
Stormwater Integrated Resource Plan (SIRP) – Finalizing the Risk Framework

Recommendation:

Utility Committee receive this report for information on the recommended finalized risk framework methodology and provide input on the proposed priorities and on the relative weightings between the risk components.

Report Contents:

This report provides an update on the activities completed since the June 8th, 2018 Utility Committee meeting. With a focus on the results of the risk ranking framework development and the public engagement results supporting the Stormwater Integrated Resource Plan. This report includes:

- A background section providing an overview of the SIRP approach and risk framework methodology.
- The results of the public opinion survey completed this summer and recommendations for flood mitigation priority policy statements to be considered by Utility Committee. Methodology of the public opinion survey is included as Appendix A. A detailed analysis is also provided as a separate attachment.
- Results of the risk analysis by sub-basin for four perspectives of Health and Safety, Environment, Social and Financial impacts to properties and customers. Detailed maps are provided in Appendix B.
- Combined risk scenarios to support the recommendation to be made by Utility Committee on the relative weightings to apply on the four perspectives.
- An update on the industry initiatives for flood mitigation where EPCOR is a participant (Appendix C).
- A summary of the next steps detailing the activities that will be completed prior to the April 2019 Utility Committee meeting.

Council input is requested on the proposed prioritization policy statements and on the relative risk weightings to support the work to be completed for April 2019.

Background:

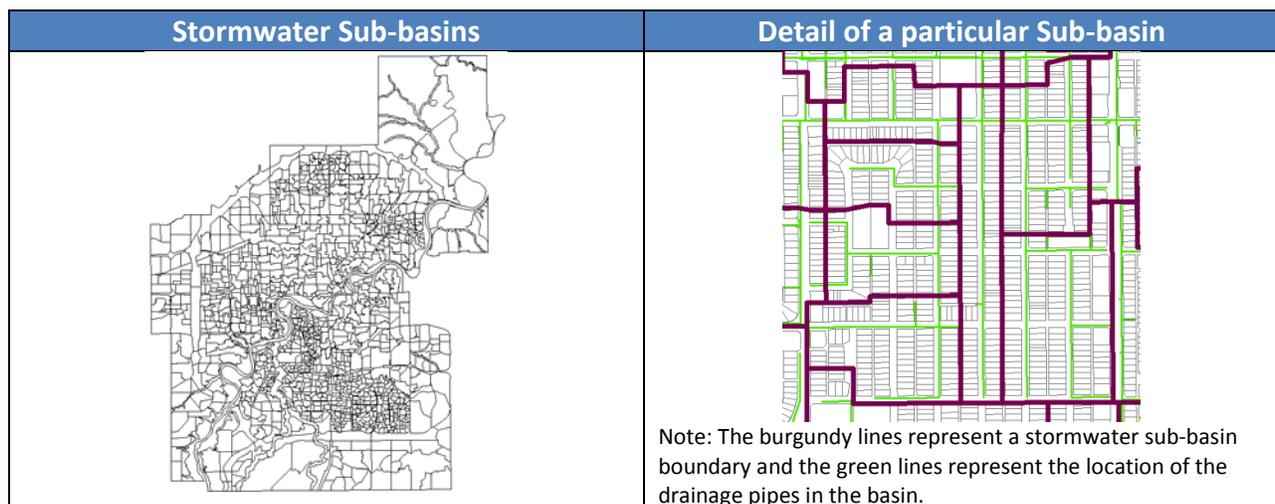
In our report to Utility Committee on February 23rd, EPCOR proposed a risk methodology aligned with the vulnerability risk analysis underway through the City of Edmonton's Climate Change Resiliency and Adaptation initiative being led by the City Environmental Strategies group. At the June 8th Utility 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.

The Climate Change Adaptation project has assessed the City of Edmonton from an overall City perspective and will be providing recommendations for a Climate Change Adaptation action plan to the Urban Planning Committee of City Council on November 13th, 2018. EPCOR has been working closely with the Climate Change Adaptation team to align the SIRP recommendations with the Climate Change Action Plan.

The Stormwater Integrated Resource Planning (SIRP) process is a dynamic process that is expected to adapt over time as additional information is collected. The current risk exposure ranking of the individual stormwater sub-basins is based on the information that is currently available from a multitude of engineering studies, stormwater and climate models, and historical flooding and maintenance records considering a wide range of storm scenarios. The framework developed allows for these different data sets to be consolidated into a consistent view of risk exposure to the citizens of Edmonton. EPCOR will continue to update the SIRP and the risk framework going forward as additional information about particular sub-basins are collected. EPCOR will also reflect the enhanced information in future utility rates filings and annual capital and operational budget proposals.

The following figure shows the stormwater sub-basins that have been identified along with a more detail example of how a stormwater sub-basin has been defined through a review of stormwater catchment areas. Through our analysis we have identified approximately 1,300 unique stormwater sub-basins that cover the city.



The number of sub-basins has increased from our February estimate of 1,200 sub-basins through the additional segmentation of sub-basins with varying surface topography that resulted in a portion of the basin having a trapped low area where water can pool after a storm. The trapped low areas are now defined as unique basins to reflect the greater risk of flooding to adjacent properties caused by the pooling of water after a storm has passed by a particular area. The sub-basins now represent both the pipe and overland catchment configurations that can impact the risk of flooding to a particular property or customer. The creeks and sub-basins have also been further segmented to reflect the different exposures to stormwater volumes between major outfall locations and the changing topography adjacent to the creeks and rivers.

The risk exposure ranking provided in the subsequent sections of this report prioritizes the stormwater sub-basins considering the risk dimensions of health and safety, environment, social and financial risks. The results are presented for each dimension independently and through different scenarios weighting the risk perspectives for a total risk score.

The risk exposure for a sub-basin reflects the potential for this risk level to be present within the basin boundary; it does not mean that every property is exposed to the same level of risk within the sub-basin. EPCOR will complete a more detailed assessment of the specific customer and property impacts that could occur during a flooding event in the sub-basin ranked as High or Medium High risk. This more detailed analysis will support the development of mitigation efforts that consider a combination of grey and green infrastructure solutions within both the public and private land space within the sub-basin.

EPCOR will present the results of the more detailed analysis of the higher risk sub-basins including recommendation for the capital and operational programs required to reduce the flood risks at the April 2019 Utility Committee for consideration to fund an accelerated flood mitigation program for Edmonton.

Public Opinion Research and the Recommended Risk Framework

This section provides an overview of the Phase 3 public opinion research process, summarizes the primary conclusions from the research, and details EPCOR's recommendations for incorporating public input into the risk framework. Phase 3 shared information on the potential impacts from flooding, and sought public input on which impacts should be prioritized for mitigation through the SIRP risk framework. Appendix A contains more details on the survey methodology and the final report detailing the results of the survey is provided as a separate attachment.

Research Process

Phases 1 and 2 of the public engagement process in 2016 and 2017 gathered information through the Edmonton Insight panel, two public opinion surveys, community discussion groups, a discussion guide and focus group discussions.

Phase 3 gathered more detailed public input through choice-based public opinion research. In August 2018, EPCOR conducted an online public opinion survey with 1,500 Edmontonians, using a statistically reliable sampling methodology to test and validate public preferences for flood mitigation (what infrastructure they want to see protected from the impacts of a flood).

Three levels of flood impact were tested: Moderate, Major, and Extreme. For Moderate impacts, respondents reviewed a list and selected the top 5 they felt should be prioritized when it comes to flood mitigation. Direct ranking was necessary to keep the total questionnaire length under 30 minutes.

Major and Extreme impacts were tested using a choice-based approach (MaxDiff). Respondents were repeatedly presented with randomized lists of potential impacts, and forced to rank the most and least important impacts to protect against. Statistical analysis of these choices identified the relative preferences among Edmonton residents for infrastructure protection

As discussed in the February and June reports, we used a choice-based approach because of the complexity of the topic and the potential trade-offs. If a survey asks, "How important are the following to protect?" everything tends to be rated as important. Choice-based survey questions employ a more realistic framework where respondents evaluate potential options (or impacts, in this case). By simulating the act of making a choice, trading-off various "impacts," the respondent is more likely to respond as they would in real life. Outputs illustrate the relative importance of each impact tested to identify their preference for what should be

protected based on flood impacts/conditions. A highly experienced third-party statistician conducted the design of the model and analyzed the raw data.

Many respondents commented on how challenging it was to make trade-offs when ranking flood protection priorities. As a representative respondent wrote:

“This survey is among the most difficult to complete that I have ever taken. The ethical calculus necessary to make choices between awful and terrible outcomes was difficult. However, I appreciate EPCOR’s courage and determination to put these serious and complex questions before the public. We all need to think these things through and contribute to the tough and expensive compromises that lie ahead.”

The flood impact scenarios that were tested during Phase 3 were developed through input from EPCOR Drainage expertise on flooding event impacts within Edmonton and other communities across North America. The scenario statements were validated for clarity with a focus group made up of representatives from the City of Edmonton Climate Change Adaptation team and a series of one-on-one reviews with the members of the EPCOR Water Canada Customer Advisory Panel.

The flood impact scenarios also addressed direction provided to EPCOR at the June 8th, 2018 Utility Committee meeting. This included incorporating: mental health and stress impacts from flooding in the Social risk consequence scale; the increased risk of soil erosion due to increased water flows in the Environmental scale; and the impacts due to displacement from properties for home owners and businesses in the Financial scale. The flood impact scenarios used in the survey are presented in Appendix A.

Once the survey was completed, an open, public-facing, shorter version was also fielded, which offered any Edmonton resident the opportunity to participate and provide feedback.

Summary: Research-Based Policy Recommendations and Risk Weighting

Based on the public opinion research, we have developed specific risk exposure targets for the highest flood protection priorities identified by Edmontonians. Achieving these targets will be the first priority in the SIRP to be presented in April:

1. Hospitals: In sub-basins that impact hospitals, the flood risk exposure adjacent to the property should not exceed the Medium Low level (green band).

2. Essential Services: In sub-basins that impact essential utilities and emergency services, the risk exposure adjacent to the property should not exceed the Medium Low level (green band).
3. Protection of Life: Where there is a risk of: (a) basement flooding up to the ground level, (b) rapid underpass flooding, or (c) underground parking garage flooding, the flood risk exposure should not exceed the Medium Low level (green band).
4. Social Services: In sub-basins where social services agencies are located, the flood risk exposure adjacent to the property should not exceed the Medium level (yellow band).

At all three levels of flood impact (Moderate, Major, and Extreme), the next most important priority for respondents was preventing the impacts from indoor household flooding. These impacts included financial consequences (such as damage to property), health and safety (such as risks of illness from exposure to sewage or mold), and social (such as having to care for displaced friends or family members).

At the major and extreme impact levels, respondents elevated access to their workplaces to a moderate level of importance, recognizing the impacts from interruptions to employment. This can be addressed through the treatment of the financial impact rating in the risk model.

With respect to prioritizing work in the remaining sub-basins, the public opinion research supports adjusting the default weightings of 25% each for the four categories in the risk framework: social, financial, health and safety, and environment. The research supports higher weightings for the social and health and safety categories, an unchanged weighting for financial, and a lower weighting for the environment category.

5. Adjusted Risk Weighting: Prioritize work in the remaining sub-basins based on the following weighting of potential flood impacts: Social (30%), Health and Safety (30%), Financial (25%), and Environment (15%). Based on this weighting, prioritize bringing any sub-basins in the High Risk (red band) or Medium High Risk (orange band) levels to the Medium Risk level (yellow band).
 - Alternative Options: *This report includes two alternative risk weightings for Utility Committee feedback: a base-case weighting (25% to each of the four categories), and a property damage-focused weighting (40% financial, 20% to each of the other three categories).*

Elsewhere, the report illustrates how the adjusted risk weightings, would change the risk ranking of sub-basins when compared to a base case, where all four risk categories are equally weighted, and a property damage-focused scenario.

The remainder of this section summarizes the specific research findings that led to the above policy statements. Later in this section, we also summarize public input, and any applicable actions, related to: lower priority impacts, waste services, low income households, and environmental impacts.

Flood Protection Priority: Hospitals, Utilities and Emergency Services

Three levels of flood impact were surveyed, both through direct ranking (moderate impacts) and MaxDiff ranking (major and extreme impacts). Consistently, across all three impact levels, the top priorities for the Edmonton public were the protection of hospital operations, essential utility services, and emergency services. In order, these ranked as the 1st, 2nd, and 4th most important priorities at the extreme impact level, and 2nd, 1st, and 3rd most important at the major impact level. Relative to other items, essential services were two to three times more important to respondents than most environmental and social impacts, and as much as five times more important than many financial impacts.

Even when asked to prioritize these impacts against the consequences of household flooding, respondents consistently chose to protect essential infrastructure and services. This likely reflects an understanding that essential services are necessary for the continued occupancy of any residence during and after a flood (even a residence that has not been directly damaged). As a representative respondent put it in the open comment portion of the survey:

“It's not important that severely damaged infrastructure doubles my commute time. It IS important that severely damaged infrastructure interferes with emergency services, interferes with clean-up and contractors, and burdens a stressed economy. Without adequate infrastructure, rebuilding cannot proceed in a timely manner.”

