Appendix C: Technical Analysis

City of Grand Rapids GHG Emissions Inventory
GLISA Climate Summary for Grand Rapids
City of Grand Rapids Climate Risk & Vulnerability Assessment

GRAND RAPIDS, MICHIGAN

2019 Inventory of Community-Wide and Government Operations Greenhouse Gas Emissions

Prepared For:

City of Grand Rapids, Michigan

Prepared By:

ICLEI – Local Governments for Sustainability USA
November 2023

Table of Contents

ICLEI – Local Governments for Sustainability USA

This template was updated by ICLEI USA in 2023.

Tables and Figures

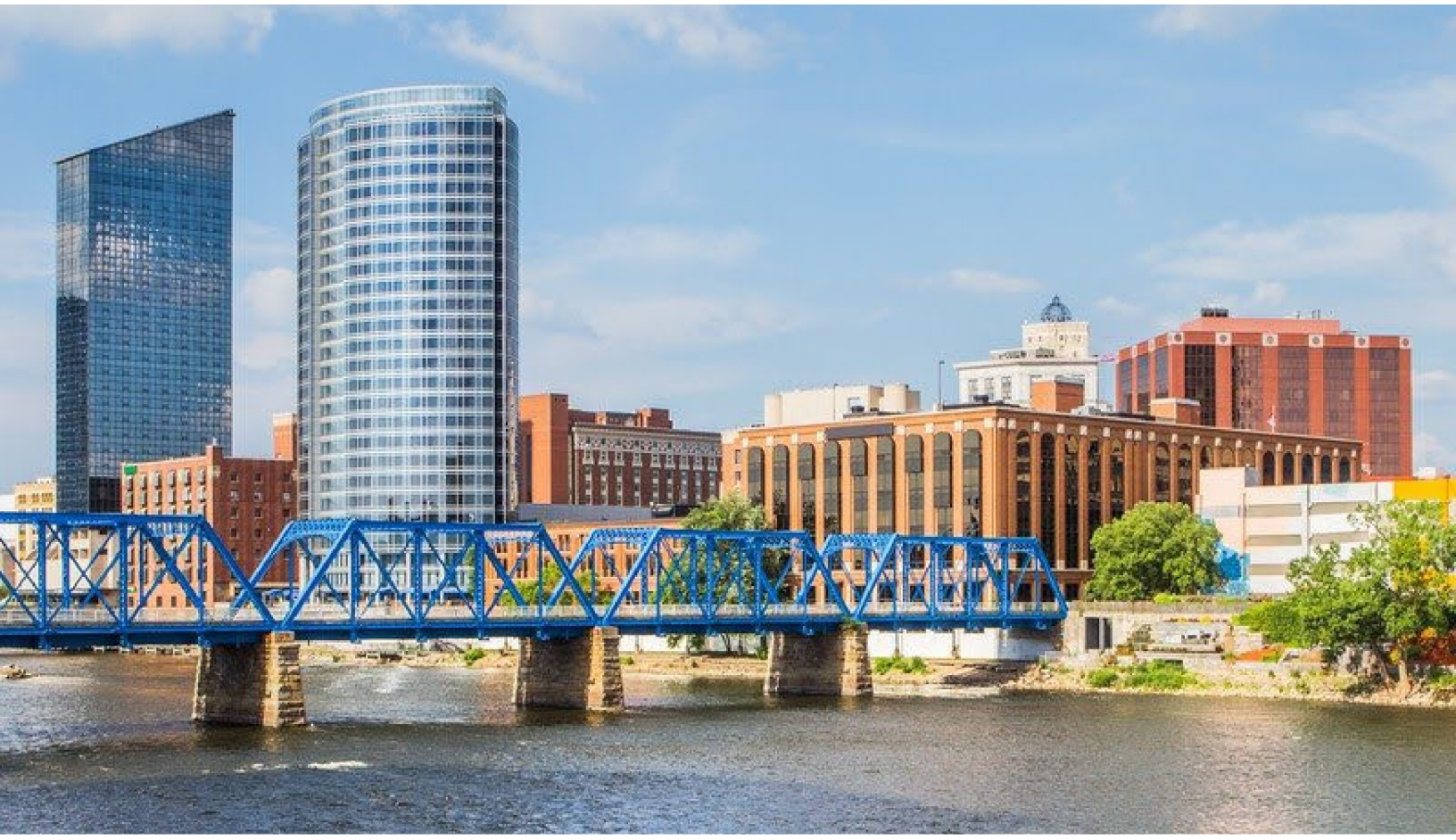
List of Tables

List of Figures

Credits and Acknowledgments

The City of Grand Rapids and ICLEI USA would like to acknowledge and thank the following for their contributions to this report:

- Alison Waske Sutter, Sustainability and Strategy Officer, for serving as the project manager for this inventory
- Annabelle Wilkinson, Environmental and Climate Justice Specialist, for contributing content
- Consumers Energy, DTE Energy, Vicinity Energy, Kent County Department of Public Works, City of Grand Rapids Water and Environmental Services Departments and the Development Center, The Rapid, and West Michigan Sustainable Business Forum for providing information needed to calculate emissions
- João Oliveira and Mike Dazy (former Office of Sustainability staff that helped collect needed information on emissions from government operations)
- Fishbeck (FTCH) for creating the City of Grand Rapids' Energy Efficiency and Conservation Strategy (2009)



Letter from the City Manager

As City Manager of the City of Grand Rapids, I'm proud of the work our team has done to build upon our historical successes in environmental sustainability and elevate our commitment to climate change action. That commitment is directly reflected in our City's six core values and in our Strategic Plan. We define sustainability as making decisions with the goal of achieving long-term net positive benefits that are informed by an understanding of how those decisions impact climate resiliency and the environment, people and communities, and finances, both today and in the future.

We are working to ensure the health of all people and the environment are advocated for, protected and enhanced. One of the objectives in our Strategic Plan is specifically focused on reducing carbon emissions, increasing climate adaptation and ensuring climate resiliency.

We know that without goals and measures, our sustainability commitment might be aspirational but not transformational. So in the fall of 2021, we adopted our first municipal greenhouse gas reduction goal – an 85% reduction by 2030 in comparison to our baseline of 2008 and carbon neutrality by 2040. While this goal is much more aggressive than those adopted by most other governmental and corporate entities, our optimism is backed up by our performance. Based on the tremendous effort of many of our departments, we reduced emissions by 30% as of 2020. In addition, we expect to achieve a 47% reduction by 2025 by converting 18,000 streetlights to LEDs, powering up our innovative biodigester and installing a nearly one megawatt ground-mounted, behind-the-meter solar array at our Lake Michigan Filtration Plant. Furthermore, 45% of our municipal electricity use was powered by renewable energy in 2022.

While it is critical that we lead by example and demonstrate that significant emissions reductions are achievable, we know that the City's municipal emissions only account for just over 2% of our community's total emissions. It is paramount that we work in partnership with our residents and employers to identify effective ways to achieve our community-wide science-based emissions reduction target of 62.8% per capita by 2030. While these strategies will require financial investment, many can provide near-immediate returns on investment (energy efficiency projects) and others have resilience benefits (on-site solar generation) that will drastically reduce and possibly eliminate future costs resulting from climate impacts.

In closing, I'd like to thank our Office of Sustainability and Strategy, particularly our Sustainability and Strategy Officer Alison Waske Sutter, for their leadership on this work and their collaboration with City departments, utilities and the community. Finally, I am grateful to our City Commission for recently adopting our fiscal year 2024 budget, which includes $27 million in climate change investments.

In partnership,

Mark A. Washington
City Manager

Executive Summary

The climate in Grand Rapids is changing, and these changes are causing immediate threats to its citizens, health, economy, and the community's overall vitality. In light of these trends, the City of Grand Rapids has decided to plan for climate change, making sure the City is considering what changes are projected to take place in the future and integrating that information into how we, as a City, operate. Guiding this work is a commitment to ensuring the health of all people - especially frontline communities that are already and will continue to experience a disproportionate share of the impacts associated with a changing climate – are advocated for, protected, and enhanced. Understanding and reducing greenhouse gas emission levels is essential to mitigating the impacts of climate change. This GHG inventory is a critical component needed to identify key emissions reduction/climate mitigation goals and actions for the community to include in the City's Climate Action and Adaptation Plan (CAAP). The City is currently co-creating the CAAP in partnership with the Community Collaboration on Climate Change and other community stakeholders that will act as a roadmap for how the community will address both mitigating and adapting to climate change.

Within the pages of this report, readers will find information on the largest sectors impacting Grand Rapids community-wide emissions. The residents and employers located in the City of Grand Rapids generated 2.5 million metric tons of carbon dioxide equivalents (also referred to as a greenhouse gas (GHG) footprint) in 2019. The three largest sources of emissions were buildings (40% total with single and multi-family residential accounting for 28% and commercial buildings accounting for 11%), the transportation sector (30% total with gasoline-powered vehicles accounting for 18%), and industrial facilities (25%). The following fuel types are responsible for the following energy-related emissions: electricity (37%), natural gas (29%), gasoline (18%), diesel (7%) and other (9%).

To achieve aggressive emissions reduction goals, Grand Rapids must focus on energy efficiency, electrification, and renewable energy. Some of the key programs and initiatives the City is working on to further these strategies include:

- Increased communication and promotion of climate change related work:
  - A new climate change website that can be accessed via grandrapidsmi.gov/sustainability
  - The publication of a monthly e-newsletter from the Office of Sustainability – you can sign up at the bottom of grandrapidsmi.gov/sustainability
  - A free, publicly available 4-part training series on climate change that is also made available for City staff
- Efforts to reduce emissions from government operations:
  - Conduct updated energy audits of key operations, establish department specific emissions reduction targets and implement efficiency projects
  - Update a City policy outlining how low to no emissions and climate resiliency can be incorporated into the City's design, construction and operation of City facilities
  - Install on-site solar at the Butterworth Landfill and other City properties
  - Purchase renewable energy credits to offset the remaining electricity supplied to the City created with fossil fuels
  - Create a plan to transition the City fleet to low or zero-emission vehicles

- Collaboration with diverse stakeholders to reduce emissions from the building, transportation and other key emissions sectors across the Grand Rapids community, including:
  - Identification of policies and programs that can equitably reduce energy consumption within the commercial and residential building sector via the Equitable, Healthy and Zero Carbon Buildings Initiative (E.H.Zero)
  - Completion of a single-family residential renovation pilot via E.H.Zero that is leveraging grant funding to implement housing upgrades that will support the households' financial stability, increased health outcomes, emissions reduction, and increased climate adaptation
  - Work with the Transportation Climate Advisory Team (T-CAT) to identify strategies to reduce emissions from the transportation sector
  - Evaluation and implementation of a comprehensive materials management program that will increase customer service, decrease contamination and ensure long-term, broad sustainability objectives can be achieved
  - Further analysis of emissions from the industrial sector

Implementing these and other actions to effectively address the community's emissions will require an "all hands on deck" approach. That is why Grand Rapids invites you to join us as it moves forward with creating a more efficient, innovative, and sustainable Grand Rapids for all.

The City is grateful for the many partners engaging in this important emissions reduction/climate change mitigation work. It will take the collective partnership and action of the City, residents, and employers to make impactful progress on the community-wide 62.8% per capita science-based emissions reduction target by 2030. The City must also work on increasing the adaptive capacity and resilience of the community. Together, Grand Rapids can build upon its successes and demonstrate that the City can be nationally recognized as an equitable, welcoming, innovative and collaborative city with a robust economy, safe and healthy community, and the opportunity for a high quality of life for all.

Key Findings

Community-Wide Inventory

Figure 1 shows community-wide emissions by sector in 2019. The largest contributor is Transportation with 30.1% of emissions. The next largest contributors are Residential Energy (27.8%) and Industrial Energy (25.1%). Actions to reduce emissions in all of these sectors will be a key part of a climate action plan. Commercial Energy, Solid Waste, Upstream Impacts, Water & Wastewater, Process & Fugitive Emissions, and Agriculture were responsible for the remaining (approximately 17%) emissions.

The Community-wide Inventory Results section of this report provides a detailed profile of emissions sources across the Grand Rapids community; information that is key to guiding local reduction efforts. These data will also provide a baseline against which the City will be able to compare future performance and demonstrate progress in reducing emissions.

EMISSIONS AT A GLANCE

1 **Transportation** 30.1%

2 **Residential Energy** 27.8%

3 **Industrial Energy** 25.1%

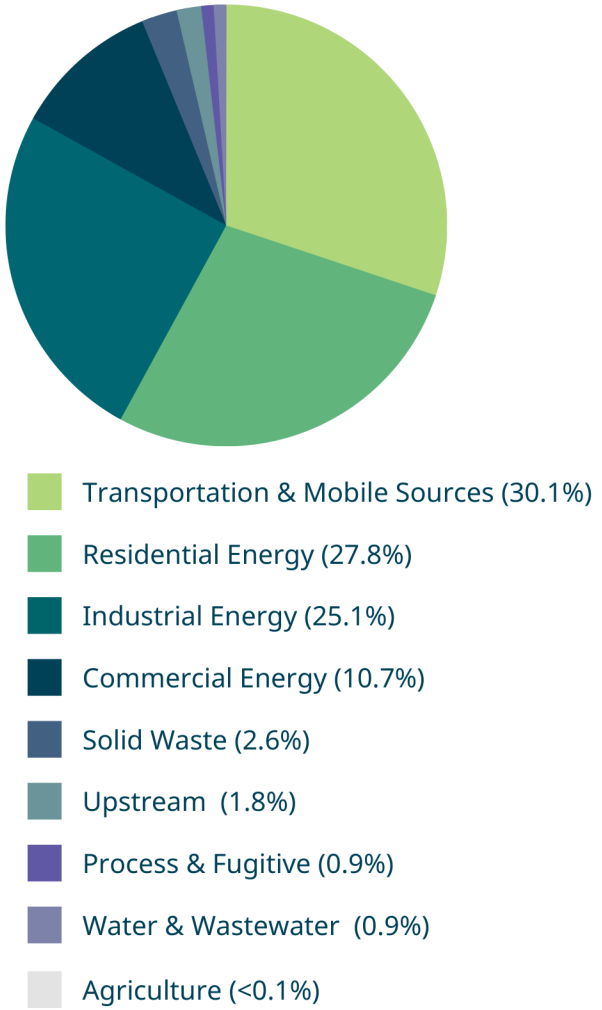


Figure 1: Community-Wide Emissions by Sector

Government Operations Inventory

Figure 2 shows government operations emissions by sector. The largest contributor is electricity with 76% of emissions. The next largest contributors are natural gas (12%) and fuel for the fleet (10%). Steam energy was responsible for the remaining (less than 3%) emissions.

Emissions from government operations contributed 2.21% of community-wide emissions. This measure was calculated based on data the City of Grand Rapids produced in partnership with Cadmus, a nationally recognized climate consultant, via SolSmart. The government operations inventory used a different methodology than the community-wide inventory. This means the two inventories did not account for all of the same emissions or use comparable sectors. For example, process and fugitive emissions from the distribution of natural gas were included in the community-wide inventory, but this was not included in the LGO inventory.

GOVERNMENT OPERATIONS EMISSIONS AT A GLANCE

1 **Electricity** 76%

2 **Fleet** 12%

3 **Natural Gas** 10%

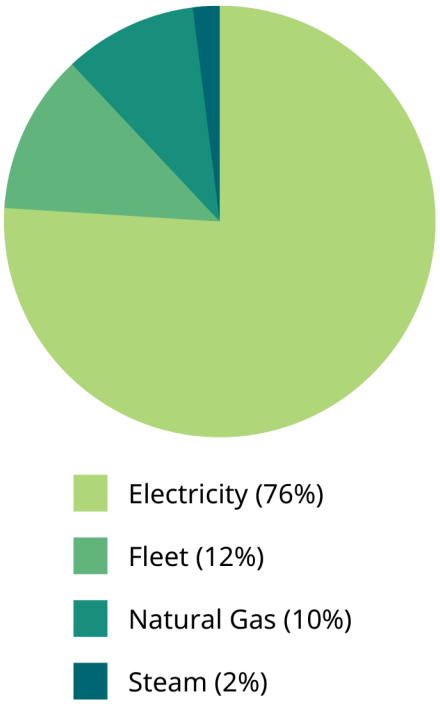


Figure 2: Government Operations Emissions by Sector

Introduction to Climate Change

Naturally occurring greenhouse gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect, as shown in the figure below [1]. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise, threatening the safety, quality of life, and economic prosperity of all humans. Although the natural greenhouse effect is needed to keep the earth warm, the human-enhanced greenhouse effect with the rapid accumulation of GHGs in the atmosphere leads to too much heat and radiation being trapped.

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report confirms that human activities are unequivocally increasing the concentration of greenhouse gases (GHGs) and changing the global and local climate [2]. The most significant contributor is burning fossil fuels for transportation, electricity generation, building and water heating, and industrial processes, which releases large amounts of carbon dioxide and other GHGs into the atmosphere. Many regions are already experiencing the consequences of global climate change, and Grand Rapids is no exception.

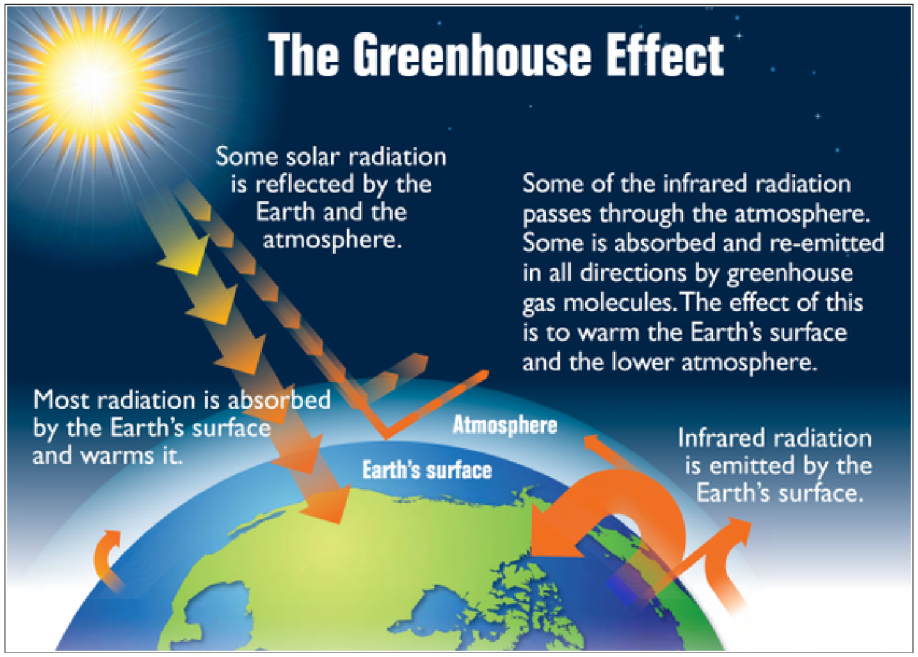


Figure 3: The Greenhouse Effect [1]

[1] Environmental Protection Agency. (n.d.). Basics of Climate Change. U.S. Environmental Protection Agency. https://www.epa.gov/climatechange-science/basics-climate-change

[2] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

Human activities have caused approximately 1.8°F of global warming since pre-industrial levels. Global warming is expected to reach 2.7°F between 2030 and 2050 (considered a high confidence or very likely scenario). Emissions from human activities will remain in the atmosphere for hundreds to thousands of years, continuing to cause additional long-term changes in the climate system, such as sea-level rise and subsequent impacts [3].

How Has and Will Grand Rapids' Climate Change?

The climate in Grand Rapids is changing, and these changes are causing immediate threats to its citizens, health, economy, and the community's overall vitality. In summary, Grand Rapids' climate is getting hotter and wetter, and producing more extreme weather events.

Even though the average annual air temperature has decreased by 0.2°F from 1951 to 2017, it's known that over the last several years Grand Rapids has experienced increased annual winter and spring temperatures. Average annual temperature is projected to increase by 3°F to 5°F by mid-century (2050). Nighttime temperatures are also rising, and the number of cold days (average 24-hour temperature < 32°F) is declining [4].

Annual precipitation is changing too: in the last several decades Grand Rapids has experienced a 16% increase in annual precipitation, with the greatest change happening in spring (a 35.8% increase, amounting to roughly an extra 3.1 inches). However, types of precipitation will vary (i.e., more winter precipitation in the form of rain)[4].

In addition, Grand Rapids has seen an increase in the frequency and intensity of severe storms, with the City experiencing a 40% increase in the number of heavy precipitation events (heaviest 1% of storms) annually. The total volume of rainfall in these extreme events has also increased by 52%. Although there will be more precipitation overall, more is anticipated to fall in shorter, extreme events, which increases the potential for drought in the future. These are just some of the changes that have led to serious impacts to the community's infrastructure, economy, social networks, cultural identity, and safety. These impacts are likely to be more extreme as the climate continues to change [4].

[3] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

[4] Great Lakes Integrated Sciences + Assessment. 2019. Climate Change in the Great Lakes Region and Grand Rapids, Michigan. Retrieved from https://glisa.umich.edu/wp-content/uploads/2022/08/Grand-Rapids-Climate-Summary.pdf

Greenhouse Gas Inventory as a Step Toward Climate Neutrality

Facing the climate crisis requires the concerted efforts of local governments, their partners, those that are close to the communities directly dealing with the impacts of climate change and residents.

Cities, towns, and counties are well positioned to create coherent and inclusive plans that address integrated climate action — climate change adaptation, resilience, and mitigation. Existing targets and plans need to be reviewed to bring in the necessary level of ambition and outline how to achieve net-zero emissions by 2050 at the latest. Net-zero emissions are "achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period" [5]. Creating a roadmap for net-zero emissions requires Grand Rapids to identify priority sectors for action, while considering climate justice, inclusiveness, local job creation, and other benefits of sustainable development.

To complete this inventory, the City of Grand Rapids utilized tools and guidelines from ICLEI - Local Governments for Sustainability (ICLEI), which provides authoritative direction for greenhouse gas emissions accounting and defines climate neutrality as follows:

> The targeted reduction of greenhouse gas (GHG) emissions and GHG avoidance in government operations and across the community in all sectors to an absolute net-zero emission level at the latest by 2050. In parallel to this, it is critical to adapt to climate change and enhance climate resilience across all sectors, in all systems and processes.

To achieve ambitious emissions reduction, and move toward climate neutrality, the City of Grand Rapids has set a goal to reduce community-wide emissions by 62.8% per capita by 2030. Climate action is an opportunity for Grand Rapids to experience a wide range of co-benefits, such as creating socio-economic opportunities, reducing poverty and inequity, and improving the health of people and nature (see Figure 4 to explore why and how accelerated climate action happens).

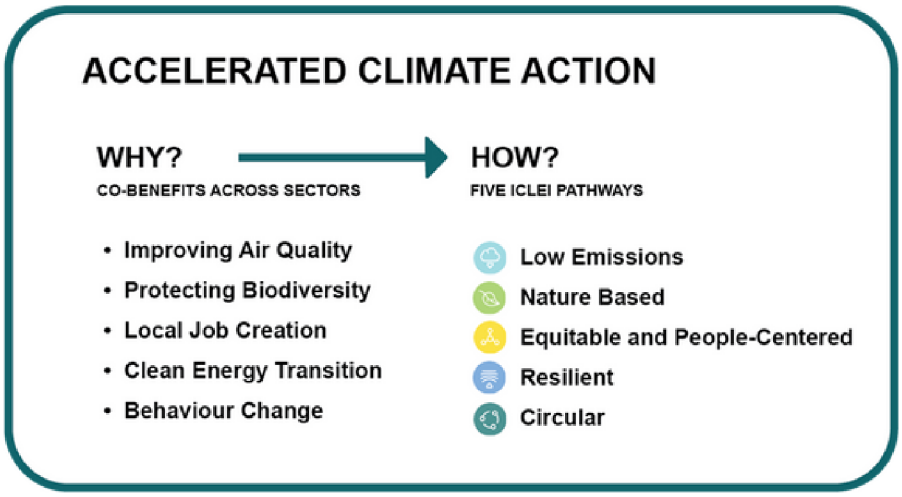


Figure 4: Co-Benefits and ICLEI Pathways to Accelerated Climate Action

[5] IPCC. 2018. Annex I: Glossary in: Global Warming of 1.5°C. Retrieved from https://www.ipcc.ch/sr15/chapter/glossary/#:~:text=The%20process%20by%20which%20countries,with%20electricity%2C%20industry%20and%20transport.

The City of Grand Rapids is acting as a leader in this space, but it takes a community working together to achieve climate neutrality. Many communities in the United States have started to take responsibility for addressing climate change at the local level. Reducing fossil fuel use in the community can have many benefits in addition to reducing greenhouse gas emissions. More efficient use of energy decreases utility and transportation costs for residents and businesses. Retrofitting homes and businesses to be more efficient creates local jobs. In addition, when residents save on energy costs, they are more likely to spend at local businesses and add in the local economy. Reducing fossil fuel use improves air quality, and increasing opportunities for walking and bicycling improves residents' health.

ICLEI Climate Mitigation Milestones

In response to the climate emergency, many communities in the United States are taking responsibility for addressing emissions at the local level. Some sources of greenhouse gas emissions can be directly or indirectly controlled through local policies. In Michigan, state laws and regulatory agencies control building and energy codes as well as regulated utilities. However, local governments can reduce community-wide emissions through land use patterns, transportation demand management, waste diversion, and economic incentives, partnerships and advocacy. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts.

ICLEI provides a framework and methodology for local governments to identify and reduce greenhouse gas emissions, organized along with Five Milestones, also shown in Figure 5:

1. Conduct an inventory and forecast of local greenhouse gas emissions;
2. Establish a greenhouse gas emissions Science-Based Target [6];
3. Develop a climate action plan for achieving the emissions reduction target;
4. Implement the climate action plan; and,
5. Monitor and report on progress.

This report represents the completion of ICLEI's Climate Mitigation Milestone One, and provides a foundation for future work to reduce greenhouse gas emissions in Grand Rapids. The City completed Milestone Two by adopting ICLEI's science-based target of 62.8% per capita community-wide emissions reduction for 2030 in November 2022 and the City is currently in the process of Milestone 3, developing a climate action plan, which is expected to be completed by the end of 2024.

Figure 5: ICLEI Climate Mitigation Milestones

[6] Science-Based Targets are calculated climate goals, in line with the latest climate science, that represent your community's fair share of the ambition necessary to meet the Paris Agreement commitment of keeping warming below 1.5°C. To achieve this goal, the Intergovernmental Panel on Climate Change (IPCC) states that we must reduce global emissions by 50% by 2030 and achieve climate neutrality by 2050. Equitably reducing global emissions by 50% requires that high-emitting, wealthy nations reduce their emissions by more than 50%.

