# Sustainable Development of Existing Buildings in the City of Northfield

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#### I. Executive Summary

Climate change has been accepted by the scientific community as a process that will impact human health, biodiversity, and crop productivity in Minnesota. It has also brought about an increase in the severity of floods. Existing residential buildings contribute to climate change primarily through greenhouse gas releases by using energy to heat and cool rooms, and power appliances. Increasing the energy efficiency of existing residential buildings will diminish their contribution to greenhouse gases. Existing buildings are also threatened by climate change due to the increasing threat of flooding that can destroy foundations and fill basements, imposing steep costs on the city and on landowners.

Currently, Northfield addresses issues of climate change by following the guidelines mandated by the building codes of the state of Minnesota for energy efficiency and has monitored and increased the energy efficiency of its publicly owned buildings. Northfield participates in the National Flood Insurance Program, has support networks set up to assist with sandbags, and provides incentives for planting rain gardens. These actions are in a position to improve as a result of Northfield's developing Climate Action Plan. The purpose of this paper is to suggest additional steps that the Climate Action Plan can take to increase the energy efficiency and flood resilience of existing buildings. Our recommendations for energy efficiency will focus on structural changes to existing residential buildings where our flooding recommendations will focus on ways that all buildings can become more resilient to flooding.

Ultimately, we recommend energy use tracking, targeted education on energy efficiency, energy efficiency rating on buildings that are bought, and high energy efficiency requirements for majorly renovated buildings. These recommendations diminish the cost to individual landowners and the government, while also offering education on energy efficiency which may elucidate the cost saving that homeowners may accrue from increasing the building's energy efficiency. The cost of increasing energy efficiency may require high costs up front, but our recommendations hope to diminish these costs.

To reduce the vulnerability of buildings to flooding, we suggest that Northfield implement new policies that will primarily incentivize the use of flood openings, rain gardens, and green roofs. We identified those three water management tactics as providing the most benefits for the lowest cost compared to other common tactics. As policy options to increase the use of flood openings, rain gardens, and green roofs, we recommend a combination of tax rebates, subsidies, low interest loans, direct mandates, and increased education. Each policy option has an advantage for promoting a specific water management tactic. We also recommend that Northfield increase collaboration with other municipalities, apply for various grants to fund flood preparedness policies, and update its existing flood mitigation strategies to adapt to changes in the floodplain. The concrete steps outlined in this paper will improve Northfield's climate change readiness, playing our part to address some of the world's most pressing issues.

# **II. Introduction**

The City of Northfield has recognized climate change to be a major issue for the city. In the Strategic Plan for the fiscal years 2018 to 2020, the plan recognizes that the projected increases in flooding and average temperatures will lead to more flooding and increasing energy use for air conditioning in the summer.<sup>1</sup> Existing buildings must then become resilient to flooding and diminish their contribution to climate change by increasing energy efficiency, thus

<sup>&</sup>lt;sup>1</sup> *FY 2018-2020 Strategic Plan*, City of Northfield, Minnesota, August **2017**, accessed April 2018 at: <u>https://www.ci.northfield.mn.us/1148/City-Strategic-Plan</u>, Appendix IV.

diminishing their greenhouse gas emissions. From these concerns the city has committed to making a Climate Action Plan in which economic development will foster "[resilience] to energy & [environmental] impacts," including decreasing flooding risk and diminishing net carbon emissions.<sup>2</sup> The city has done well, recognizing that more needs to be done to protect the existing building infrastructure and committing to diminish the severity of climate change through decreasing the city's carbon emissions.

Because existing buildings contribute to the release of greenhouse gases, they can be regulated in order to become more energy efficient, therefore burning less fossil fuels and diminishing their contribution to climate change. This recommendation will focus on Northfield's existing residential buildings. First, we recommend that Northfield work with Xcel energy to create education materials on energy efficiency and track energy use of the city as a while. Many municipalities have regulations that place enormous financial burden on individual building owners, but we will recommend that energy efficiency rating when buildings are sold and promote energy efficiency when a building is being majorly renovated. Throughout, we recommend providing educational information on energy efficiency, monitoring, and financing energy efficiency renovations so that citizens of Northfield can make the best decision for themselves.

Policies have also been used across the country to promote practices intended to reduce the likelihood of flooding and the damages that existing buildings will incur in the case of a flood. In accordance with those goals, we recommend that Northfield prioritize new incentivizes that aim to increase the use of flood openings, rain gardens, and green roofs. We recommend that

<sup>&</sup>lt;sup>2</sup> FY 2018-2020 Strategic Plan, 2.

Northfield offer tax credits and rebates to promote all three of those flood mitigation strategies, implement subsidies to decrease the price of audits for green roofs, offer low interest loans for deep-rooted green roofs, require permits by law for projects that increase impermeable pavement, increase education access regarding all storm water reduction strategies, and hold a contest to raise awareness for storm water issues. We also recommend increased collaboration with nearby municipalities, and that Northfield apply for grants to fund these incentives. We finally recommend that Northfield update its existing programs by commissioning a new floodplain map, increasing incentives for rain gardens for residents located in the floodplain, and including an implementation plan in the upcoming update of the Comprehensive Stormwater Management Plan.

First, this report will discuss the importance of climate change and ways that buildings both exacerbate climate change and are affected by the changing climate. Then, the progress that Northfield has undertaken to improve the sustainability of existing buildings will ensue. Following the discussion of Northfield's progress, a summary of regulations is discussed ended by a final recommendation for Northfield.

# **III. Importance of Regulating Existing Buildings**

Since the industrial revolution began in 1750, humans have released greenhouse gases<sup>3</sup> (carbon dioxide, methane, nitrous oxide, and fluorinated gases)<sup>4</sup> at unprecedented rates (Appendix, Figure 1)<sup>5</sup>. The increasing concentration of these gases in the atmosphere has led to a global rise in temperature of about 1.8°F,<sup>6</sup> and a variety of other climatic changes that differ

<sup>&</sup>lt;sup>3</sup> "Changes since the Industrial Revolution," American Chemical Society, accessed June 27, 2018.

<sup>&</sup>lt;sup>4</sup> "Overview of Greenhouse Gases." Greenhouse Gas Emissions. January 19, 2017. Accessed April 15, 2018.

<sup>&</sup>lt;sup>5</sup> "Changes since the Industrial Revolution," American Chemical Society, accessed June 27, 2018.

<sup>&</sup>lt;sup>6</sup> "Changes since the Industrial Revolution," American Chemical Society, accessed June 27, 2018.

across the world. Many studies have documented these changes at local levels and attempted to predict changes that will occur in the future. In Minnesota, the mean annual temperature has increased by 2.6<sup>T</sup> since 1895. In the next 50-60 years, that figure is projected to increase to over 6<sup>T</sup>, with a drastic increase in the number of dangerously hot days (over 100<sup>T</sup>). Precipitation levels have also been increasing. From 1958 to 2012, the Midwest has experienced a 37% increase in heavy precipitation events, with more flash floods and longer periods of drought. Looking to the future, there is expected to be more rain, and less snow.

In Northfield, we have experienced flooding events first hand. In September of 2010 the Cannon River rose to record heights of over 900 ft.<sup>7</sup> Floods at this level are expected to occur once every 100 years. However, the river overflowed once more only six years later in September of 2016, again forcing river-side businesses to close and pay for repairs.<sup>8</sup> At Carleton, students vacated their homes along the river and sports teams looked for new places to practice as their usual fields were water-logged and taken over by ducks. Many saw these floods as warning signs that climate change has the potential to greatly impact Northfield.

Though we are past the point of reversing some of the consequences of prior emissions, great possibilities exist to slow future damages. Climate scientists have made varying projections based on of different levels of future emissions. Figures 2 and 3 in the Appendix display some of the variety, indicating the large role current greenhouse gas emitters can play in influencing the future of our climate.<sup>9</sup>

<sup>&</sup>lt;sup>7</sup> "Advanced Hydrologic Prediction Service," National Weather Service, June 27, 2018, accessed June 27, 2018.

<sup>&</sup>lt;sup>8</sup> Nina Moini, "Northfield Business Owners Fighting Off Floodwaters," CBS Minnesota, September 24, 2016.

<sup>&</sup>lt;sup>9</sup> Bradley, Raymond, Ambarish Karmalkar, and Kathryn Woods. How Will Global Warming of 20 C Affect Minnesota? Report. Climate System Research Center, UMass Amherst. 2015. Accessed June 27, 2018.

