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Sewer Backup: Homeowner perception and mitigative behaviour in Edmonton and Toronto

By Dan Sandink

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ICLR's mission is to reduce the loss of life and property caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to adapt to, anticipate, mitigate, withstand and recover from natural disasters. ICLR is achieving its mission through the development and implementation of its programs *Open for business,* to increase the disaster resilience of small businesses, *Designed… for safer living*, which increases the disaster resilience of homes, and *RSVP cities*, to increase the disaster resilience of communities.

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Executive summary

This research is intended to increase awareness and understanding of homeowner perceptions of sewer backup and homeowner risk mitigation in Canadian municipalities, and to provide practical information for municipal staff responsible for managing basement flood risk. The study provides a discussion of the role of effective basement flood education programs for increasing homeowner basement flooding awareness and adoption of damage reducing adjustments. The report concludes with suggestions on how municipalities can increase the effectiveness of basement flood education and homeowner level mitigation programs.

Urban flooding and sewer backup

Basement flood damages in Canadian municipalities cost governments, homeowners and insurance companies millions of dollars each year. In August of 2005, a severe rainfall and urban flooding event in the Greater Toronto Area (GTA) caused extensive overland flood and sewer backup damages, resulting in the most costly storm damage in Ontario's history. In 2004, 2005 and 2006, the City of Hamilton experienced heavy rainfall events that resulted in significant overland flood and sewer backup damages. The cities of Ottawa, Sarnia, Thunder Bay, Peterborough, Winnipeg, Edmonton, Calgary and Moncton have also experienced damaging urban flood events in the last 20 years. A 2002 report by Allouche and Freure revealed that of 26 municipalities surveyed nation-wide, 42% reported that basement flooding occurred several times per year and 92% reported that basement flooding occurred at least once every several years within their jurisdictions.

Increasing urbanization, continued deterioration of public infrastructure, and a lack of municipal financial capacity to adequately monitor, maintain and upgrade sewer infrastructure will enhance the risk of urban flooding. As well, the extreme rainfall events that often cause urban floods are expected to increase in both frequency and intensity as a result of climate change.

The role of the homeowner in sewer backup mitigation

Municipalities have typically addressed sewer infrastructure problems that cause sewer backup with engineering solutions, including conducting engineering studies, separating combined sewers, and other actions related to improving sewer system engineered structures. Many infrastructure problems can be adequately addressed using engineering solutions, and municipal governments should continue upgrading storm and sanitary sewer systems and should ensure that infrastructure systems are developed in a sustainable manner. However, as Canada's municipal infrastructure continues to deteriorate, municipal governments may not have the capacity to adequately address all sewer infrastructure problems at the engineering/structural level. As a result, many municipalities in Canada address basement flood hazards with both structural engineering approaches, and non-structural or social approaches, including educating the public on basement flood risks and encouraging individual property owners to take actions to reduce basement flood risk. A summary of engineering and social approaches is provided in Table A.

Table A: Engineering and social approaches to basement flood risk

Engineering approaches
Conduct engineering studies
Separate combined sewer systems
Decrease infiltration and inflow in sanitary sewer system
Other actions directly related to improving municipal sewer system infrastructure
Social approaches
Conduct social surveys
Public education
Incentive/subsidy programs to address basement flooding at property level
Other actions related to increasing public basement flooding awareness and mitigative actions

In areas where sewer infrastructure upgrading may be delayed, or where upgrading may not be possible, homeowners who are at their risk of sustaining sewer backup damages should take action to reduce risk. Homeowner actions may include the installation of risk reducing mitigative adjustments and the disconnection of extraneous sources of water from the sanitary sewer system, such as eavestrough downspouts and foundation drain connections. Municipal governments should work to increase homeowner awareness of basement flooding risks and mitigation options through effective education programs.

This study investigated sewer backup hazard perceptions and mitigative behaviours of homeowners in Edmonton, Alberta and Toronto, Ontario. The survey sample included both homeowners who had never sustained sewer backup damages (hereafter referred to as *sewer backup negative*) and homeowners who had suffered sewer backup damages at some time in the past (hereafter referred to as *sewer backup positive*). The survey was administered in January, 2007.

Findings

This study revealed that Edmonton homeowners were often twice as likely as Toronto homeowners to adopt effective mitigative adjustments, including backwater valves. Other key findings include:

1. The majority of sewer backup positive homeowners in both the cities of Edmonton and Toronto believed that they would never sustain sewer backup damages again in the future.

2. Sewer backup positive homeowners in both case cities placed the majority of responsibility for damages they sustained from sewer backup on their municipal governments.

3. Few sewer backup positive homeowners in Edmonton and Toronto adopted some of the more effective sewer backup risk reducing adjustments, including the installation of backwater valves and sump-pumps.

4. Disconnection of eavestrough downspouts was the most popular risk reducing adjustment taken in both Edmonton and Toronto; however, less than half of homeowners surveyed in each city adopted this adjustment.

5. Insurance coverage for sewer backup damage was the most popular adjustment adopted by respondents in Toronto and Edmonton, however, there was a relatively high rate of not knowing whether or not one's insurance policy covered sewer backup damages, and few respondents claimed insurance for their most recent sewer backup damages.

6. Homeowners preferred to attain information on how to reduce sewer backup damage risk to their homes from a wide variety of sources. Informal social networks, including family and friends, and other sources, including plumbers and contractors, were the most commonly cited information sources by homeowners in this study.

7. The majority of respondents from both case cities were not aware that their municipal governments were taking actions to reduce sewer backup risk in their city, and uptake of government subsidy programs designed to increase adoption of preventative plumbing adjustments (including backwater valves) was low in both case cities.

8. Homeowners who were aware that the municipal government was taking action to reduce sewer backup were less likely to perceive themselves at risk of future damages. Furthermore, the majority of homeowners who were aware that their municipal government was taking actions considered these actions as either somewhat or very effective.

9. The cities of Edmonton and Toronto have employed education programs to increase knowledge and mitigative behaviour to reduce basement flooding, however, the City of Edmonton has been arguably more progressive in the implementation of their education program.

10. Edmonton homeowners were slightly, yet statistically significantly more knowledgeable about sewer backup hazards, more aware of how to protect themselves from damages, and more likely to adopt effective risk reducing mitigative adjustments.

Conclusions

Results from this study suggest that homeowner risk perceptions and mitigative adjustments related to sewer backup are low. Furthermore, there existed the perception that the municipal government holds the majority of the responsibility for damages caused by sewer backup. Considering the costs of upgrading sewer systems, the unpredictability of heavy rainfall events and the expectation that heavy rainfall events will increase as a result of climate change, homeowners in Edmonton and Toronto will need to become more involved in the mitigation of sewer backup risks over the short- and medium-terms. Homeowners should be encouraged to adopt personal adjustments, and should be made more aware of government programs designed to increase awareness and mitigation of basement flooding and sewer backup. Formalized hazards education programs, including comprehensive information presented from a variety of sources through a variety of channels, may increase sewer backup hazard awareness and mitigative adjustment behaviour and reduce damages caused by sewer backup.

Recommendations

Municipalities should work to provide effective hazards education programs, and encourage homeowners to adopt effective adjustments to reduce basement flood risk. Homeowners in Edmonton were more aware of sewer backup hazards, and were more likely to adopt sewer backup risk reducing adjustments than Toronto homeowners. However, improvements can still be made in awareness and risk reducing actions at the homeowner level in both cities.

Previous research has revealed that effective hazards education programs can increase hazard awareness and adoption of adjustments. In producing and presenting sewer backup reduction information, municipalities should make use of numerous information sources to allow individuals to personally validate incoming information. Along with engineers from municipal public works departments, information sources should include scientists, plumbers, contractors, insurance professionals and other trades people and professionals. Information should be provided through various channels, including print media, information brochures and mailings, internet websites, hazard maps, and so on. Providing information from diverse sources and through diverse channels will help to ensure that homeowners are getting valid information, will provide homeowners several options from which they can attain information, and will allow them to make personal judgments on the salience of that information.

Municipalities should be ready to provide information to homeowners in order to take advantage of the "windows of opportunity," or the short time periods that follow hazard occurrences when the public is most receptive to hazards information and most willing to take actions to reduce hazard risks. Formal, ongoing programs, such as Edmonton's basement flood education program, ensure that information and materials are ready as soon as a disaster hits a community.

As part of basement flooding and sewer backup hazard education programs, homeowners should be made aware that insurance coverage for sewer backup is generally optional and can be provided at a very low cost. Homeowners who do not know whether or not they have this type of coverage should be encouraged to check their policies.

Both sewer backup positive and negative respondents in this study attributed a considerable majority of responsibility for sewer backup damages to the municipal government, rather than to individual homeowners. Following this, homeowners who attributed more responsibility to homeowners were less likely to believe that the municipality should subsidize the full cost of protecting their homes from damages. Municipal education programs should work to address homeowners' perceived attribution of responsibility for basement flood damages, and encourage homeowners to accept a greater share of the responsibility for the protection of their property.

This study revealed that homeowners who sustained damages caused by sewer backup may not inform their municipal government of their damages. As well, homeowners who sustained only minor damages were less likely to inform their insurance company of their damages. Data from recent storm events in Edmonton and Toronto show that the frequency of insurance payouts for sewer backup damage were considerably higher than municipal estimates of the number of homes affected by basement flooding. Following basement flood events, municipalities should facilitate the exchange of information with insurance companies and organizations to better identify and manage flood prone homes. Exchange of information will help municipalities and insurance companies construct a comprehensive view of how sewer backup damages have affected homeowners within a municipality's jurisdiction. Further, notifying the insurance sector of actions a city is taking to reduce sewer backup damages may increase insurance sector confidence in the continuance of coverage for sewer backup damages within that city's jurisdiction.

Municipalities often target basement flood information and incentive programs to areas of their cities that sustained significant or wide-spread basement flood damages during intense rainfall events, as reported by property owners in the areas. However, many homeowners may be unwilling to report these damages to authorities. In order to better gauge which parts of a city have been affected by sewer backup, municipalities should employ alternative methods of identifying who has been subject to damages. Some homeowners may fear that admitting their home has sustained sewer backup damages will increase their insurance premium or decrease their property value. Municipalities should employ a more confidential approach to identifying areas and homes in their cities that have been subject to flooding. A confidential survey or confidential door to door census of areas that may have sustained damages following a heavy rainfall event would allow municipalities to increase their knowledge of basement flooding events, while alleviating homeowner fear or stress that may be associated with experiencing basement flooding.

Locating property in basements is a significant contributing factor in excessive basement flood damages. Previous research has revealed that average insurance claims for sewer backup damages in Canada were approximately $3,000 to $5,000. The 2005 GTA storm, however, resulted in an average insurance claim of $19,000 and the 2004 storms in Edmonton saw an average of over $15,000. Further, previous research estimated total yearly insurance claims for basement flooding at $140 million, however, sewer backup damage insurance payouts from the August, 2005 GTA storm were $247 million. These values suggest that property people are placing in their basements may be significant in both quantity and value. Findings in this study revealed that the majority of sewer backup positive homeowners did not choose to remove their important or expensive items from their basements to reduce damage risk. Homeowners should be made to understand if they choose to locate expensive or important items in flood prone basements, they do so at a risk.

Basement flood hazard information and preventative plumbing subsidy programs should be targeted not only to areas that have sustained historical damages from sewer backup and basement flooding, but also to areas that are at risk of future flooding events. Areas of municipalities that are serviced by combined sewer systems or older separated sewer systems, which may have infiltration and inflow problems, are particularly at risk. In order to address this increased risk, these areas should be targeted with basement flood mitigation education materials even if these areas have never been subject to sewer backup or basement flooding damages in the past. Municipalities should also seek out areas of the city or homeowners who have sustained only minor damages but have not reported these damages to authorities, and provide them with hazard mitigation information.

Eligibility criteria differed between preventative plumbing subsidy programs provided by Edmonton and Toronto. Toronto's program has historically required homeowners to prove that they had reported their damages to their insurance company in order to be considered for the subsidy.[1] However, as revealed in this study, many individuals who suffered only minor damages may not have reported these damages to their insurance companies. An increase in the intensity and frequency of heavy rainfall events caused by climate change may result in repeating and more severe sewer backup occurrences, thus, those who have sustained only minor damages in the past may be at risk of sustaining more severe damages in the future. Furthermore, sewer backup positive respondents in this study were largely unwilling to no longer locate expensive or important items in their basements, which may increase future damage risk. To account for a potential increase in the severity of damages, municipalities should target subsidy programs at individuals who have sustained minor damage as well as severe damages caused by sewer backup.

[1] In May, 2007, Toronto's preventative plumbing subsidy program was amended, and no longer required homeowners to prove that they had reported their basement damages to their insurance company as a condition of eligibility. The program has been expanded to offer subsidies to all homeowners, regardless of flood history.

Introduction

Municipalities in Canada have experienced numerous sewer backup events in the past. In August, 2005, a severe rainfall event struck southern Ontario, causing extensive overland flood and sewer backup damages resulting in over $500 million in insurance claims; the most costly storm event in Ontario's history (City of Toronto, 2005a; IBC, 2006); $247 million of the claims were for damages caused by sewer backup. Edmonton experienced severe flooding in 2004 caused by heavy rainfall, resulting in $143 million in sewer backup insurance claims. The same storm system that caused damage in Edmonton in July, 2004, later passed through the City of Peterborough, causing damages that resulted in $87 million in insurance claims and $25 million in government relief payouts for sewer backup and other types of flooding (Globe & Mail, 2004; Sandink, 2007). In 2004, 2005 and 2006, the City of Hamilton experienced heavy rainfall events that resulted in significant sewer backup damages (ICP, 2006). The cities of Ottawa, Sarnia, Thunder Bay, Port Alberni, Kenora, St. Johns, Winnipeg and Stratford have all experienced significant damages caused by sewer backup in the past 20 years (Campbell *et al*., 2007; Kulkarni, 1999; Shrubsole, 2007). A 2002 report by Allouche and Freure revealed that of 26 municipalities surveyed nation-wide, 42% reported that basement flooding occurred several times per year and 92% reported that basement flooding occurred at least once every several years within their jurisdictions.

Climate change will increase the frequency and intensity of heavy rainfall events in Canada (Gruntfest & Handmer, 2001; Lehner *et al*., 2006; McBean & Henstra, 2003). Researchers argue that 1 in 100 year storms will happen more often in the future, occurring as frequently as once every 10 to 15 years by 2070 (Lehner *et al*., 2006). More frequent heavy rainfall events will increase the burden placed on urban infrastructure, and will increase the occurrence of damages caused by sewer backup and other types of urban flooding (Ashley *et al*., 2005; Despotovic *et al*., 2005; Gruntfest & Handmer, 2001; White & Etkin, 1997).

Homeowners play an important role in the mitigation of the impacts of sewer backup. Homeowners can take initiative to install sewer backwater valves, sump pumps, and can adopt other precautions to reduce their risk of sustaining damages. Considering the immense cost and long-term nature of upgrading and replacing storm and sanitary sewer systems, individual homeowners may play the most important role in mitigating sewer backup risks over the short- and medium-terms. They must be adequately aware of the risks associated with sewer backup to take advantage of sewer backup mitigation subsidy programs, and must accept a certain level of responsibility in order to adopt mitigative actions themselves. However, very little research has been conducted on how individual homeowners perceive and react to sewer backup risks.

The purpose of this study is to examine risk perceptions and mitigative behaviours associated with sewer backup hazards in the cities of Toronto, Ontario and Edmonton, Alberta. The study examines perceptions and behaviours of a sample that includes homeowners who have never sustained sewer backup damages (hereafter referred to as *sewer backup negative*) and a sample of respondents who have, at some time in the past, sustained sewer backup damages (hereafter referred

to as *sewer backup positive*). The study identifies differences and similarities in perceptions and behaviours between the two municipalities. The report suggests reasons for differences and similarities in perceptions and behaviours between the two cities, including differing natures of education and preventative plumbing subsidy programs. The study serves to increase knowledge on sewer backup perceptions and behaviours, and to provide practical information to municipalities for sewer backup risk reduction at the homeowner level.

1.1 Overland flooding vs. sewer backup

Urban flooding is largely comprised of overland flooding and sewer backup. Overland flooding occurs when rainfall exceeds the capacity of municipal storm or combined sewer systems (Kulkarni, 1999). Storm sewer systems are often built to withstand storm events that occur once every 2, 5, 10 or 25 years. Municipalities compensate for storm water that exceeds the capacity of storm sewers by constructing overland flow routes, which are composed of ditches, swales, and heightened curbs that act as channels to convey water during heavy rainfall events (Lawford *et al*., 1994; UMA, 2005). When these overland flow routes are over-topped, or when the overland flow routes are not well defined, water can find paths through private property, sometimes entering lower levels of buildings through windows and doors.

Sewer backup originates from storm and sanitary sewer infrastructure, and can be exacerbated by storm water sources contributed by private building owners. Sanitary sewer systems overload and surcharge as a result of inflow and infiltration, where ground and storm water enter sanitary sewers through cracks or cross connections with the storm sewer system (UMA, 2005). Furthermore, many sections of many cities in Canada are serviced by combined sanitary sewer systems, which are designed to carry both sanitary and storm sewage (Pleau *et al*., 2005). Combined systems increase the risk of sewer backup, as heavy rain inflow can increase pressure, cause sanitary sewer surcharge, and force sewage into homes through floor drains, sinks and toilets. Several cities in Canada have identified private eavestrough downspout connections and foundation drain connections to the sanitary sewer system as significant contributors to sanitary sewer system surcharge. Roof leaders significantly increase the amount of storm water entering the sanitary system and foundation drains continually contribute groundwater into the sanitary system (City of Toronto, 2006a; UMA, 2005). The excess water contributed by private sources increases the risk of sewer backup.

