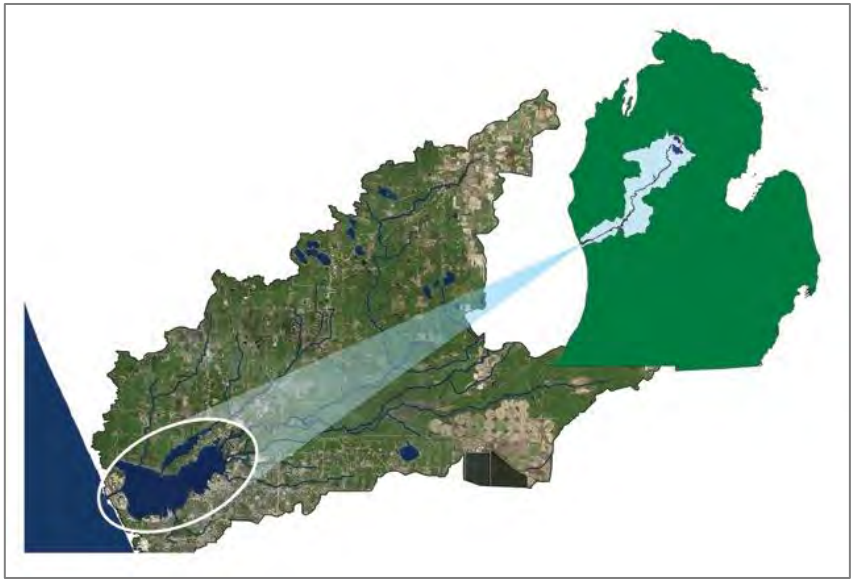
MLWP
Muskegon Lake
Watershed Partnership

Muskegon Lake Action Plan

2018 – 2025



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Muskegon Lake Watershed Partnership – Background, Purpose and Mission

The Muskegon Lake Watershed Partnership (MLWP) is a coalition of community interests dedicated to working cooperatively for the remediation, restoration and revitalization of the Muskegon Lake Watershed ecosystem, including the delisting of Muskegon Lake as a Great Lakes Area of Concern.

The MLWP's geographic focus is primarily within the immediate watershed area of Muskegon Lake, its tributaries and the Cedar Creek, Mosquito Creek and Brooks Creek watersheds.

Formed in 1992, the MLWP hosts monthly, public meetings and is organized exclusively for charitable, educational and scientific purposes that support revitalization of the ecosystem.

The MLWP partners with local, state and federal agencies and non-governmental organizations to obtain and disseminate information concerning Muskegon Lake watershed issues of interest. The MLWP provides a forum for discussion of those issues, initiates, facilitates, coordinates and implements plans and actions to improve the Muskegon Lake ecosystem.

The Muskegon Lake Watershed Partnership (MLWP) strives to maintain a diverse and balanced representation of voting stakeholders to reflect the nature and the needs of the Muskegon Lake watershed community. Membership categories include academia, business and industry, conservation and natural resources, general public, public sector, volunteer and philanthropic interests. MLWP membership is available to Muskegon Lake watershed stakeholders, including but not limited to property owners, municipal staff, elected officials, economists, agriculturalists, recreationalists, environmentalists, scientists and representatives of the general public, academic institutions, foundations, utilities, industries, neighborhood associations, churches, businesses, and community service clubs.

Purpose of the Muskegon Lake Action Plan

The Muskegon Lake "Action Plan" is a community-based plan, designed to facilitate the continuation of coordinated, natural resources stewardship of Muskegon Lake and Lower Muskegon River Watershed. It builds upon the restoration progress made under the Great Lakes Areas of Concern (AOC) program and other voluntary and regulatory cleanup programs.

The management actions contained in the Muskegon Lake AOC Remedial Action Plan (RAP) will be met in 2019. The lake will be removed from the list of Great Lakes AOCs by 2020, once final cleanups and restoration projects have been completed. The RAP, an ecosystem-based plan, addresses priorities for contaminated sediment cleanup, habitat restoration, water quality improvements and more. However, the RAP does not set long-term goals for everything needed to restore and protect the lake's water resources. Great Lakes RAP goals are short term, by design. While the Muskegon Lake RAP process has been very effective, it was meant only to bring Muskegon Lake to an environmental condition similar to other non-AOC water bodies.

The Muskegon Lake EMP will seamlessly replace the RAP as the watershed community's guiding document for ecosystem management of the Muskegon Lake watershed and for the protection of its natural resources.

The action plan is to be used, both now and into the future. It can be used to plan watershed improvement projects and stewardship activities by community organizations, academia, agencies, businesses, conservation groups, general public, local governments, students, watershed groups and other stakeholders. The Muskegon Lake Watershed Partnership (MLWP) will track progress as plan projects are developed and carried out. Monthly public meetings will be held to take public input, collaborate with partners and report on progress.

The plan was created with broad input from the general public, scientists, natural resources managers, landowners and other stakeholders. It can be used by organizations who wish to design, implement and fund water quality and natural resources improvement projects, and to demonstrate community input and support for projects designed to meet the plan's desired outcomes. Many of the plan's goals, outcomes, indicators and targets support the goals of other Great Lakes restoration plans, including the Great Lakes Action Plan II, Lake Michigan Lake Action Management Plan, Michigan Water Strategy, National Oceanic and Atmospheric Administration Muskegon Lake Habitat Focus Area Implementation Plan, Muskegon River Watershed 319 Management Plan, and the Michigan Department of Natural Resources Fisheries Management Plans for the Muskegon River, Muskegon Lake and the Lake Michigan watershed.

Muskegon Lake Watershed

Background, Current Status and Progress

Muskegon Lake is 4,232-acres in size and is part of the Great Lakes coastal wetlands in the Lake Michigan Watershed. It is a drowned river mouth lake, formed by dynamic interactions of the Muskegon River and Lake Michigan's shifting sand dune shoreline. The Muskegon River discharges to Lake Michigan through Muskegon Lake. Its channel is maintained for recreational and commercial navigation. Muskegon Lake's shoreline along Lake Michigan is within the largest assemblage of freshwater sand dunes in the world.

Muskegon Lake was designated a Great Lakes Area of Concern (AOC) in 1985 by state and federal agencies because several of its beneficial uses were impaired. Impairments were caused by historic industrial disposal practices and shoreline land use alterations and practices that filled shallow shoreline waters and adjacent wetlands. Although the Muskegon County Wastewater Management System greatly improved water quality during the mid-1970s, ecological problems remained.

Since 1992, community groups, governmental and nongovernmental organizations have worked collaboratively to improve water quality, remediate contaminated sediments and restore and protect fish

and wildlife species and their habitats. Strong partnerships and stakeholder forums exist in the AOC to support, guide and sustain the habitat restoration projects, including technical assistance for monitoring. The AOC has enjoyed strong support from federal, state and local agencies, universities and conservation groups.

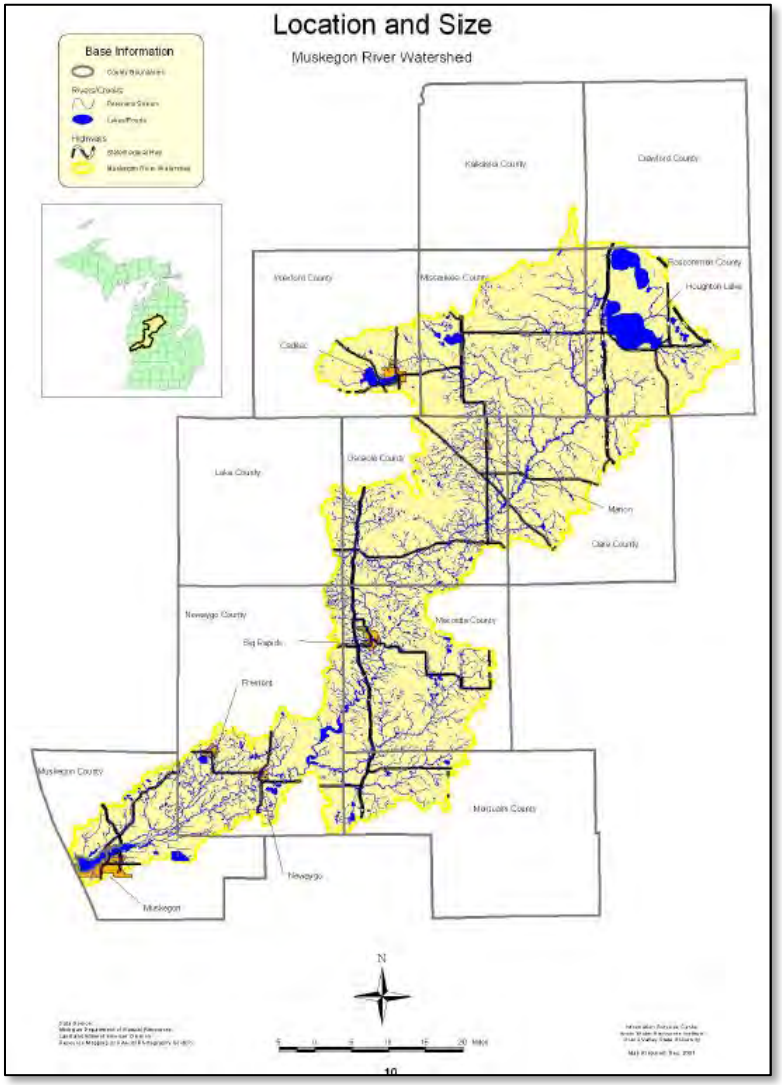
Progress made over the past decade included remediation of contaminated sediments and restoration of fish and wildlife habitat. During that time, approximately $40 million was invested. From 2015-2020, an additional $33 million from the Great Lakes Restoration Initiative (including Great Lakes Legacy Act) will implement the final projects needed to remove Muskegon Lake's Great Lakes AOC designation.

