City Buildings

City buildings were responsible for 11.6% of all City operations emissions in 2017. Emissions from all buildings were reduced 13.2% from 2015 to 2017. Despite a reduction in aggregate emissions from 2015-2017, building electricity consumption increased by 4%, while natural gas consumption decreased by 26%. After aggregate park facilities, City Hall is the largest single City building emitter, though between 2015 and 2017 the building experienced a 35% reduction in emissions. The Northfield Public Library saw the greatest increase between 2015 and 2017 (60% electricity and 47% natural gas), due to expansion.

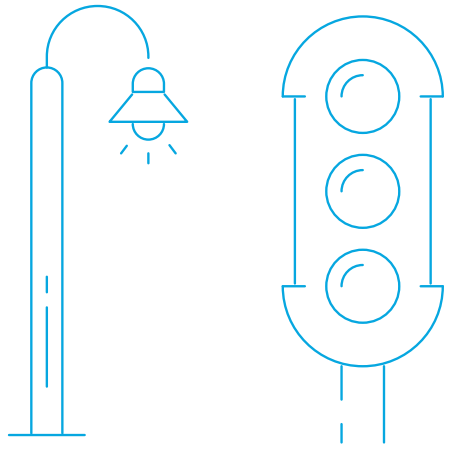
Potable Water

In 2017, potable water represented 8.9% of emissions from City operations. Emissions from potable water are attributed to the electricity used to pump and distribute the water. Between 2015 and 2017, emissions associated with potable water decreased by 13.2%. Reductions came both from improved efficiency and cleaner generation mix.

Wastewater

Emissions from the treatment of wastewater occur from the electricity used to transport water to treatment facilities and treatment operations, as well as the gases that are produced from the breakdown of organic material. Together, water pumping, distribution, and wastewater treatment account for about 1% of Northfield's total community-wide GHG emissions and 50% of total City operations emissions. The greatest portion of emissions for the treatment of water and wastewater come from electricity: 334 tonnes for potable water and 1,400 tonnes for the treatment of wastewater each year. Wastewater treatment facilities also use a significant amount of natural gas, resulting in 411 tonnes of CO_2 emitted annually.

In addition to City of Northfield wastewater, the treatment plant also processes wastewater from Carleton College and the City of Dundas, which draw from their own wells and account for approximately 7% of the total amounts treated. Volumes from both sources increased from 2015-2017, with 2017 levels 20% higher than 2015. On a per-capita basis, wastewater associated with the City was 21% higher in 2017 than in 2015. The 34% increase in electrical efficiency experienced between 2015 and 2017 had an impact of 62% of the total energy consumption in the facility (in 2017), resulting in an overall increase in efficiency of 26% despite the increase in amount of wastewater treatment.



Built Infrastructure

The built infrastructure of a City includes facilities constructed for water distribution and treatment, transportation and mobility, buildings, and critical infrastructure such as the delivery of energy. These features are crucial to the functioning of a City and the safety of its residents. Built infrastructure may be susceptible to climate hazards, especially when not maintained regularly nor constructed with consideration of future climate impacts. Built infrastructure can be particularly vulnerable to increased precipitation and freeze/thaw cycles, which can shock and stress pipes, roads, and bridges, leading to structural damage. This section provides a snapshot of climate hazards of greatest concern for built infrastructure in Northfield. Information for this section was gathered from City staff, existing reports, plans available on the City website, and data from State agencies.

Water Infrastructure

Water infrastructure includes drinking water, stormwater infrastructure, and wastewater treatment. Access to clean, potable water is central to the safety and vitality of Northfield residents and businesses. Water infrastructure may be susceptible to climate hazards including prolonged heatwaves, heavy precipitation, extreme weather events, and freeze/thaw cycles. Power outages caused by extreme weather can impact the functioning of wastewater and drinking water infrastructure. With increased heavy precipitation events, stormwater infrastructure may be stressed or overwhelmed, limiting its ability to effectively convey or allow water to infiltrate as designed. Further, flooding and flash flooding events can increase the likelihood of surface water contamination, reducing water quality. Power outages caused by extreme weather can impact the functionality of wastewater and drinking water infrastructure.

