capital investments required.



Additional capital works to harden the infrastructure are also recommended at the Rossdale and E.L. Smith Water Treatment Plants for protection from flooding; these costs are captured in the capital program for EPCOR Water and have been included in the Federal and Provincial grant programs for partial funding.

Outfalls and Control Gates Operational Cost Impacts

The additional gates with automatic controls will require additional on-going maintenance activities for debris management and preventative maintenance on the control motors and electrical equipment. The recommendation is to add three individuals to the Drainage maintenance team. These individuals will also be responsible for the maintenance of the inlets\outlets of the additional dry ponds and for the maintenance of the additional monitors and control elements proposed for the existing wet ponds.

2.5 SECURE - Maintenance Rehabilitation and Inflow/Infiltration Reduction

The SIRP approach includes as one of the flood mitigation strategies the implementation of increased maintenance and repair priorities on assets that are at higher risk of exposure to flooding. Due to the topography of the urban environment there exists numerous low or sag locations along the road network. The catch basins installed along the road network regulate the flow into the piped network to reduce the risk of pipes surcharging. Flood waters can also enter the piped network either through openings in manhole lids or through cracks in the manhole frames and in the pipe network when the soils are fully saturated.

Through our analysis it was identified that there is a high correlation between instances of basement flooding due to sanitary and combined sewer system surcharging and the locations of these low points in the road network. See Appendix B of this report. Based on this finding EPCOR has already adjusted the current maintenance rehabilitation capital program ($175,000 for 50 manholes) to place a priority on the installation of alternative manhole covers that limit flow from standing water and on flood proofing the manhole chamber walls in these localized sag areas.

As part of the SIRP we propose to accelerate this program to $2 million per year / 500 manholes per year to seal the manhole barrels and install the new manhole covers in the local sag areas across the City. In addition to the manhole sealing, this cost also allows for additional pipe rehabilitation to reduce infiltration on pipes within the ponding areas. Minor leaks on these pipes can induce a high volume of infiltration into the pipe network when the soils on top are fully saturated with water.

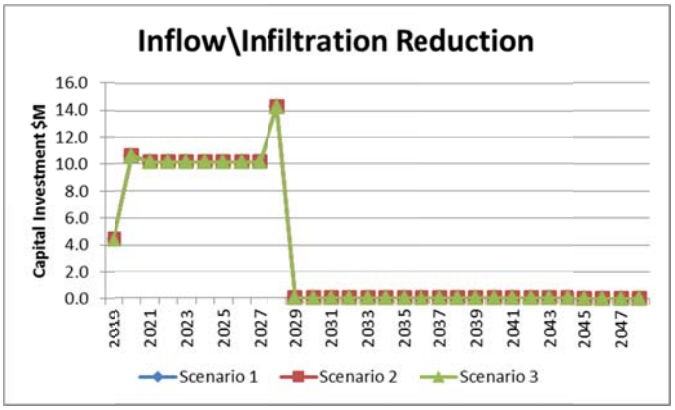
The proposal includes an additional field crew and the costs include the purchase of a fleet vehicle and equipment to support the work crew.

This program will also be coordinated with the enhanced Flood Proofing program focused on the properties adjacent to these locations described in a subsequent section of this report.

The longer term approach to manage and reduce the stormwater pooling in these locations is addressed in the capital investments in dry ponds, tunnels and sewer separation and LID elements being proposed. The manhole sealing is a method to bring partial risk reduction over a shorter time frame.

Capital Investment Scenarios – Enhanced Rehabilitation and Inflow\Infiltration Reduction $M Estimated Total Investment $100M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	4.4	10.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1	14.3
Scenario 2	4.4	10.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1	14.3
Scenario 3	4.4	10.6	10.1	10.1	10.1	10.1	10.1	10.1	10.1	14.3
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	-	-	-	-	-	-	-	-	-	-
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	-	-	-	-	-	-	-	-	-	-

EPCOR recommends that under all three scenarios that the inflow/ infiltration capital work be completed within the next 10 years.



Maintenance and I\I reduction Operational Cost Impacts

Through the development of the SIRP and the review of overland flood paths it was determined that the City of Edmonton currently does not have a preventative maintenance program to maintain the drainage functionality of the ditches, swales and culverts. Majority of ditches, swales and culverts are located in the areas currently not serviced through a traditional piped sewer network. Reactive repairs to these locations are currently coordinated between Drainage Operations and City of Edmonton Roadways Operations in response to customer complaints and/ or identification of surface flooding by City or Drainage crews moving throughout the City.

The increased storm intensities expected in the coming years necessitates that a preventative maintenance program be put in place to maintain the functionality of these facilities.

To address this concern the SIRP project has included additional operational resources to manage ditches, swales and culverts.

An additional 4 seasonal positions are proposed to manage the increased maintenance activities proposed to the ditches, swales and culverts. These operational cost increases are proposed to start in 2020, and will be primarily spring\summer term positions. The additional resources to support the manhole sealing and inflow \infiltration reduction programs cost are covered partially by having these resources charge to the capital projects and through operational efficiencies in crew deployment.

2.6 SECURE - Enhanced Building Flood Proofing

EPCOR currently offers a residential flood proofing inspection program and backwater valve subsidy to qualifying homes. This program has been in place since 2004, is open to all residents within Edmonton, and is delivered on a first come first serve scheduling approach. All new homes built since 1989 have backwater valves installed as part of the building design standard.

The SIRP analysis of the localized sag areas with higher flooding risk has identified that there are approximately 6000 properties (including 2500 in the river valley neighbourhoods) that have a higher flooding risk due to being adjacent to areas where the water in the road could pool at depths above the 1 meter depth during an extreme storm event. There are an additional 40,000 properties with a mid-high exposure risk where ponding in the road network could be between 0.35 and 1 meter depth during these extreme events.

The dry ponds, LID and tunnels, trunks and sewer separation projects proposed will reduce the flooding depths at these locations; however it will take multiple years to install these flood mitigation components. Even with the proposed mitigation efforts these homes will continue to have exposure from storms due to the topography of the land adjacent to these homes. For this reason EPCOR recommends that we provide capital and operational funding to support and encourage flood proofing on private property as the least cost approach to reduce flooding risks in the short term for these high risk locations.

EPCOR is proposing to introduce an Enhanced Building Flood Proofing Program as part of the SIRP initiative. This program would be available to residential, multifamily and commercial properties in the higher risk locations and would include additional funding and supporting expertise beyond the existing residential backwater subsidy program to assist property owners in identifying flooding risk on their property.

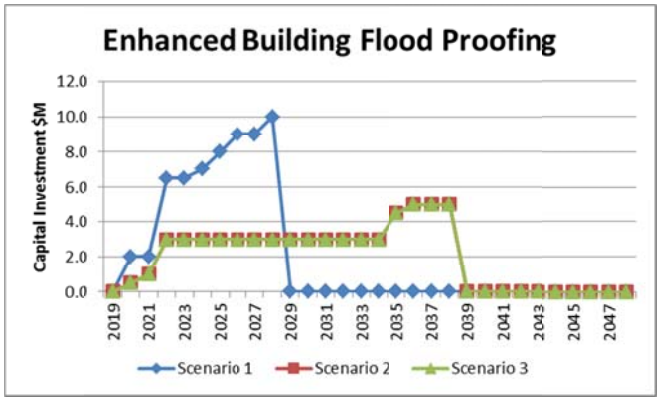
EPCOR is recommending that $60 million of capital funding be allocated to support correction of lot grading on public-owned portion of the parcel and repairs to public-owned portion of the service line pipes adjacent to these higher risk properties when constructed in conjunction with the property owner implementing these improvements on their private property. Currently EPCOR will repair a service line on the public side on a reactive basis due to a service line failure event and has an existing capital program to address minor sag locations on the public road ways that are causing drainage issues. Initial outreach will focus on the hospitals, essential services, and social agencies as was supported by the public opinion survey work completed last August, following these groups the remaining properties will be supported through

individual outreach to discuss the flooding risks particular to their location and what mitigation measures would work best for the configuration of their property and building structures.