These top priorities were consistent across demographics (age, gender, income, education), residence type (detached, semi-detached, apartment/condo), neighbourhood type (core, mature, established, developing), and personal experience of flooding.

Public Input	Recommended Risk Framework Policy	Result
One of the highest priorities for protection from moderate, major and extreme flood impacts are hospitals.	In sub-basins that impact hospitals, the flood risk exposure adjacent to these properties should not exceed Medium Low Risk (green band).	The April plan will prioritize actions to bring the parcels adjacent to the hospitals to the Medium Low Risk level.
One of the highest priorities for protection from moderate, major and extreme flood impacts are essential utility services (power, water, gas) and emergency services (fire, police, ambulance).	In sub-basins that impact essential utilities and emergency services, the risk exposure to these parcels should not exceed Medium Low Risk (green band).	The April plan will prioritize actions to bring parcels to the Medium Low Risk level.

Alternatives considered: We considered recommending that the framework target the Low Risk level rather than the Medium Low Risk level. Based on the consistent and high relative rankings given in the survey, the results indicate the public would have very low tolerance for either a substantial or extended impact to the delivery of essential services. But achieving the Low Risk level on both Likelihood and Impact may require unreasonably high level of investments and compromise the achievement of other high priority actions. If there are opportunities to protect these highest priority properties to the Low Risk level, we will identify options in the April report.

Flood Protection Priority: Human Life

At the moderate and major levels of flood impact, respondents ranked health and safety impacts to individuals as being among the most important priorities to address after essential infrastructure.

Health and safety increased in importance when respondents were presented with extreme flood impacts that included risks to human life (such as from rapid underpass flooding or basement flooding deep enough to reach ground level) or long-lasting physical or mental health

issues. Health and safety consequences were ranked as the 3rd, 5th, 7th, and 8th most important impacts at the extreme level, with notable increases in the importance of addressing safety risks from deep basement flooding, and long-lasting impacts to physical or mental health.

Based on this input, we conclude that the Edmonton public would prioritize reducing the risk to human life as the second-most important priority after essential services. This primarily involves reducing the risk of deep or rapid flooding, particularly in confined spaces.

Public Input	Recommended Risk Framework Policy	Result
<p>Protecting against risks to human life from flooding should be a high priority.</p> <p>Protecting against long-lasting physical or mental health impacts from extreme flooding should be a high priority</p>	<p>In sub-basins where there is a risk of:</p> <ul style="list-style-type: none"> • Basement flooding up to the ground level • Rapid underpass flooding, • Underground parking garage flooding <p>the flood risk exposure should not exceed the Medium Low band (Green).</p>	<p>The April plan will prioritize actions to bring the sub-basins and/or specific parcels to the Medium Low Risk level.</p>

Note: Achieving this risk outcome in a household setting can include an increased focus on flood-proofing individual properties, as well as capacity improvements throughout the sub-basin. Current household flood prevention programs rely on homeowners choosing to participate. Future programs may focus on the identification of higher risk properties, and outreach to those homeowners to encourage their participation. If there are areas where flood-proofing individual properties would be a more economical means of protection for the sub-basin than investing in utility infrastructure, future recommendations may propose utility investments on private property based on defined criteria.

Flood Protection Priority: Households, Support Agencies and Businesses

At all three levels of flood impact, respondents then prioritized the prevention of impacts that would be caused by household flooding. These impacts included financial consequences (such as damage to property), health and safety (such as risks of illness from exposure to sewage or mold), and social (such as having to care for displaced friends or family members).

In addition, respondents consistently ranked impacts to social services agencies and their clients as a high priority (6th most important in the major scenario, falling to 9th in the extreme scenario as risks to human life moved up the rankings).

At the major and extreme impact levels, respondents elevated access to their workplaces to a moderate level of importance (i.e. less important than protecting households or social services agencies, but more important than other items), recognizing the impacts from interruptions to employment.

Based on these inputs, we conclude that once essential services and the protection of human life are addressed, the Edmonton public would prioritize reducing the risk of moderate or extreme flood impacts inside homes and reducing the risk of impact to social service agencies, and then prioritize protecting businesses.

With respect to prioritizing work in the remaining sub-basins, the public opinion research supports adjusting the default weightings of 25% each for the four categories in the risk framework: social, financial, health and safety, and environment. The research supports higher weightings for the social and health and safety categories, an unchanged weighting for financial, and a lower weighting for the environment category.

Public Input	Recommended Risk Framework Policy	Result
Protecting social services agencies against risks from flooding should be an important priority.	In sub-basins where social services agencies are located, the flood risk exposure adjacent to the property should not exceed the Medium level (yellow band).	The April plan will prioritize actions to bring the parcels to the Medium level (yellow band).

Public Input	Recommended Risk Framework Policy	Result
<p>Protecting households from the risks of indoor flooding should be an important priority.</p> <p>Protecting businesses from the risks of indoor flooding is of moderate importance.</p>	<p>Prioritize work in the remaining sub-basins based on the following weighting of potential flood impacts:</p> <ul style="list-style-type: none"> • Social (30%), • Health and Safety (30%), • Financial (25%), and • Environment (15%). <p>The flood risk exposure in the remaining Edmonton sub-basins should not exceed the Medium level (yellow band)</p>	<p>Based on this weighting, the April plan will prioritize actions to bring any sub-basins in the High Risk (red band) or Medium High Risk (orange band) levels to the Medium Risk (yellow band).</p>

Additional Public Input: Other Impacts and Actions

Lower priority impacts. In general, respondents were more tolerant of impacts that were reversible (such as damage to the natural environment or public amenities that could be repaired), insurable (such as damage to vehicles or other personal property), or temporary (such as extended commute times, or loss of access to businesses or elevators). These were consistently lower priority items in all three scenarios, and no specific policies are recommended for the risk framework.

Waste services. At the major and extreme impact levels, respondents elevated waste services to a moderate level of importance, likely recognizing the essential role it would play in household and neighbourhood clean-up. This has been identified as an area for further follow-up, with the potential for recommendations that would either make waste services more resilient during or after a flood, or that would develop supplemental capacity or services to support residents.

Low income households. At the major and extreme impact levels, respondents ranked at a moderate level of importance the impact from lower income individuals being unable to afford repairs. We are not recommending a policy that would change the risk ranking of sub-basins based on income levels. Instead, our follow-up will be to explore policies, programs or grants that could target support for low income residents who are recovering from flooding. We will

be reviewing the resources currently available, with the potential for recommendations related to operating programs that target flood-response supports for low income households, grants from other orders of government, or flood protection partnerships with housing agencies.

Environmental impacts. At all three levels, but particularly at the extreme level, environmental impacts ranked lower relative to social, health and safety, and financial impacts. This lower relative ranking held even for extreme environmental impacts that were characterized in the survey as causing irreversible damage to natural environments. For example, in the moderate impact scenarios, protecting health and safety was ranked twice as important as protecting the environment. In the extreme scenarios, health and safety was 2.25 times as important as environment.

While this suggests the public might tolerate or even support developing flood mitigation responses that would protect essential services, human life, or households at the expense of the natural environment (for example, through water diversion infrastructure that could lead to permanent damage of waterways during extreme flood events), EPCOR does not support developing any such policy or infrastructure.

Instead, our takeaways from this portion of the public input are: 1) that incorporating a slightly lower weighting for environment into the risk framework would reflect the relatively higher priority the public places on the protection of impacts to property and human life; and 2) future investments that protect against environmental harm should be communicated in a way that also addresses the social, health and safety, and financial benefits of the investment. A more holistic communication of the benefits from investments in environmental protection should lead to greater support and understanding, as should regular communication of the investments being made to protect against higher priority impacts.

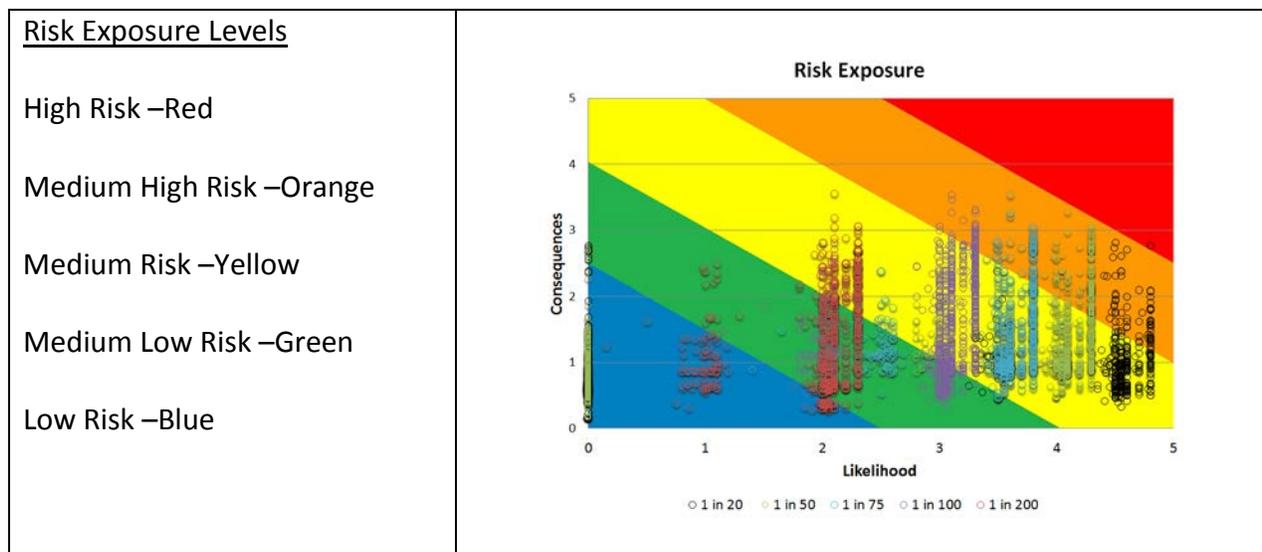
Risk Framework Analysis

This section presents the initial results of the risk framework analysis that was completed for the four perspectives of risk:

- **Health and Safety**
- **Environment**
- **Financial or Economic Impact**
- **Social or Service Level Impact**

For each of the four categories the different data sets described in the June 8th Utility Committee report was analyzed to determine the consequence and likelihood of flooding occurring within a particular sub-basin. The risk exposure for a sub-basin shown on the grids and maps below do not mean that every property within that sub-basin is exposed to the risk, but rather provides an indicator that that level of risk is present within the sub-basin boundary.

The different colored dots within the risk grid represent the different storm intensities represented from the data sets used in the analysis (1:20, 1:50, 1:75, 1:100 and 1:200 storm scenarios). The colored diagonal bands represent different risk exposure categories and help define the target risk levels for mitigation for the different basins. For sub-basins with data covering multiple storm scenarios, EPCOR has represented this sub-basin multiple times on the risk grid. Appendix B contains the maps showing the risk levels of each sub-basin for each risk category under each of the six storm scenarios analyzed.



EPCOR recognizes that not all of data sets utilized have information for every stormwater sub-basin and every storm intensity scenario. The risk framework has been structured to allow new information to be incorporated as it becomes available to allow continuous refinement of the risk ranking.

Prior to any construction occurring in a particular stormwater sub-basin, the necessary engineering analysis will be completed to validate the risk ranking through detailed reviews of the sub-basin and the specific properties and customers located within the sub-basin.

EPCOR is confident that the data sets that have been included for this analysis to date provide sufficient level of detail to prioritize the high priority stormwater sub-basins for short term investment planning to address the highest priority locations. EPCOR will continue to collect data at the sub-basin level to ensure a more fulsome analysis of the sub-basins is available for the Drainage PBR renewal scheduled for 2022.

Likelihood Scale

The flood impact scenarios described in the June 8th Utility Committee report and included as a reference in Appendix A of this report provide a description of the consequence of the flooding which determines the “y-axis” of the risk framework grid. The “x-axis” of the grid is based on the likelihood of the particular consequence event occurring.

EPCOR through their industry involvement has recognized that the leading communities working on resiliency have taken a systematic “No Regrets” risk reduction approach in adapting their communities to changing storm patterns. “No Regrets” solutions are not focused on achieving a specific design standard objective but they provide an incremental improvement that can be incorporated into a community over time without conflicting with an ultimate level or service goal. The consideration of “No Regrets” mitigation investments aligns with the approach being proposed through the City of Edmonton Climate Change Adaptation project efforts within the Energy Transition strategy. The implementation of low impact development infrastructure is an example of a “No Regrets” solution to flood mitigation.

Discussions with various representatives from the insurance industry have also highlighted that when considering impacts from storms the insurance industry approach is to consider a wide range of storm scenarios from 1:20 up to 1:200 year events when assessing risk to a property over the lifetime of the property. EPCOR was able to purchase insurance industry flood

forecast maps for the Edmonton region from one of the three modelling companies that support the insurance industry. These maps provide estimated overland and river flooding depths for seven different storm scenarios (1:20, 1:50, 1:75, 1:100 , 1:200, 1:500 and 1:1500) and EPCOR has been able to incorporate this information up to the 1:200 storm level into the risk framework analysis presented in this report to align with the insurance industry approach. EPCOR will also reference the 1:500 and 1:1500 storm levels from the insurance industry when developing the mitigation plans for the sub-basins to determine how these larger events are also mitigated by the proposed improvements.