Muskegon River Watershed

The Muskegon Lake Watershed is part of the larger Muskegon River Watershed, which encompasses 2,700 square miles. The Muskegon River is 219 miles in length. It flows from Higgins and Houghton Lakes to its mouth at Muskegon Lake. Approximately 94 tributaries drain into the Muskegon River. It is the second longest river and third largest watershed in Michigan.

Muskegon Lake is a drowned river mouth that covers approximately 4,232 acres. Tributaries that drain directly into Muskegon Lake include the Muskegon River, Ruddiman Creek, Ryerson Creek, Green Creek, and Bear Lake. Other tributaries within Muskegon County drain into the lower Muskegon River. They include Four Mile Creek, Mosquito Creek, Cedar Creek, Brooks Creek, and the Maple River.

Non-Point Source Water quality goals for Muskegon Lake and the entire Muskegon River Watershed have been identified in the Muskegon River Section 319 Watershed Management Plan. It identifies designated uses, best management practices and educational needs. The Muskegon Lake Stormwater Management Plan, Remedial Action Plan and other sub-watershed plans also address water quality and the best management practices needed to improve fish and wildlife habitat and other ecosystem assets.



Action Plan Overview

Outcomes, Recommendations, Indicators, Partners

The Muskegon Lake Action Plan identifies watershed improvement activities in an ecosystem format. It provides a framework for planning, prioritization and implementation of activities that meet local needs and the goals and priorities of overarching statewide and regional plans, including the Great Lakes Restoration Action Plan, Lake Michigan Fisheries Management Plan, Lake Michigan Lake Action Management Plan, West Michigan Great Lakes Stewardship Initiative, Muskegon River 319 Watershed Management Plan, West Michigan Cooperative Invasive Species Management Area, Michigan Water Strategy, NOAA Muskegon Lake Habitat Focus Area Implementation Plan - and others. This document is a tool to assist organizations and individuals in the preservation, protection, and improvement of Muskegon Lake and its watershed resources.

The Muskegon Lake Watershed Partnership determined that Action Plans for each of the following ecosystem components will help guide planning, monitoring and implementation of Best Management Practices for the continued improvement and sustainability of the Muskegon Lake watershed ecosystem:

1. **Coastal Resiliency**
2. **Education**
3. **Fish and Wildlife Habitat**
4. **Water Quality, Green infrastructure and Stormwater Management**
5. **Groundwater Resources**
6. **Site Remediation and Revitalization**
7. **Non-Native Invasive Species and Biodiversity**
8. **Public Access to Water Resources**
9. **Public Involvement and Input to Decision-making**
10. **Research and Monitoring**
11. **Stewardship and Hands On Opportunities**

The following chapters include **"action plans"** for each ecosystem component. The action plans were developed with broad community input, through a series of public meetings and focus groups. Each action plan includes outcomes, implementation recommendations, measurable indicators and potential project partners.

The Action Plan can be used by individuals and organizations to identify needs, projects, volunteer involvement, and support for grant proposals.

1. Coastal Resiliency and Sustainability

Background, Need and Status:

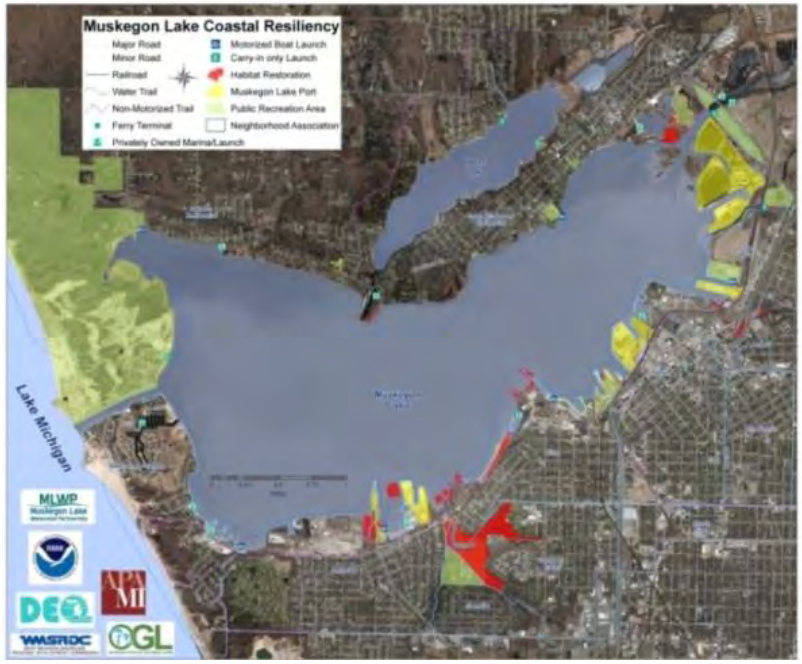
The Muskegon Lake Watershed Partnership (MLWP) determined the need to advance watershed resiliency to protect native habitat along shorelines and tributaries, and the public access and recreational amenities that support public interaction with water resources.

Coastal resiliency and sustainable decision-making were determined to be fundamental planning principles during the development of **Muskegon Lake Vision 2020** in 2015. In 2016, the MLWP also supported the development of the **Muskegon Lake Coastal Resiliency Plan**.

Sustainable planning, policy and management efforts will be needed to ensure coastal resiliency and to protect the integrity of past remediation and restoration investments throughout the Muskegon Lake Watershed.

Resilience means building the ability of a community to "bounce back" after hazardous events such as coastal storms and flooding – rather than simply reacting to impacts. Resilience is the ability to prevent a short-term hazard event from turning into a long-term community-wide disaster.

Resilient watersheds and shorelines also provide ecological services that are freely gained from the natural environment such as flood control, air quality, fish production and cultural, aesthetic, spiritual, recreational, educational and therapeutic benefits. For instance, services provided by wetlands could include groundwater recharge, flood storage, water supply, water quality benefits through filtration of sediments and absorption of nutrients, wildlife habitat, food production and a host of other valuable services.



The **Muskegon Lake Coastal Resiliency Plan** identified vulnerabilities and threats to shoreline resiliency. It includes recommendations for the protection of assets in the areas of natural resources, recreation, residential and commercial/port.

In December, 2017, the Federal Emergency Management Agency (FEMA) performed **Risk Mapping, Assessment, and Planning for the Muskegon River Watershed**. The program enables state and local governments to take preemptive measures that will minimize the increasing risk and losses from natural hazards. Many watershed communities expressed interest in mitigation activities to minimize risk. Some expressed an interest in pursuing mitigation efforts on repetitive loss properties. Communities also expressed concerns over roadway and property flooding associated with undersized and/or antiquated stormwater infrastructure. Additionally, concerns were shared about dam safety with regard to structure, as well as a desire to obtain a better understanding of the related risk.

