

# **The Threat of Disaster: Evaluating Resiliency Planning After the 2014 Burlington Flood**

by

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## **Abstract**

This Major Paper examines resiliency literature to understand the imagination and application of resiliency in the face of climate change. I critically analyze the purpose of resiliency and its flaws to provide a comprehensive approach to studying resiliency's implementation in municipal practices. Flooding is the threat against which municipalities are looking to build resiliency. An analysis of the 2014 Burlington Flood demonstrates how resiliency is imagined and applied through responding to a disaster. I argue in this paper that although there are many challenges in implementing a resiliency imagination, resiliency can ultimately be a tool to integrate mitigation and adaptation opportunities while ensuring an equitable transition towards a just, healthy, and prepared community. By reading this Major Paper and taking a critical look at the use of resiliency, the readers and relevant staff of various municipalities can fully grasp the meaning of this concept and be cognizant of its beneficial attributes and shortfalls.

**Keywords: Resilience, Resiliency Planning, Social Equity, Climate Change, Green Infrastructure, Flooding**

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I would like to thank my Supervisor Laura Taylor and my Advisor Luisa Sotomayor for the guidance provided during my two-year journey. Despite our interactions mostly relegated to remote communications, these two wonderful scholars provided the much-needed support to overcome any challenges I faced.

I would like to thank my parents for their love and compassion during this very trying time. Their understanding and encouragement propelled me to remain *resilient* despite adversities I faced during this process. With all my love, thank you.

I would like to thank the interviewees who were more than willing to lend their voice and opinion to my Major Paper. These individuals are heroes in my eyes because of their service to their respective communities.

Lastly, I would like to thank Halton Region and the City of Brampton for providing me with opportunities to submerge myself in municipal operations and municipal resiliency discourses. Please continue to support and guide future Planners with the same opportunities you provided me.

## Foreword

My interest in resiliency and climate resiliency discourses is attributed to my own academic and personal experiences. As an aspiring Registered Professional Planner, I frequently have interacted with municipal strategic visions, climate change action plans, and other public policies that engage resiliency discussions. Reading these documents raised various questions on what resiliency means, how to implement resiliency, and resiliency for whom? I also have an academic and professional interest towards bridging the gap between environmental and urban planning that I perceive to exist in many municipalities. I aspire for municipalities to not relegate environmental concerns to exist outside urban development and I strongly feel researching and writing on climate resilience will shine light on the role of the planning discipline in determining municipal resiliency. There are also my personal experiences that drove my desire to specifically target flooding as the ‘change’ that requires a resiliency approach.

As a child my family experienced the impacts of flooding in July 2013 at our home in Toronto, Ontario. We experienced the devastating impacts of a heavy rainfall event that flooded our basement and personal belongings. I remember the physical toll on my family and the determined use of buckets to remove rainwater from the basement in a desperate effort to prevent further damage. I remember the mental and emotional toll as we were drenched in rain and came to the realization that all our efforts were pointless as the torrential rains poured down on us that night. These experiences will forever live with me, and they drove my desire to cater my Major Paper to studying flooding and how municipalities can increase flooding resilience and to better understand the role that I, as a planner, might play.



**Lacaria, 2013. Left Photo: My basement flooded by rainwater in Toronto, Ontario.  
Right Photo: Flooded street outside my home; neighbour's car was totaled**



**Lacaria, 2013: My basement flooded by rainwater. Personal belongings were damaged, including the couch.**



**Lacaria, 2013: Visualizes the height of the basement flooding in comparison to the basement exit/ceiling.**



**Lacaria, 2013: Recovering after the flood.**

This Major Paper research supported both components of my Plan of Study and successfully fulfills several learning objectives. From my first component, Urban and Regional Planning, this Major Paper successfully fulfills the learning objective “To obtain the knowledge

and skills necessary to meet the program requirements of the Canadian Institute of Planners and Ontario Professional Planners Institute for Canadian Membership”. As Planners are often tasked with long-range planning, understanding how to critically analyze and implement such a widely used concept such as resiliency will undeniably benefit my future planning aspirations. “To explore planning practice within urban areas and consider how environmental threats and disasters, previous to and including climate change, have influenced policy and land-use planning” was successfully fulfilled through exploring climate change resiliency and mitigation and adaptation opportunities. “To expand my knowledge of climate change threats and how cities plan to prepare for hazards and extreme events” was successfully fulfilled through the broad examination of the threat of climate change but also with the specific focus on the threat of flooding and the hazard of its impacts demonstrated in my case study. Lastly, “To gain a deep understanding of the use of resiliency discourses in urban governance and planning” was successfully fulfilled through examining theoretical understandings of resiliency which is one of the main foundations of my Major Paper.

## Introduction

As our world progresses into the decade of the 2020s and we face new and continually changing experiences, a greater recognition is needed of the fragility of the built and natural environments. One of the most concerning changes, and one that this Major Paper targets, is the threat of climate change. The people who live and work in their respective municipality and the infrastructure and natural environments that they rely upon are increasingly vulnerable to climate change. Enter the concept of resiliency, a powerful and limitless concept through which municipalities to plan, prepare, and adapt to the reality of climate change.

Resiliency is a broad and encompassing concept. When imagined and/or implemented, resiliency varies widely in definition and interpretation. To be resilient can be emphasized in overcoming a loss of a family member. Or can be deployed to incorporate the will of a nation to be resilient in face of an economic recession. Resilience can facilitate a pre-emptive or reactive approach to a subject or change. Resilience can bring attention to ongoing food security issues in a nation. Or can be implemented to prepare and prevent against wildfires in a fire prone community. With such a wide range of applications, resiliency has found its way into municipal discourses. In my own view, resiliency is becoming a growing trend in municipal circles. As I refer to resiliency throughout this paper, it is important for the reader to understand that resiliency can be viewed as a theory or as a concept. This paper will clearly state in which sense resiliency is referred to. Nevertheless, many municipalities and members of the public do not really know what resiliency is or how it is defined. The frequent use of resiliency as a goal in response to a change or event is the exact reason why understanding what resiliency means is increasingly important. In fact, the complexity of resiliency and the frequency of its use are the driving factors of why I wanted to examine the concept and its implementation further. The title of this Major Paper brings light to this complexity, as I envision the “The Threat of Disaster” not only to be driven by flooding but also the complex and uncertain use, and possible repercussions, of resiliency itself.

The purpose of this Major Paper is to explore the theoretical understandings of resiliency planning and how these theoretical discussions translate into the conceptual resiliency of local municipalities. The Major Paper focuses on how resiliency is imagined and how resiliency can be used towards targeting a specific or broad change. In doing so, this Major Paper targets climate change broadly, and flooding specifically, as ongoing threats that have prompted a resiliency planning approach. This paper explores how resiliency is used after a disaster related to climate change and who or what is targeted to increase resiliency. The Major Paper applies this knowledge in evaluating the 2014 Burlington Flood and how the three public agencies responsible for flood mitigation imagined and applied resiliency after the disaster.

This Major Paper is ideal for those interested in resiliency discourses and the broad or specific application of the concept of resiliency in policies and planning. Additionally, this paper examines resiliency critically through analyzing theoretical discourses and significant flaws inherent in the simple inclusion of the term ‘resiliency’. These understandings are critical towards creating a comprehensive approach that will help breakdown this complex concept found in municipal operations. This Major Paper fills a void often found in current resiliency discourses. Through my research, I have come to the realization that resiliency is often perceived as a beneficial approach to addressing changes or threats. The work I have conducted will place a greater emphasis on resiliency’s relevance but also the flaws and misconceptions surrounding the theory and its conceptual application. I approach resiliency through an urban environmental planning lens that targets the threat of climate change and its impact on the severity of flooding. Therefore, the Major Paper will benefit readers interested in resiliency’s use in municipal discourses, the role of the planning discipline and its interaction with resiliency.

There are various opportunities that were not examined in this paper. These areas are all valuable research opportunities that will benefit the resiliency discussion. For example, I thought it would be interesting for a following scholar to explore what resiliency means to public and private agencies and differences between the two in goals, interpretations, and application. A study of how members of the public view the term resiliency would be informative, for instance if residents are informed or aware of how a municipality actively engages with resiliency discussions and in what ways. Another opportunity is to explore what would happen if public

agencies did *not* consider resiliency in terms of our current and future climate change reality. I assumed that municipalities would want to be resilient against a threat as devastating as climate change. Perhaps I also assumed that all municipalities believe climate change is real or that climate change is a pressing emergency, but I know now this is not true in all places. Nevertheless, I encourage a following scholar to explore ‘green gentrification’, as studying this will help prevent resiliency as a means to destroy for climate resiliency and can encourage equitable climate resiliency for all. This Major Paper explores the theoretical understandings surrounding resiliency and, as a result, engages with resiliency definitions. There are a vast number of interpretations and definitions associated with resiliency that makes including this task impossible for the scope of this paper. I encourage a following scholar to explore resiliency interpretations and create a comprehensive review. I also focused in my Major Paper on the essential integration of public consultation in resiliency planning, but I hope further studies will dive deeper into how to effectively facilitate this process. Finally, I encourage a following scholar to specifically target climate resiliency and conduct qualitative and quantitative research to assess the effectiveness of mitigation and adaptation measures in building resiliency. Such an undertaking will be extensive but would be greatly beneficial to understanding, engaging, and implementing resiliency planning.

### **Case Study: Introducing the City of Burlington**

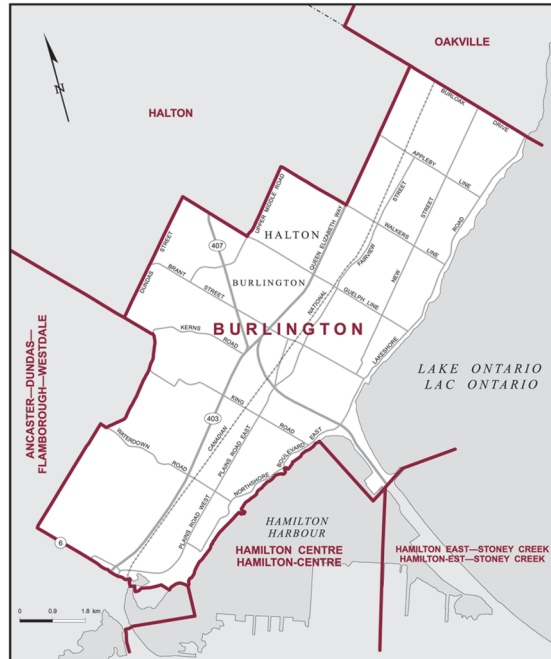
The City of Burlington is located in the Greater Toronto and Hamilton Area in the province of Ontario. Ontario is one of ten provinces (and three territories) in the country of Canada. The province is located to the east of Manitoba, to the west of Quebec, and to the north of the American states of Michigan, New York, and Minnesota. The Greater Toronto and Hamilton Area is in the southern part of Ontario and includes several municipalities on the northern shore of Lake Ontario (Figure 1). The case study location, the City of Burlington, is located to the north of the City of Hamilton and Lake Ontario, to the south of the Towns of Oakville and Milton and is the western end of the Greater Toronto and Hamilton Area. The 2016 Canada Census estimated the City of Burlington had a population of roughly 183,000, a population density of 987.3 per square kilometres, and a land area in square kilometres of 185.66 (Government of Canada, 2016). Figure 2 provides a visualization of the boundaries of the City of

Burlington and the general location of the city with neighbouring municipalities (Elections Canada, 2021).

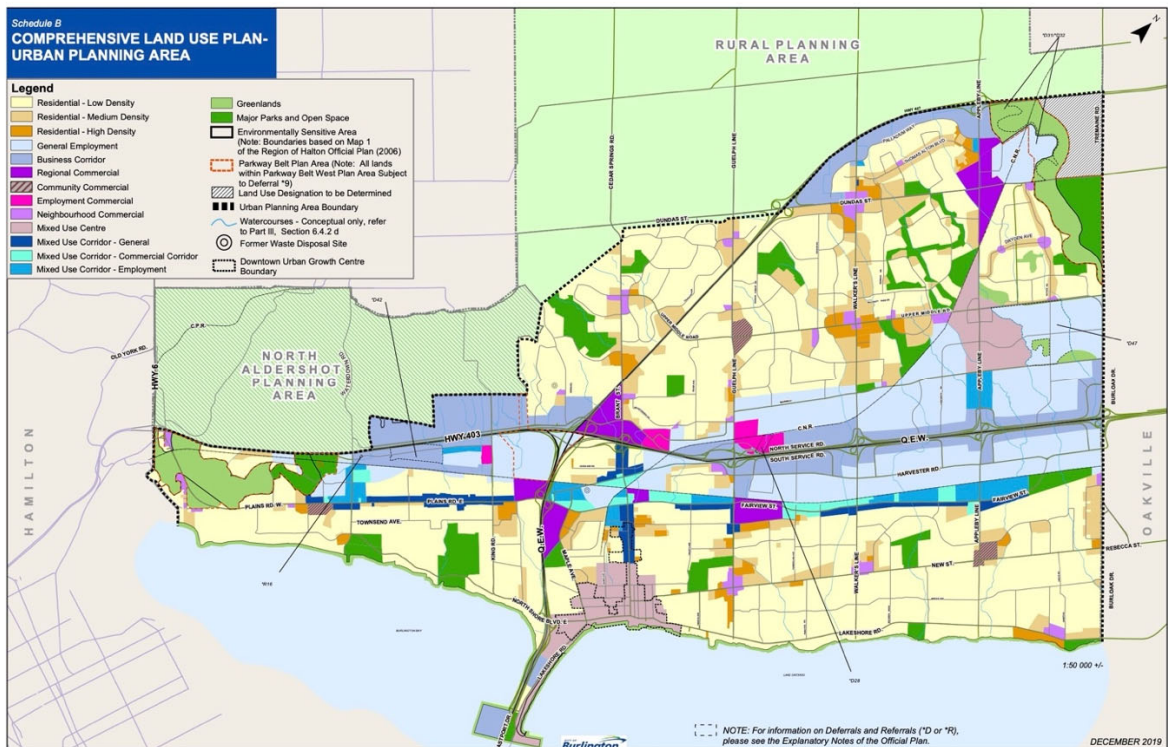
The City of Burlington is located along the shores of the Lake Ontario, which is recognized as the “largest surface freshwater system” in the world (Armenakis & Nirupama, 2014, 321). There are several extreme weather-related events that can be associated with the geographical location of the City and other municipalities in the Greater Toronto and Hamilton Area. The southern portion of Ontario faces risks related to flooding (whether inland or coastal), tornadoes, and even hurricanes (Armenakis & Nirupama, 2014, 321). Figure 3 depicts a more detailed and current mapping system of the City of Burlington. The figure demonstrates a comprehensive land-use planning map of the city to include zoning designations, green lands and open spaces, and waterways (City of Burlington, 2019, 1). The map also details the major 400-series highways that run through the City of Burlington, such as the Queen Elizabeth Way (QEW), Highway 407, and Highway 403 (City of Burlington, 2019, 1).



Figure 1: Cao, 2011, 28. Map of Ontario and its general location in Canada.



**Figure 2: Elections Canada, 2021. Borders and surrounding municipalities of the City of Burlington.**



**Figure 3: City of Burlington, 2019. Land use in the City of Burlington.**

## **Chapter 1: Methodology**

In this section, I discuss my research approach. My research proposal preceded the creation of this Major Paper. As a requirement for my Master program, I prepared a research proposal that described my research topic, specific research questions I wanted to ask, and a detailed review of literature, reports, and documents relevant to my topic. I relied on York University's online library database to research my objectives and interests and broader theoretical frameworks. At this stage, I knew I wanted to focus on climate change and I wanted to find a case study to drive the urgency and necessity for action. I originally looked at case studies in the City of Toronto. My own personal experiences heavily influenced this decision because I initially wanted to study the flooding event that ravaged my own home and community. However, these feelings and influences changed during my internship with Halton Region.