Considering all of above perspectives the risk likelihood scale (‘x-axis’) for the SIRP has been developed to support the multiple storm scenarios that have been analyzed over the last few years and incorporate the insurance flood maps also covering multiple storms. This approach has also allowed us to consolidate results from multiple engineering reports that considered different storm scenario assumptions within a particular basin.

The following table shows the percent likelihood of a particular storm event occurring in any one year, over 30 years and over a 100 years lifetime of the property and where these storm scenarios have been placed on the SIRP risk grid “x-axis”.

Storm Scenario	Percent Likelihood Over Time			SIRP Likelihood Scale
	In One Year	Over 30 years	Over 100 years	
1:20	5.00%	78.54%	99.41%	4.5
1:50	2.00%	45.45%	86.74%	4
1:75	1.33%	33.15%	73.88%	3.5
1:100	1.00%	26.03%	63.40%	3
1:200	0.50%	13.96%	39.42%	2

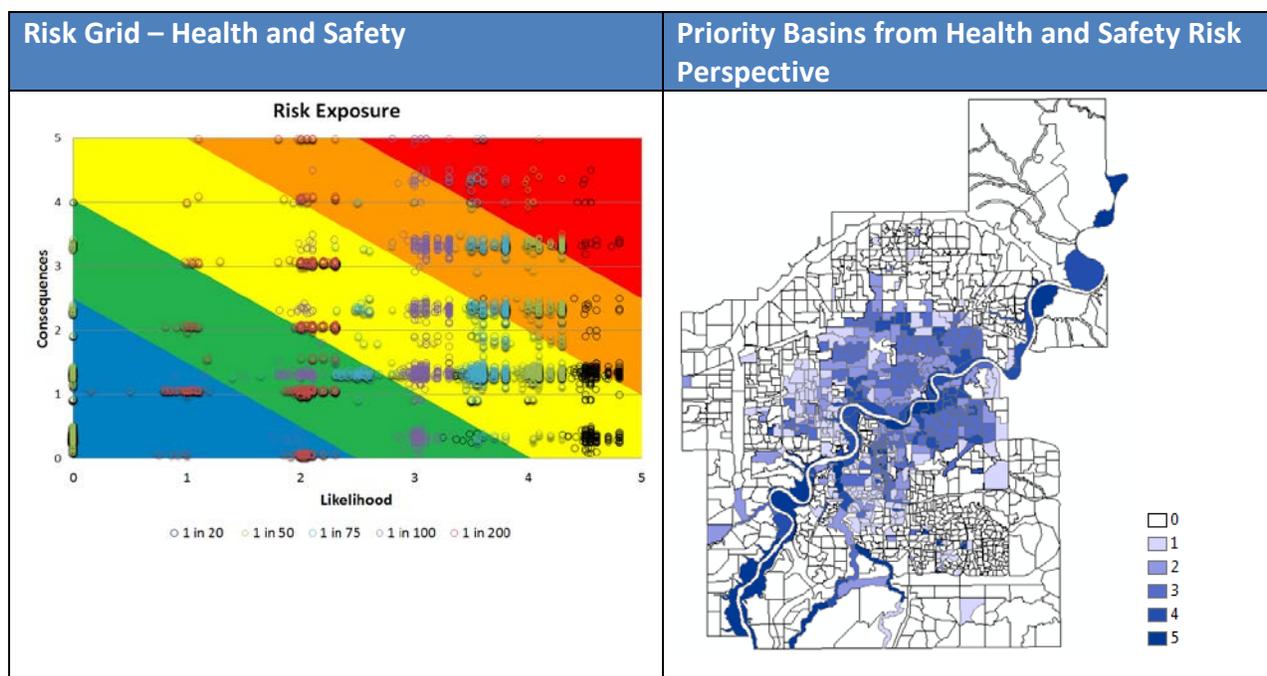
In the following sections the risk exposure grid is presented showing the multiple storm scenarios and the risk map is shown as a thematic map showing the storm water sub-basins that appear as High Risk or Medium High risk over multiple storm scenarios.

The results of the analysis are being presented showing each of the four risk dimensions: Health and Safety, Environment, Financial and Social. The Social section also contains additional specific information on the risk levels for the critical infrastructure locations that were prioritized by the public through the public opinion survey.

Later in the report these four dimensions are then combined under different weighting scenarios to show how the priority ranking for mitigation measures varies.

Health and Safety Perspective Risk Results

The map below illustrates the basins where there is a potential health and safety exposure that is High or Medium-High with the darker colors indicating that the risk exposure is indicated across multiple storm scenarios.



Health and safety risk is primarily driven by three flooding conditions:

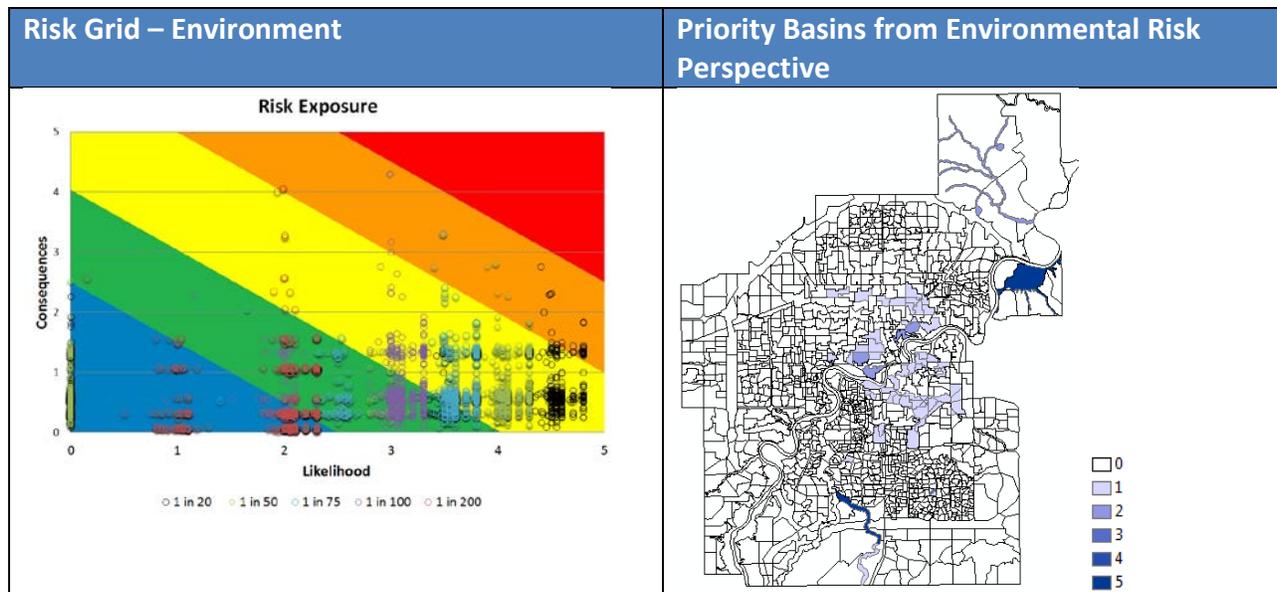
- Increased risk of basement flooding due to sanitary sewer pipes surcharging to a depth greater than typical basement floor elevation leading to health risk of exposure to sanitary sewage if the home does not have a backwater valve. (1:50 storm scenario and greater)
- Increased risk of erosion of creeks due to higher flows increasing personal safety risk due to instability of banks and trails (1:20 storm scenario and greater)

- Increased depth of overland flooding in low lying areas such as underpasses and local sag areas (1:20 storm scenario and greater)

Note: EPCOR will also be compiling the location of underground parkades across the city to incorporate the higher risks to the public if these are inundated with flood waters into the overall risk analysis. We expect that once this information is added the sub-basins where there is higher overland flooding predicted adjacent to an underground parkade the Health and Safety risk consequence ranking will be increased for these sub-basins. The City of Edmonton Urban Form and Corporate Strategy department is determining whether this information is available through the City property database (POSSE). If not EPCOR will leverage the water meter readers and our home flooding program technologists to collect this information within the basins that indicate they are at higher risk of overland flooding.

Environmental Perspective Risk Results

The map below illustrates the basins where there is a potential environmental exposure that is High or Medium-High with the darker colors indicating that the risk exposure is indicated across multiple storm scenarios.

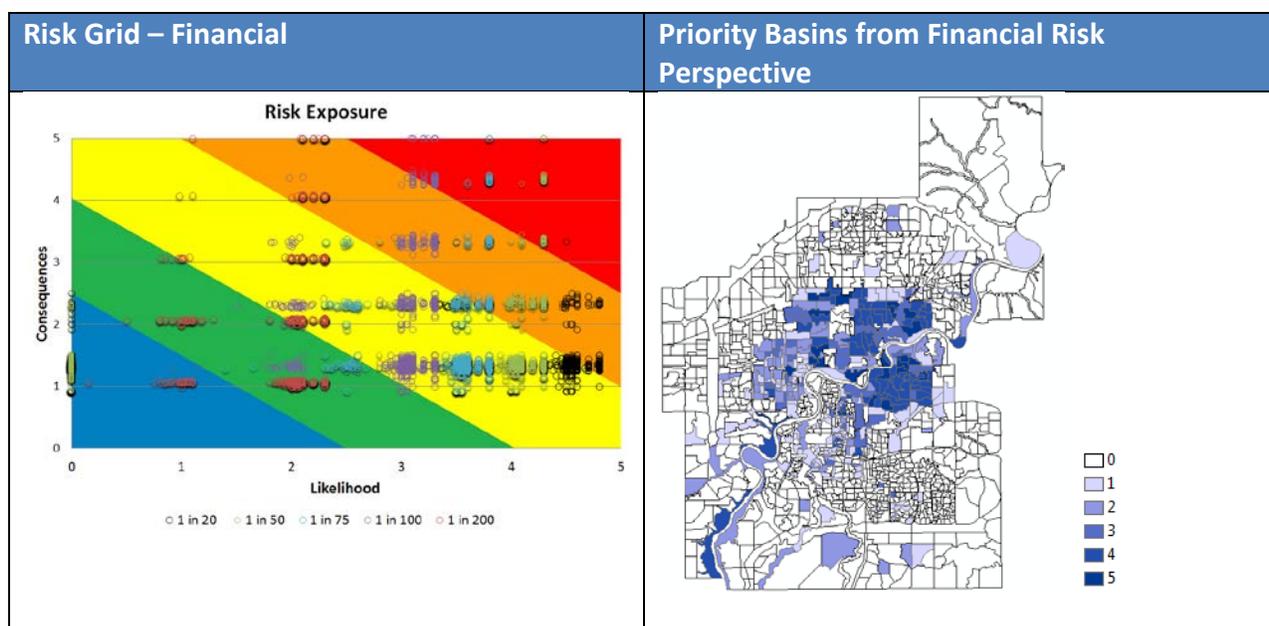


Environment risk is primarily driven by two flooding conditions, with none of the basins having a High Risk exposure:

- Increased risk of erosion of creeks due to higher flows increasing environmental risk due to increased amount of solids entering into creeks (1:20 storm scenario and greater)
- Increased risk of combined sewer overflows resulting in a release to the environment of sanitary sewage (1:20 and greater)

Financial Perspective Risk Results

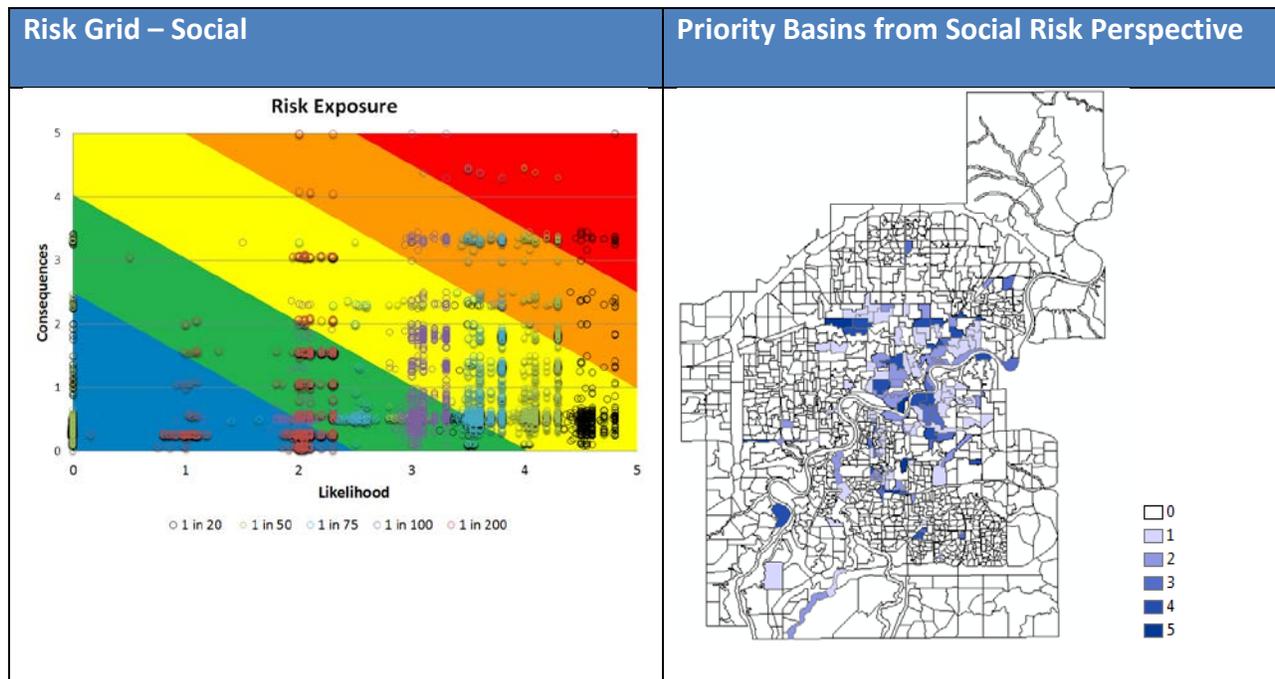
The map below illustrates the basins where there is a potential financial risk exposure that is High or Medium-High with the darker colors indicating that the risk exposure is indicated across multiple storm scenarios.