In order to responsibly develop, Northfield recognizes that it must reduce its greenhouse gas emissions in order to minimize its contribution to climate change; this transition can be achieved in part through regulation of existing residential buildings since buildings emit substantial amounts of greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) claims that 19% of global greenhouse gas emissions come from buildings.<sup>10</sup> Furthermore, because Northfield is expecting higher energy use in the summer from air conditioning as temperatures increase,<sup>11</sup> existing buildings are likely to emit even greater amounts of greenhouse gases if nothing is changed. The Energy Working Group of Northfield already noted an increase in carbon emissions by 11% from use of electricity and natural gas in existing buildings between 2012 and 2014.<sup>12</sup> Energy efficiency should therefore be a goal in Northfield's Climate Action Plan in order to diminish the greenhouse gas emissions released by existing buildings.

There is great opportunity to reduce greenhouse gas emissions from existing buildings. The IPCC recognizes that increasing energy efficiency in single family homes can reduce energy usage by up to 50-70%.<sup>13</sup> Municipalities can also expect drastic reduction in greenhouse gas emissions by increasing energy efficiency of existing residential building. For example, the climate action committee of St. Louis Park, Minnesota, estimated that the actions proposed in its climate action plan for its residential buildings will reduce the town's overall greenhouse gas

<sup>10</sup> Lucon O., D. et al, "Buildings," in: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. by Edenhofer, O., R. et al, (New York: Cambridge University Press, 2014): 678. <sup>11</sup> *FY 2018-2020 Strategic Plan*, City of Northfield, Minnesota, August 2017,

https://www.ci.northfield.mn.us/1148/City-Strategic-Plan, Appendix IV.

<sup>&</sup>lt;sup>12</sup> Energy Working Group. "Northfield Carbon Calculations: A graphical display of City and community energy use and carbon emissions in Northfield, MN." May 11, 2017.

http://northfieldsustainability.org/wp-content/uploads/2018/03/NEWG-Task-1-Energy-and-Carbon-Graphics.docx.pdf.

<sup>&</sup>lt;sup>13</sup> Lucon O., D. et al, "Buildings," 690.

emissions by 12.11% compared to its business as usual projection for 2040.<sup>14</sup> Similar reductions in greenhouse gas emissions can be achieved in Northfield by increasing the energy efficiency of existing residential buildings.

In addition to contributing to Northfield's greenhouse gas emissions, existing buildings will also suffer the consequences of their emissions. Buildings are a point of vulnerability in Northfield's preparedness for the projected flooding increase. The predicted increase in precipitation could bring costly damages to buildings if they remain in their current state. However, these damages can be mitigated if Northfield invests in flood prevention measures. In addition to monetary costs of clean up and the loss of economic activity when businesses close due to flooding, buildings are often tied in with the emotions of individuals. Seeing a personal home destroyed or damaged can be an emotionally painful experience. In a historic town like Northfield, community members feel pride for and attachment to businesses and their owners. When buildings suffer, the morale of the town if affected. With so much uncertainty in the climate, it is difficult to invest in projects that will not certainly be needed, but enough evidence exists that the frequency of damaging and costly floods is increasing in Northfield to warrant increased government investment in flood preparedness.

Existing buildings present an opportunity for citizens of Northfield to reduce their contribution to greenhouse gas emissions and to prepare for the impacts of climate change. Many examples exist across the country of municipalities making similar changes through legislation and other incentive plans that could be applied to Northfield. These improvements will require some monetary costs and effort to implement, but are associated with benefits that outweigh the

<sup>&</sup>lt;sup>14</sup> "St. Louis Park Climate Action Plan," February 2018, St. Louis Park, Minnesota, <u>https://www.stlouispark.org/home/showdocument?id=8214</u>, 24.

costs in the long term.<sup>15</sup> Housing improvements are straightforward, popular, and associated with improvements for energy efficiency and cost improvements.

# IV. Current Initiatives of the City of Northfield

Northfield recognizes the issues that Minnesota will face because of the changing climate. Because of these concerns, in addition to being located in a state that supports increasing energy efficiency, Northfield recognizes a commitment to increasing energy efficiency and has made steps to promote energy efficiency on the city's public buildings. Regarding flood preparedness, Northfield has implemented several programs and documents to protect citizens and their property when floods occur, and to reduce the chance of a flood occurring.

# A. Energy Efficiency

Some regulation of the existing buildings is done through building codes. Northfield defers most of its building codes of existing buildings to the State of Minnesota Building Codes<sup>16</sup> and the International Property Maintenance Code (IPMC)<sup>17</sup> in its building codes. The IPMC does not contain any provision about energy efficiency or GHG emission. On the other hand, the adopted Minnesota codes mandate some energy efficiency in residential buildings. The 2015 Minnesota Energy Code mandates minimum insulation capacity of windows and proper insulation technique and capacity for the insulation of walls, attics, and basements for different climate zones in Minnesota.<sup>18</sup> Therefore the state already mandates minimum standards for buildings that provide a baseline for the energy efficiency of Northfield buildings.

<sup>&</sup>lt;sup>15</sup>Tiger, Mary. "Incentivizing Flood Mitigation Efforts on Private Property before the Waters Rise." The Environmental Finance Blog (blog), January 21, 2015. Accessed June 27, 2018.

<sup>&</sup>lt;sup>16</sup> City Code of Northfield, Minnesota, Part II - Northfield Codes, Ch. 16, art. I, sec. 16-1.

<sup>&</sup>lt;sup>17</sup> City Code of Northfield, Minnesota, Part II - Northfield Codes, art. II, sec. 16-21.

<sup>&</sup>lt;sup>18</sup> 2015 Minnesota Energy Code, Chapter 4 [RE] Residential Energy Efficiency, Section R402 Building Thermal Envelope.

While Minnesota does have some regulation on the energy efficiency of existing buildings, the most promising regulations that Minnesota has enacted deals with the creation of renewable energy rather than energy's efficient use. This commitment to renewables is promising to Northfield because it can then maximize the reduction in greenhouse gases through energy efficiency, allowing for an easier transition to a building infrastructure that emits little greenhouse gases. Minnesota aspires to become "the first state in the nation to use only renewable energy."<sup>19</sup> The state has accomplished the original goal of a 15% reduction of per capita use of fossil fuels as an energy input by 2015 and has since mandated that 25% of the energy produced in the state will be derived from renewable sources by 2025.<sup>20</sup> While the state is committed to increasing the production of energy from renewable sources, Northfield is still responsible for increasing the town's energy efficiency in order to facilitate the reduction in greenhouse gases that the state is planning with its commitment to renewable energy. Since Minnesota has expressed interest in sustainable development, as these laws exemplify, Northfield is likely to receive support from the state government in its climate action plan.

Not only does the state show a commitment to sustainable development, Northfield has recently been committed to considering the environment in the city's planning. For example, in the Strategic Plan Summary of Northfield for 2018 to 2020, the plan recognizes that the projected increases in flooding and average temperatures will lead to more flooding and increasing energy use for air conditioning in the summer.<sup>21</sup> The Comprehensive Plan of Northfield states that "Environmentally-sensitive and sustainable practices will be integrated into

<sup>&</sup>lt;sup>19</sup> Chapter 85 – H. F. No. 729, 88th Minnesota Legislature, art. 12, sec. 1a.

<sup>&</sup>lt;sup>20</sup> Chapter 85 – H. F. No. 729, 88th Minnesota Legislature, sec. 3, subsec. 2.

<sup>&</sup>lt;sup>21</sup> *FY 2018-2020 Strategic Plan*, City of Northfield, Minnesota, August 2017, <u>https://www.ci.northfield.mn.us/1148/City-Strategic-Plan</u>, Appendix IV.

... redeveloped areas."<sup>22</sup> The city therefore recognizes the issues of climate change and wants to make a commitment to sustainability through the redevelopment of existing buildings or areas.

The commitment that Northfield has shown to environmental issues in its plans has also led to action to increase energy efficiency through education and renovating existing buildings. Northfield has partnerships with local organizations that offer educational opportunities and financial aids for increasing energy efficiency. Northfield is a member of the Clean Energy Resource Team which is a partnership across Minnesota by which education on energy efficiency is emanated.<sup>23</sup> Furthermore, Northfield EnergySmart BuildingWorks was created by RENew Northfield and the Northfield Area Foundation to promote education on energy efficiency, provide a fund to ease the financial burden that increasing energy efficiency has on low and medium income people, and aid in creating energy efficient housing that is also affordable. The group hopes to make energy efficient housing that has a combined mortgage or rent and utility bill that is equal to that of conventional housing in the first year. They also hope that these energy efficient yet affordable homes would be even less costly than comparable conventional housing after the first year. Northfield EnergySmart BuildingWorks was awarded grant money from the Minnesota Pollution Control Agency's Office of Environmental Assistance and the Northfield Area Foundation.<sup>24</sup>

Northfield has also taken steps to increase the energy efficiency of its public buildings through education campaigns and renovation; the Minnesota GreenStep Cities program recognizes this progress. The Minnesota Clean Energy Resource Teams and the Division of

<sup>&</sup>lt;sup>22</sup> ACP Visioning + Planning, Ltd. Development Economics, *Comprehensive Plan for Northfield*, City of Northfield, Minnesota, November 17, 2008: 11.1.