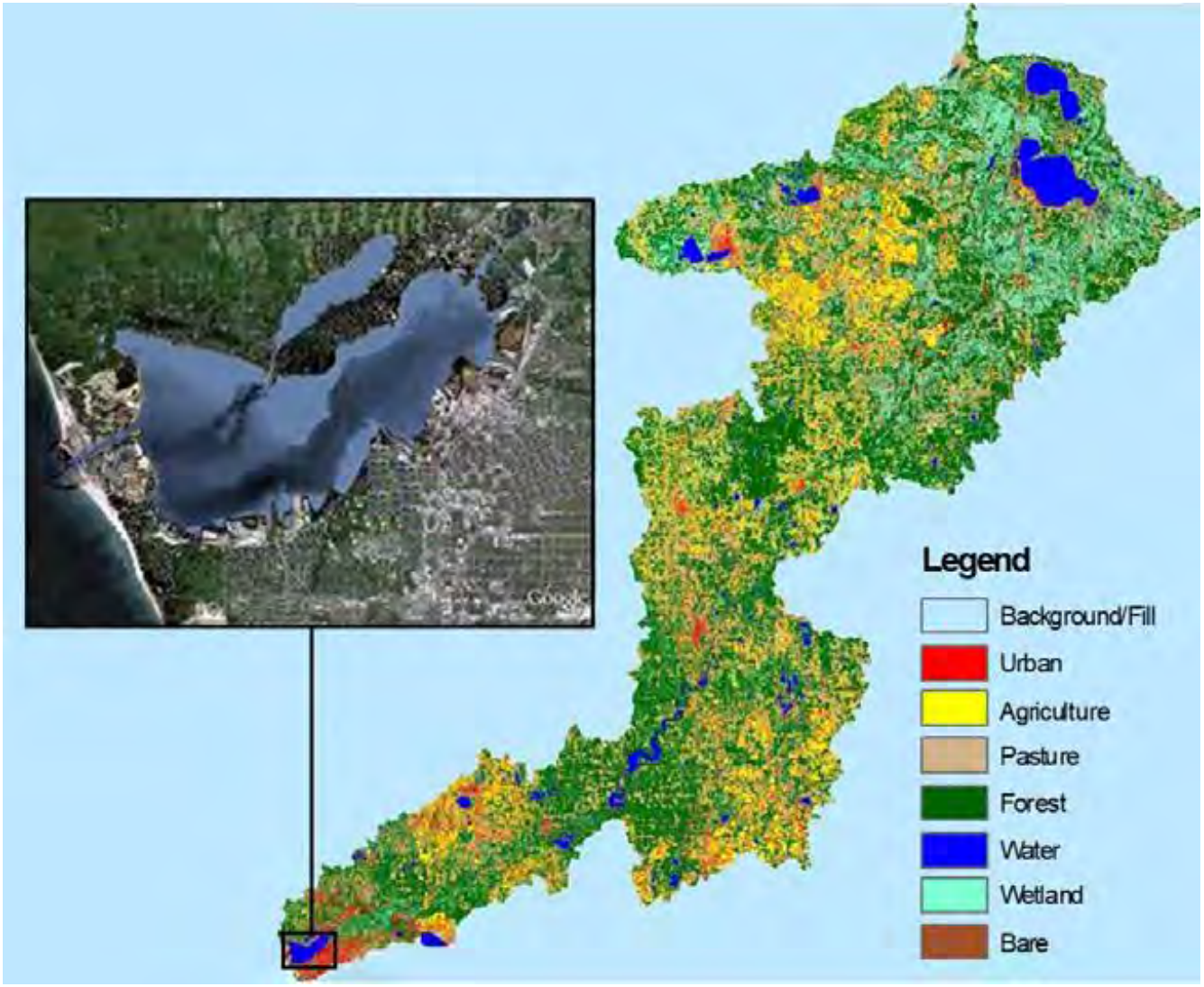
In 2015, WMSRDC completed a **Hazard Mitigation Plan for Muskegon County.** The plan was created to protect the health, safety, and economic interests of residents by reducing the impacts of natural and technological hazards through hazard mitigation planning, awareness, and implementation. Hazard mitigation is any action taken to permanently eliminate or reduce the long-term risk to human life and property from natural and technological hazards.

The majority of Muskegon River Watershed communities have received recent countywide Flood Insurance Rate Map (FIRM) updates under the Federal Emergency Management Agency's (FEMA) Map Modernization Program. Many participate in the National Flood Insurance Program (NFIP), which is designed to make communities more resilient in the face of disaster.

1. Coastal Resiliency and Sustainability – Goal: Land use, recreation, and economic activities are sustainable and supportive of a healthy ecosystem

Outcome: Aquatic ecosystems and natural resources are resilient, diverse and providing ecological services

#	Implementation Recommendations	Indicators	MLWP with Partners
1	Complete resiliency and adaptive management plans for Muskegon River sub-watersheds and shorelines	Land use policies support resiliency projects; Assets are managed and monitored	Local Governments, WMSRDC, Delta Institute, Michigan Association of Planners
3	Protect and maintain recreational, commercial, port and green infrastructure assets (built and natural)	Survey results from recreational and port users	Private Landowners, Local Governments, WMSRDC
4	Develop an infrastructure asset management plan to ensure a safe, healthy, resilient harbor	Plan is completed and assets are monitored and managed	West Michigan Port Operators, Local Governments, WMSRDC
6	Establish funding for ongoing monitoring and maintenance	Funding availability	Local Governments, Donors, Community Foundations,
7	Update land use policies to provide ecological services through natural resources setbacks, buffers	Amount of development plans with natural features included	Business Community, WMSRDC, Local Governments,
8	Seek Michigan's Natural Rivers designation for the Muskegon River or appropriate sections of river	Protected River Segment	MRWA, MDNR, Townships
9	Utilize Farmland Open Space Preservation Programs & USDA NRCS programs to reduce pollution loadings	Acres protected	USDA-NRCS, MDARD, Conservation Districts, Townships, Landowners
10	Amend and implement zoning ordinances to protect sensitive areas from development-related alterations	Acres of wetlands and lengths of riparian areas protected	Local Governments, Townships, WMSRDC
11	Upgrade stormwater infrastructure to prevent damage from severe weather (vegetative and built)	Storage capacity; Reduced financial and resource impacts	Local Governments, USACE, Developers, MDOT
12	Identify wetland restoration/creation areas; Reduce flashy drainage flows through green infrastructure.	Percent impervious surface; Green infrastructure and wetland effectiveness	Local Planning Commissions, Drain Commissioners, WMSRDC, MDEQ
13	Recreational areas provide for seasonal water flows and storage.	Gallons of water storage capacity at recreational sites	WMSRDC, Planning Commissions, MDEQ
14	Develop forest stewardship plans to maintain stable watershed hydrology in urban and rural areas.	Forest stewardship plans for priority sub-watersheds	WMSRDC, GVSU, MRWA, Conservation Districts



Muskegon River Land Use Map and Location of Muskegon Lake, Courtesy GVSU AWRI

2. Great Lakes Literacy and Natural Resource-Based Education

Background, Need and Status:

Great Lakes Literacy is an understanding of the Great Lakes' influences on you and your influence on the Great Lakes. Natural resources education for a wide audience of watershed stakeholders will help ensure the integrity of the ecosystem and its ability to function in ways that will provide beneficial ecosystem services. The following stakeholders were identified as priority audiences for targeted, continuing education:

Landowners	*General Public*	*Muskegon Community*	*Higher Education*
	Developers	*College*	*Philanthropists*
Local Governments	*Business Community*	*K-12 Schools*	*Recreational User Groups*

Many organizations provide educational programming to serve these audiences. The following are a few examples:

The GVSU Annis Water Resources Institute **Water Resources Outreach Education Program** offers students an educational experience that supports the Michigan K-12 Science Standards. Students experience hands-on science aboard the W.G. Jackson Research Vessel while monitoring Lake Michigan and Muskegon Lake. The Muskegon Area Intermediate School District Math Science Center coordinates the **West Michigan Great Lakes Stewardship Initiative**, offering students a variety of hands-on, real world opportunities to study water, experiment and restore water quality and natural resources.

The Michigan Department of Natural Resources offers the **Gillette Sand Dune Visitor Center School Programs** on topics that promote awareness of natural resources, an understanding of ecological processes, and a hands-on experience in the sand dunes. The program emphasizes the values of public lands and it promotes the role of students as resource stewards.

Michigan State University and Michigan Sea Grant, in partnership with Lawrence Technological University, offer **Water School: Essential Resources for Local Officials.** This program targets local elected and appointed officials. It is a policy-neutral, fact-based program. The program's objective to provide local decision makers with critical, relevant information needed to understand Michigan's water resources, including the fundamentals of water science, in order to support sound water management decisions and increase awareness of current and future local and state water issues.

2. Education on Natural Resources - Goal: Increase the number of citizens with knowledge and an understanding of water literacy principles.