Stormwater Infrastructure

Stormwater infrastructure supports community resiliency during periods of heavy rainfall. Conveyance systems help to move water quickly to rivers, streams, and lakes - away from the built environment. While this strategy works for most rainfalls, it may have negative impacts in times of heavier than anticipated rain events. Systems that are not designed to handle heavy rains may not have the capacity to intake large volumes of water, leading to back-ups and potential for flash flooding. Further, there may be downstream impacts related to sending too much water, too fast, and sometimes carrying debris or pollutants, into bodies of water.

Supplementing stormwater conveyance systems with green infrastructure can help mitigate some of these challenges. Green infrastructure, like bioretention ponds and rain gardens, as well as other infrastructure changes like permeable paving surfaces, can help slow the flow of stormwater and filter contaminants. According to Northfield's Comprehensive plan, the City's stormwater drainage system consists of detention and quality treatment ponds, creeks, drainage ways, roadway gutters, overflow and yard drainage swales, catch basins, storm sewer lateral and storm sewer trunk main facilities.

Photo Credit: Great Plains Institute

Conveyance Systems: In Northfield, there are about 40 miles of stormwater pipes, including gravity mains and drain tiles. Stormwater pipes primarily direct water into the Cannon River. Most pipes that the City has data on range from 12 to 36 inches in diameter. The City does not have a complete record on the age and condition of storm lines City-wide. As rainfall and precipitation increase, stormwater will increase, raising the concern of burdening the capacity of these conveyance systems.

Green Infrastructure: Northfield's green stormwater infrastructure includes 57 bioretention ponds and one infiltration basin. The stormwater ponds are an average of 20.5 years old. In 2017, a water quality assessment was completed for the City of Northfield.[15] The assessment examines stormwater ponds and measured their water quality against the state quality standard. Eight bioretention ponds were identified as high priority to be improved as they have reached or are approaching their sediment accumulation capacity. When stormwater runoff enters impaired ponds, the runoff is not adequately filtered, and therefore is less effective at mitigating flooding and improving water quality because the ponds can no longer hold water at their designed capacity. When ponds reach or exceed their design capacity, more polluted water enters the river. The City of Northfield provides incentive programs for residents to install rain gardens, native plantings, and rain barrels. These programs encourage residents to manage stormwater runoff in their own yards and residences.

Drinking Water

Water demand is forecasted to increase as summer days become warmer: community members will drink more water to cool themselves down and use more water for distressed trees and other vegetation. Potable water in Northfield comes from five ground-water wells originating from the Jordan-St. Lawrence, Jordan and Jordan-Prairie-du-Chien aquifers.[16] The wells range from 365 to 415 deep. There are three storage facilities for potable water. The water distribution system is made up of water mains ranging from 4 to 24 inches in diameter. In 2006, Northfield conducted a comprehensive water plan, which identified the water distribution system as effective and serving its purpose well.[17] To ensure resilience to climate events, the City must ensure maintenance and expansion of the water system as population trends increase and climate hazards introduce new threats to the system. As extreme weather is projected to increase, however, the City should be prepared to respond to quality and age issues of wells in the event of a pipe burst.

Wastewater Infrastructure

Wastewater infrastructure is made up of sewage lines and wastewater treatment facilities. This infrastructure may be more vulnerable to climate hazards as it ages and if maintenances is deferred. In Northfield, the sewage system serves 7.66 square miles and was originally constructed in the early 1900s.[18] The pipes range from 4 to 52 inches in diameter and the system is primarily a gravity pipe network. About 10% of the sewage lines are older than 50 years old, which is an indicator of system vulnerability to performance issues. Inflow/infiltration is a problem that may occur when clean water enters the sanitary sewer system, potentially causing back-up problems and the unnecessary treatment of clean water. In 2008, the Sewage Comprehensive Plan for Northfield indicated no significant infiltration or inflow issues in Northfield.

15 City of Northfield, City of Northfield Stormwater Pond Assessment, https://www.ci.northfield.mn.us/DocumentCenter/View/6170/Northfield-Pond-Assessment---Final-Report---12212017?bidId= , (accessed June 2019).
16 https://ci.northfield.mn.us/DocumentCenter/View/7825/2018-Northfield-CCR
17 City of Northfield, Comprehensive Water Plan, https://www.ci.northfield.mn.us/DocumentCenter/View/608/ComprehensiveWaterPlan?bidId= , (accessed June 2019).
18 City of Northfield, Comprehensive Sanitary Sewer Plan for the Northfield/Dundas Area, https://www.ci.northfield.mn.us/DocumentCenter/View/607/ComprehensiveStormsewerPlan?bidId=, (accessed June 2019).