The initial capital budget for this program has been estimated at $10,000 per property for the highest risk locations (6000 properties), with EPCOR's investment being limited to public-property side changes that have the benefit of reducing the flood risk to private property, and which would complement work done by the private property owner. The specific infrastructure to be installed will be determined through direct interaction with the individual property owner to determine the improvements required on both publically owned lands (EPCOR-funded) and on private lands (privately funded) at the parcel level.

Capital Investment Scenarios – Enhanced Building Flood Proofing $M Estimated Total Investment $60M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	-	2.0	2.0	6.5	6.5	7.0	8.0	9.0	9.0	10.0
Scenario 2	-	0.5	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Scenario 3	-	0.5	1.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	3.0	3.0	3.0	3.0	3.0	3.0	4.5	5.0	5.0	5.0
Scenario 3	3.0	3.0	3.0	3.0	3.0	3.0	4.5	5.0	5.0	5.0
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	-	-	-	-	-	-	-	-	-	-

Due to the high impact of risk mitigation that this program would provide to the community EPCOR is recommending that this program be completed within the next 20 years across the community.



Enhanced Building Flood Proofing Operational Cost Impacts

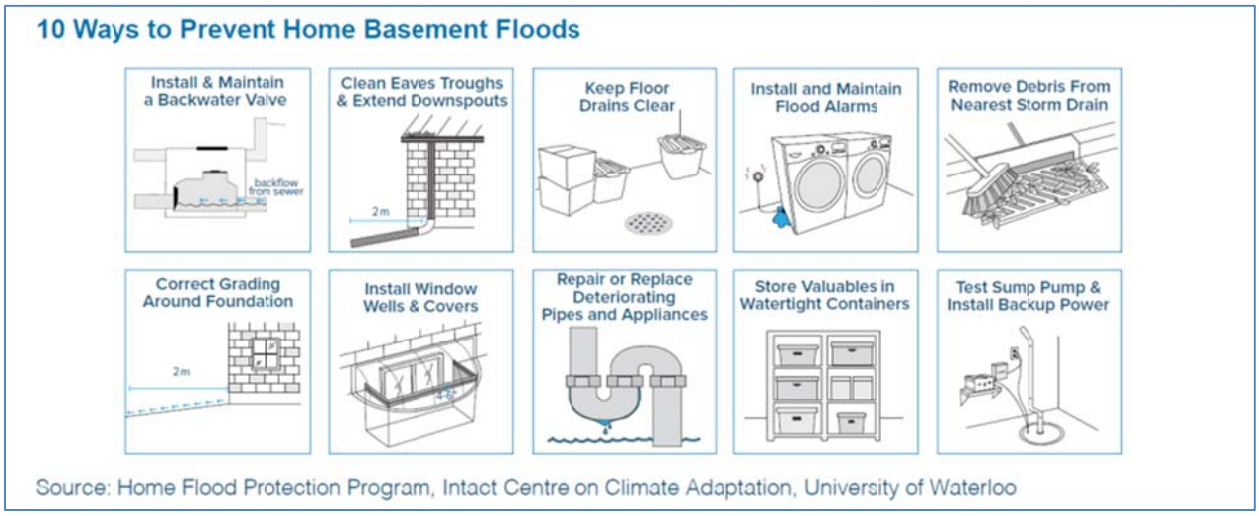
An additional $32 million of operating budget over the next 10 years is recommended to increase the backwater valve subsidy program. A 30 or 20 year scenario is not recommended due to the higher benefits and relatively lower cost of this program.

This budget has been estimated base on the current subsidy level of $800 per property targeting the 40,000 mid high risk properties identified in the SIRP review. Four additional manpower resources are recommended to support this Enhanced Flood Proofing Program over the duration that the program will run. This would include one team lead and three technologists to assess the flooding risks and coordinate the installation of the additional flood mitigation components on the properties.

These additional resources will have expertise in residential, multifamily and commercial building flood proofing techniques. It is also proposed to have these individuals work a schedule that provides support to property owners on evenings and weekends and to schedule appointments based on neighbourhoods for particular days to reduce the amount of driving between appointments to support operational efficiencies. Since adjacent neighbours will be facing similar flooding risks this will enhance the overall community awareness of risks within their area prior to the additional capital investments in their community to reduce flooding risks.

These resources are in addition to the three existing residential flood proofing technologists that support the current backwater valve subsidy program available to all residential home owners in Edmonton. The current program is funded at $500K per year including the staff resources and backwater valve subsidies distributed each year.

This approach aligns with the recommendations expected from the Intact Center on Climate Change Adaptation for flood proofing of residential properties based on the pilot programs conducted in Ontario and Saskatchewan. The results of this program have already been incorporated into the Province of Ontario's Climate Change Adaptation plan and have been summarized into 10 components that should be considered when flood proofing a property.



The Intact Center for Climate Change Adaption has rolled out a national program for home inspector training for flood mitigation in early 2019. EPCOR will ensure our inspectors attend this training.

Indications from the insurance industry are that homeowners that can demonstrate they have incorporated these best practices to flood proof their properties may be eligible for additional reductions on their home insurance policy.

2.7 PREDICT - Monitoring and Controls

The SIRP strategy includes the conversion of the existing stormwater pipe and pond network into a smart network with increase situational awareness of real time storm tracking and ability to respond to major storm events through the diversion of stormwater where the controls exist.

EPCOR's review of the current controls and monitoring of the Edmonton stormwater network have confirmed that the systems in place in Edmonton are consistent with most communities across North America that take a traditional grey infrastructure approach to managing stormwater volumes. As sensor and control technologies have improved and costs to implement have reduced, leading utilities are now implementing systems that allow the stormwater network to respond in real time to changing weather events.

The previous capital plan developed by the City had included an initial step in the direction of developing a smart storm network with the recommendation to include Early Warning systems for the underpasses located throughout the City. EPCOR has been working with the Roadways Operations team to pilot two types of warning systems over the last two years on the Whitemud Freeway and Yellowhead Trail. The capital plan for SIRP includes the installation of permanent early warning systems at 20 locations identified as being at higher risk of flooding with depths where there is a higher risk to public safety. EPCOR will continue to work with Roadways Operations to finalize the designs and timing for installation for each of these locations.

EPCOR has initiated as part of the 2020 Capital budget to acquire and install a SIRP Dashboard, example of image seen to the right. This dashboard will integrate the current multiple monitoring and control systems in place with the GIS tools used within the Utility. This tool will also be set up to incorporate the addition of real time data from third party sensors, such as weather radar stations.

Once the dashboard is installed EPCOR will be positioned to systematically add the additional sensors throughout the network to increase ability to respond to flooding events in real time. The

initial focus will be on adding the required sensors and automatic controls to the existing ponds and underground storage locations throughout the City.

