Example Hazard Mitigation Plan That Includes Green Infrastructure, Low Impact Development, Nature-based Solutions, and Water Quality Protection (DRAFT)

Case Study: Green Infrastructure and Nature-based Solutions in the City of Milwaukee's Local Hazard Mitigation Plan (2019 Update)*

Background on the Planning Effort

Natural Hazards Addressed in Milwaukee's HMP

- Flooding
- Extreme temperatures
- Coastal erosion

The City of Milwaukee's Hazard Mitigation Plan (HMP) proposes long-term, permanent solutions designed to reduce the exposure to, probability of, or potential risk to human life and property. The Draft 2019 (May) "all hazard" mitigation plan sets forth an appropriate, feasible, and effective hazard mitigation strategy through 2024 (City of Milwaukee 2019). Integrated watershed planning and floodplain management are a key component of Milwaukee's HMP due to shared objectives and input from the Southeastern Wisconsin Regional Planning Commission. The main contributors to the HMP, and their respective roles, are as follows:

All Hazards Mitigation Plan Local Planning Team: provided input on the updated plan (e.g., types of hazards, mitigation strategies) and was guided by the Department of Public Works who assembled members of the team. The team was composed of interested stakeholders including city officials, agency and business representatives, and citizens knowledgeable in hazard mitigation matters.

Southeastern Wisconsin Regional Planning Commission (SEWRPC): provides information and planning initiatives to help solve regional public works and environmental issues. SEWRPC wrote the plan and held meetings with the local planning team to solicit their feedback. The commission also handled public questions and comments (online and through meetings) for drafts of the 2019 plan.

Milwaukee Metropolitan Sewerage District (MMSD): a regional government agency that provides water reclamation and flood management services for the Greater Milwaukee Area. The involvement of MMSD was particularly important for the development of the HMP and implementation of recommended mitigation strategies.

University of Wisconsin-Madison's Nelson Institute for Environmental Studies: provided downscaled climate projections that inform about the potential impacts of extreme events and associated hazards.

*Note: Some, but not all, of this text is excerpted directly from the HMP.

Mitigation Strategies Involving Green Infrastructure and Low Impact Development

The HMP suggests an approach that is based on three components (see *Milwaukee's HMP Components* box) to mitigate potential hazards for the city. Mitigation strategies mainly focus on land/building development, education, and reducing vulnerability to an identified hazard area.

Milwaukee's HMP Components

- Analysis of hazardous events
- Community vulnerability assessments
- Hazard mitigation strategies

Existing city regulations and ongoing programs for floodplain and stormwater management are critical to the implementation the HMP—five floodplain and stormwater mitigation elements are considered in the plan (see *Milwaukee's HMP Flooding/Stormwater Mitigation Elements* box). Each element is an important component of the overall strategy for reducing flood risk and damage. The city's stormwater management ordinances cite several provisions related to green infrastructure/low impact development (GI/LID), including those that:

- Reduce adverse impacts from stormwater runoff
- Attain and maintain water quality standards
- Reduce the effects of development on erosion
- Minimize damage to public and private property
- Minimize impervious cover to reduce nonpoint source pollution
- Promote the co-benefits of visible GI
- Provide adaptation and resilience to climate change

Milwaukee's HMP Flooding/ Stormwater Mitigation Elements

- Floodplain management
- Stormwater management
- Preservation of sensitive land
- Public education/outreach
- Secondary planning

Table 1 summarizes key resilience strategies and outlines associated programs used by the city.

Elements for Successful Implementation

Common interests in advancing integrated, comprehensive watershed planning and a long history of environmental sustainability among contributing organizations were critical for successful implementation of Milwaukee's HMP. For example:

1. The City of Milwaukee has extensive experience in urban sustainability and created a sustainability advisory group in 2004 that subsequently prepared and implemented HMPs.
2. MMSD is a national leader in urban flooding issues and watershed planning (e.g., its pilot program of integrated stormwater permitting over its 6 watersheds was awarded the U.S. Water Alliance's 2012 Water Prize) and its vision encompasses two key elements: (1) integrated watershed management and (2) climate change mitigation/adaptation.
3. SEWRPC have developed or assisted with HMPs for various counties and local governments throughout the region. Stormwater and floodplain management planning was an initial focus of SEWRPC when it was established in the 1960s.