<sup>&</sup>lt;sup>23</sup> "Energy," *Greater Northfield Sustainability Collaborative*, <u>http://northfieldsustainability.org/focusareas/focus-energy/</u>.

<sup>&</sup>lt;sup>24</sup> "Northfield EnergySmart BuildingWorks," RENew Northfield, <u>http://renewnorthfield.org/?page\_id=141</u>.

Energy Resources at the Minnesota Department of Commerce created a GreenStep Cities guide which then became the Minnesota GreenStep cities program in June of 2010. The goal of the program is to offer action steps that municipal governments can enact to develop sustainably.<sup>25</sup> Northfield began its participation in the GreenStep Cities program June 15, 2010<sup>26</sup> and has progressed to becoming a Step 3 city on June 23, 2015 because it has completed 42 action steps that the program details.<sup>27</sup> Of the action items that the city has completed, two are relevant to regulation to existing buildings. First, Northfield began benchmarking some of its public buildings in 2014 using the Minnesota B3 and Energy Star benchmarking tools.<sup>28</sup> Energy benchmarking is the process by which a building's energy use is compared with the energy use of similar buildings in order to assess the comparative efficiency of the building. Benchmarking will be discussed later in this paper. Second, Northfield has upgraded the windows on its public buildings to improve building insulation.<sup>29</sup> Even though Northfield has made progress on altering public buildings to become more efficient, the city should enforce energy efficiency on existing residential buildings in Northfield to ensure that larger reductions in greenhouse gas emissions are met.

# B. Flood Mitigation and Preparedness

<sup>&</sup>lt;sup>25</sup> "The Minnesota GreenStep Cities Program: History and development," *Minnesota GreenStep Cities*, <u>https://greenstep.pca.state.mn.us/aboutProgram.cfm</u>.

 <sup>&</sup>lt;sup>26</sup> "GreenStep Cities Program History," *The City of Northfield*, <u>https://www.ci.northfield.mn.us/724/History</u>.
 <sup>27</sup> "City of Northfield," *Minnesota GreenStep Cities*,

https://greenstep.pca.state.mn.us/cityInfo.cfm?CTU\_code=2395265. <sup>28</sup> "City of Northfield," *Minnesota GreenStep Cities*,

https://greenstep.pca.state.mn.us/cityInfo.cfm?CTU\_code=2395265: Efficiency Existing Public Buildings – Action 1.

<sup>&</sup>lt;sup>29</sup> "City of Northfield," *Minnesota GreenStep Cities*,

https://greenstep.pca.state.mn.us/cityInfo.cfm?CTU\_code=2395265: Efficiency Existing Public Buildings – Action 2.

Flooding is another concern that the city of Northfield recognizes as a climate change issue that the city faces. Minnesota delegates the responsibilities to control flood damage to local governments,<sup>30</sup> and Northfield takes important actions to fulfill that responsibility. Each season the city prepares for the possibility of seasonal flooding. It participates in the National Flood Insurance Program (NFIP), which offers insurance on property based on the flooding risk of its location, and coordinates with the local 5th Bridge Organization that coordinates volunteers who place sandbags along the Cannon River during flooding events.<sup>31</sup> This effort is assisted by Northfield Shares, a volunteer group that uses its networks to find volunteers to protect river-side businesses with sandbags.<sup>32</sup> The City of Northfield also maintains its website with resources that are helpful in the case of a flood.<sup>33</sup> It contains a map that shows the locations that are most at risk during a flood,<sup>34</sup> a list with phone numbers and information about who to reach out to with questions about everything flood-related from sandbagging to electricians, and provides easy-to-follow protocols for having damage assessed after the flood.<sup>35</sup>

In addition to flooding initiatives that prepare the City to respond effectively to a flood, Northfield also encourages practices that diminish the likelihood that a flood will occur at all. The city recognizes that there is potential in landscaping and green infrastructure to reduce the negative impacts of harsh weather events on property.<sup>36</sup> Northfield offers a rain garden incentive plan. **Rain gardens** are collections of plants designed to increase ground absorption of water

<sup>&</sup>lt;sup>30</sup> Land Development Code, art. 2, sec. 5, subsec. 1(C).

<sup>&</sup>lt;sup>31</sup> "City Makes Seasonal Flood Preparations," The City Commons: A Publication of the City of Northfield 14, no. 2 (2011).

<sup>&</sup>lt;sup>32</sup> "Northfield Shares." Accessed June 27, 2018. https://northfieldshares.org/.

<sup>&</sup>lt;sup>33</sup> "Emergency Preparedness Resources." Northfield Police Department. Accessed June 27, 2018.

<sup>&</sup>lt;sup>34</sup> Flood Information Notices. March 20, 2014. Northfield, MN.

<sup>&</sup>lt;sup>35</sup> "Emergency Preparedness Resources." Northfield Police Department. Accessed June 27, 2018.

<sup>&</sup>lt;sup>36</sup> Land Development Code, art. 3, sec. 5, subsec. 1.

from storms and localized flooding. The city offers a cost share program in which any city utility account holder can receive a 50% reimbursement up to \$250 on their rain gardens. Participants need only fill out a form. Northfield also has a rain barrel rebate program. **Rain barrels** collect water, reducing the amount of rain that leaves a property as runoff. Customers who buy a rain barrel receive a \$20 credit on their utility bill after they send in a rebate form and a receipt.<sup>37</sup> These programs are funded by a **Stormwater Utility Fee**, which residents must pay as a part of their monthly utility bill.

These initiatives arose out of the **Comprehensive Surface Water Management Plan**. The plan was "developed to provide the City with direction concerning the administration and implementation of water resource activities." The document includes a list of focus areas and goals, including limiting runoff rates generated by expansions, and providing a two-feet separation between basements and high water elevations. The 2007 document was intended to be implemented in a ten-year time frame, and an update is due to The Metropolitan Council by December 31, 2018. Section IV of the plan provides a table that lists problems and concerns regarding flooding and storm water rate and a corrective action to be undertaken. The table can be seen in the Appendix as Table 4. However, many of the corrective actions have not been followed through on over the past decade.<sup>38</sup>

Northfield's 2010 update to the **City Code** includes a component regarding surface water management. Article 6 Division 2 requires that projects that involve over one acre of

 <sup>&</sup>lt;sup>37</sup> "Rain Garden / Rain Barrels/Native Plant Rebate." The City of Northfield, MN. Accessed June 27, 2018.
 <sup>38</sup> City of Northfield. WSB & Associates, Inc. *Comprehensive Surface Water Management Plan for the City Of Northfield, Minnesota*. September 10, 2007. Accessed June 27, 2018.

development must have the capacity to infiltrate the first inch of runoff from impervious surfaces. Compliance is monitored through a permitting process.<sup>39</sup>

#### V. Recommendations for Northfield's Climate Action Plan

There are many regulations that municipalities and states have implemented to increase the efficiency of existing buildings and their resilience against flooding. First, we will discuss energy efficiency policies as a means to reducing the greenhouse gas impact of existing buildings. Then, we will evaluate the benefits, costs, and feasibility of flooding mitigation policies other municipalities have enacted.

#### A. Energy Efficiency

#### (1) Recommendation Summary

Energy efficiency legislation clearly can lead to major reduction in the release of greenhouse gases, but a major issue is the burden of cost on building owners to retrofit buildings to be more energy efficient. Therefore, we recommend action that have very little cost, or offer financial planning when costs are increased for building owners. In addition to the benefits mentioned below, most of these programs or tasks would be recognized as an action step for the Minnesota GreenStep Cities Program. The goal of energy efficiency is to reduce greenhouse gas emissions, but because the reductions are dependent on the characteristics of individual buildings, decreases in greenhouse gases through implementation of these recommendations cannot be made now. On the other hand, there are several other benefits of these recommendations overview below.