In the Fall of 2020, I signed on with Halton Region as a Planning Employment Surveyor. My role required me to visit businesses throughout the Halton Region area and record data that would be used by the region to influence future policies and understand business demographics. Due to the COVID-19 pandemic, I was required to conduct interviews through remote means on questions related to business and employment. This experience greatly influenced my Major Paper because I became attached to the communities I visited throughout the Fall. Additionally, although the surveys were business related, the interactions with business owners and staff often became personal. They were eager to speak about their ongoing hardships during the pandemic and the challenges they faced during the time of crisis. It was in these communications I realized that these hardships are not uncommon through my ongoing climate change research. The experience provided faces, names, and identities to the people who are vulnerable, whether to the COVID-19 pandemic or climate change related threats. The internship as a Planning Employment Surveyor also allowed me to speak with a wide range of Halton Region staff, such as Environmental and Development Planners. It was in one of these conversations that I first learned of the 2014 Burlington Flood. I was immediately interested, and I knew that I wanted to examine and analyze this disaster in my Major Paper. After I indicated this desire in my proposal and reviewed policies that are relevant to my topic, I sought to establish a research timeline of how I was to further research and develop my paper for the winter semester months (January – April 2021).

I started researching and reviewing literature on resiliency theory and flooding. Most of the research was already completed through my major research proposal, but I continued to explore other opportunities. I began writing my paper, initially starting with the ‘climate change flood mitigation and adaptation’ section and then moving towards writing the ‘social vulnerability and social equity’. I then transitioned towards writing the ‘resiliency theory’, ‘resiliency planning’, and ‘policy analysis’ sections. The titles of these sections have drastically changed when compared to the current paper. Throughout these months, I also searched for individuals to interview who have direct or indirect knowledge of the case study, as well as staff of the three public agencies identified who would provide insight on resiliency planning and climate change. I interviewed eight people between January 2021 and May 2021. With the interviews completed and these sections subsequently written, the major research proposal underwent revisions and review. In hindsight of reviewing the research process, I realized that I did not follow the research timeline as much as I thought I would. I reorganized my research process and even reorganized the order of my paper multiple times after the various revisions. What mattered to me was to ensure the paper had a sense of flow and was accessible to the reader, something such reorganizations and revisions hoped to achieve.

The methodology section creates a structured outline to which the major research paper is founded on. This methodology will also review the analytical steps taken at the later part of this paper when I analyze resiliency responses and planning after the 2014 Burlington Flood. The objective for this analysis is to identify how resiliency was imagined and applied by each of the three public agencies. From each implementation, an analysis can occur that determines how these agencies intended to shape or imagine resiliency to the context of the flooding disaster. The imagination of resiliency is often not explicitly stated in policies and discourses after the disaster. By analyzing the end result and implementation measure, an assumption will be made on the imagination of resiliency in areas that were not otherwise explicitly stated. In the paper, I will not argue whether the resiliency imagination and application were successful or effective, but rather I sought to understand their implementation and how resiliency was imagined. Lastly, there had to be limitations set to narrow the study of the reports, policies, and programs that directly involved the 2014 Burlington Flood. That is why I limited my research to the policies and programs that were directly created or related to the 2014 Burlington Flood, spanning roughly four years after the disaster. The reports, documents, and policies researched relied on a

collection of online accessible records from their respective website and relevant sources, and what was learned from interviews conducted.

The structure of this analysis will incorporate several key topics, discourses, and themes discussed throughout the Major Paper. The first part of the analysis targets the form/context of resiliency of each public agency and how they aligned with the theories examined in the following chapter. The second part of the analysis focuses on equity and public engagement to determine if and how equity was included towards increasing the municipal resilience and the responsibility of action. These criteria were taken from the theoretical discussion of this paper to demonstrate their relevance to a resiliency case study. As such, we will first begin this journey by examining and exploring resiliency theory.

## **Chapter 2: Resiliency Theory Without Limits**

The term resilience is commonly used in today's society. There is a wide variety of uses for the term and this flexibility contributes to resiliency's power and significance. Public and private agencies often use the term to achieve various objectives. Even individuals, cultural associations, and activists engage with the concept in their own way. Resilience and its variations (resilient, resiliency) are employed in numerous contexts and degrees. Merriam-Webster (2021, para. 1) defines the term as "an ability to recover from or adjust easily to misfortune or change". The definition is broad and can be applied in a variety of circumstances. The vagueness of resiliency demonstrates the endless possibilities of theoretical or practical interpretations.

Resiliency is vast and dynamic. But these inherent characteristics of this term carry a major flaw. Resilience can be exploited, abused, and misused. The purpose of this chapter is to explore resiliency theory and various interpretations associated with the concept. Through my research of resiliency literature, I will create a foundation that will provide a base to explore resiliency and resiliency planning. I will explore theoretical literature that will help understand the use of resiliency in political discourses. The chapter will consequently explore theoretical understandings of resiliency that will structure what the paper will often refer to as an 'imagination of resiliency'.

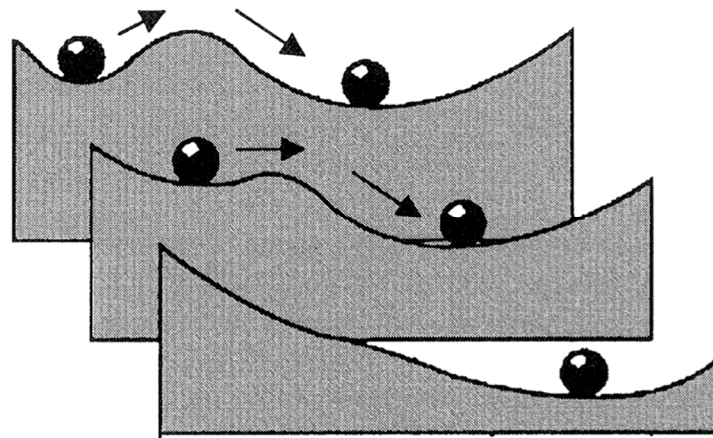
## Exploring the Many Definitions of Resiliency

Behind every application of resiliency is a vision of what resiliency means to the specific person, agency, or society. Whether the vision is carefully studied or quickly determined, what remains is an action to construct what resiliency will mean to a certain context. Scholarly literature provides useful insights into understanding how resiliency is imagined and applied. There are a wide variety of different perspectives on how to identify and address the change, event, or disturbance. The theories the paper will discuss are open to interpretation and are continually subject to expansion and critique.

Numerous scholars have tried to define or at least frame what resiliency is. One of the earliest advancements of resiliency theory is found in the work of Holling (1973, 1996). Holling (1973, 1996) defined resiliency to resemble two key forms, ecological and engineering resilience (as cited by Bertilsson et al., 2019, 971). The ecological form of resilience emphasized the absorption aspect, whereby “the capacity to absorb the disturbance” before modifying the main ecological structure was key (as cited by Bertilsson et al., 2019, 971). The engineering form of resilience developed by Holling (1973, 1996) stressed the direct focus on stability, whereby the main priority was resisting the change or threat and returning or recovering to previous conditions in a rapid order (as cited by Bertilsson et al., 2019, 971). These two resiliency forms focus on the ability of the system to respond to a change and represents two main resiliency theories this Major Paper will continue to refer back to.

Resiliency theories can be applied in contexts that spread across various disciplines. For example, an engineered resilience approach does not necessarily mean a response that is strictly focused on engineered solutions. Critically assessing the entire resiliency imagination and application will help determine the level of adherence to resiliency theories. An additional resiliency theory to examine is adaptive capacity. Adaptive capacity describes the capacity and ability towards adjusting or altering in times of change (Gunderson, 2000, 427-428). The adaptive capacity model is a system concentrated on remaining in a stable domain throughout the change, as illustrated by Figure 4 (Gunderson, 2000, 427). No matter the challenge, change, or context, the adaptive capacity theory adapts to the circumstances that tests the system’s

resiliency. The adaptive capacity theory can also be merged with a learning aspect, as the system that is able to learn from the conditions can adjust accordingly and maintain stability (Liao, 2012, 5-6). There are several factors that determine and influence adaptive capacity and which can be similarly applied to ecological and engineered resilience. These include but are not limited to economic wealth, technology, infrastructure, access to information, nature of institutions, commitment to equity, and social capital (Smit et al., 2001, 895; Klein et al., 2003, 38). The theories discussed help to provide insight into how resiliency is imagined. There are countless interpretations of resiliency theories, but the three discussed set a foundation for what this paper will continue to refer back to.



**Figure 4: Gunderson, 2000. A visual of the adaptive capacity system where the “valley represents stability domains, ball represent the system, and arrows represent disturbances” (427). Adaptive capacity describes the ability of the ball (system) to remain in a stable area.**

There are a wide range of resiliency discourses that help to further assess the ability of a system to be *resilient*. The next necessary step is to explore how resilience is defined. The Merriam-Webster (2021, para. 1) definition provided an introduction to this concept. However, what the definition does not provide is the continuous changes inherent in the term. Klein et al. (2003, 35) recognized that the term has only progressed into a “metaphorical sense to describe systems that undergo stress” since the 1970s. Definitions were surely created and expanded to frame the direction of resiliency. To look at all the various definitions is a tremendous challenge to accomplish. In addition, strictly looking at definitions would not necessarily be beneficial due to the ability of the person, agency, or group (also referred to as ‘holder’ later on) to construct

their own definition in their own vision. Therefore, for the purpose of this paper, the definition provided by the Intergovernmental Panel on Climate Change (IPCC) will assist in discussing the broader research objective of flood resilience. Resilience was defined as:

“The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC, 2014, 5).

The definition provided by IPCC highlights an interpretation envisioned for a context of climate resiliency. Despite the narrower focus, there was still a degree of vagueness with this definition. ‘Transformation’ and ‘reorganizing’ are powerful and can lead to positive and negative implications in application. The inclusion of these words and the vagueness of the definition highlights common flaws within the concept of resiliency. These flaws will be discussed at a later point, but what is important to mention is that I see the flaws are as common as the term ‘resilience’ itself. That is why providing a complete extensive list on definitions of resilience is a challenging objective that requires an independent study.

Exploring resiliency theory directed my research towards discussing the broader theme of adaptability. In my own view, adaptation can generally be measured on the ability of the system to adapt or adjust to pressing circumstances. When a change, event, or disturbance occurs, the system can adapt to the situation to minimize or remove impacts. However, often lost in the journey to achieve system adaptation is the inclusion of social aspects. The physical and social infrastructure of a city, for example, must be a significant adaptable factor in order to support resiliency (Ahern, 2011, 342). The inclusion of adaptability in a resilient system involves the protection of social groups and actions, such as meaningful public participation (Ahern, 2011, 342). Including an adaptability framework can undoubtedly help to protect the physical environment and social foundations of a community. Social equity is an important chapter in imagining resiliency. Further examination on the significance of social equity to resiliency will be conducted at a later point. However, in order to achieve an adaptable resilient system, encompassing aspects that stretch outside the physical concrete structures or engineering models is imperative. This discussion on adaptability bridges the gap between the physical and social

aspects of resiliency, since adaptability as a theme is not limited to the built environment but includes social interests.

## **Resiliency Theory Requires a Resiliency System to Implement**

A resilient system is required in order to implement a resiliency imagination. A structured system combines resiliency theories with an implementation process and transforms the theory into a practical concept. By referring to a resilient system, emphasis is placed on the system in fact being resilient. Of course, ensuring a system is resilient makes complete sense. White & O'Hara (2014, 934) recognized that the term 'resilience' itself is an agreeable notion. "To argue that society, the economy, cities, or infrastructure should be less resilient is illogical" (White & O'Hara, 2014, 934). Similar to White & O'Hara's statement, arguing that a system should not be resilient is a difficult one to defend. Therefore, the application of a resilient system (such as public and private sector policies, climate mitigation and adaptation measures, and/or land use planning) often rely on the combination of theoretical resiliency and a practical system to achieve their goals.

The system itself is meant to apply the resiliency methods (such as ecological resilience) so as to achieve a specific goal or result. There are three main identifiers embedded in a resilient system that recognize whether the goal of resiliency is accomplished. A system can imagine resiliency through recovering or returning to a normal state (Masnavi et al., 2018, 570). A normal state in a general sense can refer to the condition or environment of what the community or organization represented pre-event or disturbance. Therefore, a system of resiliency that is based on recovery imagines resiliency to be a rather quick return and, if this approach is not achieved, then the system is not resilient (Masnavi et al., 2018, 570). There is an assumption made with recovery or 'normal state'. In this regard, the 'normal state' is assumed that the prior conditions were ideal and the mention that the preconditions of the system was so ideal that a return is justified (Masnavi et al., 2018, 570). The second approach to a resilient system is focused on compatibility or adaptability, referring to the broader discussion of adaptation (Masnavi et al., 2018, 570). This approach is similar to adaptive capacity theory, as compatibility refers to the ability of the system to adjust to an event or disturbance and maintain stability in

order to return to the previous state (Masnavi et al., 2018, 570). Adaptation is core to this approach as the capability of the system to address and adapt to an event or change remains paramount. Lastly, there is a system that achieves resiliency through change (Masnavi et al., 2018, 570). Instead of returning to the previous state by recovering from the event or adapting to the disturbance, resiliency through change involves a shift towards a “renewal, rehabilitation, and self-reorganization” (Masnavi, 2018, 570). The last approach could be perceived as the most contentious of the three, the system towards change results in a modification of features towards a sense of system improvements and redevelopment. The three main forms of system resiliency provide a basis of how a system could be designed or structured to achieve resilience.

Resiliency theory is hardly ever acknowledged in actual policies or documents. The policy aspect of resiliency takes a more simplistic and basic approach than in theoretical literature by academics (White & O’Hara, 2014, 939). This simplicity might be perceived as beneficial, as the public may be more prepared to understand and access these policies. However, often the application of resiliency in a simplistic form creates issues of uncertainty. Uncertainty exists in what resiliency is intended to reflect and for whom (who benefits). These challenges and flaws will be further discussed in the next chapter. The reason for recognizing these challenges at this point is to highlight the application of resilience and the power associated with implementation.

Implementation can take numerous forms. Implementing resiliency can lead to specific and direct outcomes or uphold and reinforce pre-existing conditions (White & O’Hara, 2014, 944). Implementation can help define the method, the measures, and for which group(s) resiliency is designed. Implementation can also determine what areas of a community will be designed or adjusted to shape resiliency. For example, White & O’Hara (2014, 945) acknowledged through an analysis of resilience policy the “over-whelming tendency to interpret resilience as an ‘engineered’ response.” An engineered response in this regard is different than Holling’s engineered resilience. An engineered response requires solutions implemented through the engineering discipline, such as stormwater management improvements and permeable surfaces. That being said, flaws present in resiliency approaches challenge the ability of resiliency to be successful. A deeper analysis is required on the harmful impacts, negative

influences, and powerful messages resiliency can deliver in the process of imagination and application of the term.