A further important distinction between overland flooding and sewer backup is financial coverage for damages. In Canada, insurance companies do not cover damages to homes caused by overland flooding (IBC, 2006), including flooding caused by heavy rainfall, riverine flooding, and all other sources of overland flooding. Homeowners who sustain overland flood damages must either apply for government disaster relief or recover from the damages using their own funds. Insurance coverage, however, is available for damages caused by sewer backup (IBC, 2006). This coverage is typically excluded from a homeowner's basic policy, but for a modest premium it may be added to most homeowners' policies based on a specific request from the insurance purchaser.

1.2 Liability for damages caused by sewer backup

Damages to personal property and insurance payouts are not the only issues associated with the occurrence of sewer backup. In a report produced by Campbell *et al*. (2007), the authors identified municipal liability for failing infrastructure as a recurrent problem.

Campbell *et al*. (2007) assert that a municipality may be found liable in negligence for failing infrastructure if:

- It failed to have an infrastructure inspection system in place;
- It failed to ensure the system was reasonably maintained;
- Its employees (or agents) were careless in constructing, inspecting and maintaining the system, or;
- If it failed to respond to complaints in a timely manner (e.g., if a flood or sewer backup occurred due to slow response time by a city crew) (Campbell *et al.*, 2007: 18).

The authors note the increasing occurrence of successful litigation cases held against cities for damages associated with lack of proper maintenance of infrastructure. The municipalities of Port Alberni, Kenora, St John's, Stratford and Thunder Bay have all been held legally responsible for damages caused by sewer backup (Campbell *et al.*, 2007). Failure to meet municipal council approved sewer inspection targets, failure to complete sewer maintenance work after it had begun, and failure to take action despite occurrences of past flooding were cited as negligence on the part of the municipalities, resulting in successful litigation cases against the municipalities (Campbell *et al*., 2007).

1.3 Previous research on basement flooding

Research on homeowner perceptions and behaviours regarding sewer backup damage is limited. The Canada Housing and Mortgage Corporation undertook studies that focused on the role of drainage regulation and stormwater control in basement flooding (reviewed in Kesik & Seymour, 2003). Studies conducted in 1984 (Wisner & Hawdur, 1984) and in 2003 (Kesik & Seymour, 2003) included elements of homeowner/private property owner awareness and behaviour related to basement flood hazards. To the author's knowledge, the only other study completed on public perceptions of urban flooding, including sewer backup perceptions and behaviours, was completed by Sandink (2006, see also: Sandink, 2007).

Allouche and Freure (2002) provided some discussion on social issues related to basement flooding. Specifically, the authors argued that much of the damage that resulted from basement flooding, and insurance claims related to this damage, were a result of locating expensive property (entertainment centres, televisions, computers, etc.) in basements. Allouche and Freure (2002) reported that damages caused by basement flooding cost insurance companies approximately $140 million per year, with an average claim of approximately $3,000 to $5,000, depending on the province.

Wisner and Hawdur (1984) investigated basement flooding and flood perceptions in Ottawa. They found that individuals subject to basement flooding were not well informed of methods to reduce flooding, and that municipalities should employ integrated methods to reduce basement flooding, including mitigation at both the homeowner and municipal sewer system level. Kesik and Seymour (2003) investigated municipal actions related to basement flooding in several Canadian municipalities. The results indicate that, although most municipalities have issues with recurrent basement flooding and are working to address sewer surcharge causing basement flooding, minimum levels of protection are not being uniformly achieved in cities across Canada.

Further, the authors revealed that there are many contributors to the occurrence of basement flooding, including obsolete, under-maintained and failing infrastructure, inadequate or poorly designed household drainage and sewer connections, and lack of enforcement of bylaws regulating connections to sewer systems. The study identified the need to address basement flooding at several levels, depending on the source and nature of basement flooding occurrences. The authors argue that there is no single, simple solution to the problem of basement flooding in Canada. Some aspects of basement flooding should be addressed at the municipal level, including addressing minor and major drainage systems and failing sanitary systems, while others can be adequately addressed at the household level (Kesik & Seymour, 2003). The authors found that homeowners were seldom aware that they were responsible for sewer infrastructure on their own property, and thus had not taken steps to evaluate or maintain their own infrastructure.

Effective basement flood mitigation requires coordination of many mitigative actions at the individual/homeowner and municipal level (Kesik & Seymour, 2003). The authors revealed that there is no central repository for flood protection knowledge and that no forum exists for the exchange of information between municipalities (Kesik & Seymour, 2003).

Kesik and Seymour (2003) further identified issues associated with sewer surcharge, including negative impacts on groundwater, surface water bodies, rivers and the ecosystems that depend on these water sources. Health impacts of basement flooding include allergic reactions, asthma and other respiratory ailments associated with the growth of mould (Kesik & Seymour, 2003). Sandink (2006) revealed that approximately 43% of homeowners who sustained basement flooding caused by sewer backup suffered damages associated with mould. Kesik & Seymour (2003) further report that there are approximately 30,000 to 40,000 basement flood incidents per year in Canada.

Sandink (2006) investigated perceptions of overland flooding and sewer backup in Peterborough, Ontario. Following a severe rainfall event in July, 2004, a total of 5,154 insurance claims were paid for sewer backup damages, totaling $87 million (Sandink, 2007). The average insurance claim following the 2004 flooding event was approximately $17,000. The results revealed that the majority

of overland flood respondents (61%) and sewer backup respondents (59%) perceived future damages from their respective hazards. No statistical relationship was found between the type of hazard experienced (overland flood or sewer backup) and the perception of recurrence of the hazards. Sixty-one percent of survey respondents who reported damages from overland flooding had employed at least one risk reducing adjustment, and 43% of sewer backup respondents reported having adopted at least one risk reducing adjustment. The author revealed that individuals who sustained overland flow flooding attributed a higher amount of responsibility to homeowners for damage protection than did sewer backup respondents. Furthermore, sewer backup respondents placed a higher amount of responsibility on the municipality for damages than did overland flood respondents. The study revealed that 26% of individuals who sustained sewer backup damages installed backwater valves.

1.4 Hazard perception research

This study applies models developed through previous hazard perception research, particularly overland flood perception research, for the examination of sewer backup perceptions.

Hazards perception research has consistently revealed that individuals deny or denigrate the occurrence, recurrence and severity of hazards (Burton *et al*., 1993; 1967; Tobin & Montz, 1997), frequently do not take actions to protect themselves from hazards (Wong & Zhao, 2001), rely heavily on governments for protection (Kreutzwiser *et al*., 1994; Shrubsole *et al*., 1997; Zeigler *et al*., 1983), and attribute blame on local governments for damages caused by hazards (Arceneaux & Stein, 2006; Yates, 1998). Many of the factors that have lead to the poor understanding of hazard risk and risk reduction can be associated with an inability to understand and appreciate the nature of hazards, including hazards statistics, hazards damages, and effective means of protecting one's self from damages (Mileti, 1999).

Research has revealed several factors that may affect how individuals perceive hazards and hazard recurrence. The expectation of sustaining future damages, as well as the expected impacts of future damages is affected by experience with hazards (Browne & Hoyt, 2000; Nguyen *et al*., 2006; Siegrist & Gutscher, 2006; Tanaka, 2005; Yoshida & Deyle, 2005), including the number of past hazard experiences (Burton & Kates, 1964; Preston *et al*, 1983), the amount of time since the most recent experience (Laska, 1986), and the severity of damages experienced in previous hazard events (Jackson, 1981; 1977). Effective education programs have also been associated with an increased perception and awareness of hazards (Blanchard-Boehm & Cook, 2004; Tanaka, 2005).

Individuals who are prone to hazards are more likely to employ less intensive adjustments that are inexpensive and easy to adopt, although are less effective at reducing damage risk. Individuals much less frequently adopt risk reducing adjustments that actually decrease the chances of sustaining damage during

a future hazard event (Burton *et al*., 1993). In the case of sewer backup hazards, less intensive actions include:

- Installing water alarms;
- Purchasing sewer backup insurance coverage;
- Claiming insurance for damages;
- Applying for public disaster relief;
- Becoming involved in litigation, and;
- Doing nothing and bearing the losses.

Less intensive actions also include political actions, or actions at the community level. These actions are intended to reduce individuals' risk of sewer backup by pressuring governments to take action, and include:

- Communicating with councilors or members of parliament about damages;
- Attending public meetings;
- Becoming involved in community organizations, and/or;
- Writing letters to local media, newspapers, etc.

Risk reducing actions reduce the risk of a homeowner sustaining damages from sewer backup. These actions may include changing one's behaviour, changing the way one uses their home, or actions designed to stop sewage from entering basements. Risk reducing actions may include:

- Leaving one's basement unfinished;
- Detaching foundation drains from the sanitary sewer;
- Installing backwater valves;
- Installing sump pumps;
- Disconnecting eavestrough downspouts;
- Not locating expensive or important items in the basement, and/or;
- Moving away from a residence that is prone to sewer backup.

While individual adoption of mitigative adjustments for hazards is often low, several factors have been found to increase adoption of adjustments. If an individual has experienced a particular hazard in the past, and has sustained substantial damages, they will be more likely to adopt adjustments for that hazard (Burn, 1999; Siegel *et al*., 2003; Wong & Zhao, 2001). Conversely, research has shown that if an individual has only sustained minor damages from a hazard, they may be less likely to adopt adjustments for that hazard (Burn, 1999; Burton & Kates, 1964). Studies have associated perceived threat of sustaining damages with increased adoption of adjustments (Penning-Roswell, 1976; Preston *et al*., 1983), however, perceived threat of sustaining damages has not always increased risk reducing behaviour (Brilly & Polic, 2005; Mileti, 1999). Hazard education programs have also been associated with an increase in the adoption of risk reducing adjustments (Blanchard-Boehm & Cook, 2004; Mileti *et al*., 1992).

Attribution of responsibility is a key aspect of hazard perception. Research has shown that individuals who experience hazards or are prone to hazards attribute the majority of the responsibility for hazards damages or protection form hazards on local governments (Arceneaux & Stein, 2006; Yates, 1998). Effective hazards management, however, requires not only the actions of governments, but the actions of individuals who are prone to hazards (Burton *et al*., 1993). This is especially true for sewer backup hazards, as individual homeowners must take personal actions, such as installing backwater valves and ensuring that their insurance covers sewer backup damage, to effectively mitigate risks associated with this hazard (Sandink, 2006).

1.5 Hazard information and education

Many municipalities in Canada, including Edmonton and Toronto, employ education programs to increase public hazard awareness and encourage homeowners to take actions to reduce basement flood damages. Effective hazards education, though complex, can often lead to increased hazard awareness and adoption of adjustments.

Previous research has revealed that individuals who are prone to hazards have a poor understanding of the risks associated with hazards, and lack knowledge and understanding of how to effectively protect themselves from disasters (Kreutzwiser *et al*., 1994; Shrubsole *et al*., 1997; Shrubsole *et al*., 2003). Thus, individuals who are at risk of sustaining damages from hazards should be educated in order to promote a realistic understanding of probabilities of sustaining damages, and to help them prepare for, endure and recover from hazards (Burton *et al*., 1993; Kates, 1962; King, 2000; Mileti *et al*., 1992; Slovic *et al*., 1974; Tanaka, 2005). The need for effective education programs is further enhanced by the fact that individuals are often on their own during hazard events, and must work to mitigate damages themselves (King, 2000).

Many methods have been advanced to better educate individuals about their risks from hazards, including hazard maps (Burby, 2001; Shrubsole *et al*., 2003; Siegrist & Gutscher, 2006), mass media campaigns and hazard information days (Blanchard-Boehm & Cook, 2004), hazard warnings (Mayhorn, 2005), hazard risk information when seeking to acquire a property (Palm, 1981), insurance rates (Zaleskiewicz *et al*., 2002), as well as brochure and document mailings (Mileti *et al*., 1992). These methods have exhibited varying degrees of success. For example, Siegrist and Gutscher (2006) revealed that publicly available flood maps can increase public awareness of flood risk. However, floodplain maps have been shown to be an ineffective means of educating the public of flood risk in other circumstances (Montz, 1982; Shrubsole *et al*., 2003; Yoshida & Deyle, 2005). As well, mass media campaigns can be effective for some individuals, and ineffective for others (Mileti *et al*., 1992).

Researchers have further argued that hazard education and risk communication is a long term process, and individuals who are prone to certain hazards should be presented with a diversity of information, provided to them from a diversity of sources (government officials, scientists, other experts) through a diversity of

channels (print media, broadcast media, internet, and so on) (Brug *et al*., 2004; Fischhoff *et al*., 1993; Mieti *et al*., 1992; Nathe *et al*., 1999). Information should be specifically targeted to certain groups as characteristics of individuals, including their age, culture and hazard experience, will affect the manner in which they interpret information (Mayhorn, 2005; Nathe *et al*., 1999; Tanaka, 2005). Furthermore, effective hazard education requires understanding of public perceptions of risk and should involve the public where possible (Fischhoff *et al*., 1993; Grimm, 2005; Mileti & Peek, 2000; Walker *et al*., 1999).

Public interest in hazards and hazard mitigation wanes after an event occurs (Mileti *et al*., 1992; Solecki & Michaels, 1994) and the effectiveness of education programs may be impacted by the duration of time since the hazard or disaster event occurred (Nathe *et al*., 1999). Therefore, decision makers should take advantage of "windows of opportunity" in the few months following hazard events to inform residents of the risks of hazards and methods they can employ to reduce their risks (Mileti *et al*., 1992). Anniversaries of hazard events have also been shown to increase the effectiveness of hazards education. For example, Blanchard-Boehm and Cook (2004) found that information presented to Edmonton residents on the 10th anniversary of a serious tornado event significantly increased their adoption of mitigative adjustments.

Effective hazards education is a complex process. However, effective education programs can increase public awareness of hazards, increase the accuracy of public risk perceptions, and potentially decrease hazard damage risk.

1.6 Municipal prevention and mitigation of basement flooding

Many municipalities across Canada have been working to mitigate and prevent basement flooding by using both engineering and social approaches. Engineering approaches include

- conducting engineering studies/assessments on sewer system infrastructure;
- separating combined sanitary/storm sewer systems;
- decreasing infiltration and inflow in sewer systems;
- sewer system maintenance programs, and;
- other actions directly related to improving sewer system infrastructure, particularly at the road allowance/municipal level.

Social approaches are those that are designed to educate and increase public awareness of basement flood hazards, as well as address homeowner and public behaviour. Kesik & Seymour (2003) summarized actions that are designed to address basement flooding at the homeowner level, which include

- recommended lot grading practices and inspections;
- bylaws and enforced inspections;
- mandatory installment of backwater valves;
- mandatory installation of sump pumps, and;
- bylaws enforcing the disconnection of sewer laterals.

Strategies designed to encourage, educate and incentivize homeowners to take mitigative actions include

- education programs that make use of websites, brochures, handbooks, newspaper advertisements, etc.;
- preventative plumbing subsidy/incentive programs, and;
- property inspections and recommendations for the reduction of sewer backup.

Programs designed to reduce the occurrence of sewer backup have not been uniform across Canada. Municipalities including Vancouver, Moncton, Charlottetown, Laval, Saskatoon and Chilliwack have been addressing basement flood problems through engineering approaches. While engineering approaches are necessary, they are often expensive and can only be completed over an extended time frame. As well, despite improvements made to sewer system infrastructure, there may be some neighbourhoods, residences or buildings that will be subject to sewer backup. Thus, both engineering and social approaches are necessary to effectively reduce sewer backup damages. Table 1, on page 10, provides a summary of some of the more progressive basement flooding prevention programs in Canada, which include both engineering and social approaches for basement flood mitigation.

Bylaws have been used as important tools in the management of sewer infrastructure problems and basement flooding. For example, many municipalities have adopted bylaws which prohibit the connection of private sewer laterals which may contribute to sewer system infiltration and inflow. Municipalities in Canada have also required that foundation drains be connected to sump pits and pumps rather than be connected to the sanitary or combined sewer system. Some municipalities in Canada have also required the installation of backwater valves in newly developed homes. As well, provincial building codes address the installation of backwater valves and other measures to prevent sewer surcharging into basements. For example, Ontario's *Building Code Act* provides several provisions related to sewer surcharge backflow prevention in new homes (see section 7.4.6.4 in MMAH, 1992).

When properly enforced, bylaws are effective at increasing preventative plumbing practices in newly developed homes. However, bylaws do not ensure that proper actions are taken for homes that were constructed before bylaws requiring preventative plumbing were established. For example, while the City of Peterborough restricted the connection of eavestrough downspouts to the municipal sewer system, downspout connections were still a major contributor to the occurrence of sewer backup during a heavy rainfall event in July, 2004 (UMA, 2005). In order to encourage homeowners to comply with existing bylaws, homeowners must be adequately informed of the existence of these bylaws (and why they exist), and may require incentives to encourage compliance.