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

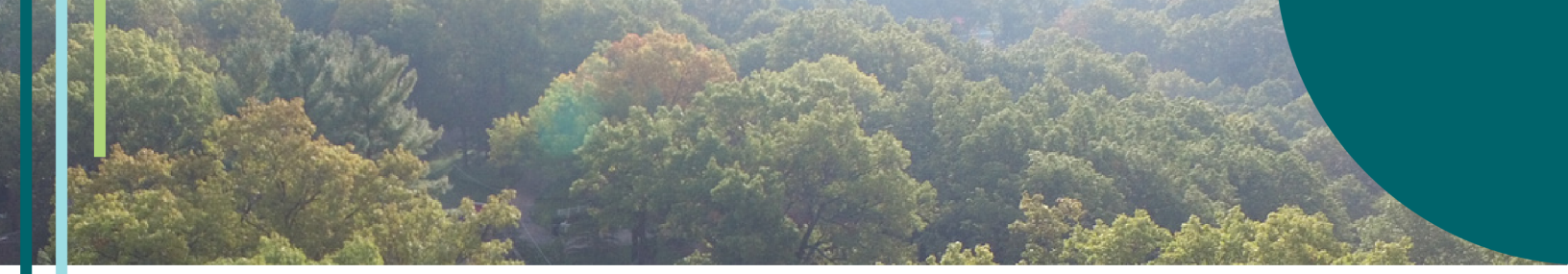
The first step toward achieving tangible greenhouse gas (GHG) emission reductions requires identifying baseline emissions levels, sources and activities generating emissions in the community. This report presents emissions from the Grand Rapids community as a whole. The government operations inventory is mostly a subset of the community-wide inventory. For example, data on commercial energy use by the community include energy consumed by government buildings, and community vehicle-miles-traveled estimates include miles driven by government fleet vehicles.

As local governments continue to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) and the Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions (LGO Protocol), both of which are described below.

Three greenhouse gases are included in this inventory: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report.

Table 1: Global Warming Potential Values (IPCC, 2014)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO2)	1
Methane (CH4)	28
Nitrous Oxide (N2O)	265



Community-Wide Emissions Protocol

Version 1.2 of the U.S. Community Protocol for Accounting and Reporting GHG Emissions [7] was released by ICLEI in 2019, and represents a national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories. It establishes reporting requirements for all community GHG emissions inventories, provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and provides a number of optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities.

The community-wide inventory in this report includes emissions from the five Basic Emissions Generating Activities required by the Community Protocol. These activities are:

- Use of electricity by the community
- Use of fuel (e.g., natural gas, propane) in residential and commercial stationary combustion equipment (e.g., furnace, hot water)
- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater/sewer treatment and distribution
- Generation of solid waste by the community

The community-wide inventory also includes the following activities:

- Wastewater treatment processes
- Off-road transportation
- Fugitive emissions from natural gas
- Upstream impacts from electricity distribution
- Use of electricity by the agricultural sector

The City hired Fishbeck to complete a 2008 community-wide inventory; however, due to deteriorated data quality and methodology changes, a comparison between 2008 and 2019 inventories could not be performed. Most notably, data collection methodologies have become more accurate in the 11 years since the 2008 inventory was developed. It is important to acknowledge that a greenhouse gas inventory is a tool used to benchmark a moment in time showcasing community emissions. To ensure future inventories can be compared to the 2019 inventory, the City will follow the same data collection practices and include the same sectors as they have here.

[7] ICLEI. 2012. US Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/tools/ghg-protocol/community-protocol

Local Government Operations (LGO) Protocol

The City of Grand Rapids conducted a local government operations inventory in 2019 that was produced in partnership with the U.S. Department of Energy's National Renewable Energy Laboratory and Cadmus, via SolSmart, to confirm LGO emissions. Cadmus is a nationally recognized climate consultant.

While ICLEI USA did not complete this inventory, featuring the LGO emissions in tandem with community-wide emissions can illustrate a holistic image of the emission profile occurring within Grand Rapids. Comparing those LGO emissions to the community-wide emissions measured in this report, government operations only account for 2.21% of total community-wide emissions (see Figure 6).

Figure 6: Relationship of Community and Government Operations Inventories

Quantifying Greenhouse Gas Emissions

Sources and Activities

Communities contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the community-wide inventory: 1) GHG emissions that are produced by "sources" located within the community boundary, and 2) GHG emissions produced as a consequence of community "activities."

Table 2: Source vs. Activity for Greenhouse Gas Emissions (GHG)

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere.	The use of energy, materials, and/or services by members of the community that result in the creation of GHG emissions.

By reporting on both GHG emissions sources and activities, local governments can develop and promote a deeper understanding of GHG emissions associated with their communities. A purely source-based emissions inventory could be summed to estimate total emissions released within the community's jurisdictional boundary. In contrast, a purely activity-based emissions inventory could provide perspective on the efficiency of the community, even when the associated emissions occur outside the jurisdictional boundary. The division of emissions into sources and activities replaces the scopes framework that is used in government operations inventories, but that does not have a clear definition for application to community-wide inventories.

Base Year

The inventory process requires the selection of a base year with which to compare current and future emissions. The City of Grand Rapids's LGO greenhouse gas emissions inventory utilizes 2008 as its baseline year because it was the most historic year for which the necessary data was available.

Quantification Methods

GHG emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of GHG emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.
- Calculation-based methodologies calculate estimated emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

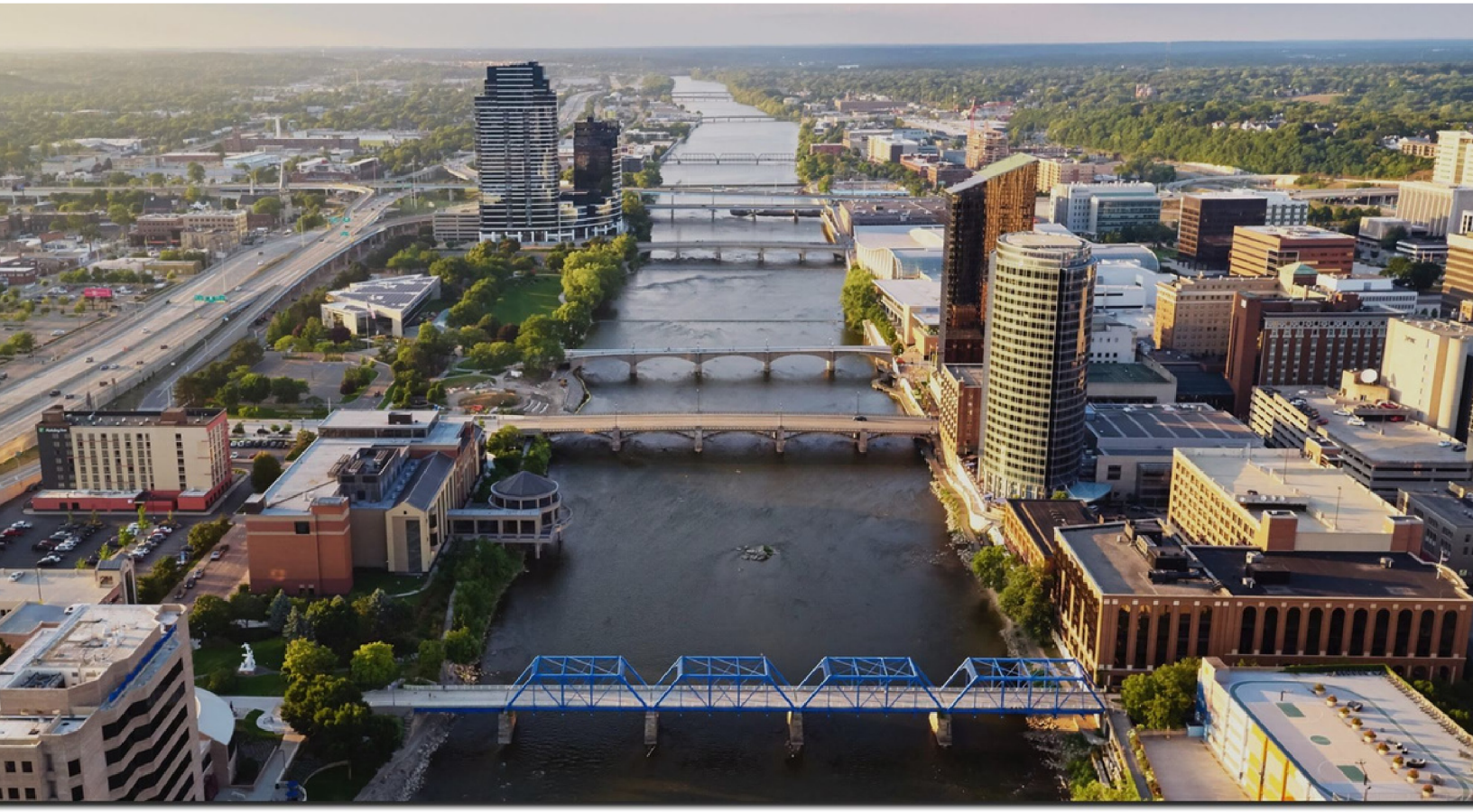
Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other GHG-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see the appendices for a detailed listing of the activity data used in composing this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g., lbs CO2/kWh of electricity). For this inventory, calculations were made using ICLEI's ClearPath Climate Planner tool.

Natural Gas Data Discussion

DTE Energy provided anonymized data for natural gas accounts with Grand Rapids mailing addresses located within one of the 11 zip codes in Grand Rapids. Of those 11 zip codes, only 1 is 100% within the city, 3 have the large majority of the zip code in the city, 2 are fairly evenly split within and outside of the city, and 5 have very little area within the city. There are many households and businesses with a Grand Rapids mailing address that are located within one of these 11 zip codes, but outside of the city proper. Based on these data restrictions, the City's Office of Sustainability and Strategy chose to include 100% of the natural gas consumption data for: the zip code completely within the city (49503), the three zip codes with the vast majority within the city (49504, 49505, and 49507), and all of the consumption for 49508 while only approximately half of that zip code falls within the city boundaries. The decision to include all of 49508 was to account for the small portion of land area that falls within the city proper for remaining five zip codes (49509, 49512, 49525, 49546, and 49548), which have been excluded from the data. Finally, DTE Energy's data for 49506 includes East Grand Rapids accounts. The City's Office of Sustainability and Strategy chose to attribute 67% of this zip code to the City of Grand Rapids residential natural gas consumption. The City was left with no option but to include 100% of 49506 for commercial businesses.



Community Emissions Inventory Results

The total community-wide emissions for the 2019 inventory are shown in Table 3 and Figure 7.

Table 3: Community-Wide Emissions Inventory

Sector	Fuel or Source	2019 Usage	Usage Unit	2019 Emissions (Mt CO2e)	Percent of Total Gross Emissions
Residential Energy	Electricity	657,812,127	kWh	329,838	13.2%
	Natural Gas	68,259,505	Therms	363,048	14.6%
Residential Energy Total				**692,886**	**27.8%**
Commercial Energy	Electricity	158,786,042	kWh	75,639	3.0%
	Distillate Fuel Oil No. 2	288,903	MMBtu	21,511	0.9%
	Propane	154,218	MMBtu	9,571	0.4%
	Kerosene	1,805	MMBtu	137	<0.0%
	Natural Gas	29,531,860	Therms	157,070	6.3%
	Wood	190,172	MMBtu	1,893	0.1%
Commercial Energy Total				**265,821**	**10.7%**
Industrial Energy	Electricity	892,108,903	kWh	447,318	17.9%
	Natural Gas	33,587,150	Therms	178,262	7.2%
Industrial Energy Total				**625,580**	**25.1%**
Transportation & Mobile Sources	Gasoline	1,091,226,936	VMT	458,236	18.4%
	Diesel	113,016,167	VMT	166,810	6.7%
	CNG	13,236	VMT	0.45	<0.0%
	Public Transit			14,729	0.6%
	Off-Road			109,868	4.4%
Transportation & Mobile Sources Total				**749,643**	**30.1%**

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 3: Community-Wide Emissions Inventory (continued)

Sector	Fuel or Source	2019 Usage	Usage Unit	2019 Emissions (Mt CO2e)	Percent of Total Gross Emissions
Solid Waste	Combustion of Solid Waste Generation (Waste to Energy)	185,388	Short Tons	64,257	2.6%
	Composting	15,943	Tons	1,111	<0.0%
Solid Waste Total				**65,368**	**2.6%**
Water & Wastewater	Wastewater Energy Use	22,429,510	kWh	11,247	0.5%
		25,956	MMBtu	1,381	0.1%
	Supply of Potable Water Energy Use	7,934,666	kWh	3,979	0.2%
		13,766	MMBtu	732	<0.0%
	N2O			5,951	0.2%
	Septic Systems			91	<0.0%
Water & Wastewater Total				**23,380**	**0.9%**
Process and Fugitive	Natural Gas Distribution	131,378,515	Therms	22,794	0.9%
Process & Fugitive Emissions Total				**22,794**	**0.9%**
Agriculture	Electricity Consumption	1,032,465	kWh	560	<0.0%
Agriculture Total				**560**	**<0.0%**
Upstream Impacts	Electric Power Transmission And Distribution Losses	1,732,169,047	kWh	46,032	1.8%
Upstream Impacts Total				**46,032**	**1.8%**
Total Gross Emissions				**2,492,064**	
Forests and Trees	Forests			-3,757	0.2%**
	Trees Outside of Forests			-15,892	0.6%**
Forests & Trees Total				**-19,649**	**0.8%****
Total Emissions with Sequestration				**2,472,415**	

*Blank cells are a result of variability in the format of available data by sector and fuel or source type.
**Value represents the percentage of total emissions with sequestration.

Figure 7 shows the distribution of community-wide emissions by sector. Transportation is the largest contributor, followed by Residential, and Industrial Energy.

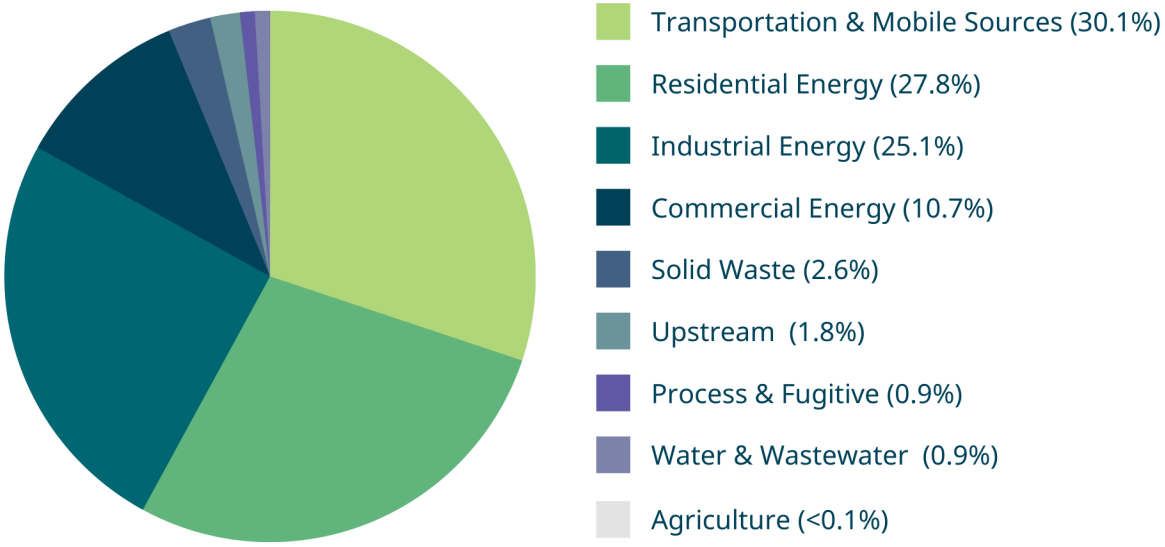


Figure 7: Community-Wide Emissions by Sector

Conclusion

This inventory marks the completion of Milestone One of the Five ICLEI Climate Mitigation Milestones.

The Intergovernmental Panel on Climate Change (IPCC) states that to meet the Paris Agreement commitment of keeping warming below 1.8°F we must reduce global emissions by 50% of the 2019 level by 2030 and reach climate neutrality by 2050 [8]. Equitably reducing global emissions by 50% requires that high-emitting, wealthy nations that have generated the most greenhouse gases to date reduce their emissions by more than 50%. More than ever, it is imperative that countries, regions, and local governments set targets that are ambitious enough to slash greenhouse gas/carbon emissions between now and mid-century (2050).

Science-Based Targets (SBTs) are calculated climate goals, in line with the latest climate science, that represent a community's fair share (taking into consideration wealthy nations generation of a larger proportion of emissions to date) of the global ambition necessary to meet the Paris Agreement commitment to keep warming to below 1.8°F [9]. Community education, involvement, and partnerships will be instrumental in achieving an SBT.

To support the bold climate action needed in Grand Rapids, ICLEI has calculated the City's science-based targets in terms of per capita and absolute. Per capita refers to an average emissions figure per person, and absolute refers to the total amount of community-wide GHGs [10]:

- **Per Capita SBT: 62.8%**
- **Absolute SBT: 60.5%**

In November 2022, the City completed Milestone Two by adopting a 62.8% per capita science-based target community-wide emissions reduction target.

This inventory should be used to focus and prioritize actions to reduce emissions. The Grand Rapids community should focus on the sectors with the greatest emissions, which include transportation, industry and residential buildings.

[8] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

[9] "Science Based Climate Targets: A Guide for Cities." Science Based Targets Network, November 4, 2021. https://sciencebasedtargetsnetwork.org/.

[10] USA, ICLEI. "Race to Zero." ICLEI USA, April 7, 2021. https://icleiusa.org/race-to-zero/.

ICLEI recommends the following actions, which are believed to produce greater emissions reductions in the largest generating sectors:

- On-road transportation
  - Vehicle electrification: Transition from internal combustion engine vehicles (passenger, transit fleets, government fleets, etc.) to electric-powered
  - Land use/infrastructure planning: Improve infrastructure to incentivize public transit usage, vehicle sharing, micro-mobility, walking, and biking
  - Work with communities to expand public transportation options
- Residential, industrial, and commercial electricity use
  - Increase distributed solar (solar installed directly on homes and buildings)
- Residential, industrial, and commercial stationary fuel use
  - Electrify building heating: Convert gas-powered heating appliances (e.g., water heaters, furnaces) to electric-powered

Completion of another GHG inventory in two to five years is recommended to assess progress resulting from any actions implemented. Regular inventories also allow for "rolling averages" to provide insight into sustained changes and can help reduce the chance of an anomalous year being incorrectly interpreted. Finally, the City is currently in the process of developing its Climate Action and Adaptation Plan, which is Milestone 3. The City expects this plan to be completed at the end of 2024. You can follow the City's progress by signing up for the Office of Sustainability's monthly e-newsletter and keeping an eye on their climate change website. Through these efforts and others, Grand Rapids can achieve environmental, economic, and social benefits beyond reducing emissions.

Appendix: Methodology Details

Energy

Table 4: Energy Data Sources

Activity	Data Source	Data Gaps/Assumptions
Residential, Commercial, and Industrial Electricity Consumption	Consumers Energy	For commercial electricity consumption, buildings are assigned based on metering rates and include large users such as hospitals and universities. This data also includes municipal and institutional buildings.
Residential, Commercial, and Industrial Natural Gas Consumption	DTE Energy	Natural gas usage data provided by DTE included usage from outside of the city proper; therefore, estimations were used to obtain usage within city limits. See the Natural Gas Data Discussion section for more information.
Residential Non-Utility Fuel Consumption	Energy Information Administration	A downscaling estimate based on statewide commercial fuel combustion estimates (from EIA) and job counts at the state and local levels were used.

Table 5: Consumers Energy (2019) Emissions Factors for Electricity Consumption

Emissions Factor/ Year	CO2 (lbs./MWh)	CH4 (lbs./GWh)	N2O (lbs./GWh)	Data Gaps and Assumptions
Consumers Energy/eGRID - 2019	1,098	114	16	The CO2 factor was provided by Consumers Energy and the CH4 and N2O factors were sourced from EPA eGRID.

Transportation

Table 6: Transportation Data Sources

Activity	Data Source	Data Gaps/Assumptions
Vehicle Miles Travelled	Google Environmental Insights Explorer	Data does not include public transit.
Government Operations	City of Grand Rapids	Records calculated emissions by fuel usage, which does not calculate CH4 and N2O emissions except CNG, which was recorded as a direct emissions entry. The off-road calculator was used for heavy-duty vehicles (diesel) because data represents activity as "rigid."
Transit Ridership	City of Grand Rapids	For the diesel hybrid from The Rapid, the source used standard diesel.
Off-Road	EPA National Emissions Inventory	Records represent all off-road/mobile sources. Source data only provides CO2/CH4 emissions.

For vehicle transportation, it is necessary to apply average miles per gallon and emissions factors for CH4 and N2O to each vehicle type. The factors used are shown in Table 7.

Table 7: MPG and Emissions Factors by Vehicle Type

Fuel	Vehicle Type	MPG	CH4 (g/mile)	N2O (g/mile)
Gasoline	Passenger car	24.1	0.0183	0.0083
Gasoline	Motorcycle	24.1	0.0183	0.0083
Diesel	Passenger car	24.1	0.0005	0.001
Diesel	Light truck	17.6	0.001	0.0015
Diesel	Heavy truck	6.4	0.0051	0.0048

Wastewater

Table 8: Wastewater Data Sources

Activity	Data Source	Data Gaps/Assumptions
Energy used in wastewater facilities	Consumers Energy	The data provided for the City of Grand Rapids included other jurisdictions. The city accounts for approximately 50% of the total usage value; therefore, 50% of the activity data was used in the inventory.
Nitrogen Discharge	City of Grand Rapids	None identified.
Process N2O Emissions From Wastewater Treatment	City of Grand Rapids	None identified.
Septic Systems	City of Grand Rapids	There are approximately 300 septic tanks in the City of Grand Rapids with an average household size of 2.51 persons; therefore, the population used to estimate septic tank emissions was 753.

Potable Water

Table 9: Potable Water Data Sources

Activity	Data Source	Data Gaps/Assumptions
Energy used in potable water facilities	Consumers Energy	The data provided for the City of Grand Rapids included other jurisdictions. The city accounts for approximately 50% of the total usage value; therefore, 50% of the activity data was used in the inventory.

Solid Waste

Table 10: Solid Waste Data Sources

Activity	Data Source	Data Gaps/Assumptions
Combustion of Solid Waste Generation (Waste to Energy)	Kent County	None identified.
Composting	City of Grand Rapids	This record represents data for 2018 and part of 2019 (one full calendar year).

Fugitive Emissions

Table 11: Fugitive Emissions Data Sources

Activity	Data Source	Data Gaps/Assumptions
Natural Gas Distribution	DTE Energy	Natural gas usage data provided by DTE included usage from outside of the city proper; therefore, estimations were used to obtain usage within city limits. See the Natural Gas Data Discussion section for more information.

Upstream Impacts

Table 12: Upstream Impacts Data Sources

Activity	Data Source	Data Gaps/Assumptions
Electric Power Transmission and Distribution Losses	Consumers Energy	None identified.

Inventory Calculations

This 2019 inventory was calculated following the US Community Protocol and ICLEI's ClearPath Climate Planner Climate Planner software. As discussed in Inventory Methodology, the IPCC 5th Assessment was used for global warming potential (GWP) values to convert methane and nitrous oxide to CO2 equivalent units. ClearPath Climate Planner's inventory calculators allow for input of the sector activity (i.e. kWh or VMT) and emission factor to calculate the final carbon dioxide equivalent (CO2e) emissions.

CLIMATE CHANGE IN THE GREAT LAKES REGION AND GRAND RAPIDS, MICHIGAN

GLISA
A NOAA RISA TEAM

This document describes the City of Grand Rapids' exposure to historic, current, and projected future changes in weather and climate.

Great Lakes Regional Summary

- Average air temperature in the Great Lakes region has increased by 2.3°F.
- Average air temperature is projected to rise 3°F to 6°F by the mid-21st century.
- Total annual precipitation has increased by 14% in the region with significant intra-regional variation.
- The total volume of rain falling in the most extreme 1% of events has increased 35%.
- Total annual precipitation will likely increase in the future, though types of precipitation will vary (i.e., more winter precipitation in the form of rain).

A. Climate Change Profile for the Great Lakes Region

Since the Industrial Revolution, human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere, changing the earth's climate. The climate of cities throughout the Great Lakes region are already experiencing the effects of those changes. Rising temperatures are leading to more storm activity in our atmosphere, helping to fuel extreme weather and increased precipitation. While heat, drought, and other changes associated with climate change remain a concern for the future, many areas of the region are already facing challenges associated with more total precipitation and more frequent downpours.

Temperature

Average annual temperatures in the Great Lakes region have increased by 2.3°F since 1951, faster than the global and national rates. Most of this warming has been observed during the late spring and early winter, and in overnight low temperatures. The average temperature for the Great Lakes region is projected to increase in the future (3°F to 6°F by 2050), and many of the northern parts of the region will likely experience the most change. The region is projected to see increases in the number of hot and very hot days by the end of the 21st century, with projections indicating the region will see 17 to 42 more days over 90°F in an average year compared to the late 20th century.

Precipitation

The Great Lakes region has experienced changes in the frequency, amount, and form of precipitation. Total precipitation has increased by 14% since 1951 across the region, though this change varies within the region. Therefore, more local data should be used where available. In addition, heavy precipitation (over 1.25" of rainfall in 24hrs) has increased rapidly throughout the region. The amount of rain falling in the most extreme events (heaviest 1% of storms) has increased by 35% and these events have generally become more frequent since 1951. Much of the region is projected to experience more average annual precipitation with total amounts ranging from an additional 2 to 6 inches per year by the end of the 21st century. In addition, the Great Lakes themselves are projected to contribute more water vapor to the air. This increase in moisture combined with rising temperatures, which are necessary for storm formation, will likely produce more intense storms in the future.

Climate change will likely accelerate in the future.

The observed trends in temperature, precipitation, and seasonality are projected to continue or accelerate into the future. The rate of warming has been fastest during the winter, with some locations experiencing twice the annual warming rate of the Great Lakes region. Temperatures will continue to warm at a pace near or faster than the current rate, and precipitation will likely continue to increase, though variability and multi-year dry periods should still be anticipated. By mid-century, summer and spring temperatures may have greater increases compared to fall and winter.

Preparing for the next normal, not a new normal.

The climate system is dynamic and will continue to change rapidly due to greenhouse gas emissions and inherent

feedback systems. The challenges, priorities, and risks of the current or next generation climate will continually change and will affect all sectors. Importantly, climate and weather conditions will not change to a new set of static conditions. This means long-term planning efforts in all departments should regularly evaluate climate and be as flexible and adaptable as possible. Assessing vulnerabilities of a city's assets is a first step toward this goal.