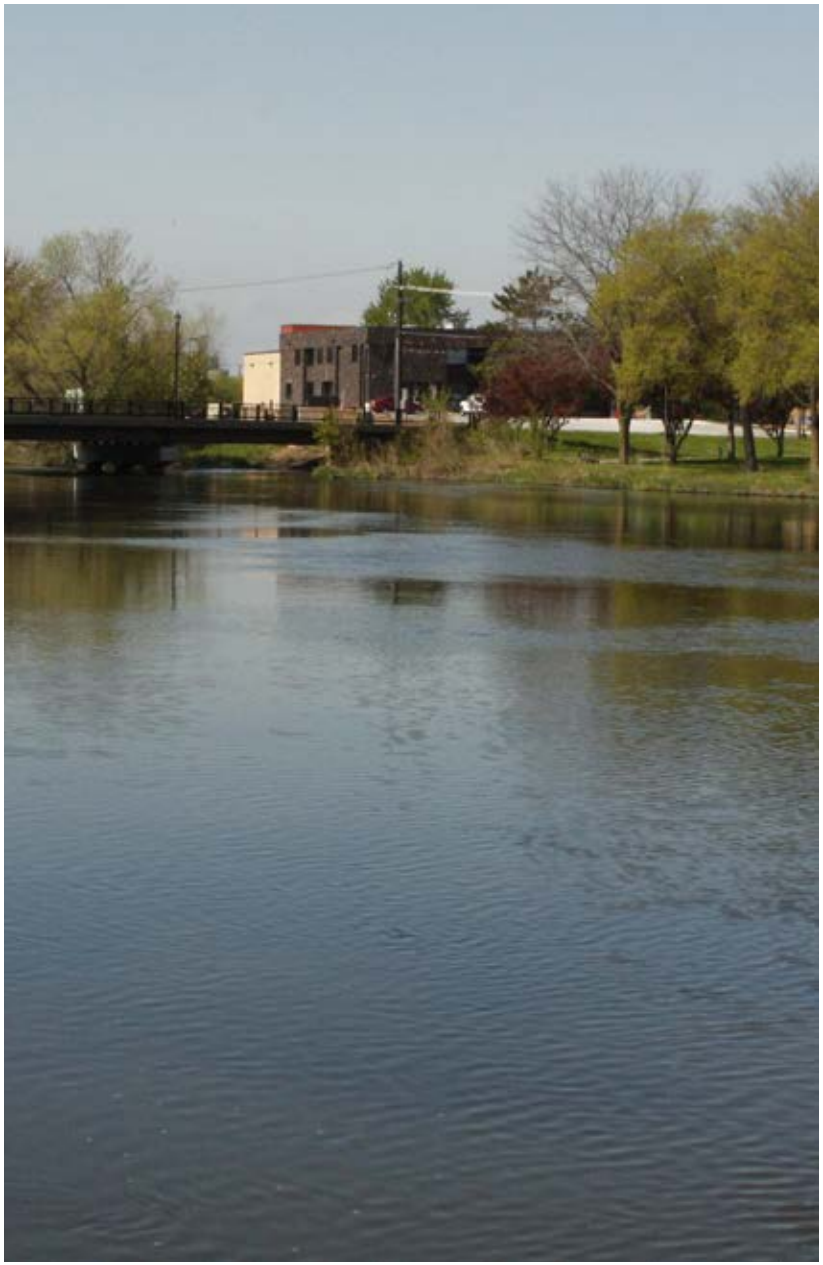


Photo Credit: Great Plains Institute

Water Supply and Quality

Stable water supply and good water quality are high priorities for communities. A stable, clean water source provides a resilient asset to the community as temperatures warm and extreme weather events increase. Increased precipitation and changing freeze-thaw cycles may impact stormwater management practices that help to maintain the health of surface water.