Priority Locations Smart Stormwater Monitoring installation			
Location	**Total Number of locations**	**Current Locations With Sensors\ Monitors**	**Locations to Add Monitors**
Underpasses	49	4 (Pilot Sites)	20
Wet Ponds\ Wetlands	207	65	142
Dry Ponds	35	9	26
Pump Stations and Real Time Control Gates	20	20	2 (New Subdivision)
Pipe and Underground Storage Network	Target is 1 per 7 Km	63	440
Total		**161**	**630**

Additional investments will occur over the next 20 years. The budget assumption for these additional investments has been based on the density of sensors of one per 7 kilometers of pipe, consistent with other communities such as Seattle that are implementing this approach. The 20 year implementation schedule is proposed due to the changing technology environment that is currently being experienced in the realm of sensors to allow us to evolve with the technology in an incremental manner.

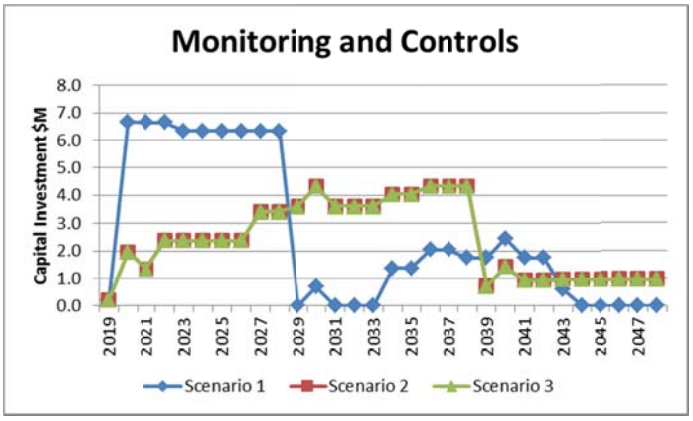
This will also provide the opportunity for Drainage Operations to optimize the placement of these sensors and control elements as EPCOR gains a better understanding of the real time flow patterns in each of the major stormwater basin in the City.

EPCOR will also be exploring the potential for the addition of sensors and flow control elements installed on private property to manage the flows of water from these properties impacting the public road and storm pipe network. Examples of this approach have been installed in other communities with smart rain barrels or smart roofs to have the utility control the discharge of water from the private to the public system. Additional review is required to assess the changes required to bylaws or property specific easements or caveats prior to pursuing a full scale implementation of this type of strategy. EPCOR will be working closely with the City of Edmonton Land Zoning and Lot Grading groups over the next year to develop recommendations

on what City planning instruments would be required to support this approach and how this would be implemented. These will be presented to City Council and/or the appropriate Council Committee - Urban Planning or Utility Committee depending on the nature of the recommendation and who has authority to enforce.

Capital Investment Scenarios – SCADA, Monitoring and Warning Systems $M Estimated Total Investment $50M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	0.2	6.7	6.6	6.6	6.3	6.3	6.3	6.3	6.3	6.3
Scenario 2	0.2	2.0	1.3	2.4	2.4	2.4	2.4	2.4	3.4	3.4
Scenario 3	0.2	2.0	1.3	2.4	2.4	2.4	2.4	2.4	3.4	3.4
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	0.7	-	-	-	1.4	1.4	2.0	2.0	1.7
Scenario 2	3.6	4.3	3.6	3.6	3.6	4.2	4.2	4.3	4.3	4.3
Scenario 3	3.6	4.3	3.6	3.6	3.6	4.2	4.2	4.3	4.3	4.3
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	1.7	2.4	1.7	1.7	0.6	-	-	-	-	-
Scenario 2	0.7	1.4	0.7	0.7	1.0	1.0	1.0	1.0	1.0	1.0
Scenario 3	0.7	1.4	0.7	0.7	1.0	1.0	1.0	1.0	1.0	1.0

The costs also include life cycle replacement of the sensors assuming a 15 year replacement cycle.



Monitoring and Controls Operational Cost Impacts

Transitioning to a smart stormwater network will require the addition of resources that are currently not part of the Drainage Operations team. It is proposed that three additional resources be hired to support this transition, one engineering position to lead the development of the overall real time operational strategy and selection of locations to install the sensors, and two field technologists to support the selection, installation and maintenance of the additional sensors and controls.

2.8 RESPOND - Emergency Response Equipment

EPCOR has reviewed the emergency response approaches for urban and river valley major flooding events. EPCOR and the City of Edmonton Emergency Management group have in place formalized protocols for response and support of each other during these types of events. The Office of Emergency Management takes the lead role in the response with EPCOR resources providing support through the deployment of sand bags and personnel during an event.

Within the river valley in addition to the residential developments of Rossdale, Cloverdale and Riverdale where EPCOR is recommending additional outfall control gates to protect the community, there are also parks and community assets that are exposed to high river water level flooding.

The current emergency protocols developed in 2009 and updated annually by some of the groups with assets within the river valley rely predominantly on the deployment of sandbags and supporting resources from both the City and EPCOR Drainage as river valley water levels increase. Through our review we believe the site-specific response plans should also be assessed from an overall perspective for the ability to respond to an event occurring concurrently at multiple locations at the same time.

In consultation with the Office of Emergency Management and with the City of Edmonton Climate Change Adaptation and Resiliency project team, EPCOR is recommending that additional investments be made to modernize the response to flooding events within the river valley and other locations with risk of higher depth of water flooding requiring temporary barriers to control water volumes.

Drainage Utility currently maintains a stock pile of sandbags acquired in the early 2000's at one of their field operation yard locations. Many communities have recognized that there are other methods to rapidly build portable flood defense barriers including systems as shown in the chart below. EPCOR will work with the Office of Emergency Management to determine the system(s) that is best suited for the locations chosen for the emergency staging locations. Sandbags are expected to still be part of the flood response solution, but rather than storing filled sandbags in the open air, it is proposed that an automated sandbag filling machine be acquired and that the bags alone be stored in a weather-resistant location.

Examples of Portable Flood Barriers

Water-gate barrier

NAOQ – Boxwall Flood Protection

Floodstop Barrier

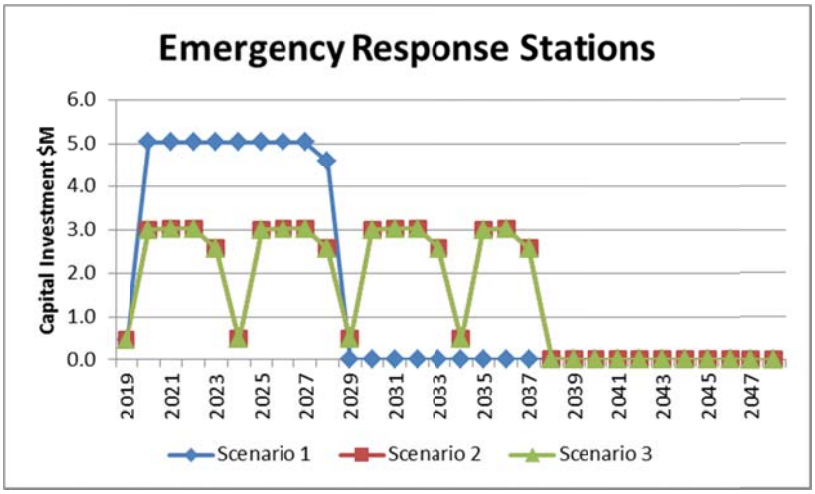
Geo-line Water-Filled Flood Barrier

EPCOR is also proposing to work with the Office of Emergency Management to develop up to 15 emergency response staging locations at a total estimated capital cost of $45 Million located throughout the City. These staging locations would consist of a building structure on City owned land and be equipped with portable flood barriers, pumps and hoses that could be deployed efficiently in the event of a river flooding risk. EPCOR would provide the funding to have these installed at the locations selected by the City.