Table 1: Municipal programs for basement flood reduction

Adjustments		Edmonton	Regina	Winnipeg	London	Toronto	St. Catherines	Peterborough	Ottawa
Information and education	Formal flood proofing program	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Webpage	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Brochures	Yes	Yes	Yes		Yes	Yes		Yes
	Public meetings	Yes	Yes			Yes		Yes	Yes
	Warnings							Ongoing	
	Check lists	Yes	Yes	Yes	Yes				Yes
	Mass media	Yes	Yes	Yes		Yes	Yes		
Action and prevention, preventative plumbing	Backwater valve	PF			PF	PF	PF	PF	PF
	Sump pump	PF			PF	PF	PF	PF	PF
	Foundation drain disconnection					Yes		PF	PF
	Eavestrough disconnection	Yes				Yes		Yes	PF
	Weeping tile disconnection					PF	PF		PF
	Free home inspections	Yes				Yes			
	Flood prevention workshops	Yes							
Recovery	Partial recovery assistance					Yes	Yes		
Technical information	Identification of high risk areas	Historical*				Historical*		Yes	
	Public consultations	Yes	Yes			Yes	Yes	Yes	Yes
	Sources of stormwater from public property							Yes	
	Public surveys		Yes			Yes		Yes	
	3rd party assessments					Yes		Yes	
	Detailed engineering study	Yes				Yes		Yes	Ongoing
Prevention and reduction	Building codes and bylaws	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Sewer separation		Yes	Yes		Yes			
	Sewer system maintenance programs	Yes		Yes		Yes		Yes	Yes
	Other structural and engineering initiatives	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

PF = Partial funding Blank space = no/unconfirmed *Areas that have had historical occurrences of basement/overland flooding are considered to be at risk of future flooding.

Sources: City of Edmonton, 2007a; Kesik & Seymour, 2003; UMA, 2005; City of Regina, 2007; City of Winnipeg, 2007; City of London, 2007; City of Toronto 2005; 2006; 2007a,b; City of St. Catharines, 2007; City of Ottawa, 2007

Municipalities may also benefit from ongoing dialogue with the insurance industry, as insurance companies may be able to provide municipalities with information that otherwise might not be available to them. For example, some homeowners may have chosen to report their damages only to their insurance company and not to the municipality. Damage data from insurance companies may help municipalities construct a more comprehensive view of how sewer backup damages have affected homeowners in their jurisdiction. Municipalities may also wish to communicate actions that they have been implementing to reduce the risk of sewer backup to the insurance industry. This will ensure that insurance companies are aware that the municipality is working to address basement flooding issues, and may reduce the occurrence of cancellation of insurance coverage for sewer backup damage within a municipal government's jurisdiction.

A specific example of the benefits of communicating with insurance companies can be seen in the City of Peterborough, Ontario. The City of Peterborough has been communicating with local insurance companies throughout the implementation of its backwater valve subsidy program (City of Peterborough, 2006). Through discussions with insurance companies, the City found that fewer people had applied for sewer backup subsidies than were required by insurance companies to have backwater valves in order to retain sewer backup coverage on their home insurance policies, which had implications for the funding levels and duration of the subsidy program (City of Peterborough, 2006). Furthermore, through implementing the backwater valve subsidy program, the City of Peterborough revealed that damages caused by sewer backup were not as widespread as initially perceived, which, when communicated to insurance companies, relieved many industry concerns over continuing coverage for sewer backup damages (City of Peterborough, 2006).

2. Methods

A telephone administered questionnaire survey was conducted by Pollara Inc. between the dates of January 11 through 21 of 2007. The questionnaire (Appendix B) was designed to gain insight into homeowner perceptions and behaviours associated with sewer backup damages, and included sections on:

- Number of experiences and nature of sewer backup experience;
- Risk perception, including perceived likelihood and severity of future damages;
- Attribution of responsibility for incurred damages, or damages within respondents' municipality;
- Knowledge of individual adjustments and source of information on adjustments;
- Adoption of individual less intensive adjustments;
- Adoption of individual risk reducing adjustments;
- Knowledge of municipal actions designed to reduce sewer backup damages;
- Community level (political, legal) actions taken by individuals;
- Consumer satisfaction with insurance, provincial disaster relief and municipal relief payments, and;
- Socioeconomic characteristics.

A total of 16,775 potential respondents were contacted, yielding a total sample of 805 and a response rate of 4.8%. Respondents were selected and contacted using systematic random sampling. Sub-samples were categorized based on experience with sewer backup hazards and city of residence (Table 2).

Table 2: Samples and sub-samples

	Sub-samples		
Samples	**Sewer backup positive respondents**	**Sewer backup negative respondents**	**Total**
Toronto	200	205	405
Edmonton	200	200	400
Total	**400**	**405**	**805**

To test the validity of the survey instrument, the final telephone survey was preceded by a pilot survey of 30 respondents on December 9, 2006. Changes made following the pilot test were minor and responses attained through the pilot test were included in the final data set. The questionnaire was also reviewed and approved by Institute for Catastrophic Loss Reduction staff and several questionnaire development and administration professionals at Pollara Inc., further ensuring the instrument's validity and logical flow.

Sampling was geo-targeted based on postal codes to areas in Edmonton and Toronto that had a higher rate of homeownership, in order to reduce costs associated with data collection. Areas with higher rates of homeownership were pre-determined by Pollara, Inc.

Respondents were screened to ensure that they were over the age of 18, and were homeowners. In order to be at risk of a sewer backup incident, a building must have a lower level or basement, in which there are drains that are connected to a sanitary or combined sewer system. Thus, the nature of sewer backup hazards required respondents to be screened to ensure that they owned either a fully-detached, semi-detached or town house.

Previous research has revealed that many of the perception characteristics for overland flooding and sewer backup are similar (Sandink, 2006). Therefore, in order to accurately determine sewer backup positive sub-samples, respondents were presented with a brief description of the nature of sewer backup damages, specifically highlighting the differences between sewer backup flooding and overland flooding.

Information on the City of Toronto and City of Edmonton's homeowner level sewer backup mitigation programs was attained from municipal websites and other municipal government literature. Municipal staff were also contacted and interviewed in order to gain further insight into the programs.

2.1 Case studies

The cities of Toronto and Edmonton were selected based on their historical and recent basement flooding experiences. The cities of Edmonton and Toronto also have large portions of residential areas serviced by combined sewer systems (Edmonton Journal, 2004b; Kulkarni, 2000a,b; Lawford *et al.*, 1994), placing many homes at risk of sustaining future sewer backup events.

Several other factors determined the selection of the case studies. As outlined below, both the cities of Edmonton and Toronto have engaged in homeowner level sewer backup mitigation and prevention programs. The programs included preventative plumbing subsidy programs, information meetings, and other methods to interact with the public to reduce the risk of future sewer backup damages. Selection of cities employing homeowner level mitigation programs allowed for a discussion of the potential effectiveness of their programs.

2.1.1 Edmonton

In July, 2004, the City of Edmonton suffered two heavy rainfall events. The first, on July 2nd, delivered approximately 75 mm of rain by 11:30 pm that evening (*Edmonton Journal,* 2004a). Reports of this event indicated both overland flooding in public streets and private property, and sanitary system surcharging resulting in sewer backup in residential properties (*Edmonton Journal*, 2004a; 2004b; 2004c). Following this event, on July 11, 2004, the City was struck by a severe 1 in 200 year rainfall event that delivered approximately 150 mm of rain on many parts of the City (*Edmonton Journal*, 2004g). Again, many parts of the City experienced overland flooding and many homeowners suffered severe flooding in their basements caused by both overland flooding and sewer backup (*Edmonton Journal*, 2004d; 2004e; 2004f). The City of Edmonton estimated that 4,000 homes were affected by basement flooding following the July, 2004 storms (City of Edmonton, 2005a). Howerver, the rate of insurance claims was much higher than the estimated

number of homes affected by basement flooding by the City, as a total of 9,500 sewer backup insurance claims were made in the City, at a value of $143 million (M. McGonigal, personal communication, February 14, 2007).

2.1.1.1 "Flood proof" homeowner level flood prevention program

The City of Edmonton operates a formal flood prevention program entitled the "Flood Proof: Flood Prevention Program" aimed at all Edmonton homeowners (City of Edmonton, 2005a; B. Steil, personal communication, October, 2006). The program is one of the more progressive and comprehensive basement flood reduction programs in Canada (see Table 1), and has gained recognition as a potential model for other cities to follow. For example, an independent community panel of academics, engineers and insurance industry professionals, recommended that the City of Hamilton implement a program similar to Edmonton's following recurrent basement flooding events (ICP, 2006).

The program has an extensive public education component, and is designed to provide Edmonton residents with information on how to protect their homes from flooding, what the City is doing to reduce flood damages – including sewer system maintenance – and what programs are available for residents to aid in preventing future flood damages (City of Edmonton, 2005a; 2005b; 2007). Educational information has been distributed through handouts and brochures, as well as a series of public information meetings, public consultations and public preventative plumbing workshops. The City has also recently engaged in a mass media campaign, including television and radio public service announcements, to increase awareness of basement flooding mitigation techniques and programs in the City.

2.1.1.1.1 Public Information Meetings

Edmonton has been relatively progressive in the administering of public information meetings, open houses, public consultation meetings and preventative plumbing workshops in areas that have been subject to historical basement flooding events. Six backwater valve workshops were conducted, generating a total attendance of 420 people. Three sump pump workshops were conducted, with a total attendance of 60 people. Public consultation meetings were held in several communities across the City. Follow-up meetings were also held in communities particularly hard hit by the 2004 heavy rainfall event (City of Edmonton, 2007c). See Table 3 for a summary of consultation events and attendance.

Table 3: Summary of basement flooding public consultation meetings in Edmonton

Timeframe	Number of sessions	Number of attendees
Spring 2005	8	470
November 2005	7	186
February 2006	1	46
May 2006	4	88
July 2006	1	84
August 2006	1	12
November 2006	1	12
March 2007	1	46
April 2007	1	55
Total	**25**	**999**

Source: City of Edmonton, 2007c

Consultation meetings included discussions of effective flood prevention measures for each community, both at the community and homeowner levels. Residents were encouraged to voice their concerns and opinions, and were given the opportunity to provide input into how flood prevention projects should be pursued (City of Edmonton, 2007b).

2.1.1.1.2 Subsidy Program

The City of Edmonton has offered a preventative plumbing subsidy program since 1991 (City of Edmonton, 2005a). The program provides funding for individual homeowners to install backwater valves, and may also provide funding for sump pumps in households where appropriate. The subsidy program was originally

available only for individuals who had previous experience with basement flooding. In 2005, the City of Edmonton's Drainage Services modified the subsidy program to allow all homeowners access to preventative plumbing subsidies, regardless of their basement flood history or flood risk (B. Steil, personal communication, July, 2007; City of Edmonton, 2005c). In Edmonton, at risk areas are defined as areas where flooding studies have been completed, and have historical or potential risk of basement flooding occurrences (City of Edmonton, 2005a; B. Steil, personal communication, October, 2006). Residents who do not live in the defined flood risk areas are eligible for the subsidy program if they have experienced basement flooding in the past (City of Edmonton, 2005c). Homeowners who apply for the program must also live in a house that was built before 1989, as the City required the installation of backwater valves in all new homes built after 1989 (City of Edmonton, 2007d). Application for the program did not require individuals to have made a claim to their insurance companies for damages caused by sewer backup (B. Steil, personal communication, April 25, 2007).

The program provides up to $975 for the installation of protective plumbing devices, and will provide an additional $1,400 where special circumstances require a sump pit and pump as a result of backwater valve installation. In these special circumstances, the total reimbursement would amount to $2,375 including taxes (B. Steil, personal communication, July 5, 2007).

Following flooding events where residents have experienced sewer backups, the City of Edmonton mailed letters to affected residents informing them of the backwater valve funding program. The City of Edmonton estimates that approximately half of those contacted and invited to participate in the program actually applied for funding through the program, and approximately three quarters of those who applied received funding (B. Steil, personal communication, April 25, 2007).

2.1.1.1.3 Eavestrough Disconnection

In the past, (1980s and 1990s), the program provided subsidies for the disconnection of eavestrough downspouts. However, the program currently does not provide funding for the disconnection of eavestrough downspouts from the sanitary sewer system. Since 1988, downspout connections to combined sewers have not been permitted in the City of Edmonton (City of Edmonton, 2005a). Residents who live in areas with a combined sewer system are required to disconnect eavestrough downspouts from the system, using their own funds. Individuals who live in areas where there is appropriate service to sustain eavestrough connection to the sewer system (where storm systems or eavestrough systems are available) are not required to disconnect their downspouts from the sewer system (B. Steil, personal communication, April 25, 2007).

2.1.2 Toronto

On August 19, 2005, a heavy rainfall event delivered 150 mm of rain to the Greater Toronto Area (GTA) in a 3 hour period (City of Toronto, 2005a), resulting in 13,011 sewer backup insurance claims, totaling $247 million (E. Patterson, personal

communication, February 8, 2007). The event was the most costly natural hazard in Ontario's history, with total insurance payouts at approximately $500 million (IBC, 2007). The event caused damage in several municipalities, and the most serious damage occurred in a large portion of the northern part of Toronto and local municipalities in adjacent areas (*Toronto Star*, 2005a; 2005b). A total of 3,600 basement flooding complaints were made to the City of Toronto following the storm (City of Toronto, 2006b).

Several storm events in May, 2000 resulted in 3,000 flooded basements (City of Toronto, 2006a; P. Clements, personal communication, April 30, 2007). The May 2000 events affected a large portion of the northern part of the City, and resulted in City Council approving several million dollars worth of sewer system and drainage improvements (City of Toronto, 2005a). Non-natural events have also resulted in sewer backups in Toronto. For example, many properties in the lower parts of the east side of Toronto were affected by basement flooding and sewer backup during the August, 2003 blackout. Sewer backups during the blackout event were caused by loss of power to sewer system pumping mechanisms (*Globe and Mail*, 2005; City of Toronto, 2005a).

2.1.2.1 Basement flood reduction in Toronto

The City of Toronto has been taking actions to reduce basement flooding at the municipal/road allowance level and the private property level. Historically, the City has focused on engineering solutions to sewer infrastructure problems, and has taken several actions at the municipal level including:

- Replacing sewers where possible;
- Removal of hydraulic bottlenecks within the sewer system;
- Separating storm and sanitary sewers;
- Reducing stormwater in sanitary sewers, and;
- Construction of in-system storage facilities (City of Toronto, 2006a; P. Clements, personal communication, July 19, 2007).

Following recurrent basement flood damages, the City of Toronto has also undertaken actions to address flood damages at the private property/homeowner level, including preventative plumbing subsidy and basement flooding education programs.

2.1.2.1.1 Actions at the private property level

Beginning in 2001, as a reaction to basement flood damages caused in May 2000, the City of Toronto enacted a preventative plumbing subsidy program to provide assistance to homeowners who had sustained damages from basement flooding (P. Clements, personal communication, July 19, 2007). The homeowner level program originally focused on high risk areas identified by flooding occurrences during the May, 2000 storm, and was designed to:

- Introduce sewer backwater valves into private residences/buildings, and;
- Reimburse residents for the disconnection of foundation drains and downspouts.

The funding program was designed to "kick in" for a temporary time period following specific flooding events, and provided subsidies to homeowners who had sustained flood damages. Preventative plumbing subsidy programs were first implemented in 2001, following the May 2000 heavy rainfall events, and in 2005, were extended to cover areas that were damaged during the August, 2005 storm (L. Boynton, personal communication, May 8, 2007). The preventative plumbing subsidy program was introduced as an interim solution while sewer systems were being upgraded in flood-prone neighbourhoods (P. Clements, personal communication, April 30, 2007).

Individuals who suffered damages following the August 2005 heavy rainfall event were notified of the subsidy program, through public meetings and mailings, and subsidies were made available on a first-come, first-served basis until February 1, 2006. Eligibility requirements included having sustained damages during the August 19, 2005 storm (and later, the May 2000 flooding event and the August 2003 blackout) and having reported damages to the City of Toronto, and providing proof that the applicant advised their insurance companies of their basement flooding in a timely manner following the storm (City of Toronto, 2005a). Homeowners who met the criteria were eligible for up to $3,200, if they installed a backwater valve and sump pump, disconnected and capped their foundation drain and disconnected their downspouts. The following subsidies were made available through the program:

- Backwater valve: 80% of the invoiced cost up to $1,000;
- Sump pump: 80% of the invoiced cost up to $1,500;
- Backwater valve and sump pump: 80% of the invoiced cost up to $2,300;
- Downspout disconnection: Residents could choose to participate in the free downspout disconnection program or receive 80% of the invoiced cost to a maximum of $500, and;
- Disconnection and capping of weeping tile pipes (foundation drain): Maximum of $400.

Of the 5,000 applications that were mailed, approximately 2,000 were returned, and 1,000 of the returned applications resulted in subsidy payouts (P. Clements, personal communication, April 30, 2007).

2.1.2.1.2 Public meetings

Public meetings were conducted as a means of informing residents of the subsidy program, as well as providing general information on how the City was addressing basement flooding. The meetings provided information on third party engineering assessments being conducted on Toronto's sewer systems, as well as the importance of installing a range of preventative plumbing devices to isolate homes from the City's sewer system. Residents were encouraged to seek the advice of plumbing professionals in order to properly select the type of preventative plumbing devices that should be installed in their homes. A total of 10 meetings were conducted following heavy rainfall events in 2000 and 2005, with approximately

1,500 residents attending (L. Boynton, personal communication, May 9, 2007). Attendees at the meetings were informed of the preventative plumbing subsidy program, and they were encouraged to take advantage of the eavestrough disconnection program. The City of Toronto considered the eavestrough disconnection program as a more economical approach to reducing basement flooding at the municipal level (P. Clements, personal communication, April 30, 2007).