These groups cite the performance and cost-effectiveness of GI/LID and advocate for their inclusion in HMPs and other municipal planning approaches. Milwaukee's *Greenseams Program* also highlights the benefits of implementing these approaches to build resilient communities.

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Table 1. Milwaukee's HMP Strategies Using Nature-based Approaches and Watershed Planning

Approach	Key Programs and Capabilities Related to Environmental Protection
Stormwater Management	MMSD GI Plan: provides a systematic plan to implement widespread GI. MMSD GI Plan for the Kinnickinnic River Watershed: supports larger flood management objectives by creating strategic recommendations for types and locations of GI. MMSD Stormwater Ordinance: requires management of volume and peak flow rate of stormwater from new and redevelopment that would increase downstream flooding. Includes preservation of environmental corridors is included. CoM Baseline Green Infrastructure Inventory: provides a baseline inventory of citywide GI installations and impervious surfaces. CoM Green Infrastructure Plan: identifies various GI practices and potential financing mechanisms, prioritizes locations, formalizes policy changes, and recognizes stakeholders. CoM Green Streets Stormwater Management Plan: provides a menu of green street stormwater strategies through implementation with street and alley improvement projects.
Integrated Watershed Planning	CoM Sustainability Plan: sets goals and targets to improve the environmental, economic, and social conditions of Milwaukee's neighborhoods. MMSD Watercourse Management Plans: develop environmentally responsible, cost-effective flood management recommendations. SEWRPC Park and Open Space Regional Land Use Plan: integrates objectives with flood management planning through the comprehensive watershed plans, which also consider water quality impacts.
Preservation of Environmentally Sensitive Land	CoM Sustainability Plan: sets goals and targets to improve the environmental, economic, and social conditions of Milwaukee's neighborhoods. CoM BaseTern Feasibility Study: examined feasibility of converting basements of abandoned homes into stormwater management facilities and community gardens. Milwaukee Greenway Master Plan: identifies land parcels recommended for protection for multiple purposes—including flood reduction, stormwater management, wildlife habitat, water quality, and recreational benefits. MMSD Greenseams: uses public acquisition or conservation easements to permanently protect key lands containing water absorbing soils and prevent flooding/water pollution.

CoM: City of Milwaukee

Reference

City of Milwaukee. 2019. *Hazard Mitigation Plan Update. Preliminary Draft.* http://www.sewrpc.org/SEWRPCFiles/CommunityAssistance/CityMilwaukeeHazardMitigation/CAPR-282-3-City-of-Milwaukee-HMP-May-2019-Draft.PDF.

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Example Hazard Mitigation Plan That Includes Green Infrastructure, Low Impact Development, Nature-based Solutions, and Water Quality Protection (DRAFT)

Case Study: Green Infrastructure and Nature-based Solutions in Minnesota's Statewide Hazard Mitigation Plan*

Background on the Planning Effort

The Minnesota Hazard Mitigation Plan (HMP) evaluates, profiles, and ranks natural and human-caused hazards affecting the state as determined by frequency of event, economic impact, deaths, and injuries. This HMP was updated in 2019 by incorporating statewide risk assessments, local and tribal risk assessments and mitigation strategies, and additional recommendations from various mitigation stakeholders. The main planning groups are as follows:

Natural Hazards Addressed in Minnesota's HMP

- Riverine and flash flooding
- Wildfires
- Blizzards, tornados, and wind
- Extreme temperatures
- Bluff and coastal erosion
- Hailstorms, ice, and severe storms
- Drought

Minnesota Department of Public Safety, Division of Homeland Security and Emergency Management: lead agency for preparation of the state HMP, and serves as the lead agency for monitoring, evaluating, and updating the plan.