### **A Trojan Horse Paradox: The Flaws of Resiliency**

The two definitions provided earlier in the paper do not immediately raise any form of concern or warning at first glance. In fact, the definitions provide a composed approach that justify the term's application in every aspect of society's public and private settings. However, what the definitions do not represent are the issues with resiliency. This creates a conundrum, as questions emerge on how something that seems to embody aspects of stability or adaptability could ever be so problematic? Why would persons/groups not want their physical neighbourhood to have the ability to adjust after a disaster? What challenges would prevent persons/groups from adapting to a resiliency framework? These questions contribute to one of the major issues with resiliency: with such a complex and interpretive concept, the opportunities to design and frame resiliency to fit certain narratives or structures are endless. Similar to the story of the *Trojan Horse*, what something is perceived to be is not always true. Resiliency can be presented as a strong framework or policy. However, resiliency can serve an end that is not always beneficial for those impacted by the change or event. What at first glance seems to be a helpful concept can in fact lead to adverse and negative outcomes. This is not to say that resiliency serves no purpose. The concept has the power to be a significant disaster mitigation and adaptation tool while simultaneously ensuring all communities have access to participatory options and essential resources. The complexity is in the details and application for resiliency. For the remainder of this research paper, resiliency will be referred to in the context of communities and municipalities at a local level, unless otherwise stated. Resiliency can be applied in other circumstances, such as on a national or a global scale. To narrow the study and to keep the study consistent with the 2014 Burlington Flood, resiliency will be limited to the context of a community/municipality.

The multiple application opportunities of resiliency may be perceived as a good thing, as vagueness can allow for a broader application of resiliency in different contexts. For a resiliency application, implementation can be demonstrated through general and specific forms that are key

to analyzing resiliency application (Masnavi et al., 2018, 572). General resilience involves the overall resilience of a system without an emphasis or referral to a particular concern or risk (Masnavi et al., 2018, 572). An example would be a municipality encompassing resiliency measures in their Official Plan and Strategic Plan, without an explicit mention or focus on a specific risk or event. On the other hand, specific resilience refers to the resilience of a specific feature or characteristic of a system to a certain event or risk (Masnavi et al., 2018, 572). An example of this form would be a municipality developing a climate action plan to prepare against specific climate change effects, like heat waves. These two forms can frame the extent and strictness of how resiliency will be imagined and applied. Masnavi et al. (2018, 572) expanded on these forms by recognizing that “a system can be resilient on larger scales, while it is not resilient on smaller scales or vice versa.” As a result, the additional scales of analysis provide more complexity to a concept that was already difficult to describe. Complexity is thus a core feature of the resilient system (Masnavi et al., 2018, 572). With so many layers and factors that shape resiliency and the effectiveness of such concept, questions arise on how successful, efficient, and beneficial resiliency can be.

The 'holder', agencies, or even stakeholders may use the complexity of the concept to their own advantage. Anguelovski et al. (2016, 334) explored this issue through an evaluative lens of climate resiliency and the establishment of two injustices: “acts of commission and acts of omission.” An act of commission emerges when land use regulations, protected areas, or investments in infrastructure displace or disproportionately impact disadvantaged groups (Anguelovski et al., 2016, 334). An act of omission is the purposeful exclusion of communities in the resiliency process, the implementation of plans that protect economic value over low-income or minority groups, and the focus on climate resiliency as the sole responsibility of the private sector (Anguelovski et al., 2016, 334). Anguelovski et al. (2016) identifies these two injustices so as to classify the common injustices resulting from a resiliency application. These injustices also recognise that resiliency, and specifically climate resiliency, can be used in a way that is not equitable to all persons in the community. The result of these two acts is the emergence of an opportunity to frame a distorted resiliency in a way to benefit a specific isolated interest.

One of the major flaws of resiliency I came across is the issue of ‘creative destruction’. I originally discovered this fault in reading Gilbert’s (2018), *The Crisis After the Crisis: Neoliberalized Discourses of Urgency, Risk and Resilience in the Reconstruction of Lac-Mégantic*, which influenced me to further explore this theory and how it relates to resiliency. ‘Creative destruction’ is frequently associated with Marxist thought as the term describes a process that results in a new set of ecological relationships (Fainstein, 2015, 162). The Marxist view sees ‘creative destruction’ as a way to destroy communities in order to reimagine an area and reinvest to create value (Fainstein, 2015, 162). The term is relevant to the resiliency analysis because ‘creative destruction’ can be used to reflect an adverse resilient system. Due to resiliency’s broad and complex interpretations, ‘creative destruction’ can distort what it means for an environment to be resilient. As a result, ‘creative destruction’ can encourage a rapid destruction in order to create a new reimagined landscape (Gilbert, 2018, 157). The term can also imagine resilience as a tool to “appease and silence demands for accountability” (Gilbert, 2018, 171). Instead of hearing the demands of those directly and indirectly impacted by the event, or empowering a population ravaged by a disaster, ‘creative destruction’ seeks the investment and financial interest of a clean slate (Gilbert, 2018, 171). The ‘creative destruction’ thought can lead to issues that justify targeted destruction to achieve climate mitigation and adaptation measures. “Climate Gentrification” summarizes the perspective that specifically and unequivocally targets more well-off communities to benefit from climate resiliency measures, increase real estate cost under a resiliency guise to remove lower income residents, and providing fewer resiliency measures for low income or racialized dominant communities (Connolly, 2019, 68-69). Resilience manipulated in these ways becomes a financial windfall and an opportunity to restructure economic value or reorganize community dynamics, instead of treating resilience as a universally accessible tool to empower all communities towards achieving climate resiliency. The manipulation of resilience is an issue in this particular discussion and is exactly why discussing the use of resilience remains a challenging task.

Gilbert (2018, 173) clearly articulates frustration with the concept of resiliency as the author relates resilience to a mechanism for conformity of the people during a crisis or event. Gilbert (2018) accurately critiques resiliency and the issues the use of the concept may cause to persist in application. However, these critiques stem from the inherent lack of certainty and the

complexity of the concept. I will argue that the issues raised, although relevant and valid, are issues with how an agency or ‘holder’ imagines and applies resiliency. Resiliency can be a tool to achieve inclusivity, protection, and sustainability objectives. To renounce resiliency entirely may do more harm than good, as opportunities to embed climate mitigation and adaptation while upholding social equity as essential can be beneficial to communities. Gilbert (2018, 174) is spot-on to be skeptical of resiliency and argue against a distorted application of the concept towards a system of manipulation. Discussing these issues and addressing these flaws can alter how communities’ benefit. Instead of resiliency to restructure, reimagine, and redevelop in financial interests, resiliency’s power is deeply entrenched in social equity, social justice, and adaptation and mitigation measures.

Resiliency is a flawed concept. Gilbert (2018) recognized these weaknesses and provided a helpful analysis to determining why resiliency is such a contentious topic. The continued stress placed on the complexity and inconsistency of this concept needs to be constantly reaffirmed. Adding to the complexity issue is the fact that resiliency lacks a standard and widely agreeable definition. Resilience involves a “multitude of different definitions” and operational tools (Klein et al., 2003, 42). Even if resiliency is imagined in the most progressive and equitable approach, the process cannot be replicated and applied in every community (Coetzee et al., 2016, 201). To do so would ignore the differences and diversity of the community, whether that be social, geographical, or economic. Therefore, a “one-size-fits-all approach” remains an impossible endeavour due to resiliency’s “differences between definitions, methodology, and areas of applicability” (Roostaie et al., 2019, 141). Resiliency is a learning process and a journey that focus on the needs of the community as core to the application. The definitions I referred to earlier in the paper provides a base to spark a discussion. However, even those definitions were quite vague and exacerbates the current issue.

All the inconsistencies, vagueness, and complexities point to the realization that there is no ‘gold standard’ of imagining, applying, measuring, or achieving resilience (Windle, 2011, 17). These difficulties are exactly why a universal model of application may be problematic. A universal model can contribute to groups being ignored, considerations being unexplored, and communities expected to conform to a model that does not represent them. Thus, the flaws of

resiliency remain clear while resiliency's meaning is still not clear. The Major Paper will continue to argue the importance of resiliency. The ability of resiliency to be imagined and applied can help increase community resiliency with integrated social equity. Successful resiliency, especially climate resiliency, requires a responsive, intersectional, and equitable approach and implementation (Weinstein et al., 2019, 274). Therefore, the next reasonable transition will be to explore social equity and its relation to resiliency.

### **Chapter 3: Social Equity... or the Lack Thereof**

The previous chapter discussed several theories and methods that are often associated and connected to resiliency. At the centre of any imagination and implementation is the 'holder'. The 'holder' of resiliency leads the journey towards building resiliency. For example, the 'holder' has the power to imagine a community that is resilient through recovery. As well, the 'holder' can structure a community that will adapt and adjust through the use of infrastructure to maintain a certain goal of stability. The 'holder' can be one person, two people, a special interest group, a municipality, or even an international agency. The exact parameters of who can apply resiliency can take numerous forms. Ultimately, it is the 'holder' that decides or determine what resiliency is to entail and who resiliency will be for.

Often lost in resiliency discussions is the inclusion of a social equity principle. There are various literature avenues one can take that discusses how a community will prepare for, or react to, an event or change. However, I came to the realization that most of the resiliency literature does not include or support social equity as part of the process. I will argue that the same emphasis should be placed on the social equity of a community as on resilience of the built environment. To include social equity as a fundamental principle of resiliency will create a meaningful process towards the goal of increasing a community's resiliency. A resilient *community* is the goal, is it not? The absence of a central social equity lens in a resilient framework can lead to loopholes and gaps. These loopholes and gaps allow for questions to emerge on whether resiliency is imagined for a specific group or the community as a whole. Therefore, social equity as a fundamental principle will support the objective of a resilient community based on equality and equity. For the purpose of this paper, I define equity as the

requirement for engagement, inclusion, and fair treatment for all members of a community and their valued participation in the resiliency decision-making process. The significance of equity does not simply entail the mere mention of this principle. The mention of social equity lacks meaningful application and does not always guarantee the principle's implementation (Castán Broto & Westman, 2017, 644; Meerow et al., 2019, 798). Social equity needs to be held to the same regard as the theoretical approaches that have shaped resiliency in communities around the world. I want to stress that resiliency of a community involves exactly that, a resilient community. To ignore social equity in the process towards a resilient community is to ignore resiliency as a whole. Such a removal from a resilient community is counter-intuitive and is not a justified.

The common emphasis when researching resiliency theory and application is the built environment. Critical infrastructures, residential areas and dwellings, and industrial areas tend to be the initial focus of resiliency. This recognition is not to say the built environment perspective serves no purpose. Vulnerabilities in the built environment can exacerbate issues depending on certain conditions, such as fragile and aging infrastructure that communities rely on (bridges, sewer management, transportation) (Green, 2016, 53). However, social dynamics maintain a critical role in resiliency discourses and resiliency applications. If communities are planned to be resilient, then essential to this objective is for the social community to be resilient as well. Upon reviewing resiliency plans from cities involved in the “Rockefeller Foundation’s 100 Resilient Cities programme”, Meerow et al. (2019, 793-794) determined there was a clear lack of action on how equity was to be implemented and the role of the social dynamics in resiliency. The review did not identify “any published systematic, cross-sectional analyses” to achieving equity in consideration and practice (Meerow et al., 2019, 794). The conclusion Meerow et al. (2019) provided marks a concerning discovery on the function of social equity in resiliency practice. A social equity approach that is balanced and meaningful is a necessity in order to ensure the community as a whole is resilient, instead of only selected groups.

The direct inclusion of equity in resiliency planning can resolve many of the flaws of the theoretical and practical concept. However, resiliency plans that do explore equity often further perpetuate social injustices through policy complexities, inconsistencies, and a lack of action

(Meerow et al., 2019, 805). If equity is to be held to a high regard, then conformity of resiliency planning to an equity foundation needs to exist. Resiliency theory and application can achieve equity goals in three different ways. In no particular order, the three forms of social equity include distributional justice, recognitional equity, and procedural equity (Meerow et al., 2019, 797-798). Distributional justice is defined by Meerow et al. (2019, 797) through the equitable access to a range of opportunities that include but is not limited to economic, infrastructure, and service opportunities. Recognitional equity involves a more intersectional approach to equity based on recognizing community members, the identities of these members, and fostering respect for the diversity of the groups (Meerow et al., 2019, 797). This form emphasizes identities such as race, gender, class, age, and economic position and the “historical injustices” that may be associated with these identities (Meerow et al., 2019, 797). Procedural equity is interlinked with the other two forms by including all identities, groups, and associations into an integral position in the decision-making process towards achieving resiliency (Meerow et al., 2019, 798). Meerow et al. (2019, 798) emphasized procedural equity, as without procedural equity, individuals, groups, and associations are “unable to participate in the community” and their subsequent needs and opinions “for social goods cannot be recognized.” The three forms of equity reflect the required measures needed to achieve a just resiliency planning process. A resiliency approach that upholds the fundamental principle of equity leads to an opportunity to closely examine social dynamics of a community.

Social dynamics entail a recognition of diversity in the race, gender, and class within a community. These intersectional dynamics are intertwined with each other, creating opportunities of advantages and disadvantages because of the inherent association with their specific dynamics. The culture, community interests, and racial undertones are just some of the many variables that can determine which group(s) benefit and which group(s) face adverse circumstances. An inclusion of equity as a fundamental principle of resiliency will recognize this issue and seek to provide significant measurable actions to overcome injustices in communities. The discussion of social equity and intersectionality translates into an examination of vulnerability. Intersectionality recognizes that there are vulnerabilities that exist on numerous scales and dynamics. These vulnerabilities can impact some more than others and is thus also interlinked with equity and vulnerability.

An important consideration I make is that vulnerability is also determined by its context. For example, if a freezing rain disaster occurs in a community, the community as a whole has a certain level of vulnerability depending on pre-emptive measures, access to resources, geographical location, and other risks. Intersectional dynamics create additional layers of vulnerabilities that add to already exacerbated issues. Thomalla et al. (2006, 43) best described these intersectional dynamics and their relation to determining vulnerability.

“Complex interactions of social, economic and environmental factors operating on different spatial and temporal scales give rise to vulnerability as they affect the ability of individuals and communities to prepare for, cope with, and recover from, disasters” (Thomalla et al., 2006, 43).

Similar to resiliency, vulnerability remains a complex discussion because of the difficulty to determine what group(s) or even broader structures (infrastructure, services) are in fact vulnerable. However, Thomalla et al. (2006, 43) provided an insight in determining which groups were more exposed, and thus vulnerable, to hazards and weather-related disasters. Those most vulnerable tend to involve specific social groups that include but are not limited to ethnic and religious minorities, marginalized and socially excluded groups, and intersectional dimensions that lack access to social and economic capital (Thomalla et al, 2006, 43). These group(s) on their own or intersecting with other variables tend to be more vulnerable to disasters that impact an entire community. Identifying vulnerability thus includes the recognition that certain groups tend to be exposed more to adverse conditions of a disaster or event, such as low-income community members living in low elevation areas (Turner, 2010, 572). This recognizes that disasters impact the whole community, but not equally. With a fundamental inclusion of social equity in the resiliency planning process, the most vulnerable are provided with substantial access to necessary resources and assistances to achieve the community resilience goal.

Resiliency and vulnerability are powerful terms. These terms often emerge in discourses due to their ability to “derive power in areas of social collapse” (Timmerman, 1981, 3). According to Timmerman (1981, 3), these two terms reflect buzzword characteristics in their

ability to be an ultimate term in their many uses and applications. Timmerman (1981, 21) explored the relationship of these two terms.

“*Vulnerability* is the degree to which a system, or part of a system may react adversely to the occurrence of a hazardous event. The degree and quality of that adverse reaction are partly conditioned by the system’s... *Resilience*, the measure of a system’s, or part of a system’s capacity to absorb and recover from the occurrence of a hazardous event” (Timmerman, 1981, 21).