2.1.2.1.3 Downspout disconnection

Toronto's municipal code prohibits the connection of eavestrough downspouts and foundation drains to sanitary, combined or storm sewer systems (City of Toronto, 2005b; 2006c). Private property owners are not to connect downspouts to sewers, but rather, drain eavestrough water at grade away from their buildings or adjacent properties (City of Toronto, 2005b). It has been estimated that 50-60% of downspouts must be disconnected in residential areas to prevent sanitary sewer surcharge, however, this level of disconnection has been difficult to attain (City of Toronto, 2006b).

In 1998, the City of Toronto implemented an extensive downspout disconnection program (City of Toronto, 2006a). The program served the purpose of decreasing stormwater load in sanitary and storm sewer system and had been implemented for the purposes of decreasing basement flooding caused by sewer surcharge and reducing the environmental impact of sewer surcharging on local water bodies (City of Toronto, 2007a; 2007b). In 2004 and 2005, approximately 3,400 homes were disconnected (City of Toronto, 2006a). There are approximately 350,000 downspouts connected directly to the sanitary or storm sewer system (*Toronto Star*, 2006). The City aimed to disconnect 40% of downspouts (City of Toronto, 2006a). Public education has been an important component of the program, and has included print ads. However, a 2006 assessment of the state of the *Wet Weather Flow Master Plan* cited the need for improved public education to increase participation in the program (City of Toronto, 2006a).

The City undertook a review of the downspout disconnection program in 2006 (City of Toronto, 2006a). Among the recommendations resulting from the review, the City considered mandatory and non-subsidized downspout disconnection for all homes in Toronto that were connected to the sewer system (City of Toronto, 2006a; *Toronto Sun*, 2006; *Toronto Star*, 2006). At the time of writing, the City of Toronto website indicated that the participation in the program was free. However, newspaper articles from October and November of 2007 Indicated that funding for the disconnection of downspout was to be discontinued as of November 2007 (*Toronto Star*, 2007a; 2007b). The articles further reported that homeowners were to be given three years to disconnect their downspouts or could be subject to fines (*Toronto Star*, 2007a; 2007b).

2.1.2.1.4 Improvements made to homeowner Level program in 2007

In May, 2007, Toronto's homeowner level preventative plumbing funding program was extended to provide assistance to owners of triplex, duplex and single family homes, regardless of past flood experience (City of Toronto, 2007d; P. Clements, personal communication, July 19, 2007). As well, eligibility criteria, including the requirement that homeowners provide proof that flood damages were reported to their insurance companies, were removed (P. Clements, personal communication, July 19, 2007). The new program provided the same funding levels as the program instated following the August 2005 heavy rainfall event (see section 2.1.2.1.1), and was aimed at increasing the uptake of foundation drain pipe severance, installation of sump pumps and installation of sewer backwater valves. The new education program included an updated brochure, as well as pages on the City of Toronto's website (P. Clements, personal communication, April 30, 2007).

The abovementioned changes were made to Toronto's homeowner level program several months following administration of the questionnaire in this study. Thus, the new program would not have had an impact on study results.

3. Results

This section presents results and analysis of the January, 2007 survey of homeowners in Edmonton and Toronto. A summary of the major findings of the study is provided in Section 4.

3.1 Hazard experience

A total of 200 respondents from the Edmonton sample and 200 respondents from the Toronto sample had experienced sewer backup at some time in the past. The majority of respondents had experienced only one event; however, some respondents reported multiple events (Table 4). No statistical difference was found between the number of sewer backup experiences between Toronto and Edmonton using Pearson's Correlation Coefficient (p=0.668).

Table 4: Number of sewer backup experiences in Edmonton and Toronto

	Edmonton sewer backup Positive		Toronto sewer backup Positive	
Number of events experienced	**%**	**Cumulative %**	**%**	**Cumulative %**
1	57%	57%	55%	55%
2	23%	80%	26%	81%
3	7%	87%	11%	91%
4	7%	94%	3%	93%
5	2%	96%	1%	94%
6 or more	4%	100%	6%	100%
Refuse to respond	<1%	–	<1%	–
Total %	**100%**	**–**	**100%**	**–**
Total n	**n=200**		**n=200**	

Respondents were asked to estimate the number of years since their most recent sewer backup experience. The majority of both Edmonton and Toronto sewer backup positive respondents had experienced an event within the last 10 years (Table 5).

Table 5: Number of years since most recent sewer backup experience

	Edmonton sewer backup Positive		Toronto sewer backup Positive	
Number of years since most recent experience	**%**	**Cumulative %**	**%**	**Cumulative %**
<=5	19%	19%	24%	24%
1.1 to 5	52%	71%	30%	54%
5.1 to 10	11%	82%	16%	70%
10.1 or more	16%	97%	28%	97%
Refuse to respond	3%	100%	3%	100%
Total %	**100%**	**–**	**100%**	**–**
Total n	**n=200**		**n=200**	

Respondents were asked to estimate the total value of damages experienced in their most recent sewer backup event (Table 6). The majority of both Edmonton and Toronto respondents who chose to answer reported damages of $5,000 or less. These values reflect previous research by Kesik and Seymour (2003), who estimated that most individuals who have suffered basement flood damages in Canada experience between $3,000 and $5,000 of insurable damage.

Table 6: Estimated value of damages

	Edmonton sewer backup Positive		**Toronto sewer backup Positive**	
Estimated total value of damages	**%**	**Cumulative %**	**%**	**Cumulative %**
$1 to $2,500	30%	30%	42%	42%
$2,501 to $5,000	13%	43%	17%	59%
$5,001 to $10,000	9%	52%	8%	67%
$10,001 to $50,000	15%	67%	7%	73%
$50,001 to $100,000	3%	69%	1%	74%
$100,000 or more	1%	70%	3%	77%
Refuse to respond	30%	100%	23%	100%
Total %	100%	–	100%	–
Total n	**n=200**		**n=200**	
	Edmonton		**Toronto**	
Mean value	**$17,088**		**$10,957**	
Maximum value	**$850,000**		**$200,000**	

Estimates from the Insurance Bureau of Canada place the average claim value for damages caused during 2004 flooding events in Edmonton at approximately $15,000 (M. McGonigal, personal communication, February 14, 2007). Estimates from the Insurance Bureau of Canada place the average claim for basement flood damages experienced during the 2005 heavy rainfall event in Toronto at $19,000 (E. Patterson, personal communication, February 8, 2007). A possible explanation for the divergence between the mean claim amounts reported in this study and those provided by the Insurance Bureau of Canada is the relatively high refusal of response rate for this item (Table 6). Insurance industry experts indicate that in many circumstances, individuals who claim for insurance and receive compensation for experienced damage are unaware of the actual value of damages incurred and, thus, covered by insurance (P. Kovacs, personal communication, December, 2006). Insurance companies often deal directly with third party consultants and provide payments directly to consultants hired to repair claimable damages (e.g., contractors, cleaning professionals). Thus, the individual who has sustained damages may be completely unaware of the actual value of damages incurred.

Respondents were asked to rate the severity of the damages they incurred during their most recent sewer backup experience, using a 5 point Likert scale (Table 7). Respondents reported a wide distribution of damages in both the Edmonton and Toronto sub-samples. The descriptive statistics and Likert means indicate that respondents generally leaned toward perceiving their damages as minor. However, a considerable portion of both populations reported their damages as either severe or very severe.

Table 7: Perception of severity of most recent damages

	Edmonton sewer backup Positive		Toronto sewer backup Positive	
Perception of severity of damages	**%**	**Cumulative %**	**%**	**Cumulative %**
1. Very minor	24%	24%	22%	22%
2. Minor	32%	55%	39%	61%
3. Moderate	2%	57%	2%	62%
4. Severe	26%	82%	29%	91%
5. Very severe	18%	100%	8%	99%
Refuse to respond	1%	100%	1%	100%
Total %	**100%**	**–**	**100%**	**–**
Total n	**n=200**		**n=200**	
Mean/5	**2.82**		**2.63**	

Respondents were asked whether or not they had indirect hazard experience, in the form of awareness of anyone in their local neighbourhood having experienced sewer backup damages (Table 8).

Table 8: Indirect experience with sewer backup

Aware of neighbours' experience with sewer backup	**Edmonton sewer backup**		**Toronto sewer backup**	
	Positive %	**Negative %**	**Positive %**	**Negative %**
Yes	59%	21%	56%	20%
No	38%	78%	40%	77%
Refuse to respond	4%	2%	5%	3%
Total %	**100%**	**100%**	**100%**	**100%**
Total n	**n=200**	**n=200**	**n=200**	**n=205**

A considerable portion of respondents from all sub-samples were aware of homeowners in their local neighbourhood having sustained sewer backup damages at some time in the past. The data suggests that individuals who had suffered sewer backup damages were more likely to have been aware of individuals in their local neighbourhoods having sustained sewer backup damages than those who had not suffered damages. This relationship was found to be statistically significant using contingency analysis and Chi-square (χ^2) statistics (p=0.000 for both Edmonton and Toronto samples).

Woodley (1992) argued that the term "neighbourhood" is subjective, and individuals may have several interpretations of this term. However, the term "local neighbourhood" was used in place of neighbourhood in an attempt to incorporate a geographic element into the term.

3.2 Risk perception

Respondents were asked whether or not they perceived themselves at risk of experiencing sewer backup damages at some time in the future. The majority of respondents did not perceive themselves to be at risk of sustaining sewer backup damages in the future (Table 9).

Table 9: Perception of the occurrence of future damages

Perceive future sewer backup damages	Edmonton sewer backup		Toronto sewer backup	
	Positive %	**Negative %**	**Positive %**	**Negative %**
Yes	35%	19%	33%	19%
No	46%	60%	39%	47%
Refuse to respond	20%	22%	28%	34%
Total %	**100%**	**100%**	**100%**	**100%**
Total n	**n=200**	**n=200**	**n=200**	**n=205**

Contingency analysis revealed that experience with sewer backup was significantly correlated with expectation of future sewer backup damages for both the Edmonton (χ^2, p=0.000) and Toronto (χ^2, p=0.003) samples. Indirect experience was also found to increase expectation of future damages, as sewer backup negative respondents who were aware of people living in their neighbourhood having sustained damages were more likely to perceive themselves at risk of future damages in both Edmonton (χ^2, p=0.010) and Toronto (χ^2, p=0.000).

The analysis of risk perception requires a quantitative analysis of the likelihood that an individual will sustain damages at some time in the future (Burton *et al*., 1993). Generally, likelihood can be measured by presenting individuals with likelihood ratios of particular hazard events (for example, a 1 in 100 year flood) (Kreutzwiser *et al*., 1994). However, as no likelihood ratios were available for the occurrence of sewer backup in Toronto and Edmonton, a qualitative approach was used to explore this aspect of risk perception. This exploration was accomplished using a five point Likert scale in which respondents were asked to rate the likelihood of experiencing a sewer backup event within the next ten years (Table 10).

Table 10: Perceived likeliness of sustaining damages in the next ten years

Likeliness of damage in next ten years	Edmonton sewer backup				Toronto sewer backup			
	Positive		Negative		Positive		Negative	
	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%
1. Not very likely	7%	7%	27%	27%	8%	8%	10%	10%
2. Somewhat unlikely	11%	18%	27%	55%	12%	20%	21%	31%
3. No opinion	4%	22%	5%	60%	3%	23%	5%	36%
4. Somewhat likely	39%	61%	39%	47%	33%	56%	56%	92%
5. Very likely	39%	100%	8%	100%	44%	100%	8%	100%
Total %	**100%**	**–**	**100%**	**–**	**100%**	**–**	**100%**	**–**
Total n*	**n=70**		**n=37**		**n=66**		**n=39**	
Mean/5	**3.90**		**2.68**		**3.94**		**3.31**	

* Total carried from Table 9.

The majority of respondents who believed that they would sustain future damages from sewer backup believed that it was somewhat likely or very likely that they would sustain damages in the next ten years in both the Edmonton (64%) and Toronto (73%) samples. Contingency analysis revealed that homeowners in Edmonton who had sustained damages in the past believed that it was more likely that they would sustain damages in the next ten years than homeowners who had not sustained sewer backup damages (χ^2, p=0.004). This relationship was not found in the Toronto sample (χ^2, p=0.174). The majority of both those who had suffered damages in the past and those who had never suffered damages in the Toronto sample believed that it is somewhat or very likely that they would sustain damages within the next ten years, with 77% and 64% falling into this category respectively.

Respondents perceived that they would sustain damages caused by sewer backup in the future were asked to indicate how severe those damages might be (Table 11).

Table 11: Perceived severity of future damages

Severity of future damage	Edmonton sewer backup				Toronto sewer backup			
	Positive		Negative		Positive		Negative	
	%	Cum.%	%	Cum.%	%	Cum.%	%	Cum.%
1. Very minor	9%	9%	8%	8%	14%	14%	3%	3%
2. Minor	34%	43%	27%	35%	39%	53%	39%	42%
3. Moderate	1%	44%	3%	38%	5%	58%	–	42%
4. Severe	37%	81%	35%	73%	33%	91%	41%	83%
5. Very severe	14%	95%	19%	92%	5%	95%	10%	92%
refused to respond	4%	100%	8%	100%	5%	100%	8%	100%
Total %	**100%**	**–**	**100%**	**–**	**100%**	**–**	**100%**	**–**
Total n*	**n=70**		**n=37**		**n=66**		**n=39**	
Mean/5	**3.15**		**3.32**		**2.75**		**3.22**	

* Total carried from Table 9.

Perceptions of future damages varied widely. Sewer backup positive respondents in Edmonton leaned toward severe damages in the future, whereas sewer backup positive respondents from Toronto leaned toward minor damages in the future. Sewer backup negative respondents in both Edmonton and Toronto leaned toward severe damages in the future (Table 11).

3.3 Attribution of responsibility

Respondents were presented with a six-point Likert scale in which they were asked to rate the responsibility of homeowners and the municipality for sewer backup damages experienced in their homes (sewer backup positive respondents) or municipalities (sewer backup negative respondents).

Figures 1 and 2 provide results for homeowner attribution of responsibility for Toronto and Edmonton.

Figure 1
Attribution of responsibility: Edmonton homeowners

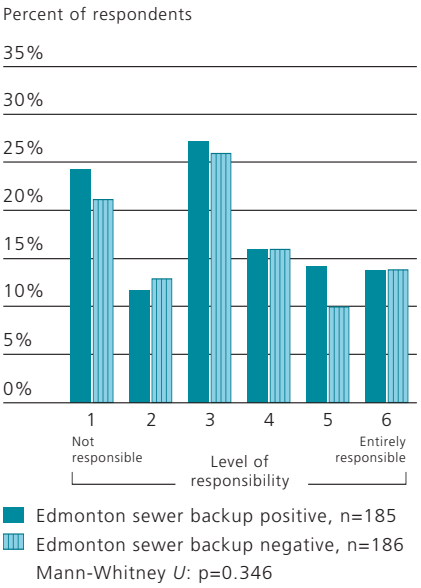


Figure 2
Attribution of responsibility: Toronto homeowners

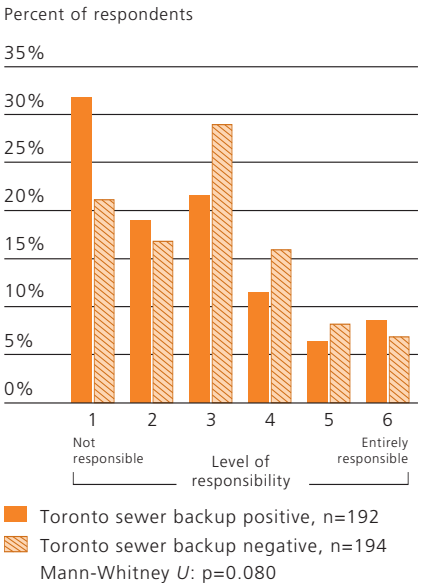
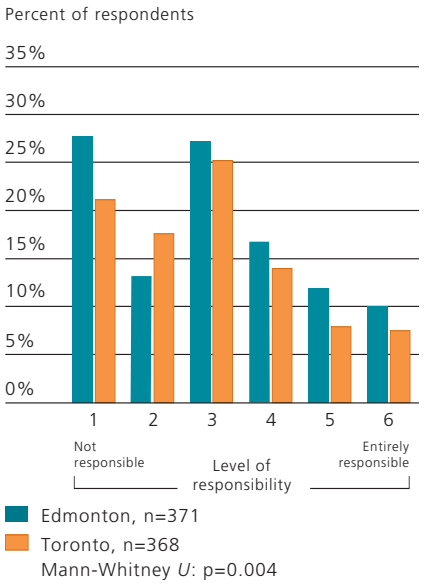


Figure 3
Attribution of responsibility: Edmonton vs. Toronto homeowners



The descriptive data indicate that respondents believed that homeowners were less responsible for damages caused by sewer backup. This distribution was found for both respondents who had suffered sewer backup damages and for those who had not. No statistical difference was found for those who had suffered sewer backup damages and those who had not, for both the Edmonton and Toronto samples (Figures 1 and 2).

The descriptive data suggest that Edmonton residents placed more responsibility on homeowners than did Toronto residents. Indeed, attribution of responsibility placed on homeowners was found to be statistically different based on city of residence (Figure 3).

Attribution of responsibility placed on the municipality for damages caused by sewer backup are presented in Figures 4 and 5.