The Silver Jackets Interagency Group: serve as the state's natural hazards risk management team and is a federal/state interagency team composed of the U.S. Army Corps of Engineers, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, U.S. Geological Survey, and various state agencies.

Interagency Climate Adaptation Team (ICAT): aims to increase collaborative efforts among state agencies and focus attention on needed action to assist Minnesota with adapting to climate change.

University of Minnesota Duluth Geospatial Analysis Center (GAC): updates the state profile, natural hazard risk assessment, vulnerability assessments, and other sections of the plan, including mapping. GAC also aids in updating many of the state's county multi-jurisdictional HMPs.

Minnesota Pollution Control Agency (MPCA): directs many of the environmental programs that create co-benefits of increasing resilience and mitigating hazards.

Mitigation Strategies Involving Green Infrastructure and Low Impact Development

Mitigation action strategies for natural hazards are grouped into 6 categories. Green infrastructure/low impact development (GI/LID), nature-based solutions, and other water quality-related strategies/actions fall into the *Local Planning and Regulations and the Natural Systems Protection categories*.

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- **Local Planning and Regulations Strategy:** guides and influences the way land and buildings are developed and built, including capital improvement programs, open space protection, and stormwater management.
- **Natural Systems Protection Strategy:** aims to minimize hazard losses and preserve or restore the functions of natural systems.
    - Includes GI/LID practices, such as sediment control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration/preservation.
    - Acquisition of flood prone homes to create stream buffers, parkland, and open space is a high priority in the HMP due to frequent flooding and property damage/loss.

Minnesota's Mitigation Action Strategy Types

- Data
- Local Planning and Regulations
- Structure and Infrastructure Projects
- Natural Systems Protection
- Education and Awareness Programs
- Mitigation Preparedness and Response Support

Six Specific Action Items are related to mitigation, resilience, and climate adaption with GI/LID or nature-based systems. In addition, the plan includes many existing programs that use GI/LID or nature-based approaches to support the resilience component of hazard mitigation. Table 1 summarizes these resilience strategies and outlines associated programs.

Minnesota's Specific Action Items with Nature-based Mitigation

- Water-sensitive infrastructure required in all comprehensive and watershed plans
- Habitat preservation/restoration focus
- Agricultural water management strengthened
- Urban heat island reduction strategies
- Conservation partnerships expanded with NGOs
- Education and outreach supported

Elements for Successful Implementation

Minnesota adopts focused, stakeholder-based analytical programs to develop and implement the HMP, including actions involving GI/LID at local and state levels. Agency departments responsible for water quality; soil, water, and natural resources, homeland security and emergency management; agriculture; transportation; economic development; and local governance are key for HMP implementation. MPCA advocates the use of GI at various scales to increase resilience and mitigate hazards. ICAT uses Minnesota's climate adaptation policies and laws to meet hazard mitigation goals and plays a lead role in the integration of water quality resilience.

Table 1. Minnesota's HMP Strategies Using Nature-based Solutions and Watershed Planning

Approach	Key Programs and Capabilities Related to Environmental Protection
Stormwater Management	Stormwater Financial Assistance: provides assistance for public entities to improve infrastructure. Minimal Impact Design Standards: outlines best management practices (BMPs), performance goals, credit calculations, design specification, and ordinance guidance. Metropolitan Council's One Water Grant Program: provides solutions for community water problems in the Twin Cities region intended to provide multiple benefits, including an innovative pilot project.