The definitions highlight the interconnected and interlinked characteristics of vulnerability and resiliency. The imagination, type, and implementation of resilience can determine the system’s vulnerability and to what degree the event may impact the system resilience it is designed for. Therefore, I see an analysis of resiliency theory as also requiring an analysis of vulnerability. The interconnectedness of the two terms and the insight Timmerman (1981) provided begins the process on creating a more meaningful and equitable resiliency implementation.

The concept of resiliency requires tweaks and improvements in order for the implementation to be as effective as possible. One noteworthy improvement is for resiliency planning and strategies to explicitly determine “resilience for whom” (Meerow et al., 2019, 806). With such a broad and encompassing concept, specifically stating who is included and narrowing the use to a particular context, issue, or event is important. Meerow et al. (2019) suggest establishing the five W’s (who, what, why, where, when) to allow resiliency to be used comprehensively. Setting an explicit focus for resiliency will allow for transparency, a meaningful participation process, and community engagement (Meerow et al., 2019, 806). Resiliency documents and planning objectives must also strive to be more transparent, educational, and accessible. Language challenges need to be addressed and public consultation meetings held at varying times to account for different employment schedules. These are just some approaches that create inclusivity not only in imagining and implementing resiliency but in any policy making process. If the goal is to increase community resilience, the integrated role of public input and participation is then vital to overcome any change, disturbance, or event. Therefore, I will transition to describing a specific change that necessitates a resiliency approach.

## Chapter 4: The Threat: Flooding

The chapter will identify and examine the threat of flooding and why climate change is a global threat that requires resiliency planning. Climate change actions are not limited to a national context. Municipalities are in a strategic role to be leaders against worsening climate change conditions and to be drivers towards implementing flood mitigation and adaptation measures. By exploring the threat, a foundation can be established on how resiliency can be implemented.

The World Health Organization (WHO) recognized climate change related deaths have the potential to contribute to an additional 250,000 deaths per year between the years 2030–2050 (WHOa., 2021, para. 2). There is a financial cost associated with worsening climate conditions, as the World Health Organization reported that the cost to health, “excluding costs such as agriculture, water, and sanitation,” are estimated to be between two to four billion dollars USD every year by 2030 (WHOb., 2021, para.1). These grave and urgent discoveries are not centralized, but instead are impacts felt on an international scale. Human activities have accelerated the changing climate. Human actions, such as the burning of fossil fuels, have warmed the world by approximately 0.85 degrees Celsius over the past 130 years (WHOb., 2021, para. 2-3). The burning of fossil fuels and the resulting greenhouse gas (GHG) emissions are critical in understanding why climate change and global warming is our current reality. GHG emissions absorb and trap heat energy in the atmosphere, leading to increases in temperatures and weather-related changes (Government of Canada, 2019, 29). The use of fossil fuels in the twentieth century has, unfortunately, become ingrained in daily routine. Human made contributions is something that we as a collective society can and must control to mitigate and adapt to our current climate reality.

Aside from direct fossil fuel combustion, the density of an ‘urban’ community is an indirect contributor to increasing GHG emissions and a warming climate. At the local level, urban communities, such as densely populated areas with extensive built infrastructure often represent a concrete jungle. The use of concrete, asphalt, and other materials combine with towering buildings and stretches of streets and highways characterize a bustling urban

community. As the increase in demand for housing and employment lands in these communities continue, the concrete infrastructure associated with these needs characterize the ‘urban’ area. This characterization has contributed to the Urban Heat Island Effect.

The Urban Heat Island Effect describes urban areas as inherently warmer (up to four degrees Celsius) compared to rural communities (Rahola et al., 2009, as cited in Mees & Driessen, 2011, 251). Urban environments are potentially dangerous settings with climate change, as health impacts can range from reduction in air quality (smog) to an increased frequency in heat waves (Nolon, 2016, 10072). Flood damage is also a significant cause for concern according to the report *After the Flood: The Impact of Climate Change on Mental Health and Lost Time from Work*. “Flooding, exacerbated by built infrastructure failures and loss of natural infrastructure, is the costliest of these extreme weather events in terms of Property and Casualty insurable losses” (Decent & Feltmate, 2018, 5). The report goes on to say that “while insurable payouts averaged \$400 million per year over the period of 1980 to 2008, for the last eight out of nine years leading up to 2017, extreme insurance payouts exceeded \$1 billion in Canada” (Decent & Feltmate, 2018, 9). The enormous cost related to extreme weather-related events has continued to increase and poses major challenges to governments, private sector companies, and Canadian residents. The challenges and risks that climate change presents to communities are clear and mounting. The inclusion of climate mitigation and adaptation solutions and policies are imperative to addressing and minimizing the impacts of climate change.

## **Understanding ‘Natural’ Disasters**

Multiple factors can determine the occurrence, frequency, and intensity of a rainfall and subsequent flooding. Human activities may not necessarily be a sole defining factor, but the human component maintains a role in the grand disaster system. The takeaway here is to recognize that GHG emissions are increasing, that these emissions are exacerbating climate issues, and that Canada is not immune to the impacts and risks associated with climate change. The challenges climate change presents and the resulting impacts of weather-related events have led to climate mitigation and adaptation strategies becoming more common in theory and

application. However, defining these disasters as ‘natural’ is a misconception often upheld by public agencies, media, and the public.

The use of the term ‘natural’ when referring to a weather-related event is in my opinion becoming increasingly common. In order to analyse an occurrence as a ‘natural’ disaster, defining the concept is the first priority. As stated by Oliver-Smith (1998), “a disaster is a collectively intersecting process and events, social, environmental, cultural, political, economic, physical, technological, transpiring over varying lengths of time” (as cited in Ali, 2009, 246). The definition best describes how there are variations and intersectionalities inherent in the term ‘disaster’. There are multiple moving factors, some with more weight than others, that intersect causing the occurrence and persistence of a disaster. The definition also incorporates the social and cultural aspects that are often not considered in describing a disaster. The environmental and economic aspects are usually at the forefront in determining the extent or resulting damage of a disaster. By referring to Oliver-Smith’s (1998) definition, identifiers that relate to race, gender, religion, and class are weighed equally with the often physical and monetary values. This approach allows for a more equitable and detailed study to exist that is not constrained to a ‘natural’ lens. Instead of simply focusing on the physical (such as environmental, infrastructure) aspect of a disaster or possible adaptive measures for future disasters, an encompassing approach similar to Oliver-Smith (1998) definition at least ensures that the discussion is inclusive.

A disaster often has natural elements that determine the severity of the event. Understanding these aspects of a disaster are beneficial in determining environmental damage, mapping future forecasts, and taking appropriate resiliency planning measures to mitigate and adapt to such events, among others. According to Ali & Novogradec (2008, 534), simply labeling the disaster as ‘natural’ is a significant misconception. The label of ‘natural’ comes with a conception of uncontrollable, inevitable, and the inability of governments, agencies, and society to control the impact (Ali & Novogradec, 2008, 534). A ‘natural’ distinction can potentially lead to public leaders and agencies absolving themselves from a role in the recovery and adjustment process post event. A representation of a ‘natural’ event creates a fantasy, identifying the cause of the event to be of natural occurrence and out of control (Ali & Novogradec, 2008, 534). Hence a return to the prior discussion of act of omission, where the

process of recovery and resiliency planning is offloaded on private responsibility (Anguelovski et al., 2016, 334). Referring to an event as a ‘natural’ disaster is potentially damaging and problematic. Public agencies and governments are expected to maintain the public interest and safety. They have the ability to shape resiliency systems in their communities and effectively ensure control over circumstances that may exacerbate a disaster (Ali & Novogradec, 2008, 534). Governments and agencies must act with the recognition of climate change and flooding as threats. The onus is not strictly on public authorities. Shared responsibility between private and public sectors and community members contribute to an effective resiliency strategy.

## **Flooding**

There are three main forms of flooding that are relevant to include in the broader discussion of resiliency. One form of flooding, coastal flooding, was not necessarily applicable to the events of the 2014 Burlington Flood. However, coastal flooding will still be included in flood examination, as it remains a continuous threat with ongoing conditions related to climate change and global warming. There are two main variations of coastal flooding, general overflowing and wave overtopping (Le Roy et al., 2015, 2498). General overflowing involves the rise in elevation of sea level above protective structures due to a combination of water effects, such as tide and storm surge (Le Roy et al., 2015, 2498). Wave overtopping involves the passing of waves overprotective structures and natural defences (Le Roy et al., 2015, 2498). These two forms of coastal flooding reflect a significant concern for municipalities that are adjacent to large bodies of water, such as the City of Burlington and Town of Oakville. Then there are the forms of flooding that are closely associated with inland flooding. Pluvial (flash floods) are concentrated floods in the form of heavy localized rainfalls that occur over a short period of time and overload water management systems (Melo et al., 2015, 79). Fluvial (general floods) are rainfalls occurring during a longer period of time that overflow rivers, inland bodies of water, and neighbouring communities (Melo et al., 2015, 79). These definitions provide a foundation for the case study of the 2014 Burlington Flood and broader flood mitigation and adaptation techniques discussed later in this Major Paper.

I do not argue that flooding is a direct and sole result of climate change, nor that the 2014 Burlington Flood occurred strictly because of climate change. Instead, several forms of flooding can be exacerbated by a multitude of factors, including climate change. Factors relevant to built characteristics can also determine the severity of a flooding disaster. Inadequate drainage and stormwater systems, development on floodplains, and the harmful impact of engineered levees are all factors that need to be recognized (Douglas et al., 2008, 191). Climate change has a significant role in shaping the future of extreme weather events. Climate change is not the sole factor but a major contributing factor within an intersectional process resulting in a catastrophic flooding event.

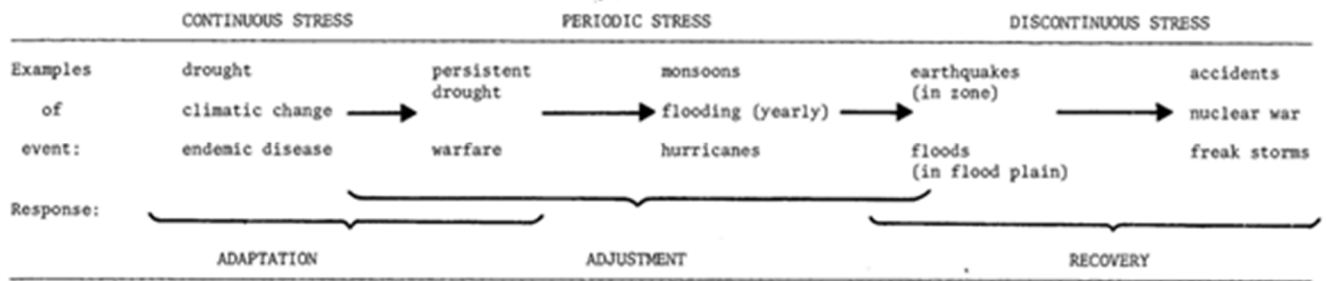
## **Chapter 5: Embedding Resiliency in Our Communities**

Resiliency planning can shape the vision, goals, practical implementation, and adaptation that communities rely on. The following section will further develop resiliency implementation, determine the significance of land use planning frameworks, and detail various mitigation and adaptation measures to flooding and climate change. Resiliency requires a multi-disciplinary approach that incorporates professions such as engineering and community politicians. A consideration of different perspectives benefit the application and implementation of resiliency.

### **The Importance of Implementation**

When public and private agencies aspire to improve the ‘resilient’ nature of a specific system or context, the action is done with a recognition that there will be a negative impact to a community without resiliency measures. Considering flood mitigation and adaptation measures recognizes that changes are required to resolve or help address an ongoing or future issue. Before I can examine these mitigation and adaptation measures, resiliency must be considered through an understanding of a “coping strategy” (Timmerman 1981, 26). This strategy describes how the event or change (in this case flooding) will pressure the community or structure in place (Timmerman, 1981, 26). The concept is useful because of the ability to recognize how stress and pressure can impact a system and how the system may respond through applicable techniques. Timmerman (1981, 26) established three strategies of stress a society or system may face:

continuous, periodic, and discontinuous. The form of stress (continuous, periodic, discontinuous) on a community or system, determined by the type of event (such as flood), may cause specific responses (adaptation, adjustment, recovery) (Timmerman, 1981, 26-27). Continuous stress may result in a period of adjustment or a longer permanent adaptation process (Timmerman, 1981, 26-27). Discontinuous stress depends on the severity on whether a focus on adjustments or recoveries will be employed, and periodic stress refers to stresses that occur regularly and require a calculated response that can blend between adaptation, adjustment, and recovery (Timmerman, 1981, 26-27). Figure 5 demonstrates the interconnected responses a system can have in relation to forms of stress. Resiliency measures must consider these relations when planning for how communities will increase their resiliency and through which avenues. Flooding impacts can be more frequent and catastrophic if communities are based in floodplains, and likewise can hinder the resiliency measures assigned to address these impacts if flooding is continually exacerbated by climate change.



**Figure 5: Timmerman, 1981, 31.**

To further improve the implementation process, creating a foundation that relies on clear goals and aspirations is vital. Distinguishing between resistance vs resilience creates an additional layer towards analyzing how resiliency is implemented (Liao, 2012, 7). Understanding this relationship allows the ‘holder’ or agency to critically assess whether mitigation and adaptation efforts are intended to *resist* the change or be *resilient* to the change. For example, flood *control* measures often place emphasis on the ability of the community to be dry and stable (Liao, 2012, 7). However, communities fully dependent on a flood *control* approach are more resistant than resilient (Liao, 2012, 7). Liao (2012, 7) established this differentiation by recognizing that these flood measures rely on keeping the community landscape “dry-and-

stable”, which results in an intolerance for wet conditions. A resist approach is further problematic because this approach “creates a false sense of security” (Liao, 2012, 8). If these measures fail, the result can be more catastrophic due to the intent to resist the risk instead of being resilient. Therefore, resilience focuses on the adjustment, adaptation, and recovery through a broader process to addressing the change or disturbance, whereas resistance is focused on the avoidance or control of the change or disturbance and not necessarily adapting to the situation (Miguez & Veról, 2017, 928). That is not to say resistance serves no purpose. The combination of a primarily resilient approach with minor resistance measures can in my view aid the broader goal of building community resilience. However, an approach based solely or primarily on resistance leaves major challenges for the community to overcome, as indicated by Liao (2012, 7-8). The discussion on identifying resistance vs resilient guides the direction climate and flood resiliency can resemble. Adjusting a climate and flood resilient community and planning for a resiliency future requires a comprehensive approach that starts with public and private involvement and the Planner’s participation.

## **Planning for Resiliency**

The implementation of resiliency tends to occur through public policies, discourses, and community initiatives. To address the threat of climate change, resiliency planning must incorporate the risks associated with climate change to be a more flexible and responsive process (Weinstein et al., 2019, 274). Although I argue in favour for the use of resiliency planning, the completion of a fully resilient community is quite impossible. There will always be threats or changes that are unplanned and unexpected. Even if these changes were expected and resiliency planning was fully implemented, there will always be improvements needed to better prepare a community. The primary goal of resiliency planning involves a greater progression towards reducing community vulnerabilities, increasing the responsiveness of community capacity, and minimizing risks that may further exacerbate a flooding disaster (Miguez & Veról, 2017, 926). A resilient system facilitates the protection of natural environments, built environments, critical infrastructure, and preservation of cultural identity and equity (Masnavi et al., 2018, 576). The implementation of a resilient system is better prepared to address these changes or disturbances among all in the community, withstanding any shocks or dangerous threats that may take place

(Masnavi et al., 2018 576). A continual progression of resiliency planning is critical, as even a city that is strategically prepared to be 100% floodable can still be challenged by an even greater event than was originally planned for (Liao, 2012, 9).

