



Adaptation Planning for Climate Resilience



A Michigan Army National Guard Pilot Project

A demonstration project to strengthen the communities neighboring three Michigan military installations

January 2017

Acknowledgments

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CHAPTER 1

Introduction

Domestic military installations play an essential role in the nation's defense, particularly in training and developing the men and women of our armed forces. But in a world of ever-evolving conditions and challenges, the modern military installation is tasked with much more than training activities. Today, the military installation in the local community is just as likely to be directly involved in overseas operations, homeland defense, emergency response and even humanitarian relief. The expertise and skills developed at domestic installations, it turns out, can be some of the best resources local communities can draw upon in times of need.



Beyond their mission capabilities, U.S. military installations already occupy important niches in their communities, often serving as major employers, land stewards and economic drivers. But historically, installations have also been kept somewhat separate and apart from their greater communities, a distance rooted in real concerns such as base security and operational effectiveness. Today, there is an increasing recognition of the interdependence of installations with the communities in which they reside, particularly in the face of modern global challenges such as climate change that are not bound by political or geographical borders. Strategic collaboration and coordination with local communities is becoming an important component of domestic readiness, and by direct extension the readiness of the military as a whole.

Several U.S. Federal agencies, including the Department of Defense (DoD), are leading pilot projects with local communities to identify shared climate change vulnerabilities and to develop local strategies to address those shared vulnerabilities. The Assistant Secretary of the Army for Installations, Energy, and Environment and the National Guard Bureau selected the Michigan Army National Guard to pilot a U.S. Council on Environmental Quality effort to increase the resiliency of military installations.

MIARNG was selected based on its ongoing sustainability/resiliency efforts as well as its participation in the Michigan Climate Coalition, a statewide partnership of universities, businesses, non-profit organizations and government agencies interested in climate science, adaptation, sustainability and related disciplines.

This report, *Adaptation Planning for Climate Resilience: A Michigan Army National Guard Pilot Project*, assesses current conditions, documents planning efforts, and makes recommendations to improve resilience in the Fort Custer Training Center (FCTC), Camp Grayling Joint Maneuver Training Center (CGJMTC), and Selfridge Air National Guard Base (SANGB) communities. The report details an action plan developed for each installation aimed at responding to and preventing the adverse impacts of climate change on the installation as well as in the greater community.

Project Overview and Origins

This project fulfills a number of federal directives to address climate change on Department of Defense installations. In 2013, the President of the United States charged the Department of Defense to prepare for the impacts of climate change, in part by increasing resiliency on military installations. Resiliency, according to this Executive Order, is “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.”¹ The Department of Defense’s 2014 Climate Change Adaptation Roadmap addressed some of the high-level challenges anticipated for the military’s domestic activities, noting:

“Our coastal installations are vulnerable to rising sea levels and increased flooding, while droughts, wildfires, and more extreme temperatures could threaten many of our training activities. Our supply chains could be impacted, and we will need to ensure our critical equipment works under more extreme weather conditions. Weather has always affected military operations, and as the climate changes, the way we execute operations may be altered or constrained.”

The Quadrennial Defense Review (QDR) is a statutorily mandated report produced by the U.S. Department of Defense (the Department) to outline the strategic direction for military activity over the subsequent four-year period.

“Michigan should seize this moment and take a leadership role in formulating and promoting efficient, effective national, regional and state policies to address climate change. These policies should holistically address the economy, renewable energy, climate change, energy efficiency and independence.”

Michigan Climate Action Council Climate Action Plan, 2009

¹ Executive Order 13653

As in past reports, the 2014 QDR highlighted the significant impacts of global climate change and the need to address it as a threat multiplier, a threat on its own, and as a driver for making changes to policy and action across a range of settings. The report further called for innovation and adaptation to climate threats, stating:

“The Department will remain ready to operate in a changing environment amid the challenges of climate change and environmental damage. We have increased our preparedness for the consequences of environmental damage and continue to seek to mitigate these risks while taking advantage of opportunities. The Department’s operational readiness hinges on unimpeded access to land, air, and sea training and test space. Consequently, the project team will complete a comprehensive assessment of all installations to assess the potential impacts of climate change on our missions and operational resiliency, and develop and implement plans to adapt as required.”

The Department of Defense issued DoD Directive 4715.21 – Climate Change Adaptation and Resilience (January 14, 2016) to formalize the roles and responsibilities laid out in DoD’s 2014 Climate Change Adaptation Roadmap. The Directive tasks the DoD Components (including the Army) to assess and manage risks to built and natural infrastructure, basing, and disaster-response mission planning and operations. The Directive also tasks the DoD Components to “collaborate with internal and external stakeholders to address common climate change challenges and opportunities, including regional planning efforts.”

The U.S. Army’s 2015 Energy Security & Sustainability Strategy (ES2 Strategy) calls on Department of Defense installations to integrate resiliency concepts into base operations and land-use planning. “The ES2 Vision describes a strong, mobile, and flexible force that is housed, trained, and maintained on resilient installations that are able to project power, unimpeded by disruptions to domestic utilities or land use constraints.”

The recommendations in this report respond to these federal mandates by increasing the resiliency, self-sufficiency, and preparedness of three Michigan installations while protecting the Michigan Army National Guard’s ability to fulfill its mission in the face of a changing climate.

The Assistant Secretary of the Army for Installations, Energy, and Environment and the National Guard Bureau selected the Michigan Army National Guard to pilot a U.S. Council on Environmental Quality effort to increase the resiliency of military installations. MIARNG was selected based on its ongoing sustainability/resiliency efforts as well as its participation in the Michigan Climate Coalition. The MIARNG enthusiastically agreed to lead the pilot project, initially planning to focus on its two largest installations: Fort Custer near Battle Creek and Kalamazoo, and Camp Grayling in the rural central northern Lower Peninsula. Later in the pilot, the MIARNG agreed to work collaboratively with the Michigan Air National Guard to consider the region around Selfridge Air National Guard Base, a joint defense unit located north of Detroit.

The State of Michigan is unique in that there are a variety of entities working on generating data and models to predict local and regional impacts of climate change and identify adaptation techniques relevant to their specific sector. For example, the Michigan Department of Natural Resources is modeling potential impacts to plant and animal species, the Michigan Department of Transportation is looking at new standards for infrastructure, and the Michigan Department of Environmental Quality is investigating climate adaptation strategies in their wetland and coastal resource management practices.

“Downscaling climate data is a strategy for generating locally relevant data using global scale predictions to create regionally specific forecasts.”

Climate Projections for the Midwest: Availability, Interpretation and Synthesis, 2012

Regional Climate Trends

The impacts of climate change on agriculture, infrastructure and human health are being felt almost everywhere across Michigan. With planning and preparation, communities can weather challenges and recover, becoming even better places to live and thrive.

Climate and weather are directly related, but not the same thing. Weather refers to the day-to-day conditions we encounter in a particular place: sun or rain, hot or

cold. Climate refers to the long-term weather patterns over regions or large geographic areas. When scientists speak of global climate change, they are referring to generalized, global patterns of weather over years and decades. Scientists use three-dimensional computer models of the Earth’s atmosphere, oceans and land surfaces to understand past trends and predict future changes. These General Circulation Models (GCM) have been improved and verified in recent years, resulting in relatively reliable predictions for climate changes over large regions. To help predict climate change at the Earth’s surface for smaller regions, scientists apply downscaling techniques.²

National

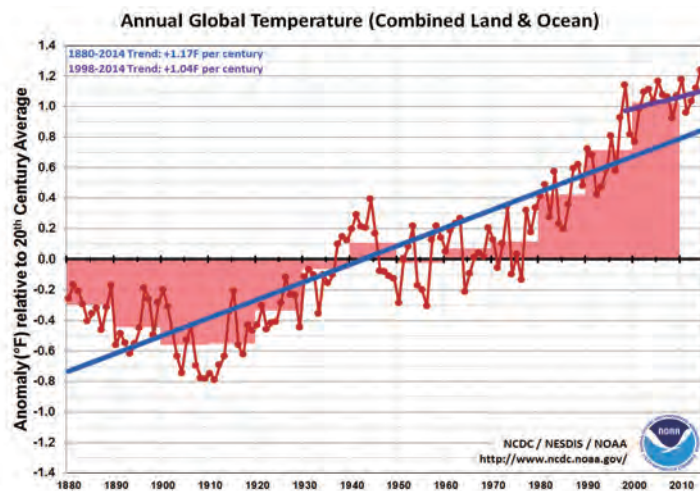
As stated by the Intergovernmental Panel on Climate Change (IPCC), significant changes in the Earth’s climate have been observed. Figure 1.1 provides a summary of observed changes in land and ocean temperatures over the last 135 years.

The Great Lakes Integrated Sciences and Assessments Program (GLISA) is a partnership between the University of Michigan and Michigan State University, housed in the Graham Sustainability Institute’s Climate Center at the University of Michigan. As one of 10 regional centers funded by the National Oceanic and Atmospheric Administration (NOAA), GLISA builds capacity to manage risks from climate change and variability in the Great Lakes region.

² Winkler, J.A., R.W. Arritt, S.C. Pryor. 2012: Climate Projections for the Midwest: Availability, Interpretation and Synthesis. In: U.S. National Climate Assessment Midwest Technical Input Report. J. Winkler, J. Andresen, J. Hatfield, D. Bidwell, and D. Brown, coordinators. Available from the Great Lakes Integrated Sciences and Assessment (GLISA) Center, http://glisa.msu.edu/docs/NCA/MTIT_Future.pdf.

According to GLISA, temperatures in the Great Lakes region are expected to increase, both in terms of averages and extremes. The region has already experienced a 2.3 degree F increase in average temperatures since the year 1900. An additional increase of 1.8 to 5.4 degrees F in average temperatures is projected by 2050. An additional 30 to 40 days per year are expected to exceed 90°F. The growing season (frost-free season) will likely extend to include an additional 40 to 50 days each year by 2100.

Figure 1.1 Observed Changes in Land and Ocean Temperatures



Precipitation is projected to increase on average but concentrate in more intense and frequent precipitation events, likely resulting in greater periods of both extreme flooding and extreme drought. An additional 2 to 3 inches of annual precipitation is expected for South Central Lower Michigan, and at least an additional 1 day each year is expected to experience heavy rain falls.

Based on the most recent models, the climate in the U.S. Midwest is expected to continue to warm, with greater increases in temperature during the winter months and at night. There are a variety of

weather impacts expected with this change in average temperatures. Some of the potential impacts of climate change in the Midwest include:

- Storms becoming more frequent and more severe
- Increases in winter and spring precipitation
- Less precipitation as snow and more as rain
- Less winter ice on lakes
- Extended growing season (earlier spring/late fall)
- More flooding events with risks of erosion
- Increases in frequency and length of severe heat events
- Increased risk of drought, particularly in summer

It is important to note that increased flooding and more intense drought are not mutually exclusive nor contradictory. In the Great Lakes region, scientists are predicting more intense rain events in the fall and winter and more intense droughts in the summer months. These changes in climate could have a number of both positive and negative effects on communities in Michigan. For example, an extended growing season could help support different crops and increase crop yields for farmers. On the other hand, highly variable weather conditions — such as severe storms and flooding mixed with summer droughts — present significant challenges to farming.

Purpose of the Report

The purpose of this project was to develop a collaborative planning process between military installations and their surrounding communities that helped to identify shared climate change vulnerabilities, opportunities for adaptation, and strategies and actions to address those shared vulnerabilities. The information in this report reflects input from a range of parties, including community members, public officials and local leaders, staff from the installations, community organizations, representatives of the Michigan Climate Coalition (MCC), state employees, and other interested individuals who participated in the process. Given the democratic approach of the process, there is a wide range of thought represented in the list of available adaptation actions. Not all of the strategies are well-suited to implementation. Some may not fit into the technical notion of “adaptation;” others may be highly practical, but politically unfeasible or limited by law. And, of course, some approaches are cost prohibitive in terms time, financial resources, or both.

“The (Department of Defense) cannot effectively assess its vulnerabilities and implement adaptive responses at its installations if neighbors and stakeholders are not part of the process.”

U.S. Department of Defense Climate Adaptation Roadmap, 2014

However, as much as the project recommendations are inclusive of all thoughts, the best suited and most appropriate recommendations were prioritized for each community. These priorities were identified during working sessions and with the MCC and installation leaders.

Project Overview

The Land Information Access Association (LIAA) worked under the oversight of the Michigan Army National Guard to compile resources, perform analysis, and convene the community for this pilot project. LIAA is a Michigan-based nonprofit organization focused on land-use planning with a particular emphasis on multi-jurisdictional planning and community resilience. The www.resilientmichigan.org website highlights information from this project as well as several others around the state, and houses presentations, notes and additional information relevant to this project.

Advisory Committee

The project also had an advisory committee made up of members of the MCC, a nonpartisan, cross-sector network of community organizations, federal, state and local agencies, academic institutions, and interested parties from across Michigan who gather bi-monthly to discuss their respective efforts, share information, and collaborate where appropriate on projects, reports and activities related to climate change.

The MCC helped to provide guidance, expertise, local-level input, and resources to the project. Several MCC members participated in local meetings and provided input and educational presentations. MCC was also asked to help identify additional solutions, prioritize solutions, and provide input for the report based on participants' expertise in various sectors.

Stakeholders

Because of the unique nature of this planning process, significant time and resources were spent at the front end of the planning process to identify and engage key stakeholders from both the installation and the greater community. In an effort to establish community conversations, a list of key stakeholders was compiled and invitations to the planning process were mailed to each contact. Examples of key stakeholders engaged included:

- Environmental Managers on each installation
- Range and Operations leaders on each installation
- Energy and Facility Managers on each installation
- County planners, administrators, health directors, emergency managers
- Municipal managers, planners, zoning administrators, public works officials
- State natural resource managers
- Watershed councils and other environmental non-governmental organizations (NGOs)
- Social service providers (Commission on Aging, Red Cross, etc.)
- Regional Metropolitan Planning Organizations (MPOs)
- Educators (MSU Extension, Michigan SeaGrant, GLISA)

“Scenarios are tools that managers can use to test decisions or develop strategy in a context of uncontrollable and uncertain environmental, social, political, economic, or technical factors...scenarios tend to be exploratory, [and] they are extremely effective at prompting managers to consider their reactions to climate change in the context of realistic allowances and restrictions (i.e., budget limitations, public support or political feasibility).”

Using Scenarios to Explore Climate Change: A Handbook for Practitioners, 2013.

Project Process

The project involved a number of key steps including gathering background information, hosting public charrettes, and conducting interviews with key installation leaders.

Gathering Background Information

As with many planning processes, the project team began with an assessment of the current conditions, potential risks and opportunities for the communities in question. Quoting the *Changing Climate, Changing Wildlife* report authored by the Michigan Department of Natural Resources (MDNR), “A vulnerability assessment is a first step in climate adaptation, just as a risk assessment is an early step in risk management.” The project team collected the necessary information in order to conduct a preliminary vulnerability

assessment for the community surrounding each installation. Through the vulnerability assessment, the population was studied in order to identify people and places throughout the community that might be most vulnerable to severe weather events and related impacts. The assessment is conducted with geographic information system (GIS) tools utilizing data available through the U.S. Census Bureau, the Michigan Geographic Data Library, county and regional planning organizations, the U.S. Department of Agriculture’s Natural Resources Conservation Service, and the Federal Emergency Management Agency (FEMA). In addition to the vulnerability assessment, the project team also examined opportunities for the community to improve the manner in which it regulates land uses, provides and manages public services, and meets the needs of residents and visitors.

Although the vulnerability assessment focused primarily on the social and environmental conditions of the areas near each installation, the results are important for the MIARNG. During sessions with MIARNG leaders, the vulnerability assessments were used to help evaluate the need to update emergency and land use plans. A vulnerability assessment may show, for example, that the key transportation routes used to reach an installation are in high-risk flood zones, and appropriate planning measures should be taken to ensure personnel are able to reach the installation. In this way, vulnerability assessments can inform emergency response planning. This is an especially relevant tool for the NGB, as troops are often at the forefront

of disaster response efforts. Social concerns — such as access to healthy foods, medical facilities, and accessibility to public transportation — are important for understanding the context surrounding the installation and identifying where community leaders should work to provide additional services and support.

The project team’s preparation work included analyses of existing land-use plans and zoning regulations, active natural resource conservation efforts, ongoing programs from local NGOs, impacts of historic storm events, community demographics, local trends and issues, and consideration of the formal and informal relationships between the installation and local community.

Public Input Process

Next, the project team sought input from local stakeholders as well as the general public. In each installation, the project team conducted a two-day intensive public input process called a *charrette*. The first day kicked off with an educational

A charrette is a public process where citizens, designers and others collaborate on a vision for development. Although many charrettes focus on design solutions, this charrette focused on solutions to vulnerabilities associated with climate change.

workshop featuring expert speakers from across Michigan focusing on topics related to climate change and resilience relevant to each individual base. For a complete list of speakers and a copy of their presentations, please see Appendices A-C.

The second day began with stakeholder interviews to better understand existing conditions within the installation and in the surrounding community, including key assets, challenges, and opportunities for improvement. The project team used this information to inform the public input process later in the second day.

The project team used a set of location-specific “scenarios” to facilitate a discussion among participants designed to consider possible future events and impacts. The scenarios were used to explore ways the community could be better prepared for long-term changes in climate and to identify steps needed to mitigate negative impacts by implementing adaptive actions in advance. “Scenario planning” is commonly used across many fields and contexts, essentially as a tool to make better decisions in light of uncertain conditions. From the military to the manufacturing sector, scenarios have helped create strategic plans that anticipate future risk and appropriate actions to address those challenges. Each scenario was set 35 years out from the present day, a timeframe that is both long-term enough to see real change and short-term enough to be both tangible and interesting for the participants. Projected climate trends for each region developed by GLISA were used to frame the scenario conditions. Each scenario is described under the Appendix for each installation.

Finally, the project team worked to analyze ongoing projects and plans for each installation and community, and provided a set of specific recommendations for that area. The recommendations come from the military leaders on each installation, community discussions, and input from public sector and academic experts. Many of these experts provided expertise and assistance throughout the project. The project team further evaluated a “matrix” of possible risks in each region, considering their likelihood and severity level, to determine which risks are the most important for each community to address.

Location Highlights

Each of the three installations and surrounding communities demonstrate a diverse set of characteristics to be addressed, including a range of geographic and geologic features, natural resources, climate-related factors, types of neighboring populations, relationships with their communities, and the opportunities they have to improve resiliency. While a similar public process and convening was conducted in each of the three locations, the pilot project findings offer a unique look at a very comprehensive set of issues that are surprisingly diverse.

Table 1.1 Location Highlights

	FORT CUSTER	CAMP GRAYLING	SELFRIDGE
Location	Calhoun and Kalamazoo Counties	Crawford, Kalkaska, and Otsego Counties	Macomb County
Number of Local Jurisdictions Involved	15 (2 Counties, 3 Cities, 2 Villages, 8 Townships)	5 (3 Counties, 1 City, 1 Township)	5 (1 County, 1 City, 3 Townships)
Population of Local Jurisdictions Involved (Not including total County populations)	107,121	7,711	181,078
Installation Size	7,500 Acres	147,000 Acres	3,075 Acres
Installation Ownership	Federally Owned, State Operated	State Owned and Operated	Federally Owned, State Operated
Year Installation Founded	1917	1913	1916
Utilities	Municipal Utilities	Independent Septic and Water	Municipal Utilities
Annual Regional Economic Impact	\$21.6 Million in Payroll, Operations & Maintenance, Minor Construction	\$49.2 Million	\$825 Million

Sources: 2014 Annual Report - 127th Wing, Selfridge Air National Guard Base; Camp Grayling Joint Maneuver Training Center Orientation Briefing Presentation; U.S. Census Bureau; Michigan National Guard Website



Fort Custer public planning charrette focusing on solutions to vulnerabilities associated with climate change.



CHAPTER 2

Fort Custer Training Center (FCTC) Region

The Fort Custer military installation occupies land in both Kalamazoo and Calhoun counties in Michigan and operates near several cities, villages and townships. Most of the facilities are located about four miles west of Battle Creek (in Calhoun County) and two miles east of Augusta (in Kalamazoo County). The Fort is about 14 miles northeast of Kalamazoo.

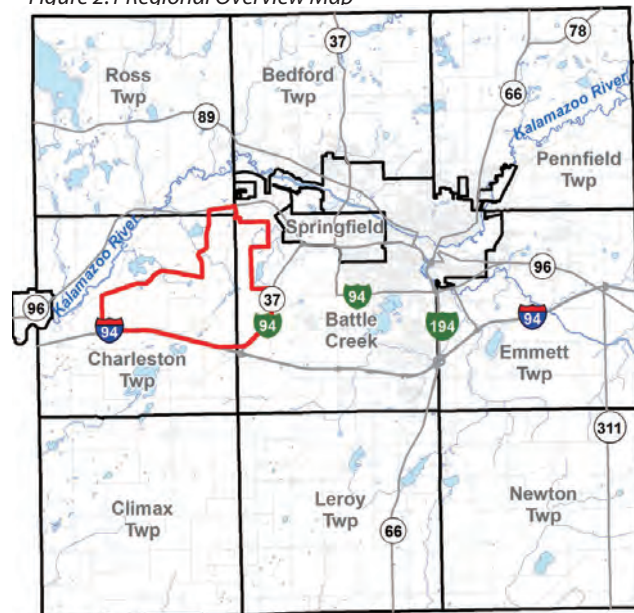
Surrounding communities that were included in the community planning process for Fort Custer included Bedford Township, the City of Springfield, the City of Battle Creek, Leroy Township, Newton Township, Emmett Township, and Pennfield Township (all part of Calhoun County); and Ross Township, Charleston Township, the Village of Augusta, and Climax Township (all part of Kalamazoo County). The landscape is characterized by gently rolling to quite level landforms.¹

Regional Climate Trends

In the Fort Custer Community, precipitation averages 34.8 inches per year and snowfall averages 73.1 inches per year.² Temperatures range from an average maximum of 83.1°F in July to an average minimum of 14.9°F in January.

The Great Lakes Integrated Sciences and Assessments Program (GLISA) looks at regional climate trends and projections for the Great Lakes Region. Fort Custer is located within GLISA's South Central Lower Michigan climate division. In this region, temperatures are expected to increase, both in

Figure 2.1 Regional Overview Map



¹ Kalamazoo County Natural Hazard Mitigation Plan 2013

² Kalamazoo County Master Plan 2009-2013

terms of averages and extremes. Assuming greenhouse gas emission rates continue to rise, South Central Lower Michigan is expected to see a 4.5°F to 5.0°F increase in average air temperature between 2041 and 2070. An additional 30 to 40 days per year are expected to exceed 90°F. The growing season (frost-free season) will likely extend to include an additional 40 to 50 days each year by 2100.

Precipitation is projected to increase on average but concentrate in more intense and frequent precipitation events, likely resulting in greater periods of both extreme flooding and extreme drought. An additional 2 to 3 inches of annual precipitation is expected for South Central Lower Michigan, and the number of days each year experiencing heavy rain falls is expected to increase by at least 1 day per year.

Fort Custer Army National Guard Installation

Fort Custer is home to the 177th Regiment, Regional Training Institute, and the Regional Maintenance Training Site. The facility is federally owned and state operated and is also home to United States Navy Reserve and United States Army Reserve units.³ These relationships allow Fort Custer Training Center to support strategically-valuable assets in addition to fulfilling its mission as a Michigan Army National Guard installation. The Training Center contains over 7,500 acres of land, including 4,225 acres of maneuver land. In 2014, the installation served as a training site for a total of 156,313 individuals.

Fort Custer's training facilities are among the most heavily used in the Midwest by the Michigan National Guard and other branches of the armed forces. Reserve Officer Training Corps (ROTC) students from colleges in Michigan, Ohio, Illinois and Indiana train at the facility, as well as the FBI, the Michigan State Police, various other law enforcement agencies, and many others.

Fort Custer's facilities include a distance-learning center, barracks and dining facilities for visiting units, and extensive training areas for small arms and maneuver training. Fort Custer is currently being considered as a possible location for a missile defense site for the eastern United States.

³ Fort Custer responds to decades of challenge and change, March 28, 2005, The Battle Creek Enquirer, Jim Richmond, <http://archive.battlecreekenquirer.com/article/20050328/LIFESTYLE08/503280302/Fort-Custer-responds-decades-challenge-change>. Fort Custer Training Center, accessed on March 3, 2015, Michigan Army National Guard, <http://minationalguard.com/fort-custer-training-center/>. U.S. Department of Veterans Affairs: Fort Custer National Cemetery, accessed on March 20, 2015, <http://www.cem.va.gov/cems/nchp/ftcuster.asp>.

History

A few months after the United States entered World War I in 1917, Camp Custer opened with 9,000 acres and nearly 1,400 buildings. More than 100,000 troops trained or demobilized at Camp Custer during the war. Following World War I, the camp was used to train the Officer Reserve Corps and the Civilian Conservation Corps.⁴ At its apex, Camp Custer reached approximately 16,000 acres in size.

On August 17, 1940, Camp Custer was designated Fort Custer and became a permanent military training base. Fort Custer trained more than 300,000 troops during World War II, and served as a prisoner of war camp for 5,000 German soldiers until 1945.⁵

Fort Custer became home to units of the Navy Reserve in 1949 and to a Marine Corps Reserve Tactical Bridge Company in 1952. Approximately 17,000 troops were trained here for the Korean War. Beginning in 1959, Fort Custer served for a decade as part of the North American Air Defense (NORAD) system.

Camp Custer Installation in 1918



Natural Resources

The natural resources within FCTC and the adjacent Fort Custer Recreation Area (FCRA) are valuable because there is relatively little undeveloped, unfarmed land otherwise remaining in the area. Within FCTC and FCRA, there are 11,000 acres of mostly closed-canopy forests. FCTC is the recipient of numerous awards for its environmental stewardship.

The installation is home to at least 32 of Michigan's threatened and endangered species, including a variety of native butterflies and moths, cerulean warbler, prairie vole, Indiana bat, eastern box turtle, eastern massasauga rattlesnake, bald eagle, and trumpeter swan. Many of these species live in the relatively undisturbed wetland

⁴ Fort Custer responds to decades of challenge and change, March 28, 2005, The Battle Creek Enquirer, Jim Richmond, <http://archive.battlecreekenquirer.com/article/20050328/LIFESTYLE08/503280302/Fort-Custer-responds-decades-challenge-change>.

⁵ Fort Custer Training Center, accessed on March 3, 2015, Michigan Army National Guard, <http://minationalguard.com/fort-custer-training-center/>.

habitats on the installation. These wetland areas, along with other important habitat lands, are monitored for potential impacts from human activity.

In accordance with DoD directives to further the conservation of threatened and endangered species, the installation's Integrated Natural Resource Management Plan identified a series of high priority projects. Installation staff are working with the US Fish and Wildlife Service (FWS), the Michigan Department of Natural Resources (MDNR) and all other cooperating agencies on monitoring and tracking these projects. Plants currently being monitored include invasive species like garlic mustard and purple loosestrife. There are also a number of projects focused on larger-scale land management objectives, including erosion and sediment controls, surface water monitoring, wetland monitoring, and fire management activities.