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Approach	Key Programs and Capabilities Related to Environmental Protection
Agricultural Water Management	Agriculture BMP Loan Program: provides low-interest loans to implement agricultural BMPs. Agricultural Water Quality Certification Program: provides a voluntary opportunity to receive funding and certification for implementing conservation practices such as cover crops and no till.
Conservation and Restoration	Reinvest in Minnesota Wetlands Conservation easements and the Wetlands Reserve Program: restores wetlands, grasslands, and frequently flooded land through permanent conservation easements. Wetland Tax Exemption Program: provides a financial incentive to maintain wetlands and promote awareness of wetland values. Forest Stewardship: provides technical advice and forest management planning to private landowners while meeting landowner goals and maintaining sustainability.
Drinking Water Source Protection	MN Clean Water, Land and Legacy Amendment: includes a voter-mandated investment in the protection of drinking water sources and protection/restoration of lakes, streams, and groundwater. Drinking Water Protection Program: includes the River Health and Restoration Program and the Soil and Water Conservation Districts.
Integrated Watershed Planning	One Watershed, One Plan: includes the Minnesota Board of Water and Soil Resources' vision to align local water planning with measurable implementation plans.
Watershed Protection Programs and Nonpoint Source Pollution	Clean Water Partnership Loans: provides funds for implementing BMPs related to nonpoint source pollution. Section 319 Grant Program: provides funds for nonpoint source BMP implementation. Wastewater Program: provides information on engineering concepts and permitting and regulations. Wastewater Financial Assistance: includes flood guidance for wastewater treatment facilities. Clean Water Fund: provides federal loans for both point source and nonpoint source water pollution control projects prioritized by MPCA, including restoration and protection.
Water Quality Protection Programs	Great Lakes Restoration Initiative Funding: provides grants to encourage tree planting and maintain boulevards on the North Shore. Surface Water Monitoring: informs hazard mitigation planning by providing data about the potential impacts of extreme events on streamflow and water quality. MN Mandatory Buffer Law: provides natural system support by requiring perennial vegetation buffers along waterbodies.

Reference

Minnesota Department of Public Safety. 2019. *Minnesota State Hazard Mitigation Plan; Including Recommended Actions for Climate Change Adaptation.* Division of Homeland Security and Emergency Management. Approved: March 11, 2019; Adopted: March 18, 2019. https://dps.mn.gov/divisions/hsem/hazard-mitigation/Documents/2019-mn-hmp-only.pdf.

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Case Study: Green Infrastructure and Nature-based Solutions in Vermont's Statewide Hazard Mitigation Plan*

Background on the Planning Effort

Vermont's Hazard Mitigation Plan (HMP) aims to protect life, property, natural resources, and quality of life by reducing vulnerability to climate change and natural disasters. The 2018 HMP is a rewrite of the state's 2013 plan and focuses on lessons learned in the aftermath of Tropical Storm Irene, which caused devastating damage across the state.

Natural Hazards Addressed in Vermont's HMP

Fluvial erosion	Wind
Inundation flooding	Heat
Ice	Landslides
Snow	Cold
Drought	Wildfires

The Vermont Emergency Management (VEM) agency in the Department of Public Safety developed and coordinated the HMP. Approximately 70 distinct organizations participated in meetings to support the 2018 HMP; however, the HMP only specifically acknowledges the contributions of the State Agency of Natural Resource's Department of Environmental Conservation and The Nature Conservancy. The 16-person steering committee included representatives from the Agency of Natural Resources, The Nature Conservancy, the Vermont River Conservancy, the Agency of Agriculture, Food and Markets, and the High Meadows Fund, a local conservation non-profit.

It is noteworthy that three (out of four total) of the Vermont HMP's "Goals" cover environmental protection—a current rarity in state and local HMPs. These environmental goals are shown in the adjacent text box. The fourth goal was to enhance the resilience of the state's built assets, a focus of all HMPs.

Vermont's HMP Goals Encompassing Environmental Protection

- Protect, restore, and enhance Vermont's natural resources to promote healthy, resilient ecosystems
- Develop and implement plans and policies that create resilient natural systems, built environments, and communities
- Create a common understanding of—and coordinated approach to—mitigation planning and action

The planning process aimed to better integrate the work of state agencies with regional and local governments, as well as nonprofit and private partners. A key objective was also to improve local leaders' understanding of hazard mitigation strategies (including protecting water quality) and aid in the development of local HMPs. Several of the mitigation actions in the state HMP are intended to simplify the local HMP development process (Vermont Emergency Management 2018).