Figure 4
Attribution of responsibility: Edmonton municipality

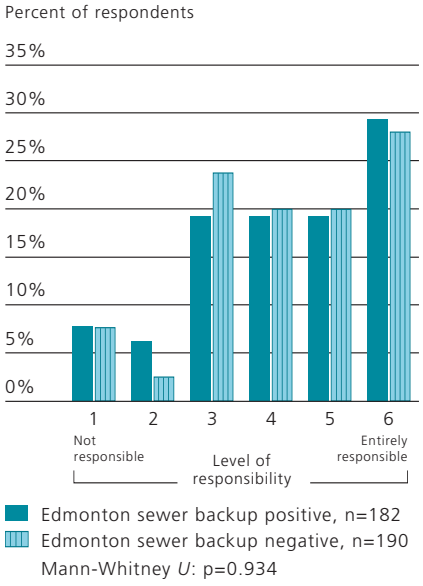


Figure 5
Attribution of responsibility: Toronto municipality

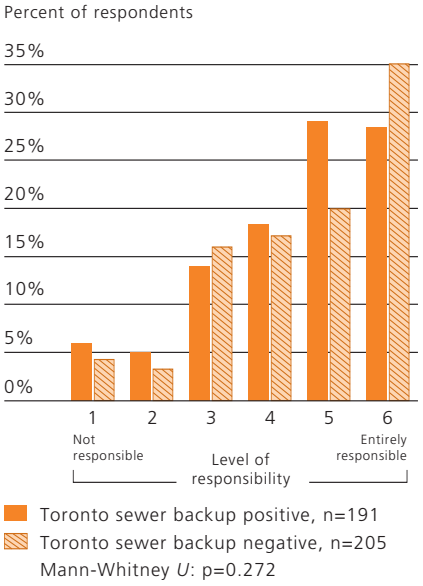
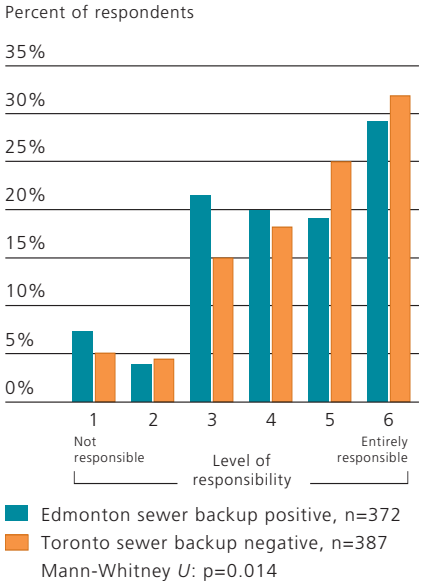


Figure 6
Attribution of responsibility: Edmonton vs. Toronto municipalities



Respondents in the sewer backup positive and negative sub-samples in both Toronto and Edmonton attributed a high amount of responsibility on their respective municipalities. There existed no statistical difference in attribution of responsibility between sewer backup positive and negative respondents in either municipality (Figures 4 and 5).

City of residence was found to be statistically associated with municipal attribution of responsibility. Toronto residents attributed a higher amount of responsibility on the municipality than Edmonton respondents (Figure 6).

Figures 7 and 8 provide a comparison of attribution of responsibility placed on homeowners and municipalities in Edmonton and Toronto. Respondents in both samples attributed significantly more responsibility on their municipal governments than on homeowners.

Figure 7
Attribution of responsibility: Edmonton homeowner responsibility vs. municipality responsibility

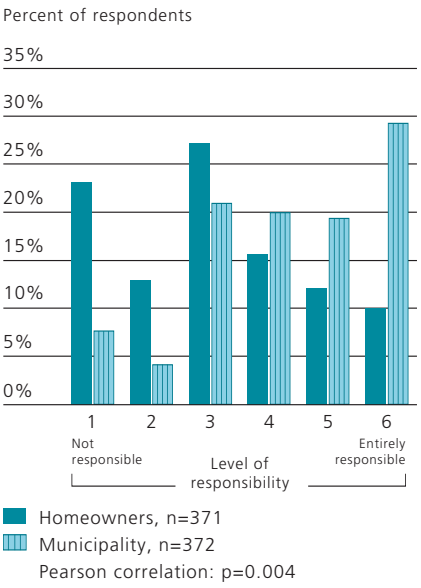
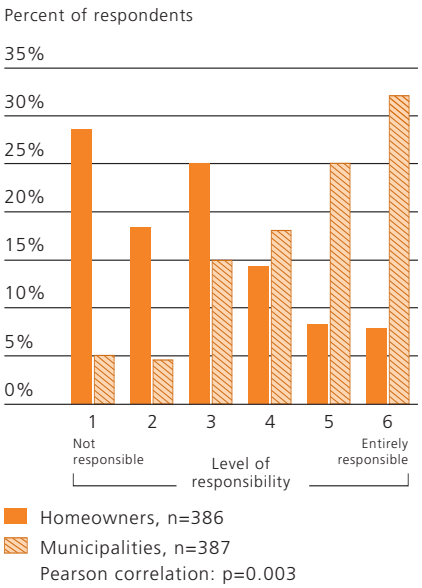


Figure 8
Attribution of responsibility: Toronto homeowner responsibility vs. municipality responsibility



3.4 Knowledge and information for individual adjustments

Respondents were asked whether or not they knew of what to do to reduce damages to their home caused by sewer backup. The majority of respondents from both the Toronto and Edmonton samples indicated that they knew what to do to reduce damages (Table 12).

Table 12: Knowledge of risk reducing adjustments

Know what to do to reduce damages	Edmonton sewer backup		Toronto sewer backup	
	Positive %	Negative %	Positive %	Negative %
Yes	85%	65%	67%	50%
No	14%	33%	33%	47%
Refuse to respond	1%	3%	<1%	2%
Total %	**100%**	**100%**	**100%**	**100%**
Total n	**n=200**	**n=200**	**n=200**	**n=205**

Experience with sewer backup hazards and city of residence correlated with knowledge of mitigative adjustments. Contingency analysis revealed that the relationship between having experienced sewer backup damages and knowing what to do to reduce damages is statistically significant for both the Edmonton (χ^2, p=0.000) and Toronto (χ^2, p=0.002) samples. This finding reflects previous research, which has revealed that individuals who have experienced hazards are more aware of available mitigative actions (Kreutzwiser *et al*., 1994; McCaffery, 2004; Parker & Harding, 1979). Contingency analysis also revealed a statistically significant relationship between city of residence and knowing what to do to reduce damages (χ^2, p=0.000). Furthermore, a statistical relationship was found between city of residence and knowledge of protective actions for sewer backup positive homeowners (χ^2, p=0.000).

Respondents who reported that they knew how to protect their homes from damages were asked where they attained their information. Respondents were given the opportunity to select one or more of a variety of options, and were provided an open-ended "Other" category. Results are presented in Table 13. Respondents indicated that they preferred attaining information from multiple sources, as only 36% of respondents in Edmonton and Toronto indicated that they attained information from only one source. The most frequently cited source of information for protective adjustments was family, friends and acquaintances for both samples and all sub-samples (Table 13, item 7). The municipal government (Table 13, item 1) and mass media (Table 13, item 4) were also cited frequently as information sources. Of note is that respondents from Edmonton reported the municipal government as an information source twice as often as Toronto respondents. The relationship between city of residence and attaining information from the municipal government was found to be statistically significant (χ^2, p=0.001).

Table 13: Information source for mitigative actions

	Edmonton sewer backup		Toronto sewer backup	
Information source	**Positive %**	**Negative %**	**Positive %**	**Negative %**
1. Municipal government	28%	14%	14%	7%
2. Internet	10%	4%	14%	5%
3. Insurance company	17%	4%	12%	12%
4. TV, radio, newspaper	23%	27%	15%	19%
5. Non-profits	4%	4%	3%	2%
6. Prov/fed government	5%	4%	2%	2%
7. Family, friend, acquaintance	45%	44%	50%	38%
8. Other	34%	41%	41%	45%
9. Refuse to respond	<1%	5%	2%	3%
Total n*	**n=200**	**n=200**	**n=200**	**n=205**

* Carried from Table 12.

Respondents reported a wide range of "Other" sources of information, including plumbers, contractors, and their own knowledge as professionals in the construction and engineering industries (e.g., many respondents reported that they were professional plumbers, engineers, carpenters, pipe-fitters, trades people, and contractors).

3.5 Adoption of mitigative adjustments

Respondents reported adopting a wide range of both risk reducing and less intensive adjustments. Table 14 reports frequency of adoption of adjustments for the Edmonton and Toronto samples and sub-samples.

Table 14: Adoption of risk reducing and less intensive adjustments

		Edmonton			Toronto		
Behavioural adjustments		**Total sample %**	**Sewer backup positive %**	**Sewer backup negative %**	**Total sample %**	**Sewer backup positive %**	**Sewer backup negative %**
Did something (Risk reducing and/or less intensive adjustment adoption)		**78%**	**72%**	**65%**	**70%**	**85%**	**57%**
Risk reducing	Left basement unfinished	15%	20%	10%	15%	20%	10%
	Detached foundation drain from sanitary sewer	16%	20%	12%	14%	16%	12%
	Moved away from sewer backup prone home	8%	9%	7%	4%	3%	5%
	Install backwater valve	27%	35%	19%	13%	18%	8%
	Install sump pump	19%	20%	18%	6%	8%	5%
	Disconnect eavestrough downspout	32%	41%	37%	28%	36%	20%
	Do not put important or expensive items in basement	29%	38%	20%	24%	32%	16%
	Total of respondents taking risk reducing actions	**54%**	**72%**	**36%**	**44%**	**60%**	**30%**
Less intensive	***Private adjustments***						
	Install water alarm	5%	6%	4%	2%	4%	1%
	Insurance policy covers sewer backup damage	55%	61%	49%	42%	45%	39%
	Made an insurance claim for sewer backup damage	19%	37%	–	16%	32%	–
	Made a claim to provincial disaster recovery program	2%	5%	–	1%	2%	–
	Became involved in litigation	2%	2%	1%	<1%	1%	–
	Community/Political adjustments						
	Communicated with city	6%	10%	1%	8%	15%	2%
	Attended public meetings	9%	14%	5%	4%	5%	4%
	Became involved in community organizations	4%	5%	4%	3%	3%	2%
	Communicated with MPP	2%	3%	1%	2%	3%	1%
	Letters to the editor of local newspapers	1%	3%	–	2%	1%	2%
	Total of respondents taking less intensive actions	**62%**	**72%**	**53%**	**51%**	**61%**	**4%**
Total responces		**n=400**	**n=200**	**n=200**	**n=405**	**n=200**	**n=205**

3.5.1 Adoption of risk reducing adjustments

Respondents reported adopting a variety of risk reducing adjustments. Disconnection of eavestrough downspouts was the most popular risk reducing adjustment in both the Edmonton and Toronto samples (Table 14). A statistical relationship between city of residence and adopting at least one risk reducing adjustment was found (χ^2, p=0.011). Thus, sewer backup positive homeowners in Edmonton were more likely to have adopted at least one risk reducing adjustment than sewer backup positive homeowners in Toronto.

Of note is that almost twice as many respondents in Edmonton who had suffered sewer backup reported adopting backwater valves than individuals who had sustained sewer backup damages in Toronto. A statistical relationship was found between city of residence and having a higher rate of adoption of backwater valves and sump pumps (Table 15). Thus, homeowners in Edmonton were more likely to have adopted backwater valves and sump-pumps than homeowners in Toronto.

Table 15: City of residence and the adoption of backwater valves and sump pumps

		Sewer backup			
		Positive [a]		Negative [b]	
Independent variable	**Dependent variable**	**Test**	**p**	**Test**	**p**
Reside in Edmonton or Toronto	Installed a backwater valve	χ^2	0.009[1]	χ^2	0.001[1]
Reside in Edmonton or Toronto	Installed a sump pump	χ^2	0.002[1]	χ^2	0.000[1]

[1] Significant at the 0.01 level
[a] n=228, [b] n=129

Sewer backup positive Edmonton homeowners were more likely to have moved away from a residence that was prone to sewer backup than Toronto sewer backup positive homeowners (χ^2, p=0.017). Experience with previous sewer backup events increased the adoption of adjustments in both Edmonton (χ^2, p=0.000) and Toronto (χ^2, p=0.000). Sewer backup positive homeowners who knew how to protect their home from sewer backup damages were more likely to do so than those who did not know, in both Toronto (χ^2, p=0.000) and Edmonton (χ^2, p=0.002).

Socio-economic variables, including income, education and having children in one's home were not associated with adopting risk reducing or less intensive adjustments for sewer backup positive Edmonton and Toronto homeowners. Disconnecting eavestrough downspouts was found to be the most popular adjustment for respondents from Toronto and Edmonton. No statistical difference was found between living in Toronto or Edmonton and disconnecting eavestrough downspouts. As discussed above, sewer backup negative homeowners in Toronto and Edmonton were more likely to perceive themselves at risk if they were aware of neighbours experiencing sewer backup damages. However, awareness of neighbours sustaining damages had no impact on adopting adjustments for the sewer backup negative sub-samples.

3.5.2 Adoption of insurance

The most commonly adopted less intensive adjustment in both samples was having an insurance policy that included coverage for sewer backup damage (Table 14). Sixty-one percent of sewer backup positive respondents in Edmonton reported having coverage for this type of damage, and 45% of Toronto sewer backup positive respondents reported this adjustment (Table 16).

A considerable portion of respondents indicated that they were unaware of their coverage for sewer backup damages. In all samples and sub-samples, between one third and one half of respondents could not indicate whether or not they had coverage for sewer backup damage (Table 16).

Table 16: Insurance coverage for sewer backup

Insurance policy covers sewer backup	Edmonton sewer backup		Toronto sewer backup	
	Positive %	Negative %	Positive %	Negative %
Yes	61%	49%	45%	39%
No	7%	12%	17%	12%
Don't know	33%	40%	38%	50%
Total n	**n=200**	**n=200**	**n=200**	**n=205**

Experience with sewer backup increased the rate of adoption of insurance coverage for sewer backup in Edmonton (χ^2, p=0.031), however, this relationship was not found in the Toronto population. Sewer backup positive homeowners in Edmonton were more likely to have insurance coverage for sewer backup than sewer backup positive Toronto homeowners (χ^2, p=0.000). No other independent variables, including indirect experience with sewer backup, perceiving future damages, perceiving future damages as severe and perceiving recent damages as severe were found to be statistically related to adoption of insurance coverage for sewer backup damages.

Respondents who indicated that they did not have sewer backup insurance coverage were asked why (Table 17).

Table 17: Reasons for not having insurance coverage for sewer backup

Reasons for not having sewer backup coverage	Edmonton sewer backup		Toronto sewer backup	
	Positive %	Negative %	Positive %	Negative %
1. Didn't know that sewer backup coverage was available	54%	22%	44%	46%
2. There is no threat of sewer backup damage in my home	15%	44%	21%	29%
3. Coverage would increase my insurance rates	69%	61%	56%	54%
4. Sewer backup coverage was cancelled	23%	–	6%	8%
Total n*	**n=13**	**n=23**	**n=34**	**n=24**

* Total carried from Table 16

The most popular reason cited for not having coverage was the belief that this type of coverage would increase insurance rates, followed by lack of knowledge of the availability of coverage. Seven (54%) sewer backup positive Edmonton respondents who did not have insurance coverage indicated that they did not know that this

type of coverage was available, and 15 (44%) sewer backup positive Toronto respondents indicated that they were unaware that coverage was available for sewer backup (Table 17, item 1).

Previous research on sewer backup perception and behaviour indicated that cancellation of sewer backup coverage, although not wide-spread, was a considerable inconvenience for several individuals who had sustained sewer backup damage (Sandink, 2006). However, very few respondents indicated that cancellation of their sewer backup damage coverage was a reason why they did not have coverage in this study (Table 17, item 4).

Previous research has revealed that claiming insurance for damages was an extremely popular adjustment. Sandink (2006) revealed that 86% of individuals who recently suffered damages caused by sewer backup had claimed insurance to assist in their recovery from damages. The results of this study show a much lower rate of adoption of this adjustment, with 37% of sewer backup positive Edmonton, and 32% of sewer backup positive Toronto respondents having made an insurance claim for their most recent sewer backup damage events.

A potential explanation of why there was such a low rate of adoption of this adjustment may be explained by the perception of severity of sewer backup damages. Table 7, in section 3.1, indicates that a considerable portion of sewer backup positive respondents from the Edmonton and Toronto samples believed that their most recent damages were minor or very minor. Contingency analysis revealed a statistically significant relationship between perception of severity of past damages and the claiming of insurance for past damages for both the Edmonton (χ^2, p=0.000) and Toronto (χ^2, p=0.000) sewer backup positive sub-samples. Thus, individuals who believed that their most recent damages were severe were more likely to have claimed insurance for those damages.

A further explanation for the low rate of insurance claims was the fear of insurance premium increases following damage claims. Newspaper reports from the Edmonton 2004 storm indicated that individuals feared premium increases as a result of claims for sewer backup damages (*Edmonton Journal*, 2004j). Thus, individuals who sustained only minor damages may have chosen to recover from those damages with no assistance from their insurance provider.

3.5.3 Adoption of other Less intensive adjustments

Aside from insurance coverage, many other less intensive adjustments were reported by survey respondents. Other adjustments included installing water alarms in basements, becoming involved in community organizations related to sewer backup or basement flooding, writing letters to the city and members of provincial parliament, and writing letters to editors of local newspapers (Table 14). Very few respondents reported having claimed for provincial disaster relief, with 10 (5%) sewer backup positive respondents in Edmonton and 4 (2%) sewer backup positive respondents in Toronto having reported adopting this adjustment.