Under the Sikes Act (1960), military installations are required to provide public access to natural resources for uses such as hunting, fishing, and trapping. The Fort Custer Training Center works with FWS and MDNR concerning conservation, protection and management of fish and wildlife resources.⁶

Energy

Notably, Fort Custer is taking a proactive approach to increase its resilience by reducing its greenhouse gas emissions and increasing its energy security posture. Fort Custer has decreased its electrical usage steadily since 2012 and has implemented a series of alternative energy projects. Based on calculations by base officials, electrical grid usage could be further reduced by 14% with the inclusion of a 500 kW solar production facility. This could be achieved by adding additional solar arrays as funding and space are identified. Fort Custer Training Center is implementing a series of alternative energy projects, including a 144 kW solar array and a wind funnel. Additional solar projects, a micro-grid and energy storage capability are planned for 2017.



Source: Diane Ursu

Recreation

In the early 1970s, 3,000 acres of the former Camp Custer became a state park and recreation area (separate from the 7,500 acres that make up FCTC). The Fort Custer Recreation Area includes 22 miles of hiking trails, 20 miles of mountain bike trails and 16 miles of bridle trails, as well as campsites and opportunities for fishing and birdwatching. The



Source: CityProfile.com

⁶ FCTC Integrated Natural Resources Management Plan (2012)

installation also holds a number of environmental outreach activities focused on youth on the base, including the Envirothon Science Competition and National Public Lands Day. Deer and turkey hunting opportunities are available each year for disabled veterans and other members of the public.

Military Cemetery

In 1981, Fort Custer was chosen as the site for a national military cemetery. The 770-acre cemetery lies on land belonging to Fort Custer and the Veterans Affairs (VA) Medical Center. The cemetery features the Avenue of Flags memorial project, which was funded through VA service organizations and private contributions. Veterans interred at Fort Custer are offered full military funeral honors and the cemetery is open year round.

Industrial Park

In the late 1970s, the Fort Custer Industrial Park was developed on 3,000 acres of installation land that lies between FCTC and the W. K. Kellogg Airport. Owned by the City of Battle Creek and developed and managed by Battle Creek Unlimited, the park houses approximately 90 companies and 9,000 jobs.

Key Issues for Consideration

Fort Custer is home to a number of tenants, many of whom are considered strategically-valuable assets to agencies outside of the Michigan Army National Guard. Therefore, climate-related events will impact the Michigan Army National Guard as well as the other Federal and State missions that Fort Custer's tenants serve. Fort Custer's efforts to become more resilient (e.g., to be able to maintain critical operations during disruptions to the electricity and water grids) are even more strategic given the many missions the installation supports.

Fort Custer is a finalist in consideration as an East Coast Missile Defense site. If selected, there will be significant implications for the installation's overall operating budget, energy footprint, natural resources and ecology, and economic impact on the larger community. These factors present both positive and negative impacts that must be thoroughly evaluated.

Fort Custer has a history of water runoff issues, and an increase in precipitation will have an adverse effect on the installation. On one occasion, severe rain events caused flooding on the installation's training grounds and ranges as well as flood damage to surrounding residences.

The installation is also home to a variety of threatened and endangered species that must be carefully managed given warmer temperatures and increases in invasive species. Ensuring the health of native, threatened, and endangered species will become increasingly challenging as the climate continues to change.

If the intensity and frequency of severe storms increases, the installation's capacity to shelter displaced citizens and provide vital support to surrounding communities will be even more important to maintain. Currently on the installation, outdated structures and insufficient communication systems may impede the emergency response capability and readiness to complete Defense Support for Civil Authority missions. There are additional communications infrastructure issues that inhibit the MIARNG's to communicate that can be affected by heavy rain events and severe storms.

The Surrounding Community

For the purposes of this report, the surrounding community was defined by communities located in proximity to the installation, including Bedford Township, the City of Springfield, the City of Battle Creek, Leroy Township, Newton Township, Emmett Township and Pennfield Township (all part of Calhoun County); and Ross Township, Charleston Township and Climax Township (all part of Kalamazoo County).

Population

Population trends from 2000 to 2010 for both counties (Table 2.1) indicate that Calhoun County lost population while Kalamazoo County gained population. In Calhoun County, the cities and more urbanized townships saw either population declines or very small increases, while the more rural areas (Newton Township and Emmett Township) saw greater population gains.

Table 2.1 Population Trends, 2000-2010

MUNICIPALITY	2000 POPULATION	2010 POPULATION	2000 to 2010 PERCENT CHANGE
Calhoun County	137,985	136,146	-1.3
Bedford Township	9,517	9,357	-1.7
City of Springfield	5,189	5,260	1.4
City of Battle Creek	53,364	52,347	-1.9
Leroy Township	3,240	3,712	14.6
Newton Township	2,493	2,551	2.3
Emmett Township	11,989	11,770	-1.8
Penfield Township	8,913	9,001	0.9
Kalamazoo County	238,603	250,331	4.9
Ross Township	5,047	4,664	-7.6
Charleston Township	1,813	1,975	8.9
Climax Township	2,412	2,463	2.1

Source: US Census

Regional Natural Resources

The Kalamazoo River and its tributary extensions comprise the most prominent natural resource in the greater Fort Custer Community. In Kalamazoo County alone, there are 365 miles of rivers and streams and over 88 lakes and reservoirs. In both Calhoun and Kalamazoo counties, there remain many forested areas, especially along the Kalamazoo River and other waterways. The higher, well-drained areas consist predominantly of oaks, sugar maple, beach and white pine. Areas of low relief support pine, aspen, basswood and maple. The floodplain areas consist of ash, silver maple, sycamore and oak.⁷ Common wildlife in the greater community include deer, raccoons, possums, rabbits, muskrats, beavers, squirrels, rodents and other small mammals.

Regional Infrastructure

I-94 serves as the primary east-west interstate route servicing the Fort Custer Community. Daily traffic counts on I-94 near Fort Custer exceed 46,000 vehicles per day, according to studies conducted by the Michigan Department of Transportation (MDOT).⁸

Review of Local Plans

There are a number of local planning efforts completed and underway that are helpful in informing actions and priorities identified in the Fort Custer DoD planning process. Zoning ordinances and community master plans are in place to guide land-use policies and local priorities at the county, city, village, and township levels. Many of these local jurisdictions also have parks and recreation master plans and economic development plans.

A variety of existing county plans were helpful in informing the collaborative planning process on the installation for this project. Both Calhoun County and Kalamazoo County have hazard mitigation plans that identify potential hazards and identify actions for reducing the risk and impact of those hazards.

The Calhoun County Farmland Preservation Ordinance “creates the Calhoun County Farmland Preservation Program which preserves productive farmland by acquiring development rights and placing agricultural conservation easements on the properties.”⁹ This is an important ordinance for the county, considering that both farmland acreage and the number of farms have declined since 2007.¹⁰

Both Calhoun and Kalamazoo counties have Public Health Department Strategic Plans (2014-2019) that provide for county-wide health assessment and monitoring; health policies and an action plan for achieving them; and the assurance that all populations have access to appropriate and cost-effective care.

⁷ Kalamazoo County Master Plan

⁸ MDOT ADT counts <http://mdot.maps.arcgis.com/>

⁹ “Amended” Calhoun County Farmland Preservation Program Ordinance, Calhoun County Planning Department

¹⁰ Calhoun County Census of Agriculture

These plans and documents were reviewed prior to the public planning process to provide background information to stakeholders and help inform goals and actions.

Surrounding Zoning Districts

It is particularly useful to look at local zoning classifications in areas that are adjacent to the installation to evaluate whether or not the zoning is compatible with current and future activities on the installation.

The City of Battle Creek borders the east side of the installation. The zoning classification is I2, or Heavy Industrial. Charleston Township accounts for the majority of the western border of the installation. All land adjacent to the installation in Charleston Township is zoned Public, Government, and/or Institutional (according to the Kalamazoo County generalized zoning map).

Prior Storm and Emergency Impacts in the Community

The Kalamazoo County Hazard Mitigation Plan documents historic storms and natural disasters, along with their impacts and future likeliness of reoccurrence. These include droughts, earthquakes, energy emergencies, extreme temperatures, wildfires, dam failures, riverine and urban flooding, shoreline flooding and erosion, and severe storms. Some historical major storm and emergency events that have occurred since 1988 in the Fort Custer community include:

1988 – Extreme heat and drought conditions led to 39 days with heat exceeding 90 degrees, causing agricultural loss, disrupting river transportation, increasing wildfire risk, and causing water supply shortages.

1991 – A March thunderstorm accompanied by high winds and hail damages area homes and businesses. Softball-sized hail up to 4.5 inches in diameter damaged windows, cars, and trees.

1997 – A severe thunderstorm severely damaged over a dozen mobile homes in western Kalamazoo County, completely destroying two homes and injured one person.

2001 – A summer heat wave destroyed approximately one-third of Michigan's fruit, vegetable, and field crops. A Disaster Declaration was called for 82 counties statewide.

2008 – Over 10 inches of rainfall in three days caused by Hurricane Ike led to a state of emergency for Kalamazoo County. The Kalamazoo River reached its third highest crest on record in the Comstock area, flooding 476 homes and businesses and shutting down many local roads.

2010 – Calhoun County officials reported an oil spill discovered during a maintenance activity just south of the City of Marshall. While Enbridge Energy worked to stop the flow of oil, approximately 800,000 gallons of crude oil spilled into the Kalamazoo River. Nearby residents were evacuated, teams were put in place to rescue and rehabilitate wildlife, and a multi-year cleanup of the Kalamazoo River began.

2010 – A severe thunderstorm produced winds exceeding 80 mph in the area causing an estimated \$125 million in damage.

Vulnerability Assessment

The Vulnerability Assessment LIAA conducted for Fort Custer and its surrounding communities is presented in full in Appendix A. In short, the assessment determined where populations sensitive to extreme heat and heavy rainfall tend to live in the community and where environmental risk to extreme heat and heavy rainfall is highest. Areas with disproportionately high sensitive populations and high environmental risk are considered vulnerable. In general, vulnerable populations are concentrated in the City of Battle Creek, both because there are high concentrations of sensitive populations and because the urbanized landscape amplifies the Urban Heat Island Effect.

In Battle Creek, there are also numerous older homes (built before 1940) located in the floodplain along the Kalamazoo River and its tributaries. Due to the construction standards of that era, homes built before 1940 are generally more susceptible to flood damage. When identifying neighborhoods located in the floodplain at the highest risk for flood damage, it is also helpful to use data from the U.S. Census Bureau to identify neighborhoods with high concentrations of people living below the poverty line, as lower incomes make it less likely that older homes have been updated to modern construction standards. These neighborhoods would be good candidates for investing in Low Impact Development techniques, an effort best led by local governments.

Highlights from the Public Process

Throughout the course of the stakeholder interviews and two evenings of community forums, a number of themes emerged, highlighting needs specific to the greater Fort Custer area.

The need to enhance regional planning and collaboration was articulated over and over by stakeholders and members of the general public alike. The urban nature of the region and the number of neighboring jurisdictions in the Fort Custer Community (more than any of the other Michigan Army National Guard installations involved in this pilot project) make this collaboration crucial. A number of groups and agencies were identified as key partners for moving resilience actions forward. These partners include the U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration (NOAA), regional councils of governments, state and county health

departments, emergency managers and responders, social service providers, natural resource managers, and farmers. These groups could come together formally through the establishment of a “resilience task force” or a similar forum, or informally by leveraging partnerships during existing day-to-day operations.

Natural resource and environmental protection was also an important value articulated by a wide range of project participants. Although Fort Custer is in an urbanized area, there are numerous opportunities for protecting and enhancing natural assets. For example, water quality can be improved by addressing flooding issues and improving farming practices. Improving environmental quality will be increasingly more important as climate impacts become more severe.

Action Plan

The following goals and actions are a result of a series of in-depth stakeholder interviews, public input from a two-day planning charrette, a vulnerability assessment conducted for the greater Fort Custer Community (Appendix A), and recommendations made by the Michigan Climate Coalition (MCC) in its capacity as the project steering committee. Not all recommendations and actions are the responsibility of the MIARNG, as several are community-wide recommendations that would be best led by local governments, watershed groups, or other NGOs.

Natural Resources

Goal: *Better manage the urban tree canopy in surrounding communities to maximize cooling and flood control.*

- *Action:* Update the tree canopy assessment with the most recent aerial photography.
- *Action:* Explore methods to measure the quality of the urban tree canopy.
- *Action:* Increase the tree requirements for public infrastructure improvements and private development.
- *Action:* Identify areas of the community with limited access to air conditioning units, and focus tree-planting programs there to increase tree canopy and decrease average temperature.

Goal: *Enhance management of natural resources.*

- *Action:* Identify climate-related stressors and priority habitat connectivity areas at Fort Custer and incorporate proactive management strategies into installation Integrated Natural Resource Management Plans and real property master plans.
- *Action:* Survey land and schedule projects as necessary to manage water runoff to prevent future flooding of nearby residential areas.

- *Action:* Integrate climate change trends and data into updates of the Integrated Natural Resources Management Plan in order to best manage sensitive ecosystems at Fort Custer, such as fens.
- *Action:* Submit a project request to the National Guard Bureau's Installations, Logistics and Environmental Division for funding for prairie restoration in the southern portion of Fort Custer.
- *Action:* Build on the coalitions already in place in the Kalamazoo Watershed Council and the Total Maximum Daily Load working group to increase watershed-wide natural resource enhancement.
- *Action:* Enhance education efforts to foster better environmental stewardship by engaging zoos, nature centers, and museums.
- *Action:* Restore ecosystem services wherever possible.
- *Action:* Identify adaptation goals and projects to increase natural resource resilience.

Infrastructure

Goal: *Collaborate with the Michigan Department of Transportation (MDOT) to reduce vulnerabilities of the road and infrastructure network in the region.*

- *Action:* Assess the opportunity to apply green infrastructure in the region similar to efforts underway in Grand Rapids.

Goal: *Support expansion of clean energy infrastructure and development.*

- *Action:* Look for opportunities in the private and public sector to take advantage of P.A.C.E. (Property Assessed Clean Energy).
- *Action:* Conduct an assessment of energy efficiency opportunities and implement findings throughout the installation, especially in new construction.
- *Action:* Continue to generate additional alternative energy under the \$2 million Environmental Security Technology Certification Program (ESTCP) project, lowering the installation's reliance on outside power sources and its utility costs in alignment with the U.S. Army's Energy Security and Sustainability Strategy.
- *Action:* Continue working with Consumers Energy for alternative energy opportunities, including ways to manage excess electrical output from planned renewable projects.
- *Action:* Partner with 110th Air Wing and Marine Reserve facility to support their future energy requirements with electrical output from planned renewable projects.

- *Action:* Work with the Missile Defense Agency to synchronize plans for future development on Fort Custer to provide electrical output from planned renewable projects for their future operations.
- *Action:* Document the lifecycle cost savings of high-performance sustainable building design to justify potential up-front incremental cost (if any) to renovate existing structures and build new construction according to green design standards.

Goal: *Improve or remove dams along the Kalamazoo River so they are no longer rated structurally insufficient.*

- *Action:* Conduct a vulnerability assessment of dams to prioritize improvements to dams and identify the potential impact of dam failure on Fort Custer.

Goal: *Identify and reduce the vulnerability of existing and new homes and infrastructure to impacts of heavy rain, flooding, high wind, and severe winter storms both on and near the installation.*

- *Action:* Coordinate with Kalamazoo County and Calhoun County Drain Commissioners and other key stakeholders to develop a water runoff, draining, and wetlands management plan around key sites, including possible missile defense sites and nearby homes and buildings.
- *Action:* Assess whether MIARNG training and operational activities may disrupt infiltration, increase stormwater runoff, and affect nearby homes and buildings.
- *Action:* Document and evaluate the impact of severe storms and high-wind events on the communication systems of armories and installation command centers.
- *Action:* Identify and prioritize backup supply and maintenance of any critical infrastructure on-post at risk during severe weather including important roadways, helicopter landing areas, and ranges.
- *Action:* Integrate higher wind speeds, and updated flood maps and rain standards, into upcoming capital improvement projects on the installation.
- *Action:* Explore strategies to reduce the vulnerability of homes, especially mobile homes, to storm events. This may include mechanisms like building codes and landowner guidelines.
- *Action:* Submit a project request to the National Guard Bureau's Installations, Logistics, and Environmental Division to address soil erosion issues on Fort Custer to protect on-post and downstream homes, infrastructure and water quality.
- *Action:* Reevaluate storage and equipment needs for road salt and snow plowing equipment and develop a plan to disseminate resources to the most essential locations on the installation.

Economic Development and Population Shifts

Goal: *Convene a group to identify strategies to increase regional economic resilience.*

- **Action:** Identify which sectors of the local economy may be most impacted by climate change and work to address threats to these industries.
- **Action:** Partner with the Southwest Michigan Sustainable Business Forum to identify opportunities for economic growth and development using renewable resources and reducing dependency on foreign oil.
- **Action:** Increase local participation in the Southwest Michigan Sustainable Business Forum.
- **Action:** Use the Fort Custer Industrial Park to attract additional employers.
- **Action:** Leverage the geographic proximity to Chicago and Detroit for economic development.

Goal: *Prepare for a potential influx of climate refugees to Michigan as climate conditions worsen elsewhere in the country.*

- **Action:** Work to update the zoning ordinance in rural areas of the community to limit sprawl and poorly planned development in anticipation of development pressure.
- **Action:** Establish a working group with local community leaders, universities, and NGOs to identify additional ways to prepare the community for increases in population.

Emergency Response and Preparedness

Goal: *Ensure emergency shelters are meeting the current and projected needs of the population.*

- **Action:** Work with local health departments to identify gaps in community shelter locations and services.
- **Action:** Conduct a vulnerability assessment to identify locations where vulnerable populations are not being serviced by shelters.
- **Action:** Provide free bus fare during an emergency weather event.
- **Action:** Prepare the Fort Custer Training Center to be an emergency management center for the region with reliable backup power, cooling centers, and water purification means.
- **Action:** Engage with community leaders and MIARNG officials to develop plans to meet the needs of the most vulnerable populations to extreme weather events.

Goal: *Increase interagency collaboration and foster multijurisdictional collaboration in times of emergency.*

- *Action:* Seek additional funding to improve and increase the resiliency of the installation for State domestic response missions, including backup power, energy storage, cooling centers, and water purification means.
- *Action:* Develop a revised domestic response plan for Battle Creek and the surrounding community.
- *Action:* Revisit installation emergency management plans and evaluate current operations for mission readiness during times of weather-related emergencies like severe rain storms, high winds, and blizzards.
- *Action:* Update Continuity of Operations (COOP) or Continuity of Government Plans and synchronize at the local, state, and federal levels to ensure all efforts harmonize.
- *Action:* Rehearse emergency operations strategies to identify interdependencies and opportunities to improve communication networks.
- *Action:* Synchronize communication plans and identify needed improvements to maintain emergency communications with Civil Support Teams, the Army G6, and A6 of the Air Wing, and other nearby agencies including airports and the Michigan State Police.
- *Action:* Continue funding and work to expand the Response Consortium, part of the Battle Creek Police Department, which was created to foster collaboration among social services and government departments with regard to emergency response.

Goal: *Better meet the needs of vulnerable populations in the community.*

- *Action:* Bring together a diversity of community advocates to address transportation and housing needs of socioeconomically disadvantaged and elderly populations.
- *Action:* Build website and Story Board to educate the public about resilience and Fort Custer renewable projects and partnerships.
- *Action:* Continue to promote school and social networks for high school students in both rural and urban areas of the community.

Land Use

Goal: *Promote sustainable farming techniques that can adapt based on climate change impacts.*

- *Action:* Partner with existing Farmer’s Markets to establish pop-up farm stands in neighborhoods with increasingly limited access to fresh, local food.
- *Action:* Work with farmers to identify existing agricultural products that are intolerant to projected climate conditions in order to increase the resiliency of agricultural land uses.
- *Action:* Work with farmers to identify strategies to reduce or eliminate fertilizer runoff that is contaminating the Kalamazoo River.
- *Action:* Look for opportunities to establish community gardens in underserved neighborhoods in order to strengthen the local food economy.
- *Action:* Examine ways to further reduce waste, such as a composting program and a more rigorous recycling program.
- *Action:* Look for opportunities to limit Concentrated Animal Feeding Operations (CAFOs) and industrial farming practices.

Goal: *Explore a Joint Land Use Study (JLUS) for Fort Custer.*

- *Action:* Use a JLUS as an opportunity to integrate climate-related data into analysis of energy compatibility, natural resources, water, and land restrictions.

Goal: *Work with local and regional jurisdictions to grow in a way that is in line with climate adaptation best management practices.*

- *Action:* Implement low impact development practices in all new development.
- *Action:* Incorporate bike lanes and other multi-modal infrastructure in all road repairs.
- *Action:* Establish a resilience task force for collaboration during non-emergencies.

Next Steps

MIARNG will continue to engage in ongoing state and local planning efforts both in Michigan and in the greater Fort Custer area. Fort Custer leaders plan to continue to monitor the most up-to-date and emerging climate trends and regional projections, and share the information with state/local planning entities.



CHAPTER 3

Camp Grayling Joint Maneuver Training Center (CGJMTC) Region

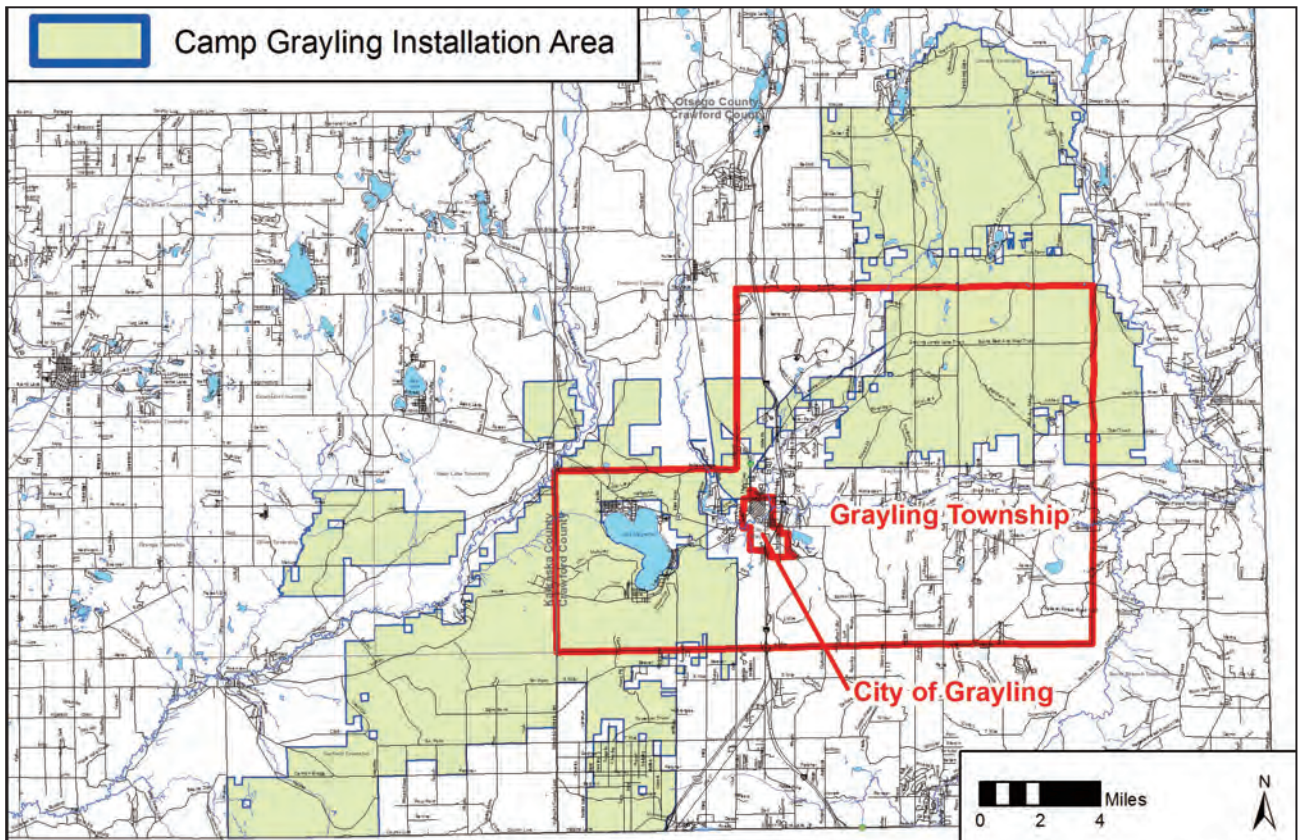
The Camp Grayling Community includes portions of Crawford, Kalkaska and Otsego counties as well as the City of Grayling and Grayling Township (see map below).

Regional Climate Trends

As stated by the Intergovernmental Panel on Climate Change (IPCC), significant changes in the Earth’s climate have been observed. The impacts of climate change on agriculture, infrastructure and human health can be felt across the Great Lakes region.

The Great Lakes Integrated Sciences and Assessments Program (GLISA) is a partnership between the University of Michigan and Michigan State University, housed in the Graham Sustainability Institute’s Climate Center at the University of Michigan. As one of 10 regional centers funded by the National Oceanic and Atmospheric Administration (NOAA), GLISA builds capacity to manage risks from climate change and variability in the Great Lakes region.