<sup>&</sup>lt;sup>39</sup> Northfield, Minnesota, Code of Ordinances art. VI, div. 1, (2010).

https://library.municode.com/mn/northfield/codes/code\_of\_ordinances?nodeId=PTIINOCO\_CH22EN\_ARTVISUW AMA#TOPTITLE

Program	Implementation	Benefits	
Energy Benchmarking	<ul> <li>Develop energy efficiency and benchmarking education materials</li> <li>Track neighborhood energy use with Xcel's Partner in Energy program</li> </ul>	<ul> <li>Better targeting for energy efficiency education and programming which may save money</li> <li>Citizens become more educated on energy efficiency</li> <li>Benchmarking tools become more accurate</li> </ul>	
Intervention at Sale/Rental	<ul> <li>Mandate by ordinance home energy ratings when homes are sold or periodically for rental properties</li> <li>Provide new homeowners with educational material on energy efficiency and financial opportunities for energy efficiency renovations</li> </ul>	<ul> <li>Near-zero cost to city government</li> <li>Homeowners have knowledge of their home and possible avenues for cutting energy costs through increasing energy efficiency with help from financial opportunities proposed by the city</li> </ul>	
Building Codes for Renovated Buildings	• Add stricter energy efficiency requirements for majorly renovated buildings	<ul> <li>Low cost to the city</li> <li>Concretely reduces greenhouse gas emissions</li> <li>Increases the comfort of the renovated home</li> </ul>	

# (2) Energy Benchmarking

In order to achieve greenhouse gas reduction goals, Northfield must assess the city's

energy consumption. Energy benchmarking is a tool that compares a building's energy

consumption to other buildings that are similar. Through energy benchmarking and other energy

monitoring tools, transitions to more energy efficient buildings can be monitored and progress can be assessed. While Northfield may currently track public building energy use through energy benchmarking on Minnesota B3 Benchmarking,<sup>40</sup> the city's entire energy landscape should be monitored. For example, Hawaii passed an Energy Efficiency Portfolio Standard in 2009 that mandated a 30% reduction in electricity usage based on "business as usual" projections for the state by 2030.<sup>41</sup> In order to reach that goal, researchers in Hawaii worked with electrical companies to assess the energy use across all buildings while also identifying the building type in order to draw conclusions about energy consumption differences across buildings.<sup>42</sup> With this information, Hawaii is then able to more accurately target energy efficiency education and legislation.

Northfield should encourage energy benchmarking for individual homes through an education campaign, because privacy forbids Northfield to track each residential building's energy use. The Environmental Protection Agency and the Department of Energy have created a joint program called Energy Star that provides an online benchmark rating system called Energy Star Portfolio Manager where building managers, owners, or even utilities can input energy use data to receive an efficiency score.<sup>43</sup> Homeowners can even track their energy use automatically through automatic energy benchmarking. Automatic benchmarking systems automatically upload energy use for a building into its Energy Star Portfolio Manager account.<sup>44</sup> Educational materials on energy efficiency and tracking should be created with help from Xcel Energy and be

<sup>&</sup>lt;sup>40</sup> Minnesota B3 Benchmarking only assessed publicly owned buildings in Minnesota. See their website at <u>https://mn.b3benchmarking.com/Default?r=2</u>.

<sup>&</sup>lt;sup>41</sup> P. Finch and A. Potes, "Hawaii Clean Energy Initiative Existing Building energy Efficiency Analysis: November 17, 2009 – June 30, 2010," *National Renewable Energy Laboratory* (2010): 1.

<sup>&</sup>lt;sup>42</sup> Finch and Potes, 2.

<sup>&</sup>lt;sup>43</sup> Mattern, 492-3.

<sup>&</sup>lt;sup>44</sup> Mattern, 499-500.

dispersed at key points of interest such as the sale of a building which will be discussed in the next section.

Furthermore, in order to track Northfield's collective energy use, residential buildings should be assessed for its energy use through Xcel's Partner in Energy program. Xcel's Partner in Energy program aims to help communities "develop an energy action plan."<sup>45</sup> St. Louis Park, Minnesota, worked with Xcel through this program to target energy programming to neighborhood with the highest average kWh of energy used per premise.<sup>46</sup> Northfield should then work with Xcel to better pinpoint buildings that need the energy efficiency planning the most using its community metric capabilities.

# (a) Implementation

Both the development of educational materials on energy benchmarking and citywide energy tracking can be organized with the help of Xcel energy. A committee of the government of Northfield, perhaps Northfield's Energy Working Group, should reach out to Xcel energy to gather information on energy efficiency and benchmarking and compiled into a document aid. Then, the committee should work with Xcel to produce an energy overview of the city of Northfield that can be replicated yearly to assess changes in energy use over time.

#### (b) Benefits

While tracking energy use does not automatically lead to reduction in greenhouse gas emissions, energy benchmarking is beneficial in that it aids energy planning, educates people on energy use and efficiency, and contributes to a database of energy consumption metrics. Having

 <sup>&</sup>lt;sup>45</sup> "Partners in Energy Overview." *Xcel Energy: Partners in Energy.* <u>https://www.xcelenergy.com/working\_with\_us/municipalities/partners\_in\_energy.</u>
 <sup>46</sup> "St. Louis Park Climate Action Plan." February 2018, St. Louis Park, Minnesota.

https://www.stlouispark.org/home/showdocument?id=8214, 22.

the knowledge of energy use across the entire city of Northfield will allow the city to better reduce its greenhouse gas emissions from that energy use. With more targeted programming, Northfield may be able to have greater reduction in greenhouse gas emissions at a lower cost. Education on energy use and efficiency may lead people to make adjustments to their home that will decrease energy usage. This education may also lead people to be more environmentally conscious. Finally, gathering data on energy use with benchmarking tools provides the tools with more information as well leading them to be able to better assess comparative energy use.

# (3) Intervention at Sale or Rental of Buildings

Northfield can implement programs on energy efficiency easily when a building is sold or rented out. Other municipalities have legislation that mandates that when a building is sold, its energy efficiency is assessed and information on energy efficiency is provided for the new building owner. Furthermore, information on financing energy efficiency renovations could be included after the building's assessment.

Many municipalities are enforcing the disclosure of energy consumption data for buildings in order to incentivize energy efficiency. These regulations require owners of certain buildings provide utility costs between relevant stakeholder groups, such as renters or new buyers of property.<sup>47</sup> For example, the city of Chicago mandates that when a building is sold, or rented, the building owner must provide information on the cost of energy to heat the building for the previous year.<sup>48</sup> St. Louis Park, Minnesota, hopes to encourage this practice in its climate

<sup>&</sup>lt;sup>47</sup> Craig Isakow, "Energy Disclosure Laws: A Wake-Up Call for Building Owners," *Real Estate Forum* 68, no. 7 (2013): 17.

<sup>&</sup>lt;sup>48</sup>City of Chicago, "Energy Disclosure Application," *Business Affairs and Consumer Protection*, <u>https://www.cityofchicago.org/city/en/depts/bacp/supp\_info/energy\_disclosureapplication.html</u>.

action plan.<sup>49</sup> Such mandatory disclosure laws are promising in that they may promote better consumer choice in renting and buying buildings. Although these laws are impressive, some owners are worried their properties will lose values if they rent to people who consume excessive amounts of energy.<sup>50</sup> To correct for variable energy use, some municipalities enforce home energy efficiency assessments when homes are sold. For example, Bedford, New York, mandates that when homes are sold, they are assessed for energy efficiency with a Home Energy Rating that is standardized by the Residential Energy Services Network.<sup>51</sup> Bedford estimates that the assessments cost the homeowner approximately \$500, which is small compared to the large investment that the new homeowner is making concurrently.<sup>52</sup> Rental properties, since the person living in the building does not have the power to make energy efficiency investments, may be assessed periodically instead of each time a new renter signs a lease. These energy efficiency ratings will allow homeowners to consider increasing the home's energy efficiency.

At the same time these energy efficiency assessments are occurring, Northfield could provide the new homeowners with information on energy efficiency and financing energy efficiency renovation. We recommended that educational materials be synthesized in cooperation with Xcel in the previous recommendation. This information can be provided to new homeowners. Furthermore, financing opportunities can be provided to these new homeowners to show that improvements in energy efficiency may be economically beneficial. One financing opportunities are Property Assessed Clean Energy (PACE) bonds. The revenues from these

<sup>&</sup>lt;sup>49</sup> "St. Louis Park Climate Action Plan," February 2018, St. Louis Park, Minnesota, <u>https://www.stlouispark.org/home/showdocument?id=8214</u>, 22.

<sup>&</sup>lt;sup>50</sup> Isakow, 17.