The following table summarizes how various climate risk factors in the Great Lakes region are expected to change in the future. The number and direction of arrows indicate the relative projected trend for mid-century and end of century. A single arrow indicates a projected moderate increase or decrease by mid-century, and two arrows indicate a substantial increase or decrease by end of century.

Table 1: Climate Change in the Great Lakes Region

Risk	By Mid Century	By End of Century	Summary
Convective Weather (Severe Winds, Lightning, Tornadoes, Hail)	**Uncertain***	**Uncertain***	While extreme precipitation has increased in the region, specific severe weather types (e.g., tornadoes and hail) have remained relatively stable over time.
Severe Winter Weather (Ice/Sleet Storms, Snow Storms)	**Uncertain***	⌄	Warmer, shorter winters will reduce the length of winter and winter-related impacts. However, some areas may see more ice, sleet, freezing rain, and wet snow with slightly warmer winter temperatures.
Extreme Heat	⌃	⌃⌃	The number of extremely hot days, those over 95°F and 100°F, will likely increase, though not as fast as in areas farther south. Overnight lows have warmed faster than daytime highs, which may lessen opportunities for relief during heat waves.
Extreme Cold	⌄	⌄⌄	The number of extremely cold days (i.e., days below 10°F) have decreased in the region and are projected to decrease even more in the future.
Dam Failures	⌃	⌃⌃	Stronger and more extreme precipitation events coupled with aging dam infrastructure will increase the probability of dam failure, if appropriate measures are not taken.
Flood Hazards	⌃	⌃⌃	Stronger and more extreme precipitation events will be more likely to overwhelm stormwater infrastructure without appropriate adaptation efforts.
Wildfires	**Uncertain***	⌃	Summer drought and the number of consecutive dry days may increase in the future, despite more precipitation annually, increasing the risk of wildfires.
Drought	**Uncertain***	⌃	Summer drought and the number of consecutive dry days may increase in the future.
Infestation	⌃	⌃	With shorter winters and longer growing seasons, conditions may become more suitable for invasive species and pests currently found elsewhere and distribute vector-borne illnesses.

**Boxes labeled uncertain reflect either a lack of available data to discern a trend or no apparent trend from existing data.*

The arrows in this table reflect a qualitative assessment made by the project team based on the best available data for the Great Lakes region. While these trends hold true for projections for most of the region, they should not be assumed to hold true for any particular location. Data used to make this assessment is provided by the NOAA Technical Report NESDIS 142-3 and the Third National Climate Assessment.

B. Grand Rapids City Summary

Grand Rapids City Summary

- Average air temperature is projected to rise 3°F to 5°F by the mid-21st century.
- Total annual precipitation has increased by 16%.
- The total volume of rainfall in extreme events (heaviest 1% of storms) has increased by 52%.
- Total annual precipitation will likely increase in the future, though types of precipitation will vary (i.e., more winter precipitation in the form of rain).

The following is a summary of historic as well as projected changes in climate specific to Grand Rapids. This information is valuable in helping us understand what changes we have already experienced as well as what changes we anticipate.

Table 2: Historic and Projected Changes in Climate for the City of Grand Rapids

	Historic (1981-2010)	Mid-Century Projections (High Emissions)	End of Century Projections (High Emissions)	Change Mid-century/ End of century	Percent Change* Mid-century/ End of century
Average Temperature	47.3°F	50 to 52°F	52 to 57°F	3 to 5°F / 5 to 10°F	6 to 10% / 10 to 21%
Winter	24.5°F	27 to 29°F	30 to 33°F	2 to 4°F / 5 to 8°F	10 to 18% / 22 to 35%
Spring	46°F	48 to 52°F	51 to 57°F	2 to 6°F / 5 to 11°F	4 to 13% / 11 to 24%
Summer	68.8°F	73 to 76°F	77 to 81°F	4 to 7°F / 8 to 12°F	6 to 10% / 12 to 18%
Fall	49.6°F	52 to 56°F	55 to 62°F	2 to 6°F / 5 to 12°F	5 to 13% / 11 to 25%
Average Low Temperature	36.3°F	39 to 41°F	42 to 46°F	3 to 5°F / 6 to 10°F	7 to 13% / 16 to 27%
Average High Temperature	58.3°F	60 to 63°F	62 to 68°F	2 to 5°F / 4 to 10°F	3 to 8% / 6 to 17%
Days/Year Greater than 90°F	7.9 days	20 to 38 days	37 to 72 days	12 to 30 days / 29 to 64 days	153 to 381% / 368 to 811%
Days/Year Greater than 95°F	1.4 days	4 to 13 days	Not Available	3 to 12 days / Not Available	186% to 829% / Not Available
Days/Year Less than 32°F	152 days	122 to 129 days	Not Available	-31 to -23 days / Not Available	-20% to -15% / Not Available
Total Annual Precipitation	34.9 in.	33 to 38 in.	33 to 42 in.	-2 to 3 in. / -2 to 7 in.	-5 to 9% / -5 to 20%
Winter	5.5 in.	6 to 8 in.	5 to 10 in.	0 to 2 in. / -1 to 4 in.	9 to 45% / -9 to 82%

Table 2: Historic and Projected Changes in Climate for the City of Grand Rapids					
Spring	9.1 in.	9 to 11 in.	9 to 12 in.	0 to 2 in. / 0 to 3 in.	-1 to 21% / -1 to 32%
Summer	9.9 in.	8 to 11 in.	7 to 11 in.	-2 to 1 in. / -3 to 1 in.	-19 to 11% / -29 to 11%
Fall	10.4 in.	9 to 11 in.	9 to 12 in.	-1 to 1 in. / -1 to 2 in.	-13 to 6% / -13 to 15%
Heavy Precipitation Days	3.8 days (> 1.25")	4.2 to 5.5 days	4.6 to 6.8 days	0.4 to 1.7 days / 0.8 to 3 days (> 1")	11 to 45% / 21 to 79%

**Percent change is calculated as the difference between the projected values and the historic average, divided by the observation and multiplied by 100.*

Data provided in this table is described in the "About the Data" section for "GHCN", "CMIP3", and "Dynamically Downscaling for the Midwest and Great Lakes Basin."

Temperature and Hot/Cold Extremes

Average Temperature

The average air temperature in Grand Rapids has decreased by 0.2°F from 1951 to 2017, with the current annual average temperature being 47.3°F. Average seasonal temperatures have also changed, with increases in winter and spring temperatures and decreases in summer temperatures. Average temperatures in Grand Rapids are projected to increase 3.0 to 5.0°F by mid-century under a business as usual (i.e., high emissions) scenario, with summer having the greatest increases of 4.0 to 7.0°F.

Hot Days

Days with temperature at or above 90°F are common with multiple occurrences in most years and a slight decreasing trend over time. Many years on record have experienced 2 to 4 consecutive days over 90°F, with events of 5 to 7 consecutive days occurring less frequently. By mid-century (i.e., 2050), models suggest an increase of anywhere from 12 to 30 more days per year over 90°F, and an increase of 29 to 64 more days per year over 90°F by end of century. Models are not able, however, to tell us if those days will be consecutive or not.

Days with high temperatures at or above 95°F have been very rare, with very few occurrences of more than one consecutive day experiencing maximum temperatures over 95°F. By mid-century (i.e., 2050), models suggest an increase of 3 to 12 days over 95°F. However, such hot days will not necessarily occur consecutively.

Heat waves can result from a combination of different drivers including high humidity, daily high temperatures, high nighttime temperatures, stagnant air movement, etc. In the future, models project an increase in the number of days experiencing high temperatures that could lead to additional heat waves, especially since air stagnation events are projected to increase. There is greater certainty that summer nighttime low temperatures will continue to increase, thereby making it more difficult to cool off at night during extended heat events. In addition, any periods of future drought will also contribute to extreme heat.

Cold Days

On average, Grand Rapids experiences 152 days per year that fall below freezing (32°F). Historical records show this number has decreased already. The city is projected to experience fewer nights below 32°F, with decreases of 23 to 31 days by mid-century.

Days with temperatures at or below 10°F are very common and have experienced a slight decreasing trend over time. Consecutive days at or below 10°F are also frequent, and typically last for 2 to 5 days with less

frequent occurrences lasting 6 to 15 days. In the future, there are projected to be even fewer very cold days, so this type of event will be even rarer.

Precipitation and Flood/Drought Indicators

Average Precipitation

The amount of total annual precipitation in Grand Rapids has increased by 16% (5.3") from 1951 to 2017. An increase in precipitation was observed in all four seasons, with the spring seeing the greatest percentage increase of 35.8% (3.1"). Average annual precipitation in Grand Rapids is projected to increase by up to 3 inches by mid-century and by up to 7 inches by the end of the century.

Heavy Precipitation

The frequency and intensity of severe storms has increased historically, with a 40% increase in the number of extreme precipitation events (heaviest 1% of storms) and a 52% increase in the total volume of rainfall during these events between 1981-2010. Grand Rapids is projected to experience an increase of up to 1.7 days of heavy precipitation (days with over 1" of rainfall) per year by mid-century and by up to 3 days per year by end of century.

Flooding results when rainfall volumes exceed the capacity of natural and built infrastructure to handle precipitation.

Stormwater managers look at several different "design" storms (inches falling over a certain length of time) when designing and managing their systems. These "design" storms are effectively the probability of any given amount of precipitation falling in a set period of time, based on historical experience. Monitoring over time shows that the volumes falling during these "design" storms are increasing. What this means is that the values used to build our existing infrastructure (Bulletin 71 (Huff and Angel, 1992), used data through 1986, and Atlas 14 (NOAA HDSC) added a longer period of data into the 21st century) are dependent on fluctuating estimates of rainfall.

The table below shows precipitation volumes in inches for both Bulletin 71 and Atlas 14 (Bulletin 71/Atlas 14) along with percent change between the two in brackets. This data shows how the "design" storm has changed over time.

In the Great Lakes region, projected changes in seasonal mean precipitation span a range of increases and decreases. In the winter and spring, the region is projected to experience wetter conditions as the global climate warms. By mid-century, some of this precipitation may manifest in the form of increasing snowfall, but projected warmer conditions by end of century suggests such precipitation events will most likely be in the form of rainfall (Wuebbles et al. / USGCRP, 2017).

Precipitation events of more than 2" in a day (i.e., 24-hour period) are projected to increase by less than one day by mid-century and up to about 1.5 days by end of century.

Table 3: Precipitation Frequencies for the City of Grand Rapids

	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1-hr	0.92 in. / 1.06 in. [15.2%]	1.11 in. / 1.24 in. [11.7%]	1.41 in. / 1.55 in. [9.9%]	1.65 in. / 1.83 in. [10.9%]	2.09 in. / 2.24 in. [7.2%]	2.48 in. / 2.58 in. [4.0%]	2.89 in. / 2.94 in. [1.7%]
12-hr	1.70 in. / 1.95 in. [14.7%]	2.06 in. / 2.25 in. [9.2%]	2.61 in. / 2.81 in. [7.7%]	3.06 in. / 3.33 in. [8.8%]	3.87 in. / 4.13 in. [6.7%]	4.58 in. / 4.82 in. [5.2%]	5.35 in. / 5.56 in. [3.9%]
24-hr	1.95 in. / 2.22 in. [13.8%]	2.37 in. / 2.56 in. [8.0%]	3.00 in. / 3.18 in. [6.0%]	3.52 in. / 3.77 in. [7.1%]	4.45 in. / 4.66 in. [4.7%]	5.27 in. / 5.43 in. [3.0%]	6.15 in. / 6.27 in. [2.0%]

This table does not show projections for how the design storm may change in the future due to climate change.

Precipitation events of more than 3" in a day are projected to increase by less than a day by both mid-century and by end of century.

Annual snowfall totals have been variable, with an increasing in the last 40 years. There has been a slight decreasing trend in days with snowfall (over 0.1" of snowfall in 24 hrs), with varying year-to-year conditions. Warmer temperatures in the future will cause some winter precipitation to transition from snow to rain over time. The projected change in annual snowfall is variable. Annual snowfall is projected to decrease by 4" to 11" by mid-century and by 10" to 17" by end-of century.

Rain Free Periods (3-week events with less than 0.5" of rain)

Drought, defined here as periods of 3 weeks with less than 0.5" of rainfall, has been highly variable year-to-year, with an overall decreasing trend. In the future, even though more annual precipitation is projected overall, more is anticipated to fall in shorter, extreme events. Thus, there will be longer periods of time that experience no rainfall, increasing the potential for drought.

About the Climate Change in the Great Lakes Region and Grand Rapids Data

Coupled Model Intercomparison Project (CMIP) Version 3. The future (mid-century) climate projections for Grand Rapids are based on the Coupled Model Intercomparison Project Version 3 (CMIP3) A2 emissions scenario, representing "business as usual" high emissions scenario. These data were selected because they were used in the Third National Climate Assessment (Melillo et. al., 2014). More information is available at: https://www.wcrp-climate.org/wgcm-cmip

"Dynamical Downscaling for the Midwest and Great Lakes Basin." Future projections are based on the dynamically downscaled data set for the Great Lakes region developed by experts at the University of Wisconsin-Madison. There are a total of six downscaled models that represent how a variety of different variables are projected to change (mid-century, 2040-2059, compared to the recent past, 1980-1999). The ranges are comprised of the lowest and highest values from all six dynamically downscaled data sets. The regional data are available for download at: https://ccr.nelson.wisc.edu/dynamical-downscaling/index.php

National Oceanic and Atmospheric Administration National Centers for Environmental Information Global Historical Climatology Network Station Observations (GHCN). More information about this station located in Grand Rapids, MI from 1981-2010 is available at: http://glisa.umich.edu/station/C00203429

"National Oceanic and Atmospheric Administration ThreadEx Long-Term Station Extremes for America". ThreadEx is a data set of extreme daily temperature and precipitation values for 270 locations in the United States. For each day of the year at each station, ThreadEx provides the top 3 record high and low daily maximum temperatures, the top 3 record high and low daily minimum temperatures, the top 3 daily precipitation totals, along with the years the records were set for the date (NCAR, 2013). ThreadEx data: http://threadex.rcc-acis.org/

National Oceanic and Atmospheric Administration Hydrometeorological Design Studies Center Atlas 14 Precipitation Frequency Estimates. Data are available at: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

This summary was produced in 2019.

References

Huff, F. and J. Angel 1992. "Rainfall Frequency Atlas of Midwest." Midwestern Climate Center and Illinois State Water Survey. NOAA National Weather Service. Champaign, Illinois. https://www.isws.illinois.edu/pubdoc/B/ISWSB-71.pdf

Implications of NOAA Atlas 14: Precipitation Frequency Atlas of the United States for Storm Water Management. Huron River Watershed Council. Factsheet of the HRWC's Climate Resilient Communities Project.

K. Kunkel et al. 2013. NOAA Technical Report NESDIS 142-3: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment Climate of the Midwest U.S. NOAA National Environmental Satellite, Data, and Information Service. https://www.nesdis.noaa.gov/sites/default/files/asset/document/NOAA_NESDIS_Tech_Report_142-3-Climate_of_the_Midwest_US.pdf

Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program 2014, 841 pp. doi: 10.7930/J0Z31WJ2.

National Center for Atmospheric Research Staff (Eds). "The Climate Data Guide: NOAA ThreadEx Long-term Station Extremes for America." Last modified 20 Nov 2013. Retrieved from https://climatedataguide.ucar.edu/climate-data/noaa-threadex-long-term-station-extremes-america.

Perica, et al. 2013. NOAA Atlas 14 Volume 8 Version 2, Precipitation Frequency Atlas of the United States, Midwestern States. NOAA National Weather Service. Silver Spring, Maryland.

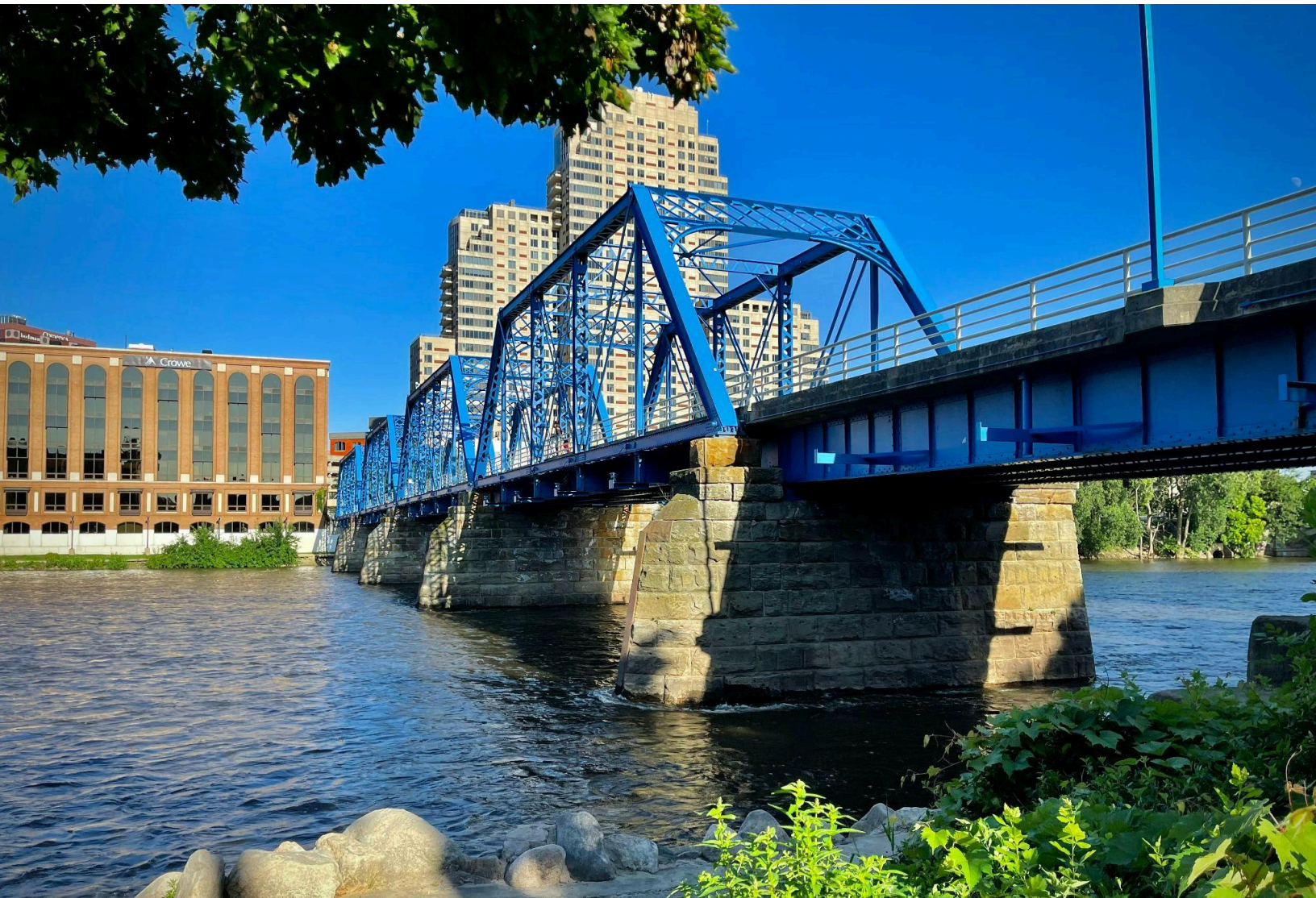
Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville, 2014: Chapter 2: Our Changing Climate. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T. C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 19-67. doi: 10.7930/J0KW5CXT.

Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.). "Climate Science Special Report: Fourth National Climate Assessment, Volume I." U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6.

Climate Risk and Vulnerability Assessment Report

City of Grand Rapids

OCTOBER, 2024



Acknowledgements

Climate Risk and Vulnerability Assessment Working Group

City of Grand Rapids:

- Alex Fleet, Former Assistant Water Systems Manager
- Allison Farole, Emergency Management Administrator
- Annabelle Wilkinson, Interim Chief Sustainability Officer
- Daniel Taber, Stormwater Manager, Environmental Services Department
- David Green, Director of Communications
- James Hurt, Public Services Director
- Jay Steffen, Assistant Planning Director
- Karie Enriquez, Project Manager (Parks and Recreation)
- Michael Staal, Project Manager
- Tim Burkman, City Engineer

Community:

- Becky Pobst, Director of Community Forestry, Friends of Grand Rapids Parks
- Erik Petrovskis, Director of Environmental Compliance and Sustainability, Meijer
- Felicia Sims, C4 Ambassador
- Fredericka Brown, C4 Ambassador
- Iris Gipson, C4 Ambassador
- Jana Mueller, Corporate Sustainability Manager, Perrigo Company plc
- Jonathan Wilson, Regional Manager, DTE Energy
- Kelsey Groesbeck, Director of Building Science, Tower Pinkster
- Nate Henschel, Community Affairs Manager, Consumers Energy
- Ned Andree, C4 Project Coordinator
- Synia Gant-Jordan, C4 Leadership Team Director
- Tasha Blackmon, President and Chief Executive Officer, Cherry Health

C4 Focus Group Team

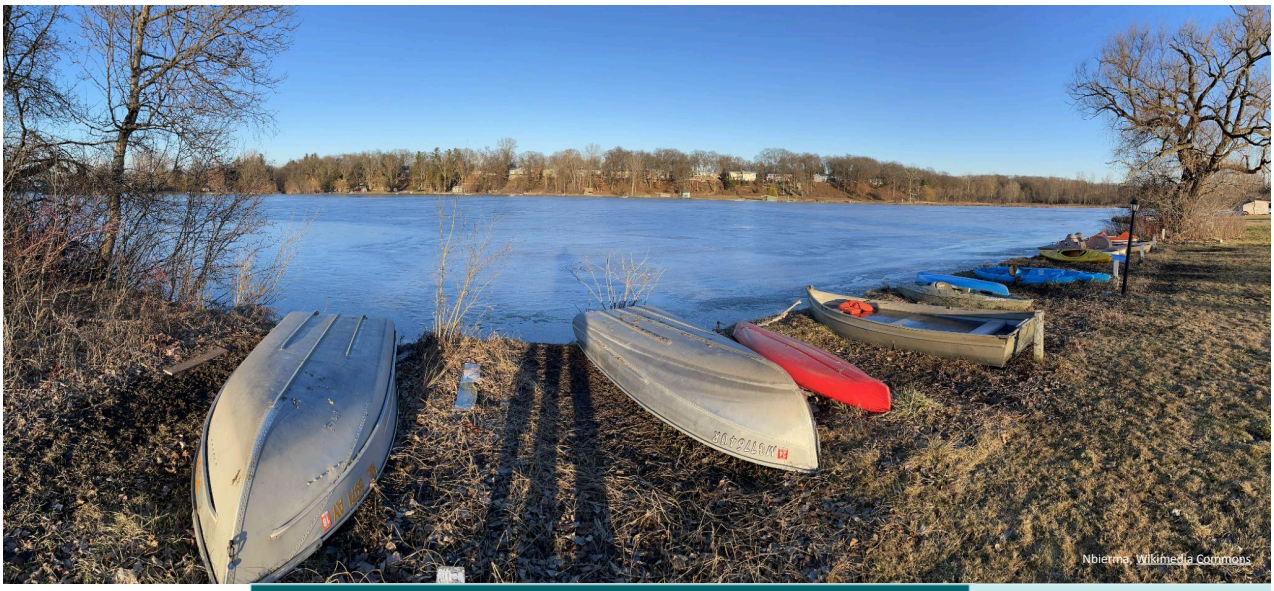
- Bestsaida Valdivia, C4 Ambassador
- Dee Jones, C4 Ambassador
- Cynthia Bailey, C4 Ambassador
- Ebony Wilson, Sistas in Development President
- Felicia Sims, C4 Ambassador
- Fredericka Brown, C4 Ambassador
- Iris Gipson, C4 Ambassador
- Ned Andree, C4 Project Coordinator
- Reyna Garcia, C4 Leadership Team Director
- Robert Simmons, C4 Ambassador
- Synia Gant-Jordan, C4 Leadership Team Director
- Yolanda Aldridge, C4 Ambassador

Contributors

- Cristy S. Rankin, Emergency Management Specialist, DTE Energy
- Erin Evenhouse, Transportation Planning Supervisor, City of Grand Rapids
- Joe Sulak, Parks Superintendent, City of Grand Rapids
- John Bartlett, Transportation Engineer, City of Grand Rapids
- Kristin Bennett, Transportation Engineering Projects Manager, City of Grand Rapids
- Richard App, Retail Retention & Attraction Specialist, Grand Rapids Chamber, City of Grand Rapids, DGRI

ICLEI USA Consultant Team

Angelica Greco, Senior Program Officer, Resilience
Anne Jansen, Resilience Associate
Catelyn Sweeney, Graduate Intern
Margot Shrift, Graduate Intern
Melissa Velasquez, Graduate Intern



This report was prepared by ICLEI–Local Governments for Sustainability USA

Table of Contents

32 participants, including youth, engage in a focus group led by C4 Ambassadors at Samaria J's Salon. Photo credit: Ned Andree #TheDNA.

Glossary

Adaptation: The process of adjusting to new and changing climate conditions in order to reduce risks to people and valued assets [1].

Adaptive Capacity: The ability of an asset or system to adjust or adapt to climate change [1].

Climate Adaptation Partnerships (CAP): National Oceanic and Atmospheric Administration (NOAA) program that supports research teams that help expand and build the nation's capacity to prepare for and adapt to climate variability and change [2].

Climate models: Models that simulate the physical, chemical, and biological processes that influence the climate system [3]. To learn more about climate models, see: [4].

Climate projections: Climate projections are the outputs of climate models, which are built on a series of assumptions about the Earth system and future greenhouse gas (GHG) emissions. Climate projections are not predictions for the future, but should instead be considered as an approximation of the range of possible future conditions. This is why it is important to view them in terms of multi-year averages, ranges, and trends [5].

Climate risk and vulnerability assessment (CRVA): A local study of the ways in which a community is susceptible to the impacts of climate change.

Combined Sewer Overflow (CSO): When runoff exceeds the capacity of a combined sewer system, causing untreated stormwater and wastewater to flow into nearby water bodies [6].

Corridor Improvement Authority (CIA): Corridor Improvement Authorities help communities plan for and fund improvements along a corridor to support economic redevelopment.

Coupled Model Intercomparison Project (CMIP): A project of the World Climate Research Programme providing climate projections to understand past, present, and future climate changes. CMIP and its associated data infrastructure have become essential to the Intergovernmental Panel on Climate Change (IPCC) and other international and national climate assessments [7].

Energy burden: The percentage of gross household income spent on energy costs.

Exposure: The presence of assets or systems in areas that are likely to experience the effects of a climate hazard now or in the future [1].

Greenhouse gases (GHGs): Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth's ocean and land surface, by the atmosphere itself and by clouds. This property causes the greenhouse effect [8].