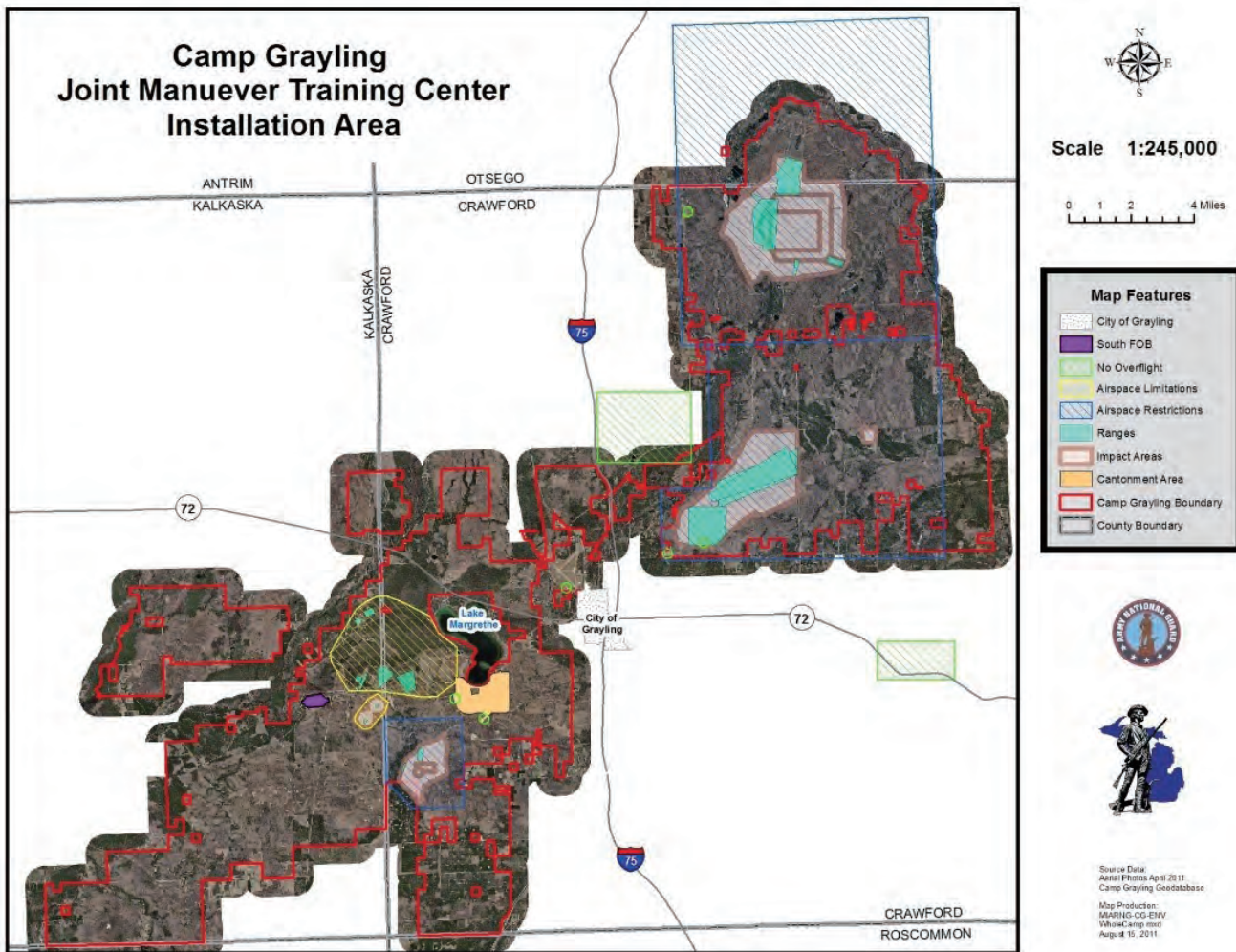
Figure 3.1 Regional Overview Map



CGJMTCC is located in the forested central northern Lower Peninsula of Michigan. According to GLISA, the area’s average overall temperature increased by about 2.8°F from 1900-2012. The greatest warming, at an average of about 3.5°F, has occurred in the winter months. Average annual precipitation has also increased by about 3.7% during that same time period. GLISA also projects that warmer temperatures and increasing CO₂ levels will increase forest productivity in the region until other impacts of climate change, such as increased drought and wildfire, present additional stressors to forests.

According to the Michigan Department of Natural Resources (MDNR), atmospheric conditions that promote wildfire spread — such as high wind speeds and drought events — are projected to become more common during summers. Altered soil moisture due to changes in transpiration from trees, changes in evaporation from soil, and changes in precipitation (e.g., more rain, less snow) are also projected to contribute to more volatile wildfire conditions in the central northern Lower Peninsula.

Figure 3.2 Camp Grayling Installation Area



Camp Grayling Joint Maneuver Training Center (CGJMTC) at a Glance

Totalling 147,000 acres, Camp Grayling is the largest National Guard installation in the country. As a premier Joint Maneuver Training Center, Camp Grayling is a leader in providing the highest level of modern training. Support resources are scheduled year-round to provide a wide range of training for service members, emergency responders and private-sector customers from around the world. Training sites provide a variety of training scenarios to meet unit readiness requirements. Large artillery, mortar, tank ranges and maneuver courses are among the highlights of Camp Grayling.

Camp Grayling was founded in 1913 when local lumber baron Rasmus Hanson donated over 13,000 acres to the State of Michigan for military training. Camp Grayling has since grown to 147,000 acres of maneuver area, state-of-the-art ranges, and modern support facilities.

The Camp Grayling management area (MA) is the Michigan National Guard training grounds used primarily for military exercises, while allowing varying degrees of MDNR management on certain portions depending on classification of ownership. The MDNR coordinates all of its prescribed activities with the MIARNG to ensure they are compatible with military training needs. On these lands, military training has precedence over resource management activities.¹

Camp Grayling is one of two arctic training sites in the country. Arctic Eagle, a joint military training exercise, was previously conducted exclusively in Alaska; exercises are now also hosted at Camp Grayling. The Department of Defense is increasingly reliant on Camp Grayling to serve this role, working with Allied Forces from Latvia, Estonia, Lithuania, Canada, Norway and the United Kingdom for arctic training. Warmer winters could affect arctic training at Camp Grayling and increase DoD costs to train forces for future arctic challenges.

Key Issues for Consideration

When considering increased collaboration and resiliency planning efforts that involve the installation and local jurisdictions, a number of issues must be acknowledged.

Infrastructure

While the size of the installation is not increasing, the intensity of uses has grown and is projected to continue to grow despite a decline in deployed troops. The installation “throughput,” or number of man days per year, has increased in recent years and is projected to increase by 82% over its five-year average. This translates into greater demand for maintenance dollars for infrastructure (that may not be available in future Army budgets) as well as an increased fire protection liability. Infrastructure on the installation has notably degraded due to declining maintenance budgets. Rail improvements are planned, but long overdue. Installation and local roads need to be

¹ Excerpt from the Camp Grayling Management Area NLP Regional Plan. 4.15 MA 15 – Camp Grayling Management Area

repaired and maintained. Ice and frost heaving, which are projected to increase as climate patterns change, will negatively impact the Grayling Army Airfield runway as well as installation and local roads.

Economic Impact

Since the surrounding communities are relatively sparsely populated, Camp Grayling has a significant impact on the local economy. The installation is the second largest employer in Crawford County, with 221 employees across all tenant organizations. The installation contributes approximately \$24.7 million in direct inputs annually to the economy, \$15.4 million in wages, \$ 7.2 million in exercises, and \$2.1 million in transient troop spending. This amounts to a \$49.2 million impact on the local economy.²

Environmental Stewardship

Camp Grayling has a rich history of taking a proactive approach to ecosystem management and engages in ongoing collaboration with several public and private entities. Camp Grayling collaborates on a watershed management plan, a wetland restoration plan, and a flora and fauna inventory. The installation is also working with the Lake Margrethe Lake Association to address invasive milfoil plants and swimmer's itch parasites. Invasive species and pathogens are on the rise in area woodlands. Specifically, increased incidence of oak wilt, gypsy moths, and the emerald ash borer could be linked to a changing climate. Pests and pathogens kill trees, resulting in more combustible fuel and increased risk of wildfire.

The installation is committed to increasing its resiliency. Currently, Camp Grayling is about 90% of the way to achieving net-zero waste. A net-zero waste installation is an installation that reduces, reuses, and recovers waste streams, converting them to resource values with zero landfill over the course of a year. In addition to efforts to reduce the volume of waste generated, the installation has a large recycling sorting facility, engages in lead recovery on-site, and is actively pursuing a composting program on base. Additionally, energy- and water-efficiency practices are prioritized for all new construction. In 2014, the installation was recognized as a recycling leader and for its "Small System Exemplary Wellhead Protection Program." Additionally, in 2010, the installation was recognized for its leadership in environmental sustainability.

Camp Grayling is also evaluating opportunities for renewable energy to increase its energy security posture. From the installation's perspective, a primary resiliency goal is energy security. Camp Grayling experiences frequent power outages. Brownouts also occur frequently and damage appliances. Additional backup generators would be effective in meeting the near-term energy security requirement as the installation moves toward renewables, battery storage and microgrids.

² ibid Colonel Thomas C. Perison

High water levels and flooding could negatively impact the total acres of maneuverable land on the installation. There is also potential for an increase in wetland acreage under a high water scenario due to climate change. These wetlands could be regulated in the future, which could restrict or prohibit certain types of training operations and activities.

“The single greatest threat to training for the MIARNG at Camp Grayling is wildfire.”

Brigadier General Michael A. Stone

Camp Grayling has also played a leadership role in the greater Grayling community by supporting a number of environmental stewardship efforts. For example, on the Au Sable and Manistee rivers, the installation has replaced and upgraded culvert crossings with environmentally friendly practices and regularly participates in the annual Au Sable River Cleanup Day.

Wildfire Protection

Wildfire is the number one natural hazard in the Grayling area in terms of both public safety and property damage. There are over 100 fires on average per year at Camp Grayling, resulting in 400 man days lost per year. The installation relies on the MDNR for wildfire response and prevention. To reduce reliance on MDNR resources, Camp Grayling will need more seasonal staff and more full-time staff for wildfire protection to maintain fire breaks on an annual basis. A comprehensive assessment or evaluation of a community’s wildfire risk is an important first step in

Meridian Boundary Fire in 2010



identifying proactive measures for community wildfire protection. Extreme heat, drought and lower water levels would have a negative impact on wildfire response, drive up costs, reduce training time for units, and threaten Camp Grayling as well as surrounding communities. Dry hydrants used to respond to wildfire are hooked up to surface water sources and are negatively impacted by lower water levels. With more projected heat events, there is an increase in heat casualties, requiring treatment and more personnel. There could also be additional requirements for personal protective equipment (PPE) (such as camel packs) during high heat events.

Cooperative Agreements

As noted previously, there is significant collaboration between the State of Michigan and the MIARNG in the Camp Grayling Community.

Fire Protection

The Department of Military and Veterans Affairs (DMVA) and MDNR have an interdepartmental agreement for prescribed burning and the use of various resources such as helicopters on portions of Camp Grayling.

Natural Resources

The MDNR assists in developing and reviewing Integrated Natural Resources Management Plans as authorized under the Sikes Act. Historically, Camp Grayling produces the plans, which are then reviewed by MDNR's Wildlife and Forest Resources divisions.

Resource Protection and Conservation

A cooperative agreement exists between DMVA and MDNR for implementation of a Management Plan for the Range 30 Complex. This area in particular is critically important because it provides crucial habitat for the federally endangered Kirtland's warbler.

The Surrounding Community

For the purposes of this report, the surrounding community was defined at the City of Grayling and Grayling Township, both located within Crawford County.

Population

Crawford County is fairly rural, and has experienced population decline over the past 10-15 years (see table below). It is interesting to note that Grayling Township has experienced a much higher rate of population decline than the City of Grayling.

While all of Crawford County has experienced a slight population decline, the county has experienced large losses in age groups that represent young families. The youth age group (19 years and younger) lost 703 persons (18.4% decrease),

and the adult age group (25-44 years of age) declined by 1,073 persons (28.3% loss). According to an analysis conducted for the Crawford County Wildfire Protection Plan, the median age of the county has increased from 34.7 years in 1990 to 47.7 years in 2010.

Table 3.1 Population Trends, 2000-2010

MUNICIPALITY	2000 POPULATION	2010 POPULATION	2000 to 2010 PERCENT CHANGE
Crawford County	14,273	14,074	-1.4
City of Grayling	1,952	1,884	-3.5
City of Springfield	6,516	5,827	-10.6

Source: US Census

Natural Resources

The Camp Grayling Community is predominantly undeveloped and is dominated by forested land. The forested landscape consists primarily of jack pine barren as well as some northern pine, northern hardwoods, red oak, hemlock and white pine. Additionally, areas of aspen, red pine and northern hardwoods with isolated pockets of lowland vegetation types cover the majority of the state forest land. Much of the area sits on the “Grayling outwash plain.” Historically, fires were very frequent in this region and were important in determining species composition.

Diverse natural resources in and around Camp Grayling provide high quality wildlife habitat, serve as a refuge for both animals and visitors, and also drive the local economy. Examples of these important natural assets include Lake Margrethe, the Manistee River, the Au Sable River, Hartwick Pines State Park, Hanson Hills recreation area, and numerous state forest campgrounds. The 3,500-acre all-season Hanson Hills recreation area is managed by the Grayling Recreation Authority. The MDNR manages Lake Margrethe, Civilian Conservation Corp Bridge, Manistee River Bridge, and Shupac Lake and Jones Lake state forest campgrounds. It should be noted that some campgrounds are located on military lands and others on non-military lands within compartments that are primarily under military ownership.

From a climate change perspective, community stakeholders are already reporting negative impacts on the recreational economy because of decreased snow accumulation in the winter months. The community noted that retailers and services must adapt for environmental and social changes by expanding outdoor recreational opportunities.

Local Plans

There are a number of local planning efforts completed and underway that are helpful in informing actions and priorities identified in the Camp Grayling DoD planning process. For example, all three counties that touch the installation have a Hazard Mitigation Plan: Crawford County from 2014, Kalkaska County from 2007,

and Otsego County from 2014. In addition, Crawford County adopted a Community Wildfire Protection Plan in 2013. Most jurisdictions also have community master plans and zoning ordinances (at both the county level and municipal level). Other strategic local plans that have direct overlap with the MIARNG planning effort include county health plans, emergency response plans, watershed management plans, parks and open space plans, and economic development plans. These plans and documents were reviewed prior to the public planning process to provide background information to stakeholders and help inform goals and actions.

Surrounding Zoning Districts

The northwest portion of the City of Grayling borders the Camp Grayling installation near the Army Airfield and the Grayling Control Tower. The city's boundary is currently zoned for C3-A (General Commercial) and G (Government). As stated in the city's zoning ordinance, C3-A is intended to accommodate office, business service, and retail uses that serve a larger market. The Government District and regulations are intended to provide an appropriate zoning classification for specified government, civic, and recreational facilities where a separate zoning district is deemed appropriate. The project team recommends that the City of Grayling work with the Camp to ensure that there are not incompatible uses or development in proximity to the Airfield.

Much of Camp Grayling resides in Grayling Township. The majority of the lands that are part of Camp Grayling and fall within the township boundary are zoned Recreation-Forest (R-F) and Deferred Development (D-D). These are areas that do not present development pressure and are compatible with installation activities. However, other areas raise issues for consistency between development in the township and installation activities. For example, an area along Jones Lake Road is an area zoned Residential Association (R-3). There are also areas zoned Single-Family Residential (R-1), General Residential (R-2), and Heavy Commercial (C-2). Much of the residential development within the township can be found along the Natural River District (NRD), which further promotes sensitive use of natural resources. The goal of the NRD is to preserve, protect and enhance the river environment in a natural state for the use and enjoyment of present and future generations, as well to promote the public health, safety and general welfare of Grayling Township and the state as a whole.

Figure 3.3 City of Grayling Zoning Districts Adjacent to Camp Grayling



Source: City of Grayling Zoning Map, 2009

Vulnerability Assessment

The Grayling Community is no stranger to impacts from natural disasters. Most notably, the community has weathered numerous wildfires as far back as extreme events have been recorded. Wildfire is the number one natural hazard in the Grayling area in terms

of both public safety and property damage. A comprehensive assessment or evaluation of a community's wildfire risk is an important first step in identifying proactive measures for community wildfire protection.

Devastating Fires in the Grayling Area

1980 Mack Lake Fire: Over 24,790 acres burned. One firefighter was killed in the line of duty and 44 homes were destroyed by the fire.

1990 Stephan Bridge Road Fire: Swept across 5,916 acres of a wildland/urban interface area near Grayling. More than 76 homes, 125 other structures and 37 vehicles and boats were destroyed or heavily damaged. Losses from the fire were estimated at \$5.5 million.

2010 Meridian Boundary Fire: Approximately 8,790 acres, with 12 residences destroyed, 2 residences damaged, and 39 out-buildings destroyed or damaged.

A vulnerability assessment (Appendix B) was completed for the greater Camp Grayling Community as part of the adaptation planning effort. The Wildfire Risk Areas Map (Map B-10 in the Camp Grayling Vulnerability Assessment, Appendix B) was compiled by the U.S. Forest Service as a part of the Great Lakes Ecological Assessment. To create this risk map, the Forest Service used a computer program to run a series of fire simulations. Data used to create the model included spatial fuels and vegetation data and locations of historic fire occurrence. These maps can inform long-term strategic planning and fuels management, especially when combined with values at risk, such as populations of concern and critical community facilities. High risk areas were used to inform the public planning process to help identify high priority actions for reducing wildfire risk.

Other key issues investigated in the vulnerability assessment process included populations vulnerable to severe weather events, locations of critical facilities and community services, areas prone to flooding, and habitats and species that are likely to be more impacted by changing climate conditions.

Highlights from the Public Process

Throughout the course of the stakeholder interviews and two evenings of convening community members, there were a number of themes that emerged, highlighting needs specific to the greater Camp Grayling Community.

A desire for increased collaboration between municipal officials, installation officials, and other community stakeholders was articulated at the meetings. For example, the MDNR and Camp Grayling have a fire protection memorandum of understanding (MOU) that is renewed every March; opportunities to bring other relevant entities into the effort, such as emergency services, were discussed. In stakeholder meetings with law enforcement and emergency management, agencies noted the need for increased funding to streamline management of natural resources and joint lands, particularly in reference to forest management and wildfire risk reduction.

Another recurring theme was the importance of leveraging the population influx at Camp Grayling for economic development in the surrounding communities. Strategies included leveraging existing placemaking efforts already underway in the City of Grayling to attract families of service members to come camping and enjoy other natural assets in and around Camp Grayling, and leveraging partnerships to enhance outdoor recreation opportunities in the region.

Action Plan

The following goals and actions are a result of a series of in-depth stakeholder interviews, public input from a two-day planning charrette focused on Camp Grayling, a vulnerability assessment conducted for the greater Camp Grayling Community, and recommendations made by installation leaders and the project steering committee, the Michigan Climate Coalition (MCC). Not all recommendations and actions are the responsibility of MIARNG, as several are community-wide recommendations that would be best led by local governments, watershed groups, or other NGOs.

Natural Resources

Goal: *Protect and enhance the region's natural resources and ecosystems, focusing on areas that may be most affected by climate change.*

- **Action:** Conduct a vulnerability assessment with potential adaptation actions to better manage natural resources in light of climate change predictions.
- **Action:** Partner with local agencies and nonprofits to develop and administer comprehensive education to all surrounding landowners on strategies for reducing the spread of invasive species.
- **Action:** Continue monitoring and evaluating climate change impacts on threatened and endangered species.

Infrastructure

Goal: *Evaluate the feasibility of a biomass energy plant on the installation to increase the Camp's energy security posture and address projected increased storm-related outages.*

- **Action:** Explore opportunities for a biomass power generation facility at Camp Grayling and conduct a cost benefit analysis, with special emphasis on the wildfire risk benefits of removing excess biomass.
- **Action:** Investigate the possibility of collaborating with Arauco (a local particleboard manufacturing facility) to utilize excess biomass from its local logging operations as a fuel source for the biomass plant.
- **Action:** Partner with a university to conduct a study of the best way to achieve net-zero energy and waste status.
- **Action:** Complete contract to install two new wind funnels.

Goal: *Maximize climate-informed infrastructure investments to benefit all members of the community.*

- **Action:** Explore opportunities for opening up the underutilized airfield to the larger community to enhance emergency response capabilities.
- **Action:** Pursue increased investment in the railroad to benefit both the military and the community.

- *Action:* Explore the feasibility of fiber-optic communication community-wide.
- *Action:* Expand sewer and water services and distribution systems into Grayling Township.
- *Action:* Explore the use of a microgrid system to make Crawford County more self-sufficient in terms of power.
- *Action:* Explore Federal transportation grant funding for a northbound exit for I-75 at Downriver Road.
- *Action:* Collaborate with MDOT to manage infrastructure impacts due to a changing climate.

Goal: *Increase energy efficiency and use of alternative energy across the installation to increase the Camp's resiliency.*

- *Action:* Conduct an assessment of energy efficiency opportunities and implement findings throughout the installation.

A microgrid is a localized grouping of electricity sources and loads that normally operates connected to and synchronous with the traditional centralized grid (macrogrid), but can disconnect and function autonomously as physical and/or economic conditions dictate.

Economic Development

Goal: *Expand outdoor recreational opportunities to keep pace with a changing climate and changing demands from visitors.*

- *Action:* Explore a marketing strategy aimed at attracting new generations to outdoor activities to enhance stewardship of these resources.
- *Action:* Create partnerships between the community and Camp Grayling to protect recreation services that may be affected by climate change.
- *Action:* Explore development of a MIARNG/community multigenerational recreational center in an underutilized building on Camp Grayling.

Goal: *Enhance climate-informed economic connections between soldiers on the installation and the larger community.*

- *Action:* Leverage ongoing placemaking initiatives in the City of Grayling to draw troops out into the community to encourage them to spend their dollars locally.
- *Action:* Actively engage installation officials when developing the county-wide Redevelopment Ready Plan to be sure to leverage collaboration of installation operations.
- *Action:* Explore a public-private partnership to provide transit or shuttles from Camp Grayling to downtown Grayling to better connect both communities and reduce the reliance on fossil fuels.

Goal: Convene a group to identify strategies to increase regional economic resilience.

- **Action:** Identify which sectors of the local economy will be most impacted by climate change and work to address threats to these industries with respect to climate change.

Emergency Response and Preparedness

Goal: Enhance the capacity for Defense Support of Civil Authorities (DSCA) at Camp Grayling.

- **Action:** Prepare appropriate plans to support necessary operations, education, and training.
- **Action:** Seek additional funding to improve and increase the resiliency of the installation for State domestic response missions, including backup power, energy storage, cooling centers, and water purification means.
- **Action:** Update Continuity of Operations (COOP) or Continuity of Government Plans and synchronize at the local, state, and federal levels to ensure all efforts harmonize.
- **Action:** Identify installation assets that might serve the community during severe emergencies such as additional housing, water, or other resources

A dry hydrant is a non-pressurized pipe installed at a pond or lake that is in close proximity to an all-weather road. Dry hydrants provide firefighters with a way to replenish their water supplies.

Goal: Support community-wide cooperative fire protection efforts, especially in areas where wildfire risk may be exacerbated by climate change.

- **Action:** Secure funding for an Integrated Wildland Fire Management Plan (IWFMP).
- **Action:** Secure funding to establish and maintain an on-post wildland fire department with a minimum of 16 full-time staff during the fire season, and two full-time staff year-round.
- **Action:** Collaborate with MDNR to secure a seasonal wildfire support crew for the greater Grayling area.
- **Action:** Secure funding for Bambi Buckets and more aircraft hangers.
- **Action:** Explore funding opportunities for Firewise community projects and other homeowner protection projects.
- **Action:** Collaborate with MDNR to secure a seasonal wildfire support crew for the greater Grayling area.
- **Action:** Conduct more frequent prescribed burns on MDNR land in areas identified as being high fire risk in the Wildfire Risk Assessment.
- **Action:** Seek and obtain funding to increase the number of dry hydrants on MDNR land.
- **Action:** Expand emergency response simulations in partnership with municipal fire departments, the MDNR, Camp Grayling, and other key community partners.
- **Action:** Work with the City of Grayling to secure funding for long-term structural fire protection, including personnel and equipment.

Goal: *Address the needs of sensitive populations in the community who will bear the burden of climate events.*

- *Action:* Form a working group with local senior citizens and the Area Commission on Aging to better identify and address the needs of an aging community.
- *Action:* Identify vulnerable populations and inventory their needs.

Goal: *Prepare for increased severe weather events at Camp Grayling and in the greater community.*

- *Action:* Evaluate any potential change in frequency, duration, and type of severe weather events, to determine potential impacts on response capabilities.
- *Action:* Designate cooling stations in outlying areas, possibly township halls.
- *Action:* Ensure backup generators are available to critical facilities.
- *Action:* Designate Dial-A-Ride and school buses as resources to relocate vulnerable populations.
- *Action:* Have fire departments, law enforcement, emergency medical services (EMS), and MIARNG enter into a mutual aid agreement.
- *Action:* Evaluate the potential to use the over-supply of existing housing located at Camp Grayling for emergency housing.
- *Action:* Conduct a scenario exercise to plan for preparedness and local response to extreme-weather events.
- *Action:* Validate Continuity of Operations (COOP) or Continuity of Government Plans and synchronize at the local, state, and federal levels to ensure all efforts harmonize

Land Use

Goal: *Support land use and development that is resilient to climate change and is mutually beneficial to the installation and the greater community.*

- *Action:* Secure funding to conduct a Joint Land Use Study (JLUS) to see where partnerships between the installation and the community could be formed with regard to land use.
- *Action:* Identify appropriate locations for community gardens that could be cooperatively run and managed by both the installation and the larger community.

Next Steps

MIARNG will continue to engage in ongoing state and local planning efforts both in Michigan and in the greater Grayling area. Camp Grayling leaders plan to continue to monitor the most up-to-date and emerging climate trends and regional projections, and share the info with state and local planning entities.



CHAPTER 4

Selfridge Air National Guard Base (SANGB) Region

The Selfridge Air National Guard Base (SANGB) is located along the western shoreline of Lake St. Clair, about 20 miles north of downtown Detroit. SANGB is in Macomb County, part of Greater Metropolitan Detroit. The region supports roughly half of Michigan's total population. The suburbanization and expanding development of the Detroit region has largely influenced Macomb County, as population continues to grow, increasing 2.3% from 2010 to 2014.¹ SANGB lies predominantly in Harrison Township, and is bordered by Chesterfield Township on the north and the Charter Township of Clinton and the City of Mount Clemens on the west.

Regional Climate Trends

As stated by the Intergovernmental Panel on Climate Change (IPCC), significant changes in the Earth's climate have been observed. The impacts of climate change on agriculture, infrastructure and human health can be felt across the Great Lakes region.

Located in the southeast Lower Peninsula of Michigan, SANGB occupies 1.85 miles of the shoreline of Lake St. Clair, which is part of the Great Lakes system. Lake St. Clair is a shallow lake, with an average depth of about 11 feet. Because of this, small fluctuations in wind, precipitation, ice coverage and temperature cause dramatic changes to Lake St. Clair.² Compared to the Great Lakes, Lake St. Clair does not produce high velocity waves and generally has calmer waves. However, as the climate changes in southeast Michigan, Lake St. Clair may experience stronger storms, warmer temperatures,

Figure 4.1 Regional Overview Map



1 U.S. Census Bureau, Population Estimates from 2010 SF1 to 2014 ACS.

2 http://projects.glc.org/habitat/lsc//documents/physical_characterization.pdf

decreased ice coverage, and changes in lake dynamics that could threaten lake health and existing fish species.³

The Great Lakes Integrated Sciences and Assessments Program (GLISA) is a partnership between the University of Michigan and Michigan State University, housed in the Graham Sustainability Institute's Climate Center at the University of Michigan. As one of 10 regional centers funded by the National Oceanic and Atmospheric Administration (NOAA), GLISA builds capacity to manage risks from climate change and variability in the Great Lakes region. According to GLISA, temperatures are expected to increase in the Selfridge Community, both in terms of averages and extremes. Southeast Michigan is projected to see a 4.5 to 5.0°F increase in average air temperatures between 2041 and 2070. An additional 30 to 40 days per year are projected to exceed 90°F. Shorter winters may accompany these temperature rises, with about 30 fewer days each year where the temperature falls below 32°F. The growing season is projected to extend by an additional 40 to 50 days each year.