Financial risk has been determined through an assessment of the risk of basement flooding through either sanitary surcharge through the service lines or via overland flooding reaching a depth that can enter the properties through openings in the building form. The Financial consequence score has been set based on the percent of the basin potential exposed to this risk with the highest consequences set if more than 50% of the basin is exposed. The consequence score has also been increased by 0.5 if the asset condition for the pipes in the basin is considered poor.

Social Perspective Risk Results

The map below illustrates the basins where there is a potential Social exposure that is High or Medium-High with the darker colors indicating that the risk exposure is indicated across multiple storm scenarios.



Social risk is primarily driven by three flooding conditions:

- The sub-basin contains a critical infrastructure service that has potential exposure due to proximity to flooding depths in excess of 1 meter or sanitary sewer charge above the typical basement floor elevation
- Creek locations at risk of significant erosion that could damage an essential utility service that is located adjacent or crossing the creek
- Basins with significant sanitary sewer surcharge depths that could result in significant damage to properties displacing residents for an extended period for repairs if the homes do not have a functioning backwater valve.

The public opinion survey indicated that there is a preference that critical infrastructure and services that supports human health and essential utilities should be protected to a higher standard; EPCOR is proposing to target a Medium-Low risk exposure for these locations. The following table summarizes the number of critical infrastructure locations with a potential risk exposure above this level.

		Sub-basin Risk Exposure Ranking Summary for Locations with Critical Infrastructure				
		Risk based on high risk seen in any Storm Scenarios				
Critical Infrastructure	Number of Assets	Low Risk	Medium-Low Risk	Medium Risk	Medium-High Risk	High Risk
Hospitals and Urgent Care Facilities	8	2		1	2	3
Police Stations	35	1	2	20	7	5
Fire Halls	28	3	6	10	6	1
Ambulance Stations	13	1	2	6	2	2
Water and Wastewater Plants	3					3
Electrical Substations	16	1		8	6	1

Over the next few months EPCOR will review the hospitals and essential services locations at the parcel level to identify flood mitigation alternatives for these specific parcels to bring the risk level to the Medium Low level. The locations of the social service agencies will also be reviewed to identify mitigation to bring these locations to Medium risk ahead of the other sub-basins. Each of the remaining high risk and medium-high risk sub-basins will also be reviewed to confirm the risks at the property level and identify proposed capital and operational programs to reduce the risks for these sub-basins to the Medium level.

Combined Risk Results

This section presents the prioritized stormwater sub-basins considering different weighting scenarios between the four risk dimensions. EPCOR requests Utility Committee feedback on the preferred scenario as this will determine the order that these basins will be assessed for flood mitigation.

For this analysis the maximum risk ranking in each dimension across all storm scenarios has been used in the weightings. Three different weighting scenarios are presented in tabular and map format.

- Scenario 1 - Equal weighting of all four risk dimensions – 25% each
- Scenario 2 - 30% Health and Safety, 30% Social, 25% Financial, 15% Environment
- Scenario 3 - 40% Financial, 20% for Health and Safety, Financial and Environment

Scenario 2 is aligned with the public opinion survey results presented earlier in this report.

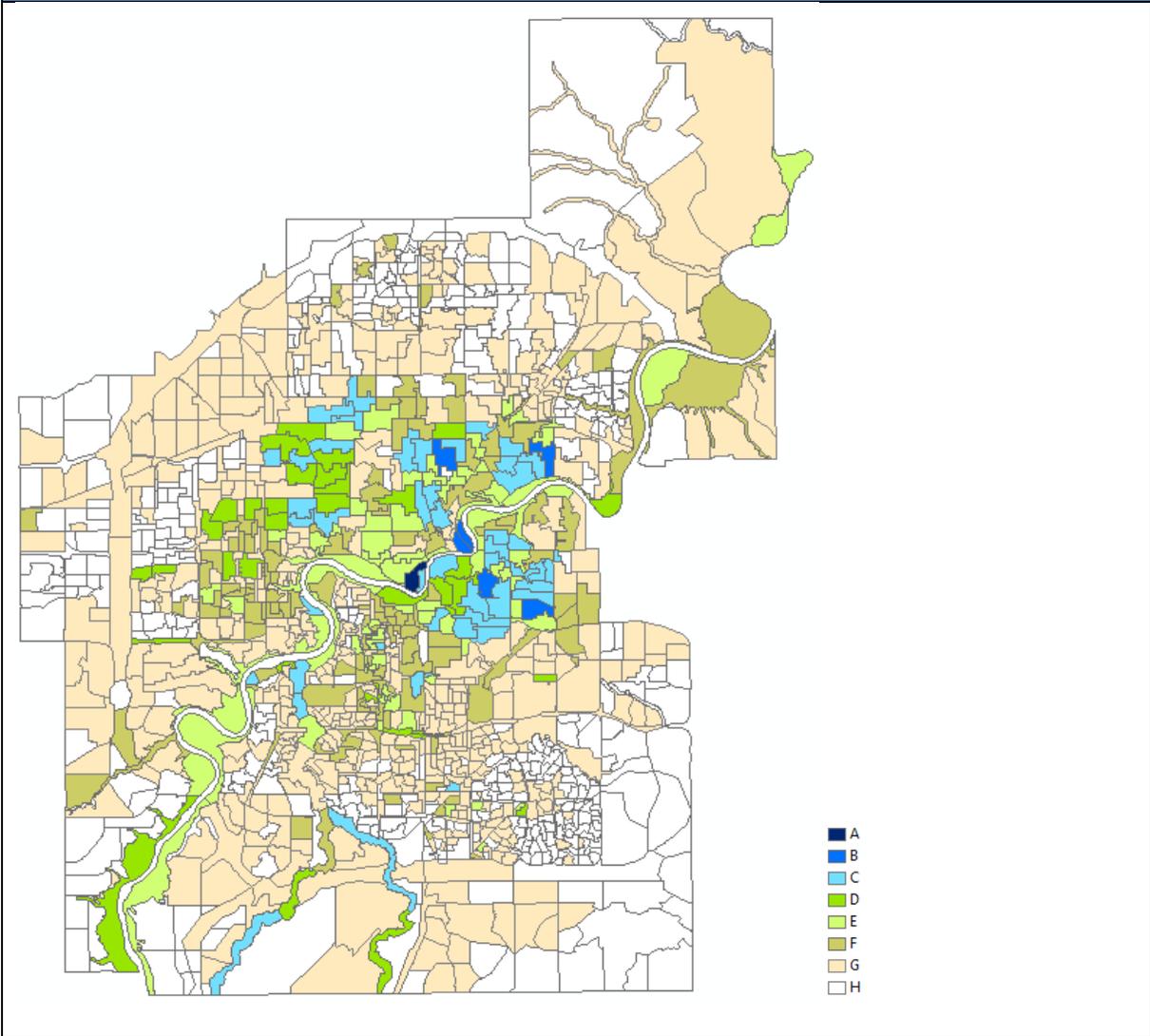
Scenario 3 places a higher focus on addressing basins that have a greater potential for property damage.

To provide additional clarity on how the sub-basin priorities shift with the different weightings, we applied additional granularity on the risk ranking for each sub-basin applied. For the April 2019 report to Utility Committee EPCOR will focus on the identification of flood mitigation initiatives for the sub-basins in Groups A to E.

For the Group F to H ranked sub-basins EPCOR expects to continue to incorporate flood mitigation opportunities through alignment with other planned construction activities. For example, within the neighbourhoods being rehabilitated through the City of Edmonton Building Great Neighbourhoods initiative over the last year the SIRP team has identified opportunities to reduce basement flooding risks in trapped low areas through sanitary manhole sealing. Discussions are underway on how to incorporate more low impact development infrastructure to increase the ability capture and detain stormwater run-off within a neighbourhood as part of the sidewalk and boulevard reconstruction starting in 2019.

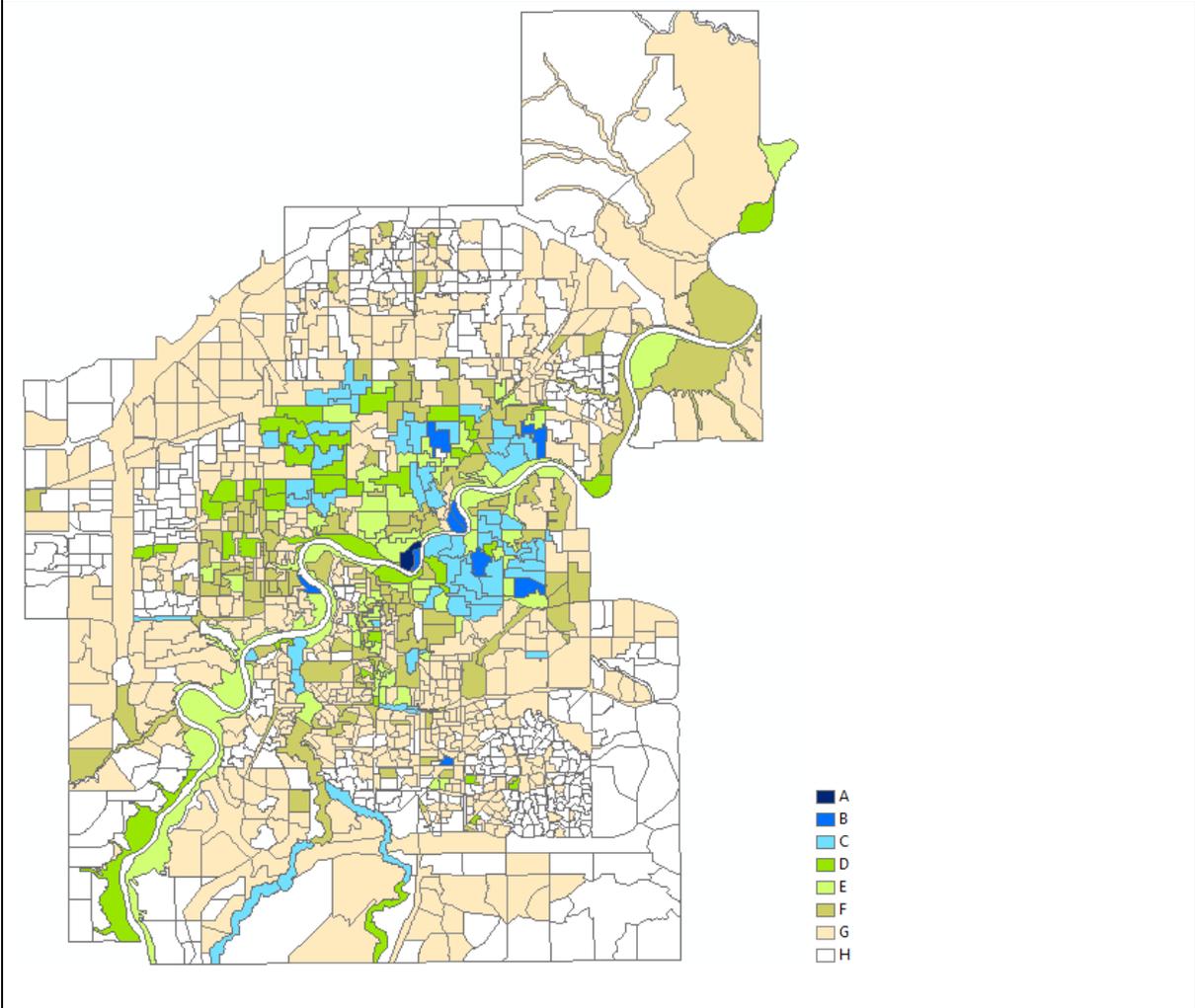
Scenario 1 - Equal Weighting	Number Basins by Risk group	
Health and Safety – 25% Environment – 25% Social – 25 % Financial 25%	Group A - 1 Group B - 6 Group C - 45 Group D - 35 Group E - 69 Group F - 140 Group G - 553 Group H - 461	<u>Groups A-C</u> include High Risk Basins <u>Groups D-F</u> include Medium High Risk Basins <u>Group G</u> is Medium Risk Basins <u>Group H</u> is Medium Low and Low Risk Basins