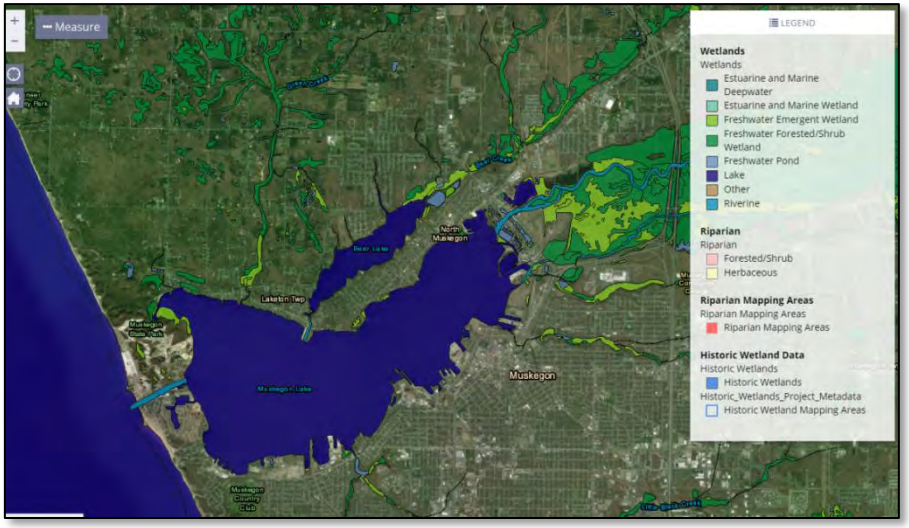
Outcome: Individuals and communities understand their responsibility for and make informed and responsible decisions regarding water resources

#	Implementation Recommendations	Indicators	MLWP with Partners
1	Landowner education and training on natural resources Best Management Practices (BMP)	Number of landowners with shoreline buffers and wetlands	Conservation Districts, MRWA
2	Integrate water literacy and experiential learning into State of Michigan and ISD curriculum standards	Number of K-12 schools in MAISD Math/Science GLSI	MAISD/GLSI, AWRI, Sea Grant, Michigan Legislature
3	Citizens and officials receive education to increase water literacy knowledge and understanding	Number of people attending educational trainings	Conservation Districts, MRWA, MSU-E, Sea Grant
4	Land use planners are educated on low impact development and green infrastructure policies	Sustained public education for adult decision-makers	Local Governments, WMSRDC, WMEAC, Delta Institute, MSU
5	Sustain public awareness and information on historic locations with known environmental conditions	Topic of an annual, MLWP public meeting presentation	Lakeshore Museum Center, GVSU AWRI, NOAA, WMSRDC
6	Non-native, invasive plant management education is available to landowners and park maintenance staff	Community organizations provide education, annually	MCD, WMCN, MERES, MLWP Shoreline Stewards
7	Technical support and funding is available for volunteers and landowners to perform hands-on restoration and maintenance of natural resources	Community organizations provide support, annually	MCD, CFFMC, WMCN, MLWP Partner Grants
8	W.G. Jackson Research Vessel education programs serve K12 and adult audiences	Number of K-12 and adult trips, annually	GVSU AWRI, Sea Grant
9	Muskegon Community College environmental curriculum and undergraduate education is promoted	Number of students registered for Life Science biology classes and summer programs	MCC Life Science Dept., MAISD, High Schools
10	Expand and promote student, natural resource-related internships	Number of students involved	GVSU AWRI, MCC, Schools, WMSRDC, NOAA, NRCS
11	Assess and define a baseline and goal for environmental literacy	Education level of environmental literacy	GVSU, MAISD Math/Science Center, Muskegon Area Sustainability Coalition

3. Fish and Wildlife Habitat

Background, Need and Status:

Muskegon Lake has very diverse fisheries. Muskegon Lake and its fish and wildlife habitat are also integral to maintaining the fisheries in Muskegon River and Lake Michigan. The connectivity of this system is critical to the native fisheries, including most of the important sport fish that need all three of these areas for survival. Muskegon Lake is part of the Great Lakes coastal wetlands system. According to the Michigan Department of Natural Resources Fisheries Division (MDNR), the primary resource concerns for Muskegon Lake are fisheries habitat protection and restoration, and maintaining and improving public access.

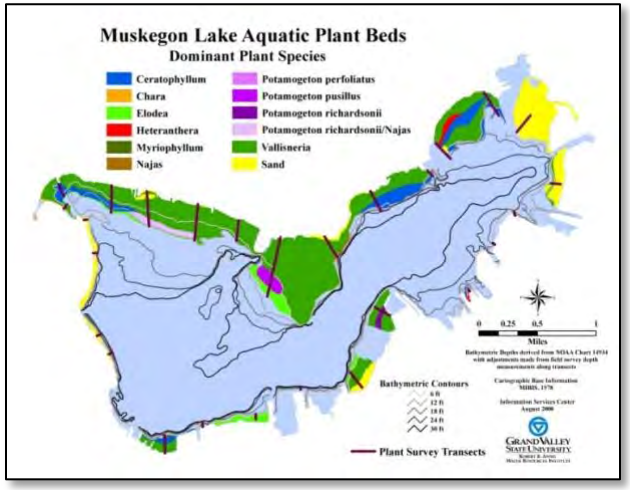


The MLWP determined that the development of a new Muskegon Lake Fish and Wildlife Habitat Restoration and Management Plan will be needed to guide future actions for a healthy fishery. The existing **Muskegon Lake AOC Fish & Wildlife Habitat Restoration & BUI Removal Strategy** addresses only the AOC needs. Most of its goals have been reached. Guidance available from the MDNR Fisheries Division and other sources will be used to develop the new plan. It will support objectives contained in the **NOAA Implementation Plan for the Muskegon Lake Habitat Focus Area,** the **Lake Michigan Fisheries Management Plan,** as well as long-term stewardship goals to sustain habitat restored under previous NOAA and EPA **Great Lakes Restoration (GLRI) Initiative** investments. In addition, stakeholders are exploring the potential for a **NOAA National Estuarine Research Reserve System** (NERRS) designation for Muskegon Lake and other drowned river mouth coastal wetland estuaries along Lake Michigan's eastern shoreline.

The MDNR conducted angler surveys and dollar estimates in the Muskegon River Watershed in 2015. Estimates are based on $39/angler-day (Lake Michigan) and $29/angler-day (inland waters) from the National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S. Fish & Wildlife 2001). **Muskegon Lake Fisheries Resource Summary, June 1, 2015**

The following list includes some of the Muskegon Lake's economically important sport fish:

- Walleye – largest spawning population in Lake Michigan south of Green Bay
- Chinook salmon – greatest amount of natural reproduction in Lake Michigan (Muskegon River)
- Steelhead - very high catch rates compared to other Michigan streams
- Lake Sturgeon – originally very abundant with remnant population in restoration phase
- Yellow Perch – Good fisheries and important production of young for Lake Michigan
- Largemouth and Smallmouth Bass – heavily used by anglers including tournaments
- Bluegill, Sunfish, Pumpkinseed, Crappie and Catfish – Good fisheries for recreational and subsistence fishery for urban and low income residents



The 2008 **Muskegon Lake AOC Fish and Wildlife Habitat Restoration and BUI Removal Strategy** set targets and criteria for the amounts and types of aquatic habitat restoration needed to remove Muskegon Lake from the list of Great Lakes AOCs. Nearly 800 acres of Muskegon Lake and associated wetlands were filled and converted to land. Additional lake fill (sawmill wood waste) also covers substantial lake bottom areas. Significant progress was made to restore shoreline habitat between 2010 and 2017. This resulted in the restoration of 60.9 acres of open water wetland, 27.6 acres of emergent wetland, removal and improvement of 86.6 acres of unnatural lake fill and the softening of 24,776 feet of shoreline with native, emergent wetland and shoreline buffer zone plantings.

The socio-economic benefits of a $10 million dollar NOAA ARRA investment to restore the south shoreline of Muskegon Lake were studied and quantified in a study by Grand Valley State University, **Muskegon AOC Habitat Restoration Socio Economic Assessment.** The project yielded a 6.6-to-1 return on the investment in economic benefits, including an increase in the number of recreational visitors, property values and revenues from increased water-based recreation spending.

Implementation of the **Michigan Lake Sturgeon Rehabilitation Strategy** will provide additional benefits to natural resources and the economy.

3. Fish and Wildlife Habitat – Goal: Habitats healthy, naturally diverse, and sufficient to sustain viable biological communities

Outcome: Sustainable and abundant aquatic life – habitat and populations are stable or increasing