Lake levels of St. Clair fluctuate along with Great Lakes water levels, changing in decadal and multi-decadal shifts. From 1986 to 2013, water levels in Lake St. Clair were declining from record highs. In 2013, water levels in Lake St. Clair were far below the long-term average. At the time of this writing (2016), water levels have quickly increased and are presently 11 inches above the long-term average. Changing water levels are a natural dynamic of the Great Lakes, though much of the built environment was not designed to adapt to both high and low water levels. During times of low water levels, dock infrastructure may be inaccessible and vulnerable to damage, boats may experience hazards in shallow water, economic spending from tourism may decline, and costly dredging becomes more necessary to maintain channel access. In times of high water levels, structures in shoreline areas can be flooded and damaged by quickly rising waters, shorelines can erode causing permanent damage, and stormwater runoff can compromise water quality and impact the ecosystem of the lake.

Lake St. Clair on SANGB



Selfridge Air National Guard Base at a Glance

Selfridge became a military post in 1917 because of its proximity to the growing industrial center of Detroit.⁴ At the time of purchase, the land served as a wetland reservoir along the shoreline and frequently flooded with lake water, making agriculture and permanent infrastructure difficult and expensive. Drainage and flooding remained an obstacle to permanent construction of the Base until 1925, when a 63-mile system of underground pipes and pumping stations were installed. The Air National Guard became the host of Selfridge Air Field in 1971, changing its name to Selfridge Air National Guard Base.

³ http://www.resilientmichigan.org/downloads/gibbons_macomb_adaptationcasestudies.pdf

⁴ <http://www.127wg.af.mil/shared/media/document/AFD-140604-005.pdf>

The Base is 3,089 acres, comprising about one-third of Harrison Township's total land area. SANGB is an important and unique installation in the State of Michigan, acting as both the home of the 127th wing of the Michigan Air National Guard and a Joint Military Community. The Base houses 44 tenants that together represent all branches of the U.S. Military. Key tenants of Selfridge ANGB include Army, Air Force, Marines, Navy, Coast Guard, and Customs and Border Protection.

Notably, SANGB is a national model for Joint Military Communities. The Base has worked to develop efficiencies and cross-sharing of services between the 127th Wing of the Michigan Air National Guard. Examples of this joint collaboration include:

- Shared repair contracts and utility services for the 600+ buildings on the Base
- Shared use of aviation fuel storage and distribution
- The largest shared-use cyber security Sensitive Compartmentalized Information Facility (SCIF) anywhere in the State
- Cross-training opportunities between U.S. Marine Corps Reserve (USMCR) Infantry, Air Wing, and other units
- Shared ground transportation assets

In addition to partnerships between military tenants and hosts, SANGB also works to ensure its economic and military resiliency into the future. From building structures that are usable for numerous purposes to factoring environmental and sustainability directives into planning and development, SANGB is taking steps to ensure it is flexible and resilient to future demands.

Economic and Social Impact

Selfridge provides an estimated \$825 million annually in economic activity in the communities outside the Base. This economic impact includes revenue generated by jobs, contracts with local businesses, and direct expenditures.

The Base employs over 6,200 people, with a mix of military and civilian employees. There are no active housing or schools on site, and permanent employees of host and tenant organizations live primarily in Macomb, Oakland, Wayne and St. Clair counties. Temporary employees and visitors provide economic stimulus to hotels and restaurants near the Base. In 2014, SANGB was assigned 500 active military duty personnel and 2,600 guard/reserve personnel. In 2014, the Base spent over \$10 million in contractual obligations with Macomb, Wayne and Oakland counties. Notably, the jobs supplied by the Base and tenant organizations are less likely to ebb and flow due to changes in the global economy. Therefore, while the Metro Detroit region recently experienced a deep economic recession due in part to a reduction in manufacturing jobs, Base employment remained strong.

Selfridge also fosters competitive expertise in the defense, security and advanced manufacturing industries in Macomb County and Metro Detroit.⁵ Training

⁵ <http://www.127wg.ang.af.mil/shared/media/document/AFD-120919-017.pdf>

opportunities and job growth for industrial and defense research and development in the region has resulted in a skilled workforce, access to capital, and numerous funding and partnership opportunities for new firms. Michigan businesses have received \$41 billion in defense contracts in the last decade, with more than 60 percent of that total going to businesses in Macomb County.⁶

Beyond providing educational and economic stimulus, SANGB is also a major defense asset to Macomb County, especially during emergencies. Macomb County Emergency Management and Selfridge's Military Emergency Management Office collaborate when developing plans and simulating missions and exercises.

The Base also provides several valuable social amenities for members of the public. STARBASE One is a free educational program for fifth graders that is implemented across the country. Selfridge hosted the first STARBASE One and continues to provide this service for classrooms in the area, helping young children to explore science, math, technology and engineering in an interactive program. Many participants in the public process for the DoD pilot project cited the value of this program in the community. The Base also offers a Selfridge Military Air Museum which is open to the public by appointment. Organized by the Michigan Air Guard Historical Association, the museum hosts many historical vessels and planes.

Key Issues for Consideration

When considering increased collaboration and resiliency planning efforts that involve the Base and local jurisdictions, a number of issues must be acknowledged.

Security

SANGB is a secure operational military base. Any visitors coming onto the Base must be cleared to enter and are escorted while on Base. High security on the perimeter of the Base is necessary for Base operations and constrains opportunities for public access to the Base during times of emergencies, for recreation along Lake St. Clair, or for other uses.

Concern Over Base Closures

In the recent past, SANGB has been the subject of proposed budget and realignment plans to reduce the Base's capacity through redistribution and changes in aircraft and military spending. While closing the Base or constricting its boundaries would open lakefront land for potential development, it would jeopardize the current economic and social benefits the Base provides to local jurisdictions. The community remains apprehensive and concerned over what a future Base closure might mean. This issue serves as a driving force in ensuring the Base's resiliency for all involved.

⁶ <http://www.127wg.ang.af.mil/shared/media/document/AFD-120919-017.pdf>

Water Control

Selfridge's elevation is three feet under Lake St. Clair's average water level. Consequently, the Base relies on significant engineered infrastructure to ensure that it does not experience flooding or ponding. Pumps run constantly to drain the Base, seawalls and berms protect the near shoreline areas in times of storms and high water levels, and numerous backups and redundancies ensure that the system does not fail. Discussions surrounding opportunities to better use water resources to increase resiliency face several key constraints. First, urban flooding remains a concern throughout Macomb County, potentially flooding transportation routes leading in and out of the Base. Second, restoring the natural shoreline or native wetlands is not a viable option for Selfridge to consider because of the property's active use as an airfield.

Land Use Compatibility

The desire to increase land use compatibility between the Base and the surrounding community stems from two key concerns: aircraft safety and noise, and regional efforts to increase recreational linkages.

First, the number of flights taking off from and arriving to SANGB has increased in recent years, prompting an updated Air Installation Compatible Use Zone study for the Base. This report studied the zoning ordinances and development patterns in areas within the noise contour and safety zones of the airfield, and found that many existing land uses and zones in neighboring communities are not compatible with the airfield. As neighboring jurisdictions are experiencing population growth, this issue requires information exchanges and collaboration to address.

Second, regional efforts are underway to increase awareness of recreational opportunities and connect them in the region. Several of these efforts have included preliminary discussions with Base leaders to connect trails through the Base along the shoreline. Trail plans — including water trails for kayakers and paddlers in Lake St. Clair and walking/biking trails in neighboring communities would benefit from increased collaboration with the Base.

The Surrounding Community

Population

SANGB is within Macomb County, a growing county in the Detroit metropolitan region. Between 2000 and 2010, Macomb County gained over 52,000 residents. As Figure 4.2 shows, Clinton Township and Harrison Township saw modest increases in population between 2000 and 2010, while Chesterfield Township's population increased by 15%, a greater percentage increase than Macomb County overall. The City of Mount Clemens, just west of Selfridge ANGB, lost about 1,000 residents over the course of the decade.

Population projections in Table 4.1 published by the Southeast Michigan Council of Governments (SEMCOG) show that the areas surrounding Selfridge, particularly Harrison and Chesterfield Township, are expected to see rapid growth in population, households and employment

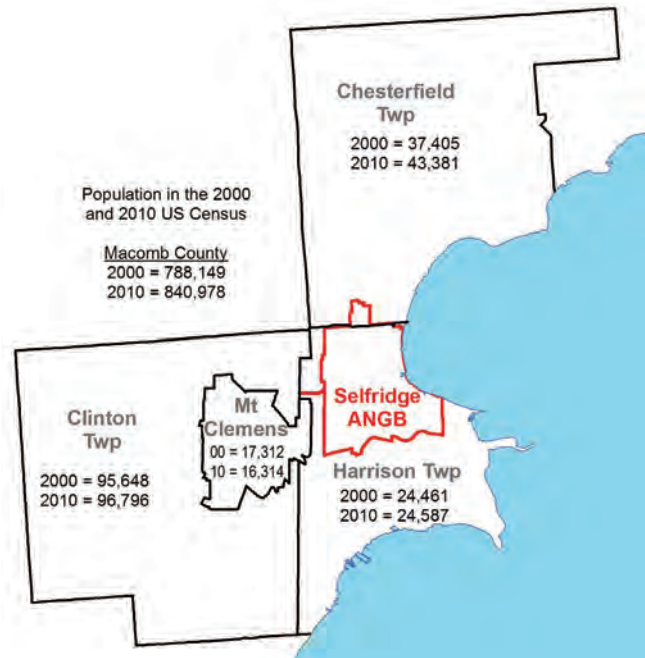
Table 4.1 Projected % Change in Population, Households, and Employment from 2010 to 2040

	CHESTERFIELD TWP.	CLINTON TWP.	HARRISON TWP.	MOUNT CLEMENS
Populations	24.6	7.3	14.3	-5.2
Households	31.1	7.6	14.0	.09
Employment	12.1	14.2	12.2	13.0

Source: US Census

The projected increases in population, especially north of SANGB, hold implications for land use and development patterns in light of the Base’s use as an airfield. The presence of noise and overhead flight routes require strong collaboration between the Base and a growing Chesterfield Township to ensure that land use compatibility is achieved.

Figure 4.2 Populations in 2000 and 2010



Lake St. Clair

Lake St. Clair is connected to both Lake Huron and Lake Erie, making SANGB part of the Great Lakes system. The Base’s role as a lakeshore community necessitates an understanding of Great Lakes climate forecasts and Lake St. Clair dynamics.

Selfridge occupies 1.85 miles of the Lake St. Clair shoreline. Lake St. Clair is a primary destination in the Great Lakes region for recreational boating and fishing, and the counties along the western lakeshore have supplied marinas and numerous destinations for boaters to lay anchor. Non-motorized boating and kayaking are also popular along Lake St. Clair, and many communities have produced mapped trails with designated launches for kayakers and paddlers.

Lake St. Clair is also a primary fishing destination in the Great Lakes, due to its nutrient-rich environment that spawns bait fish and, consequently, muskellunge, smallmouth bass, yellow perch, walleye, and others.⁷ Tourism generates tremendous economic value to jurisdictions along the shoreline, mainly due to fishing and recreational boating amenities. Macomb County alone boasts 10,000 boat slips and 50 marinas along the Lake St. Clair shoreline.⁸

7 <http://www.tourlakestclair.org/fishing.html>

8 <http://www.127wg.ang.af.mil/shared/media/document/AFD-120919-017.pdf>

Direct human intervention impacts Lake St. Clair. Because of impacts to water quality like nonpoint source pollution and sewer overflows, the Clinton River Watershed has been designated as an area of concern under the Great Lakes Water Quality Agreement.

Review of Local Plans

Macomb County's Trailways Master Plan sets forth the vision for trail expansion in Macomb County. This plan builds on the existing trail system in the county by proposing new trail corridors and providing flexibility to tailor trails to the needs of the various communities in the county. Near SANGB, the Trailways Master Plan shows the expansion of a north-south trail to the west of the Base along I-94. Implementing this trail will require, as noted in the plan, coordination with the Base to guarantee that the Base's security will not be compromised.

Land use plans and master plans for the neighboring communities of Clinton Township, Mount Clemens and Chesterfield Township do not refer to SANGB. However, Harrison Township plans do discuss the Base, though the Base is not subject to any township regulation.

The Harrison Township Recreation Plan outlines the vision for expansion of recreational amenities in the township. The recreation plan seeks to increase the sense of place and community resources near Lake St. Clair by exploring a partnership to use land owned by the Base for community recreation. To this end, the plan states that in the case of SANGB donating or selling land, the township should seek to acquire that land for additional waterfront recreation. Additionally, the recreation plan summarizes community input stressing the desire of residents to be permitted to use the Base's large number of recreational amenities, including its athletic fields and golf course.

The Harrison Township Master Plan references the Air Installation Compatible Land Use Study prepared for SANGB. The master plan seeks to implement, when feasible, the land use recommendation suggested in the Air Installation Study to provide for the safety of residents and for future development. The master plan identifies five actionable programs to address this goal:

1. Continue to improve communications between the township and the Base.
2. Ensure that all development plans are submitted to the Base for review and comment.
3. Reexamine the allocation of uses within Accident Potential Zones and Clear Zones.
4. Reexamine building code requirements with regard to sound attenuation.
5. Encourage the preservation of SANGB as a military base.

The Harrison Township Master Plan also emphasizes low impact development and landscaping practices to guard against flooding, promote resiliency, and foster a healthy natural environment in its subdivisions. The township is cognizant of potential impacts this may have on SANGB, and this concern is expressed in the master plan as a goal to reevaluate landscaping standards to ensure this effort would have limited impacts on the Base.

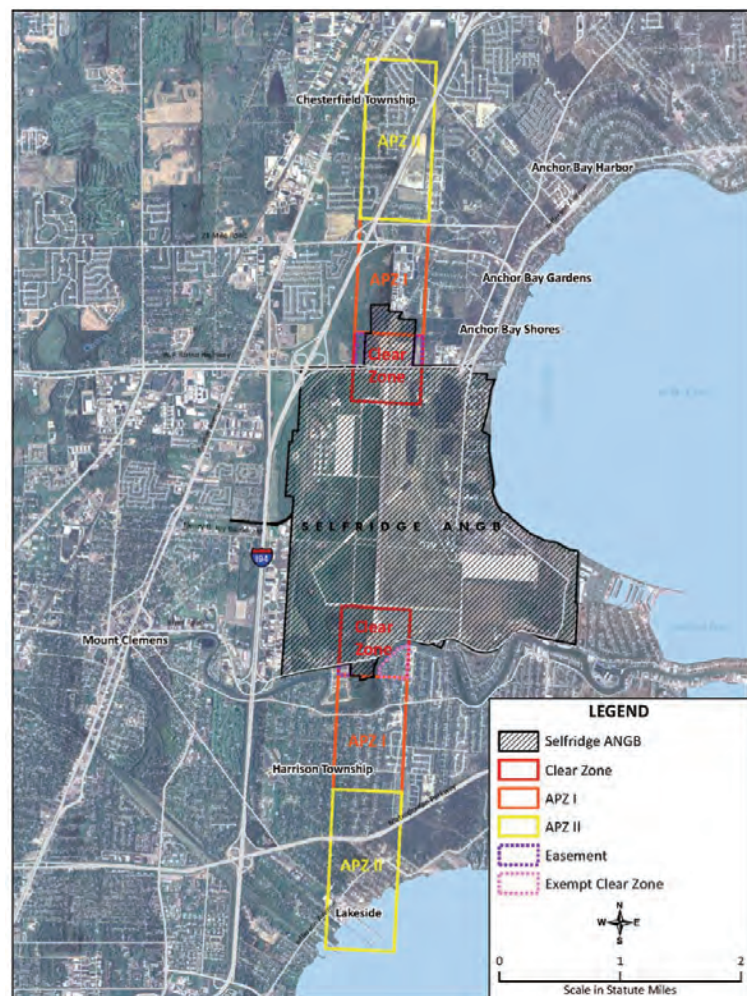
While the Harrison Township Master Plan emphasizes the value of the Base to the community, the master plan also contains reuse concepts in case of a Base closure. The reuse concepts include the construction of canals and recreational trails, additional lake access points, and thematic designs honoring the legacy of the Base. The reuse concept integrates a variety of uses, including a town center district with retail, industry, and shoreline protection and preservation.

Review of Local Zoning Ordinances in the Air Installation Compatible Use Zone Study

The Air Installation Compatible Use Zone (AICUZ) Study conducted in 2009 assigned levels of compatibility to existing land use patterns in the Clear Zones and Potential Hazard Zones defined in yellow, orange, and red on Figure 4.3. It is important to distinguish between the zoning designation of an area and its current use; although zoning guides land use, land use is a dynamic process and may differ from the zoning designation of an area. Uses like single-family residential, multi-family residential, mixed-use, manufactured homes, commercial, institutional, and transportation are considered incompatible with the Potential Hazard Zones identified by the Compatible Use Zone Study because of increased noise levels and concerns over safety. Much of the land in the affected area is already developed and is considered unlikely to change classification or use in the near future.

More than 28% of land acreage in the areas of concern is currently used in a way that is incompatible with the Base's operations. However, even more land is currently zoned for incompatible or potentially incompatible uses than is currently used for incompatible uses. Large areas of undeveloped land in Chesterfield Township to the north pose potential future incompatibility based on current zoning. As this area is expected to see rapid growth in population and employment, it is important to coordinate closely to ensure compatibility in the future and as opportunities arise to revise zoning ordinances and plans.

Figure 4.3 Airfield Potential Hazard Zone



Source: Air Installation Compatible Use Zone Report for Selfridge Air National Guard Base, 2009

Prior Storm and Emergency Impacts in the Community

The Macomb County Hazard Mitigation Plan documents historic storms and natural disasters, along with their impacts and future likeliness of reoccurrence. These include droughts, earthquakes, energy emergencies, extreme temperatures, wildfires, dam failures, riverine and urban flooding, shoreline flooding and erosion, and severe storms. Some historical major storm and emergency events that have occurred since 1980 in Macomb County include:

1980 - A large sewer main collapsed, causing the diversion of millions of gallons of raw sewage into the Clinton River leading out into Lake St. Clair.

1986 to 1988 - Because of extreme shoreline erosion and flooding concerns, funds were made available to relocate private properties out of harm's way. During these two years, 72 structures were relocated and 43 were elevated.

1995 - Flooding in Macomb County submerged cars on local freeways due to heavy rains.

2004 - After four days of continuous rainfall, the county incurred \$9 million in damage to infrastructure and \$6 million in damage to properties.

2009 - Flash flooding caused severe flooding on many roads, sometimes with up to 5 feet of standing water, and caused 80,000 residents to be without power.

2012 - High winds resulted in loss of power for one-third of the county's residents for 7 days.

2012 - A drought and extreme heat wave led to major losses in Michigan's agricultural productivity, destroying one-third of the state's fruit, vegetable and field crops.

2013 to 2014 - The winter season marked the third coldest in Macomb County's history. An air temperature of -14 °F set a new record for the county in January 2014, causing school closures, road blockages, and the opening of the county's warming shelters.

Clearing snow on SANGB during a February storm, 2011



Summary of the Vulnerability Assessment

The vulnerability assessment conducted for SANGB and its surrounding communities is presented in full in Appendix C. The assessment determined where sensitive populations to extreme heat and heavy rainfall tend to live in the community and where environmental risk to extreme heat and heavy rainfall is highest. Areas with disproportionately high sensitive populations and high environmental risk are considered vulnerable. Vulnerability to extreme heat is highest in Chesterfield Township, north of SANGB, and west of the Base in Mount Clemens. Localized flooding risk is highest in areas near the shoreline of Lake St. Clair, especially south of the Base in Harrison Township, and near the Clinton River. Flooding is a concern across the county due to the naturally occurring soil types that drain poorly. The vulnerability assessment shows that areas of Chesterfield Township are more susceptible to flooding than the other communities bordering the Base. These same areas north of the Base also have high potential for wetland restoration.

Highlights from the Public Process

The public process brought together many local stakeholders to share information, identify mutual vulnerabilities and goals, and develop ideas on ways to potentially increase collaboration between the Base and nearby communities in light of climate change. Key themes from the stakeholder meetings include opportunities and limitations for increased public access to Lake St. Clair, barriers and benefits of restoring natural shorelines, and opportunities for the Base to increase energy efficiency by assessing existing infrastructure and maximizing solar and geothermal opportunities.

During the public meetings, participants were asked to identify short- and long-term strategies to adapt to extreme heat and heavy rain events. In both climate scenarios, collaboration and education were identified as key strategies to help local communities and residents adapt. Green infrastructure and other Low Impact Development techniques surfaced as key adaptation opportunities for the Base and neighboring jurisdictions. Detailed public input, including the summaries of each activity, are included in Appendix C.

Action Plan

The following goals and actions are a result of a series of in-depth stakeholder interviews, public input from a two-day planning charrette focused on SANGB, a Vulnerability Assessment conducted for the Selfridge Community, and recommendations made by installation leaders and the project steering committee, the Michigan Climate Coalition (MCC). Not all recommendations and actions are the MIARNG's responsibility, as several are community-wide recommendations that would be best led by local governments, watershed groups, or other NGOs.

Natural Resources

Goal: *Protect existing wetlands and restore wetlands that have been degraded to increase their resiliency in response to climate change.*

- *Action:* Work with the Clinton River Watershed Council (CRWC) to identify strategic land for wetlands restoration and preservation within the watershed.
- *Action:* Partner with research universities to study methods to restore wetlands that provide water control benefits without attracting wildlife dangerous to planes.

Goal: *Address flooding issues on Base and in the areas surrounding the Base.*

- *Action:* Explore opportunities on Base to create cisterns or other stormwater retention methods, acting as an overflow for the region near the Base.
- *Action:* Update FEMA mapping to incorporate urban flooding.
- *Action:* Locate critical facilities like shelters and health facilities outside of high flood risk areas in surrounding communities.
- *Action:* Consider the use of drought-resistant trees to restore the urban tree canopy where trees have died off to enhance canopy and retain stormwater.
- *Action:* Promote the use of green infrastructure such as rain gardens, green roofs, and permeable surfaces.

Goal: *Restore coastal habitat and consider ways to reduce hardening along the Lake St. Clair shoreline to increase its resilience to climate change.*

- *Action:* Explore methods of subsurface fish habitat restoration, keeping in mind base security and wildlife threats.
- *Action:* Prioritize native plantings along the coastline and work with private property owners to educate them on the benefits of native plants.

Infrastructure

Goal: Increase availability of backup energy and water supplies throughout the community to increase community resiliency.

- Action: Explore the use of solar generators, including on personal property.
- Action: Evaluate options to establish a regional backup water supply, since the entire region relies on the City of Detroit.

Goal: Work to position SANGB and the surrounding communities as a leader in clean energy and energy efficiency and to increase SANGB's energy security posture.

- Action: Invest in airport greening efforts, such as repaving the airstrip with warm-mix asphalt and exploring solar energy.
- Action: Work with DTE Energy to explore new opportunities to invest in renewable assets on and off Base.
- Action: Leverage Harrison Township's commitment to clean energy and identify ways to collaborate in the development of wind, solar, and ground-source heating and cooling.
- Action: Explore methane, geothermal, solar energy sources, and installation of microgrids for part of a net-zero solution.



Emergency Response and Climate Resiliency

Goal: *Institute resiliency at every level of internal and external operations.*

- *Action:* Introduce climate change and resiliency topics to the Joint Base Council to implement recommendations and build awareness and capacity for change.
- *Action:* Promote and publicize the reverse 911 system.
- *Action:* Evaluate the potential to use the Base as a backup emergency shelter in the event of a climate-related emergency.
- *Action:* Evaluate any potential change in frequency, duration, and type of severe weather events to determine potential impacts on emergency response capabilities.
- *Action:* Continuity of Operations (COOP) or Continuity of Government Plans should be revalidated and synchronized at the local, state, and federal levels to ensure all efforts harmonize.

Land Use

Goal: *Promote smart growth and development that is resilient to climate change and is consistent with installation operations in surrounding communities.*

- *Action:* Work to ensure land use compatibility in Chesterfield Township and integrate consideration of Clear Zones and Potential Clear Zones in its zoning ordinance.

Next Steps

MIARNG will continue to engage in ongoing state and local planning efforts both in Michigan and in the greater Selfridge area. SANGB leaders plan to continue to monitor the most up-to-date and emerging climate trends and regional projections, and share the information with state/local planning entities.



APPENDIX A:

Vulnerability Assessment and Public Process on Fort Custer Training Center

The following appendix summarizes the vulnerability assessment process used at the community meetings to inform the recommendations found in Chapter 2. This appendix includes a vulnerability assessment, two corresponding maps, and a summary of the public input collected during the public process for the FCTC Region.

Vulnerability Assessment Purpose

This assessment is intended to provide a broad understanding of climate vulnerability in the region and largely relies on demographic and environmental data at the scale of the greater Fort Custer Community. This community vulnerability assessment does not identify Fort Custer's specific climate vulnerabilities, although community-wide vulnerabilities may have unique implications for the Michigan Army National Guard. This broad assessment served as a tool during the planning process for this project to bring diverse stakeholders together to discuss community-wide ramifications of climate change. While not specific to FCTC, it provides a useful basis to inform an installation-specific vulnerability assessment in the future.

This vulnerability assessment identifies the most vulnerable areas in the Fort Custer Community using a simple model: $VULNERABILITY = SENSITIVITY + EXPOSURE$. In this model, *sensitivity* refers to the degree to which a community or certain segments of a community could be impacted by an event, while *exposure* refers to hazards in the natural or built environment. This approach has been used recently in a variety of studies, including hazard-specific vulnerability assessments aimed at measuring exposure, sensitivity and resilience,¹ studies of vulnerability and its relationship to adaptation,² and equity and adaptation assessments conducted by the NAACP.³

This assessment identifies people and places throughout the Fort Custer region that might be most vulnerable to severe weather events and related impacts. This assessment focuses on the Fort Custer Community, defined by the Fort Custer military installation, Ross Township, Bedford Township, Pennfield Township, Charleston Township, the City of Battle Creek, Emmett Township, Climax Township, Leroy

1 Polsky, C., R. Neff, and B. Yarnal (2007). "Building comparable global change vulnerability assessments: the vulnerability scoping diagram." *Global Environmental Change* 17(3-4): 472-485.

2 Adger, W. N. (2006). "Vulnerability." *Global Environmental Change* 16 (3): 268-281. Adger, W. N., N. Arnell, and E. Tompkins (2005). "Adapting to climate change-perspectives across scales." *Global Environmental Change* 15(2):77-86.

3 Equity in Building Resilience in Adaptation Planning. National Association for the Advancement of Colored People (NAACP).

Township, and Newton Township. By focusing on this broader community, this assessment can be used to identify opportunities for the DoD to collaborate with neighboring communities to increase climate resilience.

Although the vulnerability assessment focused primarily on the social and environmental conditions of the region surrounding the installation, the results are important for the MIARNG. Social concerns — like access to healthy foods, medical facilities, and access to public transportation — are important for understanding the context surrounding the installation and identifying where community leaders should work to provide additional services and support. This vulnerability assessment can also inform emergency response planning by identifying the type of responses that may be required to confront future events. This is an especially relevant tool for the National Guard Bureau, as troops are often at the forefront of disaster response efforts.