There are several perspectives and disciplines that are important to the overall resiliency planning process. The main emphasis of this Major Paper is on exploring resiliency planning through a regional/city/ rural planning perspective. The role of the planner in aiding a resilient transition to a more resilient world is critical. There are other professions and perspectives also relevant to resiliency planning. However, I will focus primarily on the planning discipline while also referring to the engineering profession. The direction and influence the planning and engineering professions have on implementing resiliency measures is important, as both disciplines are closely interconnected in community strategies, designs, and functions.

### **Putting the Plan in Planner**

The planning profession has an opportunity to be a source of resiliency progression. Progression is not only limited to resiliency policies and decision-making on what infrastructures can help protect against flooding. The planning profession can lead resiliency education campaigns, community outreach, and generate public participation. Public participation also requires the need for local governments and the planning profession to provide financial resources in order to support engagement, such as access to informative materials and providing community funding to shape green spaces, among others (Fainstein, 2015, 165). Planners in their role with public and private agencies can delineate planning and environmental priorities and utilize zoning tools to recognize flooding issues and limit development on these lands (Fainstein, 2015, 166). There are opportunities that planners can explore in existing flood prone areas, such as investment in mitigation and adaptation and prevention of wetland destruction. Planners should present digestible information to community members on how they can be involved in the implementation process and where the stakes or urgencies lie in land use planning decisions (Fainstein, 2015, 166). This high-level overview is a starting point in demonstrating how important the role of the planner is to addressing flooding.

The planning profession often discusses the need to plan for current conditions, but also the distant future. There is no doubt then that resiliency planning will integrate well with the planners' duties and objectives. Let's remind ourselves why planners are so important. Planners advise and consult on what is best for communities at an environmental and land use planning level. For example, planners with the help of engineers can indicate flood risk areas that can hinder or harm community development and, therefore, can advise against such projects (Miller & Hutchins, 2017, 350). The planning profession can shape growth in a community at a larger regional view and local site scale and integrate climate change mitigation and adaptation in policies and practice. Planners can be well versed in water management planning towards working with engineering staff to help find sensible approaches of reducing water runoff and creating a more absorptive, rather than resistive, community (Miller & Hutchins, 2017, 357). If communities require mitigation and adaptation to be integrated in community and corporate practices, the planning profession is one of the more significant disciplines to achieve this goal. The planner's role is critical to answer how communities expect to tackle, and be resilient, to modern day and future challenges.

## **Planning Framework**

A review of planning guidelines show that planners are best suited to engage in resiliency planning. Planning decision-making and guidelines can be decided by local municipalities depending on the context and relevant jurisdictions. Municipal powers in Canada are restricted to the direction of provincial policies and legislation. Municipalities do not have any constitutionally enshrined powers and, the powers they do have, can be altered by provincial legislation. Contextualizing what municipalities can do in the Province of Ontario goes a long way towards determining how successful resiliency can be. In Canada, land use and environmental planning rules and guidelines are established by the provinces. The case study for this paper is associated with a local municipality, the City of Burlington. A deeper consideration is needed to determine how the City of Burlington, Halton Region, and Conservation Halton can implement resiliency. All three of these public agencies are located in the province of Ontario. The City of Burlington and Halton Region are under the jurisdiction of legislation that includes the *Planning Act (2020)* and *Places to Grow Act, 2005*. The three public agencies have to follow

policy guidelines such as *A Place to Grow (Growth Plan, 2020)* and *Provincial Policy Statement (PPS, 2020)*. There are also relevant environmental planning policies at the provincial level that are important to consider for wetland and environmentally protected land, such as policies in the *Oak Ridges Moraine Conservation Plan (2017)* and *Greenbelt Plan (2017)*, and *Niagara Escarpment Plan (2020)*. The documents reflect the guidance for municipal land use and environmental planning established by the Province of Ontario. For example, the *Planning Act (2020)* establishes land use planning framework (s.1), delegates powers for the Minister of Municipal Affairs and Housing (s.4), and establishes powers of municipalities (s.16, 34). Provincial governments can also implement resiliency planning through other forms of provincial policies, regulations, and guidance. For example, resiliency in Ontario found through policies such as *A Made-in-Ontario Environment Plan (2018)* and *Protecting People and Property: Ontario's Flooding Strategy (2020)*. This brief overview acknowledges Ontario's planning framework and where legislation and policies related to resiliency may be found.

## **Municipal Tools to Incorporate Resiliency Planning**

Municipalities can require land use development applications to incorporate a flood risk assessment. For example, official plans that designate which forms of development can be permitted and set limits on land use can be implemented through the use of regulations such as zoning by-laws. There are also more general overarching policies that can help apply mitigation and adaptation techniques. Policies that set general design guidelines can help require development to integrate permeable surfaces, reduce impervious surfaces, and mitigate circumstances that exacerbate flooding, such as climate change. Municipalities in Ontario have access to multiple tools that can help facilitate an increased transition towards future resiliency. In addition, municipalities are beginning to set “Green Development Standards” for new residential buildings (FCM, 2021, para. 5). These standards help manage the generation of waste, air pollution, and GHG emissions, while also integrating development guidelines to achieve community sustainability (FCM, 2021, para. 3). By addressing circumstances that increase the severity of climate change, municipalities can simultaneously mitigate and adapt to threats flooding presents. Flooding requires an approach that is not only limited to flooding risks.

Incorporating strategies that provide solutions to the climate change crisis will benefit the progression towards increasing overall resiliency of communities.

The use of zoning can determine the successfulness of resiliency measures. Recognizing the benefits of zoning on increasing resiliency in communities is important. Park et al. (2020, 7) established an evaluative method that would assist in a reduction of “urban-area flood damage during extreme rainfall events.” The method requires a classification of zoning by-laws that has a vulnerability analysis and then a classification of levels of resilience for the area (Park et al., 2020, 7). The use of zoning in this regard would greatly benefit the resiliency progression of communities towards minimizing flood risks. The use of this tool can also transition into resiliency zoning, a zone that is established as an improvement area to increase the area’s local and overall resiliency (Green, 2016, 71-72). Resiliency zoning can be used to mark new or existing neighbourhoods that may be deemed climate vulnerable and can either require resiliency investment or may limit development uses depending on the circumstances (Green, 2016, 86). Zoning presents a vital opportunity to incorporate resiliency measures in municipal operations and aid the overall goal of mitigating and adapting to flooding. I view these municipal opportunities as important options towards embedding resiliency planning within municipal practices and actions.

## **Planning Profession**

The planning field has the opportunity to work with municipal tools to shape and implement resiliency planning to address many of the current and future challenges communities face. The ability of planner’s to also be leaders in community collaboration and public engagement provides the discipline with a coveted vantage point towards interpreting and implementing resiliency. Planners can communicate with the public effectively in processes that require equitable societal change, climate informative and educational opportunities, and learning of socio-economic inequalities present in the community (Simon et al., 2020, 100). The planning profession is capable and well suited to work with resiliency in a broad and case specific context. Planners need to prioritize creating strategic policies that focus on addressing climate change impacts and urban system risks and vulnerabilities, while also integrating these

challenges for pre-emptive measures into city growth and development (Worku, 2017, 20). In order for communities to reflect sustainability guidelines and increase their resiliency, Worku (2017, 20) strongly argues for climate change considerations to be an integral component of municipal actions. This can range in application but can be commonly found in a climate lens/climate implication section within staff reports to council.

Creating a more resilient community requires the use of land use and environmental planning tools to achieve such a goal. Increasing the ability and capacity of resiliency in local communities can collectively contribute to a more resilient region and, more broadly, a more resilient country. To hesitate on resiliency measures further prolongs the progression towards ensuring that physical communities and those who live and travel within communities are protected. Common misconceptions lead to hesitations and scepticisms in taking appropriate action. Action is required from public, private, and community groups despite any prior understanding of resiliency. A multilateral and objective based focus is required that places the onus of climate and flood risk action on all members of the community (Anguelovski et al., 2016, 344-345). The greater need for a multilateral and objective based focus is required knowing that there are many in communities who are routinely silenced or discouraged in participating in the public engagement process. The intended silence of communities leads to distorted resiliency measures implicitly or explicitly in favour of economic or elite interest (Anguelovski, 2016, 344-345). Generating interest and providing incentive to invest in a community's resilience is an undertaking well suited for municipal planners. Planners should be familiar or should explore educational tools to be familiar with resiliency planning and can further link input from community members, public agencies, and private interests into practical action. There is also a requirement to create publicly accessible educational tools in order to provide a more equitable and approachable understanding of what resiliency involves in a community. Engaging with the public can lead to local change that is a necessity for the overall resiliency progression. Mann & Wolfe (2016, 2652) recognized community involvement and educational programs can aid the preparedness of residential flooding and progress overall resiliency. "Improving individuals' or household's flood preparedness can be an important strategy" to reducing community harm (Mann & Wolfe, 2016, 2652). With the inclusion and engagement of the public at a local level, community members can be empowered to practice

resiliency measures in their own actions. Community resilience is not an isolated undertaking for one group or profession to act on. A multilateral and objective based approach to generating resiliency participation will greatly improve and increase the resiliency capacity of a community, region, and nation.

## **Chapter 6: Engineered Infrastructure of Resiliency**

The scholarly literature review provides an examination on how resiliency is structured through an academic and imaginative perspective. Presenting these theories, understandings, and critiques of resiliency allows the reader to familiarize themselves with resiliency thought and empower themselves to apply resiliency in their own lives and actions. With any imagination or vision of what resiliency is to resemble, there is often the subsequent implementation. Grey and green infrastructure are the means on the ground to deal with flooding. Grey infrastructure refers to traditional engineered systems that are designed with impervious surfaces (Johns, 2019, 1378). Grey infrastructure is commonly found in storm water management infrastructure, levees, and water treatment stations (Johns, 2019, 1378). Alternatively, green infrastructure refers to the use of low impact development (LID) and the natural ecosystem process to manage the flow of water (Johns, 2019, 1384). Green infrastructure can broadly encompass the goal of climate change mitigation and adaptation, such as using community infrastructure to lower heat stress and improve air quality (Nolon, 2016, 10072). Green infrastructure incorporates the natural ecosystem and engineered permeable infrastructure within the community to aid stormwater management and also provide climate change adaptation benefits (Johns, 2019, 1379-1380).

Green and grey infrastructure extends outside water management to provide additional benefits to the public. Grey infrastructure supports the use of more engineered impervious and impermeable surfaces (such as paved parking, buildings) whereas green infrastructure incorporates natural characteristics towards public health and good (such as parks, gardens, green spaces) (Connolly, 2019, 68). Similar to grey infrastructure, there are also challenges associated with implementing green infrastructure. Johns (2019, 1380) collected emerging challenges that faced green infrastructure, including but not limited to “dominance of technical engineering, jurisdictional barriers, and lack of funding.” With the challenges in mind for both green and grey

infrastructure, an important consideration for public and private agencies to make is what forms of infrastructure do they want their community to reflect. If a priority for a community is to resemble a more resilient area in theory and application, then incorporating green infrastructure measures can provide a healthy, more sustainable, and greener society, while also supporting water management systems in place (Tzoulas et al., 2007, 175). Identifying these two forms of infrastructures sets the stage of what will help guide the exploration into mitigation and adaptation measures. These measures will be examined to demonstrate the opportunities available to communities for addressing flooding.

The demand to control the flow of water in a community in order to mitigate flooding is not an unreasonable objective. Access to water in any community is a coveted good and need. Community planners, engineers, and technicians have throughout history viewed water and urban/community drainage as a job for sewer systems and “end-of-pipe measures” (Miguez & Veról, 2017, 929). The objective of removing wastewater and rainfall from the community to outside treatment plants and other outlets tend to rely on the use of grey infrastructure to do so. However, distributing this water, reorganizing flow patterns, and altering urban drainage with the use of green infrastructure are prospective options that public leaders and professions should explore to increase a community’s resilience to floods (Miguez & Veról, 2017, 929-930). Mitigation and adaptation opportunities require a multi-disciplined and multi-stakeholder approach for a community to adequately incorporate these efforts. As communities grow, greater stress and pressure is placed on grey infrastructures that rely on human engineered stormwater systems (Fletcher et al., 2013, 261). The stresses and pressures are exacerbated as impervious surfaces eliminate infiltration and lead to a greater reliance on grey infrastructure systems to adjust for runoff and increased rainfall (Fletcher et al., 2013, 264). The disciplines and stakeholders discussed throughout the paper must account for increased urban hydrology and how managing community runoffs will improve flood protection, public health, and a preservation of a “liveability of cities” (Fletcher et al., 2013, 261).

## Increasing Sustainable Green Infrastructure

Understanding the importance of urban hydrology is key for planners, engineers, and other professions to manifest resiliency through their own disciplines towards flooding. There are three main themes this paper recognizes as imperative to guide the flow of water through measures that are not limited to the impervious characteristics and material structure. These themes are infiltration, retention, and restoration. By discussing these three themes, the paper is not implying that a removal of grey infrastructure and a reliance on forms of green infrastructure is necessary. Instead, investment in green infrastructure in communities should work alongside grey infrastructure in creating engineered but also natural measures of dealing with flooding risks.

Infiltration by the very definition is intended to allow waterflow seep through the landscape. Infiltration opportunities can allow for absorption of water flow, instead of resisting it. Infiltration-based technologies can include porous and pavements, swales, and rain gardens (unlined bioretention systems) (Fletcher et al., 2013, 268). Infiltration-based technologies help aid stormwater management by assisting with the reduction of runoff water entering grey infrastructure sewer systems (Fletcher et al., 2013, 268). Since infiltration opportunities are based on the ability of surfaces to absorb water, instances of clogging may occur related to incorrect particle size distribution or collection of sediments (Fletcher et al., 2013, 268). Despite instances of clogging, infiltration-based technologies provide a useful tool for dealing with strong rainfall events. For infiltration to be effective, a reasonable expectation is for it to be coupled with a reduction of impervious surfaces to reduce runoff towards the grey infrastructure sewer management system (Worku, 2017, 13). A reduction of impervious surfaces in exchange for an increase in permeable paving can facilitate infiltration and can dissipate water flow (Worku, 2017, 13). If permeable surfaces are considered, the requirements include elevated areas and the need for the “groundwater table’s seasonal height” to be more “than 1m below the base of the paved area (Worku, 2017, 13). With these requirements in mind, permeable surfaces can be beneficial at a case-by-case basis in order to provide much needed infiltration. Infiltration is better integrated and prepared in dealing with water runoff when it is coupled with retention measures.

The function of retention and infiltration-based technologies can have a positive impact on their own or when they are combined together. On its own, retention-based technologies relies on the accumulation of water through natural means, such as relying on storage-routing properties and stormwater harvest (Fletcher et al., 2013, 269). When combined with infiltration-based technologies, a system can absorb and direct water towards retention facilities. However, retention-based technologies require hydraulic modelling to ensure the flow of water through the infiltration and retention systems will not contribute to the unnatural erosion of surrounding landscapes (Fletcher et al., 2013, 269-270). Enabling a case-by-case approach for retention-based technologies is important to ensure an effective application and a recognition of whether the technology will benefit the overall goal of resiliency. The use of natural landscapes like wetlands, floodplains, and ponds can aid in the mitigation of flooding risks through infiltration and retention. In a dense 'urban' community, retention-based technologies are found in the use of vegetated surfaces and roofs that provide additional rainwater catchment solutions (Fletcher et al., 2013, 271). These forms of infiltration and retention technologies can provide much needed water management benefits in areas of dense city communities.