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Using the four goals, the steering committee developed five specific priorities, four of which have a significant potential for environmental protection, as shown in Table 1. Table 2 summarizes the nature-based solutions and watershed planning approaches in the HMP and outlines associated programs/capabilities available to the state.

Within the HMP, VEM conducted a vulnerability assessment to identify potential threats to people, property, the environment, and the economy that could result from a hazard event. Flood damages from storms, which are increasing in frequency and intensity, were identified as a significant natural hazard. Flood mitigation thus drives a significant portion of the broad strategies and specific actions in the HMP.

Mitigation Strategies Involving Green Infrastructure and Low Impact Development

Mitigation strategies and actions developed by the HMP steering committee focus heavily on environmental benefits associated with flood management, storm water management, and integrated watershed protection. Many of the goals, strategies, and action items in the plan have co-benefits that improve flood resilience, protect habitat connectivity, and improve water quality.

The Green Infrastructure Collaborative (GIC) partnership between Vermont's Department of Environmental Conservation (DEC) and the Lake Champlain Sea Grant Program at the University of Vermont is directly referenced in the HMP. The GIC aims to promote green infrastructure/low impact development (GI/LID) practices that can manage stormwater runoff from developed lands in Vermont watersheds. Cities and institutions in the state also have extensive experience implementing GI/LID.

Statewide, the DEC and several watershed, conservation, and natural resource groups have promoted river and stream buffers, naturalized floodplains, and infiltration practices for decades. These efforts, and others that seek to leverage better management of natural systems, are being incorporated into the state HMP. Several local HMPs reference the Lake Champlain total maximum daily load program when addressing nonpoint source pollution from stormwater runoff. Risks to the agriculture sector are also included in the state's HMP with considerations for both vulnerabilities of farms to natural hazards and hazards associated with unsustainable farming practices.

Elements for Successful Implementation

Vermont clearly recognizes the potential risk to communities, the built environment, and natural resources from climate change and associated extreme events. Vermont's HMP includes environmentally-based goals and aims to build resilience using GI and nature-based mitigation practices where possible. The result is a strategy devoted to a whole systems approach for flood mitigation. Measures that connect flood resilience, water quality, and natural habitat provide substantial co-benefits and are key components in the HMP.

Several state and local grant programs are expanded and leveraged to support these co-benefits. This helps support new projects on flood resilience, fluvial erosion mitigation, and water quality. The current realignment of Vermont's HMP strategies and actions provides a strong vision for the state to integrate water quality planning and hazard mitigation and fully realize associated co-benefits.

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Table 1. Vermont HMP Priorities with Environmental Protection Potential

Priority	Specific Actions Related to Environmental Protection
Develop a Cross-Sector Buyout Program	• Design a cross-sector program considering funding, ownership, use restrictions, incentives, stewardship, and prioritization. • Create a dedicated state fund to support the purchase or local match of hazard-prone properties and purchase of easements to conserve river corridors, floodplains, and wetlands identified as key flood attenuation areas. • Fund the Emergency Relief and Assistance Program for non-federal disasters and towns with adopted floodplain/river bylaws and to support the 25% non-federal match for buyouts. • Create and maintain a database of tax-sale/foreclosed properties located within the flood risk and river meandering maps to identify flood-vulnerable structures for acquisition. • Develop a benefit-cost methodology to facilitate buyouts in areas at risk from flood related erosion and outside of FEMA mapped Special Flood Hazard Areas.
Inventory and Protect Critical Headwater and Floodplain Storage Areas	• Work with land conservation organizations to include river corridor and floodplain protection provisions, and/or headwater storage in conservation easements. This includes the Nature Conservancy's *Water Quality Blueprint Tool*. • Develop an inventory of critical headwater and floodplain storage areas that would result in a measurable abatement of flooding. • Complete a pilot project in a strategic watershed, using the developed inventory, to prioritize land conservation and determine the cost of avoided damage. • Identify stormwater impaired headwater storage areas where stormwater treatment and stream restoration would result in hazard mitigation co-benefits.
Collaborate Across Flood Resilience, Water Quality, and Habitat Connectivity Programs and Funding	• Create a "Reconnect Vermont Rivers" initiative (or similar state planning, prioritization, and tracking mechanism) to enhance the funding eligibility and incentives for flood resilience, water quality, and habitat projects as co-benefits. • Develop hydraulic and stream power models to analyze and define valley areas and river corridor functions that would increase the storage of flood flows, sediments, and nutrients. • Promote the use of Vermont's Fish and Wildlife's Conservation Design Plan to achieve and maintain habitat connectivity and havens for Vermont rare, threatened, and endangered species.
Audit State Programs to Improve Support of Mitigation	• One stated outcome is to create resilient natural systems, built environments, and communities.
Improve Local Leaders' Understanding of Hazard Mitigation	• Complete avoided loss studies to better understand the positive impact of completed mitigation work, including the value of open space, forested, and conserved land. • Develop strategic capital budgeting training and materials to incorporate mitigation and water quality projects, explain the cost of no action, and include municipal liability concerns. • Promote and maintain technical support to communities to adopt river corridor bylaws, limit development in floodplains and river corridors, and participate in the Community Rating System.