Groundwater

Potable water in Northfield is drawn from a series of wells throughout the City. According to the City's website, all municipal wells draw from the Jordan bedrock aquifers. The geology of the aquifer is primarily composed of sandstone, which has porous characteristics and is prone to fractures. Due to the permeability and the potential for wellheads to be compromised, the aquifer is most vulnerable to contaminations, especially to nitrates. Well surveys have already identified elevated nitrate levels in some of the supply wells. Risk of contamination is further exacerbated during heavy rain events.[21] Many Northfield residents also have private wells.

Surface Water

There are five major water bodies that convey and store water through Northfield: The Cannon River, Heath Creek, Spring Creek, Rice Creek (also called Spring Brook), and Lyman Lakes (wide spots of Spring Creek located at Carleton College). The Cannon River, Heath Creek, and Rice Creek/Spring Brook are listed as impaired by the Minnesota Pollution Control Agency.[22] The Cannon River is designated as impaired for aquatic life, aquatic consumption, and aquatic recreation due to Escherichia coli (E. coli). Heath Creek is designated as impaired for aquatic life and aquatic recreation due to the presence of E. coli. Rice Creek/Spring Brook is designated as impaired for aquatic life, aquatic recreation also due to E. coli, and drinking water due to nitrate contamination.

21 Metropolitan Council, Groundwater Digest, https://metrocouncil.org/Wastewater-Water/Publications-And-Resources/WATER-SUPPLY-PLANNING/Groundwater-Digest,-Twin-Cities-Metropolitan-Area,.aspx. (Accessed June 2019).

22 Inventory of All Impaired Waters, Minnesota Pollution Control Agency (2018). https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list. (Accessed June 2019).

Wetlands

Wetlands encourage water infiltration, filtering out toxins and pollutants from runoff or fertilizers, and providing habitat and carbon sequestration. Wetlands also provide erosion and flood control and habitat for plants and vegetation, as well as facilitating groundwater recharge and discharge and creating recreation opportunities and economic value for communities

According to the National Wetland Inventory in collaboration with the Minnesota Department of Natural Resources, there are an estimated 1,695.8 acres of wetlands in Northfield, inclusive of the Riverine designations (e.g. the Cannon River). The most prominent wetland type by area after Riverine is Freshwater Emergent Wetland. This wetland type is characterized by its temporal nature, which may make it seem like there is not wetland during parts of the dry season.

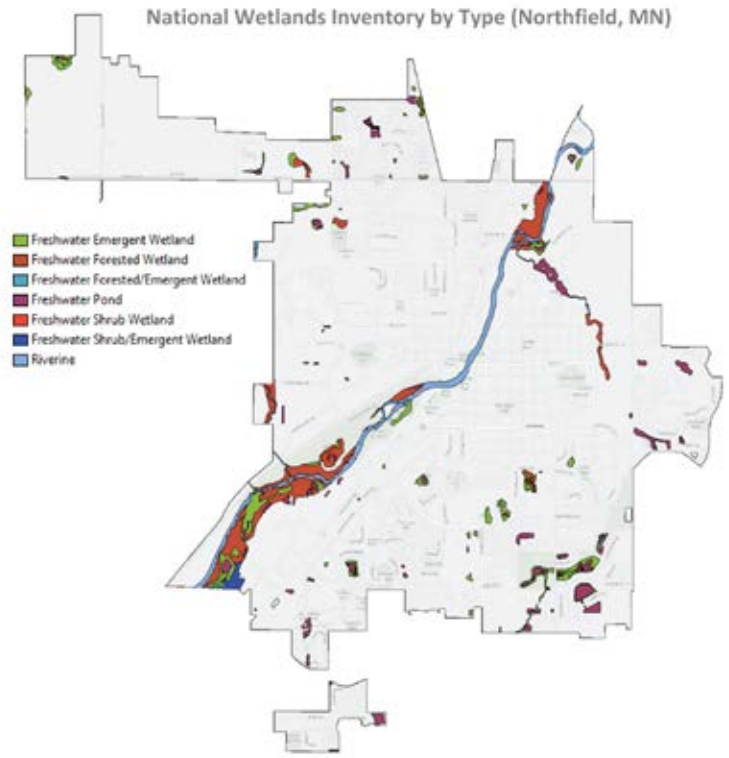


Figure 15. Inventory of all wetlands in Northfield. Source: Statewide Wetland Inventory (Minnesota DNR, 2018); map generated by Jessi Wyatt.