Two percent of sewer backup positive respondents from Edmonton and 1% of sewer backup positive respondents from Toronto reported becoming involved in litigation as a result of experiencing sewer backup damages (Table 14). This finding reflects previous research that revealed that 2% (n=58) of individuals who suffered sewer backup damages in Peterborough, Ontario became involved in litigation as a result of those damages (Sandink, 2006).

Several respondents reported attending public meetings in both Edmonton and Toronto. Fourteen percent of sewer backup positive Edmonton respondents reported having attended public meetings, and 5% of Toronto sewer backup positive respondents reported having attended public meetings related to basement flooding or sewer backup. A statistically significant relationship (χ^2, p=0.003) was found between city of residence and attending public meetings for the sewer backup positive sub-samples, with Edmonton residents having a higher rate of attendance than Toronto residents.

3.6 Perceptions of municipal actions

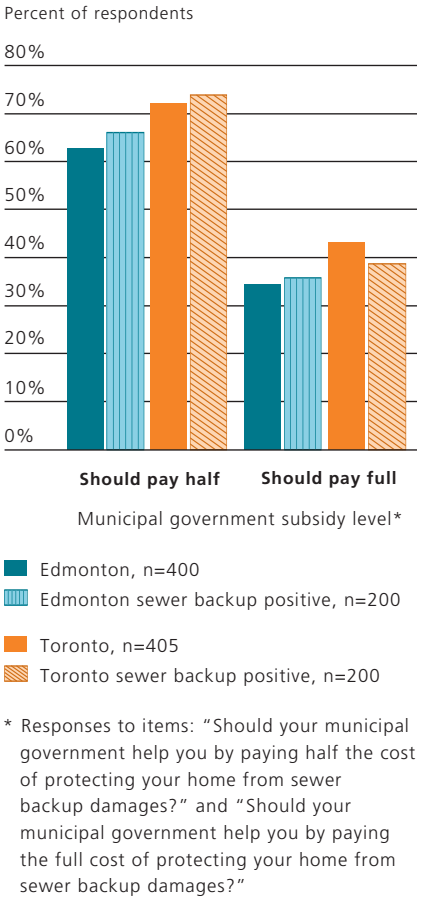
Respondents were asked to comment on levels of funding for protection of homes from sewer backup, knowledge of municipal programs designed to reduce basement flooding and their perceptions of the effectiveness of municipal level actions aimed at reducing sewer backup.

Respondents were asked whether they believed the municipal government should pay half or the full cost of protecting their homes from sewer backup damages. Results are presented in Figure 9.

More than 60% of all respondents believed that the municipal government should pay half the cost of protecting their homes from sewer backup damages. Conversely, less than 50% of all respondents believed that the municipal government should pay the full cost of protecting homes from sewer backup damages. Responses to the questions presented in Figure 9 were found to be statistically different in all samples and sub-samples.

Preference for the municipal government paying for half the cost or the full cost of protecting one's home from sewer backup was statically associated with attribution of responsibility. Statistical analysis using the Mann-Whitney *U* test (MW*U*) revealed that sewer backup positive respondents who believed that homeowners were more responsible for sewer backup damages were less likely to believe that the municipal government should pay the full cost of protecting their homes from damages in both Edmonton (p=0.001) and Toronto (p=0.002). Conversely, sewer backup positive respondents who believed that the municipal government was more responsible for damages caused by sewer backup were more likely to think that the government should pay half the cost (Edmonton: MW*U*, p=0.005; Toronto: MW*U*, p=0.022) or the full cost (Edmonton: MW*U*, p=0.008; Toronto: MW*U*, p=0.015) of protecting their home from damages.

Figure 9: Perceptions of municipal subsidy levels



* Responses to items: "Should your municipal government help you by paying half the cost of protecting your home from sewer backup damages?" and "Should your municipal government help you by paying the full cost of protecting your home from sewer backup damages?"

Respondents were further asked about their willingness to protect their homes from sewer backup damages based on the available level of funding (Table 18). Seventy-six to 80% of respondents agreed that they would be more willing to protect their homes from sewer backup damages if the government paid half the cost of doing so. Similarly, 78% to 84% of respondents agreed that they would be more willing to protect their homes from sewer backup damages if their government paid the full cost of doing so.

Table 18: Willingness to protect home based on funding

	Edmonton sewer backup		Toronto sewer backup	
Item	**Positive %**	**Negative %**	**Positive %**	**Negative %**
Responded "Yes" to: Would you be more willing to protect your home if the municipal government paid half the cost of doing so?	76%	80%	80%	76%
Responded "Yes" to: Would you be more willing to protect your home if the municipal government paid the full cost of doing so?	78%	78%	79%	84%
Total n	**n=200**	**n=200**	**n=200**	**n=205**

Respondents were asked whether or not their municipal governments were currently taking actions to reduce sewer backup in their cities. As discussed in section 2.1, the municipal governments in Toronto and Edmonton were taking actions to reduce sewer backup. However, less than half of respondents in all categories agreed that their municipal governments were taking actions to reduce sewer backup damages in their cities (Table 19).

Table 19: Responses to: Is your municipal government currently taking actions to reduce sewer backup in your city?

	Edmonton sewer backup		Toronto sewer backup	
Municipal government currently taking action?	**Positive %**	**Negative %**	**Positive %**	**Negative %**
Yes	42%	38%	36%	21%
No	24%	15%	27%	24%
Don't know	35%	48%	37%	55%
Total n	**n=200**	**n=200**	**n=200**	**n=205**

Of the sewer backup positive respondents, 42% of those who lived in Edmonton and 36% of those who lived in Toronto agreed that their municipal government was taking actions to reduce sewer backup. Of note is that 63% of respondents from the Edmonton sewer backup positive sub-sample and 64% of respondents from the Toronto sewer backup positive sub-sample either disagreed or did not know whether or not their municipal governments were taking actions to reduce sewer backup damages.

No statistical relationship was found between having experienced sewer backup damages in the past and being aware that the municipal government was currently taking actions to reduce sewer backup. However, contingency analysis revealed that those who perceived their recent damages as severe were more likely to disagree that the city was currently taking actions than those who indicated that their most recent damages were minor in the Toronto sewer backup positive sub-sample (χ^2, p=0.034). This relationship was not found for individuals who had sustained sewer backup damages in the Edmonton sub-sample.

Individuals from the sewer backup positive sub-samples in Edmonton and Toronto who perceived that they would not have future damages caused by sewer backup were more likely to agree that their municipal governments were currently taking actions to reduce sewer backup damages (Edmonton: χ^2, p=0.006; Toronto: χ^2, p=0.026). Thus, individuals who had sustained past sewer backup damages and were aware that their municipal government was taking action to reduce sewer backup damages were less likely to perceive a threat of future sewer backup damages.

Respondents were asked whether or not their municipalities had long term strategies to reduce sewer backup (Table 20). As discussed in section 2.1, reduction of damages caused by sewer surcharging is a component of Toronto's 25 year *Wet Weather Flow Master Plan* (City of Toronto, 2006a) and Edmonton's ongoing drainage system improvements will serve to reduce all types of basement flooding (City of Edmonton, 2007d).

Table 20: Responses to: Does your municipal government currently have a long term strategy to reduce sewer backup damages in Edmonton/Toronto?

Municipal government has a long term strategy?	Edmonton sewer backup		Toronto sewer backup	
	Positive %	Negative %	Positive %	Negative %
Yes	34%	32%	25%	18%
No	19%	13%	24%	22%
Don't know	47%	56%	52%	61%
Total n	**n=200**	**n=200**	**n=200**	**n=205**

The descriptive data indicate that fewer respondents agreed that the municipal governments in Edmonton and Toronto had long term strategies to reduce sewer backup than agree that the municipal governments were taking actions to reduce sewer backup damages (see Tables 19 and 20). Of note is the proportion of respondents who either disagreed or did not know that their municipal governments had long-term strategies to reduce sewer backup. Sixty-six percent of respondents in the Edmonton sewer backup positive sub-sample, and 76% of respondents in the Toronto sewer backup positive sub-sample either did not know or did not agree that their municipal governments had long-term strategies to reduce sewer backup damages in their cities.

Respondents who agreed that their municipal government was currently taking actions and/or had a long term strategy to reduce sewer backup damages were asked to give their perceptions of the effectiveness of these municipal actions using a 5-point Likert scale (Table 21).

Table 21: Responses to: How effective are the actions your municipal government is taking to reduce sewer backup?

	Edmonton sewer backup				Toronto sewer backup			
How effective are municipal actions?	**Positive**		**Negative**		**Positive**		**Negative**	
	%	**Cum.%**	**%**	**Cum.%**	**%**	**Cum.%**	**%**	**Cum.%**
1. Very effective	16%	16%	16%	16%	4%	4%	7%	7%
2. Somewhat effective	47%	63%	47%	63%	51%	55%	35%	42%
4. Somewhat ineffective	15%	78%	14%	77%	19%	74%	26%	68%
5. Very ineffective	7%	85%	4%	81%	7%	81%	9%	77%
3. No opinion	16%	100%	18%	100%	19%	100%	24%	100%
Total	**n=96**		**n=92**		**n=90**		**n=58**	
Mean/5	**2.51**		**2.44**		**2.72**		**2.95**	

The majority of respondents who knew that their municipal governments were taking actions to reduce sewer backup believed that these actions were somewhat effective at reducing sewer backup damages (Table 21).

Contingency analysis revealed a statistically significant relationship between city of residence and perception of effectiveness of municipal action to reduce sewer backup damages for the sewer backup negative subgroups (χ^2, p=0.010). A greater proportion of respondents in the Edmonton sewer backup negative sub-sample perceived municipal government actions as either somewhat or very effective than those in the Toronto sewer backup negative sub-sample. This relationship was not found in the sewer backup positive sub-samples. Perceived recurrence of damages and perception of severity of most recent damages were not statistically related to perception of effectiveness of municipal actions.

4. Summary, recommendations and conclusion

The report concludes with a summary and discussion of important findings. The report presents a discussion of the practical implications of the study, as well as recommendations for future work.

4.1 Summary and discussion

4.1.1 Perceptions of sewer backup hazards

Hazard perception findings in this study include:

1. The majority of sewer backup positive respondents in both Toronto and Edmonton perceived their most recent damages to be minor or very minor;

2. The majority of respondents, including sewer backup positive respondents, believed that they were not at risk of sustaining future sewer backup damages;
   a. Experience with sewer backup damages, including indirect experience (awareness of neighbours who had experienced damages), was statistically associated with expecting future sewer backup damages in Edmonton and Toronto;
   b. The majority of respondents who believed that they would sustain damages at some time in the future believed that it was likely or very likely that they would sustain these damages in the next 10 years, and;

3. Edmonton and Toronto homeowners felt that the municipal government was mostly responsible for damages caused by sewer backup and that homeowners had little responsibility for damages caused by sewer backup.

Similar to many previous hazard perception studies (Blanchard-Boehm & Cook, 2004; Zaleskiewicz *et al*., 2002), this study revealed that homeowners who had suffered damages caused by sewer backup perceived themselves at a low risk of sustaining future damages. This study also supports previous assertions that individuals place responsibility for damages caused by hazards on local governments (Arceneaux & Stein, 2006; Yates, 1998).

4.1.2 Information and adoption of adjustments for sewer backup

Homeowners have the opportunity to reduce their risks of sustaining sewer backup damages by taking appropriate mitigative actions. This section provides a summary of findings related to information and adoption of mitigative adjustments. Findings include:

1. Homeowners in Edmonton and Toronto who knew how to protect their homes from sewer backup damages were statistically more likely to adopt mitigative actions;
   a. The majority of homeowners in Toronto and Edmonton reported attaining sewer backup damage reduction information from more than one source;
   b. The most popular source of information for sewer backup mitigative actions was informal networks (family, friends and acquaintances);
   c. Experience with sewer backup damages was statistically associated with knowing how to protect one's home from sewer backup in both the Toronto and Edmonton samples;

2. The majority of sewer backup positive homeowners had not taken the most effective risk reducing adjustments in both Toronto and Edmonton;
    a. Homeowners in Toronto and Edmonton who had sustained damages were more likely to adopt risk reducing adjustments than those who had not;
    b. The majority of respondents had not installed sewer backwater valves and sump-pumps in both the Edmonton and Toronto samples;
    c. Disconnecting eavestrough downspouts was the most popular risk reducing adjustment in both the Edmonton and Toronto samples;

3. Insurance coverage for sewer backup – a less intensive adjustment – was the most common adjustment adopted for sewer backup in both Toronto and Edmonton;
    a. There was a high rate of not knowing whether or not one's insurance policy covered damages caused by sewer backup;
    b. Previous experience with sewer backup damage was statistically associated with having insurance coverage;
    c. The most popular response when asked why respondents did not have insurance coverage for sewer backup was the belief that coverage would increase their insurance premiums;
    d. Approximately one third of sewer backup positive Edmonton and Toronto respondents reported claiming insurance for their most recent sewer backup damages, and;
    e. Those who perceived their most recent damage as severe or very severe were statistically more likely to claim insurance.

As discussed in section 1.5, hazard education and information is an important component of hazard mitigation. Researchers have argued that well informed individuals are more likely to protect themselves from hazards (Blanchard-Boehm & Cook, 2004; Glik, 2007; Tanaka, 2005); a finding supported in this study. Similar to previous studies (Mileti *et al*., 1992), this study revealed that individuals preferred to get their information for hazard reduction from several sources. This study also supports previous research that has revealed that hazard experience increases awareness of adjustments (Kreutzwiser *et al*., 1994).

The importance of informal social networks for hazard information and mitigative behaviour has previously been discussed in hazard information and education literature (Blanchard-Boehm & Cook, 2004; Heller *et al*., 2005; Lindell & Perry, 2000). Reflecting previous literature, this study revealed that informal networks, including family, friends and acquaintances, were a highly cited source by respondents for information on mitigative actions related to sewer backup.

Findings in this study support a significant body of previous research which has revealed that individuals at risk of sustaining hazard damages do not adopt appropriate mitigative adjustments (Burton *et al*., 1993; Mileti, 1999; Nguyen *et al*.,

2006). The finding that insurance purchase was the most common adjustment adopted supports previous studies which have revealed that individuals at risk of hazards generally adopt less intensive adjustments, rather than risk reducing adjustments which can be more expensive and require more time and effort to employ (Burton *et al*., 1993). Accordingly, adoption of some of the more effective adjustments, including backwater valves, was relatively low for both the Edmonton and Toronto samples. Further, this study supports previous research that has linked hazard experience (Laska, 1986; Siegel *et al*., 2003; Wong & Zhao, 2001; Yoshida & Deyle, 2005) and hazard perception (Browne & Hoyt, 2000; Jackson, 1981; Jackson & Mukerjee, 1974; Kreutzwiser *et al*., 1994; Nguyen *et al*., 2006; Siegrist & Gutscher, 2006) with increased adoption of adjustments.

Claiming insurance for damages was found to be relatively low. By comparison, 86% of residents in Peterborough who sustained sewer backup damages in 2004 reported claiming insurance (Sandink, 2006).

4.1.3 Perceptions and awareness of municipal actions

As discussed in sections 2.1.1 and 2.1.2, the municipalities of Toronto and Edmonton were taking considerable actions to inform homeowners of, and reduce risks associated with basement flooding. This section summarizes findings associated with homeowners' awareness and perception of municipal programs. Findings include:

1. There existed a low awareness of government programs designed to reduce sewer backup damages;
    a. Less than half of respondents were aware that their municipal governments were taking actions to reduce sewer backup damages in their city;
    b. Sewer backup positive respondents were more aware of actions by the city, however, only 42% and 36% of Edmonton and Toronto sewer backup positive respondents respectively were aware that their municipal governments were currently taking actions to reduce sewer backup damages;
    c. Homeowners who were aware that their municipal government was taking actions to reduce sewer backup damages were less likely to perceive that they would sustain damages in the future;
    d. Of the respondents who were aware that their municipal government was taking actions to reduce sewer backup damages, the majority believed that those actions were either somewhat or very effective;

2. Respondents preferred that their municipal government pay half the cost of protecting individual homeowners from sewer backup damages over paying the full cost;
    a. The majority of respondents would be more willing to protect their homes from sewer backup if the municipal government paid half the cost of doing so, and;

b. Homeowners who attributed more responsibility on the municipal government were statistically more likely to believe that the government should pay half the cost or the full cost of protecting homes from sewer backup damages.

Municipal staff in Toronto and Edmonton reported that up-take of preventative plumbing subsidy programs by the public was relatively low. A relatively small uptake of personal hazard mitigation subsidy programs has been reported in previous research (Merrell *et al*., 2002). Indeed, results indicated that awareness of municipal programs in general was relatively low. This finding supports previous research which has revealed that individuals are generally unaware of programs that are designed to reduce their exposure to hazards (Kreutzwiser *et al*., 1994). Similar to previous studies, hazard experience increased awareness of government programs (Kreutzwiser *et al*., 1994; Loreli, 1982), however, less than half of homeowners in Edmonton and Toronto who experienced sewer backup damages were aware that their municipal governments were taking actions to reduce sewer backup damages.

Education has a role to play not only in increasing adoption of adjustments, but also in awareness and satisfaction with municipal programs designed to reduce sewer backup. For example, this study revealed that individuals who were aware that the municipal government was taking action to reduce sewer backup were less likely to perceive themselves at risk of future damages. Furthermore, the majority of homeowners who were aware of actions their municipal government was taking considered these actions as either somewhat or very effective. Thus, the more individuals who can be made aware that the government is indeed taking actions to reduce basement flooding, the more homeowners will perceive these actions as relatively effective.