Hazard: An event or trend that may cause injury, illness, or death to people or damage to assets. In this report the term "hazard" primarily refers to climate-related physical events or trends [1], [8].

Impacts: Consequences or outcomes, which can be positive or negative. In this document, the term "impacts" primarily refers to the impacts of climate-related hazards on people and assets [1], [8].

Neighborhoods of Focus: City of Grand Rapids census tracts with the highest percent of Black, Indigenous, and People of Color (BIPOC) residents and the greatest disparities across all quality-of-life indicators such as education, wealth, and employment [9].

Resilience: The ability of people, systems, or community assets exposed to a hazard to resist, absorb, accommodate, adapt to, transform and recover from the hazards' impacts [10].

Risk: The potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard. Risk can be assessed by multiplying the probability of a hazard by the magnitude of the negative consequence or loss [1].

Sensitivity: How an asset or system fares when exposed to a climate hazard [1].

Targeted Universalism: Targeted universalism involves setting universal goals, assessing how [different groups in the community] fare relative to the goals, and addressing barriers, structural impediments, and resource deficiencies in a targeted manner in order for all groups to meet goals. Adapted from: [11].

Vulnerability: The propensity or predisposition to be adversely affected by hazards. Vulnerability encompasses exposure, sensitivity, and adaptive capacity [1].

Abbreviations

BIPOC	Black, Indigenous, People of Color
CAP	Climate Adaptation Partnerships
CAAP	Climate Action and Adaptation Plan
CBO	Community-Based Organization
CE	Consumers Energy
CIA	Corridor Improvement Authority
CRVA	Climate risk and vulnerability assessment
CSO	Combined Sewer Overflow
C4	Community Collaboration on Climate Change
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
GHG	Greenhouse gas
GIS	Geographic information systems
HMP	Hazard Mitigation Plan
ICLEI USA	ICLEI—Local Governments for Sustainability USA
IPCC	Intergovernmental Panel on Climate Change
NOAA	National Oceanic and Atmospheric Administration
USGCRP	US Global Change Research Program
WG	Working Group

Executive Summary

This climate risk and vulnerability assessment (CRVA) Report (hereafter referred to as this Report) brings together climate information and insights on Grand Rapids' people, community systems, infrastructure, and natural resources to reveal local vulnerabilities to climate change. Grand Rapids' dedicated CRVA Working Group, composed of City staff and community members, provided local knowledge and perspectives underlying this Report's findings. The City partnered with Community Collaboration on Climate Change (C4), a majority BIPOC-led network of local Community-based Organizations (CBOs), to host focus groups with community members whose insights appear throughout this Report.

This Report focuses on four broad categories of hazards related to climate change: 1) rising temperatures and extreme heat; 2) heavy rainfall and flooding; 3) severe convective storms; and 4) drought. Additional climate hazards, including wildfire smoke and warmer winters, are also addressed to a degree in this Report. As the community experiences highlighted throughout this Report show, climate hazards are already negatively affecting Grand Rapids. According to the best available climate data and research, hazard impacts will worsen as climate change accelerates.

Climate change does not affect everyone in Grand Rapids equally. People and communities who are historically disadvantaged, marginalized, underserved, or burdened by pollution are already experiencing the impacts of climate change "first and worst". The City partnered with C4 to prioritize engagement with frontline communities through six focus groups held in May 2024. In these focus groups, 109 Grand Rapidians shared their concerns, needs, priorities, and aspirations for a climate-resilient Grand Rapids.

Key Findings and Recommendations

The following recommendations and example strategies were developed through the CRVA process. The recommendations highlight possible entryways to address the City's biggest threats. Each recommendation is paired with example adaptation strategies that the City could pursue through the Climate Action and Adaptation Plan (CAAP) process.

Table 1. Recommendations and example adaptation strategies. Note: These strategies are recommended to the City for consideration but have not been officially adopted.

Overarching Approach to Adapt to Climate Change and Build Resilience
RECOMMENDATION: Prepare for More Interconnected, Complex, and Cascading Hazards Hazards are already occurring more often than they used to. As the climate changes, Grand Rapids needs to prepare for hazards that are interconnected, complex, and cascading. Novel events, like the 2023 Canadian wildfire smoke, will happen more often. It is essential that the City monitor and prepare for interactions between hazards, such as increased urban flooding following periods of drought. The changing hazard landscape is already straining City staff and resources, as well as those of community-serving organizations. For residents and businesses, particularly those who are disadvantaged, these hazards can become "threat multipliers" that erode affordability, wealth, health, and wellbeing gains. While no place is immune to the threat of climate change, cities with *relatively* lower levels of hazard risk, like Grand Rapids (in comparison to parts of the Southeast, West, and coastal US), should consider the potential for climate-related migration in planning.
EXAMPLE ADAPTATION STRATEGIES
Collaborate: Work with a wide range of community-serving institutions to raise awareness, increase capacity, and support readiness for climate disasters
Collaborate: Build and expand existing partnerships with neighboring regional and state partners to increase readiness
Equity & Inclusion: Participate in ongoing dialogues with the community to understand the local impacts of hazards beyond what is immediately visible (e.g. physical damage); work to understand how climate change interacts with existing stressors and burdens in the community
Plans & Policies: Integrate hazard mitigation planning with climate change adaptation efforts; normalize climate resilience as a core element of hazard mitigation
Plans & Policies: Use exercises like scenario planning, which push stakeholders to think through multiple possible futures, to build understanding and governance approaches for complex outcomes, including climate-related migration
Assess & Invest: Increase emergency management staffing and investment to recommended levels
RECOMMENDATION: Center Equity and Inclusion in Resilience Action Climate change is affecting some communities first and worst. In Grand Rapids, BIPOC individuals, people with disabilities, residents of the Neighborhoods of Focus, older and younger people, people who do not speak English well, undocumented individuals, residents

who are unhoused, and many other groups are more likely to live and work in areas at risk of climate hazards and may have fewer resources to recover after disasters. For some in these groups, climate change is amplifying daily life challenges by increasing utility bills, damaging property, and causing lost income. It is essential the City and community partners co-develop and implement investments that meet a range of needs, both climate-related and otherwise. Uplift approaches that center goals and aspirations over those that define communities by their needs and challenges; center relationship-building. Acknowledge links between the social determinants of health, exposure to climate hazards, and ability to adjust or bounce back. It is important to note that decision makers may not associate needs that are top of mind for community members (e.g. energy burden, power outages) with climate change, highlighting the importance of early and sustained engagement that continues even after planning cycles end.

EXAMPLE ADAPTATION STRATEGIES

Collaborate: Co-create adaptation and mitigation strategies with frontline community members and organizations through participatory approaches (e.g. workshops, focus groups)

Equity & Inclusion: Participate in ongoing dialogues with the community to understand local impacts of climate change; work to understand how climate change interacts with existing stressors and burdens in the community

Plans & Policies: Integrate equity into all climate and environmental planning processes

Assess & Invest: Work with community partners to secure sustainable funding and investment in their work and operations

RECOMMENDATION: Resilience Building Is a Marathon

The City of Grand Rapids emphasizes sustainability and resilience as core values in decision making. The City's 2022 Strategic Plan defines sustainability as "making decisions with the goal of achieving long-term net positive benefits that are informed by an understanding of how those decisions will impact climate resiliency and the environment, people and communities, and finances, both today and in the future" [12]. The first step toward planning in line with these values is breaking down silos and taking a "whole-of-government" approach characterized by cross-departmental problem-solving and shared ownership over resilience goals. The next step is recognizing that climate change is inherently tied to all community priorities and functions, including housing, transportation, budgeting, health, environmental remediation, economic development, emissions reductions, and more. Integrating climate resilience across work in these areas can turbocharge progress while leading to efficiencies and avoiding costs down the road, while failure to consider climate impacts jeopardizes these goals. Building climate resilience is an ongoing and evolving journey that the City, community partners, and all Grand Rapidians share. The City can support residents through ongoing engagement with community partners, sustained funding for community priorities, and open communication channels.

EXAMPLE ADAPTATION STRATEGIES

Collaborate: Create a chief resilience officer position or a cross-government advisory body to advance collaboration on climate resilience across City functions

Engage & Building Capacity: Provide training and learning opportunities for staff and community-serving organizations; create forums for engagement on climate resilience

Plans & Policies: Integrate climate resilience into departmental planning processes

Assess & Invest: Tie Climate Action and Adaptation Plan (CAAP) goals to funding; include an implementation matrix that assigns deadlines and responsibilities for adaptation action; regularly update the community on progress

Recommendations by Hazard

RECOMMENDATION: Tackle Extreme Heat

Rising temperatures and extreme heat pose profound threats to health, safety, and quality of life in Grand Rapids. The city's disadvantaged individuals and neighborhoods face the highest risk. With the city's historically milder summers, residents and community-serving organizations are not accustomed to extreme heat and may underestimate risk. The impacts of heat can be worsened by co-occurrence with other hazards, including poor air quality.

EXAMPLE ADAPTATION STRATEGIES

Collaborate: Work with a wide range of community-serving institutions as well as businesses to raise awareness, increase capacity, and support their own heat readiness

Equity & Inclusion: Offer desired and convenient cooling features and interventions (e.g. splash pads, shade structures, pop-up and mobile cooling centers) that are tailored and responsive to the communities they serve

Equity & Inclusion: Develop and expand community-focused programs to help Grand Rapidians cope with heat (e.g. provision of AC units to households without) and its costs, including higher utility bills

Plans & Policies: Use maps and data layers created through this project to mitigate urban health islands; optimize tree planting and identify priority areas for de-paving; set an example by starting with city-owned property

Engage & Build Capacity: Adopt or expand efforts to inform the community about the dangers of heat and available City and community resources to protect health; disseminate information in commonly spoken languages using accessible channels and messengers

Assess & Invest: Monitor funding and capacity needs for extreme heat response

RECOMMENDATION: Maintain Momentum on Flooding and Stormwater Management Grand Rapids has made significant investments to reduce risks associated with heavy rain and flooding. These include works separating the city's combined sewers and improvements to the flood protection system following the 2013 Grand River flood. While these efforts have reduced harmful impacts of flooding in the City, it is important that they not lead to complacency, particularly as the City encourages development along the Grand River. Urban flash flooding, which can occur in non-riverfront areas outside of the floodplain, is becoming more common and damaging. This type of flooding can begin quickly, with little time to warn residents, such as when it is caused by quick, intense rainfall.
EXAMPLE ADAPTATION STRATEGIES
Collaborate: Work across the wider region to collectively manage waterways and floodplains
Equity & Inclusion: Engage with historically disadvantaged areas that host polluted waterways (e.g. Plaster Creek) to strategize around desired renewal efforts
Plans & Policies: Use maps and data layers created through this project to proactively identify areas facing increased flood risk from climate change; supplement these maps with local knowledge and studies
Plans & Policies: Continue and expand efforts to restore natural riparian systems
Engage & Build Capacity: Adopt or expand efforts to incentivize community members and businesses to install green infrastructure
Engage & Build Capacity: Raise awareness and provide education to residents on reducing flooding impacts on their homes (e.g. raising HVACs, clearing storm drains) and securing appropriate types and levels of insurance (home, renters, and flood insurance)
Assess & Invest: Prepare for the need to raise flood protection elevations to cope with increased heavy precipitation
Assess & Invest: Invest in enhancing stormwater management; ensure sufficient funds for green infrastructure, storm drains, and other needs
RECOMMENDATION: Get Ahead of Drought Despite Grand Rapids' proximity to Lake Michigan, the city remains vulnerable to drought. Among stakeholders, awareness and concern is lower than for hazards that have occurred more recently. The risk of drought deserves greater attention.
EXAMPLE ADAPTATION STRATEGIES
Collaborate: Work across the wider region to adopt a collaborative approach to water management

Equity & Inclusion: Proactively plan to ease water utility burden for low-income and disadvantaged households

Plans & Policies: Adopt or expand water conservation policies including sustainable landscaping practices, lawn removal, and regulations on outdoor water use

Engage & Build Capacity: Adopt or expand efforts to inform and incentivize community members and businesses to reduce water use

Assess & Invest: Assess and, if needed, invest in adaptation for drought-vulnerable infrastructure

RECOMMENDATION: Bolster Existing Capacity to Manage Storms
Convective storms, including thunderstorms, hail, and high winds, are a part of life in Grand Rapids. However, in recent years, Grand Rapids has been experiencing more frequent and damaging storm events than in the past. This lines up with climate change projections, which show increased storm activity in the Midwest. These storms can develop rapidly, making it difficult to disseminate warnings in time for the community to prepare. Power outages were top-of-mind for participants in the CRVA Working Group and community focus groups. Though electricity is often restored quickly, even short outages have cascading impacts on health and income.

EXAMPLE ADAPTATION STRATEGIES

Collaborate: Support and partner with utilities to shore up infrastructure and grid reliability

Collaborate: Work with a wide range of community-serving institutions as well as businesses to raise awareness, increase capacity, and support their own storm readiness

Equity & Inclusion: Build out new programs (and continue existing ones) to support vulnerable community members during power outages; seniors and people with health conditions are particularly vulnerable

Plans & Policies: Consider increased storm activity in tree planting and management, including the development of protocols for robust removal of storm debris with clearly defined roles

KEY ANGLES AND GAPS

RECOMMENDATION: Changing Climate, Changing Wellbeing
Not all impacts of climate change are visible. Warming winters and changing environments can evoke feelings of loss and grief. Changes to culturally significant winter activities and shifting territories of key species (e.g. sugar maples) are on the horizon, if not already here. Repeated climate-related disasters increase stress and anxiety. Make space and provide resources for Grand Rapidians to process their feelings.

EXAMPLE ADAPTATION STRATEGIES

Engage & Build Capacity: Support mental health services and community-based coping mechanisms (e.g. Climate cafes) and raise awareness about existing resources
RECOMMENDATION: Climate-Aware Management of Natural Assets The city's natural features, green spaces, parks, and ecosystems are under strain from development, pollution, and invasive species. Climate change will further tax these highly valued community assets. Consider the impacts of climate change in conservation and natural asset management plans, as well as the community benefits (e.g. shade, cooling, flood mitigation) Grand Rapidians receive from healthy and intact natural spaces.
EXAMPLE ADAPTATION STRATEGIES
Collaborate: Work across the wider region to adopt a collaborative approach to natural area and greenspace management
Equity & Inclusion: Continue working to improve access and equity of natural assets to reduce heat and flood risk and bring benefits to neighborhoods; use maps and data layers of heat and flood risk created through this project to help identify high-need areas
Engage & Build Capacity: Engage with Neighborhoods of Focus and historically disadvantaged areas about "volunteer" natural spaces (i.e. unmanaged and marginal areas, such as along fence lines); if desired by communities, actively manage these spaces to increase climate resilience and enhance community benefits
Plans & Policies: Consider natural assets' full range of benefits (e.g. equity, reduced heat and flooding, biodiversity) in planning, zoning, and development decisions
Plans & Policies: Adopt or expand local natural asset conservation policies including sustainable landscaping practices, lawn removal, and tree protection during development; set an example by starting with government-owned property
Assess & Invest: Monitor funding and capacity needs for climate-aware management and maintenance of natural assets; protect investments in natural areas by allocating funding to ongoing maintenance and management
RECOMMENDATION: Engage with the Business Community Recognize Grand Rapids' strong business community as both a valuable community asset in need of support around climate change, as well as a powerful force to be tapped into advance community resilience.
EXAMPLE ADAPTATION STRATEGIES
Engage & Build Capacity: Engage with local businesses about how climate change could impact them; learn about existing impacts and coping strategies to identify gaps in resilience
Engage & Build Capacity: Work to attract and support environmental social enterprises that

can build a workforce to advance climate resilience (through e.g. vacant land improvement, habitat restoration, green infrastructure maintenance) while providing career training and life sustaining jobs to individuals excluded from career opportunities
Collaborate: Support systems and resources to help businesses cope and prepare for the impacts of climate change; connect with existing networks and forums, such as the Chamber of Commerce and Corridor Improvement Authorities (CIA)
Equity & Inclusion: Raise awareness about additional challenges faced by disadvantaged businesses, including small and BIPOC-owned businesses

Community Priorities

Building an understanding of key climate vulnerabilities and community priorities in Grand Rapids is an ongoing, iterative process. Community members shared their experiences, priorities, and visions for a resilient future in Grand Rapids during six in-person focus groups hosted and facilitated by the C4 Ambassadors team. C4 intentionally engaged African American, Spanish-speaking, and unhoused Grand Rapidians. The wider community had the opportunity to weigh in on the CAAP Community Survey, which reached 440 residents between March 2023 and February 2024.

Across the survey and focus groups, Grand Rapidians shared concerns about rising costs, impacts on the economy and workers (e.g. winter recreation), effects on mental and physical health as well as personal safety, and loss of green space and natural amenities. The focus groups shared ideas for building resilience that centered around affordability, access, and education. Participants prioritized lowering utility costs and alleviating energy burden through renewable energy and relief programs; providing affordable options for increasing energy efficiency through home improvements and AC purchase and installation; increased focus on awareness and education about heat and flooding; and expanded community resources and free services to help residents cope and prepare for climate hazards. Many focus group participants and their loved ones have themselves been directly affected by heat and flooding, or witnessed the impacts of these hazards on their communities. Many shared concerns for the most vulnerable Grand Rapidians, including seniors, children, unhoused individuals, and inner city/downtown residents.

Introduction

From sudden, intense storms and flooding, to extreme cold and heat waves, extreme weather events are nothing new to the city of Grand Rapids. Looking at recent history, the 2013 Grand River flood stands out as particularly devastating. Following sudden heavy rainfall, the Grand River rose rapidly and overtopped its banks, cresting at a record-breaking 21.85 feet on April 21, its highest recorded crest [13]. Homes and businesses across the Grand Rapids metropolitan area were damaged and over 1,700 residents had to evacuate their homes. Following this event, the City made significant investments in infrastructure, including $15 million in flood protection system improvements.

The science is clear: climate change is making extreme weather events more frequent and intense. As heat-trapping greenhouse gas (GHG) emissions in Earth's atmosphere continue to rise, the impacts of climate change will get worse. In 2024 alone, extreme weather events in communities across the country highlighted dangerous gaps in climate readiness that led to tragic loss of life, infrastructure damage, and widespread disruption. The need for local governments to adapt to climate change is increasingly urgent.

Recognizing this need, the City partnered with ICLEI—Local Governments for Sustainability USA (ICLEI USA) to complete a climate risk and vulnerability assessment (CRVA), the results of which are summarized in this Report. **The purpose of this Report is to guide City planning, actions, and investments to build resilience to climate change.** To accomplish these goals, this Report assesses the vulnerability of Grand Rapids' residents, economy, infrastructure, and natural environment to climate change. Knowing who, and what, in Grand Rapids is most vulnerable will help the City prioritize actions that address its greatest risks.

This Report's findings reflect the reality that climate change does not affect everyone in Grand Rapids equally. Inequities, marginalization, discrimination, and exploitation put some in Grand Rapids "on the frontlines" of climate change. These people and groups experience the impacts of climate change first and worst and bear an outsize share of burdens and risks.

This Report is only the first step. The results of the CRVA will feed into the next step in the City's climate adaptation process, a Climate Action and Adaptation Plan (CAAP), currently in progress. Moving forward, Grand Rapids will use this Report and the CAAP as a foundation for future efforts to build community resilience, advance equitable outcomes, support a healthy and clean environment, improve quality of life, and advance preparedness for all.

About the Project

Purpose

Climate risk and vulnerability assessments (CRVAs) are local studies that identify current and future risks associated with climate change. A review of local and regional climate science and planning documents, as well as input from the community, City staff, experts, and other local stakeholders inform this Report.

Grand Rapids will use the CRVA to:

1. **Collect information about climate-related risks in a single document**, bringing together research, data, expert insights, and local knowledge and perspectives from City staff, CBOs, and community members.
2. **Incorporate climate-related risk** in future projects and planning efforts, including the City's forthcoming CAAP.
3. **Develop adaptation and resilience actions** that align with community priorities and increase resilience of the people, services, infrastructure, and ecosystems in the community that face the greatest risk from climate change.
4. **Build a case for federal, state, and philanthropic funding** that addresses the City's greatest climate risks.
5. **Increase community awareness and readiness** about the local impacts of climate change.

Key Terms

In this report, the term "vulnerability" is defined as "the propensity or predisposition to be adversely affected by hazards" [1]. Hazards can have adverse effects on people and the assets we value. In this Report, assets are broadly defined as the places, services, infrastructure, ecosystems, institutions, and other resources that the community believes are important to protect. In other words, assets are the tangible and intangible things that people and communities value. Grand Rapids assessed the vulnerability of local systems and assets to climate change using three criteria: exposure, sensitivity, and adaptive capacity (Figure 1). These terms are defined as follows:

- **Exposure** refers to whether an asset or system is located in an area that is likely to experience the effects of a climate hazard now or in the future.
- **Sensitivity** refers to how an asset or system fares when exposed to a climate hazard.
- **Adaptive capacity** refers to the ability of an asset or system to adjust or adapt to climate change.

Risk is defined as a combination of the 1) probability that a climate hazard will affect an asset or system and 2) the relative magnitude of the resulting consequences on the City as whole (Figure 2).

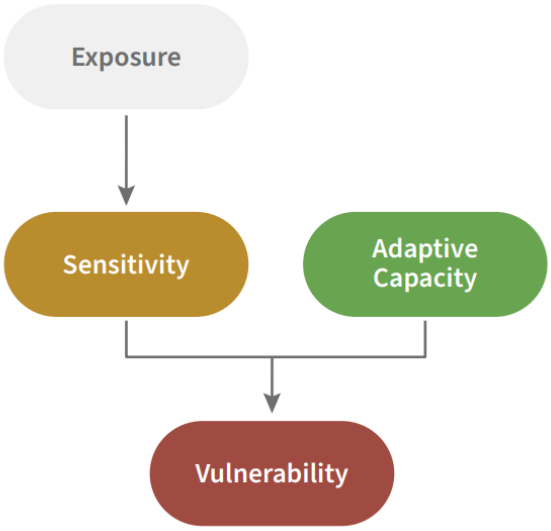


Figure 1. Vulnerability, adapted from [14].

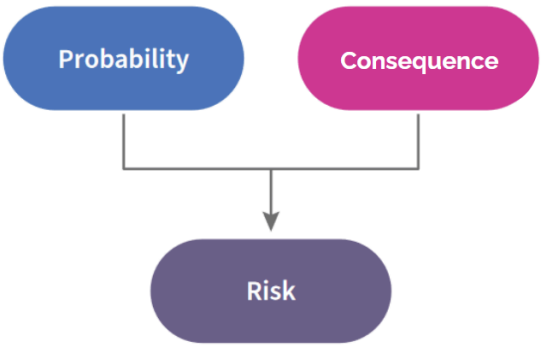


Figure 2. Risk, adapted from [14].

Resilience

Resilience is the ability of people and the assets they value to cope and adapt to the impacts of climate change. People and communities that are more resilient are better able to resist, absorb, accommodate, adapt to, transform, and recover when a hazard occurs.

The two graphs in Figure 3 illustrate the concept of resilience. The graph on the left represents the "business-as-usual" or no-action scenario in which a community has not invested in the resilience of a system, asset, or public service. In this scenario, when a hazard occurs, it pushes the system past a tipping point after which recovery efforts cannot fully restore the system to its former function, leading to permanent loss. In contrast, the graph on the right depicts a more resilient system, asset, or public service. Investments in resilience have transformed this system to the point where it is better able to respond to, and recover from, hazards.

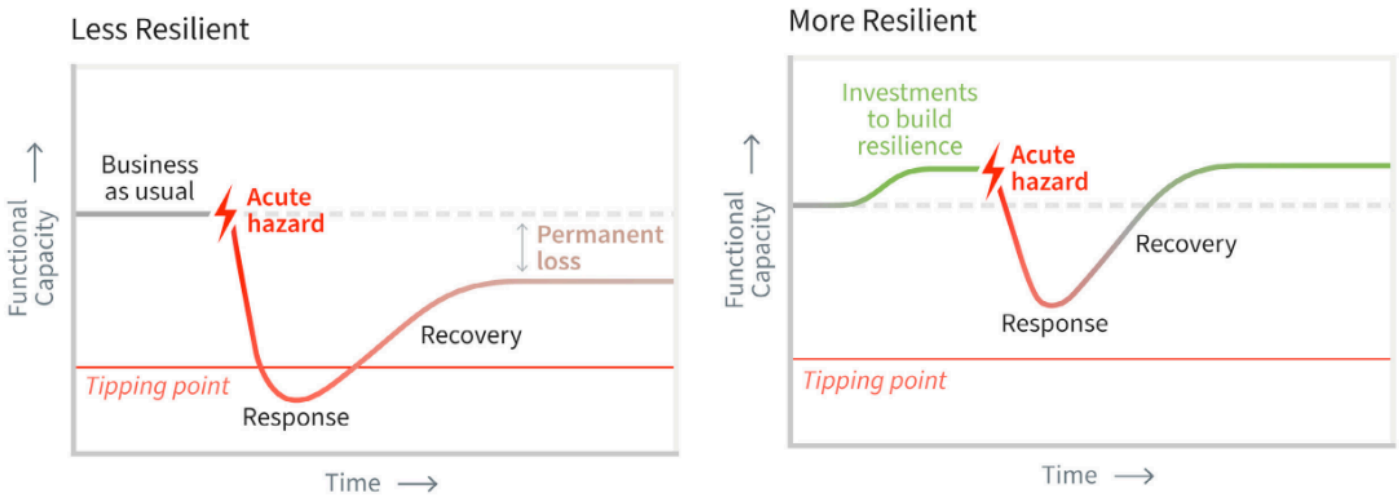


Figure 3. Resilience graphs [15].

Grand Rapids' Resilience Framework

Grand Rapids' resilience planning process is based on the U.S. Climate Resilience Toolkit Steps to Resilience Framework (Figure 4). The framework guides local governments through a comprehensive process that includes community engagement, climate change research, action brainstorming, project prioritization, implementation, monitoring, and evaluation.

The City's CRVA focused on three of the five Steps to Resilience: Get Started, Understand Exposure, and Assess Vulnerability & Risk. The City's process for each step is outlined in Table 2. Moving forward, the City will continue advancing resilience by taking the Investigate Options, Prioritize & Plan, and Take Action steps through the CAAP process.

While this is a step-by-step framework, it is important to recognize that adapting to climate change is a long-term, iterative process. No community will ever be completely resilient; this work will never be finished. This is why Grand Rapids is committed to revisiting the Steps to Resilience over time.