The SIRP approach broadens the role of the traditional stormwater utility from one that focuses primarily on the installation of pipes to move stormwater, to one where the utility is an active participant in the response to the flooding event and proactively develops emergency response

protocols in advance of the flooding events to support the Office of Emergency Management who leads the response efforts.

Capital Investment Scenarios – Emergency Response Support Equipment $M Estimated Total Investment $50M										
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Scenario 1	0.5	5.0	5.0	5.05.0	5.0	5.0	5.0	5.0	5.0	4.6
Scenario 2	0.5	3.0	3.0	3.0	2.6	0.5	3.0	3.0	3.0	2.6
Scenario 3	0.5	3.0	3.0	3.0	2.6	0.5	3.0	3.0	3.0	2.6
	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	0.5	3.0	3.0	3.0	2.6	0.5	3.0	3.0	2.6	-
Scenario 3	0.5	3.0	3.0	3.0	2.6	0.5	3.0	3.0	2.6	-
	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Scenario 1	-	-	-	-	-	-	-	-	-	-
Scenario 2	-	-	-	-	-	-	-	-	-	-
Scenario 3	-	-	-	-	-	-	-	-	-	-



EPCOR recommends that the 15 locations be identified and flood response equipment be installed and within the next 20 years.

Emergency Response Operational Cost Impacts

EPCOR is proposing that an additional full time resource be added to work directly with the Office of Emergency Management in the development of these emergency response locations and updating and exercising of the Emergency Response Plans for the community. This individual will also assist in general community education to support flood risk mitigation awareness throughout the community.

Part 3 – Financial Impacts

3.1 Capital Investment Scenarios

The following tables summarize the proposed Capital investments in 2019 dollars considering the three options for the timing of construction for the SIRP recommended improvements. All three scenarios consider the impact over a thirty year investment cycle.

Scenario 1 – targets the completion of the majority of the Capital within 10 years

Scenario 2 – targets the completion of the majority of the Capital within 20 years

Scenario 3 – Is similar to Scenario 2, but spreads the investments in pipes, ponds and LID over the 30 year period. The investments in the remaining categories are completed within 20 years.

All three capital scenarios for the SIRP require the increased operational expenses summarized in the subsequent section of this report. Scenario 1 has the highest investment cost due to the loss of opportunity to coordinate the installation of LID components with the Building Great Neighbourhoods and other City initiatives. Scenario 3 is comparable to current levels of capital investments in Flood Mitigation with the focus shifting to include a different mix of asset types.

Scenario 1 – 10 Year Investment Focus - $M					
	2019-2021	**2022-2028**	**2029-2038**	**2039-2048**	**Total**
SLOW - Dry Ponds	67.2	403.6			470.8
SLOW - LID	42.9	522.5			565.4
MOVE - Trunks and Sewer Separation	62.7	238.8			301.5
SECURE -Outfalls and Control Gates	9.7	23.7			33.5
SECURE - Inflow\Infiltration Rehabilitation	25.5	75.1			100.3
SECURE -Building Flood Proofing	4	56.0			60
PREDICT - Monitoring and Controls	13.5	44.7	9.3	8.3	75.8
RESPOND -Emergency Response Stations	10.5	34.8			45.3
Total	235.7	1399.2	9.3	8.3	1652.5

Scenario 2 – 20 Year Investment Focus - $M					
	2019-2021	**2022-2028**	**2029-2038**	**2039-2048**	**Total**
SLOW - Dry Ponds	54.6	194.7	221.5		470.8
SLOW - LID	25.8	273.8	183.2		482.8
MOVE - Trunks and Sewer Separation	39.3	134.1	128.2		301.5
SECURE -Outfalls and Control Gates	5.2	24.1	4.2		33.5
SECURE - Inflow\Infiltration Rehabilitation	25.2	75.1			100.3
SECURE -Building Flood Proofing	1.5	21.0	37.5		60
PREDICT - Monitoring and Controls	3.5	18.6	39.8	9.7	71.7
RESPOND -Emergency Response Stations	6.5	17.7	21.2		45.3
Total	161.6	759.0	635.5	9.7	1565.8

Scenario 3 – 30 Year Investment Focus - $M					
	2019-2021	**2022-2028**	**2029-2038**	**2039-2048**	**Total**
SLOW - Dry Ponds	51.5	76.1	167.3	175.9	450.7
SLOW - LID	20.4	73.4	205.0	123.7	422.5
MOVE - Trunks and Sewer Separation	14.4	105.4	99.9	81.8	301.5
SECURE -Outfalls and Control Gates	5.2	24.1	4.2		33.5
SECURE - Inflow\Infiltration Rehabilitation	25.2	75.1			100.3
SECURE -Building Flood Proofing	1.5	21.0	37.5		60
PREDICT - Monitoring and Controls	3.5	18.6	39.8	9.7	71.7
RESPOND -Emergency Response Stations	6.5	17.7	21.2		45.3
Total	128.1	411.4	574.8	391.1	1505.4

EPCOR is recommending that Utility Committee support the Scenario 2 – 20 year proposal, this scenario averages at approximately $77.8M per year. All three of the scenarios above have

incorporated the recently announced grant funding from the Provincial ACRP ($5.255 M) and Federal DMAF ($53.8M) grants to support the construction of dry ponds and the upgrades to outfalls. A portion of these grants are designated to support the hardening of the flood defenses at the Water treatment plants. This grant funding has been removed from the above analysis and will be reported in future updates from EPCOR Water.

Should Utility Committee wish to adjust to a longer time frame to implement to reduce rate impacts to the customers, EPCOR would recommend extending the timelines for the SLOW - LID installations to limit these to installation being completed only in conjunction with Building Great Neighbourhoods or aligned with adjacent road or drainage utility rehabilitation construction. The other components of the plan are recommended to remain within the 20 year scenario as described in this report.

For reference, the following table summarizes the proposed stormwater capital investments related to Flood mitigation in the previous City 10 year budget 2015-2026. This budget was the basis for the EPCOR Drainage Services Bylaw (18100) determining the stormwater rate and overall capital budget plan for the Utility for the initial PBR 2018-2021.

Current Capital Plan
Capital Investment Scenarios – City of Edmonton 2015-2026 Capital Plan
Flood Mitigation Projects

	Current PBR 2018-2021 – Total - $316.4M				Future PBR – Total - $249.4				
	2018	2019	2020	2021	2022	2023	2024	2025	2026
Flood Mitigation	17.6	38.8	40.8	50.8	53.6	42.2	42.5	52.4	54.0
Tweddle Place Dry Pond	7.5	12.9	9.1	-	-	-	-	-	-
Ekota Dry Pond	1.4	-	-	-	-	-	-	-	-
Tawa Dry Pond	10.0	-	-	-	-	-	-	-	-
Malcolm Tweddle Dry Pond	8.8	22.2	17.5	9.8	2.7	2.0	-	-	-
Totals	45.4	74.0	67.5	60.6	56.3	44.2	42.5	52.4	54.0

Average expenditure forecast in the previous 9 year City plan for 2018 to 2026 was $55.2M per year for Flood Mitigation projects.

Appendix A has a summary of the previous City Wide Flood Mitigation investment scenarios as additional alternatives to the SIRP approach. This work will continue to be referenced to support design alternatives in each location in the City should there be limitations identified through the Open Spaces process in the ability to install dry ponds or LID in a specific location.

3.2 Operational Cost Impacts Summary

The integrated resource planning approach utilized in SIRP methodology allows for a reduced overall capital expense within the community as compared to the previous alternatives developed through the City Wide Flood Mitigation analysis. However, for success, this approach also requires an increase in the operational expenses within the Utility. These additional manpower resources are necessary to support the increased focus on maintenance, installation of green infrastructure, increased focus on flood-proofing of at-risk properties throughout the City, increased customer interactions, and the implementation of flood mitigation solutions that require broader community engagement vs. the traditional grey infrastructure approaches.