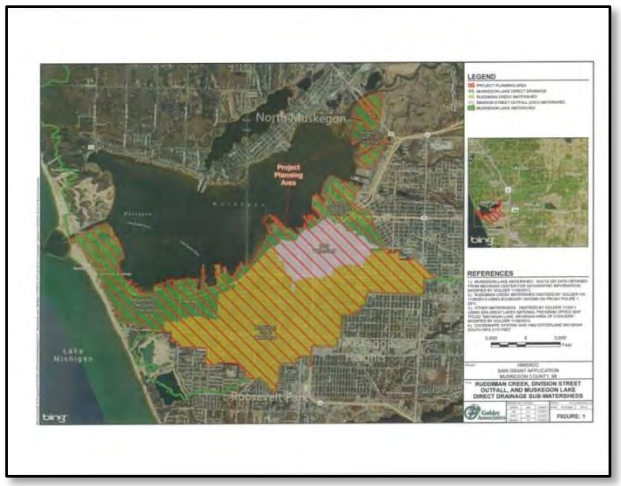
#	Implementation Recommendations	Indicators	MLWP with Partners
1	Coldwater species are present and thriving with no net loss of cold water habitat due to water withdrawals and habitat manipulations; Cold water systems are identified and quantified	Critical habitat is identified, restored and preserved (amount and biodiversity)	Trout Unlimited, MRWA, Federal Agencies, MDNR Fisheries, Tribes, Conservation Districts, GVSU AWRI
2	Sturgeon populations are rehabilitated in Muskegon Lake and its tributaries (in support of Michigan's Lake Sturgeon Rehabilitation Strategy)	Fish and wildlife populations and abundance are restored and protected	MDNR Fisheries, MRWA, Great Lakes Tribes, Federal Agencies, Muskegon Conservation District, GVSU AWRI, Sea Grant
3	Dredging, filling and disposal are regulated by local, state and federal policies to prevent degraded bottom habitat and water quality	Aquatic habitat is restored and protected (emergent wetlands, benthos and macrophytes)	Local Governments, State and Federal Regulatory Agencies, WMSRDC
4	Increase and improve fish and wildlife habitat for warm water, game and forage species	Fish and wildlife meets the subsistence needs of local community and economy; Populations are self-sustaining	Sportfishing associations, MDNR Fisheries, MDEQ, Tribes, MRWA, Muskegon Conservation District, WMSRDC, Federal Agencies
5	Local land use policies protect restored habitats and other habitats to ensure that life cycle needs of native fish and wildlife are met	Fish and wildlife habitat and travel corridors are identified and critical habitats protected or restored	MSU-E, Sea Grant, WMSRDC, Delta Institute, local governments, Land Conservancies, WMSRDC
6	Track and map the presence and integrity of all habitats & species (wetlands, open water, terrestrial)	Habitat change (integrity, loss/ gain) (AL says too ambitious)	WMSRDC, TNC, GVSU AWRI, MRWA, State & Fed. Agencies
7	Coordinate with natural resources agencies to ensure a robust population of fish, accessible and free of contaminants	Public satisfaction of fisheries, (Creel Census and Angler Surveys)	MDHHS/Eat Safe Fish, Health Departments, State & Fed. Agencies, AWRI, Tribes
8	Protect, monitor and restore cold water tributaries to support native fisheries (more specificity to restore-AL)	Water temperature, chemistry, sedimentation, and hydrology	State & Fed. Agencies, TU, GVSU AWRI, NOAA GLERL

9	Lake trout are naturally reproducing and supporting wild-fish based fisheries in Lake Michigan (outside purvue of Muskegon Lake-AL)	Stocking records indicate Self-sustaining populations	Great Lakes Tribes, MDNR Fisheries, Sea Grant, NOAA, Commercial and Sport Fisheries, GVSU AWRI, MSU
10	Formal and informal educational experiential programs are provided to all watershed stakeholders	A citizenry that is involved and educated on the fundamentals of healthy habitats – HOW?	GVSU AWRI, MAISD, MLWP Conservation Districts, MSU, U of M, TNC, MDNR
11	Monitoring supports a self-sustaining native sport fishery and a healthy commercial fishery	Fisheries diversity and abundance	MDNR Fisheries, GVSU AWRI, NOAA, USFW, MSU, U of M,
12	Implement greenways and wildlife corridors to connect isolated and fragmented habitats, wetlands and water resources	Shoreline/Stream Corridor Setbacks; Connectivity of natural resources	Local Governments, WMSRDC, Landowners, MDOT, MDNR, Land Conservancy of West Michigan, TNC
13	Identify, prioritize and protect quality native habitats in critical, functioning sub-watershed areas	Biodiversity/floristic quality assessment	Land Conservancy of West Michigan, TNC, Landowners

4. Water Quality, Green infrastructure & Stormwater

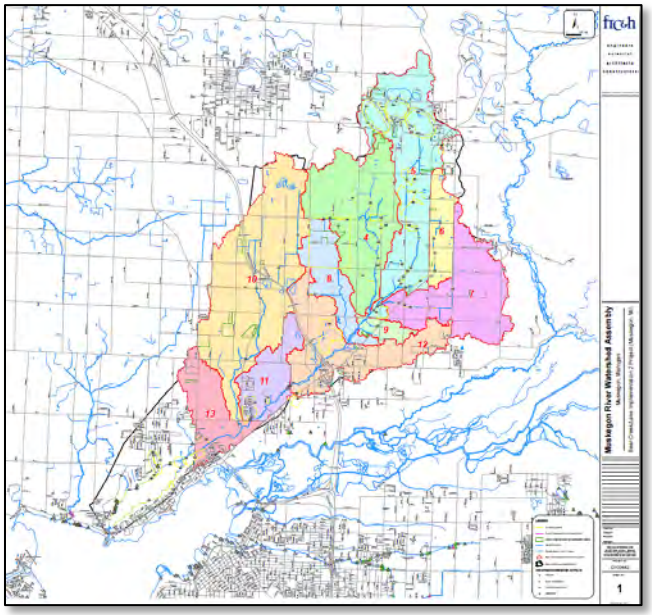
Background, Need and Status:

The quality of Muskegon Lake and its surface water resources are critical to the region's environmental, social and economic health. Efforts to integrate green infrastructure to manage stormwater runoff have included a 2015-2017 MDEQ Stormwater Asset Planning project and a City of Muskegon U.S. EPA Shoreline Cities Green Infrastructure implementation project. The **Watershed Management Plan** focused on the urban storm drainage system along the south shoreline of Muskegon Lake and the sub-watersheds of Ruddiman Creek and Division Street Outfall (historically, Beidler's Creek).

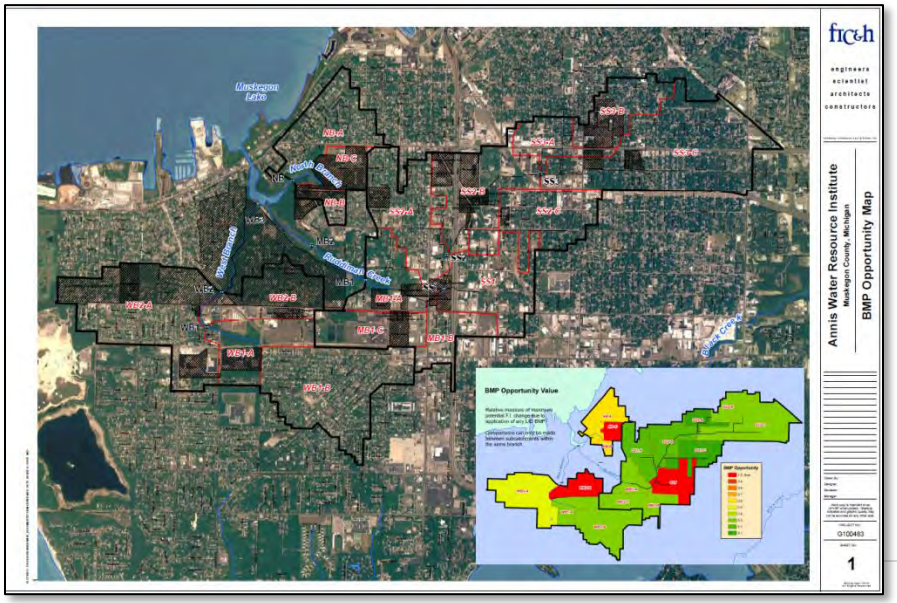


Along the south side of Muskegon Lake and the Lakeshore Trail bike path, several large-scale NOAA / EPA grant-funded projects were implemented to restore fish and wildlife habitat, while enhancing water quality, scenic views and recreational opportunities. Native plant rain gardens were established near the Grand Trunk boat launch ramp to control stormwater runoff. GVSU Annis Water Resources Institute, Lakeshore Area Chamber of Commerce, LaFarge and others have implemented rain gardens, green roofs and native plant landscapes that help infiltrate and filter stormwater on their properties, before it discharges to Muskegon Lake.

In the Bear Lake watershed, Best Management Practices (BMPs) have been implemented to control stormwater runoff and reduce nutrient inputs to Bear Lake. BMPs have been funded through implementation of the **Bear Creek 319 Watershed Management Plan**, and under a NOAA Great Lakes Restoration Initiative wetland habitat restoration project at a former celery farm, located at the mouth of Bear Creek at Bear Lake. Muskegon County acquired two NOAA/MDEQ land acquisition grants to acquire the former celery farm parcels for the purpose of restoration. GVSU AWRI completed the **Bear Creek Nutrient Monitoring Study** for this project and the USGS completed a related Groundwater Flux and Nutrient Loading Study of Bear Lake in 2015.