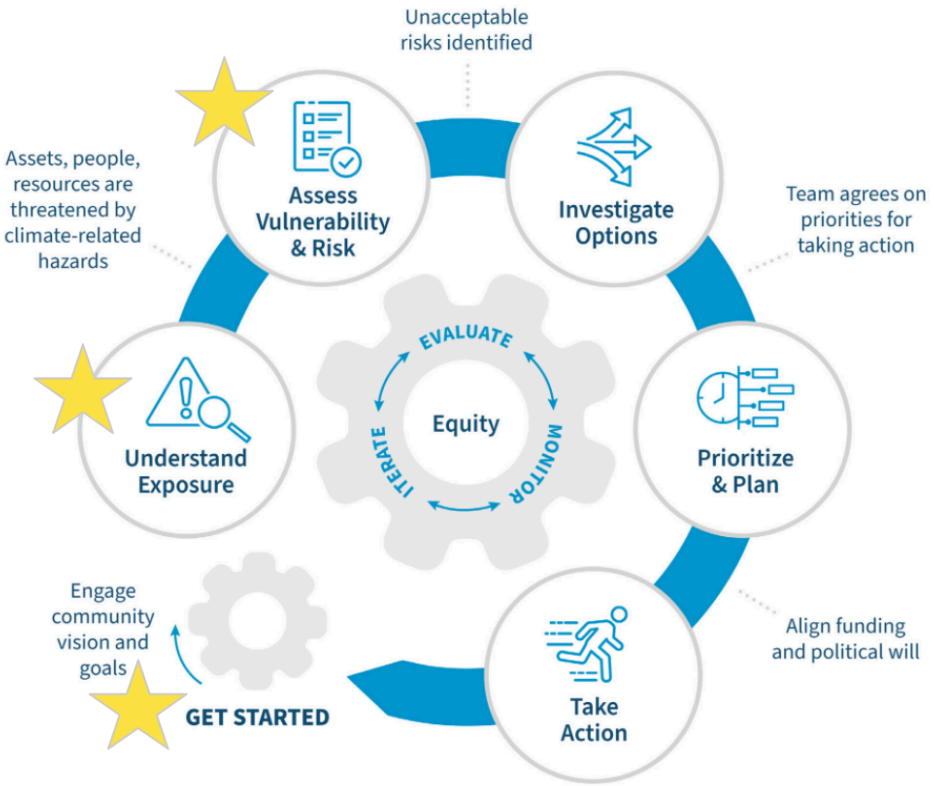


Figure 4. The Steps to Resilience framework [15] with stars added to indicate steps completed as part of Grand Rapids' CRVA.

Table 2. Overview of Grand Rapids' CRVA process.

Step	Description
Get Started: Community and Staff Participation	• Convene City staff, partners, and community stakeholders as members of the CRVA Working Group. • Between March 2023 and February 2024, the City of Grand Rapids conducted a survey of 440 residents in which they described the ways in which they are being affected by climate change and how they envision the climate future of Grand Rapids. • Partner with the C4 to develop materials and plan focus groups.
Understand Exposure	• Review information about past climate events and projected future climate to understand the primary climate change hazards that affect Grand Rapids.

	• Use GIS to map the city's exposure to flooding and extreme heat. Overlay hazard exposure maps with information about socioeconomic vulnerability and Grand Rapids' Neighborhoods of Focus to identify areas where hazard exposure overlaps with disadvantaged communities. • CRVA Working Group participates in a workshop to brainstorm local impacts of climate change in Grand Rapids.
Assess Vulnerability and Risk	• CRVA Working Group participates in a workshop to assess vulnerability and risk. • C4 conducts six community focus groups to learn about resident experiences with heat and flooding, coping mechanisms, needs from the City, and ideas for a resilient future in Grand Rapids. • Available data, research, and insights from workshops, focus groups, surveys, and consultations with local stakeholders were used to assess the vulnerability of Grand Rapids' community systems to climate change hazards and risk associated with specific impacts. • CRVA Working Group and local stakeholders review and adjust results.

Get Started: Community and Staff Participation

The City convened staff and community stakeholders as members of the CRVA Working Group in October 2023. Participants represented a range of City departments as well as community expertise and interests.

CRVA Working Group members participated in virtual meetings and in-person workshops to complete the CRVA work (Table 3). During meetings and workshops, participants got to know each other; learned about CRVAs and climate change adaptation; brainstormed climate change impacts in Grand Rapids; shared insights on community systems, vulnerabilities, and risks; reviewed deliverables; and shared priorities for adaptation action.

Table 3. CRVA Working Group meetings.

Meeting/Workshop	Purpose and Description	Date
Kickoff and Introduction Meeting	CRVA WG participants learn about the project, meet each other and the City/ICLEI USA team	10/30/2023
Climate Impacts Workshop	Participants listen to a presentation on climate conditions and brainstorm climate change impacts	1/4/2024
Vulnerability Assessment Survey Introduction Meeting	Participants listen to explanation of vulnerability assessment survey activity (to be completed on own time)	2/29/2024
Risk Assessment Workshop	Participants listen to presentation of survey results, work in small groups to share insights on identified risks	6/12/2024
Wrap-Up and Debrief Meeting	Participants reviewed and discussed Report recommendations.	9/10/2024

Climate Equity

Approaching climate action planning with an equity lens is essential to ensuring that all voices are part of the decision-making process, not just advantaged groups. Equity calls for "ensuring that people have access to the same opportunities and have what they need to thrive and succeed… This understanding recognizes that people may have different starting points and may need different types and levels of support to flourish" [16].

Climate change does not affect all Grand Rapidians equally. Some people and groups are already being disproportionately harmed by climate change, putting them "on the frontlines" of impacts.

People and Communities on the Frontlines of Climate Change are those that experience the consequences of climate change first and worst. They include people who are both highly exposed to climate risks because of the places they live and have fewer resources, capacity, safety nets, or political power to respond to those risks because of widespread discrimination, promoted by histories of colonialism, white supremacy, domination of nature, and economic exploitation. They include Black people, Indigenous Peoples, people of color, people with low incomes and from low income backgrounds as well as other individuals and communities such as immigrants, those at-risk of displacement, old and young people, people experiencing

homelessness, outdoor workers, incarcerated people, renters, people with disabilities, and chronically ill or hospitalized people.[1]

Grand Rapids is home to a diverse group of nearly 200,000 people, with 42.5% of residents self-identifying racially or ethnically as persons of color (18.4% Black or African American; 16.5% as Hispanic or Latinx; 2.3% as Asian alone; 0.3% as American Indian or Alaskan Native alone and 4.6% as two or more races) [18]. While the community as a whole is racially and ethnically diverse, Grand Rapids is similar to many other American cities in that racial and ethnic segregation are still very prominent.

The federal government redlined Grand Rapids on November 5, 1937. Consistent with the requirements of the government Underwriting Manual, redlining specifically targeted residents of color in Grand Rapids, deeming their neighborhoods as "hazardous" to investment because they were home to residents of color, or even just located nearby. Redlining, and the lack of investment in neighborhoods of color following redlining, created a cascading effect on the city. The legacy of redlining and systemic inequities is significant disparities in services, resources, and outcomes like income, wealth, and homeownership across neighborhoods. Today, areas where residents of color were redlined overlap with industrial zoning as well as locations where our Black and Brown communities currently reside (Figure 5). This correlates with health issues in these communities, including poor air quality, high concentrations of asthma, lead poisoning, and negative birth outcomes.

Robust tree canopy leads to many neighborhood benefits, including shade, cooling, reduced erosion and runoff, and aesthetic value. Tree canopy reduces risks of both heat and flooding, top climate hazards of concern in Grand Rapids. When comparing the geographic areas in the city where there is less urban tree canopy and where redlining occurred, there is significant overlap.

[1] Excerpted and adapted from American Society of Adaptation Professionals (ASAP) Professional Guidance Resources Glossary [17].

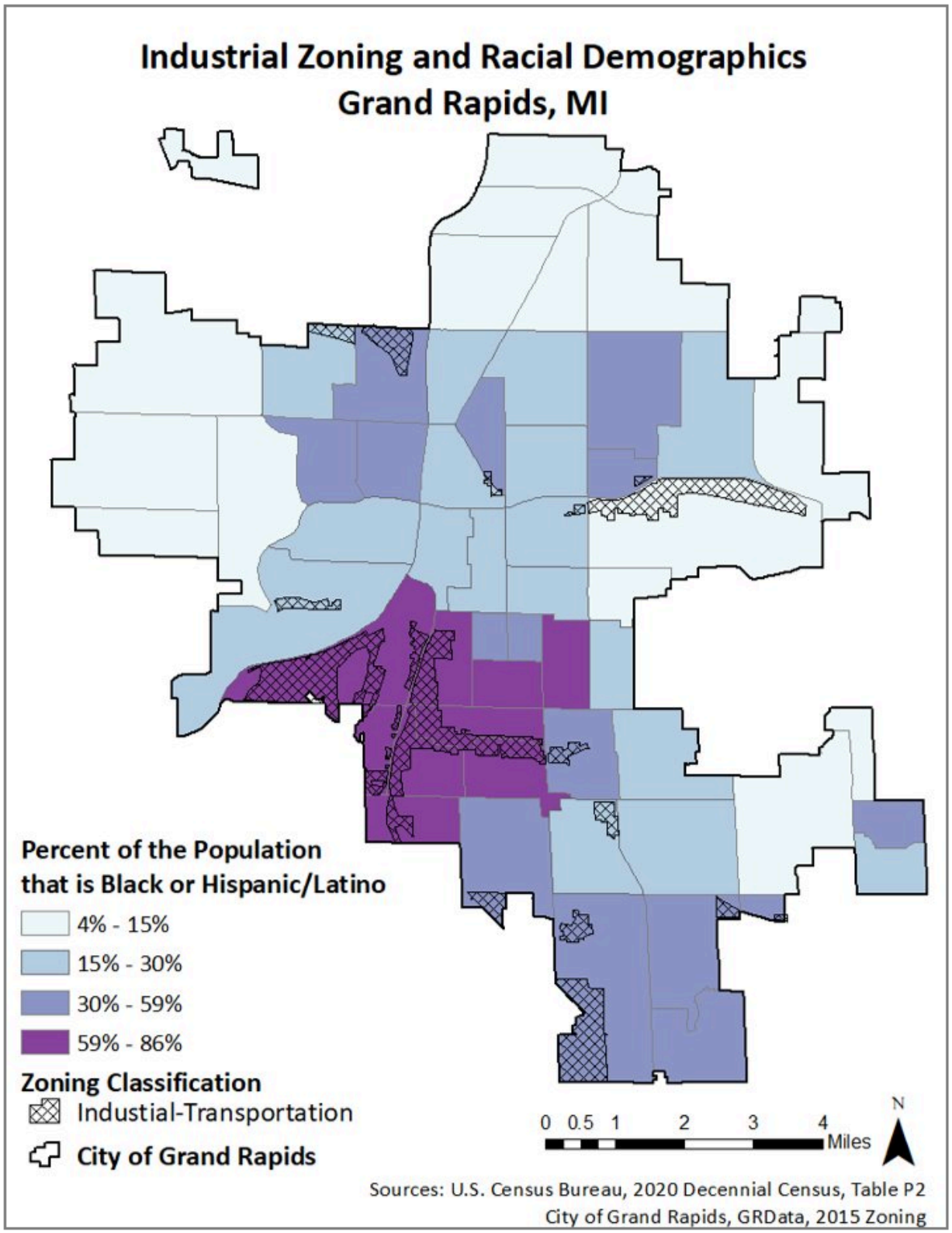


Figure 5. Industrial zoning classification overlaid with percent of population that is Black or Hispanic/Latino in the City of Grand Rapids [19].

The City of Grand Rapids is committed to reversing the harmful effects of redlining and systemic inequities by adopting policies that broaden opportunities, tracking disparities, building community partnerships, and allocating capacity and investment. To that end, the Grand Rapids Office of Equity and Engagement identified 17 census tracts near the west and south side of the City as Neighborhoods of Focus. The Neighborhoods of Focus are census tracts with the highest percent of Black, Indigenous, and People of Color (BIPOC) residents and the greatest disparities across all quality-of-life indicators such as education, wealth, and employment (Figure 6).

The City recognizes that climate change adds to the burdens of residents already facing industrial pollution, low tree canopy, and disparities in health and financial security. The intersection of these challenges makes it difficult for these communities to build resilience and respond to the growing threats posed by climate change.

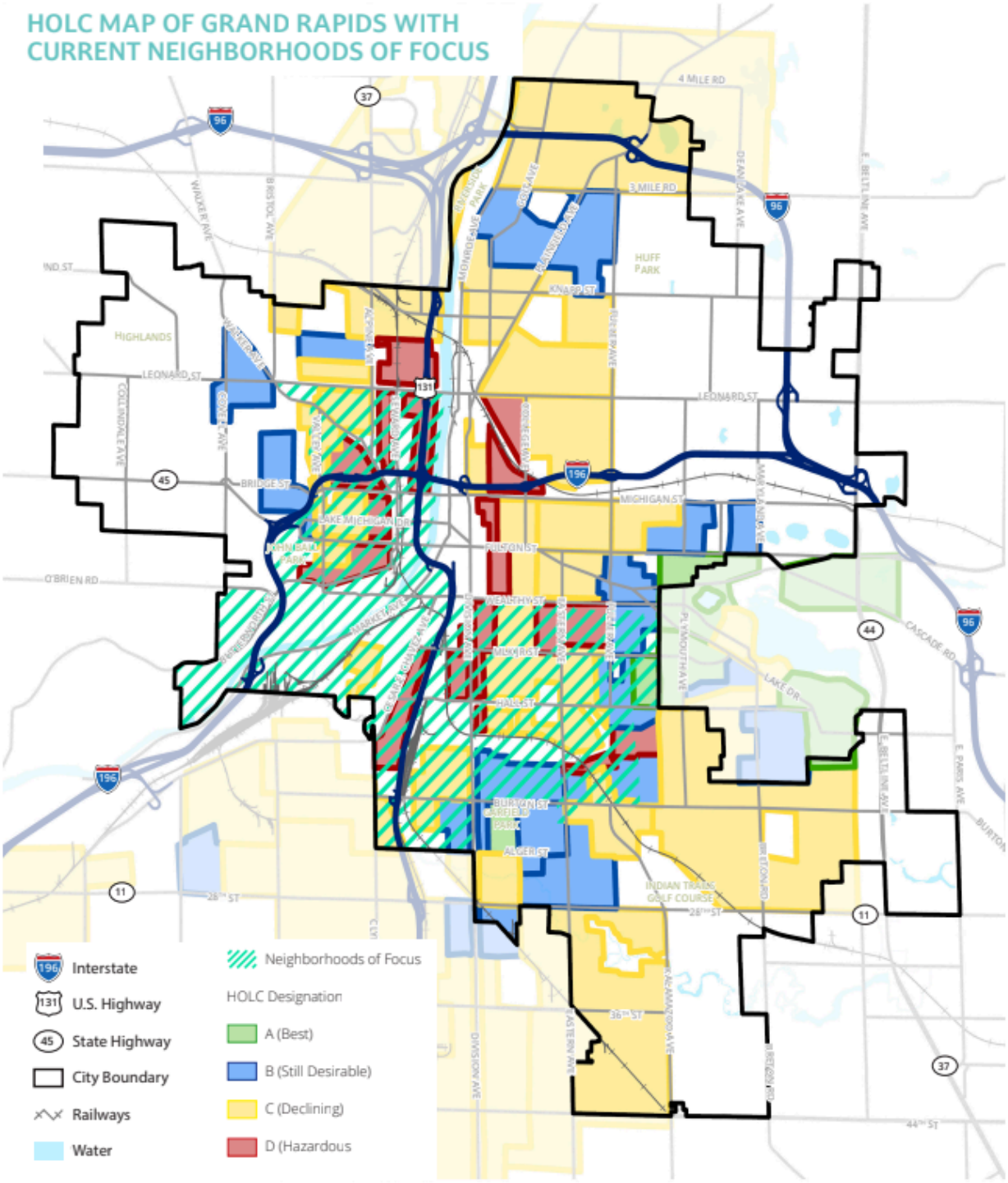


Figure 6. Map showing redlined areas overlaid with the Neighborhoods of Focus [20].

Approach to Community Engagement

Grand Rapids adopted a targeted universalism approach to engage the community in the CRVA, focusing on underrepresented community members. Targeted universalism means "setting universal goals, assessing how [different groups in the community] fare relative to the goals, and addressing barriers, structural impediments, and resource deficiencies in a targeted manner in order for all groups to meet goals" [11]. In practice, this means that community engagement efforts were centered on those most likely to face barriers to participation, including residents who are unhoused or identifying as African American, youth and seniors, and Spanish-speaking communities.

The community was engaged in the CRVA process via a survey and six in-person focus groups organized and hosted by C4 in May 2024. The survey was introduced to the community at the C4 Climate Plan Kickoff Event: A Call to Climate Justice and distributed while tabling at a variety of diverse community events in 2023. For the focus groups, C4 Ambassadors held in-person gatherings to engage with residents. The focus groups discussed participants' past experiences with heat and flooding, possible future impacts of heat and flooding, coping mechanisms used, what residents need from the City, and ideas for a resilient future in Grand Rapids.

Five focus groups explored heat, one of which was completed in Spanish. Two of the focus groups were composed mainly of younger and older African Americans. One group focused on flooding and was largely unhoused residents.

Table 4. Community focus groups hosted by C4.

Location	Date (2024)	Attendees	Topic and Demographic (if noted)
King Building	May 9	10	Heat
Cook Library	May 20	20	Heat (Spanish language)
GR Proactive, Division Ave S	May 23	21	Flooding (unhoused demographic)
Metro Night Club	May 26	18	Heat (20-30 years old)
Twelve 'O One Soul	May 28	20	Heat (youth to seniors, mainly African Americans)
Samaria J's Salon	May 30	20	Heat (youth to seniors, African Americans)

Clockwise from top left: 1) C4 Ambassador Robert Simmons leads a focus group discussion 2) C4 Co-Chair Kareem Scales visits a focus group at Samaria J's Salon 3) C4 Ambassador Dee Jones leads a focus group discussion 4) C4 Leadership Team Director Reyna Garcia and C4 Ambassador Betsaida Valdivia give a presentation. Photo credit: Ned Andree #TheDNA.

Each session began with a recorded presentation that covered 1) climate change and its causes; 2) how climate change is affecting Grand Rapids; 3) and what the City is doing to address climate change through the CAAP. After the presentation, the participants settled into guided focus groups of around six participants. A C4 Ambassador was assigned as the facilitator to guide each group in discussion and take notes. Moving at their own pace, the facilitator guided the group through three parts, 1) discussing the participants' experiences with heat/flooding, 2) possible future impacts of climate change, and 3) residents' coping mechanisms and needs from the city. Each session closed on a full room hopeful note with a "future visioning" question where all participants were asked to imagine and describe what a resilient Grand Rapids looked like.

Clockwise from top left: 1) Samaria J's Salon, venue 2) C4 Leadership Team Director Synia Gant-Jordan and Sistas in Development President Ebony Wilson prepare a meal 3) C4 Ambassadors Iris Gipson and Cynthia Bailey set up the King Building venue 4) GR Metro Nightclub, venue. Photo credit: Ned Andree #TheDNA.

Understand Exposure: Climate Change in Grand Rapids

Grand Rapids and Kent County are already experiencing extreme weather events associated with climate change, including:

Flooding: A State of Emergency was declared in Grand Rapids on April 21, 2013, after heavy rainfall caused flooding of the Grand River lasting 13 days. The Grand River crested at a record-setting 21.85 feet. Over 1,700 residents were evacuated during the event [13]. Over 1,200 homes were flooded and 300 roads were closed. There were no reported fatalities. Monetary loss was estimated near $43 million [21].

Community Experience

"Age 16, room in basement was ruined due to flooding areas"

Drought: Kent County experienced severe drought in 2021 [13].

Heat: In 2018, temperatures in Grand Rapids reached 94°F and the heat index reached up to 107°F [13]. Schools were closed as recently as August 27, 2024, due to dangerous heat [28].

Poor Air Quality: On June 27, 2023, the state of Michigan issued a state-wide air quality advisory due to an influx of smoke from Canadian wildfires [23]. Levels of air pollution reached such high levels that everyone—not just sensitive groups—was at risk of negative health impacts. Grand Rapids and other parts of West Michigan were particularly affected, with measured levels of air pollution among the worst of any major city worldwide.

Storms: On August 24, 2023, an unusual, severe thunderstorm system in western Lower Michigan produced 60-70 mph wind gusts, heavy lightning, and two tornados, one of which touched down in Kent County [24]. Around the state, 460,000 customers lost power. Back-to-back storms hit Grand Rapids and damaged the local weather station in 2021 [13]. Tornadoes injured 6 people and caused $4.5 million in damage in Kent County in 2014 [13].

Winter Weather: Extreme cold temperatures were felt all across Michigan during a polar vortex in January of 2019. A State of Emergency was declared due to the freezing conditions; temperatures reached -30°F with wind chill [13].

The impacts of these events point to the need to focus on preparedness and resilience, as extreme weather events will continue—and accelerate—alongside emissions of climate-warming GHGs.

The City chose four priority climate change hazards to focus on in this Report: rising temperatures and extreme heat; heavy rainfall and flooding; severe convective storms; and drought. Other climate-related hazards, including wildfire smoke, poor air quality, and severe winter weather were also explored in the CRVA Working Group and in the focus groups.

To better understand Grand Rapids' past and future climate, ICLEI USA reviewed the City's climate summary report (Appendix A). GLISA, NOAA's Great Lakes Climate Adaptation Partnership (CAP) team, created Grand Rapids' climate summary report in 2019. The report describes the City's historic, current, and future projected changes in climate and weather.

Climate Projections

Climate projections are the outputs of climate models, which are built on a series of assumptions about the Earth system and future GHG emissions. Climate projections are not predictions for the future, but should instead be considered as an approximation of the range of possible future conditions. This is why it is important to view them in terms of multi-year averages, ranges, and trends. Climate projections are helpful tools that can be used to inform future planning; however, it is not appropriate to use them as the sole foundation for decision-making [5].

Figure 7. Flooding in Grand Rapids following the 2013 Grand River flood. Photo credit: WM Rapids [25].

The majority of the future projections in the climate summary are based on the Coupled Model Intercomparison Project Version 3 (CMIP3) A2 emissions scenario, which represents a high emissions "business as usual" scenario. ICLEI USA shared select climate information and data

from the climate summary report, along with best-available peer reviewed research, with the CRVA Working Group as well as C4 focus group attendees to inform their discussions.

Broadly, climate projections indicate that Grand Rapids needs to prepare for hotter weather and more extreme heat events; more heavy rainfall and flooding; stronger convective storms; and more frequent drought conditions.

Summary of Future Climate Projections for Grand Rapids

The GLISA climate summary report includes historical data and projections for future drought, extreme heat, flooding, severe convective storms, and winter weather. A snapshot of this information is included below [26]:

Extreme Heat: Historically, days above 95°F have been very rare in Grand Rapids. By mid-century (i.e., 2050), models suggest an increase of 3-12 days over 95°F. While such hot days will not necessarily occur consecutively, an increase in heat waves is possible. Heat waves are driven by a combination of factors including high daytime and nighttime temperatures, high humidity, and stagnant air. Models indicate an increase in heat waves in the future as climate change leads to higher temperatures and more air stagnation events. Summers will also be hotter on average: by the middle of the century, the average summer maximum temperature could increase from the high 60s to the mid 70s.

Flooding: In Grand Rapids, the frequency and intensity of heavy precipitation events has increased historically, with a 40% increase in the number of extreme precipitation events (heaviest 1% of rainfall events) and a 52% increase in the total volume of rainfall during these events between 1981-2010. These changes are evident when looking at “design” storms (inches of precipitation falling over a set period of time) which are used to design and manage stormwater systems (Table 5).

In the future, average annual precipitation in Grand Rapids is projected to increase by up to 3 inches by mid-century and by up to 7 inches by the end of the century. A greater percentage of total precipitation is expected to fall in heavy rain events (instead of in fewer, smaller events), in a continuation of historical trends. This will increase the risk of flooding in Grand Rapids.

Table 5. Precipitation Frequencies for the City of Grand Rapids [26]. The table below shows precipitation volumes in inches for both Bulletin 71 and Atlas 14 along with percent change between the two in brackets. This data shows how the "design" storm has changed over time. This table does not consider climate change. NOAA Atlas 15, which will consider climate change, is scheduled for public release in 2025 [27].[2]

	1-Yr	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
1-hr	0.92 in. / 1.06 in. [15.2%]	1.11 in. / 1.24 in. [11.7%]	1.41 in. / 1.55 in. [9.9%]	1.65 in. / 1.83 in. [10.9%]	2.09 in. / 2.24 in. [7.2%]	2.48 in. / 2.58 in. [4.0%]	2.89 in. / 2.94 in. [1.7%]
12-hr	1.70 in. / 1.95 in. [14.7%]	2.06 in. / 2.25 in. [9.2%]	2.61 in. / 2.81 in. [7.7%]	3.06 in. / 3.33 in. [8.8%]	3.87 in. / 4.13 in. [6.7%]	4.58 in. / 4.82 in. [5.2%]	5.35 in. / 5.56 in. [3.9%]
24-hr	1.95 in. / 2.22 in. [13.8%]	2.37 in. / 2.56 in. [8.0%]	3.00 in. / 3.18 in. [6.0%]	3.52 in. / 3.77 in. [7.1%]	4.45 in. / 4.66 in. [4.7%]	5.27 in. / 5.43 in. [3.0%]	6.15 in. / 6.27 in. [2.0%]

Drought: Historically, rain-free periods (periods of 3 weeks with less than 0.5" of rainfall) have been highly variable in Grand Rapids, with an overall decreasing trend. In the future, even though more annual precipitation is projected overall, more is anticipated to fall in shorter, extreme events. Thus, there will be longer periods of time that experience no rainfall, increasing the potential for drought.

Severe Convective Storms: There is some evidence the frequency and intensity of convective storm activity, a category that includes thunderstorms, tornadoes, hail, and high winds could increase in the future, particularly in the Midwest and Great Plains in spring. Confidence in these projections is low as these events are particularly challenging to explore with climate models. This is because severe convective storms occur relatively randomly, are rare, and only last for a short period of time [28]. Another challenge is that modeling storms requires capturing highly localized, small-scale elements of the climate system [4]. Because storms are compound events that can include wind, precipitation, and flooding, they cannot be represented by "single-indicator" projections (e.g. total annual precipitation, annual average temperature).

Winter Weather: Annual snowfall totals in Grand Rapids have been variable, with a small increasing trend over the past 40 years. In the coming years, increases in lake effect snow are possible due to warmer surface water temperatures and declining ice cover on the Great Lakes

[2] The City uses the most recent rainfall data (Atlas 14) for design storms, and is aware of the NOAA Atlas 15 update with the intention of incorporating best available data when published.

[29]. This is because warmer air is able to hold more moisture, which readily evaporates off the ice-free lakes. By the mid-century, however, annual snowfall in Grand Rapids is projected to decrease by 4" to 11" and by 10" to 17" by the end of the century as warming turns lake-effect snow to "lake-effect rain".