EPCOR is recommending the addition of 18 staff positions starting in 2020 to support the implementation of the SIRP. These positions include:

- Four management/engineering positions to support the conceptual design and community engagement requirements for Dry ponds, LID, Monitoring and Controls and Enhanced Building Flood Proofing initiatives.
- Six technologists to support LID, Monitoring and Controls, Emergency Response and Enhanced Building Flood Proofing program (3 individuals)
- Four field labour positions to support the operations of overland drainage including LID and ditches and swales maintenance
- Four specialized field operators to support the mechanical, electrical and controls maintenance for the new outfall gates and additional monitoring and controls proposed throughout the City.

The annual operating cost impact for these positions is $2.2M per year with the first full year for these positions starting in 2020. Upon approval of the NRA in 2019, EPCOR will post these positions and start the hiring process to ensure the resources are in place for 2020.

EPCOR also recommends that the backwater valve subsidy program increase to $32 Million over the next 10 years to support the targeted installation of an additional 40,000 backwater valves for homes immediately adjacent to localized sag areas where stormwater will continue to pool due to the topography of the City. The resources for this program are covered in the additional four positions proposed for the Enhanced Building Flood Proofing Program (1 manager, three field technologists).

3.3 Revenue Requirements and Stormwater Rate Impacts

Revenue Requirement

The total incremental revenue requirements resulting for the 10, 20 and 30 year scenarios are provided in the following Tables. These tables have been limited for illustrative purposes to the revenue requirements for the remainder of the current PBR term (2019-2021) and the next term (2022-2026) (periods beyond that timeframe are illustrated below).

The revenue requirement is comprised of both operating costs resulting from the additional staff required by the SIRP program and the Enhanced Home Flood Proofing Subsidy program as well as costs related to the planned capital projects. The revenue requirements have also been reduced by the amount of the current Flood Mitigation activities that are already within customer rates in order to eliminate double counting.

Specifically, during the transition of Drainage to EPCOR, it was determined that the City's 9 Year Capital Forecast contained an average annual capital expenditure of $55.2 million (2018-2026) directed to Flood Mitigation. It was agreed that any future Flood Mitigation program revenue requirement and associated rate increase would be determined on an incremental basis to that level of spending. In order to incorporate the spending on a comparable basis, the existing flood mitigation activities have been modelled on a revenue requirement basis determined by the timing for the asset to be placed in to service and those amounts are deducted from the overall SIRP revenue requirement. The revenue requirement has also been reduced by the recently announced grants awarded for flood mitigation.

Scenario #1 – 10 Year Investment Focus - Revenue Requirement

Revenue Requirement - $ Millions Scenario 1 - 10 Year	2019	2020	2021	2022	2023	2024	2025	2026
Operating and Maintennce								
Staffing	1.1	1.1	2.3	2.3	2.4	2.4	2.5	2.5
Home Flood Proofing Subsidy	0.8	1.2	1.7	3.8	3.9	4.0	4.1	5.1
Sub-total - Operating and Maintenance	1.9	2.3	4.0	6.2	6.3	6.4	6.6	7.6
Depreciation	0.1	1.0	2.7	5.4	8.6	12.7	17.2	21.4
Amortization of contributions	0.0	(0.0)	(0.2)	(0.3)	(0.4)	(0.6)	(0.7)	(0.8)
Return on rate base financed by debt	0.1	0.8	3.1	6.4	10.4	15.9	21.9	26.9
Return on rate base financed by equity	0.2	1.7	4.7	9.6	15.6	23.9	32.9	40.5
Scenario 1 Revenue Requirements	2.2	5.8	14.3	27.2	40.4	58.3	77.8	95.7
Less: Existing Neighborhood Flood Mitigatic	(1.4)	(3.6)	(6.1)	(10.1)	(13.0)	(16.2)	(19.3)	(22.6)
Total Incremental Revenue Requirement	0.8	2.2	8.3	17.2	27.4	42.1	58.6	73.0

Scenario #2 – 20 Year Investment Focus - Revenue Requirement

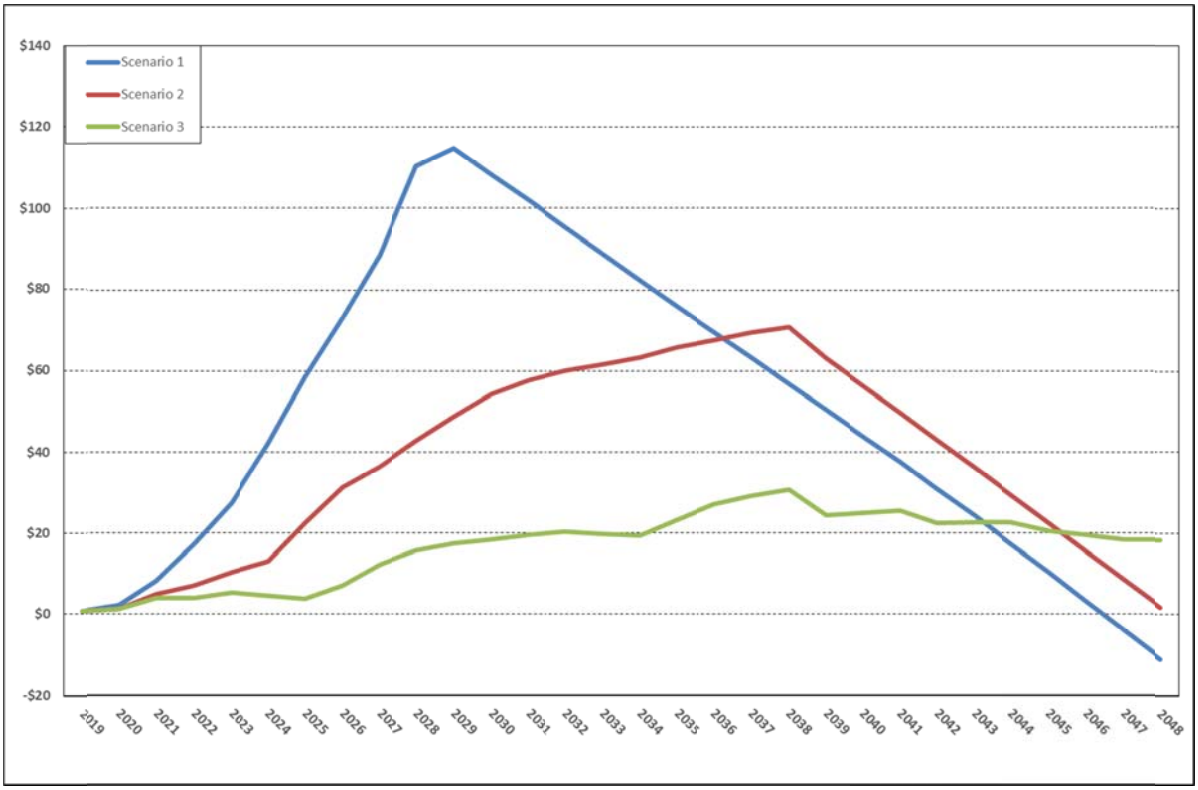
Revenue Requirement - $ Millions Scenario 2 - 20 Year	2019	2020	2021	2022	2023	2024	2025	2026
Operating and Maintennce								
Staffing	1.1	1.1	2.3	2.3	2.4	2.4	2.5	2.5
Home Flood Proofing Subsidy	0.8	1.2	1.7	1.7	1.7	1.8	1.8	1.9
Sub-total - Operating and Maintenance	1.9	2.3	4.0	4.0	4.1	4.2	4.3	4.4
Depreciation	0.1	0.7	1.7	3.2	4.8	6.3	9.0	11.7
Amortization of contributions	0.0	(0.0)	(0.2)	(0.3)	(0.4)	(0.6)	(0.7)	(0.8)
Return on rate base financed by debt	0.1	0.6	2.2	4.1	6.0	7.7	11.6	15.4
Return on rate base financed by equity	0.2	1.3	3.3	6.1	9.0	11.6	17.5	23.2
Scenario 1 Revenue Requirements	2.2	4.9	11.0	17.1	23.4	29.2	41.8	53.9
Less: Existing Neighborhood Flood Mitigatic	(1.4)	(3.6)	(6.1)	(10.1)	(13.0)	(16.2)	(19.3)	(22.6)
Total Incremental Revenue Requirement	0.8	1.4	4.9	7.1	10.4	13.0	22.5	31.3