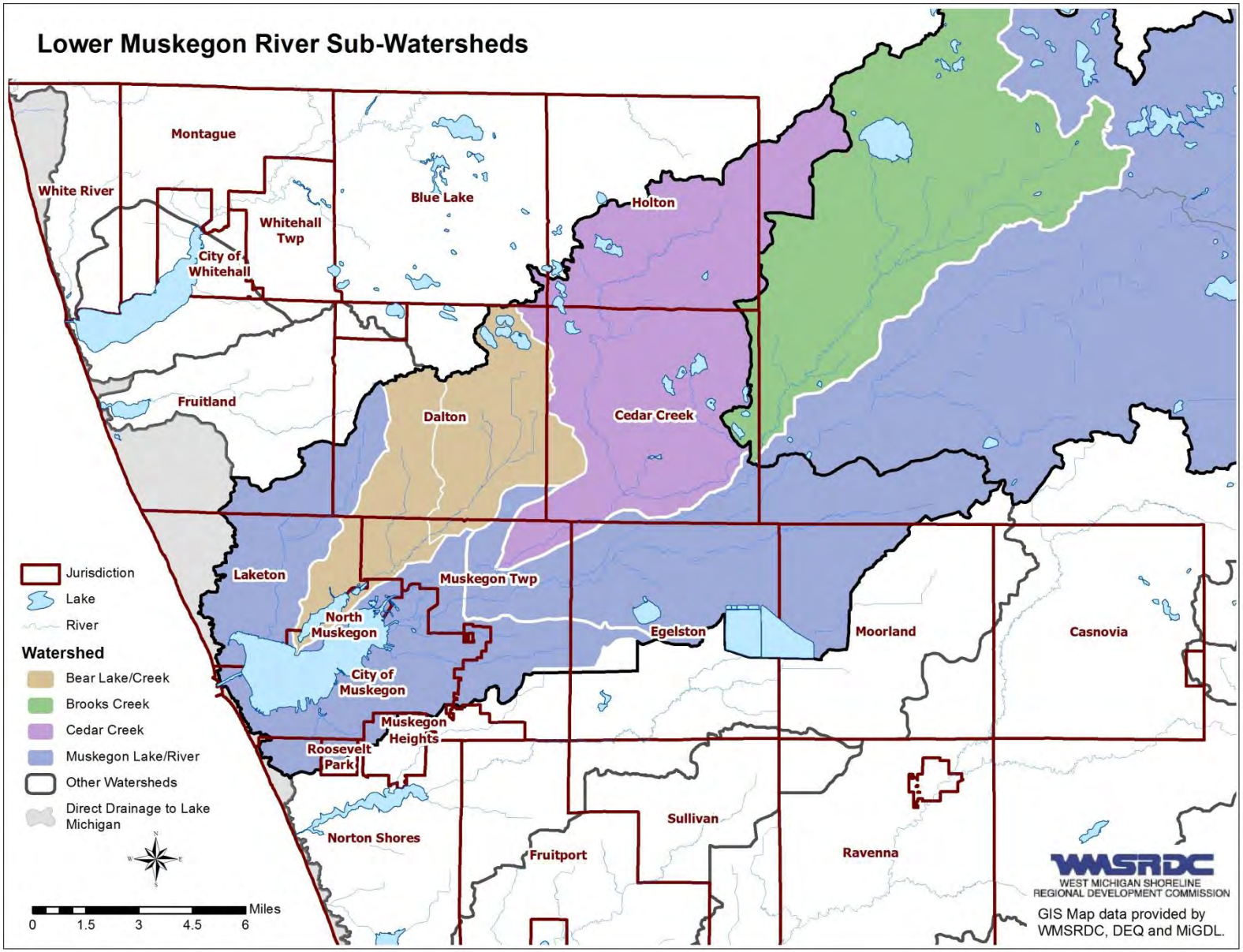


Efforts to integrate stormwater management with land use policies have also been implemented in the Cedar Creek, Brooks Creek and Bear Creek watersheds. The **Cedar Creek Watershed Land Use Project** identifies priorities.



In the Ruddiman Creek watershed, a **Best Management Practice Scoping Tool** was developed to help landowners target specific areas where BMPs would be most effective at reducing flashy stormwater flows. Flashy flows scour out the sandy stream bed and reduce the diversity and abundance of the aquatic life that depend on the creek for their habitat. In addition, the City of Muskegon, Norton Shores, Roosevelt Park and Muskegon Heights have partnered to correct illicit connections between the sanitary and storm drain system to improve the health of surface waters.

4. Water Quality, Green infrastructure, Stormwater Management – Goal: Surface waters within the watershed are safe for drinking, swimming and fishing			
Outcome: Surface waters meet water quality standards for being swimmable, fishable and drinkable			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	Monitoring indicates attainment of water quality standards	Nutrients, dissolved oxygen, temperature, E.coli, etc.	MDEQ, AWRI, Health Departments
2	Beach monitoring indicates swimmable access	Number of no partial body or full body contact postings	Public Health Muskegon County, MDEQ, AWRI
3	Waters of the state meet Water Quality Standards for being swimmable, fishable and drinkable	Toxicity of surface water, groundwater and sediment	MDEQ, Health Departments, AWRI
4	Reduce soil erosion and sedimentation, flashy flows, nutrient inputs and unstable hydrology	Percent impervious surface, benthic diversity and water quality of tributary streams	Local Governments, WMSRDC, MCD, AWRI, MDEQ, EPA, NOAA, MSUE
5	Implement watershed management plans (Muskegon River 319; Muskegon Lake: Ruddiman/DSO/South Shoreline; MS4 Phase II; Bear Creek 319)	Number of Best Management Practices Implemented	MRWA, WMSRDC, MCD, AWRI, MDEQ, EPA, MSUE, Local Governments
6	Illicit connections between storm and sanitary sewers continue to be investigated and corrected	MS4 monitoring is within permit compliance limits	Muskegon Lake Watershed Cities,
7	Land use planning incorporates green space and integrates native habitat into development designs	Diversity and abundance of native, aquatic wildlife	WMSRDC, Local Governments, Business community, MSUE
8	Public drinking water supply is safe	Assessment of Source Water Intake Protection Plans	Water Systems Managers, Local Governments, MDEQ
9	Public perception is sampled through statistically significant method/s	Public Perception of water resources	GVSU, MSU, WMSRDC
10	Promote LID green infrastructure, rain gardens, native landscape lawn alternatives, green space to restore hydrology and to prevent storm water runoff	Eutrophication and undesirable algae is reduced and surface waters are in attainment with water quality standards	MDEQ, Local Governments, Bear Lake Board, GVSU-AWRI, Business Community
11.	Work with agricultural community to address nutrient runoff into surface drains	Nutrient reduction into surface water bodies	NRCS, MDARD, Conservation Districts


Lower Muskegon River Sub-Watersheds
Montague
White River
Whitehall Twp
City of Whitehall
Blue Lake
Holton
Fruitland
Dalton
Cedar Creek
Laketon
Muskegon Twp
North Muskegon
Egelston
Moorland
Casnovia
City of Muskegon
Muskegon Heights
Roosevelt Park
Norton Shores
Fruitport
Sullivan
Ravenna
Jurisdiction
Lake
River
Watershed
Bear Lake/Creek
Brooks Creek
Cedar Creek
Muskegon Lake/River
Other Watersheds
Direct Drainage to Lake Michigan
Miles
0 1.5 3 4.5 6
WMSRDC
WEST MICHIGAN SHORELINE REGIONAL DEVELOPMENT COMMISSION
GIS Map data provided by WMSRDC, DEQ and MiGDL.

5. Groundwater Resources

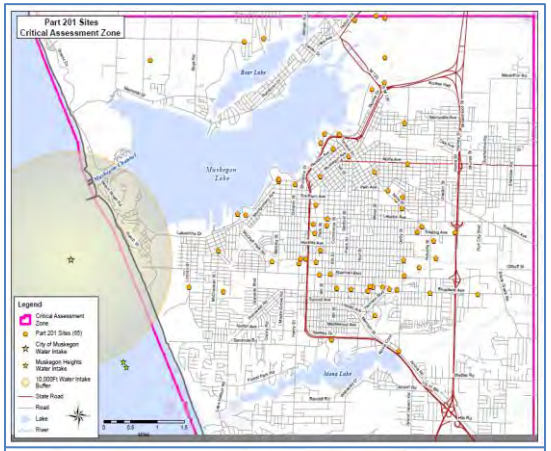
Background, Need and Status:

The MLWP identified groundwater quality and quantity as important to the health of aquatic habitats, fisheries and public health throughout the watershed. Groundwater moves slowly, discharging into lakes, streams and wetlands. It helps provide cool water that supports aquatic life and it is used as a source of drinking water.

The Muskegon Lake watershed's sandy soils provide opportunities to use green infrastructure for filtration of stormwater runoff. But, sandy soils can also facilitate the rapid infiltration of spills and pollutants from the land's surface into the underlying groundwater. Polluted groundwater has the potential to affect the quality and the cost for treatment of drinking water from both public water supplies and from private wells.

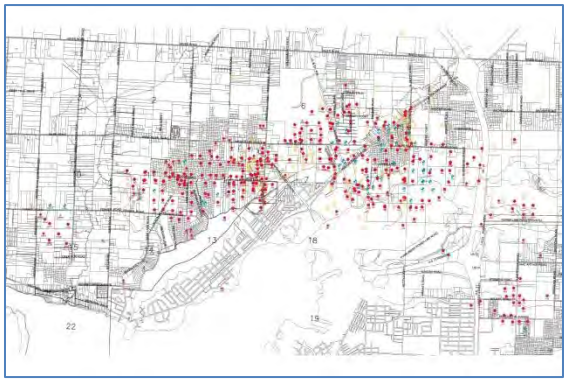
In 2017, the City of Muskegon completed a **Source Water Intake Protection Plan** to protect its public drinking water supply. No such plan exists to protect the Muskegon Lake watershed's groundwater resources. However, municipal wellhead protection zones are established for municipalities that use groundwater as a public water supply.