The Geography of Heat and Flood Risk

Geographic distribution of climate risk varies within Grand Rapids based on factors in the built and natural environments. To identify areas where further study and increased preparedness may be needed, ICLEI USA used GIS to provide an overview of:

1. **Exposure:** Grand Rapids' exposure to current and future climate change hazards (i.e., physical areas where flooding and high heat occur). Satellite data showing land surface temperature, impervious surface coverage (a proxy for dark surfaces, such as pavement, that radiate heat) and tree canopy coverage was used to understand where heat hazard is likely to be highest. FEMA flood hazard area maps and First Street Flood Factor parcel risk scores (which consider climate change) were used to identify areas with current and future flood exposure. Flood Factor characterizes parcels on a risk scale from 1-10. Parcels with higher scores are more likely to experience flooding, more likely to experience high flood depths, or both. Parcels that have been scored at a 7 or above are characterized as severe risk (with a Flood Factor of "severe" or "extreme" following Flood Factor's parcel rating system) [30].

2. **Vulnerability:** Communities, areas, and assets in the City that may be more vulnerable to hazards due to socioeconomic and health characteristics. To identify areas with high social vulnerability, ICLEI USA merged the socioeconomic factors and sensitive population indices from MiEJScreen. Census tracts in the 75th percentile were considered to have high vulnerability. These areas show a strong overlap with Grand Rapids' Neighborhoods of Focus and areas that were redlined.

3. **Risk:** Areas where exposure to hazards and vulnerability overlap, indicating higher risk from climate change.

For more maps and information on the methodology, refer to the Climate Risk Summary Memo (Appendix B).

Areas directly to the west and north adjacent to the Grand River feature high concentrations of exposure and vulnerability to flooding and heat.

Heat hazard (Figure 8) is highest in the downtown area and the farthest south area in the city limit. Areas in and near downtown as well as adjacent to the Grand River, especially on the west side of the river, are highly exposed to heat hazards. Future projections also indicate increased flood risk in some of the same areas. Much of the high heat hazard area overlaps with areas of social vulnerability as identified by MiEJScreen, the Neighborhoods of Focus, redlined areas, and places with a high proportion of industrial land use. The area on the far south side of the city (north of 44th street) experiences very high heat hazard due to the near complete lack of tree canopy coverage and dominance of impervious surfaces in this area.

Community Experience

"Last week, while waiting at the bus stop at Burton and Kalamazoo, the heat was excruciating"

Large proportions of severe-risk parcels are present north and west of the Grand River where some census tracts have as many as 20% of parcels at severe risk for flooding (Figure 9). This area overlaps with some of Grand Rapids' Neighborhoods of Focus and redlined areas. Parts of this area are currently protected by flood protection systems [31]. One area on the east side of the river in the downtown falls in the same category. Severe-risk parcels are also relatively common along the eastern peripheral areas of the city. Note that even areas where few or no parcels are designated as *severe risk* for flooding may still have areas with *low or moderate risk* of flooding.

Grand Rapids: Distribution of Heat Hazard

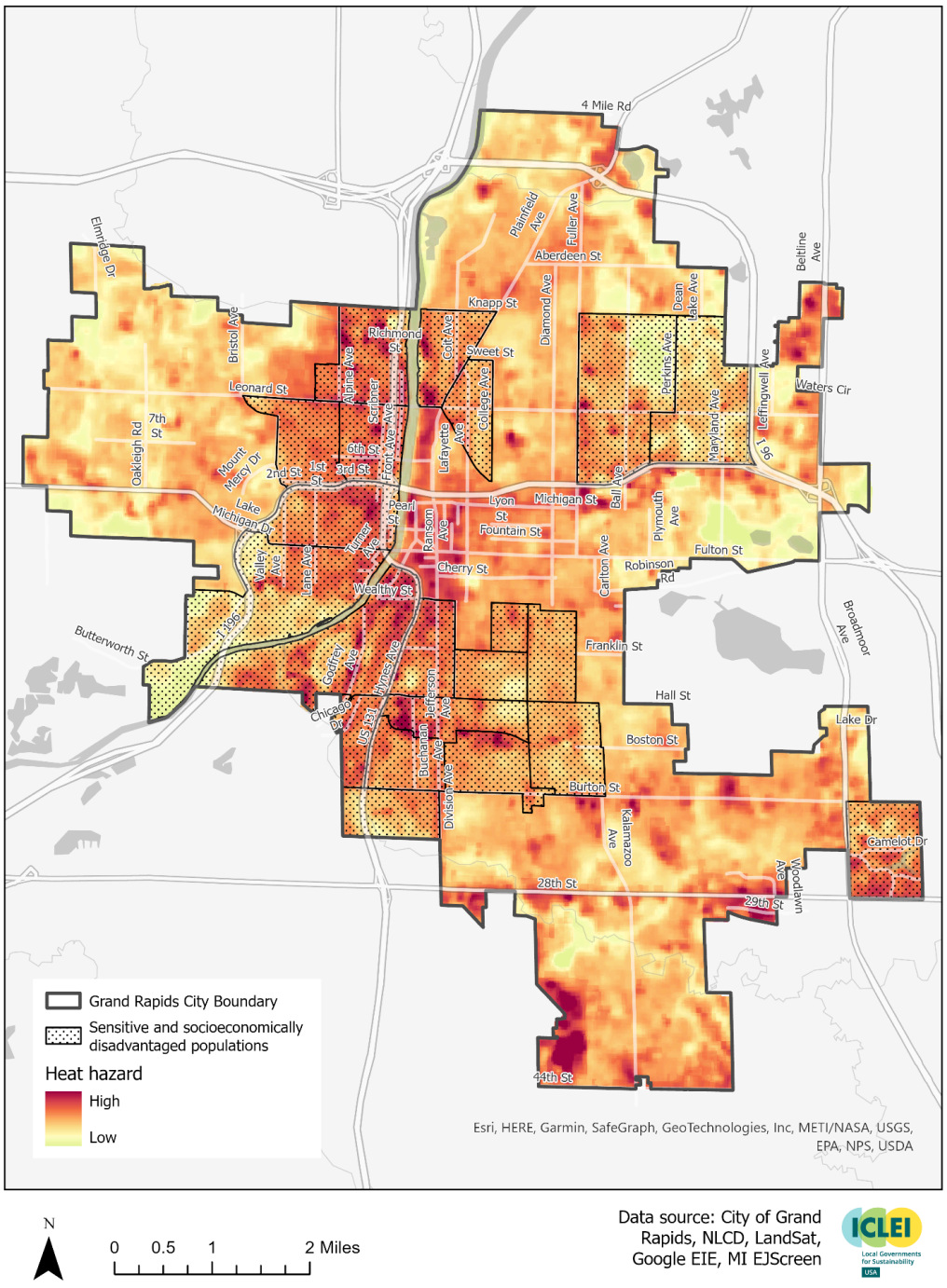


Figure 8. Distribution of heat hazard in the City, calculated from land surface temperature, impervious surface coverage, and tree canopy coverage. Darker red shading indicates higher heat hazard.

Grand Rapids: Climate Change Adjusted Parcel Flood Risk

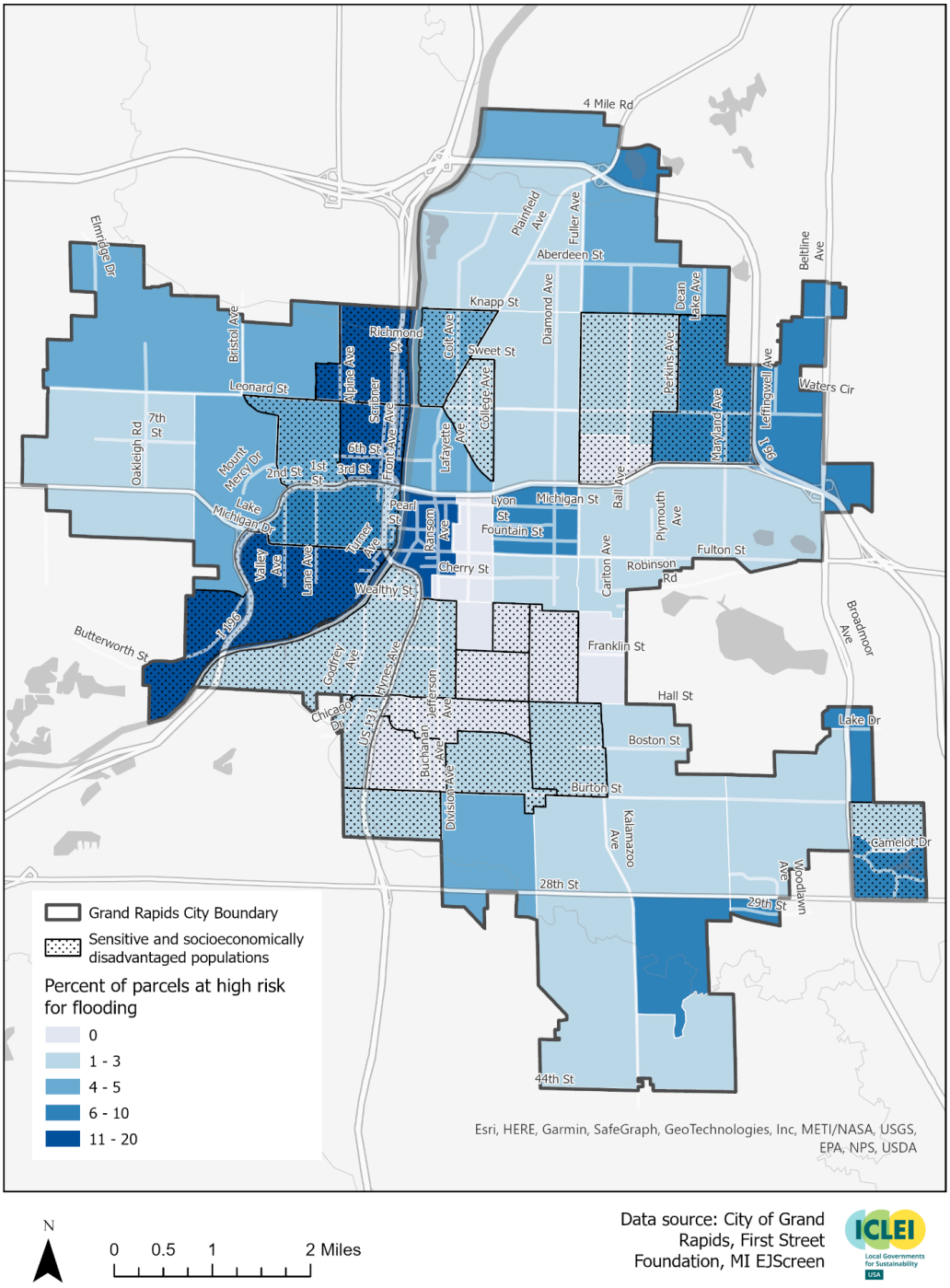


Figure 9. Parcel-based, climate change adjusted flood risk by census tract, 2023-2053 [32]. The darker blue the census tract, the greater percentage of its parcels have a "severe" or "extreme" risk of flooding on Flood Factor. Note: tracts where few or no parcels designated as *severe risk* for flooding may still have many parcels with *low or moderate risk* of flooding. Dots indicate a census tract is in the 75th percentile for vulnerability.

Assess Vulnerability and Risk

Identifying Impacts of Climate Change

A key step in CRVAs is working with City staff and the community to understand ways in which Grand Rapids—its people, infrastructure, and natural systems—could be vulnerable to the changing climate, now and in the future. After reviewing information and projections that show how the climate could change, the CRVA Working Group brainstormed their local impacts in a workshop. ICLEI USA consolidated these inputs, along with insights from City planning documents, into a set of impact statements for review by City staff.

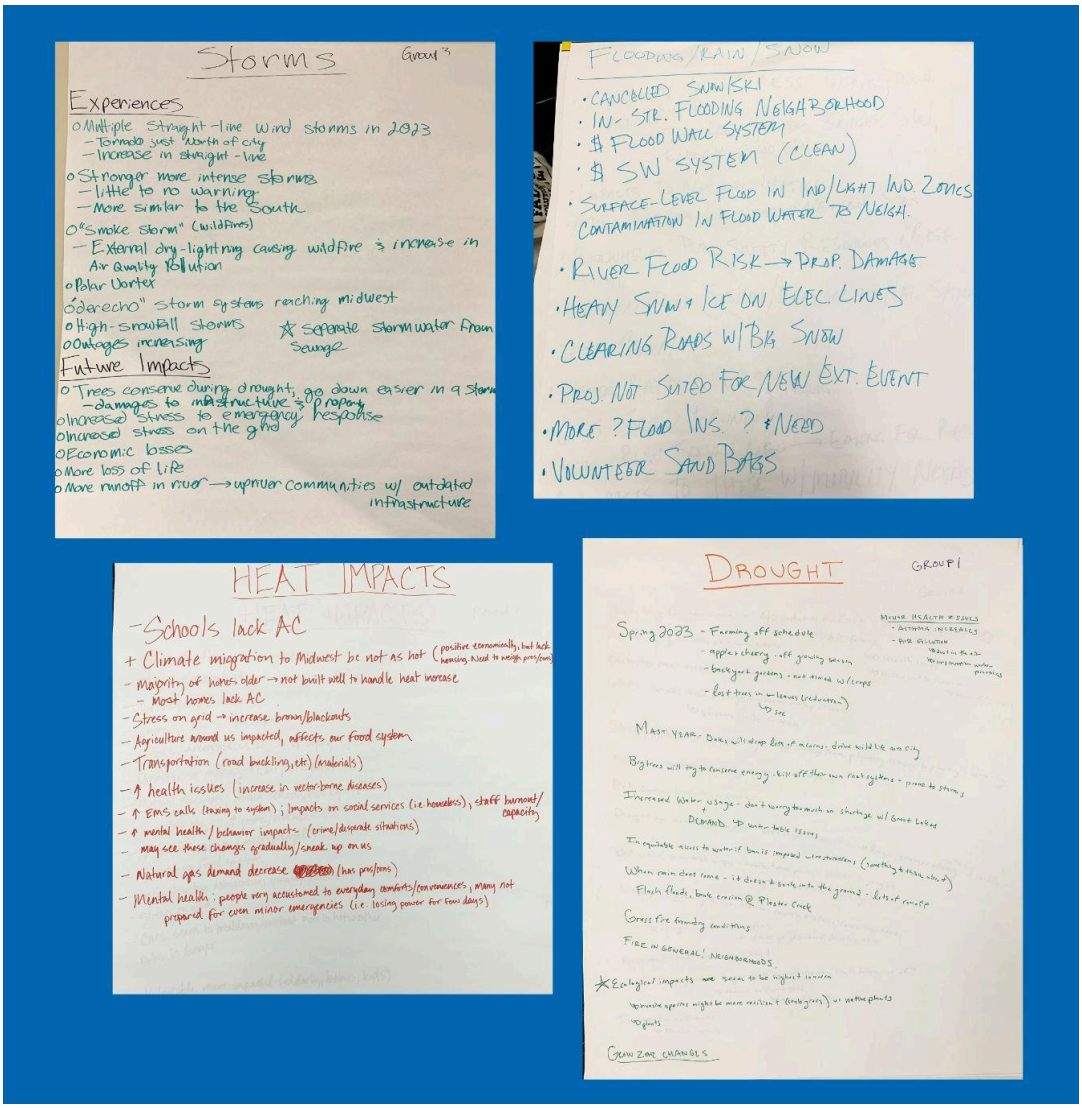


Figure 10. Impacts identified by the CRVA Working Group during the Climate Impacts Workshop for heat, storms, drought, and heavy rainfall, flooding, and winter weather.

Impact statements pair climate hazards with information about social, infrastructure, and environmental vulnerabilities to articulate possible or likely consequences of climate change [33]. Impact statements include the following elements:

- One or more climate change hazards or stressors (e.g. extreme heat)
- How the hazards or stressors could impact a community's people, infrastructure, or environment (e.g. by disrupting public services)
- Local drivers of vulnerability (e.g. outsize impacts on disadvantaged communities)

During a workshop, the CRVA Working Group brainstormed a list of over 100 possible impacts of climate change in Grand Rapids and shared information about many local drivers of vulnerability. ICLEI USA reviewed and condensed these into a shorter, concise list of distinct impact statements.

Vulnerability and Risk

The CRVA Working Group met to discuss vulnerability and risk in an in-person workshop. First, participants provided information about vulnerability from the perspective of Grand Rapids' "community systems". Community systems are the tangible and intangible things that keep our communities running and make them places that we love to live and work.

The CRVA Working Group evaluated the following community systems: Housing; Food; Energy; Emergency Management; Ecosystems and Biodiversity; Local Business and Industry; Parks and Green Space; Public Buildings and Facilities; Public Health; Stormwater; Transportation; Water Bodies; and Workforce.[3] Facilitators asked the working group to consider factors contributing to each system's sensitivity and ability to adapt to climate change (Figure 11).

[3] The Public Buildings and Facilities and Workforce systems are combined with other systems in this Report.

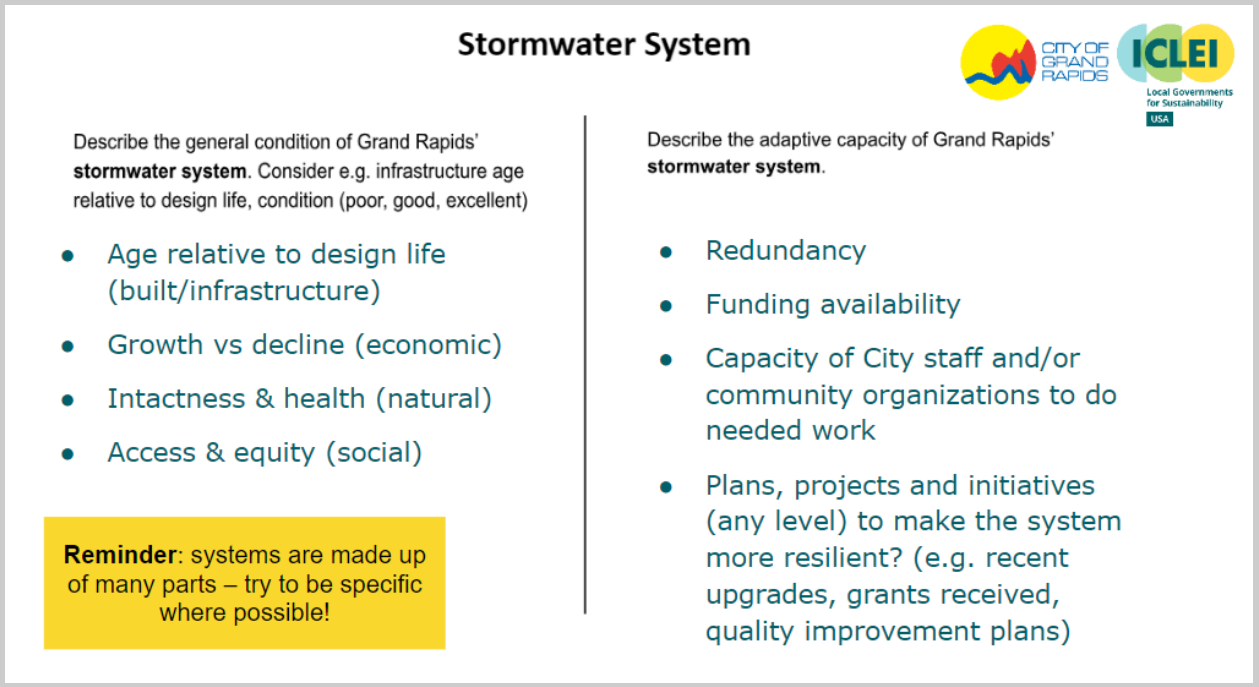


Figure 11. Prompts for the CRVA Working Group activity on sensitivity and adaptive capacity of Grand Rapids' community systems.

Working Group participants then broke out into small groups organized by sector to take a deep dive on specific impact statements, such as: "Heavy rainfall and flooding could overwhelm and damage stormwater infrastructure" and "Extreme heat could make outdoor activities unpleasant or even unsafe, leading to impacts on residents' physical and mental health." Small groups filled out worksheets with ideas on:

- The most likely consequences of each impact statement statement
- How likely these consequences are to occur
- Who in Grand Rapids could be more adversely affected by the impact and its consequences
- Rankings of the magnitude of the consequences of the impact on the City of Grand Rapids as a whole across four dimensions: relative monetary cost of associated damage or loss; level of community disruption; potential for injuries and loss of life; and outsize impacts on environmental justice communities (Table 6).

To assess system-level vulnerability and the risk associated with specific impacts, ICLEI USA reviewed the completed worksheets and activities, City plans, research, and conducted interviews with City staff and other stakeholders. These additional interviews filled gaps and provided more context on what was shared in CRVA Working Group meetings and workshops.

Table 6. Four dimensions used to assess magnitude of consequence on the city as a whole.

Ranking	Monetary Cost	Community Disruption	Injuries and Loss of Life	Environmental Justice
HIGH	Catastrophic costs incurred, possible threat to solvency ($$$)	Widespread and extensive disruption to community services, routines, and ways of life	Event may commonly cause death and serious injury/illness	Widespread and highly damaging impacts on EJ communities
MEDIUM	Costs incurred are manageable but may cause financial strain ($$)	Limited, significant disruption to services, routines, and ways of life	Limited potential for injury or illness	EJ communities are more likely to face negative impacts
LOW	Minimal or no costs incurred ($)	Minimal disruption to services, routines, and ways of life	No or very low possibility of death, injury, or illness	Impacts are generally even across groups

Assessment Findings

Learnings from Community Engagement

Community members engaged in this project through two main channels: a community-wide survey conducted for the CAAP and focus groups organized and delivered by C4. Insights shared via these channels indicate that Grand Rapidians are feeling the effects of climate change. Many respondents stressed the economic and livelihood impacts caused by extreme heat, flooding events, and other hazards. Common experiences include rising costs, increased physical health impacts, and loss of access to resources. There is a shared sense among respondents that the local government and utilities can and should do more to assist the community with both climate resilience and emissions mitigation strategies, particularly to alleviate the burdens on residents who are affected the most such as seniors and unhoused individuals.

CAAP Community Survey

From March 2023 to February 2024, the City of Grand Rapids conducted a survey of 440 residents in which they described the ways in which they are being affected by climate change and how they envision the climate future of Grand Rapids.

When asked how a changing climate affects their lives, responses varied widely, with one participant responding with: “how doesn't it? Virtually every aspect of life is affected,” and another noting that the “changing climate has captured the attention of folks in all sectors of the community.” The majority of impacts identified fall into the broad categories of economic and financial impacts, mental health impacts, physical health impacts, and natural hazards and changes to the local environment.

Economic Impacts

Many survey respondents identified rising costs as an impact they anticipate as the climate changes. This includes rising costs of food, rising costs of home maintenance and repair, higher energy and water bills, and changes to the types of goods and services residents are spending their money on. Respondents also expressed general uncertainty about what economic impacts are likely, including changes to employment, livelihoods, increased economic inequality, and how the changing climate will affect local industries (such as winter recreation). Responses generally conveyed anxiety about “perpetually” rising costs and decreasing economic opportunity. Respondents noted their energy costs have already risen, and they are needing to use air conditioning earlier in the year than before. Others noted that climate change may lead them to switch from active transportation or public transportation to increased car usage, which can be more costly.

Mental Health and Lifestyle

Mental health and lifestyle impacts identified by survey respondents include existential dread and worry about friends, family members, children, and vulnerable populations. Respondents also expressed specifically worrying about being impacted by natural disasters, losing community stability and cohesion, and feeling unsafe. Respondents expressed worry about “the future of the Earth” to the extent that it has affected their decisions on whether to have children. One respondent expressed “I have such deep sadness and regret that my generation did so little to stop this disastrous climate change.”

Respondents generally worried about how climate change has and will continue to affect their day-to-day lives, one example being a response from a parent who was disappointed that their child was not able to go sledding this winter due to the lack of snow accumulation. Respondents

expressed low moods, grief, hopelessness, and anxiety over the changes they've seen both locally and globally, as well concern for future generations.

Physical Health

Community Experience

"The spring was really hot. It affected my breathing. And I've noticed it's hotter in the inner city"

Respondents identified a wide range of physical health impacts, including respiratory impacts, decreased outdoor recreation, heat-related illness, allergies, increased physical discomfort, severe impacts to vulnerable populations, and a general reduction in quality of life. Multiple respondents noted that heat and poor air quality has already exacerbated their asthma and made breathing more difficult. Another respondent noted that they were unable to take their baby outside for the first few months of their life due to the impacts of high heat. Many respondents noted feeling sick or experiencing heat exhaustion and heat stroke and worry about this becoming more common. Severe impacts on vulnerable populations such as the elderly, the unhoused, and those without access to air conditioning or shelter were also a point of concern for many respondents.

Environmental Impacts and Natural Hazards

Respondents expressed concerns about both individual climate hazards and natural disasters as well as general changes to the local environment. Climate hazards that came up in the responses include flooding, extreme heat events, wildfire smoke (such as from the Canadian wildfires in summer of 2023), unpredictable weather and storm events, and property damage, injury, or power outages from extreme weather events. Respondents expressed concern over safety, with one noting: "The changing climate creates a lot of uncertainty about safety. The recent unpredictable storms, unsafe air, heat waves, wildfires, flooding, long winters, and other hazards are all shaping how I move through the world. Just getting to and from work or going outside can be a challenge when crazy weather events happen (which is a lot more frequently)." Another respondent commented that they had prioritized low flood risk when purchasing a house, and many responses mentioned fear of property damage from flooding.

Responses related to the changing environment included concerns about changes to the seasons (such as warmer weather year-round and more unpredictable winter weather), impacts to biodiversity, agricultural impacts (such as changes to the growing season or the types of crops that will be able to thrive locally), impacts to local habitats and animal and plant life, and reduced water and air quality impacting both wildlife and humans. Respondents noted that climate change has affected their connection to nature, as they spend more time indoors and with degradation of local natural areas due to climate change, with one response noting "who

wants to have their child suffer with a warming planet, less natural resources and limited biodiversity."

C4 Community Focus Groups

Visions and Strategies for a Resilient Future Grand Rapids

When envisioning a resilient Grand Rapids, participants described an increase in community-focused programs (e.g. affordable health care, options for children and seniors, educational initiatives, community grants, energy and efficiency rebates), reduced cost of living, renewable and energy efficient energy sources, improved resources for the unhoused, updated and resilient infrastructure, improved public transit system, and accessible and affordable adaptation resources. Participants commonly used the following characteristics to describe the feeling of a resilient Grand Rapids: safe, happy, affordable, green, and cool. A breakdown of learnings aggregated by general theme is shown in Figure 12. Participants also had the chance to weigh in on actions and strategies that they want the City to pursue to build resilience within their communities (Figure 13). See Appendix C for a list of all actions and strategies shared in the focus groups.