Vegetated roofs and spaces can aid the improvement of city resilience. They can also provide much needed climate change mitigation and adaptation solutions by reducing heat emitted by the built environment. Aside from the retention-based technologies discussed thus far, there are other honourable mentions such as the use of urban storage basins to store excess rainwater or human constructed wetlands to improve stormwater quality and control (Worku, 2017, 14). Water storage opportunities provide needed flooding protection during heavy rainfalls, as these measures help manage water-level and rainfall accumulation (Ploeg, 2011, 212). Whether the context specific location is in a densely populated and built community or in a rural neighbourhood, the use of green retention-based technologies can provide a benefit to increasing resiliency against flooding. The natural characteristics and landscapes that does exist, such as wetlands, provide an unimaginable environmental protection from flooding that needs to be a coveted part of community planning.

The final theme to consider in exploring the use of green infrastructure to support a flood mitigation and adaptation approach is to focus on restoration. Restoration provides a needed rehabilitation process for communities. Restoration in this case would protect existing green spaces and incorporate more green options to improve the general health and protection of the community. There are two notions of restorations relevant to flooding. The first is the restoration and protection of green spaces in communities. As communities look to greatly increase their ability to combat climate change, the integration of green spaces in community planning and development will go a long way to achieve this end. Similar to the discussions previous to infiltration and retention, restoring and preserving greenspaces in a community can provide beneficial local and regional flood mitigation measures. Integrating urban tree canopies with bustling communities provide local opportunities of water management, help cool temperatures and provide shade to the community, and offers healthy landscapes for human and wildlife to interact in (Nolon, 2016, 10071). An urban design that embraces green spaces and urban tree canopies aid in the broader progression towards encouraging infiltration, restoration, and retention measures in communities.

The second notion of restoration relevant to this paper is through rivers. Rivers provide valuable retention capabilities and can help channel waterflow away from communities depending on the geographical landscape (Worku, 2017, 13). River restoration can also resemble the reconnection of rivers with flood plains and wetlands to provide additional water storage capacity (retention) and renaturalizing embankments to protect against river erosion, enhance infiltration of floodwater, and improve vegetation growth (Worku, 2017, 13). By restoring rivers and waterways that run through municipalities, an added layer of protection can exist against flooding risks. Reflecting on the themes of infiltration, restoration, and retention demonstrates the interconnected nature and role they have in communities. The themes and their respective measures serve a vital role for communities. Miguez & Veról (2017, 928) highlighted this role by recognizing the balance needed of communities between the needs of humans and the dynamics of nature. Integrating green measures into community planning, engineering, and sustainability practices can help address the challenge of managing hydrology. As communities plan for growth and/or the creation of sustainable infrastructure and strong employment

connections, public agencies need to remember the greater need of incorporating green infrastructure and increasing resiliency.

The three themes explored create an interesting avenue of interpretation as they can be used in conjunction with or in isolation from others. These green infrastructure measures bring with them heightened possibilities on how a community can increase resiliency and also provide sustainable options and environmental protection. At a larger scale, the three themes can combine to reflect a mitigation and adaptation measure commonly referred to as sponge city technology. The sponge city idea was recently adopted by China as an answer to address pluvial flooding disasters, with the aspiration of a more sustainable progression in urban development projects (Jiang et al., 2018, 135). The initiative serves as an example of an implementation effort towards incorporating infiltration, retention, and restoration as a major function in the community's stormwater management system. The sponge city system requires the integration of infiltration surfaces that also aid in rainwater retention (Jiang et al., 2018, 135). The system utilizes land use planning and design strategies to enable and restore natural landscapes with engineered retention capabilities to absorb and store rainwater (Jiang et al., 2018, 135). The required multi-discipline and multi-administrative project provides an example of the possibilities infiltration and retention can have in transforming a community towards mitigating and adapting to flood risks (Jiang et al., 2018, 135). Critical to this is the recognition that the natural landscapes can provide massive societal benefits outside of important functions like helping mental health and protecting wildlife. Natural landscapes and the preservation of these areas are a massive component to building the resilience of a community. I view sponge city technology and other widescale initiatives as great opportunities to build flood resilience and further adding to the necessity of a separate study that studies the effectiveness of mitigation and adaptation measures.

### **Incorporating Infiltration, Restoration, and Retention in Planning Initiatives**

Whether it be through the use of zoning by-laws or the integration of green spaces and vegetation in municipal planning policies, planners have a fundamental role towards encouraging and implementing green infrastructure in a community. In addition to establishing policies and directives

meant to be resilient to flooding, retrofitting can help enable community and corporate stakeholders in doing their part to mitigate and adapt to flooding events. Communities can reduce their reliance on flood control measures by encouraging flood retrofitting in the built environment, natural landscapes, professional disciplines, and community systems (Liao, 2012, 10). There are also planning requirements that can help aid investment and growth in the use of green infrastructure to overcome flooding woes. Erosion and sediment controls are requirements that can be included in site plan and subdivision regulations (Nolon, 2016, 10072). Public agencies can incentivize developers to incorporate green elements, design, and infrastructure in their development applications through a reduction or elimination of fees and development charges (Nolon, 2016, 10072). The use of Low Impact Development (LID) systems is an integral tool for public and private agencies to engage in green infrastructure. LIDs refer to the infiltration, retention, and restoration mechanisms previously discussed at a site-specific development level and focuses on how construction may impact hydrology and flooding risks at the site itself (Nolon, 2016, 10073). In an effort to minimize damage or creating adverse impacts in relation to water runoff and flooding risks, LIDs enable the site-specific inclusion of minimizing impervious services, preserving vegetation and existing trees, and incorporating green infrastructure measures in a narrow context (Nolon, 2016, 10073). In the context of flooding, understanding geographical landscape, community demographics, and climatic patterns are essential to addressing flooding risks.

Planners must incorporate the three themes towards building more resilient communities using mapping flood-prone areas in existing communities (Worku, 2017, 11). This also goes without mention that a best practice to mitigating and adapting to flood risks is to not develop floodplain and wetland areas to begin with. Limiting these developments will allow for the preservation of rivers, wetlands, and green spaces that are paramount in the goal of increasing the flood resilience of communities (Worku, 2017, 11). Restrictions to development on these lands will limit development and will allow these natural systems to be zoned as a protected area to serve a resilience function (Worku, 2017, 11). The value that these lands provide range from environmental and flood risk protection to the reduction in damage to built infrastructure and community members. This value far outweighs any monetary value that may be associated with the development of these lands, as the human and environmental health and protection needs to be recognized as fundamental to any resilient community.

Green infrastructure provides a sustainable approach to addressing flood risk and increasing community resilience. As climate change further exacerbates the severity and frequency of flooding, green infrastructure provides hope to tackling this emerging and concerning threat. When public and private agencies consider green infrastructure as part or core to the implementation of resiliency planning, these bodies must also consider that a community can never be fully flood proof. Therefore, there will always be the risk of a flooding event greater than the measures and designs in place or a risk of flood infrastructure failure (Bertilsson et al., 2019, 971). The adage of a 100-year storm is no longer a relevant estimate for communities to rely on due to the increasing built development of communities in vulnerable areas, growing populations, and the threats climate change presents (Black, 2010, 365). Integrating flood resilient infrastructure into the fabric of every community is a requirement that will both mitigating flooding damage and establish a standard of preemption to the threat of such disaster. Resiliency planning is more than capable of facilitating this end and providing the needed support, perseverance, and equitable treatment for all in the community against minor and catastrophic floods.

## **Chapter 7: Case Study - 2014 Burlington Flood**

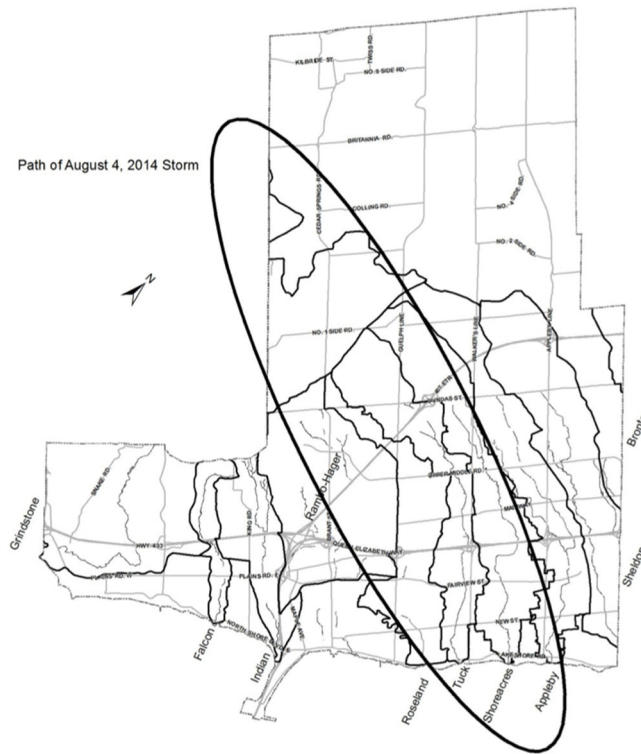
The examination of resiliency theory provides a set foundation to be used to analyze resiliency in practice, using the 2014 Burlington Flood as a case study. The 2014 Burlington Flood case study provides an opportunity to take what was discussed and examined up to this point and use this knowledge to understand how three public agencies imagined and applied resiliency in an effort to mitigate and adapt to flooding. The case study will establish the events that led to the disaster, the damage and aftermath, and a media review related to the flood event to visualize and describe the raw reactions and physical toll of the disaster. I conclude that the resiliency planning approach in Burlington after the flooding disaster reflected an engineered focus.

### **What Happened**

On Monday August 4<sup>th</sup>, 2014, the City of Burlington like other communities throughout Canada was celebrating a Civic Holiday. The weather for the day was sunny with no rainfall in the forecast to conclude the long weekend (Lacaria, 2021a). However, the weather that afternoon was vastly different. For roughly eight straight hours, a series of “training storms” emerged over

the centre east side of the City of Burlington (Martins, 2014, para. 5). “Training storms” are storm events that develop over a particular area and continue to redevelop in succession (Martins, 2014, para.5). “Training [storms] describes the phenomenon whereby a series of storm cells move over the same area several times in a short period of time” (Amec Foster Wheeler, 2017, 4). The extent of the storm was north to Mountsberg Road, south to Lake Ontario, east to Burloak Drive, and west to Brant Street (Conservation Halton, 2015, 3). The isolated and narrow focus of the storm led to a massive amount of rainfall in a concentrated area. The heaviest rainfall was concentrated in areas of the city that were linked to “Upper Rambo/Hager, Roseland, Tuck, Shoreacres, Appleby, and Sheldon Creek watershed areas” (Burlington, 2015, 5). Figure 6 demonstrates the path of the August 4, 2014 storm and the geographical area in which the storm was concentrated (Burlington, 2015, 28). By the time the storm subsided, up to 190mm of rainfall were measured in approximately eight hours, similar to an estimated amount of two months’ worth of rainfall (Burlington, Flood Recovery, para.1). The rainfall continued well into the evening when community leaders, engineers, and residents were able to get a glimpse of the aftermath (Lacaria, 2021a). The flooding event was substantial, and the true toll of the flooding would take several months to recognize.

The storm generated “significant runoff in a short period of time (flash flood) that flooded homes, businesses, parks, overtopped watercourse crossings, closed roads, and flooded motor vehicles” (Conservation Halton, 2015, 3). “Roads, highways and more than 3000 homes were flooded” (Burlington, Flood Recovery, para. 1). The rainfall and subsequent flooding led to sewage back up, debris blockage of sewer gates, and maintenance holes floating above several feet of dark coloured water (Lacaria, 2021a). A City of Burlington report dated July 6, 2015 provides a detailed examination of riverine and community flooding around the watershed systems and creeks that run through the City of Burlington. Of the various creeks and watershed systems, the Tuck, Shoreacres, and Appleby Creeks experienced “considerable” flooding whereas the other creeks and systems were able to function properly (Burlington, 2015, 6-7). These three creeks had considerable riverine flooding that resulted in overtopping and flooding of nearby roads, homes, and community infrastructure (Burlington, 2015, 6-7). The Upper Rambo/Hager System, Roseland Creek, and Sheldon Creek had no reported riverine flooding, but the Upper Rambo/Hager System and Roseland Creek did have localized flooding in roadways and highways in the general vicinity unrelated to overtopping floods (Burlington, 2015, 6-7).



**Figure 6: Burlington, 2015, 28. Path of the August 4<sup>th</sup> storm.**

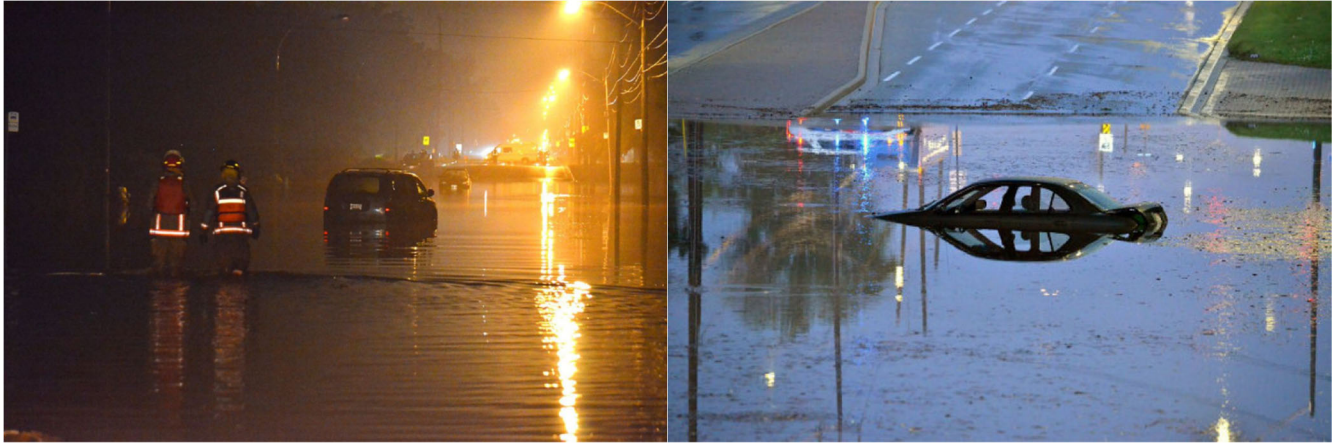
The damage the flood caused was significant. Preliminary estimates from the Insurance Bureau of Canada (IBC) indicated insured damage was just over \$90 million (Conservation Halton, 2015, 6). Creeks and wetland areas that provide valuable green infrastructure were damaged. Damage occurred along Roseland, Appleby, and Sheldon Creeks, with the most significant damage to creeks and bank erosion found along Tuck and Shoreacres Creeks (Burlington, 2015, 4). The use of media and private photo imaging will help demonstrate the severity of the flood to the City of Burlington residents and businesses.

## **Media Review**

As part of my research, I set out to grasp the extent of the flooding disaster by researching media reports at the time, including testimony from people affected by flooding. The best way I thought to fulfill this objective would be to explore how news and social media captured what took place and distributed the findings to various audiences. Media has the power to interpret, frame, and apply

resiliency through their coverage. No matter the form of media, the avenues of distributing information can directly or indirectly determine communities' views of resiliency, the extent of the disasters, or the emotions of audiences. In terms of the case study, I focused my research on gathering online media reports. I searched with key phrases such as "2014 Burlington Flood", "August 4, 2014 Flood Burlington", and "southern Ontario flood 2014". There were also limits that had to be set as there were countless search findings related to the flood. Therefore, several reports were gathered that were published by major news media sites and local news networks. I present my findings in two parts, by first discussing the wording and discourses of the media reports and second by photo analysis.