Efforts to improve groundwater quality include the cleanup of soil and groundwater at two National Priority List Superfund Sites, located to the north of Muskegon and Bear Lakes. Municipalities are also aware of historic oil and gas wells from past exploration activities. Wells plugged in the 1930s do not meet current standards, and some have leaked into surface waters and groundwater. The **Lower Muskegon River Watershed Oil Field Assessment** was developed to provide awareness for those with drinking water wells in the Muskegon Lake and Bear Lake watersheds. Historic wells are often discovered and properly plugged during residential and commercial developments.



Potential Contaminant Sources	SWA	CAZ	Buffer Zone
Superfund Sites	13	2	0
CAFOs	12	0	0
RCRA	6	4	0
Part 201 Sites	239	65	0
UST	176	26	1
LUST (Part 213)	464	84	0
NPDES Permits	452	30	1
BEA Sites	888	173	1

Source: Muskegon Source Water Intake Plan



Source: Westshore Oil & Gas Exploration Well Report

5. Groundwater Resources – Goal: The quality of groundwater resources is improving			
Outcome: Groundwater resources support healthy aquatic habitats and drinking water supplies			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	Protect drinking and source water from contamination and spills	Assessment of Source Water Protection Plans	Water Systems Managers/Local Governments, MDEQ, Health Departments
2	Pass a statewide sanitary code and inspection requirements for on-site septic systems	Water Quality	MDEQ, Health Departments, State Legislature
3	Ensure the integrity and availability of groundwater resources across the watershed	Quantity, availability, functionality	MDEQ, Local Governments, Business, Industry, Agriculture, Watershed Stakeholders
4	Maintain database of potentially unknown landfills, soil, groundwater and sediment contamination sites	Creation and use of database	MDEQ, AWRI, WMSRDC, Health Departments
5	Survey, locate and map abandoned oil wells and historic petroleum infrastructure	Update Westshore Oil Well Report	MDEQ, OGMD, WMSRDC
6	Map and track known groundwater plumes and identify their potential for affecting water resources	Map and database established	GVSU AWRI, MDEQ, OGMD, Local Governments, Health Departments
7	Assess the effectiveness of Wellhead Protection Programs	Groundwater protected in source water areas	MDEQ, Local Governments,
8	Identify and protect groundwater sources to headwater streams and cold water resources	Maintain adequate temperatures and base flow	MDNR, MDEQ, Drain Commissioners
9	Large groundwater withdrawal users efficiently manage systems to prevent local water table impacts.	Sustainable water tables	MDARD, MDEQ, MSU-E, NRCS, Conservation Districts
10	Drains are managed to protect year-round base flows	Sustainable water tables	Drain Commissioners, Road Commissions, Landowners
11	Monitor nutrient loading from groundwater to surface waters	Receiving waters do not exceed standards	AWRI, MDEQ, WMSRDC, Health Departments
12	Utilize green infrastructure for infiltration and protection of groundwater resources	Creation and protection of wetlands, prairies, other BMPS	Local Governments, MDEQ, Landowners, WMSRDC

6. Site Remediation and Revitalization

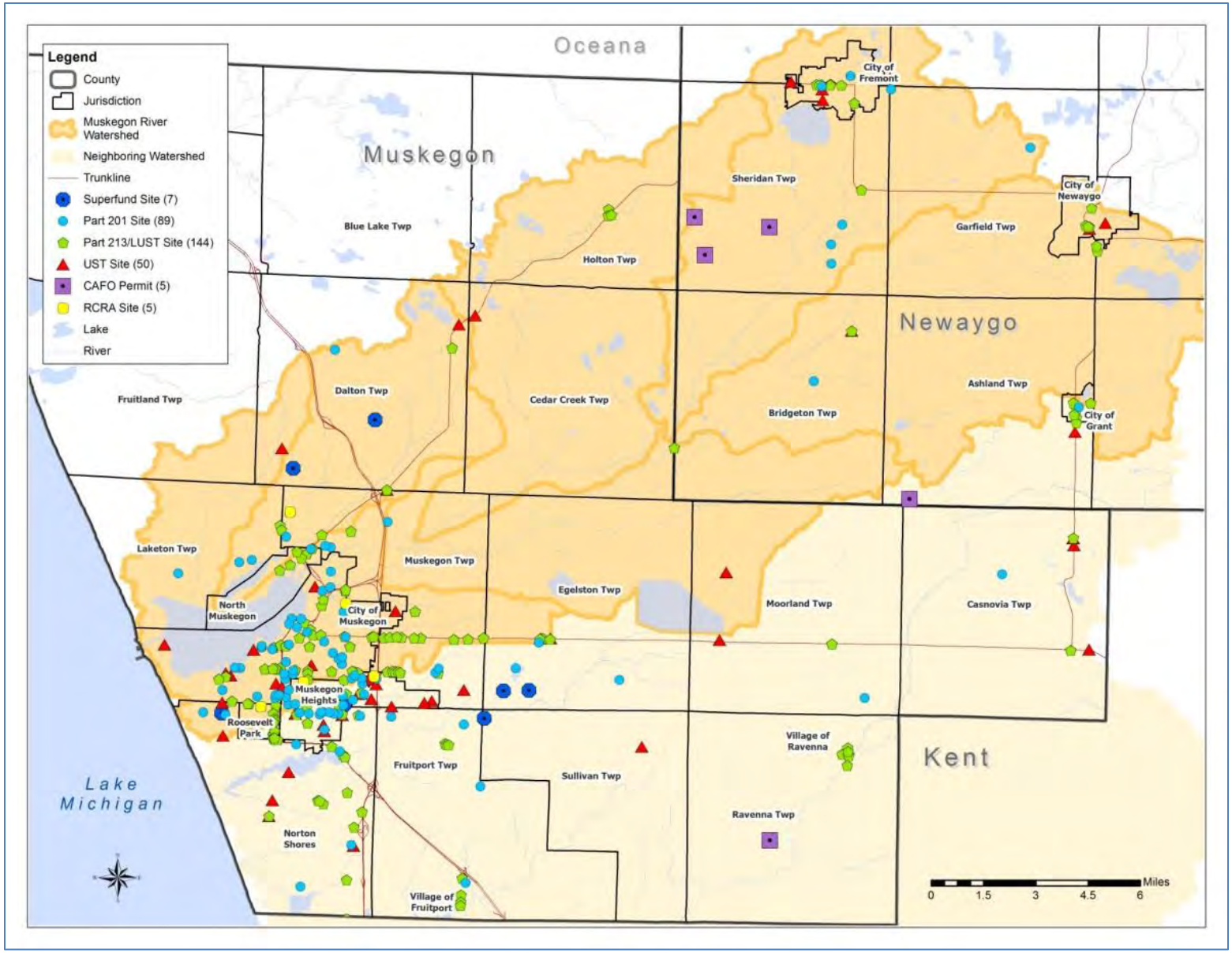
Background, Need and Status:

Contaminated sediment cleanups, shoreline brownfield cleanup and redevelopment, and the cleanup of contaminated soils and groundwater are priorities for the MLWP. As the official Public Advisory Council for the Muskegon Lake Area of Concern (AOC), the MLWP has worked in partnership with the U.S. Environmental Protection Agency (EPA) and the Michigan Department of Environmental Quality (MDEQ) to involve the public and advance the remediation of contaminated sediments in the Muskegon Lake AOC.

Contaminated sediment cleanup projects include a 2006 cleanup of Ruddiman Creek, a 2012 cleanup of Muskegon Lake at the Division Street Outfall, and the 2018 Muskegon River cleanup at the former Zephyr Oil Refinery. The MLWP and the West Michigan Shoreline Regional Development Commission (WMSRDC) is also working with public and private partners to advance the cleanup of Muskegon Lake at the mouth of Ryerson Creek. Information about these Great Lakes Legacy Act projects is available at www.greatlakesmud.org. The projects are implemented in partnership with the State of Michigan and the U.S. EPA Great Lakes Legacy Act (GLLA), now part of the Great Lakes Restoration Initiative.

The MLWP also determined the need to continue to evaluate post remediation monitoring information for the GLLA cleanups, and to initiate additional action to support the remediation of environmental conditions that could not be remediated under the GLLA.

The MLWP developed a list of sites that will need to be addressed under existing public/private initiatives and state and federal remediation programs. This list was developed in association with the identification of the final management actions needed to delist the AOC. The sites include, but are not limited to state and federally designated National Priority List Superfund Sites, abandoned oil and gas exploration well fields, Part 201 sites, LUST sites and historic landfills.