4.1.4 Similarities and differences between Edmonton and Toronto

This study revealed that Edmonton homeowners were slightly, yet significantly more knowledgeable about sewer backup hazards, more aware of how to protect themselves and more likely to protect themselves from damages. Specific findings include:

1. Edmonton homeowners were more likely to know how to protect their home from sewer backup damages than Toronto homeowners;
   a. Edmonton homeowners were statistically more likely to attain information on how to protect their home from the municipal government than Toronto homeowners;

2. Toronto homeowners attributed slightly, yet statistically significantly more responsibility on the municipality for damages caused by sewer backup than Edmonton homeowners; conversely, Edmonton homeowners attributed slightly yet statistically significantly more responsibility on homeowners for sewer backup damages than Toronto homeowners;

3. Edmonton respondents were generally more likely to have adopted risk reducing and less intensive adjustments than Toronto homeowners;
    a. Edmonton homeowners were statistically more likely to adopt backwater valves and sump pumps than Toronto homeowners;
    b. Sewer backup positive homeowners in Edmonton were statistically more likely to have attended public meetings than sewer backup positive homeowners in Toronto;
    c. Sewer backup positive homeowners in Edmonton were statistically more likely to have insurance overage for sewer backup damages than sewer backup positive homeowners in Toronto;

4. Disconnecting eavestrough downspouts was the most popular risk reducing adjustment for both Toronto and Edmonton respondents; adopting this adjustment was not statistically associated with living in Toronto or Edmonton;

5. Homeowners' perception of whether or not they would sustain damages in the future, whether or not they detached their foundation drains from the sanitary sewer, whether or not they placed important items in the basement (as a means of reducing damage risk), and whether or not they claimed insurance for damages caused by sewer backup did not depend on whether homeowners lived in Toronto or Edmonton.

Findings 1 through 3 in this section reveal that homeowners in Edmonton were more aware of sewer backup hazards, more likely to adopt some of the more effective adjustments, and were more likely to accept responsibility for damages caused by sewer backup. The author argues that these findings may, in part, be related to the nature of hazard education programs in Toronto and Edmonton, and on the nature of preventative plumbing subsidy programs in the two case cities.

Hazard education and risk communication literature purports the importance of relevant and interactive education provided over a long time-frame from diverse sources and channels as a means of increasing awareness and risk reducing behaviour in hazard-prone individuals (Brug *et al*., 2004; Glik, 2007; Nathe *et al*., 1999). Both the cities of Edmonton and Toronto have employed education programs including websites, brochures and newsletters, as well as protective plumbing subsidy programs. The City of Edmonton, however, has been arguably more progressive in the implementation of education programs; including frequent public information meetings (see section 2.1.1). Furthermore, hazards literature purports that education programs should take place over the long term, in order to solidify hazard information presented to the public (Mileti *et al*., 1992; Nathe *et al*., 1999). The City of Edmonton appears to be extending significant efforts to ensure public education for flooding over the long term. For example, the most recent meeting was held in April, 2007. This meeting discussed further actions designed to reduce flooding caused by storms similar to that of July, 2004. The frequent and long-term nature of public meetings in Edmonton may provide an explanation for the finding that Edmonton homeowners were statistically more likely to have attended meetings than Toronto homeowners.

A further possible explanation for the higher rates of adoption of mitigative adjustments in Edmonton is the nature of the education programs and subsidy programs. Rather than temporary and less-formalized programs, as employed by the City of Toronto, the education and subsidy programs employed in Edmonton had been formalized for several years before the 2004 flooding events. Hazard education and risk communication literature often argues that decision makers must take advantage of the "window of opportunity" following a hazard event, as the short time period following an event is when public interest in the hazard is highest (Mileti *et al*., 1992; Solecki & Michaels, 1994). The literature further argues that in order to take advantage of these windows of opportunity, decision makers should have information and programs ready to be mobilized within a short-time frame following the event (Nathe *et al*, 1999). Formalization of the flood mitigation programs in Edmonton may have allowed information dissemination through brochures, announcements and public meetings to be conducted in a short time period after flooding events, and thus, allowed the City to take advantage of the window of opportunity following flood events.

The case cities differed in the nature of their preventative plumbing subsidy programs. Edmonton has had a funding program in place for the installation of backwater valves and sump pumps since 1991. Though the program was originally designed to provide subsidies only to those who had sustained sewer backup damages in the past, in September, 2005, the program was extended to all homeowners who live in areas that have been subject to basement flooding. Toronto, until May, 2007, has required that individuals applying for the subsidy program prove that they had sustained damages caused by sewer backup and had reported these damages to their insurance companies (City of Toronto 2005a; 2007d). Also, preventative plumbing incentive programs in Toronto have been of a temporary nature, and have required that homeowners apply for funding within a few months of the establishment of the programs. Differing durations and eligibility criteria in subsidy programs may have been a contributing factor in the greater level of adoption of risk reducing mitigative adjustments in Edmonton.

Finding 4 in this section reveals no difference in the rate of disconnecting eavestrough downspouts between Edmonton and Toronto. Beginning in 1998, the City of Toronto has maintained a downspout disconnection subsidy program. The program was ongoing, advertised to the public, provided a full subsidy for disconnection, and did not require previous experience with flood hazards for eligibility. While the City of Edmonton has not subsidized the disconnection of downspouts since the 1990s, the City has required that individuals with homes in areas that have combined sewers disconnect their downspouts. Results form this study suggest that levels of adoption of downspout disconnection in Edmonton and Toronto are similar, and highlight the effectiveness of Toronto's downspout disconnection program, and the comparative effectiveness of Edmonton's downspout disconnection requirement and past funding programs.

4.2 Recommendations for municipalities

This study revealed a low awareness of sewer backup hazard risk, a low rate of adoption of mitigative adjustments and a low awareness of municipal programs designed to reduce the risk of basement flooding and sewer backup. This study recommends more progressive basement flooding education programs, more accurate identification of who is at risk of sewer backup, as well as targeting information to areas that may be at risk of sewer backup due to climate change and aging infrastructure. Homeowners should also be made more aware of the nature of sewer backup insurance coverage.

Information on basement flooding in many municipalities is often supplied by an official source, generally the municipal public works department responsible for sewer systems. However, previous research has revealed that individuals at risk of hazards prefer to "seek out" their own information, and individuals need to validate information based on several sources in order to make a personal judgment on the salience of hazard information (Glik, 2007; Mileti *et al*., 1992). This study revealed that homeowners prefer to attain sewer backup risk reduction information from a wide variety of sources. Specifically, informal networks, including family and friends, and other sources, including plumbers and contractors, were the most highly cited sources of information by respondents in this study. Municipalities should work to ensure that hazards information programs make use of a wide variety of sources and provide information through a variety of channels. Municipalities should make use of all available information channels, including public meetings, mass media, internet, information mailings, hazard maps, and so on. In producing and presenting sewer backup reducing information, municipalities should make use of numerous sources to allow individuals to personally validate information. Along with engineers from municipal public works departments, information sources should include scientists, plumbers, insurance professionals, contractors and other trades people and professionals. Providing information from diverse channels and through diverse sources will help to ensure that homeowners are receiving valid information, and will allow them to make personal judgments on the salience of that information.

Both sewer backup positive and negative respondents in this study attributed a considerable majority of responsibility for sewer backup damages to the municipal government, rather than to individual homeowners. Following this, homeowners who attributed more responsibility to homeowners were less likely to believe that the municipality should subsidize the full cost of protecting their homes from damages. Previous research has revealed that individuals attribute the majority of responsibility for both overland flooding and sewer backup to municipal governments; however, residents place significantly more responsibility on governments for damages caused by sewer backup than overland flooding (Sandink, 2006). Municipal education programs should work to address homeowner's perceived attribution of responsibility for basement flood damages, and encourage homeowners to accept a greater share of the responsibility for the protection of their property.

Municipalities should consider working with insurance companies to share sewer backup data and information, and in disseminating information to homeowners who are prone to sewer backup. As discussed in the Peterborough example in section 1.6, municipalities and the insurance industry may benefit from ongoing communications throughout the implementation of basement flooding mitigation programs. Sharing information may allow both groups to construct a more comprehensive picture of how sewer backup has affected homeowners within a municipality's jurisdiction, and may alleviate insurance sector anxiety and allow for continuation of sewer backup coverage in an affected municipality.

The City of Toronto reported that 3,600 basement flood complaints were made to the City following the August, 2005 storm (City of Toronto 2006b), and the City of Edmonton estimated that 4,000 homes were affected by basement flooding following the July, 2004 storms (City of Edmonton, 2005a). These figures contrast with the 13,011 sewer backup insurance claims made for sewer backup in the GTA, and the 9,500 sewer backup insurance claims made in Edmonton following the aforementioned heavy rainfall events. Furthermore, individuals who had minor or very minor damages were unlikely to make an insurance claim for their damages (see Table 14). These findings suggest that many homeowners who sustain sewer backup damages may not report these damages to authorities. Municipalities often target basement flood information programs and other mitigative actions to areas that have been identified as having a high rate of basement flood damages, as reported by residents who sustained damages during hazard events. Municipal staff in Edmonton and Toronto indicated that their municipal governments focus damage mitigation and education efforts on areas that have high occurrences of emergency calls from homeowners who have sustained sewer backup damages. This method was also evident in the City of Peterborough following flooding in 2002 and 2004 (Sandink, 2006). To better gauge which parts of a city have been affected by sewer backup, municipalities should employ alternative methods of identifying who has been subject to damages.

Homeowners may fear that admitting their home has sustained sewer backup damages will increase their insurance premium or decrease their property value. Thus, municipalities should employ a more confidential approach to identifying areas and homes in the city that have been subject to flooding. A confidential survey, confidential door to door census of areas that may have sustained damages following a heavy rainfall event or ongoing communications and information sharing with insurance companies would allow municipalities to increase their knowledge base on basement flooding events, while alleviating homeowner fear or stress that may be associated with experiencing basement flooding.

Municipal staff indicated that the municipalities of Edmonton and Toronto target information meetings and information mailings to neighbourhoods that have historical damages from basement flooding and sewer backup. Climate change will increase heavy rainfall events, and aging infrastructure will potentially increase the risk of sewer backup events in sections of cities that have not been subject to basement flooding in the past (Ashley *et al*., 2005; Lehner *et al*., 2006). Thus,

information should be targeted not only to areas of the city that have sustained historical damages from sewer backup and basement flooding, but also to areas of the city that are at risk of future flooding events. Areas of municipalities that are serviced by combined sewer systems or older separated sewer systems that may have infiltration and inflow problems are particularly at risk, due to increasing heavy rainfall events caused by climate change (UMA, 2005; Lawford *et al*., 1994; White & Etkin, 1997). In order to address this increasing risk, areas of municipalities that have older separated systems or combined systems should be targeted with basement flood mitigation education materials even if the areas have never been subject to sewer backup or basement flooding damages in the past. Furthermore, as discussed above, municipalities should seek out areas of the city or homeowners who have sustained only minor damages but have not reported these damages to authorities. While these damages may have been minor in the past, homeowners who have experienced minor damages may be at risk of sustaining more serious damages in the event of increasing heavy rainfall caused by climate change.

Edmonton homeowners were more likely to have adopted backwater valves than Toronto homeowners. A possible explanation is the nature and formality of the preventative plumbing subsidy programs employed by the case cities. In the short period following disaster events, individuals are much more receptive to information and much more willing to take mitigative actions to reduce the risk of sustaining future damages (see section 1.5). Municipalities should be ready to provide information to homeowners and take advantage of the windows of opportunity that follow basement flooding occurrences. Formal, ongoing programs, such as Edmonton's *FloodProof* program, ensure that information and materials are ready as soon as a disaster hits a community. Less-formalized programs require time to be organized and may have less capacity to take advantage of windows of opportunity. Thus, an important component of effective sewer backup/basement flooding education is a formal program, on which the municipal government can draw in the short time-period following a flood event.

This study revealed a lack of awareness of insurance coverage for sewer backup. Although insurance coverage was the most frequently adopted adjustment for sewer backup hazards, a considerable proportion of respondents did not know whether or not they had insurance coverage for sewer backup. Furthermore, homeowners who did not have sewer backup coverage indicated that they did not have this coverage because they felt it would increase their insurance premiums. As part of basement flooding and sewer backup hazard education programs, homeowners should be made aware that insurance coverage for sewer backup is usually an optional coverage, and not covered in basic home insurance policies (IBC, 2006). Homeowners who do not know whether or not they have this type of coverage should be encouraged to check their policies. Furthermore, homeowners should be made aware that insurance coverage for sewer backup will not necessarily significantly increase home insurance premiums. For most homes, sewer backup insurance would add $30 to $40 to yearly home insurance premiums.

The location of property in basements is a primary factor in damage caused during basement flood events. Wisner and Hawdur (1984) reported an average damage value of $3,000 for residents in Ottawa, and Allouche and Freure (2002) report that the average insurance claims for sewer backup in Canada were about $3,000 to $5,000. Responses in this study support averages presented by these researchers, however, information provided by the Insurance Bureau of Canada suggested that these averages were significantly lower than actual average insurance payouts. The 2005 GTA storm, for example, resulted in an average insurance claim of $19,000 and the 2004 storms in Edmonton saw an average of over $15,000. Furthermore, previous research has reported that total yearly claims for basement flood damages in Canada were approximately $140 million (Allouche & Freure, 2002; Kesik & Seymour, 2003). However, sewer backup damages in the August, 2005 GTA storm alone were $247 million. These values suggest that the property people are placing in their basements may be significant in both quantity and value. As indicated in Table 14 on page 29, the majority of sewer backup positive homeowners had not chosen to remove their important or expensive items from their basements. Homeowners should be made to understand that placing expensive property in basements that are prone to flooding is risky, and if they choose to locate their property in their basement, they should be made aware that they should take steps to protect it.

Researchers have argued that subsidy programs can increase adoption of risk reducing adjustments (Kreibich *et al*., 2005; McCaffrey, 2004). As revealed in this study, subsidy programs may be viewed favorably by the public as effective means of reducing basement flooding (see Figure 9 on page 33). Subsidy programs are employed by several Canadian municipalities to encourage homeowners to reduce their risk of sustaining damages from sewer backup and basement flooding (see Table 1 on page 10). Toronto and Edmonton have also employed subsidy programs; however, eligibility criteria differed between the programs. Toronto's program has historically required homeowners to prove that they had reported their damages to their insurance company in order to be considered for the subsidy. However, as revealed in this study, many individuals who suffered only minor damages may not have reported these adjustments to their insurance companies. An increase in the intensity and frequency of heavy rainfall events caused by climate change may result in repeating and more severe sewer backup occurrences, thus, those who have sustained only minor damages in the past may be at risk of sustaining more severe damages in the future. Furthermore, sewer backup positive respondents in this study were largely unwilling to no longer locate expensive or important items in their basements, which may increase future damage risk. To account for a potential increase in the severity of damages, municipalities should target subsidy programs at individuals who have sustained minor damage as well as severe damages caused by sewer backup.

4.3 Future work

This study revealed that homeowners may prefer half or partial subsidy programs over programs that subsidize the full cost of installing protective plumbing to reduce basement flooding. Little or no research exists on the most effective means of distributing homeowner level hazard mitigation funding for the mitigation of basement flood hazards. Future research should seek to examine the effectiveness of full and partial subsidies for the encouragement of homeowner mitigative action.

Municipal staff interviewed in this study reported that uptake of homeowner financial assistance and incentive programs designed to increase preventative plumbing adoption was low. Further research should be conducted to explain why uptake of financial incentive programs was low in both case cities. Toronto municipal staff indicated that homeowners who were potentially affected by flooding were notified of available preventative plumbing subsidies by means of information mailings. A potential study method may involve mailing questionnaires to homeowners who received notification of their eligibility for preventative plumbing subsidy programs. The questionnaire would explore whether or not the homeowner applied for a subsidy, if they were accepted for a subsidy, whether they turned down a subsidy, and several other variables. Such an investigation may allow municipalities to more accurately target homeowners who would be willing to take advantage of preventative plumbing subsidy programs.

Similar to the findings of Kesik and Seymour (2003) and Wisner and Hawdur (1984), this study revealed that there is no standardized approach to homeowner level sewer backup and basement flooding mitigation in Canada. Furthermore, this study provides support that a formal, long-term education and public information program may increase public hazard awareness and adoption of mitigative adjustments. A homeowner level basement flooding mitigation program framework should be developed based on previous hazards risk communication studies and theories, and should be applied to identify effective hazard education programs in Canada and to adapt these programs to address sewer backup and basement flooding. Application of the framework should lead to the development of a comprehensive manual, or best practice, for basement flooding risk and mitigation communication. The best practice should be based on accomplishments made in Edmonton, Toronto and other municipalities, and should be designed to be readily integrated into existing basement flooding education programs. Potential elements of a basement flooding risk communication framework are presented in Appendix A.

4.4 Conclusion

Sewer backup hazards cause millions of dollars in damage in many Canadian municipalities every year. Heavy rainfall events, the cause of many sewer backup events, are expected to increase in both intensity and frequency as a result of climate change. Coupled with the aging and deteriorating nature of much of Canada's municipal sewer systems, it is likely that sewer backup damages will increase. Furthermore, municipalities are not immune from litigation for damages caused by sewer backup. These factors contribute to a need to actively reduce risks associated with basement flood hazards.