I narrowed media reports to the initial day of the flooding (August 4<sup>th</sup>, 2014) and the subsequent days following the event. Searching through various news outlets, I found the focus of the coverage was on three main themes. Firstly, the focus of several news releases was on the general flooding that occurred. The flooding coverage mentioned the damage to homes and businesses and focused heavily on the flooding of parts of highway QEW, 407, and 403 (CBC, 2014a; Brown, 2014; CTV, 2014; Wilson, 2014; CityNews, 2014; CBC, 2014b). Media focused primarily on the flooding of highways and roadways, with secondary attention given to homes and businesses. In fairness, the immediate aftermath of the disaster was not fully recognized since the extent of damage to personal properties was not yet fully understood. Secondly, there was a direct focus on the toll of the disaster on human health. Media reports frequently mentioned that there were fortunately no deaths or injuries associated with the flooding disaster, with the main concern related to health coming from a few individuals who were hit by lightning (CBC, 2014a; Brown, 2014; Armstrong & Shum, 2014; CityNews, 2014). Media reports also highlighted steps the public could take to protect themselves from the flooding and possible consequences, such as staying at home and turning off gas products and breakers if a building begins to flood (CTV, 2014; Wilson, 2014). Lastly, in the immediate aftermath, media reports recognized and replicated shock and surprise. The unexpected flooding that occurred, the unpreparedness and astonishment from residences, and the initial recovery steps reflected community shock (CBC, 2014a; Armstrong & Shum, 2014; CBC, 2014b). The media reports and immediate reaction from community leaders did not reinforce the notion that the disaster was fundamentally 'natural' and out of control or responsibility of the City of Burlington. Instead, a general consensus indicated a public and private responsibility to better prepare the City of Burlington for future flood risks.



**Figure 7: Brown, 2014.**



**Figure 8. J. Cohn, Global News, as cited by Armstrong & Shum, 2014.**



**Figure 9: Conservation Halton, 2015, 12.**

The photos collected from the aftermath of the 2014 flooding disaster serves a different function than the media reports. They provide additional insights by displaying the extent of the disaster on the community as a whole. Especially considering the number of flooded homes were in the thousands, these photos really speak louder than the words written in the media reports. The media reports, the recorded events, and the photos demonstrated the primary flooding impact occurred on roadways, in residences' homes, and in riverine and waterway systems. The overwhelming force and velocity of the flooding devastated the City of Burlington and the thousands of people who live and travel through the municipality. These images will forever illustrate the damage and catastrophe that occurred on August 4<sup>th</sup>, 2014. Vehicles damaged, homes saturated with murky brown water, and personal belongings destroyed. The flooding had a massive impact on the communities within the City. These photos do not accurately capture the human impact because of the focus on material and environmental damage. Although there were no injuries or deaths, the flooding impact on homeowners and those who travel and live within the boundaries of the storm was significant. The damage to the physical items can be repaired or the items replaced, but the mental and emotional toll will forever live on with those impacted. With this context, media reports, and images in mind, the next step in thinking of planning for future flood events is to explore the resiliency policies and actions taken by the City of Burlington, Halton Region, and Conservation Halton. The actions of these public agencies will determine what resiliency means for the City of Burlington and how the community will be more resilient in the face of extreme rainfall in the future.

## **Chapter 8: Criteria Analysis**

In reaction to the Burlington flood, planning by the City, Region, and conservation authority commenced in order to avoid a similar disaster in the future. The recent, concentrated effort provides a good case study about what resiliency means in practice, how resiliency is being implemented, and for whom resiliency is intended to serve.

Before I begin my criteria analysis, I first want to state an informal hypothesis of what I hope to see from my criteria analysis. I hope to see the inclusion and support of those in the community and a resiliency approach that is not purely focused on engineered solutions. I hope

to see resiliency measures that are progressive towards investing in communities to be more resilient to climate change, and not less. Most importantly, I hope to see a resiliency response that is not infatuated by ‘creative destruction’ ideology and instead one focused on the people, on the recovery, and resiliency that is equitable and engaging. Based on my review of the scholarly literature, this is my preestablished imagining of what I would like to or expect to see through this analysis.

## **City of Burlington**

The City of Burlington’s resilience response spanned several years following the August 4<sup>th</sup>, 2014 disaster. City of Burlington published a series of reports documenting studies, assessments, and programs that followed the flood. The response from the City of Burlington closely resembles the theory of adaptive capacity. Adaptive capacity can be traced through various measures taken by the city to understand the threat and to increase city resilience. The physical resiliency approaches focused on studying, improving, and expanding stormwater infrastructure (Burlington, 2015, 23-24). Notable mentions included in the estimated \$20.04 - \$24.11 million, 10-year Capital Program which were upgrades to site specific stormwater infrastructure areas (close proximity to creeks, channels, and flood vulnerable areas) and updates to flood design standards with the knowledge obtained from the August 4<sup>th</sup> flood (Burlington, 2015, 23-24). These measures highlight some of the adjustments made to increase present and future capacity of stormwater infrastructure within the City of Burlington.

The City is a lower tier municipality and responsibilities include local planning and stormwater management. Programs were created or enhanced to aid resiliency building for those directly impacted by the flooding. A program to assist homeowners was approved that would cover the cost of building permit fees on restoration work and preventative measures in the aftermath of the flooding event (Burlington, 2014c, 11). I judged the city-led measures as a learning process, whereby the experiences and damages that occurred influenced the imagination of resiliency and subsequently required a focus on community capacity. The measures implemented formed a learning framework inherent in adaptive capacity that dictated how the City of Burlington would increase their resiliency. This was especially evident in the objectives

of the municipality when retaining Amec Foster Wheeler (renamed Wood Group) to undertake a Flood Vulnerability, Prioritization and Mitigation Study (Burlington, 2015, 4). Core to what the City of Burlington wanted to learn from this assessment was the impact the flood had on the respected areas impacted but also how the same flood event would transpire in various areas across the entire city (Burlington, 2015, 4). Summarized in the 2015 City of Burlington report was the identification of flood vulnerable areas characterized in two forms (Burlington, 2015, 8). 75 riverine flood vulnerable areas “prioritized in order of their risk of flooding to properties and buildings” and 132 bridges and culverts that were prioritized “in order of the risk of overtopping of the roads” (Burlington, 2015, 8). In addition, 110 identified areas prioritized by their “flood frequency potential and number of impacted buildings” (Burlington, 2015, 8). These areas were identified by vulnerability modelling and assessments to highlight areas that required flood mitigation and adaptation techniques.

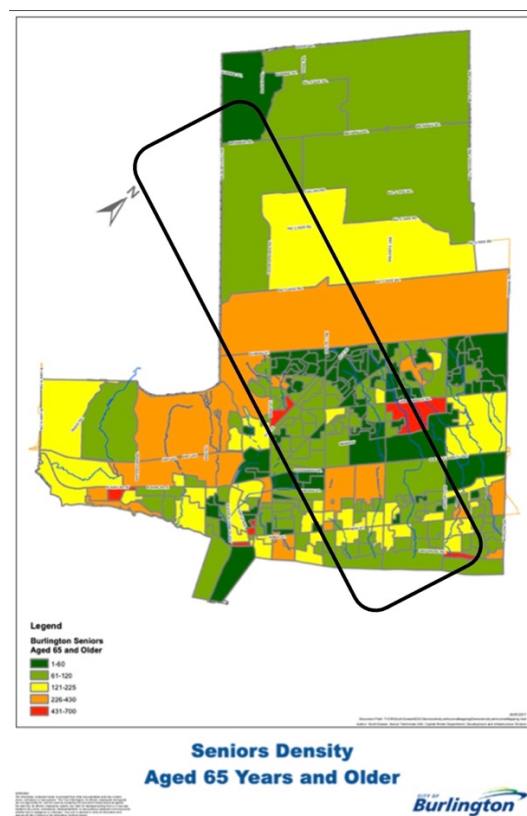
I identified adaptive capacity as the resiliency theory that closely resembled the City of Burlington’s response. As previously discussed, adaptive capacity is concentrated on remaining in a stable domain throughout change by adjusting and adapting to the threat (Gunderson, 2000, 427-428). The City’s resiliency response focused on capacity and encouraged community adaptation, while also integrating a learning recognition. I saw the learning aspect fulfilled as the City underwent an assessment to learn how the flood could impact the rest of the City and the public engagement and consultation measures initiated in the aftermath. I also realized that the implementation of resiliency at the municipal public agency level was focused on building resiliency towards flooding, not resisting floods.

Capturing the emotions, insights, and directions of the people impacted by the flooding event is undoubtedly vital towards shaping a resiliency response. The City of Burlington actively engaged the community members and the people most impacted by the flooding event and this interaction undeniably influenced what resiliency response the city was to take and how to achieve it. Shortly after the August 4<sup>th</sup>, 2014 disaster, the City of Burlington set out to listen and reflect on the impacts on residence during council meetings, describing the personal experiences and dangerous conditions residence were faced with (Burlington, 2014a, 2). According to report CW-09-15, city staff responded to “a significant number of resident calls including one-on-one

meetings with residents” (Burlington, 2015, 13). In recounting the personal experiences of those impacted by the flooding, a city staff representative recounted in an interview the emotional and physical tolls on Burlington residents and the several encounters he had with distressed community members (Lacaria, 2021a). People were meeting on their lawns and speaking on their experiences trying to remove as much water as possible while the rainfall and sewage were continually flowing into their basements (Lacaria, 2021a). Recognizing these experiences demonstrates the vital need for a resiliency approach to incorporate public engagement and community outreach into the implementation. Aside from the programs already discussed, the City of Burlington was also in development with a Flood Prevention Home Checkup, whereby a simplified evaluation was made for homeowners to make progressive changes on their property to reduce flooding risks (Burlington, 2015, 13). Empowering community members to organize, share a space to reflect on their experiences, and provide opportunities to incorporate flood mitigation and adaptation opportunities at a local level greatly increases the ability of the city to be resilient.

Analyzing the work the City of Burlington engaged in to incorporate social equity in their resiliency response remained a challenge. For the most part, it seemed the responsibility of increasing community resiliency was placed on the role of the city itself. There were a variety of opportunities implemented that empowered local private community members to make changes to reduce flooding risk, but the main priority was on the overall structure and system design of how the city viewed stormwater and flood vulnerability. Additionally, the extent of flood vulnerability had to do with the geographical and topographical landscapes that influence the severity of flooding damage. Missing from the vulnerability analysis was any careful study of the social vulnerabilities and disadvantaged communities. The extent of social vulnerability addressed was on homeowners and businesses. Although the inclusion of these groups was valid, there was a gap in the equitable recognition and treatment of those who do not land in these classifications. Discussing social vulnerability, such as the demographics of those who experienced flooding compared to those who did not in the August 4<sup>th</sup>, 2014 affected area, would be beneficial. The extent of these demographics was demonstrated in the population number and location mapping of seniors living in the City of Burlington (Figure 10) (Amec Foster Wheeler, 2017, 353). However, no analysis or conclusion of these findings were presented. Figure 10

illustrates the path of the storm event (I added the outline of the path of the storm for context) and establishes a high number of senior residents residing in the path of the heavy rainfall event. Understanding these experiences and connecting these mapping results point to a major population of elderly residents who were not included in the resiliency planning documents from the City of Burlington. Perhaps the research was limited in this regard. However, this limitation was still concerning as the report produced by Amec Foster Wheeler to consult the City of Burlington on flood vulnerability, prioritization, and mitigation did not include any public consultation (Amec Foster Wheeler, 2017, 2). The inclusion of this data and input alongside other vulnerable aspects of the City (such as social housing, schools, community centres) is significant to increasing the resiliency of any community and for academic scholars, professionals, and community members to learn of resiliency and flood preparation.



**Figure 10: Amec Foster Wheeler, 2017, 353.  
Extent of vulnerability and social equity analysis.**

## Halton Region

Resiliency planning for Halton Region was primarily focused on engineered resiliency measures. Their approach did dabble into other theoretical perspectives and also explicitly embraced a goal of increasing Halton Region's resiliency. However, engineered resilience discussed in this paper closely resembles the region's response. There are two ways to look at how Halton Region applied an engineered resiliency response. One is through the theory itself that focuses on maintaining stability through resisting the change or threat and recovery (as cited by Bertilsson et al., 2019, 971). The other way was to look at engineered resilience through the scope of a specific engineering response, one that relies on the engineering discipline to direct or resist the flow of water and reduce the risk of flooding. These two views were demonstrated by Halton Region in two phases, with Phase 1 approving funding for \$3.2 million in "sewer system optimization projects" and \$1.65 million in the Halton Region's enhanced Voluntary Downspout Disconnection program for priority areas (Halton Region, 2015, 2). Phase 1 involved improvements to 146 pipe segments of the wastewater collection system and the concentrated targeting of 9,300 Burlington homeowners in priority areas in order to disconnect their downspout from wastewater systems (Halton Region, 2016, 4). The downspout disconnection initiative in particular intended to remove rainfall water from flowing into and overwhelming wastewater systems, and instead connect the downspouts and weeping tiles to installed sump pumps and backwater valves (Halton Region, 2016, 2-4). This was in response to the recognition that over 90 percent of homes impacted by the storm event and subsequent flooding had their weeping tile and downspout systems connected to the wastewater system (Halton Region, 2015, 6).

Phase 2 of Halton Region's response involved a broader application of their flood mitigation efforts to the rest of Halton Region. Phase 2 applied the targeted downspout disconnection program with an increased subsidy of covering 100 percent of the costs and a "10-sewer system optimization capital program (Halton Region, 2016, 5). Similar to Phase 1, the sewer optimization efforts in Phase 2 would take what was done for specific isolated locations in Burlington and apply these engineered improvements throughout Halton Region in order to future increase "resiliency of the system to the impacts of future storm events" (Halton Region,

2016, 6). Additionally, the downspout disconnection program was applied to approximately 50,000 additional homes throughout Halton Region targeted for voluntary downspout disconnection with an enhanced subsidy to encourage public participation (Halton Region, 2016, 6-8). However, a breakdown of homeowners who were able to access this program was not provided, limiting an analysis of which community members and economic statuses were able to access this funding. Additionally, the engineered measures required a coordination with municipalities in the Halton Region, especially the cooperation of the City of Burlington. An “Inter-Jurisdictional Working Group” incorporated Halton Region, the municipalities within the region’s jurisdiction, and two Conservation Authorities to take coordinated action to improve resiliency of public infrastructure to flooding and the broader adaptation to climate change (Halton Region, 2016, 10). Therefore, assessing these Halton Region-led measures demonstrate the resiliency planning response to the flooding event.

The mitigation and adaptation measures Halton Region implemented clearly establish the challenge of determining which theoretical understanding of resiliency was most relevant. At first, their response seems to be closely entwined with an engineered resilience response. The downspout disconnection program for example was the result of water engineering assessments that determined the substantial benefit of removing rainfall flow from wastewater infrastructure to prevent overflowing and flooding in basements (Halton Region, 2016, 5). This does mitigate basement flooding by reducing the possibility of flooding but does not increase the capacity of Halton Region and homeowners to adapt to the flooding threat. Instead, these measures primarily resist rainwater in the hope of increasing resiliency. Likewise, the research conducted by the Region identifies sewer optimization and the repairs and reinforcement to existing wastewater systems as part of the resiliency effort. To this point I identify engineered resilience as the main theory here, but there are traces of adaptive capacity in the way Halton Region approached rainfall monitoring. The learning aspect of adaptive capacity was also identified, as the Region discovered issues with the flood warning system. Coordinated action led by Halton Region in Phase 2 of their measures included the installation of an estimated two dozen sewer flow monitors to “assess sewer system response” and performance to wet weather events (Halton Region, 2016, 9). Therefore, this inclusion towards the broader goal of increasing Halton Region’s resiliency demonstrates the difficulty of identifying which theoretical understanding of

resiliency was most relevant. There was a significant focus on an engineered sense of resiliency both through a focus on the engineered solutions and the theoretical notion of resisting, but there were also traces of adaptive capacity in the work Halton Region carried out in increasing internal awareness on how their infrastructure handles a similar event.