This assessment focuses on the community's vulnerability to extreme heat and flooding events, although many of the considerations and societal impacts identified would be present under other stresses and shocks within the community. A number of maps were produced through this assessment and were used primarily to solicit feedback from the public and installation leaders during the public meetings. Separate maps were created for sensitivity (i.e., where sensitive populations live) and exposure (i.e., where the built or natural environment is most susceptible to heat or flooding events), but for brevity, only the resulting, cumulative vulnerability maps are included on the following pages. The full set of maps is available by request.

Vulnerability Assessment Data

This vulnerability assessment is based in part on data obtained from the American Community Survey (ACS), a continuing survey program operated by the U.S. Census Bureau. ACS data includes information on housing, income and education characteristics of populations in geographic areas called “Block Groups,” containing between 600 and 3,000 individuals. The assessment also uses data from the 2010 U.S. Census, including population, age and racial composition collected by Census “Blocks,” which are the smallest available geographic areas for demographic data. Data sets concerning land-parcel characteristics were obtained from Calhoun and Kalamazoo counties, the Fort Custer installation, and neighboring jurisdictions. LIAA digitized building footprints and tree canopy using a geometrically rectified aerial photo (orthophotograph) from 2009.⁴ LIAA used the Federal Emergency Management Agency's Flood Insurance Rate Maps to identify areas with high flood risk exposure in the community.

⁴ USDA and NRCS Geospatial Data Gateway.

The census data used likely double-counts people, such as in cases when multiple sensitivity characteristics apply to the same individual; this may overestimate the severity of the sensitivities in some locations. The sensitivity analysis may also underestimate some risk because it does not include several key sensitive populations, such as those with preexisting health concerns that exacerbate heat vulnerability (for example, cardiovascular disease or psychiatric disorders); such data is not often available publicly or on the Census Block level. Emergency managers, hospitals, and community health departments may have additional data available that can be included as the community looks to better understand its overall sensitive populations. To further improve the analysis, additional variables could be collected through local surveys and observation, such as the degree of social connections among individuals within a community, or materials used in housing.⁵

Vulnerability Assessment for Extreme Heat

Extreme heat is caused by very high temperatures and very high humidity. Extreme heat events that last for several days are called heat waves, and can cause serious health conditions like heat exhaustion, heatstroke, and even death.⁶ Heat waves can also damage agricultural products, exacerbate drought, and create problems for infrastructure such as roads and utilities. Additionally, extreme heat events are hard to plan for, as weather forecasts often fail to predict prolonged heat waves in the long-term, and short-term forecasts leave little time to prepare.⁷ The vulnerability assessment process provides an initial step in before an event occurs.

A number of factors can make a community more vulnerable to extreme heat. In Michigan, heat intensity varies based on a community's proximity to the Great Lakes and geographic latitude. Studies have shown that heat-related mortality generally occurs in areas of the community that are warmer, less stable, and home to more disadvantaged populations.⁸ One study found that neighborhoods with the highest temperatures and the least amount of open space and vegetation were also likely to be the most socioeconomically disadvantaged.⁹ The same study also found that residents with access to air conditioning and transportation were the most protected from extreme heat impacts.

5 Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730–1736 (2009). doi:10.1289/ehp.0900683 available via <http://dx.doi.org/> [Online 10 June 2009]

6 Center for Disease Control and Prevention, Climate Change and Extreme Heat Events. <http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf>

7 Ibid.

8 Foundations for Community Climate Action: Defining Climate Change Vulnerability in Detroit. University of Michigan. December 2012.

9 Semenza JC, Rubin CH, Falter KH, et al. Heat-related deaths during the July 1995 heat wave in Chicago. *N Engl J Med* 1996; 335:84–90.

Heat Sensitivity Assessment

Researchers who study heat impacts have found that several groups of people tend to experience the most harm from a heat event.¹⁰ The following populations were considered relatively more sensitive in LIAA's vulnerability assessment of the Fort Custer Community:

- Residents 65 years of age and over: Studies indicate that older age is associated with higher hospital admission rates in heat waves.¹¹
- Residents living alone: Although living alone is not necessarily a risk, people who are socially isolated are at greater risk during an extreme heat event. Isolated people may not be able to recognize symptoms of heat-related illness and may fail to take proper action.¹²
- Minority populations: Studies also suggest that minorities are at greater risk during extreme heat events. This may be for various reasons, including less reliable access to health care, transportation and other social supports needed to reduce heat exposures.¹³ In other words, a correlation exists between non-white populations and increased sensitivity to extreme heat.
- Populations in poverty: Living in poverty is associated with increased heat-related morbidity and mortality. In general, persons living at or below the poverty line have less access to resources such as air conditioning or cooling options for their residences. This can limit a person's access to relief from an extreme heat event.¹⁴
- People over 25 with less than a high school education: Studies demonstrate a link between low educational attainment and heat-related illness and death.¹⁵

There are other factors that could increase an individual's risk of heat-related illness that were not mapped in this assessment. Many additional variables could be collected through local surveys or other sources including:¹⁶

- The degree of social connectivity among individuals within a community;
- Populations with preexisting health concerns like substance addiction, mental illness, or confinement; and
- Populations who live on higher floors of multistory buildings

10 Foundation for Community Climate Action: Defining Climate Change Vulnerability in Detroit (December 2012). University of Michigan's Taubman College of Architecture and Urban Planning.

11 Curriero FC, Heiner KS, Samet JM, et al. Temperature and mortality in 11 cities of the eastern United States. *American Journal of Epidemiology*. 30 (2001): 1126-8.

12 Smoyer-Tomic, K.E.; Kuhn, R.; Hudson, A. Heat wave hazards: An overview of heat wave impacts in Canada. *Nat. Hazards* 2003, 28, 465-486.

13 Waugh and Tierney (eds.) *Emergency Management: Principles and Practices for Local Government*. Chapter 13: Identifying and addressing social vulnerabilities by Elaine Enarson.

14 Smoyer KE. Putting Risk in its place: methodological considerations for investigating extreme event health risk. *Social Science and Medicine*. 47:11 (1998):1809-1824.

15 Curriero FC, Heiner KS, Samet JM, et al. Temperature and mortality in 11 cities of the eastern United States. *American Journal of Epidemiology*. 30 (2001): 1126-8.

16 Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730-1736 (2009).

Heat Exposure

Exposure refers to the environmental factors that increase the risk of extreme heat. When larger communities experience heat waves, air temperatures can vary significantly from place to place during the day and at night. Some of these differences can be attributed to the varying types of land cover found throughout the community.¹⁷ For example, temperatures can be significantly lower at night in locations with a heavy tree canopy and very little pavement. Conversely, temperatures can be higher in locations with little greenery and lots of pavement. This temperature relationship is called the Urban Heat Island (UHI) Effect.

Where the Urban Heat Island Effect is not prevalent, heat indexes (the combination of air temperature and humidity) rise when the sun is shining during the day and drop when the sun goes down in the evening. Urban Heat Islands are caused when buildings, roads, and other impervious surfaces absorb heat from the sun during the day and release heat throughout the night. In other words, in areas with excessive impervious surfaces and less natural ground coverage, heat indexes are higher, even at night. During a heat wave, the environment stays warm even at night, and sensitive populations are at even greater risk of heat-related illness. Studies have documented that despite nearby rural areas, the Urban Heat Island Effect can cause a 2 to 9 degree Fahrenheit increase in air temperature.¹⁸

Two key factors were used to determine areas in the Fort Custer Community with high heat exposure: impervious surfaces and tree canopy coverage.

- **Impervious Surfaces:** Impervious surfaces refer to parking lots, roads, sidewalks, building footprints, and any other area that is paved. Data for impervious surfaces was digitized using aerial imagery. Like all urbanized areas, the Fort Custer region has some areas with significant impervious surface coverage caused by roads, homes, and commercial areas.
- **Tree Canopy Coverage:** Tree canopy refers to the land within a community covered by trees, shrubs, or other vegetation. Trees and vegetation actually lower the surface and air temperature nearby, reducing the Urban Heat Island effect.¹⁹ The community's tree canopy data was digitized using aerial imagery and mapped as a percentage of total land cover within each Census Block.

Environmental exposure can be high in a Census Block even if zero or few residents live in the Block. Although zero or few residents live in these areas, exposure in these areas is still important to consider, as residents in surrounding Blocks may feel the impacts of high environmental exposure. Additionally, commercial and industrial areas with high exposure increase the vulnerability for sensitive populations that may visit, shop or work in these areas.

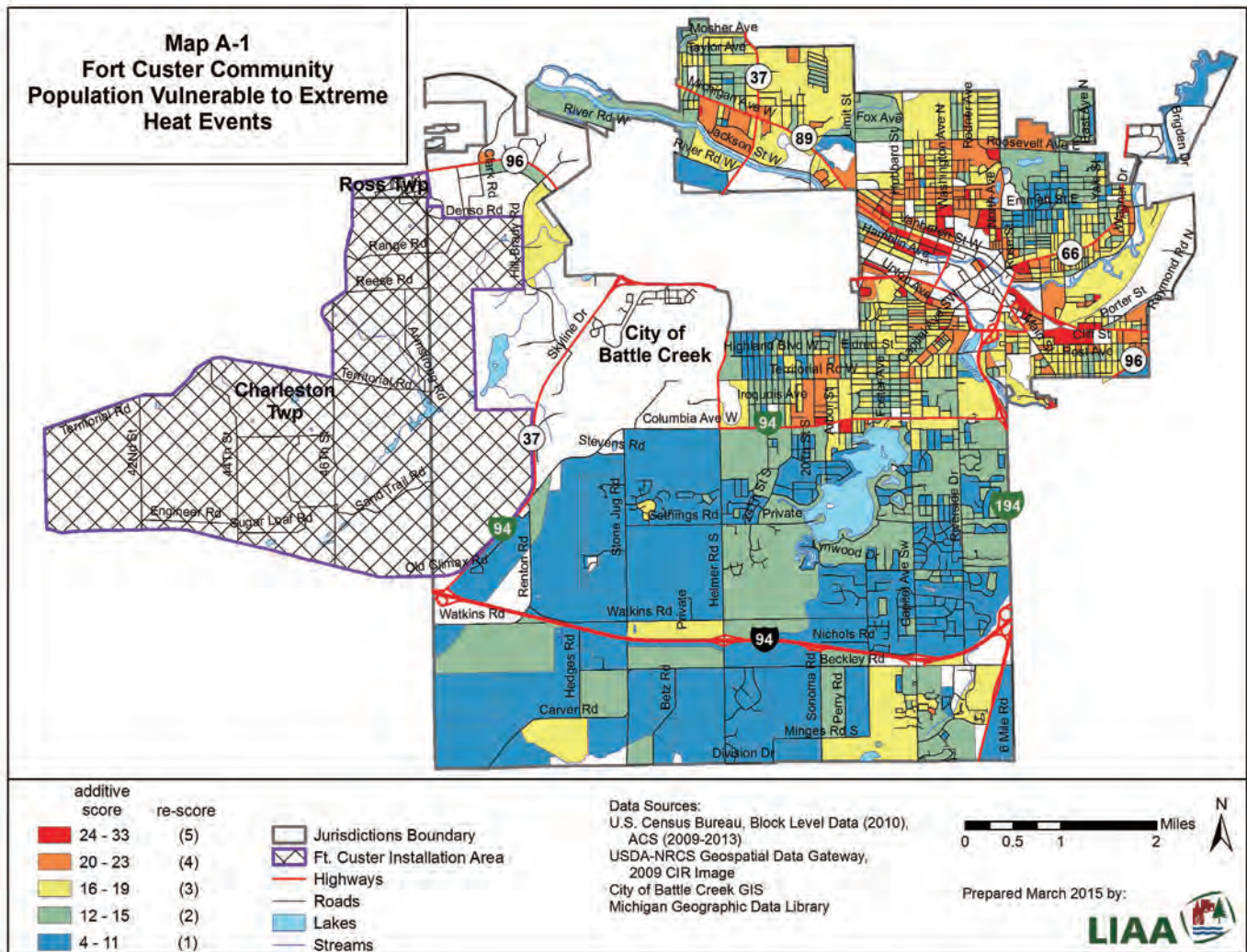
¹⁷ Landsberg, H. (Ed.), 1981. *The Urban Climate*. Academic Press, New York.

¹⁸ For more information on the Urban Heat Island effect, see this Environmental Protection Agency's publication. <http://www.epa.gov/sites/production/files/2014-06/documents/basicscompendium.pdf>

¹⁹ For more information on using trees and greenery to reduce the Urban Heat Island effect, see this Environmental Protection Agency's web page. <http://www.epa.gov/heat-islands/heat-island-cooling-strategies>

Heat Vulnerability Assessment Findings

Through the vulnerability assessment process, LIAA created a composite heat sensitivity map (i.e., where sensitive populations live) and a composite heat exposure map (i.e., where environmental risk to extreme heat is greatest.) Map A-1, the Fort Custer Community Population Vulnerable to Extreme Heat Events Map, is a simple additive combination of the scores within each Census Block on the overall sensitivity map and the overall exposures map. In other words, this map shows where higher environmental exposure and higher concentrations of sensitive populations tend to overlap. In general, populations in those areas with the highest composite scores (orange and red) may be particularly vulnerable to extreme heat events.



Areas with high vulnerability do not indicate that residents in these locations are in immediate danger. Rather, the Population Vulnerable to Extreme Heat Events Map offers the community new ways to:

- Identify areas in the Fort Custer Community where heat waves could present serious problems for a significant number of citizens. There are a number of areas within the region with relatively high concentrations of sensitive populations.
- Identify areas where the Urban Heat Island Effect is greatest in the community.
- Guide the allocation of resources like new emergency shelters, cooling centers, tree planting, or parks.

The map shows that a number of areas in the Fort Custer Community are relatively more vulnerable to extreme heat events. These areas are clustered in several locations including the City of Battle Creek along the North Branch Kalamazoo River.

Heavy Rain and Flooding

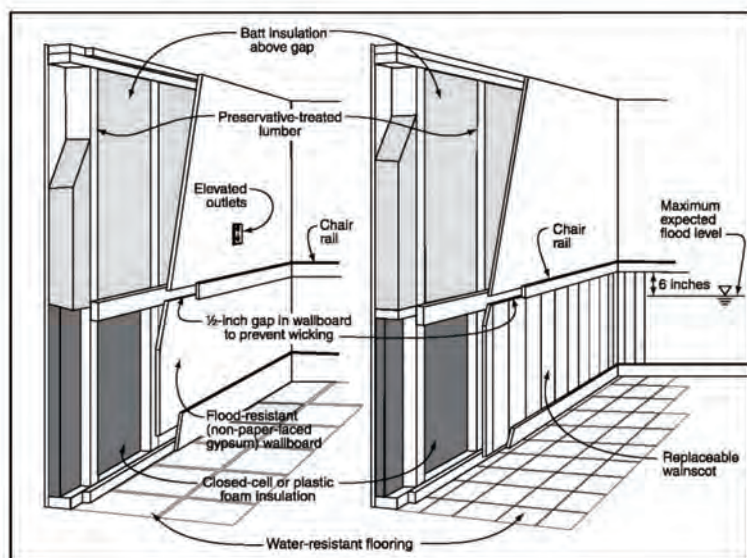
Climate experts from the Great Lakes Integrated Sciences and Assessments Program (GLISA) have found that the Fort Custer Community and all of mid-Michigan can

expect more frequent storms of increasing severity in the decades ahead. The total amount of precipitation per year is also likely to increase. However, climate models suggest the precipitation will be more concentrated in the winter, spring and fall seasons and there will be more localized, intense storms at almost any time of year. The potential for substantially larger rain events raises concerns over the potential for harm to human health and damage to buildings and infrastructure.

The following summarizes a flooding vulnerability assessment LIAA conducted for the Fort Custer Community. In assessing vulnerability, community planners evaluate potential exposures as well as sensitivity to flooding. Buildings, roads, bridges, sewer lines

and other infrastructure located in a flood zone are exposed to greater risks. Where flowing floodwaters have the greatest energy, structures may be undercut, collapsed or moved, and soils will erode. Even areas outside of an identified floodplain are subject to flooding from heavy downpours. Where the soils have low permeability and physical drainage is inadequate, water will accumulate and cause ponding during large storm events. Appropriate planning and land-use regulations can help reduce exposures caused by poor site selection. The sensitivity of structures can be modified to reduce risk of damage by applying flood-resistant design standards. See Figure A-1 for an overview of recommendations from the Federal Emergency Management Agency (FEMA) for retrofitting homes to make them more resilient to flooding events.

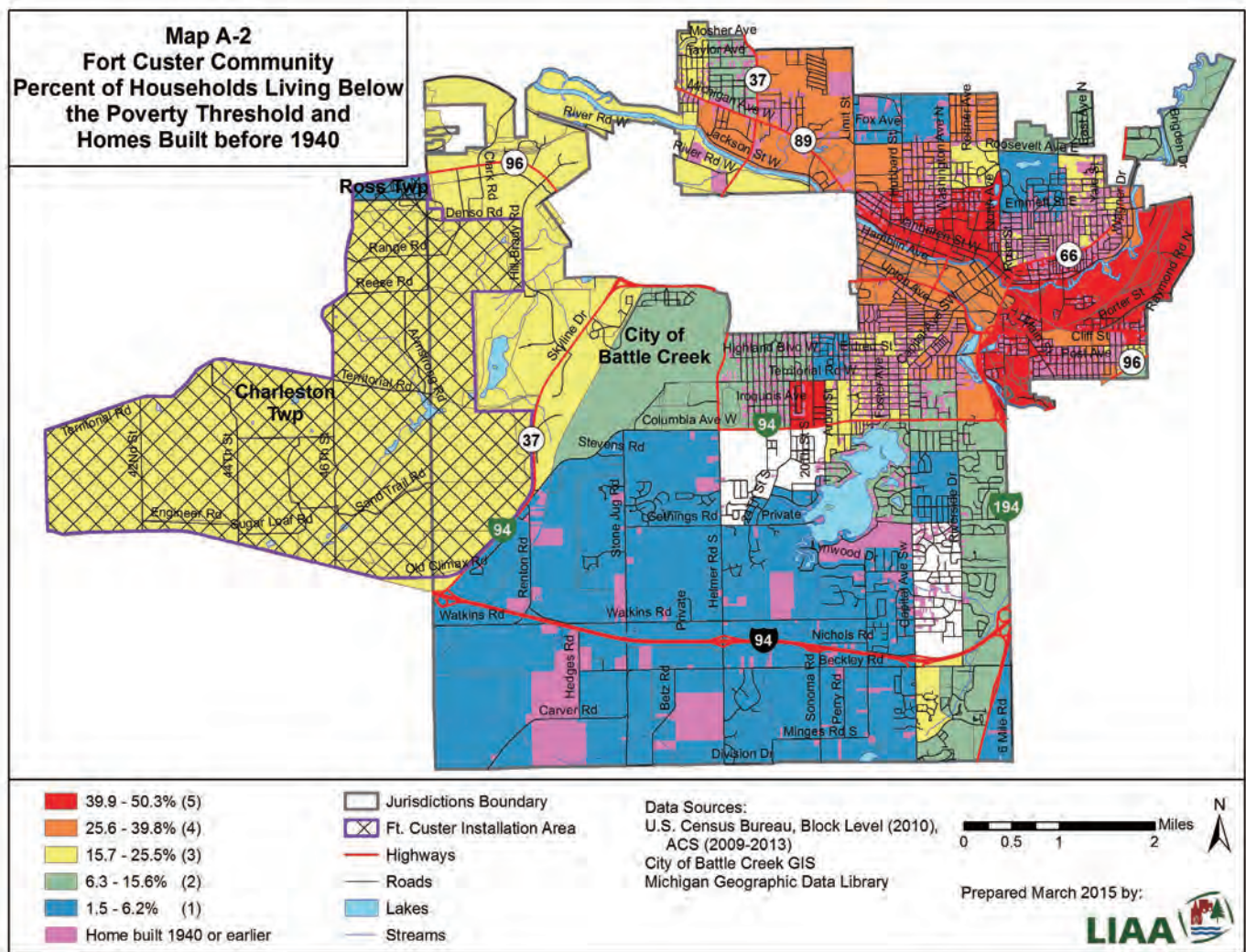
Figure A-1. Home Design Techniques for Flood Resilience



Source: FEMA.gov

Exposure to Flooding Hazards

LIAA used FEMA’s Flood Insurance Rate Maps (FIRMs) for the community to assess flood exposure. The FIRMs show areas subject to flooding based on historic, hydrological, hydraulic and meteorological data as well as flood controls. The maps identify a base flood elevation (BFE), sometimes referred to as the 100-year flood zone. These are areas that have a 1% chance of flooding in any given year. The maps also identify the areas with a 0.2% chance of flooding in any given year, also known as the 500-year flood zone. FEMA points out these ratios are only probabilities, not forecasts. It should be noted that most military installations do not have complete FEMA flood mapping data, so it is difficult to access the flooding vulnerability risk on base. Instead, many installations manage their own flood risk assessments.



Household Sensitivity to Flooding

In many communities, flood impacts are felt most severely at the household level. A home's flood risk is based on its relative location to floodplains and other flooding hazard areas. A household's flood sensitivity refers to how well the house structure is equipped to deal with flooding. As modeled by the University of Michigan, household sensitivity to flooding can be determined by looking at the age of the housing stock and the homeowner's financial ability to maintain and improve the home, which is approximated using the median household income. In general, homes built before 1940 used a more porous concrete material for basement construction, so water can flow more rapidly through the foundation. As a result, older homes may be more vulnerable to flooding if residents have not had the financial resources to make improvements and upgrades. By looking at median household income as a marker of likely upkeep of the home, LIAA attempted to exclude older homes that have been well-maintained and undergone upgrades in areas of flood damage risk.

Household Vulnerability to Flooding

Map A-2 shows the relative vulnerability of homes to flooding by visually overlapping three data sets: areas of high flood risk, the locations of parcels containing older homes, and the percentage of households living below the poverty threshold by Block Group. These areas likely have higher vulnerability to flooding damage.

It is important to note that other factors contribute to flood risk. For example, mobile and manufactured homes are often particularly susceptible to flood damage because they generally lack a reinforced foundation. In addition, municipal infrastructure plays an important role in protecting homes from flood damage. Communities with storm-sewer systems that are aging or not fully disconnected from the sanitary sewer are more prone to damage from an overloaded system in a severe rain event.

Wetlands

For many urbanized areas across the State of Michigan, wetlands are an important component of fostering resilient communities in the face of increased precipitation. In addition to critical fish and wildlife habitat, wetlands provide water quality protection and improvement, sediment and erosion control, and flood management — all of which are extremely valuable ecosystem services. LIAA mapped the locations of existing wetlands and areas with a high potential for wetland restoration as a part of this vulnerability assessment. These are generally areas with pre-settlement wetlands and hydric soils in the Fort Custer Community. The most effective strategies focus on preserving existing wetland hydrology while assuring the connectivity of wetlands and other natural resources. In fact, the restoration of wetlands and wetland buffers may be one of the most cost-effective techniques available to urban communities for managing the storms of climate change.

Other Considerations for Evaluating Community Vulnerability

It is important to identify locations of key community assets and assess how accessible these assets are to residents, emergency responders, and other key personnel. It is also important to identify key infrastructure and assets that could be at risk, or would be most negatively impacted not only by severe weather, but also by increased frequency and duration of their use during an emergency.

Critical Facilities

In general usage, the term “critical facilities” is used to describe all man-made structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired.²⁰ LIAA mapped the locations of critical facilities in the community as a part of the community planning process in the Fort Custer Community. Critical facilities include:

- emergency response facilities (fire stations, police stations, rescue squads, and emergency operation centers [EOCs]);
- custodial facilities (hospitals, long-term care facilities, healthcare facilities, jails, and other detention centers)
- schools;
- emergency shelters;
- utilities (water supply, wastewater treatment facilities, and power);
- communications facilities;
- other assets determined by the community to be of critical importance for the protection of the health and safety of the population; and
- places where 300+ people congregate.

Access and Distribution of Social Services

Service centers and institutions (such as homeless shelters and churches) are important in delivering day-to-day support to residents. In the event of an emergency such as an extreme heat event or flash flooding episode, service centers and institutions are especially important as a safe place where residents can go if they cannot return home. LIAA mapped the locations of places where residents may seek temporary refuge in the event of an emergency. These locations include schools, places of worship, governmental buildings, hospitals and clinics, libraries, and other non-profit social service organizations. In the Fort Custer Community, social services are concentrated in the downtown core and along major commercial corridors.

Communities with high population densities, frequent extreme weather events, or both, are likely to have designated services centers. In the event of extreme heat waves, designated community cooling centers may provide refuge for sensitive populations and for those without access to air conditioning. In the event of loss of

²⁰ Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds. FEMA 543 January 2007.

power due to flooding or extreme storms, locations with a backup power source, such as a generator, are essential. A best management practice for a resilient community is to designate community service centers that are accessible, evenly distributed across the population, open 24 hours, and well known to residents.

Food Availability

Just as cultivating local entrepreneurship makes a community stronger, the capacity of a community to produce and process its own food greatly increases resilience. Climate change will likely have significant impacts on the availability and prices of food across global markets. A community can decrease its vulnerability to disruptions in food sources through a strong local food economy. Support for and reliance upon locally produced foods not only alleviates potential future challenges in the food market, but also helps foster another strong economic sector for the region.

In evaluating community vulnerabilities, LIAA looks at locations of full-service grocery stores in relation to where people live. In the event of loss of power or disruption in potable water supplies, it is important to ensure that residents have access to affordable food and drinking water. For this vulnerability assessment, LIAA mapped the areas in the community that are located within one mile of a full-service grocery store.

LIAA also evaluates access to healthy food to see if there are areas of the community that qualify as food deserts. According to the United States Department of Agriculture (USDA), a food desert is defined as an area devoid of fresh fruit, vegetables, and other healthful whole foods, usually found in impoverished areas. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers. Communities looking to reduce the number of residents living in food deserts can promote or zone for pop-up farm stands in low-income areas, enact housing policies supportive of mixed incomes, and establish community gardens in areas identified as food deserts.

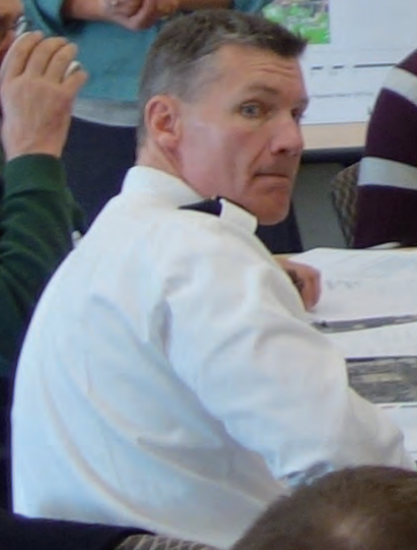


Vulnerabilities

- WATER SUPPLY
- WASTE WATER TREATMENT PLANT
- Soil erosion (in wet + downed trees have been felled)
- Limited space for new use

Assets

- Natural Gas/CO2 Pipeline Corridor
- Fire/Land (see... on map)
- Local Trees
- Heat Caves for Geothermal Energy
- Geothermal Energy
- Recreation Area
- Local Community
- Mountain View of Lake
- Ft. Collins Recreation Area
- Local Community
- Transportation Corridor
- Highway



FCTC Public Process

This section provides a record of the notes taken by the community planners at LIAA staff during the planning charrette on March 23rd and 24th, 2015, at the Fort Custer Education Center. These notes summarize the input of all participants throughout the meeting and do not represent the Michigan Army National Guard.