Scenario 1 – Sub-basin Priority Map



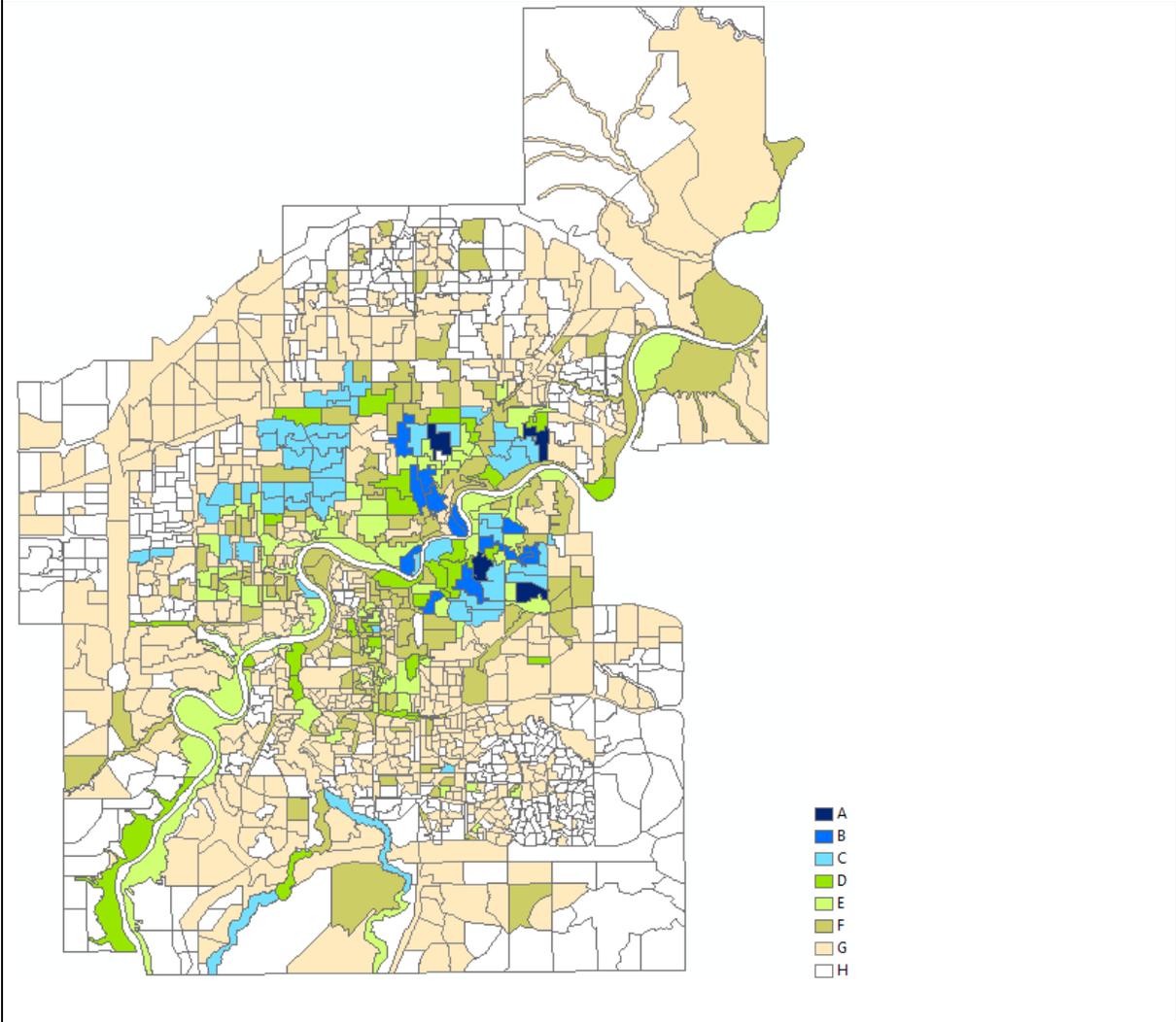
Scenario 2 – Public Opinion Survey Preference	Number Basins by Risk group	
Health and Safety – 30% Environment – 15% Social – 30 % Financial 25%	Group A – 1 Group B - 9 Group C - 51 Group D - 39 Group E - 66 Group F - 139 Group G - 543 Group H - 462	<u>Groups A-C</u> include High Risk Basins <u>Groups D-F</u> include Medium High Risk Basins <u>Group G</u> is Medium Risk Basins <u>Group H</u> is Medium Low and Low Risk Basins

Scenario 2 – Public Opinion Survey Preference Map



Scenario 3 – Property Damage Focus	Number Basins by Risk group	
Health and Safety – 20% Environment – 20% Social – 20 % Financial 40%	Group A - 4 Group B - 13 Group C - 46 Group D - 30 Group E - 72 Group F - 143 Group G - 553 Group H - 449	<u>Groups A-C</u> include High Risk Basins <u>Groups D-F</u> include Medium High Risk Basins <u>Group G</u> is Medium Risk Basins <u>Group H</u> is Medium Low and Low Risk Basins

Scenario 3 – Property Damage Focus Map



Utility Committee Feedback Required and Next Steps

Utility Committee support of the recommended policy directions are requested to consider a lower risk tolerance target for the flooding impacts identified as higher priority to mitigate from the public opinion survey.

- Hospitals: In sub-basins that impact hospitals, the flood risk exposure adjacent to the property should not exceed the Medium Low level (green band).
- Essential Services: In sub-basins that impact essential utilities and emergency services, the risk exposure adjacent to the property should not exceed the Medium Low level (green band).
- Protection of Life: Where there is a risk of: (a) basement flooding up to the ground level, (b) rapid underpass flooding, or (c) underground parking garage flooding, the flood risk exposure should not exceed the Medium Low level (green band).
- Social Services: In sub-basins where social services agencies are located, the flood risk exposure adjacent to the property should not exceed the Medium level (yellow band).

EPCOR also requests that the Utility Committee support the risk framework methodology and provide direction on the preferred weightings between the four risk dimensions for stormwater sub-basin prioritization to determine the priority risk basins that will be reviewed in more detail for capital and operational flood mitigation initiatives. EPCOR is proposing to focus on sub-basins between the risk groupings A to E.

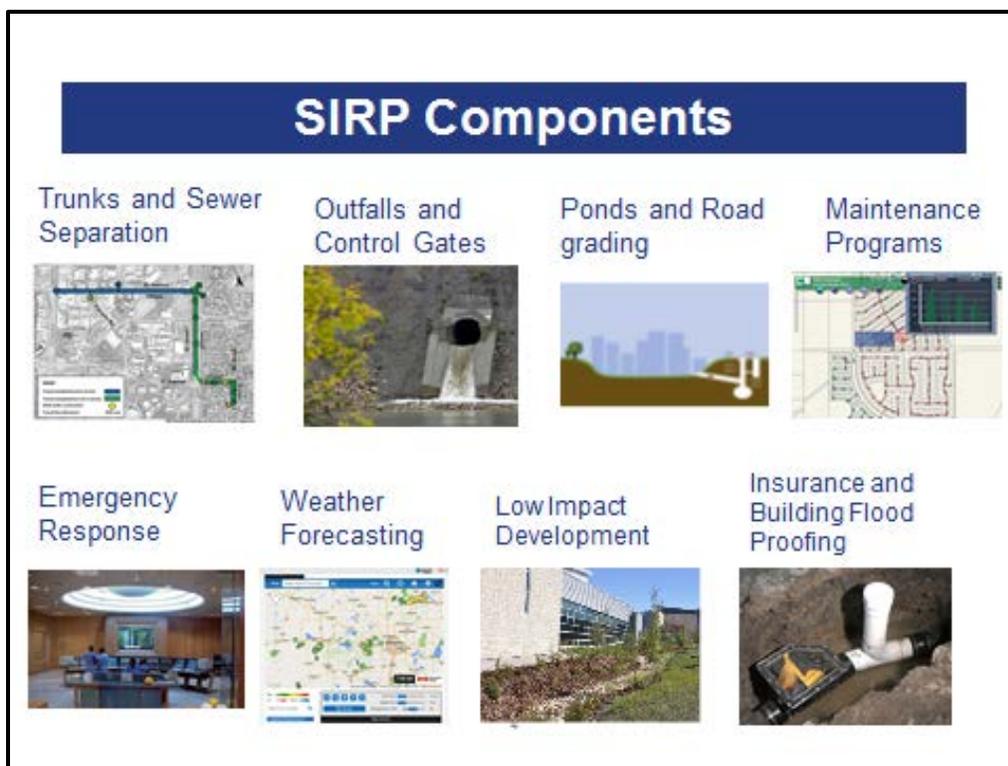
Based on the preference of Utility Committee, EPCOR will develop recommendations for capital infrastructure investments and operational program resourcing to reduce the overall risks for the targeted sub-basins. We anticipate developing a number of different spend profiles covering multiple timelines for consideration.

We will return to Utility Committee in April 2019 with a proposal for an Accelerated Flood Mitigation program, along with the proposed adjustments to the stormwater rates to support the program to cover to the end of the Drainage PBR period. Subsequent investments in flood mitigation will be incorporated into the overall Drainage PBR renewal through the normal regulatory approval process with Utility Committee and City Council.

Prior to the next PBR renewal we will continue to enhance the overall risk framework analysis through the continued enhancement of the information contained in the different data sets supporting the risk analysis. The public engagement survey results will continue to be

referenced through the process of identifying mitigation initiatives to ensure the solutions address the flooding impacts important to citizens

The solutions that will be reviewed will include a mix of grey and green infrastructure components installed within the public right-of-way or within City- or EPCOR-owned parcels. EPCOR will also review the potential for increased flood proofing on private property to reduce the exposure to sanitary surcharge and overland flooding risks. Operational maintenance programs and monitoring programs will also be considered to provide additional mitigation prior to the installation of physical flood mitigation options. The following figure from the February 23rd Utility Committee presentation summarizes these different options.



EPCOR will continue to coordinate with City of Edmonton programs to identify additional opportunities to leverage flood mitigation as part of programs such as Building Great Neighbourhoods.

Appendix A - Public Opinion Survey Results

The SIRP process will result in a series of recommended investments, operational improvements and design standard choices. The City of Edmonton Utility Committee is the key decision maker for approving the overall risk methodology and goals, and for approving Drainage rate filings and capital plans.

EPCOR is integrating public and stakeholder input into the building of the recommendation on the overall approach to risk framework to prioritize mitigation efforts and will incorporate additional public involvement in the concept and detailed design as specific infrastructure projects are identified for construction.

The SIRP risk methodology presented in this report has incorporated the public feedback gathered through the two phases of public engagement work that was conducted between November 2016 and June 2017 (Phases 1 and 2) by the City of Edmonton and the most recent public opinion survey(s) completed by EPCOR (Phase 3) in the last few months.

Phases 1 and 2 gathered information through the Edmonton Insight panel, two public opinion surveys, community discussion groups and included input gathered through a discussion guide and focus group discussions.

Phase 1 and 2 Public Engagement Feedback	
Phase 1	Phase 2
<ul style="list-style-type: none"> Edmontonians need more information on flood risk levels Citizens and community groups recognize the importance of improving Edmonton’s drainage system Opinions are mixed on the best approach to mitigate flood risk and how to pay for it Edmontonians need more information about drainage ponds Edmontonians are willing to accept construction if done with proper considerations 	<ul style="list-style-type: none"> It is important to improve Edmonton’s drainage system to reduce the risk of overland flooding. Underpasses and residential areas should be prioritized over industrial areas. Faster construction schedules are preferred. The majority of Edmontonians consider adding dry ponds to parkland and/or sports fields to be an environmentally friendly solution for flood mitigation.

Phase 3 of the public engagement efforts occurred over the last few months (August and September 2018) and focused on gathering additional public input to refine the risk framework developed to support the SIRP risk prioritization approach.

Phase 3 consisted of an online public opinion survey with Edmontonians, using a statistically reliable sampling methodology to test and validate public preferences for flood mitigation (what infrastructure they want to see protected from the impacts of a flood). Once the survey was completed, an open public-facing version was prepared to enable further public engagement. The final report of Phase 3 is also provided as a separate attachment for reference.

The following tables provide a high-level comparison of the two online survey approaches and participant pool.

Phase 3 SIRP Public Opinion Survey - Part 1 & 2 Comparison of Approaches		
	Primary survey	Public engagement survey
Survey period	August 9 -19, 2018	August 20 - November 2018
Sample size	n=1,500 Edmonton residents (Edmonton proper)	n=TBD respondents (non-representative sample)
Survey sampling and distribution	<ul style="list-style-type: none"> The majority of respondents were recruited through MARU’s Voice Canada online panel, along with ThinkHQ’s Voice of Alberta panel. 	<ul style="list-style-type: none"> The public engagement survey was open to anyone who wished to participate. Survey links were shared with a number of sources including EPCOR employees, EPCOR’s social media and industry sources (UDI, etc.). NOTE: A shorter survey was used for this exercise.
Accuracy/sampling approach	<ul style="list-style-type: none"> A balanced sampling approach was used to survey Edmontonians. This online survey utilizes a representative but non-random sample; therefore, margin of error is not applicable. However, a probability sample of this size would yield a margin of error of +/- 2.5 percentage points at a 95% confidence interval. Data was also weighted to reflect gender and age of the Edmonton population according to Statistics Canada. 	<ul style="list-style-type: none"> Anonymous survey links were shared with various lists and through social media. Respondents voluntarily chose to participate (self-selection bias) and therefore, may not represent the average Edmontonian. Results from this channel were focused on engaging all citizens that wished to contribute.
Methods used to rank the flood impact scenarios for mitigation:		
Moderate impacts	Select top five	Select top five
Major impacts	Choice-modeling*	Choice-modeling*
Extreme impacts	Choice-modeling*	Not surveyed

Flood Impact Scenarios

The flood impact scenarios used in the Phase 3 public engagement survey are presented in the following tables for the Moderate, Major and Extreme flooding events.