Scenario #3 – 30 Year Investment Focus - Revenue Requirement

Revenue Requirement - $ Millions Scenario 3 - 30 Year	2019	2020	2021	2022	2023	2024	2025	2026
Operating and Maintennce								
Staffing	1.1	2.2	2.3	2.3	2.4	2.4	2.5	2.5
Home Flood Proofing Subsidy	0.8	1.6	3.3	3.8	3.9	4.0	4.1	4.6
Sub-total - Operating and Maintenance	1.9	3.9	5.6	6.2	6.3	6.4	6.6	7.2
Depreciation	0.1	0.7	1.6	2.7	3.8	4.6	5.4	7.0
Amortization of contributions	0.0	(0.0)	(0.2)	(0.3)	(0.4)	(0.6)	(0.7)	(0.8)
Return on rate base financed by debt	0.1	0.6	1.9	3.1	4.3	5.0	5.6	7.6
Return on rate base financed by equity	0.2	1.3	2.8	4.7	6.5	7.5	8.4	11.5
Scenario 1 Revenue Requirements	2.2	6.4	11.7	16.3	20.6	23.0	25.4	32.4
Less: Existing Neighborhood Flood Mitigatic	(1.4)	(3.6)	(6.1)	(10.1)	(13.0)	(16.2)	(19.3)	(22.6)
Total Incremental Revenue Requirement	0.8	2.9	5.6	6.2	7.5	6.8	6.1	9.8

The complete 2019-2048 incremental impact on Revenue requirement is illustrated in the following Figure. As noted, Scenario #1 (10 year) reaches a maximum incremental revenue requirement impact of $114.7 million in 2029. Scenario #2 (20 year) reaches a maximum of $70.8 million in 2038 while Scenario 3 (30 Year) reaches a maximum revenue requirement impact of $30.7 million in 2037.

Total Incremental SIRP Revenue Requirement ($Millions)



Non-Routine Adjustment

The following table summarizes the incremental revenue requirement and proposed associated Non-Routine Adjustment (NRA) under each of the three scenarios until the next PBR term. The revenue requirement represents the costs related to the SIRP program not already incorporated within existing customer rates and the non-routine adjustment represents the recovery of those costs.

As previously noted, EPCOR is recommending Scenario #2, which would result in an $0.56 increase to the average monthly residential bill commencing January 1, 2020 assuming scenario 2 is accepted as currently defined. For reference, the average monthly wastewater bill in 2018 including both the fixed monthly service charge and the variable consumption charge was $34.86, comprised of $11.22 for Storm services and $23.98 for Sanitary services.

Revenue Requirement Impact in Current PBR Term (2019-2021)
To be Recovered by NRA Beginning April 1, 2020

Incremental Revenue Requirement and Non Routine Adjustment	Revenue Requirement Impact - $ Million				Non Routine Adjustment*
	2019	2020	2021	Total	
Scenario #1 - 10 year	0.8	2.2	8.3	11.3	$0.89
Scenario #2 - 20 year	0.8	1.4	4.9	7.1	$0.56
Scenario #3 - 30 year	0.8	1.4	4.0	6.1	$0.48

*$per Average Monthly Residential Bill

After receiving Utility Committee feedback, EPCOR intends to file an application with additional financial detail prior to end of 2019, seeking a Non-Routine Adjustment ("NRA") to drainage rates beginning January 1, 2020. The specific amount of the NRA will be based on the final timing of the SIRP implementation based on Committee feedback. The basis for the NRA are defined with the EPCOR Drainage Services Bylaw (Bylaw 18100). Specifically, the costs associated with the SIRP program average $2.4 million (scenario #2) over the three years and exceeds the $500,000 annual revenue requirement threshold. The SIRP program also meets the NRA criteria set out under the Schedule 3, section 4.8 of Bylaw 18100:

> *4.8 Flood Mitigation - Costs incurred to implement accelerated flood mitigation projects or initiatives will be considered as non-routine.* [1]

Future Rate Impacts

Given the timeframe of the SIRP program and the higher levels of capital spending in future years, future PBR rate applications will also contain components of the program. In these applications, the SIRP methodology and risk framework will be incorporated into the stormwater capital program and subject to the same criteria for business cases and other justifications as any other capital. This will provide City Council, as regulator, the opportunity to

[1] Section 4.8, Schedule 3 of City of Edmonton Bylaw 18100, EPCOR Drainage Services Bylaw.

assess future spending on the program and adjust risk priorities to meet the community expectations.

Assuming the SIRP program is implemented as currently defined, the incremental impact on the average monthly in-city residential wastewater bill for each scenario is shown below.

Average Monthly Residential Rate Increase by PBR Term	2022-2026	2027-2031	2032-2036	2037-2041	2042-2046
Scenario #1 - 10 year	$6.52	$14.58	$10.62	$6.00	$1.91
Scenario #2 - 20 year	$2.51	$6.66	$8.18	$7.36	$3.23
Scenario #3 - 30 year	$0.75	$2.31	$2.82	$3.19	$2.36

Part 4 – Next Steps

Non Routine Adjustment and Cost of Service Study

EPCOR is requesting Utility Committee input to confirm that the recommended implementation Scenario 2 – 20 Year focus aligns with their objectives.

An NRA is required to bridge until the next PBR renewal. Prior to end of 2019, EWSI intends to file an application seeking a Non Routine Adjustment ("NRA") to stormwater rates beginning January 1, 2020 to recover the costs associated with the SIRP implementation. If scenario 2 of the SIRP strategy is accepted as currently defined, the average annual increase in the stormwater revenue requirement is approximately $2.4 million per year for the remaining three years of the current PBR term (2019-2021). The NRA increases the average monthly bill for the residential stormwater customer by $0.56 per month beginning January 1, 2020. If the Utility Committee advises alternative timing is preferable, the revenue requirement and associated rate increase will be adjusted to the spending requirements for that timing.

Over the next year as part of the Cost of Service Study review for Drainage a more detailed review of the stormwater rates and revenue requirement will occur and any recommendations for alternative rate structures based on pervious\impervious property characteristics will be developed and submitted as part of the PBR renewal for 2022. Adjustment to any clauses in the Drainage bylaw will also be determined if these are required to support on-site retention of peak stormwater flows on private property. EPCOR is currently working with a consulting firm, Mantle314 to review similar clauses in other communities to determine their potential for implementation in Edmonton.

The next PBR submission scheduled to be submitted to Utility Committee in Q1 2021, will include the detailed business cases for the SIRP capital expenditures anticipated for the 2022 – 2026 period.