 <sup>&</sup>lt;sup>51</sup> "Town of Bedford Climate Action Plan," January 19, 2010, Town of Bedford, New York, http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf, 36.
 <sup>52</sup> "Town of Bedford Climate Action Plan," January 19, 2010, Town of Bedford, New York, http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf, 36.

bonds can be lent out to property owners to finance retrofits that can be repaid through a tax over a certain amount of years.<sup>53</sup> While these plans are promising for easing the initial cost of retrofits, studies have found that these types of subsidy programs tend to only help affluent property owners.<sup>54</sup> Low and medium income homeowners can be specifically targeted by promoting funds that are meant to help people with financial struggles such as the Northfield EnergySmart BuildingWorks that is mentioned previously. Bedford, New York provides an innovative funding strategy that can be introduced to homeowners when they buy new property. The city helps pay for energy efficiency renovation and then collects the money back through an additional property tax that is likely to be entirely or partially offset by the energy savings of the retrofit.<sup>55</sup> If energy efficiency rating and education are coupled, then homeowners will be able to increase their home's energy efficiency as they are able to.

### (a) Implementation

Northfield should mandate by local ordinance that all homes when sold conduct a Home Energy Rating. In addition, homeowners should be provided with educational materials on home energy efficiency and financing options for increasing energy efficiency of homes.

#### (b) Benefits

Intervening at the Sale of a building is beneficial because it includes energy planning into existing administrative structure and provides homeowners with directly applicable information on their home's energy efficiency. While mandating Home Energy Ratings will put a cost burden

<sup>&</sup>lt;sup>53</sup> Erin Elizabeth Burg Hupp, "Refining Green Building Regulations and Funding Green Buildings in Order to Achieve Greenhouse Gas Reductions," *The Urban Lawyer* 42, no. 3 (2010): 645.

<sup>&</sup>lt;sup>54</sup> Paul C. Stern, *Energy Efficiency in Buildings: Behavioral Issues* (Washington D. C.: National Academies Press, 1985), <u>http://ebookcentral.proquest.com/lib/carleton-ebooks/detail.action?docID=4388297</u>: 2.

<sup>&</sup>lt;sup>55</sup> "Town of Bedford Climate Action Plan," January 19, 2010, Town of Bedford, New York, <u>http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf</u>, 34.

on new homeowners, the city government will not increase its size or bare an increase in cost because the regulation fits into the existing administrative structure. New homeowners may have to bear a small upfront cost with the energy efficiency rating, but they have the opportunity to improve their home's energy efficiency, equipped with information on their building and financing options, that could end up saving the homeowner money over time, depending on their home's energy efficiency characteristics.

### (4) Building Codes for Renovated Buildings

Altering the building codes for the city of Northfield will allow the city to hold renovated buildings to higher efficiency standards. Creating rehabilitation codes for remodeled existing buildings can provide standardized procedures that provides ease to builders while also allowing for minimum energy efficiency standards.<sup>56</sup> Dubuque, Iowa, and Bedford, New York, both amended their building codes as part of their climate action plants to hold renovated buildings to a higher efficiency standard. Dubuque was able to amend their building codes easily by adopting the International Energy Conservation Code for renovated buildings.<sup>57</sup> Furthermore, to not overburden homeowners who make small renovations to their homes, Bedford has the building codes apply only to buildings where more than 50% of the "conditioned area" of the building is being renovated.<sup>58</sup>

While mandating higher efficiency on renovated buildings, the financial burden on landowners is not as high as perceived. Bedford estimates that the payoff for the energy efficient

<sup>&</sup>lt;sup>56</sup> Sara C. Galvan, "Rehabilitating Rehab Through State Building Codes," *Yale Law Journal* 115 (2006): 1762. <sup>57</sup> Green Dubuque, "Dubuque Community Climate Action & Resiliency Plan 2013," http://www.cityofdubuque.org/DocumentCenter/View/18359/Reduction\_strategy\_final?bidId=, 75.

<sup>&</sup>lt;sup>58</sup> "Town of Bedford Climate Action Plan" January 19, 2010, Town of Bedford, New York, <u>http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf</u>, 38.

renovations is two and half years.<sup>59</sup> Furthermore, if a large amount of a building is being renovated, then including energy efficiency standards will be a minor increase in cost that is likely not to prevent renovation.

### (a) Implementation

Northfield should enact through ordinance stricter building codes for majorly renovated buildings by adopting the International Energy Conservation Code or another building code with comparable energy efficiency standards. These standards should apply to building that are majorly renovated which should be operationalized by the city as the city of Bedford does. In order to amend the Northfield building codes, the city will have to request approval from the state building official to be allowed to enact a more strict building code. If the building official disapproves, then an appeal can be made to the commissioner.<sup>60</sup> Because Minnesota is progressive on the issue of energy, it is likely that stricter building codes for majorly renovated buildings will be accepted.

#### (b) Benefits

New building codes for majorly renovated buildings is beneficial because it includes energy planning into existing administrative structure, concretely increases energy efficiency which both decreases greenhouse gas emissions and may provide a more comfortable home. Even though it is burdensome for the city to have to petition to amend the building codes, if allowed, the ordinance will not put extra burden on the city financially. This recommendation would also concrete diminish greenhouse gases and likely provide more comfortable homes

 <sup>&</sup>lt;sup>59</sup> "Town of Bedford Climate Action Plan" January 19, 2010, Town of Bedford, New York, <a href="http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf">http://www.bedfordny.gov/wp-content/uploads/2014/05/Climate-Action-Plan-Final.pdf</a>, 38.
 <sup>60</sup> Minn. Statute 326B.121, subdivision 2c.

because indoor temperature is better regulated, noise is reduced inside, and air quality is increased for energy efficient homes.<sup>61</sup>

# B. Flood Mitigation and Preparedness

In addition to legislation that would promote greenhouse gas reductions in existing buildings, Northfield should consider policies that encourage the adoption of flood damage mitigation strategies. In this subsection, we will begin by providing background information on various strategies that can be employed to reduce flooding damage. We will then review the tactics municipalities have implemented to promote these practices. Finally, we will offer recommendations for Northfield based on the success of the policies of other municipalities, and the current status of Northfield initiatives. This section will answer the key policy questions: What practices should be implemented to mitigate flooding and reduce flood damages, and what strategies should Northfield implement to encourage these practices?

# (1) Flood Management Options

Assessing policy options for the flood preparedness and mitigation potential of existing buildings requires some background on different flood management options. The most common strategies employed to reduce the threat of flooding are basement renovations, permeable pavements, rain gardens, rain barrels, green roofs, and tree trenches. The benefits and drawbacks of these practices must be understood in order to implement the most feasible and cost-effective incentive programs, and their definitions must be understood to assess the impacts and viability for Northfield of flood mitigation policies across the country. Though each of these practices is an effective way to mitigate the impacts and risks of flooding, **we find that flood openings, rain** 

<sup>&</sup>lt;sup>61</sup> Martin Jakob, "Marginal costs and co-benefits of energy efficiency investments: The case of the Swiss residential sector," *Energy Policy* 34 (2006): 181-2.

# gardens, and green roofs are the most impactful and cost-effective and should be prioritized when forming incentives.

The Federal Emergency Management Agency (FEMA) provides five types of recommendations for preparing buildings for floods: interior modification, wet flood proofing, dry flood proofing, and barriers. Table 5 in the Appendix summarizes the cost, complexity, and potential for success of each measure in each category. Of these suggestions, the improvement with the lowest cost, lowest complexity, and highest potential for reducing flood damage is flood openings. **Flood openings** are a wet flood proofing measure where vents are added to a building's foundation. The openings allow water to enter and exit a building freely, reducing pressure on its walls and foundation that could otherwise lead it to collapse. Flood openings need to be maintained, but will last from 15 to 20 years and have low installation and maintenance costs.<sup>62</sup> Of all potential flood prevention and damage mitigation efforts, flood openings are associated with the greatest economic benefits for homes at a high risk of flooding. The costs of installation are much lower than the cost of reconstructing a building after its foundation collapsed. Flood openings will also improve the property value of the building, and may reduce flood insurance premiums.