Land Use and Agriculture

Northfield is a thriving, rural community with agricultural characteristics located about an hour south of the Twin Cities metro. It was mentioned previously that there are numerous land uses and practices that contribute to climate change, but there are also many climate and resilience benefits that can be realized through sustainable land use and agricultural practices. Specifically, land use decisions can help mitigate effects of rainfall, reduce urban heat island effect, store carbon, and support local food production.

In consideration of the increasing likelihood of heavy precipitation events, land cover practices that incorporate stormwater management best practices will help improve the City's ability to withstand such events. Impervious surface refers to non-vegetated land – typically buildings, roads, parking lots, and other concrete areas. About 40% of land in Northfield is classified as impervious surface. High impervious cover can exacerbate and contribute to climate hazards like heavy precipitation events and urban heat island effect. Increasing vegetative cover and pervious surface, on the other hand, helps to minimize the impact of those hazards in addition to other benefits like storing carbon.

The agricultural nature of the community presents an opportunity to expand local food options. The Inter-Governmental Panel on Climate Change (IPCC) recently released a report highlighting sustainable land management and food security. The report points to declines in crop yields and global instability around food access, suggesting major shifts to the food system. Northfield has opportunity to leverage its local agricultural resources to expand food production and increase access to healthy food. Rice County conducted a survey in 2016 as part of its comprehensive plan update. One question asked about the importance of local food production in the county — 55.8% of respondents strongly agreed and 36.8% agreed, underscoring its importance to community members. Encouraging edible urban tree canopies, community gardens, and partnerships with local farms and community-supported agriculture can help minimize large climate hazards that risk interruption of traditional food supply chains to Northfield residents.

RS – 2 Enhance the Resilience of Built Infrastructure

Description: Ensure long-term integrity and reliability of built infrastructure systems through maintenance and integration of resilience into long-term planning and projects.

Recommended Actions

Stormwater

- Incorporate resilience into the capital improvement plan to ensure City infrastructure projects consider projected climate impacts *GSC best practice 17*
  - o Conduct an asset management assessment in consideration of life cycle costs and climate risks
  - o Develop and utilize a climate lens for all City infrastructure planning
- Increase community energy resilience during power outages through the development of micro-grids with storage and renewable electricity generation *GSC best practice 20*
- Evaluate upstream and downstream impact on the Cannon River of the Ames Mill Dam removal *GSC best practice 17*
- Use the higher historical rain events (500 or 1000-year floods) from Atlas 14 or projections as they become available for stormwater system planning and construction *GSC best practice 17*
- Incorporate smart sewer systems to monitor flows, overflow potential, and backup issues through sensors *GSC best practice 20*
- Increase the utilization of green infrastructure to supplement existing and future stormwater management systems, such as stormwater ponds and infiltration basins *GSC best practice 29*
- Work with upstream jurisdictions to mitigate flooding

Potable Water

- Work with State agencies and other local governments to monitor the stability of the water supply from the Jordan aquifer and support management efforts *GSC best practice 20*
- Ensure the drinking water availability is adequate and balanced to meet future demand without risking the supply *GSC best practice 20*
- Continue to ensure the wastewater system has capacity to support increase demand *GSC best practice 20*

Emergency Response

- Coordinate with Dakota and Rice counties to plan for the management and recovery of waste after extreme weather events *GSC best practice 22*
- Ensure the incorporation of resilient elements such as microgrids, solar plus storage, and backup energy infrastructure *GSC best practice 2*

Land Use

- Incorporate additional transportation modes (such as bike infrastructure, wide sidewalks) and green stormwater infrastructure systems (such as rain gardens) into street maintenance and reconstruction projects *GSC best practice 12*
- Prioritize community multi-modal connectivity in long-term planning *GSC best practice 12*
- Increase bicycle and pedestrian network connectivity through the Complete Streets Policy implementation and implementation of the “Pedestrian, Bike and Trail System Final Report" (April 2019), with an emphasis on connecting low-income neighborhoods with downtown Northfield *GSC best practice 12*
- Continue to include Accessory Dwelling Units as a permitted use in Northfield’s Land Development Code to enable more efficient use of land *GSC best practice 14*