Current Initiatives and Alignment with City Plans

Within the current PBR, EPCOR will continue the existing plans for flood mitigation including the additional ponds and outfall gates identified in the DMAF and ACRP grant funding announcements for 2019-2021. EPCOR is also coordinating with City of Edmonton construction projects to incorporate LID aspects within the Imagine Jasper Avenue and Strathcona Building

Great Neighbourhood projects. This work includes the development of formal design standards for the LID components to reduce the complexity for future incorporation of these elements during the design phase and a Service Level Agreement for the maintenance of the LID features proposed.

EPCOR will also continue to support the City of Edmonton Climate Change Adaptation activities and support the update to Plan Edmonton and the associated Land Use Zoning reviews. In particular focusing on how LID components can be incorporated into the zoning process.

Emergency response planning will also continue with the Office of Emergency Management. An initial meeting was held in late March to review the at risk areas in the River Valley as well as any risks to the specific Fire Station buildings and road response paths from each station.

Communication, Marketing and Public Engagement

Successful implementation of the SIRP approach will require expanded public engagement activity related to community infrastructure, and marketing and education to support new initiatives.

Public Engagement

The February 2018 Utility Committee SIRP report included a detailed description of the public engagement process for dry pond siting, design and development, and how siting, sizing and recreational amenities are coordinated with other City priorities through the City of Edmonton's Open Spaces team. As indicated earlier, the recommended SIRP approach includes dry ponds as a flood mitigation measure in 31 neighbourhoods, with 6 ponds in development at any one time (2 in planning, 2 in design and 2 in construction). Recently announced federal funding will support the development of 13 dry ponds over the next 10-years.

EPCOR-led engagement team will be established for each dry pond project or regional groupings of projects. The costs of public engagement are incorporated in the capital cost estimates for the projects. The team will work through the life-cycle of the development and finalization of both the concept design and the detailed design of the dry pond projects, and provide a single point of contact for the community that integrates multiple EPCOR and City functions.

At the highest level, activities will occur in four phases: pre-design, concept design, detailed design, and construction. The focus and level of engagement or communication activity as each stage is as follows:

- Pre-Design: Information is gathered from community members and technical requirements are refined. Stakeholders are engaged to the Advise level with a focus on obtaining site-specific flooding histories, and local preferences for the design of the engagement process.
- Concept Design: Through public engagement and work with the City's Open Spaces team, a concept design is developed for the dry pond. The process includes the development of options, technical studies, cost-benefit analysis, and information on how different concept designs align with City objectives and community values. Public engagement is conducted to the Refine level. The focus of engagement is on identifying the values and interests in the affected communities, understanding views on the trade-offs available within concept and final design (e.g. which types of amenities are valued or preferred) and any trade-offs between dry ponds and other mitigation approaches. Where multiple sites are available in a community, wider engagement may be conducted as a supplement to site-specific engagement. Ultimately, a preferred concept design is selected for the dry pond, and stakeholders are advised how the concept decision incorporated public input, the budget implications, any net amenities impacts, and trade-offs made in the design selection.
- Detailed Design: The final design, capital budget and construction plan for the project is developed. Design options and drafts are shared through the engagement process, with the final design incorporating feedback from this iterative process. Public engagement is conducted to the Refine level, and potentially the Create level. The focus of engagement is on optimizing the design, layout and infrastructure at a site-specific level, working with directly affected stakeholders and the City of Edmonton, and identifying and addressing construction-related impacts.
- Construction: Communication throughout the construction and commissioning process keeps stakeholders informed of the project's progress and potential impacts, and two-way channels are available for community members to identify concerns and have them resolved.

Public engagement will also be conducted to support the design and implementation of the flood protection measures proposed for the Rossdale and E.L. Smith Water Treatment Plants.

Marketing and Public Education

Elements of the SIRP that will require targeted public education and marketing initiatives include:

- Increasing take-up for the revised Backwater Valve subsidy program from 100 homes per year to 4,000 homes per year for 10-years;
- Motivating private property owners to participate in the Enhanced Building Flood Proofing Program, coordinating their investments in flood-proofing their lots with EPCOR's investments on adjacent public lands. The initial participation sought is from 6,000 properties in the highest-risk locations;
- Improving public understanding of and participation in Low Impact Development solutions, including property owners implementing the four priority LID types (Rain Gardens, Box Planters, Bioretention Basins and Tree Trenches/Tree Soil Cells) on their own properties, and the inclusion of LID in public engagement for the Building Great Neighbourhoods Program and neighbourhood renewal; and
- Developing public education and public communication protocols to support the effectiveness of the 15 emergency response stations to be located throughout the city, in coordination with the Office of Emergency Management.

Industry Initiatives

EPCOR also continues to participate in industry committees supporting the adaptation of communities to climate impacts of increased flooding. Edmonton is currently included as a case study in three research projects underway and has been a frequent invited speaker to present our SIRP methodology at conferences.

The research projects that EPCOR is currently supporting include:

- Joint venture between Public Sector Digest, Canadian Water and Wastewater Association (CWWA) , Canadian Water Network (CWN) and Federation of Canadian Municipalities (FCM) to document Case Studies from across the Country - Title of the research is "Using Better Data to Identify Climate Change-related Infrastructure Vulnerabilities in Canadian Communities
- Partnership project with Canadian Water Network, National Resources Canada and Insurance Bureau of Canada – "Pilot project on Mechanisms for Broad Scale Sharing of High-Resolution Data and Existing Knowledge to Improve Flood Risk Evaluation"

- University of Western Ontario – "The Economic Impacts of Urban Flood Mapping: The Case of Edmonton Alberta"

The conferences where SIRP methodology has been shared since October of last year include:

- CWWA Annual Conference
- Canadian Stormwater Conference
- Ontario Green Communities Webinar Series
- Northern Alberta Insurance Institute Insurance Symposium

Additional presentations have been made in the community to interest groups including various consultants, architects and departments within the City of Edmonton. On May 2nd the SIRP will also have been presented at the University of Alberta Life Long Learning series lectures. The SIRP has also been accepted to present at the Western Canada Water and Wastewater Conference scheduled for Edmonton in mid-September.

Appendix A - Summary of the Previous City of Edmonton Scenarios

The City of Edmonton Drainage department previously proposed four scenarios for investment in City Wide Flood Mitigation. The detailed submission was presented at the Utility Committee meeting on June 9th, 2017 as CR_4408 and is summarized below for reference.

The proposed investment focused on the upgrading of the existing storm pipe network to a particular design standard to be selected by Utility Committee. Four design storms were analysed and capital investments types limited to the installation of tunnels and trunks, sewer separation and dry ponds were proposed.

City Wide Flooding – Estimated Capital Investment – Jun 2017

City of Edmonton Drainage Branch

Capital Type	Scenario 1 1:100 Large	Scenario 2 1:50 Large	Scenario 3 1:100 Small	Scenario 4 1:50 Small
Storm Tunnels	$1,730 M	$1,570 M	$655 M	$605 M
Local Pipe Upgrades	$415 M	$385 M	$365 M	$350 M
Large Ponds	$635M	$560 M	$555 M	$515 M
Sewer Separation	$1,900 M	$930 M	$970 M	$735 M
Total	$4.6 Billion	$3.4 Billion	$2.5 Billion	$2.2 Billion

Appendix B – Overland Ponding and Increased Risk of Basement Flooding

One of the major conclusions from the SIRP analysis was the high degree of correlation between the incidents of basement flooding vs. the potential for surface ponding of water due to localized areas of lower topography. This finding aligns with the analysis being completed in communities such as Ottawa and Markham Ontario that have been able to determine that increased basement flooding is evident along the paths of historical streams and small ponds that have been redeveloped over time in the community.