**Permeable pavement** is gaining popularity as a strategy to reduce storm water runoff by increasing the capacity of solid surfaces to absorb water. Permeable pavement is concrete without the finer particles that fill in gaps between larger sediments. The spaces allow some water to trickle down slowly into the underlying soil instead of running off into sewers. Permeable pavement can be used for driveways, walkways, and any other solid surface. It is

<sup>&</sup>lt;sup>62</sup>United States. Federal Emergency Management Agency. *Reducing Flood Risk to Residential Buildings That Cannot Be Elevated*. September 2015. Accessed June 27, 2018

most suitable in a low traffic area with sandy soil, shallow slopes (<5 degrees), and a water table with a seasonable high of 24 inches or more, all of which are commonly met throughout Northfield. The main drawbacks are the cost, maintenance, and limits on permeability. Typical construction costs vary from \$5 to \$10 per square foot. Pores can get clogged by smaller sediments, and should be vacuumed and hosed down at a high pressure at least four times a year. Permeable pavers are also susceptible to eroding if vehicles are frequently driving over them. Patching mixes can be purchased to repair holes at a price of about \$200 per acre per year.<sup>63</sup> Permeable pavement typically can only avert one inch of rain from running off, a fraction of what can be reduced by vegetated areas.

The benefits of **rain gardens** and **rain barrels** are described in greater detail in Section IV subsection B of this paper, as Northfield currently offers incentives for them. A rain garden costs around \$3 to \$4 per square foot and requires effort to establish and periodic maintenance,<sup>64</sup> while a rain barrel costs around \$120.<sup>65</sup> Rain gardens offer a relatively cheap, aesthetically pleasing way to increase infiltration substantially.

A green roof is a roof that covered in vegetation. The root system stores rainwater in its lightweight, engineered soil. The plants absorb water which is evaporated back into the atmosphere rather than falling on the ground.<sup>66</sup> Green roofs reduce runoff by between 50% and 60% (70% -100% in the summer and 40%-50% in winter). This infrastructure reduces runoff more than the other common tactics surveyed here, and is also associated with a variety of benefits beyond storm water management. Green roofs absorb heat, reducing air conditioning

<sup>&</sup>lt;sup>63</sup> Clark, Mark, Glenn Acomb, and Eban Bean. *Florida Guide to Low Impact Development: Permeable Surfaces.* Report. Program for Resource Efficient Communities, University of Florida. 2008.

<sup>&</sup>lt;sup>64</sup> "Bioretention." LID Urban Design Tools. Accessed June 27, 2018.

<sup>&</sup>lt;sup>65</sup> "Rain Barrels & Cisterns." LID Urban Design Tools. Accessed June 27, 2018.

<sup>&</sup>lt;sup>66</sup> Prince George's County. Rushern L. Baker, III. Green Roof Fact Sheet. Accessed June 27, 2018.

needs in the summer. This quality is particularly important considering the rising temperatures with climate change (Appendix, Figure 3). Green roofs also provide insulation, reducing energy needs throughout the year. They also sequester carbon, and provide wildlife habitat, most commonly to pollinators. While costs can be 30% greater than the price of a conventional roof, this cost is offset by around 50% when considering the long-term benefits from the savings on energy bills, reduced roof maintenance, and an increase in a roof's lifespan up to a 20 years.<sup>67</sup> Still, the initial costs can be between \$15 and \$40 per square foot, depending on the complexity, garden size, and roof slope. The installation can also be complex, and is often done by a green roof contractor rather than a homeowner.<sup>68</sup> Despite the costs, the many benefits associated with green roofs make it one of the most appealing tactics to incentivize.

A **tree trench** functions similarly to a rain garden. Tree trenches are simple systems made up of trees, structural soils, and water-storage pipes. The pipes are designed to hold water after rain events, and release it slowly to water the trees.<sup>69</sup> Tree trenches are often installed as interruptions of impervious materials like sidewalks, providing infiltration and water storage in areas that produce the most runoff. Trees also provide additional benefits of cleaner air and carbon sequestration. These installations can be quite costly. A project in Maplegrove, MN to install tree trenches cost \$18,000 per tree, though only about \$4,800 in for a Minneapolis project that did not require as much disturbance to impermeable surfaces.<sup>70</sup>

<sup>&</sup>lt;sup>67</sup> Sena, Angela. "Water Wednesday: Living Roofs Reduce Energy Use, Stormwater Runoff." The EPA Blog (blog), July 8, 2015. Accessed June 27, 2018.

 <sup>&</sup>lt;sup>68</sup> Prince George's County. Rushern L. Baker, III. *Green Roof Fact Sheet*. Accessed June 27, 2018.
 <sup>69</sup> "Tree Trenches." Minnehaha Creek Watershed District. Accessed June 27, 2018.
 <u>http://www.minnehahacreek.org/education/keep-our-water-clean-our-communities/tree-trenches</u>.

<sup>&</sup>lt;sup>70</sup>"Case studies for tree trenches and tree boxes." Minnesota Stormwater Manual. <u>https://storm</u> water.pca.state.mn.us/index.php?title=Case studies for tree trenches and tree boxes.

In addition to the environmental benefits of each of these programs, they provide a variety of external benefits. Economically, investments in flood mitigation will increase the market value of a property and reduce the chances of property damage from flooding. Socially, the incentives of permeable pavement, rain gardens, rain barrels, green roofs, and tree trenches reduce the threat of flooding for the entire community by reducing storm water runoff and thus sewer and river levels. Homeowners that invest in these strategies are investing in the safety of their neighbors and their neighbors' property, and reducing the damage to communities that occur when disasters occur.

(2) Options for Governmental Support for Flood Management Practices

Municipalities across the country have been striving to support the environmental, economic, and social benefits of the popular flood mitigation strategies described in the previous section. In order to understand how Northfield can best continue to support these causes, we looked into 41 programs across 19 U.S. cities with the goal of understanding what types of programs would function best in Northfield. We identified seven categories of incentives: tax credits, tax rebates, subsidies, loans, direct mandates, education, and contests. Additionally, we identified two notable features of incentive programs that Northfield should consider: collaboration, and funding sources. In this subsection, we summarize the general type of program in each incentive category, and highlight noteworthy examples. We will also attend to program effectiveness, key issues in program implementation, and the feasibility of accomplishing a similar program in Northfield.

The majority of storm water management incentives around the country take the form of **tax credits**. Citizens submit forms confirming their participation in the incentivized practice,

then awarded a reduction in their taxes to the city. Minneapolis offers a Stormwater Credit Program that offers credits on the city's storm water utility fee to buildings that improve storm water management practices. Buildings employing infrastructure that reduces storm water quantity may receive a 100% return on the fee, while buildings improving storm water quality may receive up to a 50% return.<sup>71</sup> This program is unique in that it does not specify a desired practice, rather it assesses the benefits of the practices employed by each applicant and offers the appropriate payment. One challenge with this flexibility from an applicant's point of view is the unknown variable of exactly how much money they will receive when they are planning a project. Nashville, TN also employs a tax credit incentive, offering up to a 75% downward adjustment to Stormwater User Fees for sites designed in accordance with the Low Impact Development Manual.<sup>72</sup> For one year, New York City building owners can receive a tax credit of \$4.5 per square foot of a green roof installation that encompasses at least 50% of available roof space and has at least two inches of growing vegetation. Credits are capped at \$100,000.73 Palo Alto, CA offers a credit of \$1.50 per square foot of green roof.<sup>74</sup> These examples demonstrate the flexibility of tax credit incentives. Cities can offer as much as they can afford to offer, and can incentivize any type of practice. Applications are simple for participants, and the tax system is already set up to make issuing credits simple and understandable. Based on these advantages, tax rates are popular and could be easily employed by Northfield.

 <sup>&</sup>lt;sup>71</sup> "How Can I Reduce My Stormwater Fee?." Minneapolismn.gov. February 20, 2018. Accessed June 27, 2018.
 <u>http://www.minneapolismn.gov/publicworks/storm water/fee/storm water\_fee\_storm water\_mngmnt\_feecredits</u>.
 <sup>72</sup> "Stormwater Fee." Nashville.gov. Accessed June 27, 2018.

http://www.nashville.gov/Water-Services/Stormwater/Stormwater-Fee.aspx.

<sup>&</sup>lt;sup>73</sup> "Green Roof Tax Abatement." Green Buildings & Energy Efficiency. Accessed June 27, 2018. <u>http://www.nyc.gov/html/gbee/html/incentives/roof.shtml</u>

<sup>&</sup>lt;sup>74</sup> *Green Roofs*. City of Palo Alto, CA. May 16, 2018. Accessed June 27, 2018. https://www.cityofpaloalto.org/gov/depts/pwd/stormwater/rebates/greenroofs.asp

**Rebates** function similarly to tax credits, but have the advantage of not requiring that the participant pay taxes to receive the credit. If a citizen has a fee waived based on their income bracket, they can still participate in the program and receive payment. Rebates are thus more inclusive to low income populations, but are not likely to lead to substantially more participation in programs compared to tax credits. Baltimore offers a \$2 per square foot rebate on green roofs not exceeding 50% or the project's total cost.<sup>75</sup> Prince George County, MA tailors their incentive based on the degree of participation. They offer a rebate of \$10 per square foot of green roofs installed with under 6 inches of planting, and \$20 for roofs with over 6 inches of vegetation. This makes sense because more extensive green roofs require higher costs to implement, and have higher potential for water absorption. They also offer a higher maximum rebate for commercial and multifamily dwellings.<sup>76</sup>

Based on these tax credit and rebate programs, (1) we recommend offering a rebate or a tax credit to the already established Stormwater Utility Fee for the adoption of any of the flood management tactics listed in the previous section. As done in Minneapolis and Prince George County, we recommend offering different credit amounts based on the size of the benefits resulting from the tactics employed by the applicant, with the greatest rewards for flood openings, rain gardens, and green roofs with deep vegetation. The size of the credit can be set based on the city's budget, and we suggest that the city consider capping the amount of credit able to be received as the New York City incentive did.