Results from this study suggest that risk perceptions and behavioural adjustments related to sewer backup are low. Additionally, the study revealed the perception that the municipal government holds the majority of the responsibility for damages caused by sewer backup. Considering the immense costs of upgrading sewer systems, the unpredictability and expected increase of heavy rainfall events, homeowners in Edmonton and Toronto will need to become more involved in the mitigation of sewer backup risks over the short- and medium-terms. Homeowners should be encouraged to adopt personal adjustments, and should be made more aware of government programs designed to increase their awareness of basement flooding and sewer backup. Formalized hazards education programs, including comprehensive information presented from a variety of sources through a variety of channels, may increase sewer backup hazard awareness and mitigative adjustment behaviour, and reduce damages caused by sewer backup.

Appendix A: Framework for basement flood education

This section provides a potential framework for the implementation of an effective hazards education program. The framework is largely based on recommendations for earthquake education made by Nathe *et al*. (1999) and is supplemented by other studies (Blanchard-Boehm & Cook, 2004; Fischhoff *et al*., 1993; Grimm, 2005; Grothmann & Reusswig, 2006; King, 2000; Mileti & Peek, 2000; Mileti *et al*., 1992; Tanaka, 2005; Walker *et al*., 1999) and adapted for basement flooding. As presented by Nathe *et al*. (1999), the framework is offered in two sections: The message to be given to the public, and the public education process.

Constructing the Message

Information should be presented in an accessible manner. Communications materials, including press releases, should avoid technical language, and should be provided in manageable amounts. Jargon should be avoided, and statistics (such as the 1 in 100 year storm event) should be clearly explained so that the public is not confused about their meaning. Fit the information source with the topic: For example, municipal engineers should provide information on the sewer system, plumbers should provide information on household plumbing measures, firefighters should discuss home safety and health professionals should provide information on health impacts of sewer backup.

Information should be consistent. Most people are exposed to information through a number of channels. This information must be consistent in order to be perceived as credible. The municipality should communicate with local contractors, insurance companies, plumbers and other potential information sources to ensure information is consistent from all channels and sources.

Information should be pre-packaged for the media. The media should have information on hand for basement flooding events. Provide media with diagrams of backwater valves and other mitigation mechanisms, as well as information on what to do during and directly after a flood event. Assemble photos, maps, basement flood mitigation checklists, and other materials so the media can draw on these resources directly.

Describe potential loses. People may not clearly understand the impact that sewer backup or basement flooding will have on their home. The public should be assisted by descriptions of other basement flooding events, pictures, scenarios and maps showing areas of the city that are at risk of basement flooding. As well, information should be made relevant to the local community; information should be targeted to renters, homeowners and business owners.

Discuss the chances that basement flooding may take place within a certain amount of time. Most people will want to understand the chances or odds that a basement flooding event could occur in their home while they are living there. People will want this information to be given within a relatively small time frame (chances of it occurring in 5, 10 or 20 years). Probability estimates on their own will

not motivate people to take action, but the information will assist in creating the uncertainty that is important for behaviour change. Homeowners should also be aware that predictions are not necessarily completely accurate.

Describe how homeowners can reduce damages. The public must be informed of measures they can employ to reduce damages or reduce the risk of basement flooding. Multiple media may increase the effectiveness of communications: How-to videos on installing sump-pumps, basement flooding prevention checklists, basement flooding clean-up check lists, websites with clear descriptions of mitigation mechanisms, public backwater valve installation and maintenance workshops, and so on. Information on mitigation mechanisms should be comprehensive, and should include the relative effectiveness of mitigation mechanisms, costs of installing mitigation mechanisms, available subsidies for installation of mitigation mechanisms, approved plumber and contractor contact information, and so on.

Specify who is at risk of basement flooding for both education and planning purposes. Homes in older neighbourhoods, serviced by combined sewers are at a higher risk of sustaining damages from sewer backup than homes in neighbourhoods with separated sewers. Also, homes located in neighbourhoods with older separated sewer systems that may have infiltration/inflow problems are at a higher risk of sewer backup than new subdivisions, homes at the bottom of hills have a higher risk, and so on. Homeowners should be aware if they are living in a home with a high or low risk of basement flooding.

People should be made aware of the secondary effects of sustaining damages from basement flooding. Basement flooding does not only damage property, but can cause health impacts due to mould growth and dampness. As well, recurrent basement flood events can increase premiums or cause cancellation of insurance coverage for sewer backup. Sustaining damages from any hazard event increases individuals' stress levels and can cause major inconveniences. Homeowners should be made aware of all impacts of basement flooding.

The Process of Educating the Public

Use multiple credible resources for information. Information should be provided from a source perceived as trustworthy. Provide information from engineers, insurance professionals, contractors and trades people. Information should be provided through as many channels as possible, including web pages, mass media, CD ROMs, information mailings, public meetings, and community groups.

Tailor information to suit the needs of a diverse public. Information should be tailored to homeowners, renters and business owners. People who live in basement apartments should be aware that they will need to purchase renters insurance to protect themselves from sewer backup damages. If required, information should be presented in several languages.

Media should be attractive and professionally produced, and presented from several sources. Make use of internet, radio, television, brochures, checklists, newsletters, handbooks, CD ROMs, and other media. Media should be attractive and professionally presented.

Use media that reflects the needs of the target population. Some people may be uncomfortable accessing information from the internet. Non-English speakers or those with low incomes may be better reached through other means, such as providing information to local community groups. Conversely, technologically sophisticated packaging targets middle-class audiences.

Information should be easily accessible. On an ongoing basis, successful public education works to motivate a few people to do something to reduce risk. Their activities contribute to an incremental process of reaching others as well. Information should be accessible when someone wants to find it. Do not place documents relevant to infrastructure works and flood mitigation on hard to find web pages, deep within the municipal internet site. Provide a dedicated webpage on basement flooding, with a link from the city's home page. Provide homeowners with a phone number and email address so that they can directly contact municipal staff to ask questions about basement flooding. Make sure that relevant municipal staff are knowledgeable about flood mitigation and municipal programs, so that they can quickly respond to emails and phone calls from the public. Available information should be comprehensive, and include all aspects of basement flood mitigation.

Information dissemination should be incremental. Organize information to highlight related themes successively. News-letters and brochures, distributed periodically, should emphasize specific aspects of basement flood mitigation. One newsletter could be based on proper lot grading, the next on installing wells around basement windows, the next on backwater valves, etc.

Use flood events as learning opportunities. Use flooding events to focus media and political attention on flooding issues. Have councilors and the news media view damage to homes and basements in order to increase interest in the issue. Provide them information on how to reduce flood risk so that they can report it in the media, and provide it to their constituents.

Periodically evaluate information and flood mitigation campaigns. Assess the efficacy if your materials and approaches and revise what does not work. Evaluate the effectiveness of education programs by surveying the public and identifying increases or decreases in the rate of adoption of mitigative adjustments. Find out if your information is being accessed and applied, and asses how well the information is being understood by the public. Share that knowledge with other educators, both within your municipality and within other municipalities, so that several education programs can benefit from the information. Use your data to justify continued or increased financial support.

Continue support of education and information programs over several years. Education and information programs should be highly visible and accessible over a long time frame, even during periods when basement flooding is not perceived as a major problem. The longer your program is around to provide helpful and effective information, the more it will become trusted by the public and the more effective it will be when flooding becomes an issue. Ensure consistency: Do not decrease credibility by altering missions, or by changing logos or names. Ensure that funding for the program will be provided over a long time frame.

Appendix B: Questionnaire

Hello. I am calling from Pollara. We are conducting a survey for the Institute for Catastrophic Loss Reduction. This research will be used to study methods to reduce future sewer backup damages. The survey should take 10 minutes or less to complete, and your responses will be completely confidential. You may contact Professor Paul Kovacs, executive director of the institute, if you have any questions or concerns. May I continue?

A. Screening

A1. In what age category do you fall?
1. Under 18 – **Terminate interview**
2. 18-24
3. 25-34
4. 35-44
5. 45-54
6. 55-64
7. 65 and over

A2. Do you own your home?
1. Yes (not read) Go to **A4**.
2. No (not read) Go to **A3**.

A3. May I speak to the homeowner?
1. Yes (not read)
2. No/no homeowner (not read) – **Terminate interview**

A4. Do you live in a town house, semi-detached or detached home?
1. Yes (not read)
2. No (not read) – **Terminate interview**

A5. How many years have you lived in (Edmonton / Toronto)?
_____ Months
_____ Years

B. Hazard Experience

In this section, we are interested in your perceptions of sewer backup. Unlike overland flooding which would have entered your home from the surface through a window or door, sewer backup consists of water, sewage or a combination of both that would have entered through a toilet, sink or floor drain in the basement or a lower floor of your home.

B1. Have you ever had sewer backup damages?
1. Yes (not read) Add to Sewer Backup Quota, Go to **B2**.
2. No (not read) Add to no Sewer Backup Quota, Go to **B6**.
3. Don't know (not read) – **Terminate interview**

B2. How many times have you had sewer backup damages?
_____ Times

B3. How many years has it been since your most recent sewer backup damages?
_____ Years

B4. What do you estimate was the total value of damages that you had during this most recent event?
$ _____

B5. Using the following scale, how would you describe the damages you had during your most recent sewer backup incident? ***(Reverse order of items 1 through 4 every other interview)***
1. Very minor
2. Minor
3. Severe
4. Very severe
5. Moderate (not read)

B6. (All persons) Are you aware of anyone in your local neighbourhood who has ever had sewer backup damages?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

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C. Risk perception

C1. (All persons) Do you think that you will ever have sewer backup damages (if yes to **B1** insert "again")?
1. Yes (not read)
2. No (not read) Go to **D1**.
3. Don't know (not read) Go to **D1**.

C2. How likely is it that you will have sewer backup damages in the next 10 years? ***(Reverse order of items 1 through 4 every other interview)***
1. Not very likely
2. Somewhat unlikely
3. Somewhat likely
4. Very Likely
5. No opinion (not read)

C3. Using the following scale, how bad do you think your damages might be the next time you have sewer backup? ***(Reverse order of items 1 through 4 every other interview)***
1. Very minor
2. Minor
3. Severe
4. Very severe
5. Moderate (not read)

D. Attribution of responsibility

D1. On a scale of 1 to 6, 1 being not at all responsible and 6 being entirely responsible, please rate how responsible each of the following are for sewer backup damages in your city.
(Randomize items 1 through 4)
1. Homeowners
   a. _____ (response 1 to 6)
2. Municipal Government
   a. _____ (response 1 to 6)
3. Provincial Government
   a. _____ (response 1 to 6)
4. Federal Government
   a. _____ (response 1 to 6)
5. Forces Beyond Human Control
   a. _____ (response 1 to 6)

E. Adoption of individual adjustments

Now, I would like to find out what you know about protecting your home from sewer backup damages, and what measures you have taken to protect your home.

E1. Do you know of anything you can do to protect your home from sewer backup damages?
1. Yes (not read)
2. No (not read) Go to **E3**.
3. Don't know (not read) Go to **E3**.

E2. Where did you learn about what to do?
(Randomize items 1. through 7.)
1. Municipal government
2. Internet
3. Insurance company
4. Television, radio, newspaper
5. Nonprofit organizations (e.g. Red Cross)
6. Provincial or federal government
7. Family, friends, neighbour or acquaintance
8. Do you learn from any sources that I didn't list?
   a. Yes. Please specify:
   i. (response)

(Reverse order of E3 and E4 every other interview)

E3. Would you like to receive information from your *municipal government* on how to protect your home from sewer backup damage?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E4. Would you like to receive information from your *home insurance company* on how to protect your home from sewer backup damage?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E5. Have you taken any actions to reduce sewer backup damage to your home?
1. Yes (not read)
2. No (not read) Go to **E16**.
3. Don't know/refuse (not read) Go to **E16**.

E6. Which of the following actions have you taken?

E7. Installed water alarm
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E8. Do not locate important items, including furniture, televisions, and other items in the basement or lower level of home
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E9. Left basement unfinished
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E10. Detached foundation drain from sanitary sewer
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E11. Moved away from sewer backup prone residence
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E12. Installed backflow prevention device
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E13. Installed sewer backwater valve
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E14. Installed sump pump
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E15. Disconnected eavestrough downspout from sewer
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E16. Should your municipal government help you by paying half the cost of protecting your home from sewer backup damages?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E17. Would you be more willing to protect your home if the municipal government paid half the cost of doing so?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E18. Should your municipal government help you by paying the full cost of protecting your home from sewer backup damages?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

E19. Would you be more willing to protect your home if the municipal government paid the full cost of doing so?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F. Community actions

F1. Is your municipal government currently taking actions to reduce sewer backup in your city?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F2. Does your municipal government currently have a long term strategy to reduce sewer backup damages in (**Edmonton/Toronto**)?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

(if "No" or "Don't know" to F1 and F2, then go to F4. If "Yes" to F1 or F2, then go to F3)

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F3. How effective are the actions your municipal government is taking to reduce sewer backup? Use the following scale to answer: ***(Reverse order of items 1 through 4 every other interview)***
1. Very ineffective
2. Somewhat ineffective
3. Somewhat effective
4. Very effective
5. Don't know/neither effective nor ineffective (not read)

F4. Have you talked to or written to a city councilor or mayor about sewer backup damages?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F5. Have you attended public meetings about flooding and sewer backup?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F6. Have you been involved in community organizations that focused on sewer backup?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F7. Have you talked to or written to your member of provincial parliament about sewer backup?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F8. Have you been involved in litigation or a class action lawsuit because of sewer backup?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

F9. Have you written letters to the editor of local newspapers regarding sewer backup?
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

G. Insurance and ODRAP/Disaster relief

Next, I will ask you some questions about financial coverage for damage to your home.

If Yes to B1, then answer G1. If No to B1, then go to G14.

G1. Did you make an insurance claim for your most recent sewer backup damages?
1. Yes (not read)
2. No (not read) Go to **G6**.
3. Don't know/refused (not read) Go to **G6**.

G2. How do you feel about how your insurance claim was handled? ***(Reverse order of items 1 through 4 every other interview)***
1. Very satisfied
2. Satisfied
3. Dissatisfied
4. Very dissatisfied
5. Don't know/refused (not read)

G3. Did you receive any money from your insurance company?
1. Yes (not read)
2. No (not read) Go to **G6**.
3. Don't know/refused (not read) Go to **G6**.

G4. How much money did you receive from your insurance company?
$ _____
Don't know/refused (not read)

G5. How many weeks did it take to receive this settlement?
_____ Weeks
Don't know/refused (not read)

G6. Did you make a claim to **(if Edmonton: Alberta's Disaster Relief or Disaster Recovery program – if Toronto: the Ontario Disaster Relief and Assistance Program)** for your most recent damages?
1. Yes (not read)
2. No (not read) Go to **G11**.
3. Don't know/refused (not read) Go to **G11**.

G7. How do you feel about how your provincial relief claim was handled? ***(Reverse order of items 1 through 4 every other interview)***
1. Very satisfied
2. Satisfied
3. Dissatisfied
4. Very dissatisfied
5. Don't know/refused (not read)

G8. Did you receive any money from this program?
Yes
No Go to **G11**.

G9. What was the total amount of money you received?
$ _____
Don't know

G10. How many weeks did it take to receive this settlement?
_____ Weeks
Don't know

G11. Did you receive any money from your municipal government to help you recover from your most recent sewer backup damages?
Yes
No Go to **G14**.

G12. What was the total amount of money you received?
$ _____
Don't know

G13. How many weeks did it take for you to receive this money?
_____ Weeks
Don't know

G14. Do you have fire and theft insurance for your home?
1. Yes (not read)
2. No (not read) Go to **G16**.
3. Don't know (not read) Go to **G16**.

G15. Why do you purchase fire and theft insurance?
(Open ended response)

G16. Does your insurance policy currently cover sewer backup damages?
1. Yes (not read) Go to **H1**.
2. Don't know (not read) Go to **H1**.
3. No

G17. We are interested in the reasons why you do not have sewer backup coverage. Please tell us by answering yes or no to any of the following if they apply to you.

(Randomize items G18 through G21)

G18. You did not know that sewer backup coverage was available.
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

G19. Insurance is not necessary because there is no threat of sewer backup in your home.
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

G20. Sewer backup coverage would increase your insurance payments.
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

G21. Your sewer backup coverage was cancelled.
1. Yes (not read)
2. No (not read)
3. Don't know (not read)

G22. Are there any other reasons that I did not list?
(open ended)

H. Socioeconomic Variables

Finally, I have a few statistical questions to classify your responses.

H1. How many people in your household are under 18?
_____ People

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H2. What was the last level of education that you had the opportunity to complete?
Grade school
High school
University or college
Trade or vocational school

H3. What is your total household income before taxes?
Under $20 000
$20 000 to $39 999
$40 000 to $79 999
$80 000 or more
Refused to respond (not read)

H4. What is your gender?
Female
Male

End of Questionnaire

Personal communications

Boynton, Lisa
Toronto Water, City of Toronto.

Clements, Paul
Toronto Water, City of Toronto.

Kovacs, Paul
Institute for Catastrophic Loss Reduction, Toronto.

McGonigal, Mary-Ann
Insurance Bureau of Canada. Prairies, NWT and Nunavut Office, Edmonton.

Patterson, Eve
Insurance Bureau of Canada, Ontario Office, Toronto.

Steil, Brian
Drainage Services, City of Edmonton.

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The Institute for Catastrophic Loss Reduction, established in 1998, is a world-class centre for multi-disciplinary disaster prevention research and communications. ICLR is an independent, not-for-profit research institute founded by the insurance industry and affiliated with the University of Western Ontario. ICLR staff and research associates are recognized internationally for their expertise in wind and seismic engineering, atmospheric science, risk perception, hydrology, economics, geography, health sciences, and public policy, among other disciplines.

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