Moderate Flood Impact Scenarios

Health and Safety

- For a few weeks, residents and contractors in your neighbourhood are at risk of illness (e.g., respiratory and digestive issues) through contact with sewage and mold while clean-up and repairs are made.
- Basement flooding puts residents at risk of injuries (e.g. tripping, pulled muscles, sprains, etc.).
- Due to flooding impacting the building, wait-times increase at a local hospital or urgent care centre overflowing with patients who become ill or injured during flooding.
- Stormwater floods part of the street in front of your home. Flooding is contained to the road between the curbs until it recedes/drains away.
- An underpass or parking lot floods at a high rate of speed, causing vehicles to stall and be abandoned by owners, and some minor injuries are incurred.

Environment

- Vegetation in neighbourhood yards, parks, playgrounds and greenspaces is seriously damaged by flooding and requires some restoration.
- Some vegetation, insects and wildlife are all killed in a localized area due to a small amount of chemical pollutant or sewage spilling.
- Neighbourhood parks, trails, creeks and sidewalks are damaged due to soil erosion, making them inaccessible for several weeks while being repaired.
- Some vegetation, insects and wildlife are all killed in the immediate vicinity of a flood-related accident involving a truck/train derailment spilling the chemicals, oil or gases they are carrying.
- Garbage clean-up in your neighbourhood is delayed for several weeks due to large amounts of garbage (e.g., discarded furniture, household items and damaged drywall) piling up in yards, sidewalks and roadways.

Social

- A high-rise building with offices and residential condos loses power. The building is accessible but for several weeks, people must take the stairs to their floor.
- Family members or close family friends are temporarily displaced from their home, requiring you to care for them or support them for several weeks.
- Major roadways, bridges or transit infrastructure are damaged, doubling your commute to and from your home for several weeks.
- Agencies that support homeless or vulnerable citizens are temporarily displaced for several weeks and unable to get enough essential services they need such as food, shelter or addiction/mental health support.
- Your neighbourhood loses an essential utility (such as power, natural gas or drinking water) for several weeks. Access to your home could be restricted until service is restored.
- The impacts of flooding cause personal stress for several weeks as you worry about home repairs and finances.
- Emergency services buildings (police, fire, EMS) are damaged, limiting access to services for several weeks for repairs and response times are delayed.

Financial

- Local businesses and services (e.g. local mall, recreation centre, businesses you frequent, etc.) are forced to close for several weeks.
- Your employer's building (or a family member's employer) is temporarily inaccessible until repairs are completed, causing lost wages for a few weeks.
- Homes and properties in your neighbourhood experience serious outdoor damage (e.g. damage to fencing, vehicles, gardens, etc. outside the home). Home-owners are out of pocket thousands of dollars to replace or fix.
- Residential properties in your neighbourhood are damaged and require repairs. Single family homes have up to 6-inches of water in the basement and condos/apartment buildings have up to 6-inches of water in the basement or lower-level suites.
- Vehicles in parkades, garages and parking lots in your neighbourhood are damaged due to stormwater around the wheels/floorboards/brakes. Vehicles require repairs taking several weeks.
- Low income individuals are unable to afford repairs to their homes without assistance, forcing them to live in a damaged home for several weeks.

Major Flood Impact Scenarios

Health and Safety

- For a few months, residents and contractors in your neighbourhood are at risk of illness (e.g., respiratory and digestive issues) through contact with sewage and mold while clean-up and repairs are made.
- Basement flooding puts residents at risk of injuries requiring medical attention (e.g. falls, back injuries, electric shock, etc.).
- Due to flooding impacting the building, a local hospital or urgent care centre is forced to close, turning away all patients.
- Stormwater floods streets in your neighbourhood and extends onto your property or lawn. Access to your location is restricted until the area can be cleaned and sanitized.
- An underpass or parking lot floods at a high rate of speed, causing vehicles to stall or collide, and people need to be rescued from their vehicles and taken to the hospital.

Environment

- The ecosystem (vegetation, insects and wildlife) in your yard, neighbourhood parks, playgrounds and greenspaces is destroyed and vegetation needs to be replanted.
- The ecosystem (vegetation, insects and wildlife) in a large natural area is killed due to a large amount of chemical pollutant or sewage spilling into it.
- Neighbourhood parks, trails, creeks and sidewalks are damaged due to soil erosion, making them inaccessible for several months while being repaired.
- The ecosystem (vegetation, insects and wildlife) in a large area (e.g., area the size of a pond or a neighbourhood) is killed as a result of a flood-related accident involving a truck/train derailment spilling the chemicals, oil or gases it is carrying
- Garbage clean-up in your neighbourhood is delayed for several months due to large amounts of garbage (e.g., discarded furniture, household items and damaged drywall) piling up in yards, sidewalks and roadways).

Social

- A high-rise building with offices and residential condos loses power. The building is inaccessible for several months.
- Family members or close family friends are temporarily displaced from their home, requiring you to care for them or support them for several months.
- Major roadways, bridges or transit infrastructure are damaged, doubling your commute to and from your home for several months.
- Agencies that support homeless or vulnerable citizens are temporarily displaced for several months and unable to get enough essential services they need such as food, shelter or addiction/mental health support.
- Your neighbourhood loses an essential utility (such as power, natural gas or drinking water) for several months. Access to your home could be restricted until service is restored.
- The impacts of flooding cause extensive personal stress (e.g., depression, anxiety, sleep disorders, etc.) for several months as you worry about home repairs, finances and accommodations.
- Emergency services buildings (police, fire, EMS) are damaged limiting access to services for several months for repairs. Services are limited during repairs.

Financial

- Local businesses and services (e.g. local mall, recreation centre, businesses you frequent, etc.) are forced to close for several months.
- Your employer's building (or a family member's employer) is temporarily inaccessible until repairs are completed, causing lost wages for a few months.
- Homes and properties in your neighbourhood experience serious outdoor damage (e.g. damage to fencing, vehicles, gardens, etc. outside the home). Home-owners are out-of-pocket tens of thousands of dollars to replace or fix.
- Residential properties in your neighbourhood are damaged and require repairs. Single family homes have up to 4-feet of water in the basement and condos/apartment buildings have up to 4-feet of water in the basement or lower-level suites.
- Vehicles in parkades, garages and parking lots in your neighbourhood are damaged due to stormwater getting into the engine. Vehicles and parking areas require repairs taking several months.
- Low income individuals are unable to afford repairs to their homes without assistance, forcing them to live in a damaged home for several months.

Extreme Flood Impact Scenarios

Health and Safety

- The health authority intervenes after increased reports of residents and contractors in your neighbourhood falling ill (e.g., respiratory and digestive issues) through prolonged contact with sewage and mold. Homes/dwellings are condemned.
- Basement flooding to ground-level puts residents at risk of drowning/death from not being able to escape to higher ground.
- Due to flooding impacting the building, a local hospital with specialized services is forced to close, and surgeries and other critical procedures need to be canceled, resulting in patient deaths or worsened conditions.
- Stormwater floods streets in your neighbourhood and completely covers your property or lawn, touching the lower walls of your home/building. Access to your location is restricted until the area can be cleaned and sanitized.
- An underpass or parking lot floods at a high rate of speed, increasing risk of drowning deaths of people unable to escape their vehicles.

Environment

- A large natural area is permanently damaged and not able to be replanted, including vegetation in your yard neighbourhood parks, playgrounds and greenspaces
- The ecosystem (vegetation, insects and wildlife) in the North Saskatchewan River is killed due to a large amount of chemical pollutant or sewage spilling into it.
- Neighbourhood parks, trails, creeks and sidewalks are damaged due to soil erosion, making them inaccessible for upwards of a year while being repaired.
- The ecosystem (vegetation, insects and wildlife) in a major natural area/whole watershed/drainage basin is killed as a result of a flood-related accident involving a truck/train derailment spilling the chemicals, oil or gases it is carrying.
- Garbage clean-up in your neighbourhood is delayed for upwards of a year due to large amounts of garbage (e.g., discarded furniture, household items and damaged drywall) piling up in yards, sidewalks and roadways.

Social

- A high-rise building with offices and residential condos experiences extensive damage, and utilities are unavailable. The building is inaccessible for upwards of a year.
- Family members or close family friends are temporarily displaced from their home, requiring you to care for them or support them for upwards of a year.
- Major roadways, bridges or transit infrastructure are damaged, doubling your commute to and from your home for upwards of a year.
- Agencies that support homeless or vulnerable citizens are temporarily displaced for upwards of a year and unable to get enough essential services they need such as food, shelter or addiction/mental health support.
- Your neighbourhood loses an essential utility (such as power, natural gas or drinking water) for upwards of a year. Your neighbourhood is evacuated – at the time of the flood.
- The impacts of flooding cause life-long chronic mental and physical health issues. Some may go on long-term disability as a result of the impacts.
- Emergency services buildings (police, fire, EMS) are destroyed, staff and services are relocated, and response times may be impacted. Services from the destroyed building are unavailable for months.

Financial

- Local businesses and services (e.g. local mall, recreation centre, businesses you frequent, etc.) are forced to close for upwards of a year.
- Your employer's building (or a family member's employer) is temporarily inaccessible until repairs are completed, causing lost wages for upwards of a year.
- Homes and properties in your neighbourhood experience serious outdoor damage (e.g. damage to fencing, vehicles, gardens, etc. outside the home). Home-owners are out-of-pocket hundreds of thousands of dollars to replace or fix.
- Residential properties in your neighbourhood are so damaged they require demolition (single family homes and condos/apartment buildings).
- Vehicles in parkades, garages and parking lots in your neighbourhood are completely damaged because vehicles are entirely submerged in stormwater. Vehicles are written-off and parking areas require repairs taking upwards of a year.
- Low income individuals are unable to afford repairs to their homes without assistance, forcing them to leave their homes permanently.

Principal Research Findings

A copy of the research results report from ThinkHQ is appended to this document. This section summarizes the principal results from the MaxDiff research.

Demographics of Respondents

The survey participants (n=1,501) had the following demographic characteristics:

- Gender: 50% male, 50% female
- Age: 34% 18-34, 35% 35-54; 31% 55+
- Household income: 22% <\$50k, 35% \$50-99k, 32% \$100+k, 11% did not disclose
- Education: 13% high school, 33% college, 54% university
- Employment: 66% full-time, 9% seeking employment, 3% student, 22% not working
- Business owner: 4%
- Born in Canada: 82% yes, 18% no
- Moved to Canada (n=276): 17% <5 years, 15% 5-10 years ago, 16% 11-20 years ago, 51% >20 years ago
- Caregivers: 32% children at home, 10% caregiver, 1% receive care, 60% none of these

MaxDiff Relative Importance Scores

Analysis of the choice-based research results in a relative importance score for each flood impact. Impacts with a higher score hold a higher degree of importance in comparison to the other impacts measured. The values are not percentages – instead, they indicate the degree of relative difference between the items. An impact with a value of 80 is twice as important as an impact with a value of 40.

Values that are clustered together have relatively similar importance. In the table below, the clusters have been further broken down into three broad categories: items with higher relative preference, moderate relative preference, and low relative preference.