 <sup>&</sup>lt;sup>75</sup>Blue Water Baltimore, "Green Roofs: The Basics." Green Roofs – Water Audit 2013. Accessed June 27, 2018.
 <u>https://www.bluewaterbaltimore.org/wp-content/uploads/Green-Roof-BMP-Fact-Sheet-2013.pdf</u>.
 <sup>76</sup> "Green Roofs," Prince George's County. Accessed June 27, 2018.

https://www.princegeorgescountymd.gov/DocumentCenter/View/15433/Guidelines Green-Roofs.

**Subsidies** are payments from the government designed to reduce the cost of a good to encourage its consumption. Subsidies are particularly useful on goods and services required for the beginning stages of a project. Customers can become discouraged by a daunting task, and may need an incentive to learn more.. Washington D.C. provides funds to offset the costs of a structural assessment for buildings 2500 square feet or less that are considering contracting a green roof. The city makes the first step of looking into getting a green roof cheaply, hoping that after this first step, citizens will feel empowered to commit to the project.<sup>77</sup> For these reasons, **(2) subsidies for audits are the best option for green roof promotion, and we recommend that Northfield pursue a similar program.** 

There has been some success in promoting flood mitigation efforts through **loans**. For example, Connecticut offers low-interest (2.75%) loans for flood mitigation efforts in a program called ShoreUp. Loans can be between \$10,000 and \$300,000 and are used to elevate buildings above 500-year flood height. Borrowers are allowed 15 years to pay back the loan. Funding comes through Connecticut's Department of Housing.<sup>78</sup> In a collaboration between the Ohio Environmental Protection Agency, the Metropolitan Sewer District of Greater Cincinnati, and the Cincinnati Office of Environment and Sustainability, Cincinnati offers below-market-rate loans for citizens looking to install green roofs.<sup>79</sup> Offering low interest loans does not require the city to pay any money, but loans are often less enticing for citizens than other incentives. A loan system may also be difficult to set up, requiring collaborations with banks, the availability of

<sup>&</sup>lt;sup>77</sup> "DDOE Helps Pay for Green Roofs on District Buildings." Department of Energy and Environment. Accessed June 27, 2018. <u>https://doee.dc.gov/es/release/ddoe-helps-pay-green-roofs-district-buildings</u>

<sup>&</sup>lt;sup>78</sup> Connecticut's Shoreline Resiliency Loan Fund Program, July 2014. Accessed June 27, 2018. http://www.ct.gov/ctrecovers/cwp/view.asp?a=4498&Q=540106

<sup>&</sup>lt;sup>79</sup> *Green Cincinnati Plan*, 2018. Accessed June 27, 2018. https://www.cincinnati-oh.gov/oes/

large sums of money, and the assumption of risk by the city if the loans are not repaid. We therefore find loans to be a less appealing incentive than tax credits, rebates, and subsidies. However, (3) we recommend that Northfield consider offering a low interest loan for more expensive projects with longer term economic returns like green roofs, if money is unavailable to offer substantial, direct payments.

**Direct Mandates** are the most predictable option for ensuring that citizens implement storm water management practices. However, they can require resources to enforce and may elicit some backlash from the population. Seattle has a score-based code requirement called the Seattle Green Factor. Zoning laws establish a minimum score that buildings must meet. A homeowner's score increase if they implement storm water management practices. For example, a green roof that covers over 30% of a roof will add to an individual's score. The Seattle Green Factor promotes flood preparedness while allowing homeowners the flexibility to choose which strategies are best for them.<sup>80</sup> The establishment of a green score could also assist in the implementation of other incentives. For example, buildings with a score above a certain threshold could receive a tax credit on their Stormwater Utility Fee. The town of Northfield, Illinois provides another example of an effective mandate. The town has a strict permitting system for land use changes that increase runoff levels. It requires permits for all additions, patios, walks, and driveways. Recall that Northfield, Minnesota only requires permits for projects covering over an acre. The Building Department of Northfield, Illinois strictly reviews how projects will influence where water goes when considering whether or not to issue permits. They require that projects leading to the construction of over 1000 square feet of impervious

<sup>&</sup>lt;sup>80</sup> Torgelson, Nathan. *Seattle Green Factor*. Seattle Department of Construction & Inspections. <u>http://www.seattle.gov/dpd/codesrules/codes/greenfactor/default.htm</u>

ground require providing storm water detention to accommodate runoff. For projects smaller than 1000 square feet, owners can pay \$4.50 for each square foot of new impervious surface, or provide the appropriate detention. Credits are given to owners when impervious surfaces are removed.<sup>81</sup> (4) We recommend that Northfield, Minnesota implement a similar plan as Northfield, Illinois. The charge for impervious surfaces strongly incentivizes the use of pervious pavement, and provides some revenue to the government that can be used for other incentives, or to subsidize the pervious pavement. In the long-term, (5) we recommend that Northfield implement a Green Factor scoring system like Portland. This incentive is unique and may therefore be a challenge to implement, but it offers a flexible way of mandating storm water management improvements.

Education is an important part of encouraging actions to mitigate flooding. Often, residents will take on projects without monetary incentives if they are aware of the benefits, and know how to properly implement the project. The majority of cross-country incentives described in this section are accompanied by online resources provided by the city to assist in the implementation of the target project. These resources support citizens in their projects by helping them understand the costs and benefits of the project, and how exactly to get the project done. Portland offers particularly helpful resources for ecoroofs (a more advanced green roof) including a planning guide, do-it-yourself guide, handbook, and instructional videos.<sup>82</sup> (6) We recommend that Northfield provide extensive educational opportunities for residents to learn about each of the storm water reduction tactics explained in the previous section.

 <sup>&</sup>lt;sup>81</sup> Your Guide to Home Improvement in Northfield, July 2014. Accessed June 27, 2018.
 <u>https://www.northfieldil.org/DocumentCenter/View/609/Home-Improvement-Guide?bidId=</u>
 <sup>82</sup> "Stormwater Management." The City of Portland Oregon. Accessed June 27, 2018.
 <u>https://www.portlandoregon.gov/bes/31892</u>

Northfield currently supplies some information on the benefits of its programs, but not on how to implement the target tactic. For example, for the rain garden program, Northfield should provide resources on where to purchase seeds locally in addition to the available information content of the effectiveness of plants at increasing infiltration.

**Contests** are a creative way to incentivize storm water management practices and build awareness for the cause. Raleigh, North Carolina offers a program called Capture It! Stormwater Arts Contest, which encourages high school students to convey the importance of storm water runoff in a 60-second video, painting, or drawing. The winner's art is used to decorate a rain barrel, or cover storm drain. Running a contest is an easy way to gain promotional material, and encourage young people to think critically about storm water.<sup>83</sup> (7) We recommend that Northfield run a similar art contest for students, but that the prize support a home renovation like a free rain barrel or green roof audit to promote flood mitigation of existing buildings.

All of the previous recommendations could be improved by involving nearby communities. Northfield benefits from storm water management practices from townships miles upstream of the Cannon River, as Northfield's practices impact townships miles downstream. Flooding is a danger that is shared throughout the Cannon River Watershed and beyond, providing great potential for **collaboration** in storm mitigation efforts. The benefits of each lesson Northfield learns about managing storm water will be compounded if pathways are established to share information across effected parties. With a shared interest at heart, each action Northfield takes will be compounded if it shares its resources with other townships and

<sup>&</sup>lt;sup>83</sup> "Capture It! Stormwater Arts Contest." City of Raleigh. March 29, 2018. Accessed June 27, 2018.

encourages them to take action as well. In Massachusetts, the Merrimack Valley Stormwater Collaborative effectively united municipalities around Merrimack Valley to work towards their shared interest of a safer, cleaner environment. The collaborative is composed of fifteen communities "working together on regional approaches to cost-effective storm water management." Representatives from each community meet the first Wednesday of every month to discuss intermunicipal coordination in training, education, and best management practice implementation. Like Northfield, Merrimack Valley has a Stormwater Management Program, but Merrimack Valley is looking to implement it on a larger scale with support. The collaboration was funded through a Community Innovation Challenge Grant awarded by the Massachusetts Executive Office of Administration and Finance.<sup>84</sup> (8) **We recommend that Northfield form an body made up of leaders in nearby communities that meets monthly to** collaborate on storm water mitigation issues.