The Drainage Branch as part of the City Wide Flood mitigation work had completed overland flood modelling for the 1:100 and 1:50 year storm scenarios and identified locations with higher risk of surface water ponding. EPCOR was able to purchase the flood maps available to the Insurance industry for river and urban flooding that show the expected depth of flooding based on storm scenarios ranging from the 1:20 year to 1:1500 year scenario to broaden the data set to compare flooding risks with historical basement flooding.

The limitation with the Insurance maps is that they do not include in their predictions the flood mitigation that occurs due to the pipe and pond network installed by the utility in the community. The maps are also limited in resolution due them being based on the Canada wide topographic maps available from Natural Resources Canada. They are however a good indicator of the risk to the community if the stormwater network is not fully functional.

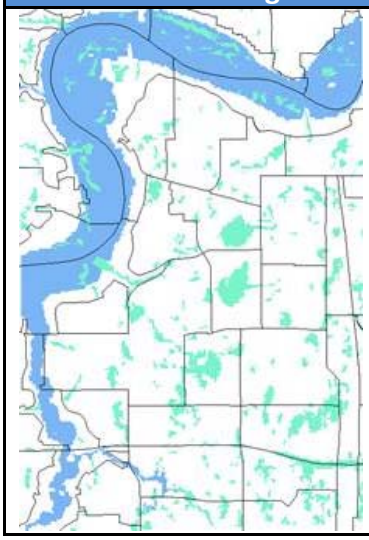
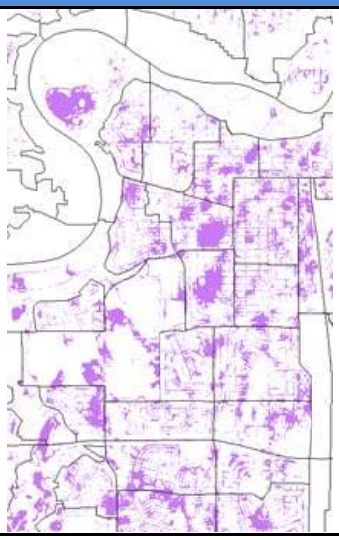
EPCOR is currently participating in a research project with the Insurance Bureau of Canada, the Canadian Water Network and Natural Resources Canada to pilot methodologies to incorporate utility information and higher resolution topographic information in the insurance map production.

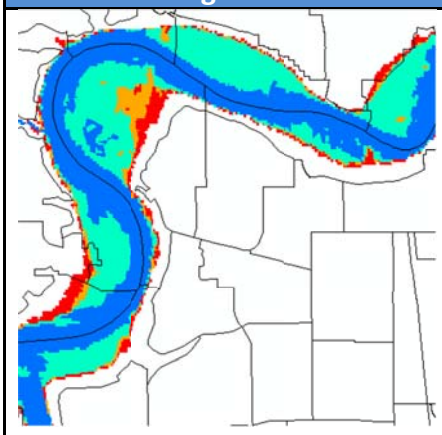
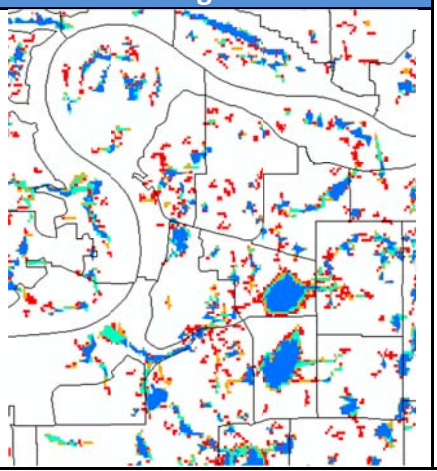
EPCOR completed a comparison of the insurance maps with the previous detailed engineering assessments that were done as part of the City Wide Flood Mitigation projects as part of the SIRP analysis. Three comparisons were done:

- Comparison of the Insurance Flood maps to the City Wide Flood Mitigation engineering analysis for the 1:100 year storm scenario
- Assessment of the areas of land impacted by Flooding between the 1:20 , 1:100, 1:200 and 1:1500 storm scenario for both River and Urban Flooding
- Comparison of the Insurance Flood maps 1:100 and 1:1500 urban flood maps to historical 311 reports of basement flooding.

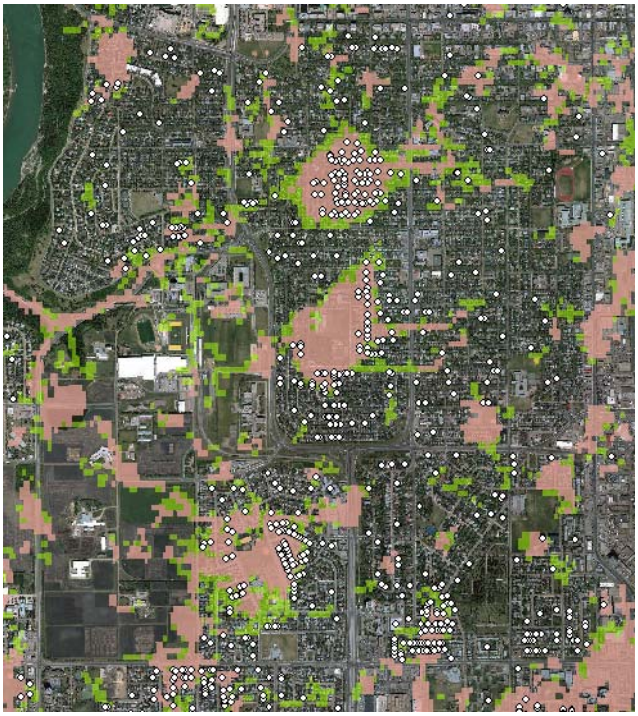
The following charts summarize this review.

The maps below compare the Insurance flood map predictions vs. the City Wide Engineering analysis for an area in south Edmonton.

Comparison of Insurance Maps to Engineering Analysis – 1:100 Year storm		
Insurance Flood Maps River and Urban Flooding	City Wide Flood Mitigation	
		Insurance Maps and Engineering analysis both identify same locations of highest risk of surface flooding. Insurance maps indicate higher risk in locations where existing dry ponds have been installed Engineering maps show more detail of roadway flooding due to higher resolution topography

Insurance Maps – Extent of Area for Different Storms 1:20 Blue, 1:100 Green, 1:200 Orange, 1:1500 Red		
River Flooding	Urban Flooding	
		Insurance maps provide additional low cost quick assessment of impacts of larger storms over the same locations. Of particular note is the localized nature of urban flooding around topographic sag areas across the wide spectrum of storm intensities

Comparison of Insurance Maps (1:100 - pink and 1:1500 Urban Flooding - green) and 311 Historical Basement floods (white dots) – 2003 to 2016



The clustering of 311 reported basement flooding to the Insurance map modelled predictions of surface ponding can be seen.

Parkallen is visible in the middle of the figure and the area of no basement flooding is where the proposed pond currently in the design phase will be located.

South of Parkallen are the Lendrum and Malmo ponds installed in the last few years to address flooding risks in these areas.

North of Parkallen is the McKernan area where a stormwater trunk has been constructed in the last few years to the river to mitigate flooding risks. Additional reviews of this area have been flagged in the SIRP to confirm the approach to manage these surface volumes.

In the lower right corner the basement flooding is offset from the ponding area, this location is the interface between the combined and separated sewer systems, indicating there is an influence of the pipe network on the flooding in this area.