Major Flood Impacts

Relative Importance Score by category:

- 63 Health & Safety
- 57 Social

- 46 Financial
- 29 Environment

Higher Relative Preference (to protect against)

Score	Impact (short-form descriptor)	Category
90	Essential utilities lost	Social
88	Hospitals forced to close	Health & Safety
84	Emergency buildings damaged	Social
74	Residential – indoor damage	Financial
71	Home – risk of illness	Health & Safety

Moderate Relative Preference – Higher Middle (to protect against)

Score	Impact (short-form descriptor)	Category
62	Support agencies displaced	Social
60	Some can't afford repairs	Financial
58	Basement – injury risk	Health & Safety
58	Underpass floods quickly	Health & Safety

Moderate Relative Preference - Lower Middle (to protect against)

Score	Impact (short-form descriptor)	Category
52	Work building inaccessible	Financial
47	Garbage clean-up delayed	Environment
45	Personal stress	Social
43	Residential – outdoor damage	Financial
43	Street flooded at home	Health & Safety
43	Care for friends and family	Social
42	Nature killed – chemical spill	Environment

Low Relative Preference (to protect against)

Score	Impact (short-form descriptor)	Category
38	Highrise inaccessible	Social
36	Doubled commute time	Social
35	Nature killed – pollutants	Environment
26	Businesses closed	Financial
20	Vehicles damaged	Financial
16	Nature requires restoration	Environment
8	Sidewalks damaged	Environment

Extreme Flood Impacts

Relative Importance Score by category:

- 70 Health & Safety
- 56 Social
- 42 Financial
- 31 Environment

Higher Relative Preference (to protect against)

Score	Impact (short-form descriptor)	Category
89	Hospitals forced to close	Health & Safety
85	Essential utilities lost	Social
84	Homes lost / illness	Health & Safety
83	Emergency buildings destroyed	Social
74	Basement – injury risk	Health & Safety

Moderate Relative Preference – Higher Middle (to protect against)

Score	Impact (short-form descriptor)	Category
65	Residential – properties demolished	Financial
64	Personal health issues (physical/mental)	Health & Safety
62	Underpass floods quickly	Health & Safety
59	Support agencies displaced	Social
58	Some can't afford repairs	Financial

Moderate Relative Preference - Lower Middle (to protect against)

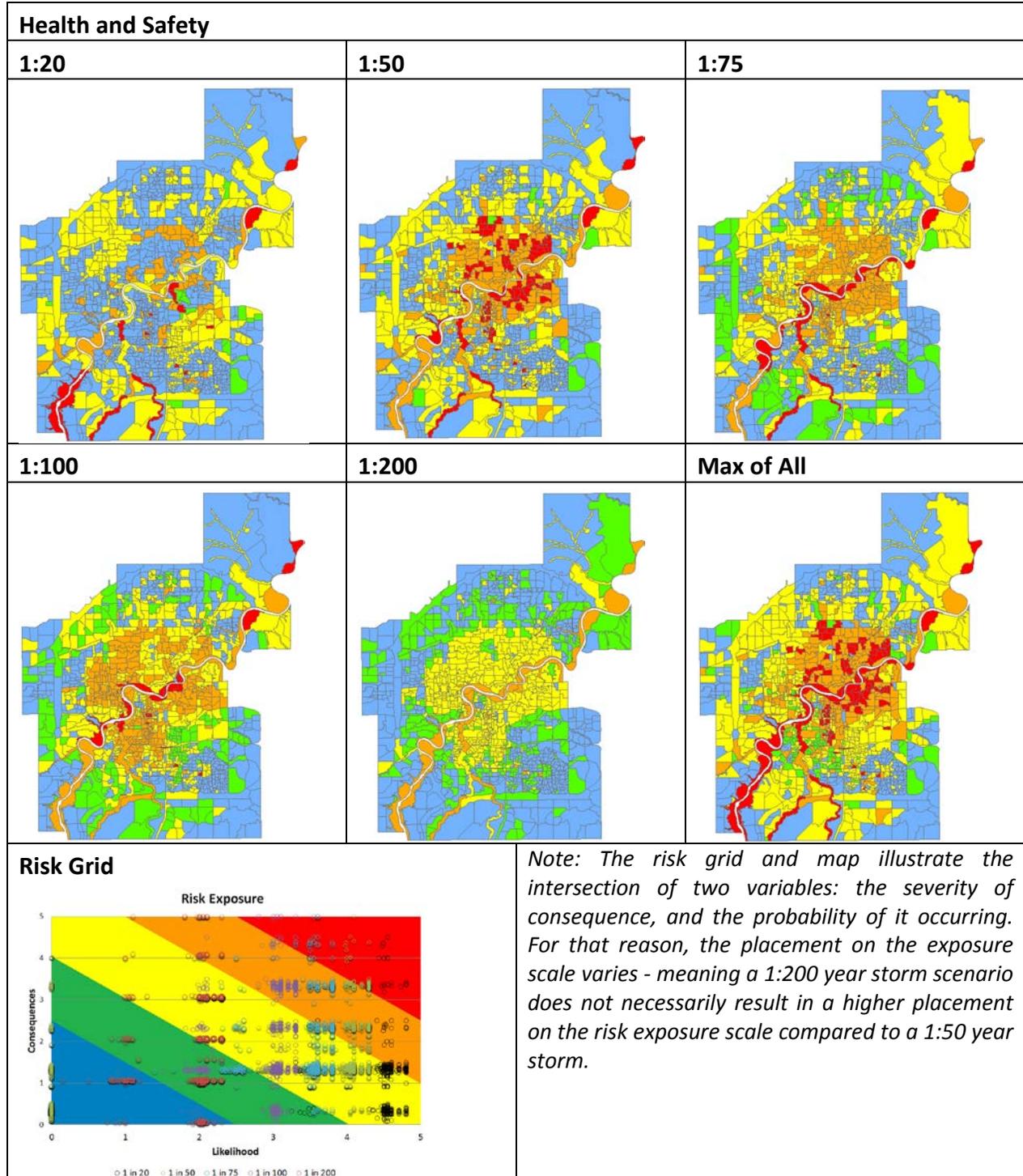
Score	Impact (short-form descriptor)	Category
52	Work building inaccessible	Financial
47	Garbage clean-up delayed	Environment
44	Street flooded at home	Health & Safety
42	Nature killed – chemical spill	Environment
41	Nature killed – pollutants	Environment
40	Residential – outdoor damage	Financial
40	Care for friends and family	Social

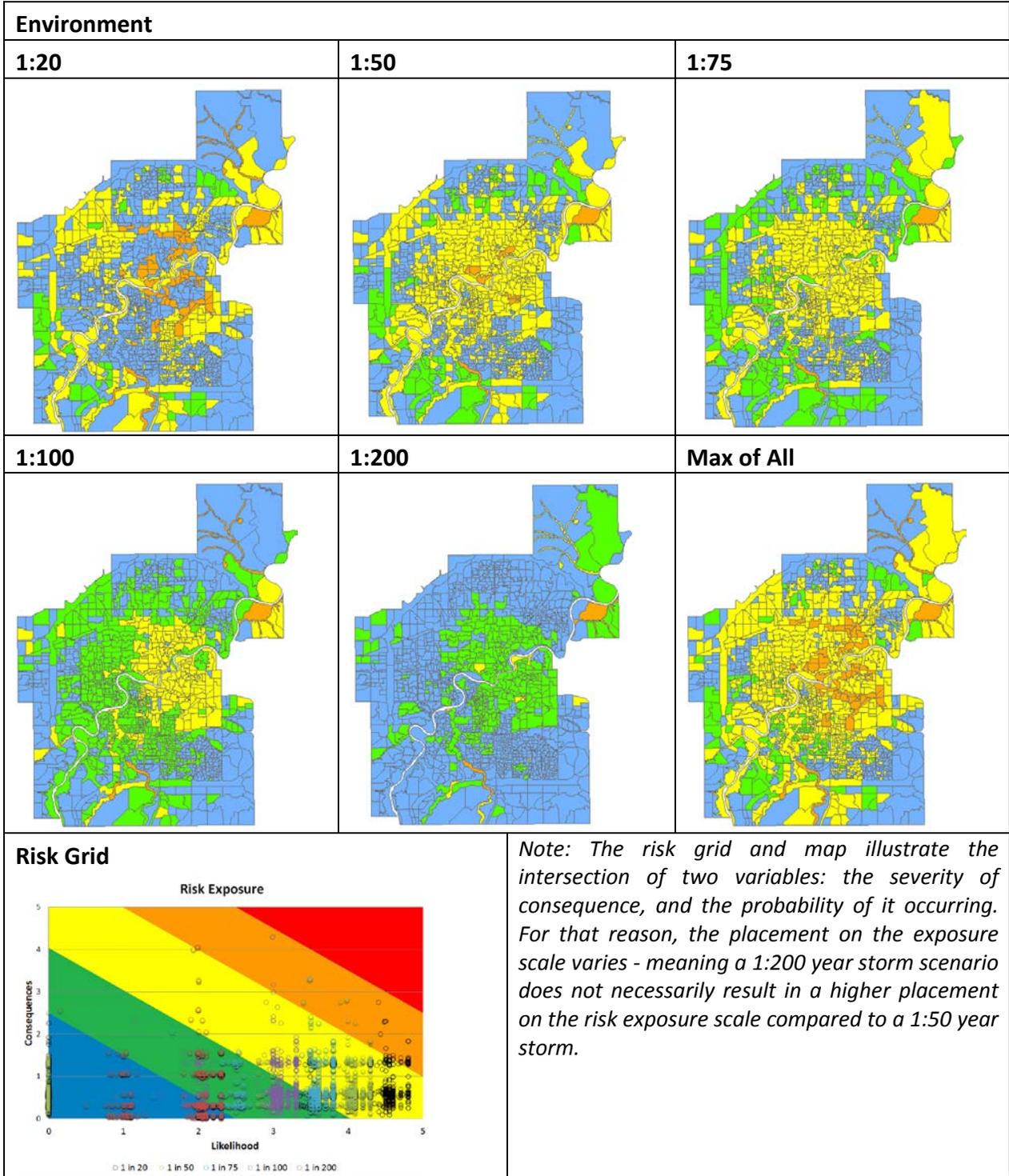
Low Relative Preference (to protect against)

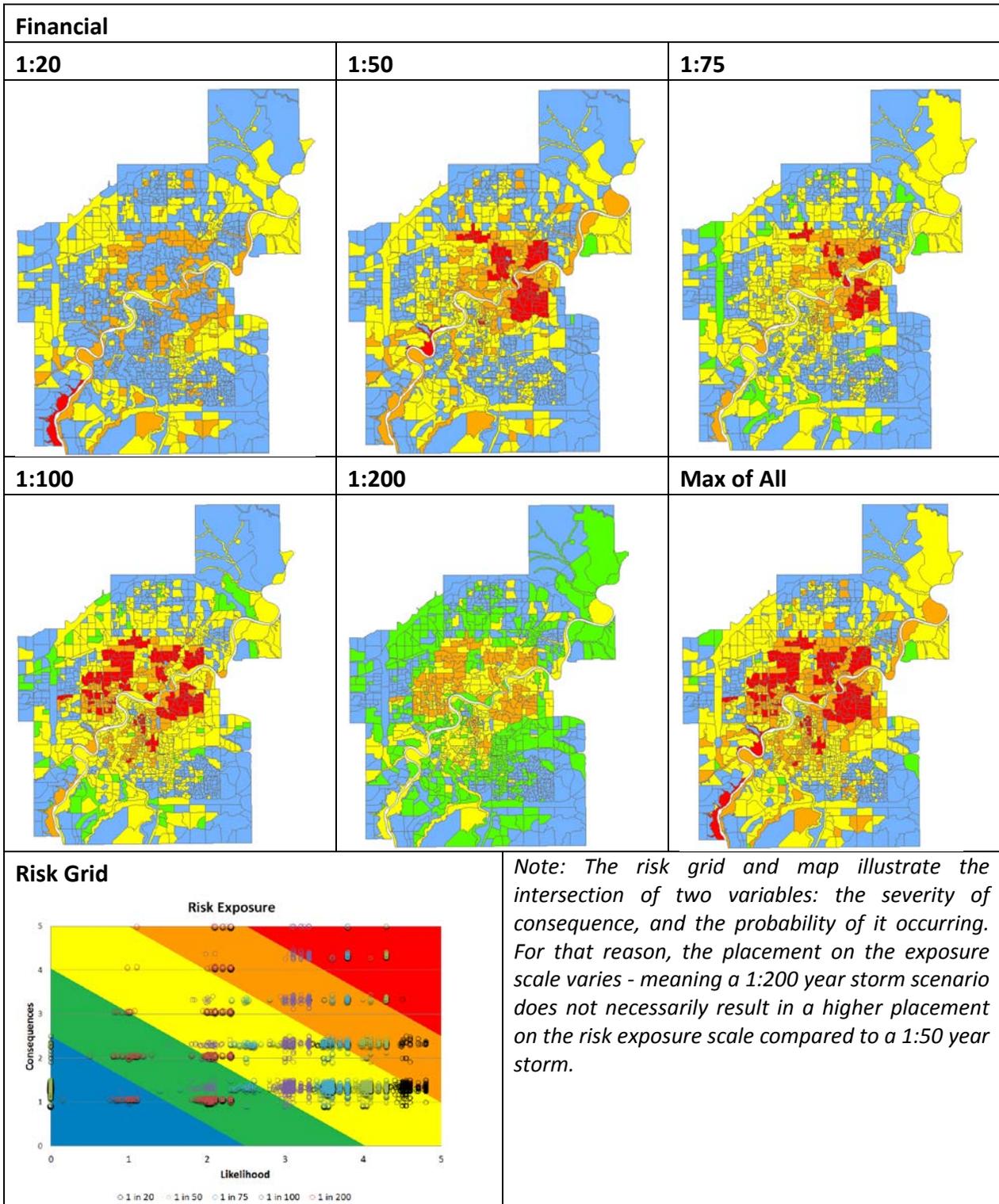
Score	Impact (short-form descriptor)	Category
32	Highrise inaccessible	Social