There are a variety of **funding options** for storm water management incentives that can be used to implement our recommendations. Currently Northfield funds programs using the Stormwater Utility Fee, which it could be increased to provide support for more programs. Another option is to implement the charge on the development of impermeable surfaces as done in Northfield, Illinois. The most common form of payment for larger projects is applying for grant money. The Minnesota Department of Natural Resources offers a Flood Hazard Mitigation Grant. Cities, counties, townships, and watershed districts may apply for technical and financial assistant for conducting studies about and planning for flood damage reduction measures.

<sup>&</sup>lt;sup>84</sup> "Who We Are." Merrimack Valley Stormwater Collaborative. Accessed June 27, 2018.

Applicants may receive a maximum of 50% of the total project cost up to \$150,000.<sup>85</sup> FEMA has three programs that Northfield may want to consider: The Flood Mitigation Assistance (FMA) program, the Pre-Disaster Mitigation (PDM) program, and the Community Rating System (CRS). PDM funds hazardous mitigation planning projects on an annual basis, and FMA funds planning and projects to reduce risk of flood damage to buildings insured by the NFIP.<sup>86</sup> FMA grants must be submitted by a State, but are often on behalf of a more local unit to the level of a homeowner. The CRS is a voluntary program for NFIP-participating communities that provides insurance reductions up to 45% for flood damage mitigation behavior beyond what is mandated by the NFIP.<sup>87</sup> (9) We recommend that Northfield increase the Stormwater Utility Fee, charge residents for new impermeable surfaces, and apply for grants from the MNDNR and FEMA.

#### (4) Updates to Current Initiatives

While the policies of municipalities around the country provide impressive frameworks for new ways to reduce the threats from flooding, Northfield should begin by improving the projects it already has. These improvements are likely the most feasible because the existing infrastructure and community support are in place. To begin, **(10) we recommend that Northfield commission a new floodplain map**. Given that Northfield has experienced two 100 year floods in the past decade, the current 2012 map is alarmingly outdated. Creating a new map is a two year process conducted by FEMA, so Northfield should begin the process as soon as possible. Northfield can apply on their website. Having accurate flooding information is vital to

<sup>&</sup>lt;sup>85</sup> "Flood Hazard Mitigation grant assistance," MN Department of Natural Resources, <u>https://www.dnr.state.mn.us/grants/water/flood\_hazard.html</u>.

<sup>&</sup>lt;sup>86</sup> "Hazard Mitigation Assistance," FEMA, <u>https://www.fema.gov/hazard-mitigation-assistance</u>.

<sup>&</sup>lt;sup>87</sup> "Community Rating System," FEMA, <u>https://www.fema.gov/community-rating-system</u>.

flood preparations because it identifies the buildings that are the most vulnerable. An updated map will also update the requirements from the NFIP, prompting further actions by Northfield residents.

Because an updated flood map is so important, **(11) we also recommend commissioning an unofficial floodplain map** to be made while the FEMA map is in the process. This map can be used in preparing for flooding, as well as to improve the rain garden and rain barrel incentives. Water infiltration and capture are most important in the floodplains, where runoff can do the most damage. Increasing the incentives based on their flood risk and decreasing incentives outside of the floodplain could increase participation where these practices will have the greatest impact without increasing the cost to the city.

For the new Comprehensive Stormwater Management Plan due in 2018, **(12) we recommend including plans and timelines for the implementation of the goals**. The document is full of commitments to storm water management that have the potential to greatly benefit Northfield.

### VII. Conclusion

Northfield's Climate Action Plan presents a powerful avenue for the city to make substantial contributions to reducing its greenhouse gas emissions, and better preparing for the expected increase in flood risk. For greenhouse gas reductions, we recommend citywide energy monitoring, education on energy efficiency, energy efficiency ratings for newly bought homes, and higher energy efficiency requirements for majorly renovated buildings. For flood risk reductions, we recommend that Northfield provide incentives to increase the utilization of flood openings, rain gardens, and green roofs. We recommend that these incentives include a combination of tax credits, subsidies, low interest loans, direct mandates, increased information access, and updates to existing programs. Implementing these recommendations will reduce the effects of climate change by addressing both the causes and consequences.

Appendix







Figure 2. Comparison of potential warming in Minnesota by 2070 given a lower emissions future and a higher emissions future.



Figure 3. Projected precipitation changes in Minnesota in summer and winter given a lower emissions future and a higher emissions future.

	Identified Problem, Issue, or Concern	Corrective Action	
1	The City has reviewed its existing hydraulic and hydrologic modeling information as part of this Plan. Based on this review, it was determined that an updated hydrologic model needs to be developed for the five major subwatersheds within the City.	The City will maintain and update hydrologic/hydraulic model and GIS database.	
2	Based on the City's review of its existing hydraulic and hydrologic information, there is a lack of information on the hydraulic capacity of Lincoln Parkway drainage system.	<ul> <li>Complete hydraulic study to investigate storm system capacity and need for additional storage/capacity in Greenvale Drainageway.</li> <li>Construct stormwater improvements as part of Greenvale School Corridor and Trail project.</li> </ul>	
3	Additional flood storage and possibly additional water quality treatment is needed upstream of Spring Creek, Heath Creek, Lincoln Waterway and Cannon River watersheds.	<ul> <li>In partnership with future development applications, construct and oversize where appropriate, regional water quality and flood control ponding area upstream of Woodley Street/CSAH 28 within Spring Creek Watershed.</li> <li>In partnership with future development applications, construct and oversize where appropriate regional water quality and flood control ponding upstream of ponding area in Lincoln Waterway watershed.</li> <li>In partnership with future development applications, local government and interest groups, construct and oversize where appropriate regional water quality and flood control ponding in area upstream of ponding in Heath Creek watershed.</li> <li>In partnership with future development applications, construct and oversize where appropriate regional water quality and flood control ponding in area upstream of ponding in Heath Creek watershed.</li> <li>In partnership with future development applications, construct and oversize where appropriate regional water quality and flood control ponding in applications, construct and oversize where appropriate regional water quality and flood control ponding area upstream of ponding in Cannon River watershed.</li> </ul>	
4	There is a lack of inter-community water resource related agreements for rate control and water quality treatment with neighboring municipalities and townships.	The City will work with neighboring municipalities and townships to develop water resource related agreements for rate control and water quality treatment for water discharged into the City.	
5	There are limited opportunities and land available to treat storm water in the downtown area. This area discharges storm water directly to the Cannon River and treatment of this water has been identified as a concern.	<ul> <li>The City will explore alternative storm water Best Management Practices and investigate incorporating a Low Impact Development (LID) demonstration project into downtown redevelopment projects where feasible.</li> </ul>	
6	Based on the City's stormwater modeling information, water will overtop Woodley Street in events greater than the 25-year event.	Construct stormwater improvements and pond maintenance as part of Woodley Street reconstruction project.	

Figure 4. Stormwater Problems and Corrective Actions from the Comprehensive Surface Water Management Plan.

Mitigation Measure	Life Cycle Cost	Expected Useful Life	Design Complexity	Potential for Reducing Flood Damage
Wet Floodproofing Measures				
Flood Openings	Low	15-20 years	Low	High
Elevate building utilities	Low to Moderate	15-20 years	Low	Moderate
Floodproof building utilities	Low to Moderate	15-20 years	Moderate	Limited
Flood damage-resistant materials	Moderate	10-20 years	Moderate	Limited
Dry Floodproofing Measures		2		
Dry floodproofing system	High	15-30 years	High	Moderate
Barrier Measures	<i>a</i>	-		A
Floodwall with or without gates	High	50 years	High	Moderate
Levee with and without gates	High	50-100 years	High	Moderate
Interior Modification/Retrofit M	leasures			
Basement infill	Moderate to High	30-50 years	High	High
Abandon lowest floor	Moderate to High	30-50 years	High	High
Elevate lowest interior floor	Moderate to High	30-50 years	High	High

Figure 5. Comparison of costs, complexity, and damage reduction potential of various home improvements to address damages associated with flooding.

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