Day One: March 23rd, 2015

Community Stakeholder Meeting

Meeting with representatives of local governments and agencies, the MIARNG and LIAA sought to introduce the major concepts of resilience and the goals for the project; gather information on any local planning that currently incorporates factors of climate change or community resilience; learn about activities that might help build resilience that are currently underway across the region; and identify the specific vulnerabilities that are of greatest importance and impact to the long-term health of the community.

Participants in the preliminary session were asked to respond to the following issues/questions:

- Define “resilience”;
- Review goals of the project, the roles of the stakeholders and the plan for this meeting;
- Identify Key Community Issues and Discuss Vulnerabilities
- Review Vulnerability Analysis

In general, participants acknowledged the reality of climate change and the challenges it would present for local communities and the MARNG. Specific responses focused on:

- Community conversations, which are important and can serve to ignite a focus on climate change.
 - For example, the Response Consortium, part of the Battle Creek Police Department, has been created to foster collaboration among social services and government department with regard to response.
 - There is a need for a sustainability advisory committee. This could come out of efforts already underway – for example the Southwest Michigan Sustainable Business Forum.
 - There are key stakeholders who should be at the table including the Tribe [Nottawaseppi Huron Band of Potawatomi], social services providers, and community planners.

- Emergency management should be expanded and more groups should be at the table.
 - Events are happening with more frequency and increased severity – for example the 2011 wind event and 2015 snow/ice storm.
 - Red Cross cooling shelters should be expanded and awareness should be increased.
- There are a series of data needs.
 - Better understanding of the quality of trees in the region and which ones are at risk
 - More information on water availability
 - FEMA maps need to be updated and reflect forecasted changes in future precipitation

Public Education Session

The education session was structured to provide participants with a range of facts, viewpoints and considerations as they explore the issues that might affect the community's resilience in the years to come. The speakers provided valuable information about Fort Custer's activities, an analysis of past and likely future climate trends, and specific ideas and measures that other communities are exploring to help be better prepared for the future. Participants then explored how they felt the community around Fort Custer could be more resilient. These presentations are available on the project website: www.ResilientMichigan.org/MIARNG

Day Two: March 24th, 2015

Community Stakeholder Meeting: Asset and Vulnerability Mapping

Participants were invited to identify specific assets and vulnerabilities throughout the region, placing markers on large maps and describing the specific sites or the meaning of that marker. Each participant was invited to prioritize the three most important assets and three most important vulnerabilities.

When discussing key assets, there were a number of themes that emerged.

- The existing social fabric of the surround community is very strong and efforts should be made to leverage this existing social capital.
 - Examples of this social capital includes local planning agencies and municipal staff, community centers, the Emergency Planning Consortium, Civil Support Team, Police and Safety, Natural Resource Managers and conservation partnerships, the Community Foundation, and local media outlets.
 - The Kalamazoo Promise is a big asset for the community.

- Large employers well established in the community that employ locals and are philanthropic.
- Natural Resources
 - Lakes
 - Kalamazoo River corridor with high quality habitat
 - Parks
 - Farmland and open space.
- Built infrastructure
 - Access to freight and passenger rail lines
 - Interstate highways
 - The VA Hospital

There were also a number of vulnerabilities that were highlighted by community participants. Key themes that emerged from this discussion with community stakeholders included:

- Kalamazoo River dams are outdated and rated structurally insufficient.
- Older homes are in poor condition and would not be able to withstand a significant storm event.
- The water supply is susceptible to contamination.
 - This concern stemmed from concern over erosion due to poor construction practices, Concentrated Animal Feeding Operations (CAFOs) and industrial farming practices.
- Dated and inefficient utility system and limited access to back-up power supplies.
- Vulnerable populations
 - There are pockets of concentrated vulnerable populations.
 - Housing affordability is an issue. There is also housing segregation in Battle Creek and Kalamazoo.
 - Superfund sites in Kalamazoo often concentrated in poor neighborhoods.

Future Climate Scenarios

Participants gathered in smaller groups of 8 – 12 and were given four scenarios set in the year 2050 that involved probable long-term weather trends coupled with a weather event and a set of impacts to the region. The scenarios were based on projected climate data and weather events from the past in the Battle Creek area. For each scenario, participant groups discussed a range of questions and we recorded the group's thoughts, ideas for solutions and project plans, and finally their top priorities. In considering solutions and project ideas, consideration was given both to short-term needs (which could help identify improvements to social systems and hazard planning, for example) as well as the long-term requirements to help improve community

resilience to the shocks and stresses presented. Individuals were again asked to identify their top three priorities.

There were a number of themes that emerged in the scenario responses, most focused on long-term response and prevention of adverse impacts from climate events.

Recommendations for short-term responses to all four scenarios included:

- Offer free bus fare during events
- Employ communication systems that alerts citizens of impending heat event and informs of steps to take to protect oneself and family
 - For example, reverse 911.
 - Focus on Public Service Announcements that will educate people on how best to respond to the issue at hand. For example, Communicate with people on how to cool without AC
- Urge businesses to provide supplies to residents including water
- Eliminate roadblocks for emergency vehicles; make sure vehicles are equipped to traverse the terrain created by the flood.

Recommendations for long-term responses to prevent the impacts and/or intensity of all four scenarios included:

- Expand Energy Efficiency Programs
 - Encourage/require energy efficient home/building construction for future development.
 - Encourage participation in the Michigan Saves program.
 - Install solar charging stations for electronics
- Coordinate emergency response activities
 - Create an organized and efficient cooling center system.
 - Identify emergency routes beforehand.
- Institute a neighborhood check in program and/or institute something similar to Chicago's "Adopt-a-Neighbor"
- Green Infrastructure activities
 - Explore increased use of green roofs, rain gardens, and pervious pavement in local ordinances
 - Construct and maintain green infrastructure for better water containment.
 - Conduct flood-plain management studies.
 - Find innovative, cost-effective ways to collect water in cities.
 - Increase tree canopy.

- Consider adopting a street tree requirement and/or a tree planting program
- Find areas with low concentration of AC (usually poor areas), and focus tree planting programs there to increase tree canopy and decrease average temperature
- Maximize protection and restoration of wetlands through wetland preserve easements and strategic placement of conservation lands for wetlands.
- Wildfire response strategies:
 - Develop efficient hydrant cooling systems for wildfire response
 - Tanker trucks to supply water when pumping is rendered useless.
- Engine in Holistic water management planning.
 - Infiltration systems.
 - Reduce runoff and impervious surfaces.
 - Map community water recharge areas.
- Farmland management and adaptation:
 - Identify which communities are vulnerable to crop loss issues.
 - Forecast future climate and determine appropriate crops to grow in changing system.

After creating lists, the small groups reported out and the larger group worked together to review and discuss any vulnerabilities or assets that stood out, that might not have been addressed through the scenario discussion, and to add additional project ideas to the list.

Gallery Walk

The charrette concluded with a “gallery” of the materials from the Charrette exercises and project ideas from the community. Participants were encouraged to provide additional input by placing sticky notes with comments on the displayed materials and filling out comment sheets, and could discuss their questions and comments with the project team.

Next Steps

Refining the Project List, Project Feasibility Review, and High Priority Projects

Following the meeting, additional input was sought from stakeholders including additional representatives of the local jurisdictions and project partners from the Michigan Climate Coalition (MCC). The MCC, founded in 2010, brings together individuals from non-profit organizations, businesses, government, and educational institutions to enhance networking and collaboration, communication, and action around climate change and adaptation for Michigan. MCC served as a steering committee for the MIARNG project, offering expert advice on climate data and helping inform the public engagement process. On August 13, 2015, MCC reviewed recommendations from the Fort Custer Charrette and made the following recommendations in regards to what they viewed as key areas of focus for future projects:

- Communications
 - There is potential to work with MSU Extension for communications and preparedness across community.
 - Is there FEMA application for reverse 911?
- Coordination
 - Increased emphasis on regional planning to address many issues, especially climate change. Regional land use planning for mitigation and response- between federal/cities/counties.
 - Convene Emergency Management groups to meet, work together with zoning organizations.
 - Is there opportunity to leverage Kellogg networking agencies for a JLUS?
 - There is a weak regional Council of Government – is there opportunity to improve this?
 - Watershed level planning could extend to the neighborhood.
 - Prepare FCTC to be an emergency management center for the region with reliable back-up power, cooling centers, and water purification
 - Establishment of resilience task force of community organizations to collaborate during non-emergencies.
 - Combine water management/floodplain management- plan with University/DOT/USACE.

- Natural Resource Management
 - Look for opportunities to combine water management and floodplain management studies.
 - Need better knowledge of the food market. Opportunities to better determine what is produced locally and regionally.
 - Restore ecosystem services/natural communities.
- Infrastructure
 - Fund high-quality routine maintenance of utilities.
 - Identify robust vulnerabilities specific to installation.
- Data needs
 - Identify high flood risk/toxic superfund properties along rivers. Understand where private wellheads and septic systems are.
 - Is there opportunity for data incorporating future flooding into modeling for 911 plans and margin of safety?
 - Update existing floodplain maps.
 - Groundwater mapper in relation to access to water. Water infrastructure and floodplain management/development based off NOAA rainfall data plus margin of safety 10%.
 - Conduct vulnerability assessment for installation in all aspects- training, ranges, infrastructure, and built environment.
 - Conduct water management and flood management studies.



APPENDIX B

Camp Grayling Joint Maneuver Training Center (CGJMTC) Region: Vulnerability Assessment and Public Process

The following appendix summarizes the vulnerability assessment process used at the community meetings to inform the recommendations found in Chapter 3. This appendix includes a vulnerability assessment, one corresponding map, and a summary of the public input collected during the public process for the CGJMTC Region.

Vulnerability Assessment Purpose

This assessment is intended to provide a broad understanding of climate vulnerability in the region and largely relies on demographic and environmental data at the scale of the greater Camp Grayling Community. This community vulnerability assessment does not identify Camp Grayling's specific climate vulnerabilities, although community-wide vulnerabilities may have unique implications for the Michigan Army National Guard. This broad assessment served as a tool during the planning process for this project to bring diverse stakeholders together to discuss community-wide ramifications of climate change. While not specific to CGJMTC, it provides a useful basis to inform an installation-specific vulnerability assessment in the future.

This vulnerability assessment identifies the most vulnerable areas in the Camp Grayling Community using a simple model: $VULNERABILITY = SENSITIVITY + EXPOSURE$. In this model, sensitivity refers to the degree to which a community or certain segments of a community could be impacted by an event, while exposure refers to hazards in the natural or built environment. This approach has been used recently in a variety of studies, including hazard-specific vulnerability assessments aimed at measuring exposure, sensitivity and resilience, studies of vulnerability and its relationship to adaptation, and equity and adaptation assessments conducted by the NAACP.

This assessment identifies people and places throughout the Camp Grayling region that might be most vulnerable to severe weather events and related impacts. By focusing on this broader community, this assessment can be used to identify opportunities for the DoD to collaborate with neighboring communities to increase climate resilience.

Although the vulnerability assessment focused primarily on the social and environmental conditions of the region surrounding the installation, the results are important for the

MIARNG. Social concerns — like access to healthy foods, medical facilities, and access to public transportation — are important for understanding the context surrounding the installation and identifying where community leaders should work to provide additional services and support. This vulnerability assessment can also inform emergency response planning by identifying the type of responses that may be required to confront future events. This is an especially relevant tool for the National Guard Bureau, as troops are often at the forefront of disaster response efforts.

This assessment focuses on the community's vulnerability to extreme weather events, particularly wildfire, although many of the considerations and societal impacts identified would be present under other stresses and shocks within the community. A number of maps were produced through this assessment and were used primarily to solicit feedback from the public and installation leaders during the public meetings. Separate maps were created for sensitivity (i.e., where sensitive populations live) and exposure (i.e., where the built or natural environment is most susceptible to wildfire), but for brevity, only the resulting, cumulative vulnerability maps are included on the following pages. The full set of maps is available by request.

Extreme Weather Events Sensitivity Assessment

To create the sensitivity maps, LIAA relied on methodologies developed by the University of Michigan's Taubman College of Architecture and Urban Planning in a 2012 report.¹ To conduct the sensitivity assessment of the Camp Grayling Community, LIAA used a geographic information system (GIS) for spatial data analyses to show the relative distribution of people most at risk. LIAA considered five factors as primary contributors to the sensitivities and risks of community members, including age, isolation, race/ethnicity, poverty, and educational attainment. Using U.S. Census data, LIAA identified the percentages of people living in each area (census block group or census block) for each sensitivity factor. The following populations were considered relatively more sensitive in LIAA's vulnerability assessment of the Camp Grayling Community:

- Residents 65 years of age and over: Studies indicate that older age is associated with higher hospital admission rates in heat waves.
- Residents living alone: Although living alone is not necessarily a risk, people who are socially isolated are at greater risk during an extreme heat event. Isolated people may not be able to recognize symptoms of heat-related illness and may fail to take proper action.
- Minority populations: Studies also suggest that minorities are at greater risk during extreme heat events. This may be for various reasons, including less reliable access to health care, transportation and other social supports needed to reduce heat exposures. In other words, a correlation exists between non-white populations and increased sensitivity to extreme heat.

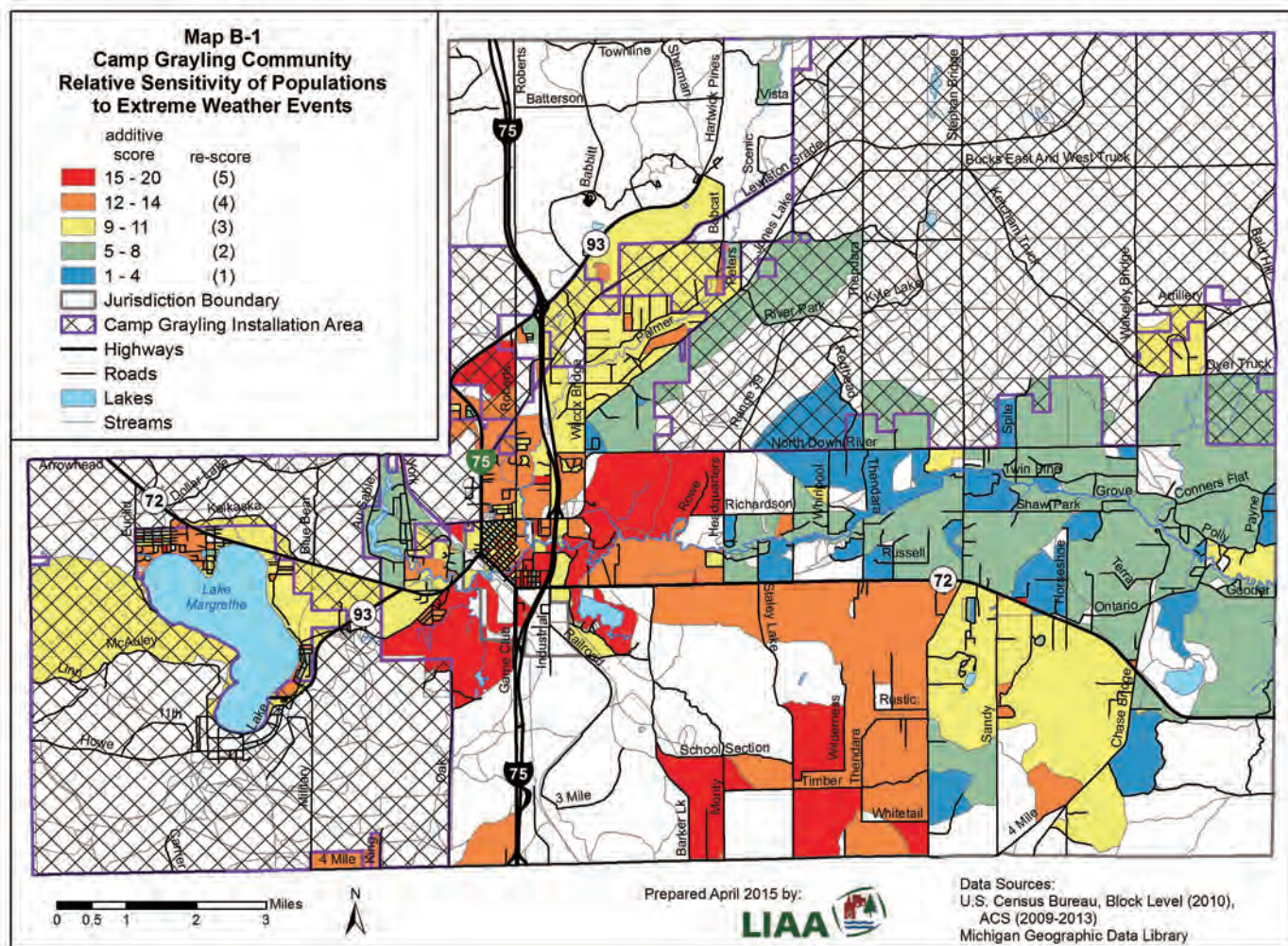
¹ Foundation for Community Climate Action: Defining Climate Change Vulnerability in Detroit (December 2012) University of Michigan's Taubman College of Architecture and Urban Planning.

- Populations in poverty: Living in poverty is associated with increased heat-related morbidity and mortality. In general, persons living at or below the poverty line have less access to resources such as air conditioning or cooling options for their residences. This can limit a person’s access to relief from an extreme heat event.
- People over 25 with less than a high school education: Studies demonstrate a link between low educational attainment and heat-related illness and death.

There are other factors that could increase an individual’s risk of being impacted that were not mapped in this assessment. Many additional variables could be collected through local surveys or other sources including:

- The degree of social connectivity among individuals within a community;
- Populations with preexisting health concerns like substance addiction, mental illness, or confinement; and
- Populations who live on higher floors of multistory buildings.

To complete the sensitivity assessment, LIAA created a cumulative score for all five sensitivity factors for each census block. For each of the sensitivity factors, the percentages



were grouped into five categories, ranging from a very low percentage of people to a relatively high percentage living with the identified sensitivity. The five categorical groupings were generated by the GIS software ArcMap using natural breaks in the data (groupings). We assigned a ranking of 1 to 5 to each of the categories, ranging from 1 for the lowest percentage to 5 for the highest. Finally, LIAA combined the scores within each census block. Thus, the most sensitive census blocks would be scored up to a maximum of 25. The sensitivity is color-coded for ease of identifying areas with the greatest sensitivity.

The Camp Grayling Community Sensitivity to Extreme Weather Events Map (Map B-1) provides a reasonably detailed map of locations where the highest percentages of at-risk residents live. This does not mean these community residents are in immediate danger. Rather, the map gives planning officials a new way to identify areas where extreme weather could present serious problems for a significant number of citizens.

The census data used likely double-counts people, such as in cases where a person is both a minority and over 65; this may overestimate the severity of the sensitivities in some locations. The sensitivity analysis may also underestimate some risk because it does not include several key sensitive populations, such as those with preexisting health concerns that exacerbate vulnerability to stressors (for example, cardiovascular disease or psychiatric disorders). Such data is not often available publicly or on the census block level. Emergency managers, hospitals, and community health departments may have additional data available that can be included as the community looks to better understand its overall sensitive populations. To further improve the analysis, additional variables could be collected through local surveys and observation, such as the degree of social connections among individuals within a community, or materials used in housing.²

Other Considerations for Evaluating Community Vulnerability

It is important to identify locations of key community assets and assess how accessible these assets are to residents, emergency responders, and other key personnel. It is also important to identify key infrastructure and assets that could be at risk, or would be most negatively impacted not only by severe weather, but also by increased frequency and duration of their use during an emergency.

² Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730–1736 (2009). doi:10.1289/ehp.0900683 available via <http://dx.doi.org/> [Online 10 June 2009].

Critical Facilities

In general usage, the term “critical facilities” is used to describe all man-made structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired.³ Critical facilities include:

- emergency response facilities (fire stations, police stations, rescue squads, and emergency operation centers [EOCs]);
- custodial facilities (hospitals, long-term care facilities, health care facilities, jails, and other detention centers)
- schools;
- emergency shelters;
- utilities (water supply, wastewater treatment facilities, and power);
- communications facilities;
- other assets determined by the community to be of critical importance for the protection of the health and safety of the population; and
- places where 300+ people congregate.

Access and Distribution of Social Services

Service centers and institutions (such as homeless shelters and churches) are important in delivering day-to-day support to residents. In the event of an emergency such as an extreme heat event or flash flooding episode, service centers and institutions are especially important as a safe place where residents can go if they cannot return home. LIAA mapped the locations of places where residents may seek temporary refuge in the event of an emergency. These locations include schools, places of worship, governmental buildings, hospitals and clinics, libraries, and other non-profit social service organizations. In the Camp Grayling Community, social services are concentrated in downtown Grayling and along major corridors.

Communities with high population densities, frequent extreme weather events, or both, are likely to have designated services centers. In the event of power outages, designated community cooling centers may provide refuge for sensitive populations and for those without access to air conditioning. In the event of loss of power due to flooding or extreme storms, locations with a backup power source, such as a generator, are essential. A best management practice for a resilient community is to designate community service centers that are accessible, evenly distributed across the population, open 24 hours, and well known to residents.

³ Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds. FEMA 543 January 2007.

Exposure to Wildfire Risk

Wildfire is the number one natural hazard in the Grayling Community in terms of both public safety and property damage. In general, fire risk peaks in May because of low humidity, higher wind speeds,⁴ and old-growth jack pine needles that are at their driest just before they fall off. Jack pine is one of the most common forest fuels in the Grayling Community, growing in large, dense and continuous blocks. Jack pine produces vegetation regarded as the most explosive (in the sense of extremely rapid ignition and spread) in all of the Great Lakes states. A comprehensive assessment or evaluation of a community's wildfire risk is an important first step in identifying proactive measures for community wildfire protection.

According to the Great Lakes Integrated Sciences and Assessments Program (GLISA), warmer temperatures and increasing CO₂ will contribute to increases in forest productivity, which will likely increase other impacts of climate change, such as increased drought and wildfire, and present additional stressors to forests.

The Michigan Department of Natural Resources (MDNR) notes that atmospheric conditions that promote wildfire spread, such as increasing wind speeds and increasing drought events, are expected to become more prevalent during summers. Altered soil moisture due to changes in transpiration from trees, changes in evaporation from soil, and changes in precipitation (e.g., more rain, less snow) also contribute to more volatile wildfire conditions in the central northern Lower Peninsula.

Other non-climate factors contributing to greater wildfire risk in the Camp Grayling Community include increases in population in northern Michigan, more fragmentation of the forest, and greater wildland-urban interface (WUI) areas. In addition, more suppression in fire-prone forests could result in more catastrophic fires.

To identify locations most prone to wildfires, the following maps were created to inform the public process:

- The Wildfire Locations Map was used to show locations of wildfires that occurred in Camp Grayling and the surrounding area from 2001-2012, broken down by size (less than 5 acres, 5-10 acres, and greater than 10 acres).
- The Wildfire Risk Areas Map, which was compiled as a part of the Great Lakes Ecological Assessment conducted by the U.S. Forest Service. To create this risk map, the Forest Service used a computer program to run a series of fire simulations. Data used to create the model included spatial fuels and vegetation data and locations of historic fire occurrence. These maps can inform long-term strategic planning and fuels management, especially when combined with values at risk.

Figure B-2 Example of the Wildland-Urban Interface Surrounding Camp Grayling.



Source : Aerial Image from Bing Maps

⁴ 1990 National Fire Protection Association – Stephen Bridge Road Case Study

- The Water Source Locations Map was a sensitivity map created by the Northeast Michigan Council of Governments (NEMCOG) and can be used to inform the wildfire vulnerability assessments. Locations of fuel breaks can also be integrated into wildfire vulnerability assessments. The MDNR and the U.S. Forest Service have programs for establishing and maintaining fuel breaks in Crawford County. It is acknowledged that in recent years maintenance of some fuel breaks has not been adequate.

Communities can further use a landscape-level fire risk assessment tool to identify areas that are of highest risk for loss of lives, property, and resource values by the threat of catastrophic fire. The outcome of the assessment is a composite risk ranking for specific geographic areas of the community accompanied by relevant information and maps that can be used to identify appropriate fire mitigation strategies and allocation of resources.

Consideration of the wildland-urban interface (WUI) boundary is an important sensitivity that can inform wildfire vulnerability assessments. As more and more property owners decide to build in outlying forested areas, the risk of wildfire to structures increases. Strategies to reduce risk to homes in these WUI areas include fire retardant building materials, the creation of defensible space, and landscaping techniques. The Crawford County Wildfire Protection Plan identifies treatment areas and priorities in and around WUI areas.

Natural Resource Vulnerabilities

A Forest Cover Map was created to depict the forest makeup of the Camp Grayling region when the U.S. Geological Survey (USGS) flew the region in 1978. The composition of the region's forests is expected to change as rising temperatures drive habitats for many tree species northward.

According to the MDNR, oak trees are limited by temperature, so the range of oaks is likely to expand northward. However, oaks in the Community are threatened by spring freezes and overall forest health (the fungus that causes oak wilt moves through the root system, blocking the trees vascular system). Oak regeneration may also be affected by changes in soil moisture. Aspen is another tree species that is adapted to ecosystem and climate disturbances, but could be more impacted by drought, and forest pests are also a concern. Jack pines are currently prevalent throughout the region and are limited by increased temperatures, pests, and disease threats (Jack Pine Bud worm, mountain pine beetle). Red pine is limited by increased temperatures, and pests and diseases are also a concern given predicted climate changes.⁵

Because climate change is expected to result in warmer average air and water temperatures, cold streams and lakes will likely transition to cool bodies of water, while cool streams and lakes will likely transition to warm. These temperature changes are expected to result in fewer cold-water fish (such as trout and cisco).

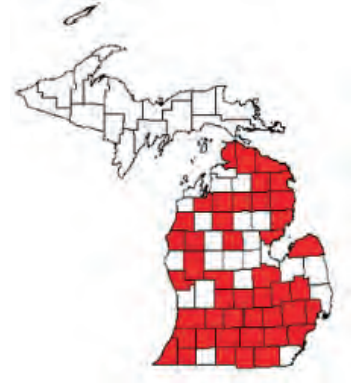
⁵ Presentation by Amy Clark Eagle, May 4, 2015, Biodiversity & Conservation Program Leader Michigan DNR, Wildlife Division.