Figure 12. Focus group participants' visions for a resilient future Grand Rapids.

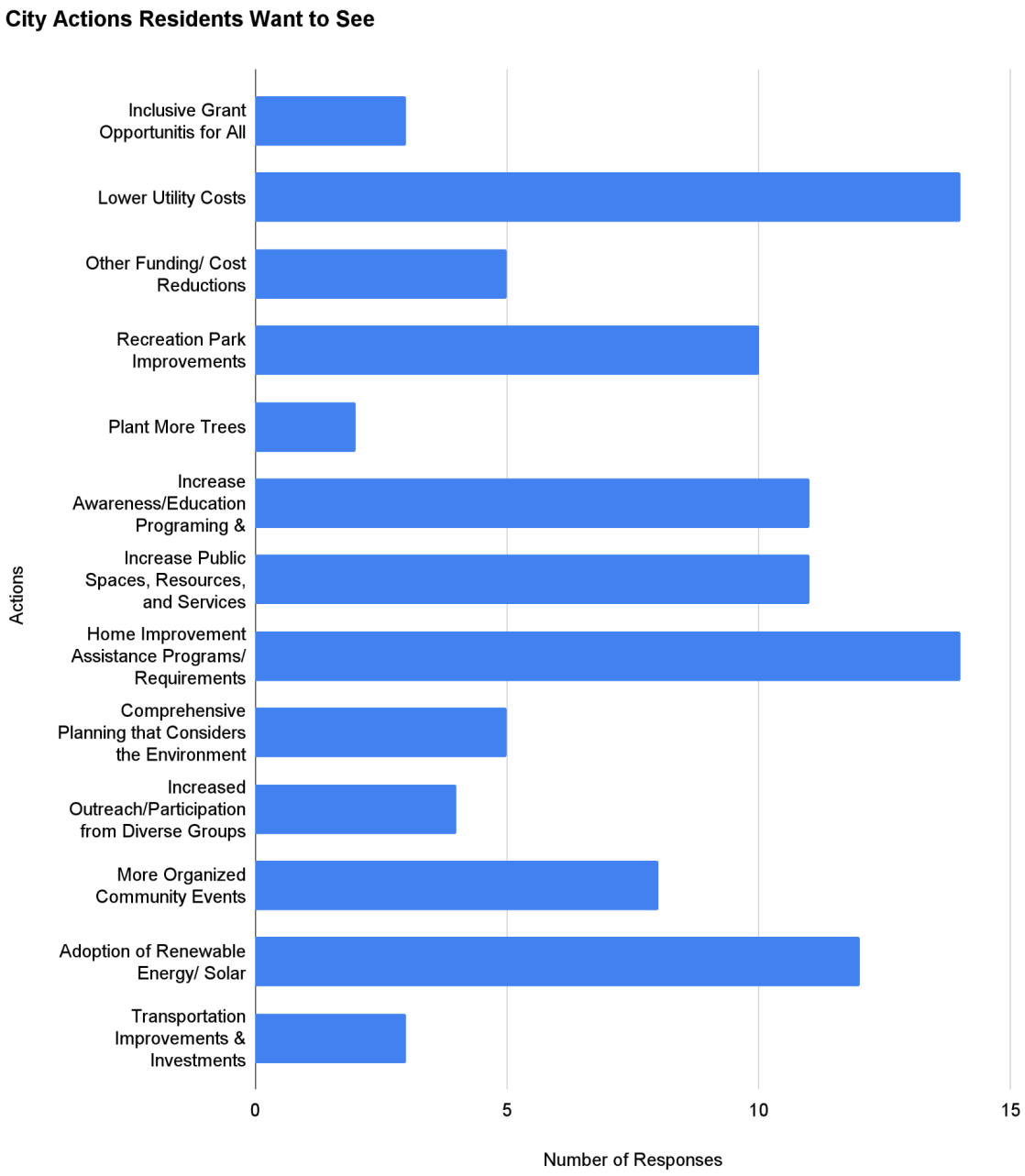


Figure 13. City actions focus group participants want to see, organized into categories, with the number of times the actions were documented in notes from the focus groups.

Extreme Heat

The majority of the community focus groups focused on extreme heat. When asked about their experiences with heat, health impacts were by far the most frequently mentioned (Figure 14).

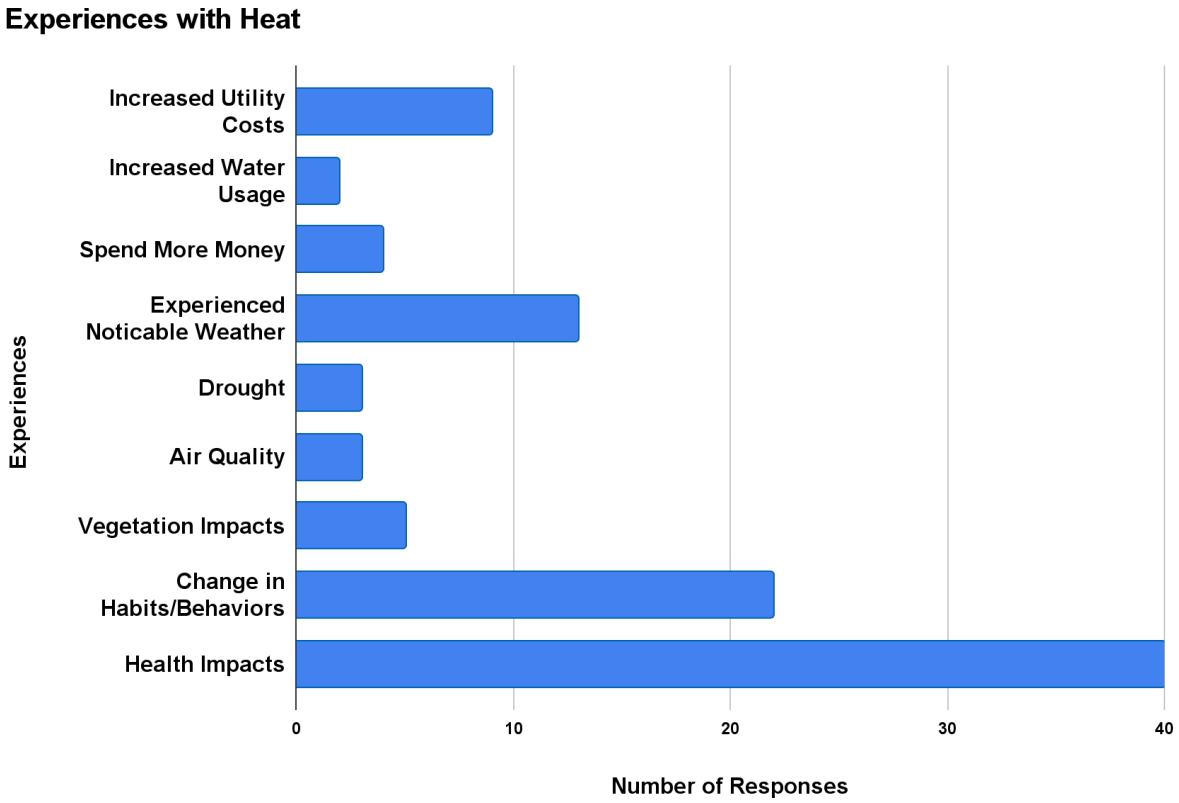


Figure 14. Focus group participants' past experiences with heat, organized by frequency of response.

Extreme Heat	
Past Experiences	**Future Impacts**
Experiences: ● Increased utility costs ● Health impacts ● Vegetation impacts ● Increased agitation **Disproportionately impacted areas and populations:** ● Downtown ● Unhoused community	**Impacted livelihoods due to:** ● Seeking cooling strategies ● Increased health impacts ● Increased irritation ● Income disruptions ● Uncomfortable working conditions **Predicted disproportionately impacted populations:** ● Elderly ● Children

- Elderly
- Older school buildings
- Those living without central AC

- Factory workers
- Pets

Coping Strategies and Ways the City Can Help

Coping Strategies:

- Staying inside
- Spending more time at pools/splash pads
- Seeking ways to cool down their home such as the use of blackout curtains and fans
- Spending time at air conditioned community/public spaces to cool down
- Staying hydrated

Ways the City Can Help:

- Strategically plan to reduce harm from heat
- Increase the number of cooling centers
- Financial support and grants to help community members adapt to climate change (for e.g. energy efficiency upgrades, air conditioning)
- Implement nature-based solutions
- Make infrastructure upgrades, improve/increase communication and education about heat
- Increase renewable energy (preference for solar)

Flooding

One focus group focused on flooding. All participants in that focus group were unhoused. Focus group participants shared their experiences living outside—on the streets, in vehicles, and along the Grand River—and in shelters downtown. Those living outdoors are highly exposed to climate hazards like extreme heat, flooding, storms, winter weather, and poor air quality. For these individuals, moving to higher ground means moving farther up the river bank to avoid flood waters. In recent years, homeless encampments along the Grand River have been flooded and damaged by storms, with residents' shelter and possessions destroyed or swept away. Limited access to information further hinders unhoused residents' ability to prepare for extreme weather. These individuals routinely face disenfranchisement and marginalization; their stories rarely make the news.

The participants in this focus group reported a range of impacts, including witnessing flooding in natural areas and having to move to higher ground. Overall, damage to cars and water damage to property were the most frequently reported impacts, though the smaller number of participants engaged around flooding make it difficult to see larger patterns in responses.

Flooding

Past Experiences

Experiences:

- Car damage
- Basement damage
- "Hectic and long" clean up process

Areas prone to flooding:

- Oakdale Avenue
- Division and 28th
- Comstock Park [location just outside City limits]

Future Impacts

Impacted livelihoods due to:

- Moving to higher ground/safer locations
- Loss of access to resources and services
- Negative employment impacts
- Feeling of instability

Predicted needs:

- Emergency planning and preparation

Coping Strategies and Ways the City Can Help

Ways the City Can Help:

- Improved communications
- Improved emergency planning systems
- Increase accessibility of homeless and emergency evacuation shelters
- Increased resources (such as emergency kits)
- Infrastructure upgrades (such as drains and pumps)
- Improved power reliability

Community Systems and Priority Risks

This section describes the vulnerability of community systems in Grand Rapids (see summary in Table 7). Vulnerability is determined by sensitivity (how a system fares when exposed to hazards) and adaptive capacity (a system's ability to adjust or adapt to hazards). High sensitivity **increases** vulnerability because it means that a system fairs **worse** when exposed to hazards. High adaptive capacity **decreases** vulnerability because it means that a system is **better** able to adjust and adapt. This relationship is described by the vulnerability matrix in Figure 15.

Each sub-section includes insights shared by the CRVA Working Group and focus groups related to sensitivity, adaptive capacity, and equity, along with a risk ranking for specific change impacts of concern associated with each system. ICLEI USA and the CRVA Working Group determined these risk rankings by weighing the likelihood and magnitude of consequence associated with each impact. The top contributors to each impact's risk ranking are also listed.

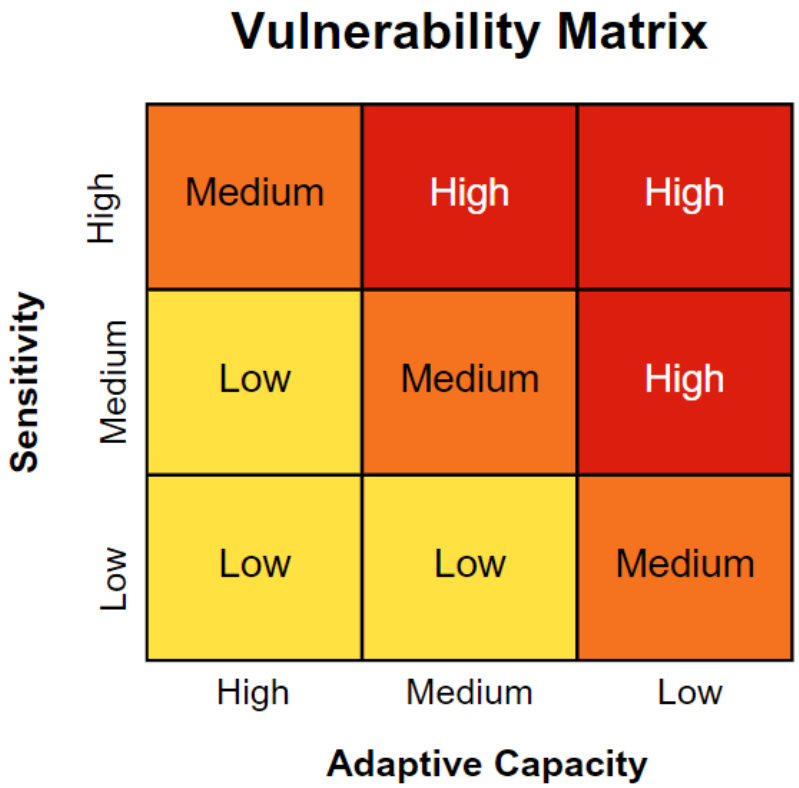


Figure 15. Vulnerability matrix.

Table 7. System vulnerability assessment summary.

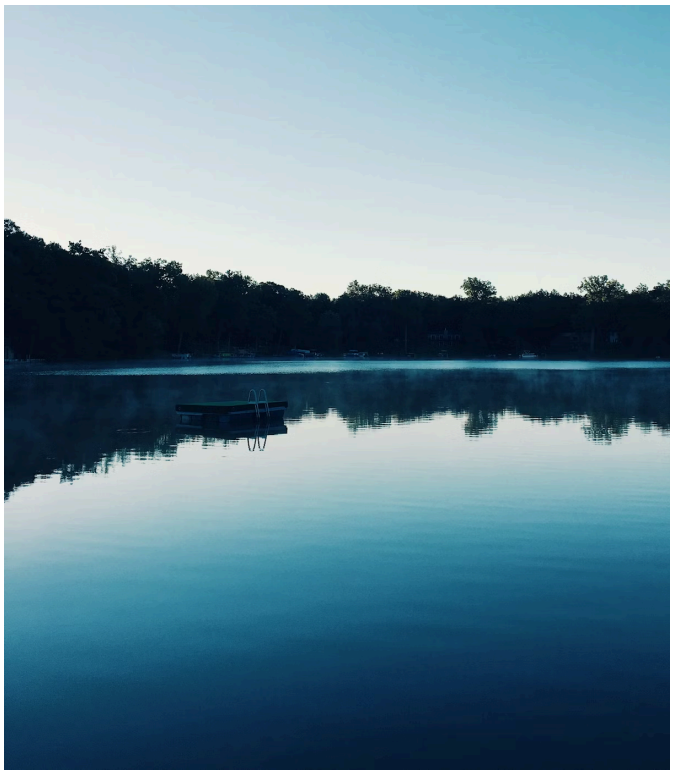
Community System	Sensitivity	Adaptive Capacity	Vulnerability
Natural Systems			
Ecosystems and Biodiversity	High	Low	**High**
Water Bodies	High	Medium	**High**
Parks and Green Space	Medium	Medium	**Medium**
People and Community			
Food Systems	High	Low	**High**
Housing Systems	Medium	Low	**High**
Public Health and Wellbeing	High	Medium	**High**
Emergency Management and Response	Medium	Medium	**Medium**
Local Business and Industry	Medium	Medium	**Medium**
Built Environment and Infrastructure			
Stormwater and Sewer Systems	Medium	Medium	**Medium**
Transportation Systems	Medium	High	**Low**
Energy Systems	Medium	High	**Low**

Natural Systems

Ecosystems and Biodiversity

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Ecosystems and Biodiversity	High	Low	**High**

Sensitivity



Grand Rapids is largely built-out and urbanized. Ecosystems and biodiversity are generally confined to small, managed areas, and are under pressure from human activities, development, pollution, invasive species, and imbalances (e.g. overabundance of deer). Changing seasonal conditions, increasing temperatures, decreased freeze-thaw cycles, storms, heavy rainfall, and flooding already cause substantial impacts on natural areas.

Adaptive Capacity

Improvements in ecosystem health and biodiversity can be achieved through planning, investment, and management. These efforts are underway in some parks (e.g. 32nd Street SE). The CRVA Working Group noted capacity and resource gaps around ecosystem management. Outside of parks and forestry, there is no clear mandate on ecosystem management, which must compete with other priorities for limited funding and capacity. These challenges and existing degraded ecosystem conditions contribute to a low adaptive capacity rating.

Equity

Green spaces are not equally distributed across neighborhoods in Grand Rapids. Natural areas located in disadvantaged communities are more likely to be "volunteers" (i.e. not intentionally planted) in areas that are marginal or not maintained (e.g. along fence lines). This leads to invasive species infiltration and weaker ecosystems that are more likely to succumb to climate hazards.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Changing seasonal conditions could cause wildlife and pests (e.g. ticks, mosquitoes, rodents) to become active at different times of year and/or spread into new areas.	**Medium**	$$$
Rising temperatures could lead to species of trees, plants, animals, and insects moving into Grand Rapids from other areas, while local species could be harmed (e.g. by lack of winter freezing).	**Medium**	$$$

$$$ Monetary cost of resulting damage

Unequal impacts on environmental justice communities

Potential for injuries and loss of life

Severity of community disruption

Water Bodies

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Water Bodies	High	Medium	**High**

Sensitivity

Heavy rainfall causes flooding and increases runoff, which reduces water quality. Higher temperatures and extreme heat can lead to reductions in water quantity and quality. Water bodies in parks are not complete ecosystems, though they are managed to the point where recreation is possible. Increased water velocity causes streambank erosion and failure. Sedimentation, legacy industrial pollution, and *E. coli* contamination are problems in some water bodies (e.g. Plaster Creek). Burial of natural creeks and small tributaries hinders the functioning of a natural riparian system in Grand Rapids, increasing the system's sensitivity to climate change.

Adaptive Capacity

Efforts to improve water quality can improve the adaptive capacity of water bodies, though issues caused by runoff and flooding remain. Grand Rapids has a number of initiatives and interventions focused on water bodies, particularly the Grand River, that have led to water quality gains. These include the City's sewer separation project (completed in 2015) and River for All. Through the River for All effort, Grand Rapids is working to restore natural ecology and bring rapids back to the Grand River. These and other current efforts, as well as other planned future work, increase adaptive capacity.

Equity

Plaster and Silver Creek, which have high levels of contamination, are located in the 3rd Ward. The 3rd Ward is not directly included in River for All work since it does not connect to the Grand River.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Heavy rainfall, flooding, rising temperatures, and extreme heat could all worsen water quality in local water bodies.	**Medium**	
Heavy rainfall, flooding, rising temperatures, and extreme heat could all increase harmful algal blooms.	**High**	

$$$ Monetary cost of resulting damage

Unequal impacts on environmental justice communities

Potential for injuries and loss of life

Severity of community disruption

Parks and Green Space

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Parks and Green Space	Medium	Medium	**Medium**

Sensitivity

Parks and green spaces are under pressure from human activities and invasive species. Climate related hazards, including changing seasonal conditions, increasing temperatures, decreased freeze-thaw cycles, storms, heavy rainfall, and flooding are already causing damage to these areas. Some parks along the river, including Riverside and Ab-Nab-Awen, are allowed to flood to prevent flooding upstream.

Adaptive Capacity

Funding for parks is generally adequate; however, changing conditions related to climate change are already increasing costs for maintenance such as irrigation and tree planting. The Parks millage provides critical funding for some projects. The City is already working to increase tree canopy coverage and diversity through Vital Street projects. A strong local volunteer network helps support efforts like tree planting, though relying on volunteers is not always sustainable. Management of green spaces, such as those located on undeveloped city lots, schools, and in community gardens, is less likely to have a secure funding source. Parks staff must regularly return river-edge parks to usable condition following flooding, which requires resources.

Equity

Trees located in disadvantaged communities are more likely to be "volunteers" (i.e. not intentionally planted) in areas that are marginal or not maintained (e.g. along fence lines). This leads to invasive species infiltration and weaker trees that are more likely to succumb to hazards. Storms are a primary concern.

The City recognizes the need to improve park access and equity to reach the goal of having all residents within 10 minutes of a park [34]. The gap in park and green space equity is particularly evident in the 3rd Ward. The 3rd Ward is not connected to the downtown area or the Grand River, and CRVA Working Group members noted that it has been passed over for trail and greenway improvements in the past.

Focus group participants reported uncomfortably hot conditions in unshaded parks and on playgrounds, even issues with burns on hot playground equipment. Those who have AC indicated they would stay home more.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Climate change and extreme weather events could weaken local trees and cause urban tree canopy losses.	**Medium**	$$$ ⚖
Climate change and extreme weather events could harm private and public landscaping and green spaces, negatively impacting ecosystem services.	**Medium**	$$$ ⚖

$$$ Monetary cost of resulting damage

⚖ Unequal impacts on environmental justice communities

Potential for injuries and loss of life

Severity of community disruption

People and Community

Food Systems

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Food Systems	High	Low	**High**

Sensitivity

While most of Grand Rapids' food supply is not grown within city limits, Kent County is a large producer of fruit and other items and interest in local food is growing. The region has a large food manufacturing presence, with food suppliers Meijer and SpartanNash based in West Michigan. However, the food supply remains vulnerable to supply chain disruptions locally and in other areas and states, as was evident in disruptions and shortages that occurred during the COVID-19 pandemic. Climate hazards contribute to crop damage and support the spread of pests (through e.g. warmer and wetter weather).

Anecdotally, stakeholders reported that home and community gardens are rising in popularity and may supplement purchased food for some households. Heavy rain and flooding in Grand Rapids have the potential to damage home and community gardens in exposed areas. However, since no entity tracks or monitors community gardens in Grand Rapids or Kent County [35], it is not possible to determine if gardens are located in flood-prone locations without additional outreach and data collection. Rising temperatures and changing seasonal conditions can make gardening more challenging and lead to harvest loss.

Adaptive Capacity

Many local organizations work to support food security, justice, and community agriculture in the Grand Rapids area, including Our Kitchen Table (OKT), Access of West Michigan, the Michigan Good Food Fund, along with many others. The City has worked to make community agriculture more accessible through policy changes and funding for urban gardens via the Neighborhood Match Fund [36]. The Kent County Food Assessment shows a concentration of food access locations, processing centers, and retail outlets in the city of Grand Rapids [35], which indicates city residents would have better access to food during emergencies compared to surrounding areas in the county. However, the extent to which infrastructure and community services are prepared to handle these challenges is not known.

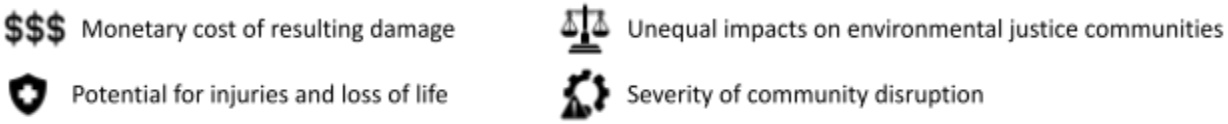
Equity

Backyard gardens, which are becoming increasingly popular, are negatively impacted by hazards and pests. Gardeners may lack funds to pay for pest management.

A variety of root causes, including systemic discrimination and legacies of neighborhood segregation, contribute to lack of access to healthy food in some parts of Grand Rapids. These areas are concentrated in places where residents of color and those with lower incomes reside. A 2019 study found that Neighborhoods of Focus had the highest populations with limited access to healthy food [37]. Households with children and Black households are disproportionately likely to receive SNAP benefits in Kent County [35].

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Climate change and extreme weather events regionally or even in other parts of the world could increase the cost of food and cause supply shortages and disruptions in Grand Rapids.	**High**	
Changing seasonal conditions are altering growing seasons, which could impact urban gardening and agricultural areas that serve Grand Rapids.	**Medium**	



Housing Systems

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Housing Systems	Medium	Low	**High**

Sensitivity

Population trends and projections in the City's 2022 Housing Needs Assessment show the housing gap in Grand Rapids is growing. The report estimates a growing housing gap of 7,951 rental units (a 48.9% increase since 2020) and 6,155 for-sale units (a 73.5% increase since 2020) over the 2022-2027 period [38]. Affordable housing is already scarce and subject to waitlists, which perpetuates housing burden for low-income households [38]. The quality of the existing housing stock varies across neighborhoods [20]. Substandard conditions and environmental exposures are known issues in housing stock in the Neighborhoods of Focus [37]. This combination of factors increases sensitivity, as substandard housing is more likely to be damaged by hazards like convective storms and flooding. Residents experiencing housing burden are less able to afford improvements and maintenance that reduce risk. Recent flooding in Grand Rapids has primarily affected businesses, though homes on the north side of the Grand River face springtime nuisance flooding. While there is currently no data available on the proportion of Grand Rapids homes that have AC, anecdotally, many homes (particularly older homes) in the City lack it and residents use fans or window AC units. This can expose residents to dangerous conditions during hot weather.

Adaptive Capacity

Housing is a high-priority concern for Grand Rapids residents [20]. The City needs more housing as well as better options in terms of quality, density, proximity to jobs and amenities, and affordability. Legacies of redlining and systemic inequities continue to constrain residential choices. Stakeholders report that housing agencies are stretched thin and capacity is low. The City's 2024 Draft Community Master Plan identifies housing as a priority and calls for creating complete and stable neighborhoods, anti-displacement strategies, expanding housing stock, improving options at all income levels, and increasing resources and city programs to support housing-related needs. Implementing these actions will increase the adaptive capacity of the city's housing systems. On a household level, insurance can help people recoup losses caused by extreme weather events. However, some residents are under-insured or lack appropriate insurance to cover flood impacts.

The City should also consider the potential impacts of climate-related migration, which refers to the movement of people influenced by climate change, in housing discussions and planning efforts. News stories have identified midwestern cities, including Grand Rapids, as places that are comparatively more affordable and safer from hazards than coastal and western population centers. A large influx of new residents in Grand Rapids could exacerbate inequities and strain local resources. However, it is important to note the many uncertainties related to migration flows; climate change is only one of many factors people consider when deciding where to live. The majority of US moves are within the same county and data shows large growth in population in states with significant climate risk, including California, Texas, and Florida, over relatively safer climate options like Michigan [39]. Yet existing migration flows may change as climate change worsens in the coming decades, making it essential that communities, cities, states, and the federal government prepare. No community can meet this challenge alone. Activities like scenario planning exercises, which push stakeholders to think through multiple possible futures, can help cities build understanding of the complexities of climate-related migration and increase buy-in for action.