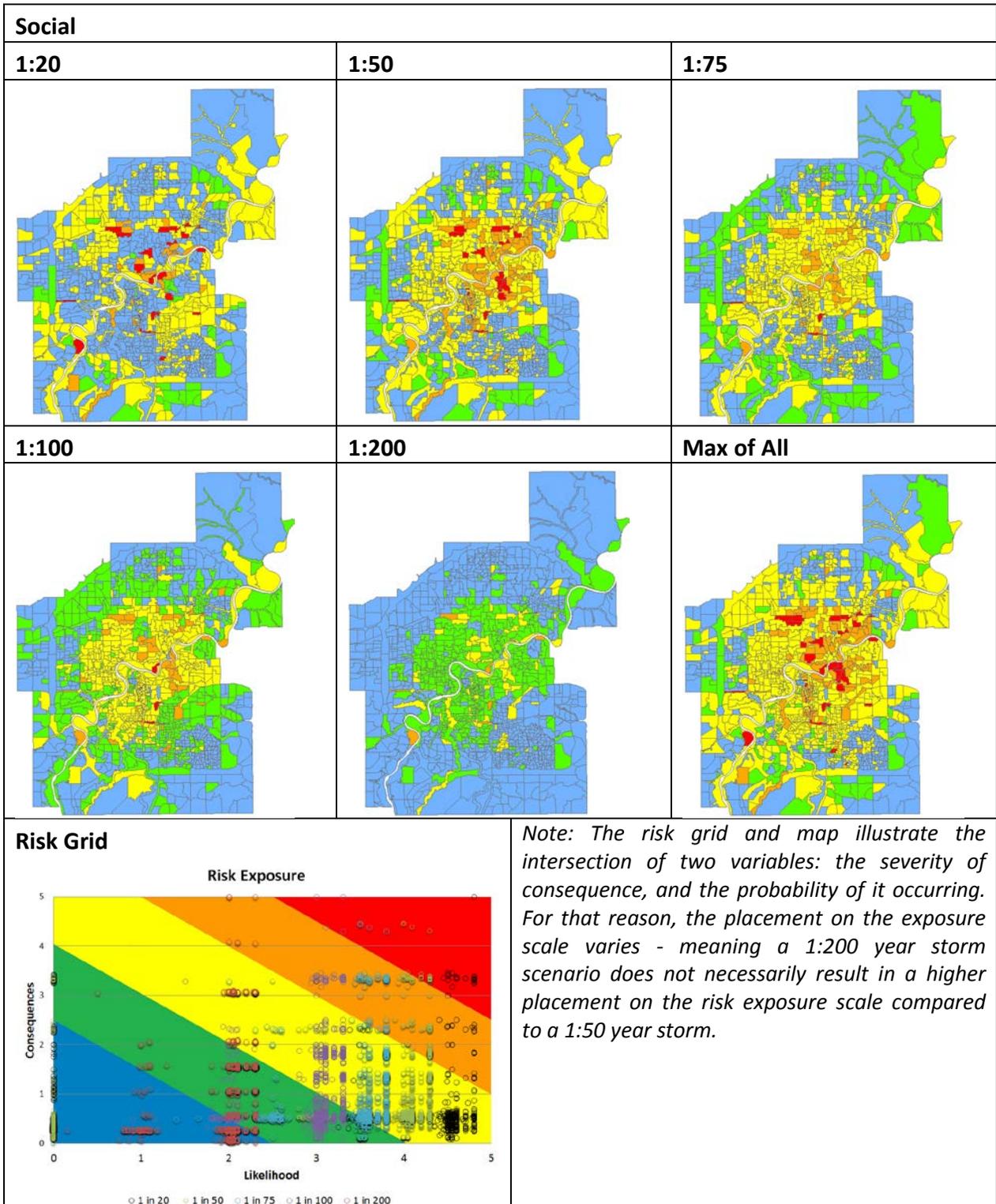
28	Doubled commute time	Social
21	Businesses closed	Financial
18	Nature permanently damaged	Environment
17	Vehicles damaged	Financial
8	Sidewalks damaged	Environment

Appendix B – Flood Risk Maps by Risk Category and Storm Scenario









Appendix C - Industry Initiatives Participation

To ensure that the development of the SIRP aligns with industry best practices and leverages innovative approaches being implemented by cities around the world, EPCOR has increased the level of industry participation by the Drainage utility over the last year. This section provides a brief overview of these activities and how this participation is contributing to the overall SIRP development and supports recognition that Edmonton is a leading utility in addressing flood mitigation.

Standards, Best Practices and Policy development	
Intact Center on Climate Change Adaptation	EPCOR is a member of the project team developing this best practice guideline. This has included participation in a series of workshops and conference calls including representatives from utilities, municipalities, insurance industry, consultants, home builders and provincial and federal government representatives.
Existing Community Flood Mitigation Best Practices	The draft document is currently in circulation for comments with a particular focus on how to manage risk and prioritization of capital investments. There is potential for SIRP to be included as a best practice case study
Canadian Standards Association	EPCOR is a member of the project team adapting the ICCA Best Practices for Flood Mitigation in Greenfield development into a CSA Standard.
Best Practices for Flood Resilient Greenfield Development	EPCOR is participating as reviewer of the overall standard and providing input on how the standard will support and integrate with the local municipal policy and design standards. A major input from EPCOR was to clarify the end audience of the standard to determine the level of detail required. This resulted in the focus shifting to focus on developing a standard that a municipality can use to audit/validate their local standards as opposed to a standard meant to replace the local standard. The focus was also expanded to cover the additional operational risks that occur in greenfield development during the full build out construction process.
Intact Center on Climate Change Adaptation and Canadian Standards Association	EPCOR has been in contact with ICCA and CSA and with the communities that have been piloting the flood assessment protocols and new flood protection standard. The standard was formally released in August and training across Canada on home inspection for flood risk reduction will be available in January/February 2019.
Home Flood Risk Assessment Training Course and CSA Z800 Basement Flood Protection Standard	EPCOR is currently reviewing the CSA Z800 standard for any changes required to the Edmonton design standards and will be incorporating the enhanced training into the current Home Flood Assessment programs offered by EPCOR as the program is rolled out across Canada

Standards, Best Practices and Policy development

<p>Canadian Water and Wastewater Association</p> <p>Climate Change Committee and National Roundtable on Flood Proofing</p>	<p>EPCOR (and Drainage Planning prior to transfer) is a member of the CWWA Climate Change Adaptation Committee. This includes participation on national discussions around potential changes to design storm assumptions and providing support to the National Roundtable on Flood Proofing initiative.</p> <p>For the National Roundtable on Flood Proofing this is a joint initiative being led by Public Services Canada and the Insurance Bureau of Canada. CWWA represents the municipal utility voice on this initiative with specific focus on the financing and modelling and mapping of flooding risks. EPCOR has volunteered to take a lead role on these subcommittees representing CWWA. The initial focus of this initiative has been on river flooding, with CWWA advocating that Urban flooding should also be considered.</p>
<p>Canadian Water Network / Insurance Bureau of Canada / NRCan</p> <p>National Flood Mapping Initiative</p>	<p>EPCOR is a member of the Canadian Water Network Leadership Consortium Group and Susan AnceI (SIRP Project Lead) is a CWN Board member.</p> <p>CWN in conjunction with IBC and NRCan is developing a research project to assess the value of improved topographical mapping being available from NRCan to improve the overall risk assessment of flooding in built up urban environments. Current NRCan topography information available is at a 30-meter grid. The focus of the project will be to determine if the most recent 1-meter grid that NRCan is due to release will be sufficient or if LIDAR (cm accuracy) is required. EPCOR will participate in the project to assess the benefits of the increased level of accuracy and whether the additional expense is required or if sufficient detail to make business choices is available with the 1-meter grid.</p>
<p>Water Research Foundation (WRF)</p> <p>Real Life Enterprise Resiliency Handbook for Utilities</p>	<p>EPCOR is a long term member of the Water Research Foundation and Water Environment Research Foundation (recently merged with WRF).</p> <p>WRF has been funding a series of research projects focused on risk mitigation within utilities. EPCOR participated as a case study in Phases 1 and 2, and is participating in Phase 4 which is developing a handbook and on-line resource for utility leaders compiling the current knowledge of risk management techniques into one location.</p>
<p>University of Waterloo</p> <p>Flood Risk Policy Instruments Research</p>	<p>EPCOR contributed to the University of Waterloo research project exploring the different governmental policy instruments that can be used to manage development within high risk flooding areas.</p> <p>EPCOR was able to share the perspective of the challenges of managing land zoning and building forms through the development process as the hand-offs occur between the developer and builder and land owner. The City of Edmonton development materials available were particularly valuable to the researcher in showing the transition and approvals that occur from municipal plans, area plans, neighbourhood plans, subdivisions, to building permits.</p>

Industry Presentations and Peer Sharing

<p>Canadian Water Network Canadian Leadership Group Meeting and Blue Cities Conference</p>	<p>EPCOR participated in the CWN-CLG meeting held in May which included participants from the major municipalities across Canada and representatives from the major insurance agencies that provide overland insurance coverage across Canada.</p> <p>The focus of the discussion was on sharing the approaches being taken by both industry sectors to reduce flooding risks and raise awareness of the general population. This meeting highlighted the need for the utilities and municipalities to look beyond a single design standard target and to focus on the risks across multiple storms over the life of the property. This is also where the availability of the insurance overland and river flood maps for multiple storm scenarios was identified.</p> <p>CWN also hosted the Blue Cities conference that same week where EPCOR led a panel discussion on the roles of disaster recovery, insurance and utilities in mitigating the risks of flooding and how this is adapting as climate change influences the intensities and frequencies of storm events.</p>
<p>CWWA National Conference</p>	<p>EPCOR will be presenting the SIRP initiative at the CWWA National conference in early November.</p> <p>This conference includes representatives from across Canada from the utility and consultant industries.</p>
<p>CSIS – Canadian Stormwater Institute Conference</p>	<p>EPCOR has been invited to present the SIRP initiative at the Canadian Stormwater Institute Conference in late November.</p> <p>This conference is organized by the Western Canada Water Environment Association and is the inaugural event for what is expected to be an annual conference focused on urban runoff and wet weather flow management</p>
<p>Canadian Benchmarking Exchange – Stormwater Seminar</p>	<p>EPCOR is a member of the Canadian Benchmarking Exchange. This group with representatives from municipalities across Canada regularly meets and shares performance measures and strategies for water, wastewater and storm utility systems.</p> <p>EPCOR will be hosting a two day seminar in Edmonton including representatives from utilities focused on stormwater management.</p>
<p>Alberta Low Impact Development Partnership (ADLIP) Seminar</p>	<p>ADLIP hosts regular seminars in Calgary and Edmonton promoting the application of green infrastructure in Alberta.</p> <p>EPCOR provided an overview of the SIRP at their Edmonton seminar in June.</p>

Industry Presentations and Peer Sharing

<p>Stormwater Rates Survey</p>	<p>EPCOR has been reviewing stormwater rate models used in different jurisdictions across North America from the perspective of gaining a better understanding of the resources and technologies required to support stormwater rates that consider pervious vs. impervious land use.</p> <p>To date we have had detailed discussions with Halifax, Kitchener, Mississauga, Saskatoon, Ottawa in Canada and Denver and Memphis in the United States.</p> <p>EPCOR expects to present a summary of these approaches as contrasted to the current stormwater rate structure in Edmonton as part of the April 2019 update to Utility Committee.</p>
<p>General Peer Sharing</p>	<p>EPCOR continues to outreach to peer communities across Canada to understand the different approaches for prioritizing their stormwater improvements and to gain a better understanding of the extent of implementation of green infrastructure components within the mix of infrastructure being constructed.</p> <p>Regular contact and sharing of our initiatives peer to peer is occurring between ourselves and Calgary, Halifax, Ottawa and Saskatoon. More general interaction is occurring through EPCOR’s involvement in the development of the standards and best practices mentioned previously.</p>

The success of the SIRP is also dependent on the mitigation measures developed integrating into the other programs within the community led by the City of Edmonton. The SIRP team has been involved in a number of discussions with representatives and consultants supporting the initiatives below and continues to identify opportunities to align and leverage investments with these activities.

City of Edmonton Initiatives Alignment

<p>Climate Change Adaptation Plan Development</p>	<p>EPCOR SIRP team and the Climate Change Adaptation team are meeting approximately every two weeks to ensure alignment between our two major initiatives.</p> <p>EPCOR also participated in the VRA and action plan development workshops and the Climate Change team supported the development of the flooding scenarios used in the SIRP Public Engagement survey. We will continue to work closely together as the action plans for both initiatives proceed. Report going to Urban Planning committee on November 13th.</p>
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City of Edmonton Initiatives Alignment

Open Space Planning	<p>EPCOR has regular meetings with the Open Space planning team for the dry ponds that are currently in the development phase.</p> <p>For future ponds we have been discussing the approaches for community engagement to assess amenity impacts and the processes to support land acquisition if required.</p> <p>Representatives from the Open Space planning team have also attended the biweekly meetings with the Climate Change Adaptation team and EPCOR will participate in their Repurposing of Open Space Strategy development. Report going to Urban Planning in Oct 30th.</p>
Grant Applications	<p>EPCOR continues to work with the City of Edmonton on the preparation and submission of grant applications for Federal and Provincial funding to support flood mitigation efforts. Most recently this includes application submitted to DMAF, ICIP, ACRP.</p>
Building Great Neighbourhoods	<p>EPCOR has met with representatives from BGN to coordinate sewer line upgrading in advance of neighbourhood construction as was done prior to the transfer to EPCOR. As the SIRP has been developing EPCOR has also been able to identify additional opportunities to reduce inflow/infiltration during the final paving and manhole restoration process and is exploring opportunities for installation and financing of low impact development during sideway and boulevard installation.</p>
LRT Corridors	<p>EPCOR and the SIRP team has met with the LRT project teams to discuss flooding risks along the LRT corridors and methods to reduce risks due to trapped low areas along the alignments.</p>
Imagine Jasper Avenue	<p>EPCOR is working with the City to evaluate the potential for the installation of low impact development tree cells along the Imagine Jasper Avenue corridor.</p>