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Table 2. Vermont's HMP Strategies Using Nature-based Solutions and Watershed Planning

Approach	Key Programs and Capabilities Related to Environmental Protection
Stormwater Management	VT DEC Green Infrastructure: promotes LID/GI for stormwater from developed lands. VT Better Roads Program: provides technical support and grant funding to municipalities for erosion control and protection of water quality. VT DEC Clean Water State Revolving Fund: funds Clean Water Projects in the form of low interest loans to municipalities.
Agricultural/ Forestry Water Management	UVM Extension - Center for Sustainable Agriculture: provides technical assistance to farmers on water quality improvements. VT AAFM - Required Agricultural Practices: provides management strategies to reduce the impact of agricultural activities on water quality. VT DFPR AMPs for Maintaining Water Quality on Logging Jobs: provide measures for the forestry sector to minimize potential discharges and comply with water quality standards. USDA funding sources: provide support for wetlands restoration, riparian buffers, soil improvement, and other water quality work.
Conservation and Restoration	VT DEC River Corridor Easement Program: provides financial incentive to landowners to allow for passive restoration of channel stability. Statewide River Corridors Risk Analysis & Hazard Mitigation Prioritization Tool: includes conservation; for use by the state, regional, and local governments, funded by Vermont (multi-agency) & FEMA's Hazard Mitigation Grant Program. VT Dam Screening Tool: prioritizes dams for removal based on ecological impact to fish passage in the Lake Champlain Basin (VT) with The Nature Conservancy as a partner.
Integrated Watershed Planning and Nonpoint Source Pollution	VT Watersheds Grants: provides funding and integrates state actions with federally funded mitigation projects with water quality and hazard mitigation co-benefits. VT DEC Water Initiative Program: funds projects that restore and protect waterbodies from nonpoint source runoff/pollution. VT DEC Ecosystem Restoration Grant Program: funds priorities that restore and protect waterbodies from nonpoint source runoff/pollution. VT Standard River Management Principles and Practices: supports flood recovery implementation and best river management practices. VT Shoreland Protection Act & Permitting: regulates shoreland development within 250 feet of lakes/ponds. High Meadows Fund - Watershed Collaboration Grant Program: funds cross-community collaboration on watershed projects. (*Non-profit watershed protection fund*) Lake Champlain Basin Program - Grants: supports implementation of local projects that benefit the lake. (*Non-profit watershed protection fund*)

VT: Vermont; UVM: University of Vermont; AAFM: Agency of Agriculture, Food and Markets; DFPR: Department of Forests, Parks and Recreation; AMP: Acceptable Management Practices.

Reference

Vermont Emergency Management. 2018. *Vermont Stronger: Vermont State Hazard Mitigation Plan*. https://vem.vermont.gov/sites/demhs/files/documents/2018%20Vermont%20State%20Hazard%20Mitigation%20Plan%20-%20Final%20Adopted_Interactive.pdf.

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