Most Michigan wildlife is climate vulnerable. According to the MDNR, Michigan hare are highly vulnerable to climatic changes and are most affected by high summer temperatures.

The eastern massasauga rattlesnake (EMR) is also highly vulnerable to climate changes as well as to changes in the ecology due to development and forestry. The snake is primarily associated with wetland habitats.⁶ In recent years, Michigan's EMR population has declined, primarily due to habitat loss and fragmentation, human persecution or indiscriminant killing, and illegal collection.

The Kirtland's warbler breeds in a very limited geographic range, making the species rare and unique to the Grayling area. The area is about 100 miles long and 60 miles wide. The warbler is also a neotropical migrant, spending the winter in the Bahamas. The Kirtland's warbler nests in groves of young Jack pines.

Figure B-3 Distribution of Eastern Massasauga Rattlesnake



Source: Michigan Natural Features Inventory (<http://mnfi.anr.msu.edu/emr/>)

Flooding and Erosion

Projected changes in precipitation for the Grayling Community will likely result in larger rain events and more severe runoff.

According to the Crawford County Wildfire Protection Plan and Hazard Mitigation Plan, summer precipitation comes mainly in the form of afternoon showers and thundershowers. Most precipitation occurs in the months of April to September, a period that received an average of 20.76 inches, or 62% of the average annual total, from 1971-2000. During this same period the average wettest month was September, which averaged 4.01 inches, while the average driest month was February which averaged 1.27 inches.

The Federal Emergency Management Agency (FEMA) develops Flood Insurance Rate Map (FIRMs) for each County in the United States. According to FEMA, the FIRM is “the primary tool for state and local governments to mitigate the effects of flooding in their communities.” The National Flood Insurance Program was created in 1968 to reduce future damage and provide an insurance program that would help protect property owners from losses. The FIRM shows areas subject to flooding, based on historic, hydrological, hydraulic and meteorological data as well as flood controls. The maps identify a base flood elevation (BFE), sometimes referred to as the 100-year flood zone. These are areas that have a 1% chance of flooding in any given year. The maps also identify the areas with a 0.2% chance of flooding in any given year, also known as the 500-year flood zone. FEMA points out these ratios are only probabilities, not forecasts.

Increases in extreme precipitation events are likely to cause increases in erosion, silt and chemicals in the water, further lowering local water quality. A Soil Drainage Classification Map can help resource managers identify areas that are more prone to

⁶ Michigan Natural Features Inventory

flooding and erosion. The surface geology of Crawford County consists of moraines, till plains and outwash plains.

“Additionally, knowledge of the location of excessively drained soils will assist in identifying wildfire prone areas. Soil types influence the location of plant communities that grow in the county. Pine forests, particularly jack pine, are adapted to grow on sandy, draughty soils, while northern hardwood forests thrive on sandy loam soils and cedar forests prefer mucky wet soils.”⁷

Wetlands

For many urbanized areas across the State of Michigan, wetlands are an important component of fostering resilient communities in the face of climate change. In addition to critical fish and wildlife habitat, wetlands provide water quality protection and improvement, sediment and erosion control, and flood management — all extremely valuable ecosystem services. By identifying the locations of existing wetlands and wetlands with a high potential for wetland restoration, community planners can better identify areas to protect and restore. These are generally areas with pre-settlement wetlands and hydric soils in the Camp Grayling Community. The most effective strategies focus on preserving existing wetland hydrology while assuring the connectivity of wetlands and other natural resources. In fact, the restoration of wetlands and wetland buffers may be one of the most cost-effective techniques available to urban communities for managing the storms of climate change.

⁷ Crawford County Community Wildfire protection Plan, p. 2-24

Charrette Day 1
Information Session
Monday, May 4, 2015

IDA
Networking
Overview
Community Planner II, LIAA
Grayling Garrison
Grayling Region
Geographer, Department of Geography at Michigan
Michigan Communities
Energy LLC
Michigan's Natural Resources
Department of Natural Resources
Activity

Camp Grayling Community
2011 & 2014 Orthophoto

Camp Grayling Isolation Area
Community Boundary
Township/City Boundary



Data Sources
USDA Geospatial Data Gateway (2014)
Michigan Army National Guard (2011)
Michigan Geographic Data Library

CGJMTC Public Process

This section provides a record of the notes taken by the community planners at LIAA staff during the planning charrette on May 4th and 5th, 2015, at Camp Grayling. These notes summarize the input of all participants throughout the meeting and do not represent the Michigan Army National Guard.

Day One: May 4th, 2015

Open House and Resilience Symposium

The public process began with a public open house and resilience symposium during which LIAA planning staff provided a medium for community stakeholders to identify community assets and vulnerabilities, learn from experts on topics like climate change and energy. Participants were asked to identify assets and vulnerabilities in the Camp Grayling area.

Participants identified a number of key assets in the Camp Grayling community that can be summarized into several key points:

- Natural resources
 - The Au Sable River, Lake Margrethe, Hartwick Pines State Park, Hanson Hills Recreation Area, and the Manistee River provide numerous opportunities to camp, fish, bird watch, bike, and volunteer.
 - Fens and wetlands, provide habitat for rare wildlife species and sustain ecological diversity.
- Strong communication and transportation linkages
 - Large interstates including I-75 and US-127
 - Local fiber optic grid
 - Regional airport
- Community amenities
 - Facilities like Munson Healthcare Grayling Hospital, Kirtland Community College, and the Ralph A. MacMullan Conference Center
 - Non-motorized pathways
 - Regional railroads
 - Grayling Fire Department

Participants identified a number of vulnerabilities in the Camp Grayling community that can be summarized into several key points:

- High wildfire risk is a serious threat to property and well-being in the community.
 - Many residents are unaware of the area's high wildfire risk and are not taking proper steps to prepare.
- Camp Grayling itself is viewed as separate, largely, from the surrounding community.
 - Participants have strong familial and work history on the installation and believe that heightened security on the installation in recent years has deteriorated this sense of pride.
 - Yet the actions of the base can strain community resources. MIARNG vehicles cause damage to county roads and the City of Grayling's fire department provides services to the Installation at no cost. The City of Grayling used to benefit from soldiers spending money off-installation but this no longer occurs.
- Social concerns.
 - Poverty
 - Chronic health problems, like diabetes
 - Aging population. Many seniors no longer drive and lack access to public transportation.
 - High cost of food is relatively high in the area
 - Many struggle to find adequate, affordable rental housing.
- The area's natural resources are vulnerable to a number of external threats.
 - Development pressure by Lake Margherete
 - Fish farming
 - Pipeline 5
 - Oil fields have raised concerns over fracking
 - Climate change reducing snowfall has impacts on tourism such as snowmobiling and skiing

Public Education Session

The education session was structured to provide participants with a range of facts, viewpoints and considerations as they explore the issues that might affect the community's resilience in the years to come. The speakers provided valuable information about Camp Grayling's activities, an analysis of past and likely future climate trends, and specific ideas and measures that other communities are exploring to help be better prepared for the future. Participants then explored how they felt the community around Fort Custer could be more resilient. These presentations are available on the project website: www.ResilientMichigan.org/MIARNG

Day Two: May 5th, 2015

Community Stakeholder Meetings

The morning and afternoon of day two was comprised of several meetings on Camp Grayling and in the greater community. Each meeting was specific to a community topic ranging from economic development and business to law enforcement and emergency management. The goal of the stakeholder meetings was to receive further input on assets and vulnerabilities and identify projects that may help address vulnerabilities. The following is a summary of the projects each group contributed.

Law Enforcement and Emergency Management

Tuesday, May 5, 2015 – 202 W. Michigan Avenue, Grayling, MI – 11:00am

Projects

- Increase awareness of fire risk and educational outreach to residents
 - Perhaps through the creation of a subcommittee to focus on specific areas
 - After a wildfire event, hold a public meeting to reflect on what was done well and where communications need to be improved
 - Consider areas with poor access and work with public entities to improve infrastructure
 - Conduct additional simulations for fire response
 - Fund a new contract with the City of Grayling Fire Department for structural fire protection.

Economic Development and Business

Tuesday, May 5, 2015 – The Nature Center – 1:00pm

- Attract dollars from the Installation by enticing soldiers to visit the City of Grayling.
- Perhaps a bus could be used to transport soldiers to and from the City of Grayling.
- Create a tourism campaign to encourage soldiers to return to the area with friends and family.
- The airfield on the camp could be used for commercial flights and more charter planes. The airport could also have rental cars to make visiting Grayling easier.
- Invest in redeveloping the railroad.
- Emphasize the local fiber optics network in attracting new businesses.
- Invest in public transportation to reduce wait times and ensure accessibility by vulnerable populations.
- Increase awareness of the state lands that can be used for economic development by the private sector.
- Market outdoor resources to a new generation that is less enthralled by hunting and fishing.

- Diversify recreational and seasonal activities through events like soccer tournaments and other organized sporting events.
- Work with the City of Grayling to improve nightlife and entertainment opportunities.
- Pursue a Joint Land Use Study to see where partnerships could be formed to improve state and local land management.

Community Health

Tuesday, May 5, 2015 – MSU Extension Health Department – 1:30pm

- Create warming and cooling centers on Camp Grayling during extreme events.
- Open recreational buildings on Camp Grayling to community members.
- Develop youth and after-school programming, health, energy, and food accessibility programs.
- Establish a community group that works with Camp Grayling to identify potential collaboration.

Natural Resources and Recreation

Tuesday, May 5, 2015 – Camp Grayling – 4:00pm

- Conduct more prescribed burns to reduce overall wildfire risk
- Educate surrounding landowners and retailers on invasive species
- Improve fuel breaks around private properties
- Create a Fire Wise Plan for the Camp.
- Use Fire Wise projects as a demonstration for the community.

Future Climate Scenarios

Participants gathered in smaller groups of 8 – 12 and were given four scenarios set in the year 2050 that involved probable long-term weather trends coupled with a weather event and a set of impacts to the region. The scenarios were based on projected climate data and weather events from the past in the Crawford County area. For each scenario, participants discussed a range of questions and recorded the group's ideas and top priorities. In considering solutions and project ideas, consideration was given both to short-term needs (which could help identify improvements to social systems and hazard planning, for example) as well as the long-term requirements to help improve community resilience to the shocks and stresses presented. Participants then prioritized the top three project ideas from the compiled list of ideas. Below are the top three priority projects identified by participants, organized by topic area.

Buildings and Infrastructure

- Create a consolidated fire and emergency response service on the airfield for Camp Grayling and the community.
- Create a Fire Department for Camp Grayling.

- Identify and repair blighted areas in the City of Grayling by activating volunteers to remove trash, work with entrepreneurs and artists to enliven vacant spaces, and improve road appearance.

Natural Resources

- Build a new lodge and conference center at Hanson Hills for military and community use.
- Free up more private land for development.
- Create a system to better educate residents about the area's important natural resources.

Communications and Education

- Increase affordable access to high-speed internet.
- Develop a system for continually sharing information between the community and Camp Grayling.
- Better connect the installation and the community through tours, educational materials, and tourism campaigns.

Community Collaboration

- Construct a community center to encourage recreation in the winter months.
- Have one point of contact for all of community economic development facilitation.
- Encourage Camp Grayling representatives to participate on local community boards and commissions.

Next Steps

Refining the Project List, Project Feasibility Review, and High Priority Projects

Following the meeting, additional input was sought from stakeholders including additional representatives of the local jurisdictions and project partners from the Michigan Climate Coalition (MCC). The MCC, founded in 2010, brings together individuals from non-profit organizations, businesses, government, and educational institutions to enhance networking and collaboration, communication, and action around climate change and adaptation for Michigan. MCC served as a steering committee for the MIARNG project, offering expert advice on climate data and helping inform the public engagement process. On August 13, 2015, MCC reviewed recommendations from the Fort Custer Charrette and made the following recommendations in regards to what they viewed as key areas of focus for future projects:

- Wildfire risk
 - Coordinate fire and emergency services between community and the installation.

- Create a Camp Grayling Fire Department.
- Use the Fire Wise program to improve outreach to the community using nongovernmental entities and creative approaches.
- Conduct additional clear cuts to establish fuel breaks in the community.
- Emergency planning
 - Convene a local emergency planning committee to clarify CGJMTC's role in community-wide emergencies.
 - Partner with local food activists and others to plan for food systems in the event of a drought
 - Establish evacuation plans
 - Identify vulnerable populations and inventory their locations.
 - Conduct an inventory and gap analysis of backup power generators
 - Consolidate emergency and fire response teams within CGJMTC and the community.
 - Enhance 911 capabilities, cell towers, and communication lines
- Installation and community coordination
 - Integrate community + CG leadership for coordinated planning on all fronts.
- Economic development
 - Diversify the economy with outdoor recreation activities that are not snow dependent such as birding, cold water recreation, and fishing.
- Natural resources
 - Consider invasive species a regional concern and address through local and county planning initiatives.
 - Integrate climate change knowledge into local decisions.
 - Partner with local hunt clubs and anglers to create grassroots educational campaigns
 - Protect natural rivers from development through zoning restrictions and other regulation.



Camp Grayling public planning charrette focusing on solutions to vulnerabilities associated with climate change.



APPENDIX C:

Vulnerability Assessment and Public Process on Selfridge Air National Guard Base

The following appendix summarizes the vulnerability assessment process used at the community meetings to inform the recommendations found in Chapter 4. This appendix includes a vulnerability assessment, two corresponding maps, and a summary of the public input collected during the public process for the Selfridge Region.

Vulnerability Assessment Purpose

This assessment is intended to provide a broad understanding of climate vulnerability in the region and largely relies on demographic and environmental data at the scale of the greater Selfridge Community. This community vulnerability assessment does not identify Selfridge's specific climate vulnerabilities, although community-wide vulnerabilities may have unique implications for the Michigan Air National Guard. This broad assessment served as a tool during the planning process for this project to bring diverse stakeholders together to discuss community-wide ramifications of climate change. While not specific to SANGB, it provides a useful basis to inform an installation-specific vulnerability assessment in the future.

This vulnerability assessment identifies the most vulnerable areas in the Selfridge Community using a simple model: $VULNERABILITY = SENSITIVITY + EXPOSURE$. In this model, *sensitivity* refers to the degree to which a community or certain segments of a community could be impacted by an event, while *exposure* refers to hazards in the natural or built environment. This approach has been used recently in a variety of studies, including hazard-specific vulnerability assessments aimed at measuring exposure, sensitivity and resilience,¹ studies of vulnerability and its relationship to adaptation,² and equity and adaptation assessments conducted by the NAACP.³

This assessment identifies people and places throughout the Selfridge region that might be most vulnerable to severe weather events and related impacts. This assessment focuses on the Selfridge Community, defined by the Selfridge Air National Guard Base, Harrison Township, Chesterfield Township, the City of Mount Clemens, and Clinton Township.

1 Polsky, C., R. Neff, and B. Yarnal (2007). "Building comparable global change vulnerability assessments: the vulnerability scoping diagram." *Global Environmental Change* 17(3-4): 472-485.

2 Adger, W. N. (2006). "Vulnerability." *Global Environmental Change* 16 (3): 268-281. Adger, W. N., N. Arnell, and E. Tompkins (2005). "Adapting to climate change-perspectives across scales." *Global Environmental Change* 15(2):77-86.

3 Equity in Building Resilience in Adaptation Planning. National Association for the Advancement of Colored People (NAACP).

By focusing on this broader community, this assessment can be used to identify opportunities for the DoD to collaborate with neighboring communities to increase climate resilience.

Although the vulnerability assessment focused primarily on the social and environmental conditions of the region surrounding the installation, the results are important for the MIARNG. Social concerns — like access to healthy foods, medical facilities, and access to public transportation — are important for understanding the context surrounding the installation and identifying where community leaders should work to provide additional services and support. This vulnerability assessment can also inform emergency response planning by identifying the type of responses that may be required to confront future events. This is an especially relevant tool for the National Guard Bureau, as troops are often at the forefront of disaster response efforts.

This assessment focuses on the community's vulnerability to extreme heat and flooding events, although many of the considerations and societal impacts identified would be present under other stresses and shocks within the community. A number of maps were produced through this assessment and were used primarily to solicit feedback from the public and installation leaders during the public meetings. Separate maps were created for sensitivity (i.e., where sensitive populations live) and exposure (i.e., where the built or natural environment is most susceptible to heat or flooding events), but for brevity, only the resulting, cumulative vulnerability maps are included on the following pages. The full set of maps is available by request.

Vulnerability Assessment Data

This vulnerability assessment is based in part on data obtained from the American Community Survey (ACS), a continuing survey program operated by the U.S. Census Bureau. ACS data includes information on housing, income and education characteristics of populations in geographic areas called "Block Groups," containing between 600 and 3,000 individuals. The assessment also uses data from the 2010 U.S. Census, including population, age and racial composition collected by Census "Blocks," which are the smallest available geographic areas for demographic data. LIAA obtained data on impervious surface and tree canopy from Macomb County. LIAA used the Federal Emergency Management Agency's Flood Insurance Rate Maps to identify areas with high flood risk exposure in the community.

The census data used likely double-counts people, such as in cases when multiple sensitivity characteristics apply to the same individual; this may overestimate the severity of the sensitivities in some locations. The sensitivity analysis may also underestimate some risk because it does not include several key sensitive populations, such as those with preexisting health concerns that exacerbate heat vulnerability (for example, cardiovascular disease or psychiatric disorders); such

data is not often available publicly or on the Census Block level. Emergency managers, hospitals, and community health departments may have additional data available that can be included as the community looks to better understand its overall sensitive populations. To further improve the analysis, additional variables could be collected through local surveys and observation, such as the degree of social connections among individuals within a community, or materials used in housing.⁴

Vulnerability Assessment for Extreme Heat

Extreme heat is caused by very high temperatures and very high humidity. Extreme heat events that last for several days are called heat waves, and can cause serious health conditions like heat exhaustion, heatstroke, and even death.⁵ Heat waves can also damage agricultural products, exacerbate drought, and create problems for infrastructure such as roads and utilities. Additionally, extreme heat events are hard to plan for, as weather forecasts often fail to predict prolonged heat waves in the long-term, and short-term forecasts leave little time to prepare.⁶ The vulnerability assessment process provides an initial step in building the relationships and resources necessary to mitigate the severe consequences of heat waves before an event occurs.

A number of factors can make a community more vulnerable to extreme heat. In Michigan, heat intensity varies based on a community's proximity to the Great Lakes and geographic latitude. Studies have shown that heat-related mortality generally occurs in areas of the community that are warmer, less stable, and home to more disadvantaged populations.⁷ One study found that neighborhoods with the highest temperatures and the least amount of open space and vegetation were also likely to be the most socioeconomically disadvantaged.⁸ The same study also found that residents with access to air conditioning and transportation were the most protected from extreme heat impacts.

Heat Sensitivity Assessment

Researchers who study heat impacts have found that several groups of people tend to experience the most harm from a heat event.⁹ The following populations were considered relatively more sensitive in LIAA's vulnerability assessment of the Selfridge Community:

- Residents 65 years of age and over: Studies indicate that older age is associated with higher hospital admission rates in heat waves.¹⁰

4 Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730–1736 (2009). doi:10.1289/ehp.0900683 available via <http://dx.doi.org/> [Online 10 June 2009]

5 Center for Disease Control and Prevention, Climate Change and Extreme Heat Events. <http://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf>

6 Ibid.

7 Foundations for Community Climate Action: Defining Climate Change Vulnerability in Detroit. University of Michigan. December 2012.

8 Semenza JC, Rubin CH, Falter KH, et al. Heat-related deaths during the July 1995 heat wave in Chicago. *N Engl J Med* 1996; 335:84–90.

9 Foundation for Community Climate Action: Defining Climate Change Vulnerability in Detroit (December 2012). University of Michigan's Taubman College of Architecture and Urban Planning.

10 Curriero FC, Heiner KS, Samet JM, et al. Temperature and mortality in 11 cities of the eastern United States. *American Journal of Epidemiology*. 30 (2001): 1126-8.

- Residents living alone: Although living alone is not necessarily a risk, people who are socially isolated are at greater risk during an extreme heat event. Isolated people may not be able to recognize symptoms of heat-related illness and may fail to take proper action.¹¹
- Minority populations: Studies also suggest that minorities are at greater risk during extreme heat events. This may be for various reasons, including less reliable access to health care, transportation and other social supports needed to reduce heat exposures.¹² In other words, a correlation exists between non-white populations and increased sensitivity to extreme heat.
- Populations in poverty: Living in poverty is associated with increased heat-related morbidity and mortality. In general, persons living at or below the poverty line have less access to resources such as air conditioning or cooling options for their residences. This can limit a person's access to relief from an extreme heat event.¹³
- People over 25 with less than a high school education: Studies demonstrate a link between low educational attainment and heat-related illness and death.¹⁴

There are other factors that could increase an individual's risk of heat-related illness that were not mapped in this assessment. Many additional variables could be collected through local surveys or other sources including:¹⁵

- The degree of social connectivity among individuals within a community;
- Populations with preexisting health concerns like substance addiction, mental illness, or confinement; and
- Populations who live on higher floors of multistory buildings.

Heat Exposure

Exposure refers to the environmental factors that increase the risk of extreme heat. When larger communities experience heat waves, air temperatures can vary significantly from place to place during the day and at night. Some of these differences can be attributed to the varying types of land cover found throughout the community.¹⁶ For example, temperatures can be significantly lower at night in locations with a heavy tree canopy and very little pavement. Conversely, temperatures can be higher in locations with little greenery and lots of pavement. This temperature relationship is called the Urban Heat Island (UHI) Effect.

11 Smoyer-Tomic, K.E.; Kuhn, R.; Hudson, A. Heat wave hazards: An overview of heat wave impacts in Canada. *Nat. Hazards* 2003, 28, 465–486.

12 Waugh and Tierney (eds.) *Emergency Management: Principles and Practices for Local Government*. Chapter 13: Identifying and addressing social vulnerabilities by Elaine Enarson.

13 Smoyer KE. Putting Risk in its place: methodological considerations for investigating extreme event health risk. *Social Science and Medicine*. 47:11 (1998):1809-1824.

14 Curriero FC, Heiner KS, Samet JM, et al. Temperature and mortality in 11 cities of the eastern United States. *American Journal of Epidemiology*. 30 (2001): 1126-8.

15 Mapping Community Determinants of Heat Vulnerability. *Environ Health Perspectives* 117:1730–1736 (2009).

16 Landsberg, H. (Ed.), 1981. *The Urban Climate*. Academic Press, New York.

Where the Urban Heat Island Effect is not prevalent, heat indexes (the combination of air temperature and humidity) rise when the sun is shining during the day and drop when the sun goes down in the evening. Urban Heat Islands are caused when buildings, roads, and other impervious surfaces absorb heat from the sun during the day and release heat throughout the night. In other words, in areas with excessive impervious surfaces and less natural ground coverage, heat indexes are higher, even at night. During a heat wave, the environment stays warm even at night, and sensitive populations are at even greater risk of heat-related illness. Studies have documented that despite nearby rural areas, the Urban Heat Island Effect can cause a 2 to 9 degree Fahrenheit increase in air temperature.¹⁷

Two key factors were used to determine areas in the Selfridge Community with high heat exposure: impervious surfaces and tree canopy coverage.

- **Impervious Surfaces:** Impervious surfaces refer to parking lots, roads, sidewalks, building footprints, and any other area that is paved. Data for impervious surfaces was digitized using aerial imagery. Like all urbanized areas, the Selfridge region has some areas with significant impervious surface coverage caused by roads, homes, and commercial areas.
- **Tree Canopy Coverage:** Tree canopy refers to the land within a community covered by trees, shrubs, or other vegetation. Trees and vegetation actually lower the surface and air temperature nearby, reducing the Urban Heat Island effect.¹⁸ The community's tree canopy data was digitized using aerial imagery and mapped as a percentage of total land cover within each Census Block.

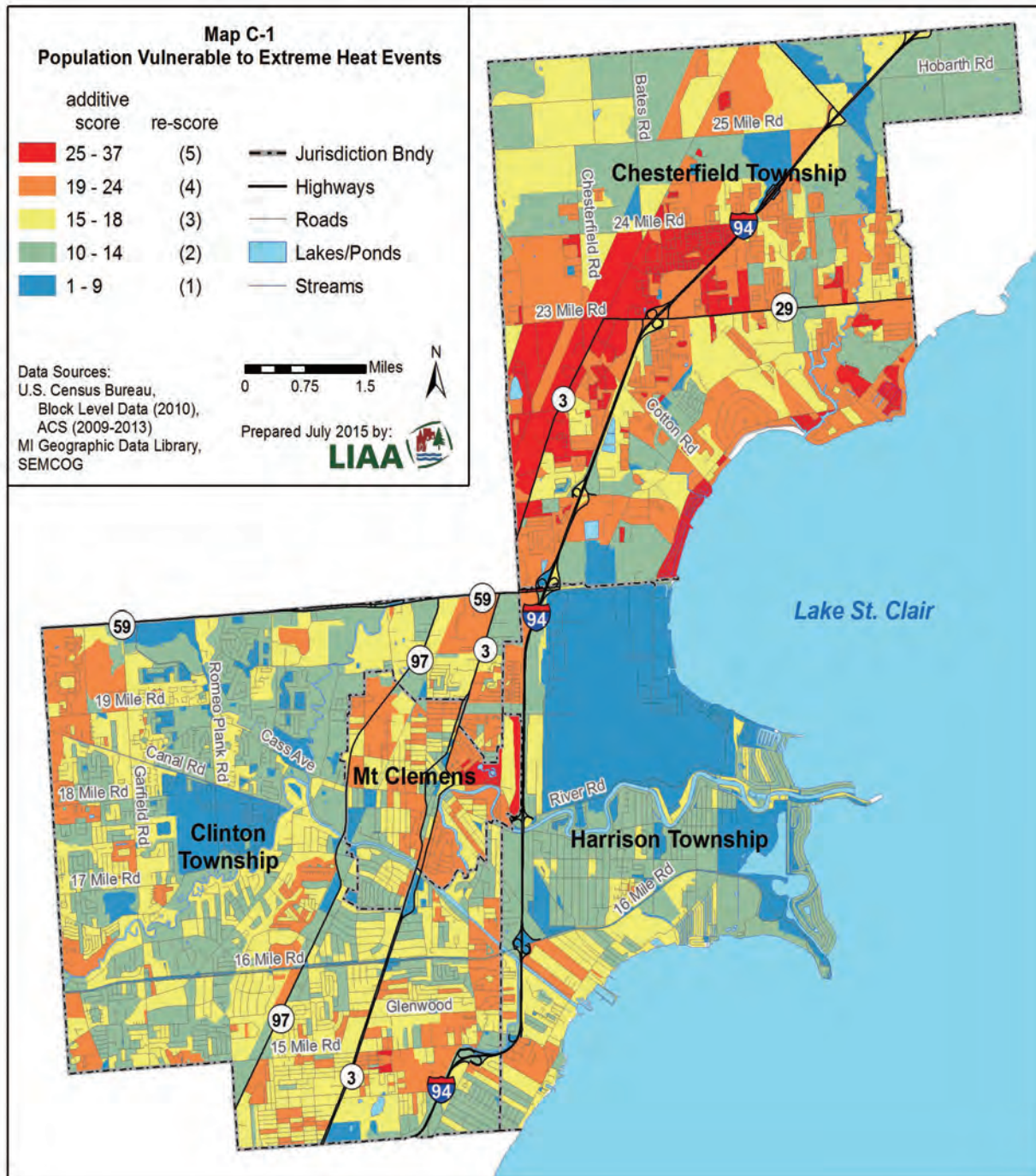
Environmental exposure can be high in a Census Block even if zero or few residents live in the Block. Although zero or few residents live in these areas, exposure in these areas is still important to consider, as residents in surrounding Blocks may feel the impacts of high environmental exposure. Additionally, commercial and industrial areas with high exposure increase the vulnerability for sensitive populations that may visit, shop or work in these areas.