Understanding Halton Region's response through a social equity assessment requires a recognition of the municipality's role. As an upper tier regional authority, Halton Region is involved in matters that reflect regional interests, such as emergency planning, waste management, wastewater, and regional planning. Researching Halton Region's resiliency response points to the focus on public education and engagement with flooding matters. This was clear in their resiliency response with the downspout disconnection program, as Halton Region's resiliency was connected to the number of homeowners who participated with the program. I found other supporting measures to increase community awareness on the risk of flooding, like general "communication initiatives" in correlation to the Basement Flooding Prevention Program (Halton Region, 2016, 10). The creation and circulation of "A Guide to Flooding Prevention & Recovery) was also helpful to the goal of increasing public awareness, including topics such as types of flooding, the promotion of the "Basement Flooding Prevention Subsidy Program", and how residents can prepare for and adapt to a flooding event to minimize private damage and adverse health impacts (Halton Region, A Guide to Flooding Prevention & Recovery, 4, 8, 11, 14). These resiliency measures go a long way to empowering those in Halton Region with the needed education and resources to mitigate and adapt to flooding risks.

Where resiliency falls short, similar to the City of Burlington, is the lack of recognition of those who are vulnerable in their communities and who may have added difficulties with adjusting or recovering from a flooding event. There was no mention of these groups in the documents that I reviewed, compared to the City of Burlington that at least included a very general overview of the location of senior residents in the municipality. The absence of an equitable assessment and social equity focus was a disappointment, as the impact of the flooding event on factors such as age, ethnicity, gender, and class were not considered. This alarming deficiency of these two public agencies is not something new. The previous examination of resiliency in application already made light of this unfortunate trend. White & O'Hara (2014,

945) highlighted that resiliency responses tend to be focused on a more engineered physical sense and not on the social level. I recognize that the two agencies fell into this description White & O'Hara provided, but this is not to say there was an overt intent to exclude an equitable approach or to ignore vulnerable social community aspects in the resiliency planning. Instead, this recognition is made to identify this alarming trend in the hopes that changes will be made to how agencies and communities (and planners) view resiliency. I see this as a direct or indirect act of omission as discussed earlier in this paper through the work of Anguelovski et al. (2016, 334).

### **Conservation Halton**

Conservation Halton's resiliency report was concentrated on the ecological system in relation to the flooding event. Their assessments and responses were focused on the runoff that overflowed watercourse banks that led to riverine flood hazards (Conservation Halton, 2015, 3). Ecological resilience is the theory that closely resembles this public agency's response, even if one strictly adheres to the theoretical perspective or the more liberal focus on environmental dynamics. In the aftermath of the storm event, Conservation Halton coordinated with other public agencies in providing their flood damage findings and how the creeks and waterways that flowed through the City of Burlington adjusted and handled the event (Conservation Halton, 2015, 6-7). The conservation agency determined that the most significant riverine/floodplain flooding that occurred was located in areas of the city "developed prior to the application of Provincial and Conservation Authority flood plain planning policies" (Conservation Halton, 2015, 9). Those areas of development that had already implemented aspects of the Provincial and Conservation Authority flood plan experienced "significantly less erosion and flood damages" (Conservation Halton, 2015, 9). The Conservation Halton response was to recommend a coordinated investigation with the City of Burlington to determine mitigation measures to reduce future riverine flood damage along the city's many creek locations (Conservation Halton, 2015, 9). In addition, the conservation authority recommended an expansion to the number and location of telemetered rainfall and streamflow gauges, coordinated by three public agencies relevant to this paper, and updated watershed studies to reduce storm runoff rates and volumes

(Conservation Halton, 2015, 9). These measures required the coordination between the three public agencies in implementing ecological resilience.

Conservation Halton's recommendations required Halton Region and the City of Burlington to at least work with some aspects of ecological resilience. Conservation Halton's recommendations were incorporated in measures of Halton Region and the City of Burlington responses and was later included in the published report by Amec Foster Wheeler (2017). For example, Conservation Halton and the City of Burlington staff removed debris from more than 120 locations in the municipality's urban creek system and additional funding was allocated by Burlington Council for creek maintenance, such as inspections and the debris clean-up program (Burlington, 2015, 12). This was one example of the level of coordination required for the conservation authority in responding to the storm and flooding event.

The theoretical aspect of ecological resilience was demonstrated in the Conservation Halton's intent to emphasize the absorption capability of riverine systems. Ecological resilience was also clear in the agency's focus on the inherent capability riverine systems provide in dealing with flood hazards and additional engineered designs that can further increase the system's effectiveness. The designation of the agency's resiliency response as closely aligned with ecological resilience is not surprising given the function of the public agency. They achieved the theoretical view of ecological resilience by focusing on increasing the riverine system function in absorbing the flooding events in several of the creeks and clearing debris to prevent blockages. Reflecting on the essential role of Conservation Halton highlights the management responsibilities with surrounding ecosystems that define the communities of Halton Region. The conservation authority also provides critical services such as watershed planning and ecological protections. The focus on the ecological resilience theory in order to increase community resilience is therefore quite logical. The same can be said to a certain extent on why there was little discussion or exploration of social equity in Conservation Halton's resiliency response. This was possibly a result of the agency's direct focus and priorities on the natural ecosystems of communities and mitigating flooding hazards. The noticeable vacancy of a social equity engagement or even public education programs is concerning. The lack of social inclusion measures in decision-making processes or the social impacts on riverine flooding from the

Conservation Halton's resiliency response is troubling given the fundamental requirement of resiliency is the community members themselves. The analysis of each of the three public agencies leave a pressing and difficult question to be answered, such as whether resiliency is truly the goal if the input, inclusion, and equitable participation of community members are not a part of this process? Who or what exactly are these resiliency measures really intended for with the absence of these social aspects?

## **Chapter 9: Is Burlington a Resilient City?**

The analysis of the three public agencies' response and their engagement with resiliency indicated how resiliency was structured and framed post August 4<sup>th</sup>, 2014 flooding event. The takeaways discussed as a result of the analysis highlight numerous key themes and discussion points relevant to the resiliency planning that occurred. A prominent realization was that the resiliency response overwhelmingly focused on engineered solutions to increase the city's resiliency. This realization is not to discredit the benefit engineered solutions will have in increasing a city's resiliency. However, the focus on these engineered solutions brings to light the exclusion or indirect misplacement of social vulnerabilities within communities. Resiliency against flooding was solely directed through improving stormwater and wastewater infrastructure and investment in homeowner flood preparations. There was little recognition of the social dynamics at play and who the people were that were impacted by the flooding, such as lines of class, gender, age, and race and how these groups interacted with and were included in the resiliency planning. Additionally, these predominantly grey infrastructure initiatives overwhelmed the inclusion of additional green infrastructure measures that could help promote and integrate infiltration, retention, and restoration within the City of Burlington. The second realization of researching and analyzing the applicable policies and reports was the clear absence of the planning discipline in these resiliency measures. The solutions provided were intended increase the city's resiliency with specific relation to the flow of water and associated risks. However, if municipalities are continually creating policies for the future of the community, then so too should a resiliency commitment be reflected in the respective planning discipline. Municipalities should aspire to create a resiliency plan that incorporates the corporate and community responsibilities throughout various disciplines in meeting an increased city resiliency aspiration. Finally, I am relieved to see that in this specific case study resiliency was not viewed with the aspiration of a 'creative destruction' ideology.

To certain perspectives, resiliency may mean different things and may be associated with different measures. However, no matter a perceived or established notion of resiliency, the aspiration of achieving ultimate and complete resiliency can never be fulfilled. Such a distinction is impossible and quite dangerous. Claiming a city is fully resilient is to claim that no matter the change, event, or disturbance, the city will not need to improve or recover. That being said, the resiliency measures seen in the response from the City of Burlington, Halton Region, and Conservation Halton did contribute towards building overall resiliency. The effectiveness or the degree of successfulness is unknown, but the measures at least on paper did contribute in some form to building resiliency. With this recognition in mind, the next opportunity is to look to how professionals at these three public agencies viewed resiliency and the usefulness of this concept for the communities they represent. The same question raised in this chapter was directed towards the various professionals interviewed. The names or identification of these individuals will be kept private and will be referred to in a general manner. The initial interview inquiries and subsequent interviews were conducted through remote means of communication.

Several email and telephone requests were directed to the City of Burlington's Capital Works and Community Planning Department to obtain interview(s) for the current paper. An employee from the Capital Works Department responded to this inquiry and was interviewed on subjects relating to the 2014 Burlington Flood and resiliency topics. The interviewee discussed a general definition of resiliency as the implementation of measures to reduce the vulnerability of change or impacts (Lacaria, 2021c). However, in this perspective the interviewee attributed resiliency to incorporate engineered designs and technologies into building physical resiliency of the community (Lacaria, 2021c). The engineered design of resiliency can take numerous forms, as the interviewee spoke to infiltration technologies and the use of green infrastructure measures such as rain gardens (Lacaria 2021c). There was also a social component to resiliency application, as the interviewee reflected on the workshop coordination the City of Burlington had with other public agencies to inform, educate, and engage the community in climate and flood resiliency measures (Lacaria, 2021c). When I asked if the City of Burlington is a resilient city, the response was a clear no (Lacaria, 2021c). The interviewee spoke to the need for resiliency to be a journey, an ongoing process, and a progression that is done at a local, national, and international level (Lacaria, 2021c). The interviewee stated there was more work to be done and the City of Burlington can

learn from other cities around the world on how to improve stormwater management systems and integrate green infrastructure in the municipality's resiliency endeavor (Lacaria, 2021c).

Through a series of social media/ remote communications, I fortunately got into contact with an employee at Halton Region who stated interest in the work and willingness to inquire with other professionals whether they would like to participate in the research paper. A total of three individuals were interviewed from Halton Region. Individual #1 focused on the need for the natural heritage system to be an integral part of any resiliency aspiration (Lacaria, 2021d). Individual #1 asserted that an integration of natural heritage with resiliency will allow for increased resiliency capacity to absorb the flooding event and allow communities to be more prepared when dealing with such threat (Lacaria, 2021d). Individual #3 stated a significant point for resiliency, in that everyone wants to be resilient, but how a community becomes resilient is the important consideration (Lacaria, 2021d). The statement from Individual #3 highlights the frequency of resiliency's use but also the complexity associated with the massive question of how to achieve the concept. To answer the main question of this chapter, all three individuals stated a resounding no (Lacaria, 2021d). Individual #2 stated that the coordinated response after the flooding event was a learning opportunity and will continue to influence how policies and actions for the future years to come (Lacaria, 2021d). Individual #1 answer focused on the significant need for development to stay out of flood hazard areas as much as possible in order to continue to build flood resiliency for the City of Burlington and Halton Region (Lacaria, 2021d). Individual #3 envisioned resiliency to also be a process and is not an "end state", finding that a municipality is not fully resilient but can only continue to increase (or decrease) resiliency (Lacaria, 2021d).

After sending a couple emails to Conservation Halton, I was fortunate to receive a response rather quickly. An interview was scheduled with three Conservation Halton professionals with different discipline backgrounds. Individual #1 imagined resilience to have an open and flexible mindset, stating that a resiliency system or imagination that is rigid and limited is problematic (Lacaria, 2021b). Individual #2 interpreted resiliency as a learning process and moving a community as a whole forward (Lacaria, 2021b). Individual #3 found resiliency to resemble a "no regret approach" whereby integrating resiliency into a community's fabric is the goal. Despite the varying opinions and interpretations of resiliency, to answer the question led to the collective agreement among the professionals that there is a lot of work to be done and the priority to increasing flood resilient community is keeping clear of

development in flood prone areas (Lacaria, 2021b). The priority from all three individuals is to “mitigate first” and then adapt, with emphasis on mitigation (Lacaria, 2021b). According to the interviewees, restricting development in flood plain and watershed areas is the simplest and effective way of reducing flooding risks and vulnerability (Lacaria, 2021b).

Resilience means planning to avoid future flooding, according to those interviewed. The insights provided by all interviewees were extremely valuable. They demonstrated the various interpretations of resiliency and the importance of resiliency to their professional disciplines in a short discussion. In review of the interviews conducted, revisiting the relevance of a mitigation or “avoidance” approach is quite significant. The emphasis on restricting or keeping out of geographical areas prone to flooding was a clear resilience measure emphasized by the professionals interviewed. The use of avoidance as a resiliency measure highlights the “overwhelming consensus” that more emphasis must be placed on avoidance to meet “wetland management goals” and flooding resilience (Clare et al, 2011, 178).

The goal of this chapter was to answer whether the City of Burlington was resilient after each public agency implemented their own resiliency vision. The answer to this question is the City of Burlington can never be fully and completely resilient, but instead can build towards a more resilient community. With this recognition and the desire that more work needs to be done on the integration of resiliency in society, there are several recommendations for the reader, professionals, and public and private agencies to consider. The following recommendations are intended to summarize what this paper has discussed in the several chapters in the hope to continue to grow and empower every individual who interacts with, imagines, or applies resiliency.

## **Chapter 10: Conclusion**

My Major Paper examines resiliency literature, the imagination and implementation processes of resiliency, and flood resilience. These three core components were used to analyze the 2014 Burlington Flood and the resiliency response that determined how the City of Burlington intended to build its own resiliency. My goal in pursuing this Major Paper was never to analyze the effectiveness or the success of the three public agencies’ resiliency implementation. Instead, I wanted to answer the lingering question I continue to have when I personally interacted with resiliency policies: who is this resiliency for and what purpose does

this resiliency serve? I encourage all who engage with resiliency to ask these two important questions whenever they attempt to imagine resiliency for a certain context or attempt to understand resiliency that was already implemented. I strongly believe resiliency is well suited for municipal discourses and is a useful tool for planners in mitigating and adapting to climate change. Based on the research, analysis, and arguments made, I recommend for those who interact, view, or imagine resiliency:

- To critically assess who the resiliency is for and how it is to be used
- To establish the Five W's (who, what, why, where, when) to ensure a just, equitable, and prepared resiliency
- To recognize the flaws and remove these flaws that hinder the overall process of resiliency
- To view and embed resilience as a process, progression, and journey, not an end state
- To prioritize ensuring resiliency is integrated throughout multi-disciplines and operations
- To apply a climate and resilience lens to personal interactions and municipal corporate and community operations

Resiliency is frequently used in a variety of discourses but often with an absence of what it truly means. As I reflect on my Major Paper, I cannot help viewing the photos from my own personal terrible experience with flooding and imagine how others who face the threat of neighbourhood flooding are able to respond. I wonder how others who may not have adequate access to resources or support may have endured an even greater traumatic experience than myself. As a planner, I wonder how municipalities are creating and structuring resiliency policies and I am curious to see whether resiliency zoning can become more commonplace as municipalities look to build their internal and community resiliency. I imagine resiliency as an opportunity for all to identify a challenge, change, or threat, and endeavor towards a just equitable process. Resiliency is an essential tool for all to use, and the sooner community members, public agencies, and private agencies recognize this, the sooner will community resiliency be realized for the benefit of all.

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