Equity

Homeowners and renters in the Neighborhoods of Focus reported higher levels of housing cost burden than the city as a whole. Residents of these areas have lower rates of homeownership than the city as a whole [37]. BIPOC individuals are more likely to experience housing insecurity due to the legacy of redlining and ongoing systemic discrimination in housing markets [37]. Grand Rapidians who are unhoused or housing insecure face extreme risk from all climate hazards. Residents, particularly those who are low-income, may be un- or under-insured, leaving them with fewer resources to recover after extreme weather events. Insurance is often not an option for unhoused and housing-insecure Grand Rapidians, leaving them without options to cope with lost or damaged property.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Heavy rainfall and flooding, including basement flooding, could damage residential property.	**Medium**	$$$ ⚖
Increased heavy rainfall and flooding could increase the price of insurance for residents and businesses and mean more property owners need to purchase flood insurance.	**Medium**	$$$ ⚖

$$$ Monetary cost of resulting damage

⚖ Unequal impacts on environmental justice communities

Potential for injuries and loss of life

Severity of community disruption

Public Health and Wellbeing

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Public Health and Wellbeing	High	Medium	**High**

Sensitivity

Health concerns related to climate change (primarily extreme heat) emerged as a priority in community focus groups and the CRVA Working Group. Many attendees reported impacts on their own and loved ones' personal health including dehydration, mood changes, heat stroke and exhaustion, dizziness, and problems with breathing and asthma. In Grand Rapids, people can be more exposed to climate hazards because of where they live, the jobs they do, and their socioeconomic circumstances.

As discussed in the housing sub-section, substandard housing puts people at risk of negative health impacts. Contact with floodwater exposes residents to contaminants. Flooded properties

expose residents to mold. These issues will increase as climate change worsens heat and flooding. Substandard conditions and environmental exposures are known issues in Neighborhoods of Focus [37]. These same communities have higher rates of health conditions, such as asthma, that make people more susceptible to heat-related illness. Residents who are unhoused or housing insecure, such as those living in vehicles, are at high risk, as are those who work outside or in hot conditions, including utility, agricultural, construction, food delivery, restaurant, and warehouse workers. Focus group participants reported issues with high temperatures in school buildings, some of which still lack air conditioning. This has led to school closures as recently as August 27, 2024 [22].

Healthcare workers and infrastructure also face risk. Rising temperatures and more extreme heat can strain health facilities and workers with increased cases of heat-related illness. Storms and flooding can reduce emergency response access to affected areas. Though area hospitals are not located in the 100-Year Floodplain according to EPA's EJScreen tool, this does not mean that they are immune to disruptions caused by flooding, which can affect road access, supply chains, and power supply.

Climate change is also impacting mental health and wellbeing by increasing stress and anxiety. Repeated exposure to hazards, associated damage to property, loss of income, and disrupted routines all cause mental strain.

Adaptive Capacity

Those who bear the brunt of climate change's impacts on physical health and wellbeing often have the fewest resources to take adaptive measures such as installing AC or shifting schedules so outdoor work occurs during cooler periods. Focus group participants had many ideas for actions the city and community-serving organizations could take to reduce their risk, many of which related to social programs. Partnering with the community groups serving those most in need around preparedness for heat, storms, and flooding would create many opportunities to increase adaptive capacity. Local organizations are active in the public health space, including the Baxter Community Center, LINC UP, C4 and others. Installation of AC is planned for schools that currently lack it.

Equity

In general, frontline and disadvantaged groups are more sensitive to heat due to multiple factors, including higher rates of health conditions like asthma and diabetes. In 2019, residents of the Neighborhoods of Focus were twice as likely to be uninsured than Kent County and the state of Michigan as a whole [37]. Grand Rapidians who are unhoused or housing insecure face extreme risk from all climate hazards.

Focus group participants reported that housing and school buildings in their neighborhoods are older and lack air conditioning. They also noted that higher summer energy bills are causing financial hardship. For these residents, substandard older housing and lack of weatherization is leading to high energy burden as households are forced to spend a greater portion of their income on energy costs. Some households with AC may avoid using it to reduce costs, which can expose residents to dangerously hot conditions.

Those who are unhoused shared that they struggled to find places to shelter during extreme heat and heavy precipitation events. For unhoused Grand Rapidians, damage to property such as tents and cars creates extreme hardship.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Health		
Rising temperatures and extreme heat are health risks (e.g. heat stress, worsening of chronic illness, cardiovascular and lung disease, mental health impacts) and could lead to increases in heat-related illness and mortality.	**High**	
Heavy rainfall and flooding could create health risks for Grand Rapids residents through direct injuries and exposure to contaminated water, pollution, and mold.	**High**	
Extreme heat and wildfires—even when they are far away from Grand Rapids—could lead to poor air quality in the city, which poses health risks to residents.	**High**	
Rising temperatures and extreme heat could threaten children's health and learning outcomes in cases where schools are insufficiently air-conditioned or forced to close.	**High**	
Changing climate conditions could lead to increased pollen, which could worsen allergies and upper respiratory issues for Grand Rapids residents, especially in combination with poor air quality.	**Medium**	

Extreme heat could make outdoor activities unpleasant or even unsafe, leading to impacts on residents' physical and mental health.	**Medium**	
Climate change and severe weather could negatively impact mental health and increase stress in the Grand Rapids community.	**Medium**	
Community Wellbeing and Prosperity		
Extreme heat could threaten the ability of frontline and outdoor workers (e.g. construction, agricultural) to do their jobs safely.	**High**	$$$  
Climate change and extreme weather events could cause life altering hardship (due to e.g. property damage, loss of livelihoods) for Grand Rapids residents.	**High**	$$$ 

$$$ Monetary cost of resulting damage

 Unequal impacts on environmental justice communities

 Potential for injuries and loss of life

 Severity of community disruption

Emergency Management and Response

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Emergency Management and Response	Medium	Medium	**Medium**

Sensitivity

Climate change poses a number of threats to emergency management systems, personnel, and first responders. Extreme heat events can increase demand for emergency management capacity, emergency services, and medical care while also exposing responders to dangerous heat. Flooding and storm events have been known to strain capacity while power outages and blocked roads impede emergency response. More extreme weather, climate, and other events (e.g. civil unrest) can interact and cascade, putting further strain on services.

Adaptive Capacity

Climate-related hazards are increasing risk in Grand Rapids, but emergency management staffing and investment has not kept up. Frequent hazard events and the COVID-19 pandemic contribute to burnout. Emergency management staff level falls below the recommended level of 4 full-time staff for a community the size of Grand Rapids. More coordination is needed around the climate resilience and emergency management nexus.

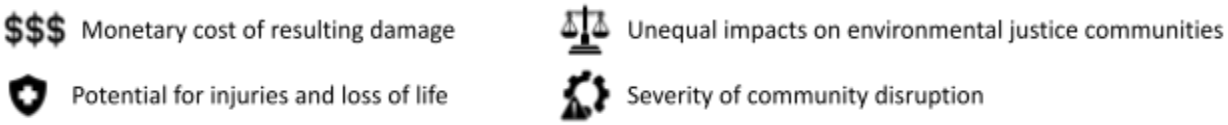
Equity

Grand Rapids was designated as having Medically Underserved Populations, which means low-income residents have a shortage of primary care providers and barriers to access [37]. This can contribute to increased reliance on emergency services for medical needs. Residents of the Neighborhoods of Focus face legacy lack of investment in transportation infrastructure as well as higher rates of health concerns. This combination could mean that in-need individuals in these areas are less reachable during an emergency.

Those with the greatest needs are often hardest to reach with emergency alerts. Focus group participants who were unhoused shared that they had difficulty accessing online alerts and resources.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Increasingly erratic and severe weather events could strain emergency management and response systems.	**High**	
Heavy rainfall, snowfall, flooding, and severe storms could threaten access to emergency services and medical treatment (e.g. due to street flooding, blocked roads), delaying access to care.	**Medium**	



Local Business and Industry

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Local Business and Industry	Medium	Medium	**Medium**

Sensitivity

Climate-related hazards disrupt business in Grand Rapids, with small businesses more likely to face outsize impacts. Extreme heat puts workers at risk and can reduce customer patronage at outdoor businesses. Storms and flooding can cause power outages that reduce productivity, disrupt transportation routes and supply chains, and cause property damage. Downtown businesses are located in areas that have been affected by flooding in the past; these areas are now protected by flood protection systems and have not seen significant impacts from flooding in recent years according to Grand Rapids Emergency Management. High temperatures and poor air quality could disrupt community events, which spark economic activity in downtown areas. In recent years, winter events have been negatively affected by warmer temperatures and a lack of snow.

Adaptive Capacity

The City places a strong emphasis on economic development and supporting small businesses. This is emphasized in existing city plans, including the draft Bridge to Our Future Community Master Plan and the 2017 Equitable Economic Development and Mobility Strategic Plan. The 2017 Strategic Plan sets out strategies to address economic and mobility disparities with a focus on closing gaps for disadvantaged communities. Implementation of these strategies supports resilience for residents and the business community to a range of disruptions and stressors, including those caused by climate change. Corridor Improvement Authorities can help business districts plan for and fund capital improvements. The authorities could be leveraged to help local businesses plan for and implement resilience actions.

Rising temperatures could create opportunities for some businesses. For example, outdoor businesses may be able to extend their seasons in milder winters.

Equity

Small and minority-owned businesses are more likely to face outsize impacts from climate change. Focus group participants reported severe heat issues in their workplaces, including sweltering warehouses, factories, and industrial areas of Grand Rapids. Hot environments create the risk of health impacts and reduce productivity.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Heavy rainfall and flooding could lead to negative impacts on river-edge businesses, including property damage and hazardous conditions.	**High**	$$$ 
Rising temperatures and extreme heat could reduce productivity and customer patronage at outdoor businesses.	**Medium**	$$$
Rising temperatures, extreme heat and drought could threaten outdoor recreation businesses (e.g. winter and water based recreation) in and around Grand Rapids.	**Medium**	$$$ 
Power outages related to climate hazards could hurt local businesses by reducing worker productivity and customer patronage.	**Medium**	$$$ 
Heavy rainfall and flooding could cause costly damage to commercial property, including structural damage and mold, resulting in economic losses for businesses.	**Medium**	$$$

$$$ Monetary cost of resulting damage

 Potential for injuries and loss of life

 Unequal impacts on environmental justice communities

 Severity of community disruption

Built Environment and Infrastructure

Stormwater and Sewer Systems

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Stormwater and Sewer Systems	Medium	Medium	**Medium**

Sensitivity

Sensitivity was assessed as medium due to the high exposure of the stormwater and sewer systems to climate change, particularly heavy rainfall events. These events can be a "destructive force" on stormwater infrastructure and already cause periodic road and culvert washouts and contribute to streambank erosion and failure. High rates of impervious surfaces, particularly in downtown areas, prevent water from infiltrating into soil, worsening stormwater issues. The City has reduced sensitivity by making significant investments in the systems. All Combined Sewer Overflow (CSO) points in the system were eliminated in 2015 when the city completed the process of separating its stormwater and sanitary sewers. This significantly reduces but does not eliminate the possibility that untreated sewage could be discharged into the Grand River [13]. Stakeholders in the CRVA Working Group reported that planning and maintenance of some green infrastructure could be improved.

Adaptive Capacity

The City's work separating its combined sewers shows leadership and a proactive approach. Though significant investments have already been made, more funding is needed for maintenance, staff, and training. According to stakeholders in the CRVA Working Group, green infrastructure is not funded at needed levels, and flood protection elevations may need to be raised to cope with future climate change.

Equity
Neighborhoods of Focus are subject to legacy lack of investment in infrastructure, including stormwater infrastructure. Focus group participants reported increased water bills, which can cause financial hardship.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Heavy rainfall and flooding could overwhelm and damage stormwater infrastructure.	**High**	$$$  
Heavy rainfall will lead to increased inflow at Water Resource Recovery Facilities (WRRFs), which could increase rates for consumers and property owners.	**Medium**	$$$ 
Though the city eliminated all CSO points in the system, heavy rainfall and flooding could still lead to sewer backups.	**Low**	

$$$ Monetary cost of resulting damage

 Unequal impacts on environmental justice communities

 Potential for injuries and loss of life

 Severity of community disruption

Transportation Systems

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Transportation Systems	Medium	High	**Low**

Sensitivity

Grand Rapids' transportation system, which includes built assets like roads and bridges as well as public transit, bicycling, and pedestrian infrastructure, is sensitive to climate change. Heavy rainfall and flooding, which can overwhelm dispersed stormwater infrastructure, already cause periodic road and culvert washouts that impact infrastructure usability. Trail networks near rivers and streams can be affected by high water levels, streambank erosion and failure. Repeated exposure to flooding degrades roads and bridges over time. Issues with flooding and washouts could worsen with increases in storm activity and more heavy rain events.

While the city has not yet experienced many heat-related impacts on infrastructure (e.g. road melting), this could change in a future with more extreme heat events. Heat already impacts the usability of transportation systems for people, who are exposed to heat while walking, bicycling, and waiting at transit stops. Other extreme weather conditions, including winter weather, heavy rainfall, and poor air quality, can make it uncomfortable and even dangerous to wait outside for public transportation.

Across the six-city region served by the RAPID transit network, slightly more than 10% of bus stops have shelters, with more shaded by tree canopy. Long wait times for transit increase heat exposure. Because the RAPID transit network is owned and operated by a regional group, the City does not have direct influence over transit frequency or reliability, outside of the Downtown Area Shuttle (DASH) service, which is funded by the City. The City works in partnership with The Rapid to invest in travel stop amenities. It is imperative that the City consider the impacts of heat and flooding as it seeks to expand walking, bicycling, and transit infrastructure to meet its economic, equity, and climate goals.

Adaptive Capacity

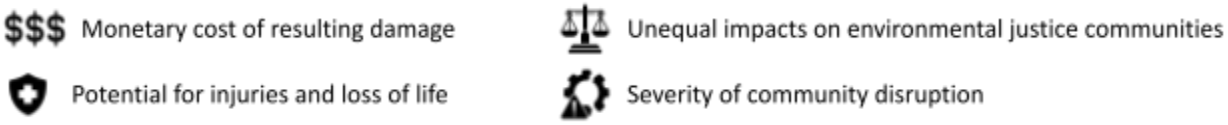
There is redundancy in the transportation system to cope with flooding. The Vital Streets program has made strides around improving water quality, managing flow, and preventing standing water and flooding. Accessible interventions related to heat exposure for transit riders, such as reducing wait times and adding shade structures, exist but implementation could depend on additional funding and coordination with the regional group that manages The RAPID. The City could take advantage of local, state, and federal funding opportunities to support transportation resilience planning.

Equity

The Neighborhoods of Focus face legacy lack of investment in infrastructure, including transportation infrastructure. Public transit use is not always a choice. Low-income residents, who are more likely to not own personal vehicles, are primarily affected when there are issues with public transit. Across all Neighborhoods of Focus, 14% of households do not have access to a vehicle, though in one census tract (28), 41% of residents do not have access [37]. Overall, 12% of Grand Rapidians do not have access to a vehicle. Focus group participants shared that bus waiting areas can feel especially hot and noted hour and a half wait times.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Extreme heat, heavy precipitation, and flooding could damage public transit assets and impact service.	**High**	
Extreme heat and flooding could damage transportation infrastructure, including roads, bridges, culverts, and sidewalks (e.g. by causing potholes, washouts, melting, buckling, cracking).	**Medium**	$$$ 



Energy Systems

Community System	Sensitivity	Adaptive Capacity	Vulnerability
Energy Systems	Medium	High	**Low**

Sensitivity

Extreme heat, convective storms, and flooding can all pose threats to electricity infrastructure in and around Grand Rapids. In recent years, stronger and more unpredictable storm activity has been leading to more frequent power outages, though large-scale, long-lasting electrical failures remain uncommon. Gas infrastructure is mostly underground; outages that occur are unrelated to weather events. Power outages are a top concern for residents, who have noticed their increasing frequency. Even short-term outages lead to a number of negative community impacts, including loss of cooling, refrigeration, and income due to inability to work.

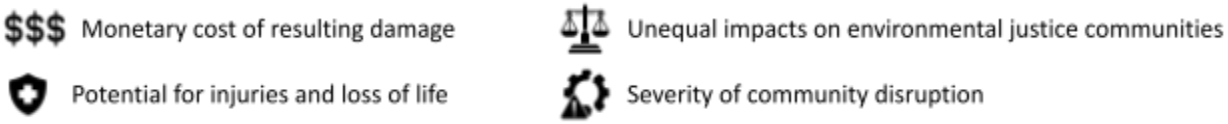
Adaptive Capacity

Consumers Energy (CE) is in the process of a large system upgrade focused on reliability and hardening, and has received federal grants to support grid resiliency, modernization, and work with disadvantaged communities. DTE Energy, which provides natural gas, is also in the process of upgrading its infrastructure. Both providers have plans in place for disruptions.

Equity
Extreme heat can increase energy costs, increasing energy cost burden on low-income households. Older homes are more likely to lack insulation and AC.

Risk Assessment: Specific Impacts of Concern

Impact Statement	Risk Ranking	Top Contributors to Risk
Extreme heat, severe storms, and flooding could overload or damage energy infrastructure, leading to extended power outages.	**Medium**	



Conclusion and Next Steps

This report underscores the urgent need for the City of Grand Rapids to adapt to climate change, as well as the many opportunities available to build resilience.

Moving forward, the City recognizes that it must build resilience by strengthening all aspects of local communities, including residents, infrastructure, and natural systems. Furthermore, when people and communities approach resilience holistically, it can lead to a variety of co-benefits, including creation of wildlife habitat, green jobs, energy savings, and health and quality of life improvements. It is imperative that this future work involve, collaborate with, and empower frontline communities to shape their own adaptive futures. Government and community must come together to achieve equitable and lasting resilient outcomes.

Hard work and challenges lie ahead. Now is the time to move toward a better future. The City of Grand Rapids will take the information and recommendations provided by the CRVA Report and incorporate them into the City's upcoming Climate Action and Adaptation Plan. The Climate Action and Adaptation Plan will be brought to City leadership for adoption in Spring of 2025. By planning and taking action on climate change, we have the opportunity to make the City of Grand Rapids a healthy and safe community for ourselves and future generations.

References

[1] U.S. Federal Government, “Glossary,” U.S. Climate Resilience Toolkit. Accessed: Feb. 20, 2023. [Online]. Available: https://toolkit.climate.gov/content/glossary

[2] NOAA, “Climate Adaptation Partnerships Program History.” Accessed: Sep. 26, 2024. [Online]. Available: https://cpo.noaa.gov/divisions-programs/climate-and-societal-interactions/cap-risa/climate-adaptation-partnerships-program-history/

[3] USGCRP, “Glossary,” GlobalChange.gov. Accessed: Feb. 21, 2023. [Online]. Available: https://www.globalchange.gov/climate-change/glossary

[4] NOAA, “Climate Models,” Climate.gov. Accessed: Feb. 21, 2023. [Online]. Available: https://www.climate.gov/maps-data/climate-data-primer/predicting-climate/climate-models

[5] U.S. Federal Government, “Frequently Asked Questions,” U.S. Climate Resilience Toolkit Climate Explorer. Accessed: Feb. 21, 2023. [Online]. Available: https://crt-climate-explorer.nemac.org/faq/

[6] EPA, “Combined Sewer Overflows (CSOs).” Accessed: Sep. 26, 2024. [Online]. Available: https://www.epa.gov/npdes/combined-sewer-overflows-csos

[7] CMIP, “Coupled Model Intercomparison Project.” Accessed: Sep. 26, 2024. [Online]. Available: https://wcrp-cmip.org/

[8] IPCC, “Annex II: Glossary,” Cambridge, UK and New York, USA, 2014. [Online]. Available: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_Annex-II.pdf

[9] City of Grand Rapids, “Neighborhoods of Focus (NOF).” Accessed: Sep. 27, 2024. [Online]. Available: https://www.grandrapidsmi.gov/Government/Departments/Office-of-Equity-and-Engagement/Demographics-Statement#section-5

[10] United Nations Office for Disaster Risk Reduction, “Terminology: Resilience,” undrr.org. Accessed: Feb. 20, 2023. [Online]. Available: https://www.undrr.org/terminology/resilience#:~:text=The%20ability%20of%20a%20system,and%20functions%20through%20risk%20management.

[11] Clara Fang, Jessica Hench, Christa Daniels, and Abigail Abrash Walton, “Centering Equity in Climate Resilience Planning and Action: A Practitioner’s Guide,” Antioch University New England, 2022.

[12] City of Grand Rapids, “City of Grand Rapids Strategic Plan,” 2022. Accessed: Oct. 08, 2024. [Online]. Available: https://www.grandrapidsmi.gov/Government/Departments/Office-of-the-City-Manager/Strategic-Plan

[13] City of Grand Rapids, Kent County, and Ottowa County, “Kent County, Ottawa County and the City of Grand Rapids Regional Hazard Mitigation Plan,” 2022. Accessed: Apr. 26, 2024. [Online]. Available: https://www.accesskent.com/Sheriff/pdfs/GGRHazMitPlan_2022.pdf

[14] Matt Hutchins, Jim Fox, Aaska Patel, and Kom Rhodes, “Implementing the Steps to Resilience: A Practitioner’s Guide,” NOAA Climate Program Office, 2022. Accessed: Dec. 07, 2023. [Online]. Available:

https://toolkit.climate.gov/content/practitioners-guidance-implementing-steps-resilience
[15] U.S. Federal Government, “U.S. Climate Resilience Toolkit.” Accessed: Nov. 08, 2023. [Online]. Available: http://toolkit.climate.gov/
[16] Urban Sustainability Directors Network, “Guide to Equitable, Community-Driven Climate Preparedness Planning,” May 2017. Accessed: Nov. 16, 2023. [Online]. Available: https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness-_high_res.pdf
[17] American Society of Adaptation Professionals (ASAP), “ASAP Professional Guidance Resources Glossary.” 2021. Accessed: Feb. 20, 2023. [Online]. Available: https://adaptationprofessionals.org/wp-content/uploads/2021/03/ASAP-Glossary.pdf
[18] U.S. Census Bureau, “2020 Decennial, Table P1.”
[19] Planning Next and CNT, “Community Master Plan Presentation,”
[20] Planning Next and City of Grand Rapids, “Bridge to Our Future: Grand Rapids Community Master Plan [Draft],” 2024.
[21] N. US Department of Commerce, “Flooding in Michigan.” Accessed: May 07, 2024. [Online]. Available: https://www.weather.gov/safety/flood-states-mi
[22] Danielle James, “Extreme heat forces Grand Rapids Public Schools to cancel classes Tuesday,” *MLive.com*, Aug. 27, 2024. [Online]. Available: https://www.mlive.com/news/grand-rapids/2024/08/extreme-heat-forces-grand-rapids-public-schools-to-cancel-classes-tuesday.html
[23] Irena Li, “Michigan under statewide advisory as Canada wildfire smoke hits Midwest,” Jun. 27, 2023. Accessed: Oct. 03, 2024. [Online]. Available: https://www.bridgemi.com/michigan-environment-watch/michigan-under-statewide-advisory-canada-wildfire-smoke-hits-midwest
[24] Grand Rapids, MI Weather Forecast Office, “August 24, 2023 Tornadoes.” [Online]. Available: https://www.weather.gov/grr/August24_2023_Tornadoes#:~:text=Structural%20damage%20was%20done%20to,on%20the%20Enhanced%20Fujita%20Scale
[25] WMrapids, “2013 Grand Rapids flood,” Wikimedia Commons. Accessed: Sep. 27, 2024. [Online]. Available: https://commons.wikimedia.org/wiki/File:2013_Grand_Rapids_flood.jpg
[26] GLISA, “Climate Change in the Great lakes and Grand Rapids, Michigan,” 2019.
[27] NOAA Office of Water Prediction, “NOAA Atlas 15: Update to the National Precipitation Frequency Standard.” Accessed: Sep. 26, 2024. [Online]. Available: https://www.weather.gov/media/owp/hdsc_documents/NOAA_Atlas_15_Flyer.pdf
[28] USGCRP, “Climate Science Special Report: Fourth National Climate Assessment, Volume I,” U.S. Global Change Research Program, Washington, DC, USA, 2017. Accessed: Feb. 23, 2023. [Online]. Available: https://science2017.globalchange.gov/
[29] GLISA, “Lake-effect Snow in the Great Lakes Region.” Accessed: Sep. 06, 2024. [Online]. Available: https://glisa.umich.edu/resources-tools/climate-impacts/lake-effect-snow-in-the-great-lakes-region/#:~:text=During%20the%20late%20fall%20and,the%20southern%20and%20eastern%20shores.
[30] Risk Factor, “How is my Flood Factor calculated?” [Online]. Available:

https://help.riskfactor.com/hc/en-us/articles/360047585694-How-is-my-Flood-Factor-calculated#:~:text=A%20property%27s%20Flood%20Factor%20is,experience%20high%20floods%20or%20both
[31] First Street, “First Street National Flood Adaptation Database (Grand Rapids, MI).” Accessed: Sep. 06, 2024. [Online]. Available: https://firststreet.org/city/grand-rapids-mi/2634000_fsid/flood/maps?eventId=887#adaptation-protections
[32] First Street Foundation, “Flood Factor.” 2023.
[33] ICLEI Canada, “Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation.” Accessed: Dec. 07, 2023. [Online]. Available: https://icleicanada.org/wp-content/uploads/2019/07/Guide.pdf
[34] City of Grand Rapids, “Your City Your Parks: City of Grand Rapids Parks & Recreation Department 2022 Strategic Master Plan Update,” 2022. Accessed: Sep. 06, 2025. [Online]. Available: https://www.grandrapidsmi.gov/Government/Departments/Parks-and-Recreation/Parks-and-Recreation-Strategic-Master-Plan
[35] Kent County Food Policy Council, “Kent County, Michigan Food System Assessment: Executive Summary,” 2023. Accessed: Sep. 06, 2024. [Online]. Available: https://kentfoodpolicy.org/wp-content/uploads/2023/09/KCFPC_FoodAssessment_2023.pdf
[36] LINC UP and Detroiters Working for Environmental Justice, “Health, Environment and Race in Grand Rapids,” 2019. Accessed: Aug. 08, 2024. [Online]. Available: https://oktjustice.org/wp-content/uploads/2019/04/dwej_linc_final_web-1.pdf
[37] Trish R. Abalo, Kallie Bauer, Brian Herron, and Melyssa Tsai O’Brien, “Housing Equity in Grand Rapids’ ‘Neighborhoods of Focus,’” 2022. Accessed: Sep. 06, 2024. [Online]. Available: https://johnsoncenter.org/wp-content/uploads/2022/03/SDOH-Report-WEB.pdf
[38] Bowen National Research, “Housing Needs Assessment Grand Rapids/Kent County, MI,” 2022. Accessed: Sep. 06, 2024. [Online]. Available: https://www.grandrapidsmi.gov/Government/Departments/Planning/City-Housing-Policy-Amendments
[39] First Street Foundation, “Climate Abandonment Areas,” 2023. Accessed: Sep. 06, 2024. [Online]. Available: https://firststreet.org/research-library/climate-abandonment-areas