¹⁷ For more information on the Urban Heat Island effect, see this Environmental Protection Agency's publication. <http://www.epa.gov/sites/production/files/2014-06/documents/basiccompendium.pdf>

¹⁸ For more information on using trees and greenery to reduce the Urban Heat Island effect, see this Environmental Protection Agency's web page. <http://www.epa.gov/heat-islands/heat-island-cooling-strategies>

Heat Vulnerability Assessment Findings

Through the vulnerability assessment process, LIAA created a composite heat sensitivity map (i.e., where sensitive populations live) and a composite heat exposure map (i.e., where environmental risk to extreme heat is greatest.) Map C-1, the Selfridge Community Population Vulnerable to Extreme Heat Events Map is a simple additive combination of the



scores within each Census Block on the overall sensitivity map and the overall exposures map. In other words, this map shows where higher environmental exposure and higher concentrations of sensitive populations tend to overlap. In general, populations in those areas with the highest composite scores (orange and red) may be particularly vulnerable to extreme heat events.

Areas with high vulnerability do not indicate that residents in these locations are in immediate danger. Rather, the Population Vulnerable to Extreme Heat Events Map offers the community new ways to:

- Identify areas in the Selfridge Community where heat waves could present serious problems for a significant number of citizens. There are a number of areas within the region with relatively high concentrations of sensitive populations.
- Identify areas where the Urban Heat Island Effect is greatest in the community.
- Guide the allocation of resources like new emergency shelters, cooling centers, tree planting, or parks.

The map shows that a number of areas in the Selfridge Community are relatively more vulnerable to extreme heat events. These areas are clustered in several locations including commercial corridors in Chesterfield Township and downtown Mount Clemens.

Heavy Rain and Flooding

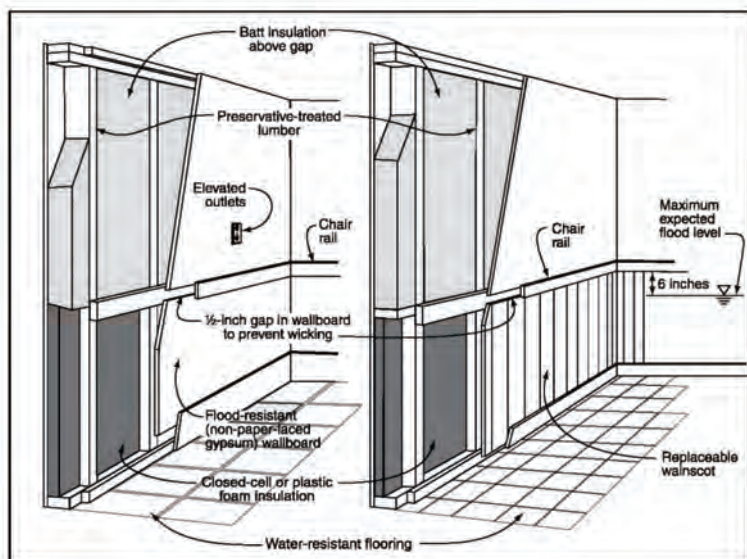
Climate experts from the Great Lakes Integrated Sciences and Assessments Program

(GLISA) have found that the Selfridge Community and all of Michigan can expect more frequent storms of increasing severity in the decades ahead. The total amount of precipitation per year is also likely to increase. However, climate models suggest the precipitation will be more concentrated in the winter, spring and fall seasons and there will be more localized, intense storms at almost any time of year. The potential for substantially larger rain events raises concerns over the potential for harm to human health and damage to buildings and infrastructure.

The following summarizes a flooding vulnerability assessment LIAA conducted for the Selfridge Community. In assessing vulnerability, community planners evaluate

potential exposures as well as sensitivity to flooding. Buildings, roads, bridges, sewer lines and other infrastructure located in a flood zone are exposed to greater risks. Where flowing floodwaters have the greatest energy, structures may be undercut, collapsed

Figure C-1. Home Design Techniques for Flood Resilience



Source: FEMA.gov

or moved, and soils will erode. Even areas outside of an identified floodplain are subject to flooding from heavy downpours. Where the soils have low permeability and physical drainage is inadequate, water will accumulate and cause ponding during large storm events. Appropriate planning and land-use regulations can help reduce exposures caused by poor site selection. The sensitivity of structures can be modified to reduce risk of damage by applying flood-resistant design standards. See Figure C-1 for an overview of recommendations from the Federal Emergency Management Agency (FEMA) for retrofitting homes to make them more resilient to flooding events.

Exposure to Flooding Hazards

LIAA used FEMA's Flood Insurance Rate Maps (FIRMs) for the community to assess flood exposure. The FIRMs show areas subject to flooding based on historic, hydrological, hydraulic and meteorological data as well as flood controls. The maps identify a base flood elevation (BFE), sometimes referred to as the 100-year flood zone. These are areas that have a 1% chance of flooding in any given year. The maps also identify the areas with a 0.2% chance of flooding in any given year, also known as the 500-year flood zone. FEMA points out these ratios are only probabilities, not forecasts. It should be noted that most military installations do not have complete FEMA flood mapping data, so it is difficult to access the flooding vulnerability risk on base. Instead, many installations manage their own flood risk assessments.

Household Sensitivity to Flooding

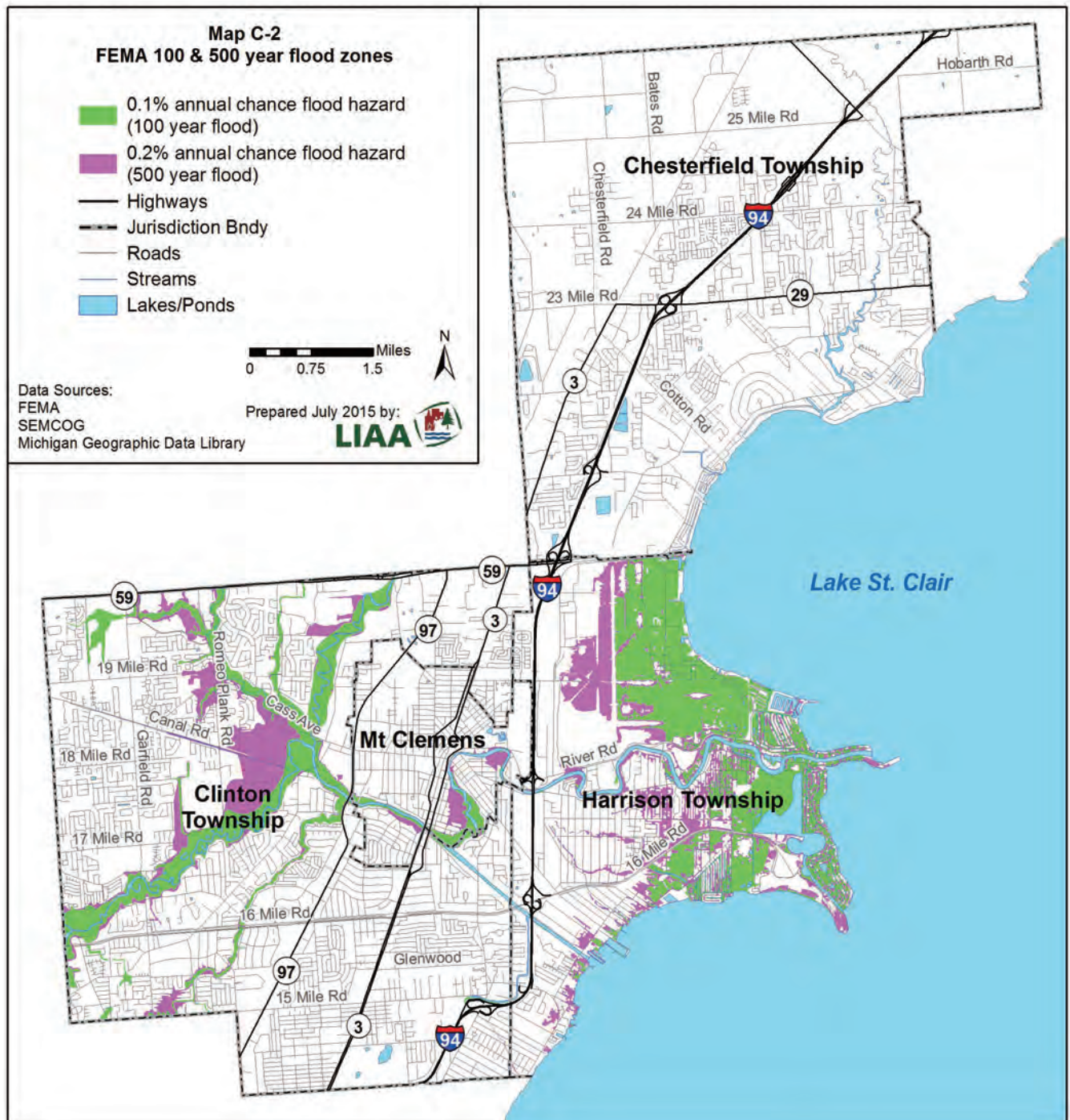
In many communities, flood impacts are felt most severely at the household level. A home's flood risk is based on its relative location to floodplains and other flooding hazard areas. A household's flood sensitivity refers to how well the house structure is equipped to deal with flooding. As modeled by the University of Michigan, household sensitivity to flooding can be determined by looking at the age of the housing stock and the homeowner's financial ability to maintain and improve the home, which is approximated using the median household income. In general, homes built before 1940 used a more porous concrete material for basement construction, so water can flow more rapidly through the foundation. As a result, older homes may be more vulnerable to flooding if residents have not had the financial resources to make improvements and upgrades. By looking at median household income as a marker of likely upkeep of the home, LIAA attempted to exclude older homes that have been well-maintained and undergone upgrades in areas of flood damage risk.

Household Vulnerability to Flooding

Map C-2 shows the areas that likely have higher vulnerability to flooding damage. The map shows the locations of floodplains as designated by FEMA. To further refine the areas of flood vulnerability, the community should identify the locations of older homes within the floodplains.

It is important to note that other factors contribute to flood risk. For example, mobile and manufactured homes are often particularly susceptible to flood damage because

they generally lack a reinforced foundation. In addition, municipal infrastructure plays an important role in protecting homes from flood damage. Communities with storm-sewer systems that are aging or not fully disconnected from the sanitary sewer are more prone to damage from an overloaded system in a severe rain event.



Wetlands

For many urbanized areas across the State of Michigan, wetlands are an important component of fostering resilient communities in the face of increased precipitation. In addition to critical fish and wildlife habitat, wetlands provide water quality protection and improvement, sediment and erosion control, and flood management — all of which are extremely valuable ecosystem services. LIAA mapped the locations of existing wetlands and areas with a high potential for wetland restoration as a part of this vulnerability assessment. These are generally areas with pre-settlement wetlands and hydric soils in the Selfridge Community. The most effective strategies focus on preserving existing wetland hydrology while assuring the connectivity of wetlands and other natural resources. In fact, the restoration of wetlands and wetland buffers may be one of the most cost-effective techniques available to urban communities for managing the storms of climate change.

Other Considerations for Evaluating Community Vulnerability

It is important to identify locations of key community assets and assess how accessible these assets are to residents, emergency responders, and other key personnel. It is also important to identify key infrastructure and assets that could be at risk, or would be most negatively impacted not only by severe weather, but also by increased frequency and duration of their use during an emergency.

Critical Facilities

In general usage, the term “critical facilities” is used to describe all man-made structures or other improvements that, because of their function, size, service area, or uniqueness, have the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if they are destroyed, damaged, or if their functionality is impaired.¹⁹ LIAA mapped the locations of critical facilities in the community as a part of the community planning process in the Selfridge Community. Critical facilities include:

- emergency response facilities (fire stations, police stations, rescue squads, and emergency operation centers [EOCs]);
- custodial facilities (hospitals, long-term care facilities, healthcare facilities, jails, and other detention centers)
- schools;
- emergency shelters;
- utilities (water supply, wastewater treatment facilities, and power);
- communications facilities;
- other assets determined by the community to be of critical importance for the protection of the health and safety of the population; and
- places where 300+ people congregate.

¹⁹ Risk Management Series Design Guide for Improving Critical Facility Safety from Flooding and High Winds. FEMA 543 January 2007.

Access and Distribution of Social Services

Service centers and institutions (such as homeless shelters and churches) are important in delivering day-to-day support to residents. In the event of an emergency such as an extreme heat event or flash flooding episode, service centers and institutions are especially important as a safe place where residents can go if they cannot return home. LIAA mapped the locations of places where residents may seek temporary refuge in the event of an emergency. These locations include schools, places of worship, governmental buildings, hospitals and clinics, libraries, and other non-profit social service organizations. In the Selfridge Community, social services are concentrated in the downtown core and along major commercial corridors.

Communities with high population densities, frequent extreme weather events, or both, are likely to have designated services centers. In the event of extreme heat waves, designated community cooling centers may provide refuge for sensitive populations and for those without access to air conditioning. In the event of loss of power due to flooding or extreme storms, locations with a backup power source, such as a generator, are essential. A best management practice for a resilient community is to designate community service centers that are accessible, evenly distributed across the population, open 24 hours, and well known to residents.

Food Availability

Just as cultivating local entrepreneurship makes a community stronger, the capacity of a community to produce and process its own food greatly increases resilience. Climate change will likely have significant impacts on the availability and prices of food across global markets. A community can decrease its vulnerability to disruptions in food sources through a strong local food economy. Support for and reliance upon locally produced foods not only alleviates potential future challenges in the food market, but also helps foster another strong economic sector for the region.

In evaluating community vulnerabilities, LIAA looks at locations of full-service grocery stores in relation to where people live. In the event of loss of power or disruption in potable water supplies, it is important to ensure that residents have access to affordable food and drinking water. For this vulnerability assessment, LIAA mapped the areas in the community that are located within one mile of a full-service grocery store.

LIAA also evaluates access to healthy food to see if there are areas of the community that qualify as food deserts. According to the United States Department of Agriculture (USDA), a food desert is defined as an area devoid of fresh fruit, vegetables, and other healthful whole foods, usually found in impoverished areas. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers. Communities looking to reduce the number of residents living in food deserts can promote or zone for pop-up farm stands in low-income areas, enact housing policies supportive of mixed incomes, and establish community gardens in areas identified as food deserts.

Selfridge ANGB



Colonel
Rolf Mar
127th Wing Vice



SANGB Public Process

This section provides a record of the notes taken by the community planners at LIAA staff during the planning charrette on July 29th and 30th, 2015, at the Macomb Intermediate School District near SANGB. These notes summarize the input of all participants throughout the meeting and do not represent the Michigan Army National Guard.

Day One: July 29th, 2015

Open House and Resilience Symposium

The public process began with a public open house and resilience symposium during which LIAA planning staff provided a medium for community stakeholders to identify community assets and vulnerabilities, learn from experts on topics like climate change and energy. Participants were asked to identify projects that could be implemented in the Selfridge community. The following is a summary of project ideas organized by topic area.

Green Infrastructure

- Create better incentives for private property owners to adopt green practices
- Reforestation with trees compatible with a changing climate
- Change ordinances to be more accepting of green infrastructure
- Macomb County should adopt model environmental ordinances
- Floodplain and wetland restoration
- Use green infrastructure like permeable pavement, rain gardens, road diets, and native vegetation.

Education

- Develop hands-on, experiential education programs
- Long-term education plan
- Motivate and collaborate by centralizing ideas

Emergency Planning

- Use generators for stand-alone power for emergencies, especially in storm water pump stations and hospitals, shelters
- Solar Generators, even on private properties
- Reverse notification system for flooding and extreme heat events

Stormwater Improvements

- Separate gray water that can be reused without treatment

- Disconnect Combined Sewer Overflow systems
- Water Storage and Filtration
- Support Draining improvement east of Gratiot north of Joy Road
- Support County efforts to restore Clinton River Spillway

Public Education Session

The education session was structured to provide participants with a range of facts, viewpoints and considerations as they explore the issues that might affect the community's resilience in the years to come. The speakers provided valuable information about Selfridge's activities, an analysis of past and likely future climate trends, and specific ideas and measures that other communities are exploring to help be better prepared for the future. Participants then explored how they felt the community around Selfridge could be more resilient. These presentations are available on the project website: www.ResilientMichigan.org/MIARNG

Day Two: July 30th, 2015

Community Stakeholder Meetings

The morning and afternoon of day two was comprised of several community stakeholder meetings that took place throughout the day both throughout the Selfridge community. Each meeting was specific to a community topic ranging from economic development and business to law enforcement and emergency management. The goal of the stakeholder meetings was to identify assets and vulnerabilities as well as projects that could be implemented on SANGB or in the larger community.

The following summarizes the key themes from each stakeholder meeting.

Emergency Management

Key Assets

- Macomb County has a robust emergency plan and Emergency Operations Center.
- Some collaboration between SANGB and Macomb County during emergency planning
- Transportation infrastructure in the region is redundant, which is helpful during emergencies.

Key Vulnerabilities

- Selfridge's presence is both an asset and a risk for Macomb County. The Base's main concerns are plane crashes, fuel leaks, and flood zones. Each of these present a risk to the County and general community as well.
- Macomb County is especially vulnerable to severe wind, heavy snow, ice/sleet storms, and tornadoes.
- Thousands of homes have been repetitively flooded along the Lake St. Clair shoreline.

- A number of sensitive populations including many immigrant households that do not speak English.

Project Ideas

- Install generators at County shelters.
- Additional funding for shelter in place programs.
- Repurpose the vacant housing on base to serve economic or social needs.

County Planning and Public Works

Key Assets

- Road infrastructure exists for much more robust transit.
- Length of shoreline along the SANGB.
- Extensive stormwater pumping system with backup generators.
- Base has the capacity to treat its own water.
- Base provides economic boost to the hospitality industry.
- Collaboration between tenants and host on SANGB is a nationally-recognized model.

Key Vulnerabilities

- Under-utilized transportation capacity for mass transit.
- No public access to the shoreline has disconnected residents from coastal resources.
- Rip rap along the shoreline causes pollution issues over time.
- Water quality issues in Lake St. Clair
- Airport using restrict the wetland wildlife and makes restoring and managing wetlands difficult.
- Invasive plants that spread quickly and attract wildlife near the airport.

Project Ideas

- Use the base for economic development, such as private defense-related industries
- Create a public bike trail along the waterfront
- Create the trail in a way that does not compromise security or waterflow
- Restore shorelines for fish habitats and subsurface health.
- Consider softening the shoreline to prevent future flooding.
- Require neighboring communities to stop building structures in the “Accident Potential Zone”
- Serve as a Point of Refuge for paddlers.
- Provide camping for military families and veterans.
- Engineer green infrastructure such as bioswales to keep flood water controlled.
- Assess existing sewer infrastructure and condition.
- Leverage DNR managed fishing areas when planning for public recreation.

- Reevaluate stormwater strategy, especially the series of incomplete berms along the Lake St. Clair shoreline on SANGB.

Community Health and Public Health

Key Assets

- Collaboration between Macomb County Public Health Department and the Macomb County Emergency Operations Center during emergencies.

Key Vulnerabilities

- Macomb County is still recovering from the long-term impacts of severe flooding.
 - Mental health of residents, environmental health, and emergency preparedness for future events.
- The County has limited resources for emergency preparedness and few shelters have backup generators.
- The County has limited public transportation.
- Sensitive populations in the County include a number of immigrant households that do not speak English.
- Information on flooding, mold, and emergency preparedness have not been translated.
- Intense storms bring out many toxins, bugs, and other problems creating environmental health issues.
- Beach closures and water quality warnings for fishermen, swimmers, etc.
- 90 Degree heat days cause serious problems for households without air conditioning and seniors.
 - Cooling centers tend to have regular business hours and there is no better system of communication.
- Aging population will need more services over time.

Project Ideas

- Under-utilized transportation capacity for mass transit.
- Produce emergency preparedness material in multiple languages.
- Make emergency preparedness information more visible to the public.
- Invest in a regional transportation plan that emphasizes public transit for the poor, seniors, and other at-risk populations.
- Identify job centers and work to provide transportation linkages in those areas.

Environment and Natural Resources

Key Assets

- Clinton River Watershed Council and Clean Water Action are strong regional partners for water quality and coastal planning.
 - WaterTowns program is helping connect people to their water environment by promoting recreation and green infrastructure.

Key Vulnerabilities

- Phragmites and other invasive species on SANGB.
- Boating and fishing are economic drivers of the region but are dependent on water quality and high water levels.
- The entire watershed is an Area of Concern due to rapid urbanization and suburbanization.
- Wildlife attraction is a continued problem for SANGB given its use as an airport. This restricts green infrastructure methods in that water cannot be retained on the Base.
- Privatized area with very little public land.

Project Ideas

- Use grey water cisterns for uses like washing vehicles and equipment.
- Increase geothermal heating on SANGB.
- Remediate the shoreline to prevent phosphorus, fertilizer, and other runoff from entering Lake St. Clair.
- Fund the bike path through the base and use regional partners to advertise and maintain the trail.
- Mitigate wetlands in strategic locations elsewhere in the watershed.

Energy

Key Assets

- SANGB is working on a Renewable Energy Management Plan that will guide new investment.
- Methane under SANGB, even at very low levels, could be used for economic development.
- Solar energy is a strong possibility for future investment in renewable energy.

Key Vulnerabilities

- Procuring methane under SANGB raises concerns of fracking.
- Boating and fishing are economic drivers of the region but are dependent on water quality and high water levels.
- The entire watershed is an Area of Concern due to rapid urbanization and suburbanization.

- Wildlife attraction is a continued problem for SANGB given its use as an airport. This restricts green infrastructure methods in that water cannot be retained on the Base.
- Privatized area with very little public land.

Project Ideas

- Consider using a live meter to better monitor peak energy usage.
- Battery storage for excess solar panels that could be sold back to DTE Electric Energy Company.
- Commission a study to identify the existing conditions of underground piping on SANGB.
- Energy power study to determine what is possible for renewable energy on SANGB.
- Work with SANGB's tenants to get funding from other entities for renewable energy measures.

Future Climate Scenarios

Participants gathered in smaller groups of 8 – 12 and were given four scenarios set in the year 2050 that involved probable long-term weather trends coupled with a weather event and a set of impacts to the region. The scenarios were based on projected climate data and weather events from the past in the Macomb County area. For each scenario, participants discussed a range of questions and recorded the group's ideas and top priorities. In considering solutions and project ideas, consideration was given both to short-term needs (which could help identify improvements to social systems and hazard planning, for example) as well as the long-term requirements to help improve community resilience to the shocks and stresses presented. Participants then prioritized the top three project ideas from the compiled list of ideas. Below are the top priority projects identified by participants, organized by topic area.

Buildings and Infrastructure

- Install backup generators at County shelters.
- Reuse grey water by enabling grey water infrastructure and cisterns.
- Encourage Low Impact Development strategies like green roofs, white roofs, pervious pavement, road diets, solar pumps, and rain barrels.
 - Consider implementing a stormwater tax to fund these improvements.
- Use standpipes and other street drain improvements to reduce flooding of existing stormwater infrastructure.
- Locate critical infrastructure above the 500-year floodplain.
- Improve the Clinton River Spillway.
- Separate stormwater and sewer systems.

- Evaluate parking requirements, remove minimum parking requirements where appropriate.
- Install electric vehicle charging stations in parking areas.
- Reduce reliance on septic systems, especially near rivers and lakes.

Natural Resources

- Increase tree canopy with tree planting programs. Be sure trees planted are resistant to drought and other future climate conditions.
- Remove dams.
- Promote alternative fuel for boaters.

Communications and Education

- Institute a reverse 911 system, whereby vulnerable populations receive phone calls during an emergency.
- Build knowledge of low impact development among private property owners, large institutions, and contractors.
- Conduct emergency response drills.
- Create safe harbor locations along Lake St. Clair shoreline for boaters and paddlers.
- Secure portable medics and other equipment to bring healthcare to population centers during emergency recovery.
- Encourage local communities to participate in the National Flood Insurance Program to reduce repetitive loss properties.
- Investigate the use of Selfridge as an evacuation site or as a storage site for food and other supplies in an emergency.

Community Collaboration

- Intentionally build coalitions of cross-disciplinary working groups.
- Integrate new ideas and climate science into existing plans.
- Proactively plan in areas where suburbanization is occurring, mostly in the rural parts of Northern Macomb County.
- Create community garden projects to better promote community cohesion and resiliency.

Next Steps

Refining the Project List, Project Feasibility Review, and High Priority Projects

Following the meeting, additional input was sought from stakeholders including additional representatives of the local jurisdictions and project partners from the Michigan Climate Coalition (MCC). The MCC, founded in 2010, brings together individuals from non-profit organizations, businesses, government, and educational institutions to enhance networking and collaboration, communication, and action

around climate change and adaptation for Michigan. MCC served as a steering committee for the MIARNG project, offering expert advice on climate data and helping inform the public engagement process. On August 13, 2015, MCC reviewed recommendations from the Selfridge Air National Guard public meeting and made the following recommendations in regards to what they viewed as key areas of focus for future projects:

Flooding/Stormwater Management

- Incorporate data on urbanized flooding locations to aid in directing green infrastructure techniques.
- Relocate critical facilities from the 500-year floodplain.
- Disconnect Combined Sewer Overflow systems.
- Improve street drains to better withstand projected increases in precipitation.
- Require planting of native plant species near water sources to protect water quality.
- Consider piloting Low Impact Development and green infrastructure improvements on SANGB that can educate the greater community.

Utilities and Infrastructure

- Incorporate climate projections into infrastructure improvements such as revised precipitation projections for stormwater improvements.
- Enable green infrastructure in local zoning ordinances such as green roofs, pervious pavement, solar panels,
- Conduct a regional energy plan with an emphasis on solar energy.
- Consider district heating using grid districts and geothermal heating.
- Reduce reliance on septic systems near water sources, especially in urbanized areas.
- Further investigate the risks related to methane collection for energy.
- Upgrade the Clinton River Spillway.

Community Health

- Intentionally reach vulnerable populations in public health discussions.
- Identify areas subject to Heat Islands during a heatwave.

Emergency Planning

- Secure funding for backup generators at emergency shelters.
- Evaluate the capacity of SANGB to provide support to the greater community during an emergency (shelter, food, supplies, etc.)
- Create a plan for backup water supply.