Legend
County
Jurisdiction
Muskegon River Watershed
Neighboring Watershed
Trunkline
Superfund Site (7)
Part 201 Site (89)
Part 213/LUST Site (144)
UST Site (50)
CAFO Permit (5)
RCRA Site (5)
Lake
River
Oceana
Muskegon
Newaygo
Kent
Lake Michigan
City of Fremont
Sheridan Twp
City of Newaygo
Blue Lake Twp
Holton Twp
Garfield Twp
Fruitland Twp
Dalton Twp
Cedar Creek Twp
Bridgeton Twp
Ashland Twp
City of Grant
Laketon Twp
Muskegon Twp
Egelston Twp
Moorland Twp
Casnovia Twp
North Muskegon
City of Muskegon
Muskegon Heights
Roosevelt Park
Fruitport Twp
Sullivan Twp
Village of Ravenna
Ravenna Twp
Norton Shores
Village of Fruitport
Miles
0
1.5
3
4.5
6

6. Site Remediation and Revitalization – Goal: Pathways of contamination do not affect ecosystem integrity. People, wildlife and natural resources are protected from emerging pollutants and legacy pollutants

Outcome: Soil, sediment, and groundwater resources support a healthy ecosystem

#	Implementation Recommendations	Indicators	MLWP with Partners
1	Maintain integrity of the contaminated sediment cleanup sites (Ruddiman Creek, Muskegon Lake/Division Street Outfall, Muskegon River/Zephyr, and Muskegon Lake/Ryerson)	Sediment quality	EPA, MDEQ, MDNR OGL, GVSU AWRI
	Prioritize, monitor and remediate sites with known environmental conditions (e.g., Part 201, LUST, NPL, brownfield redevelopment sites)	Reduction of acres and numbers of degraded sites	Landowners, MDEQ, Health Departments, EPA, WMSRDC
2	Map all historic lake and lower river "fill" locations and quantify acreages (including Bear Lake)	Sites quantified and mapped	GVSU AWRI, WMSRDC
3	Map historic dump sites and unregulated landfills for assessment or remediation (private, commercial and public lands)	Sites identified and public health protected	WMSRDC, MDEQ, Health Departments, AWRI
4	Integrate stakeholder engagement into planning processes	Iteratively revisit stakeholder survey documents	Local government, WMSRDC
5	Integrate aesthetics, public access and habitat BMPs with remedial designs for holistic site cleanup and revitalization (to achieve sustainable results/enhanced quality of life/highest and best use)	Diversity of uses and ecosystem services provided	Developers, MDEQ Landowners, Local Government, WMSRDC
6	Iteratively revisit master plans and community visions to integrate the interests of all stakeholders into site remediation and revitalization.	Review developments and master plans	Developers, MDEQ Landowners, Local Government, WMSRDC
7	Reassess AOC remediation sites for completeness, effectiveness, and further needs.	Monitoring	GVSU AWRI, WMSRDC, EPA, MDEQ, MDNR OGL

7. Non-Native Invasive Species and Biodiversity

Background, Need and Status:

There is a need to prevent the spread of the non-native invasive species that threaten to degrade native aquatic and terrestrial habitats. Biodiversity is necessary for the watershed's plant and animal communities that depend upon native plant habitats for their survival.

Past efforts to reduce non-native invasive plant species have focused on the protection of restored habitats and to prevent the spread of non-native invasive plants around the Muskegon Lake and Bear Lake shorelines.

In 2012, the WMSRDC completed a biodiversity protection plan to support the goals of the **Lake Michigan Lake Action Management Plan** (LAMP). The plan included a GIS field survey and ranking of Phragmites Australis.

In 2015, with support from the Great Lakes Restoration Initiative, the 2012 baseline survey was updated and included in the **Muskegon Lake Biodiversity Protection and Phragmites Management Plan**.

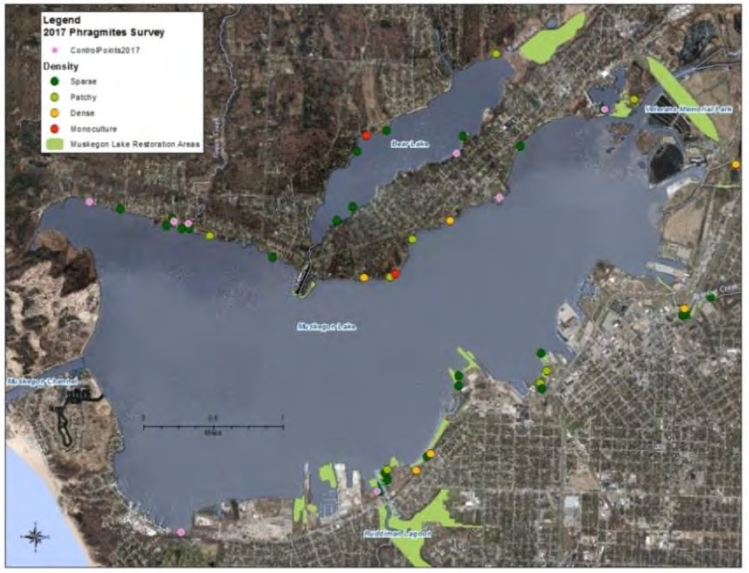
The 2015 project reduced the presence of non-native invasive plants, educated landowners and volunteers, provided experiential learning opportunities for students grades 6-12, and developed a strategy to sustain these efforts. It was recommended that survey be repeated every 3-5 years and that educational and control efforts be expanded throughout the watershed. In addition to the non-native invasive plants in wetlands and shorelines, the MLWP determined the need to address in-lake submerged vegetation and water column non-native invasive species.

BEFORE Phragmites Control
Muskegon Lake at Mouth of Green Creek - 2013

AFTER Phragmites Control
Muskegon Lake at Mouth of Green Creek - 2015

The reduction and elimination of non-native invasive species in and of itself does not necessarily restore diverse native plant and animal communities. Native plantings have been integral to the effort of restoring habitats to improve fish and wildlife populations and to delist Muskegon Lake as an AOC. Because native habitats are necessary to maintain a healthy watershed ecosystem, the restoration and protection of habitat is addressed in the fish and wildlife habitat chapter of this plan.

The images (right), illustrate the difference in abundance and density of Phragmites Australis on the shorelines of Muskegon Lake and Bear Lake. The image (top right) illustrates the status in 2015. The image (bottom right) illustrates the status in 2017, following two consecutive years of survey and control efforts.



Phragmites Density Values	
	Sparse
	Patchy
	Dense
	Monoculture

7. Non-Native Invasive Species and Biodiversity – Goal: Organizations, landowners and volunteers coordinate monitoring and management activities to prevent the loss of native plant and animal biodiversity			
Outcome: The Muskegon Lake watershed supports biologically diverse, native plant and animal communities			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	Prevent introduction of new Aquatic Invasive Species (AIS) and control established populations.	Varieties and density of identified IS	WMCN, MDNR, MRWA, USFW, NOAA, Tribes, MCD
2	Assess the economic impacts of IS and inform the public and stakeholders	Stakeholder awareness and responses	GVSU, Businesses, Local Governments
3	Inventory and map dispersal pathways and introduction mechanisms of targeted IS species	Effectiveness of tools developed to limit IS spread	WMCN, MDEQ, MDNR
4	Institutionalize a local framework for partners to prioritize IS, control and apply for permits as needed	Ability to manage IS treatments / alternatives	Landowners, Lake Boards, Governments, Tribes, WMCN
6	Provide Early Detection Rapid Response (EDRR) education for volunteers, landowners, students	Ability for community to respond to IS threats	MISIN, GLSI, Lake Boards, Conservation Districts, WMCN
7	Coordinate management strategies and management implementation with local and regional partners	Partnership involvement and effectiveness	WMSRDC, MRWA, TNC, MDEQ, Conservation Districts, WMCN, MDNR, Tribes, Governments
8	Monitor and manage existing Aquatic Invasive Species (AIS)	Presence, abundance of IS and changes in native plant communities	WMCN/CISMA, Muskegon Conservation District, MRWA,WMSRDC, Landowners
9	Maintain a public awareness and education program	Ability for community to respond appropriately to IS	WMCN/CISMA, Conservation Districts
10	Monitor and manage IS on adjacent uplands and forest habitats	Presence and abundance of invasive species	WMCN/CISMA, Muskegon Conservation District
11	Restore and enhance habitats and native plant communities	Plant and animal diversity and acres of native habitat	Conservation Districts, Landowners, TNC, MCC, State Parks, Agencies, Other Partners
13	Effectively train community landowners and local governments in plant ID and control methods	Ability for landowners to effectively control IS	Conservation Districts, WMCN/ CISMA, Stewardship Network, Phragmites Collaborative, MISIN, MSU-E, Sea Grant

8. Public Access to Natural Resources

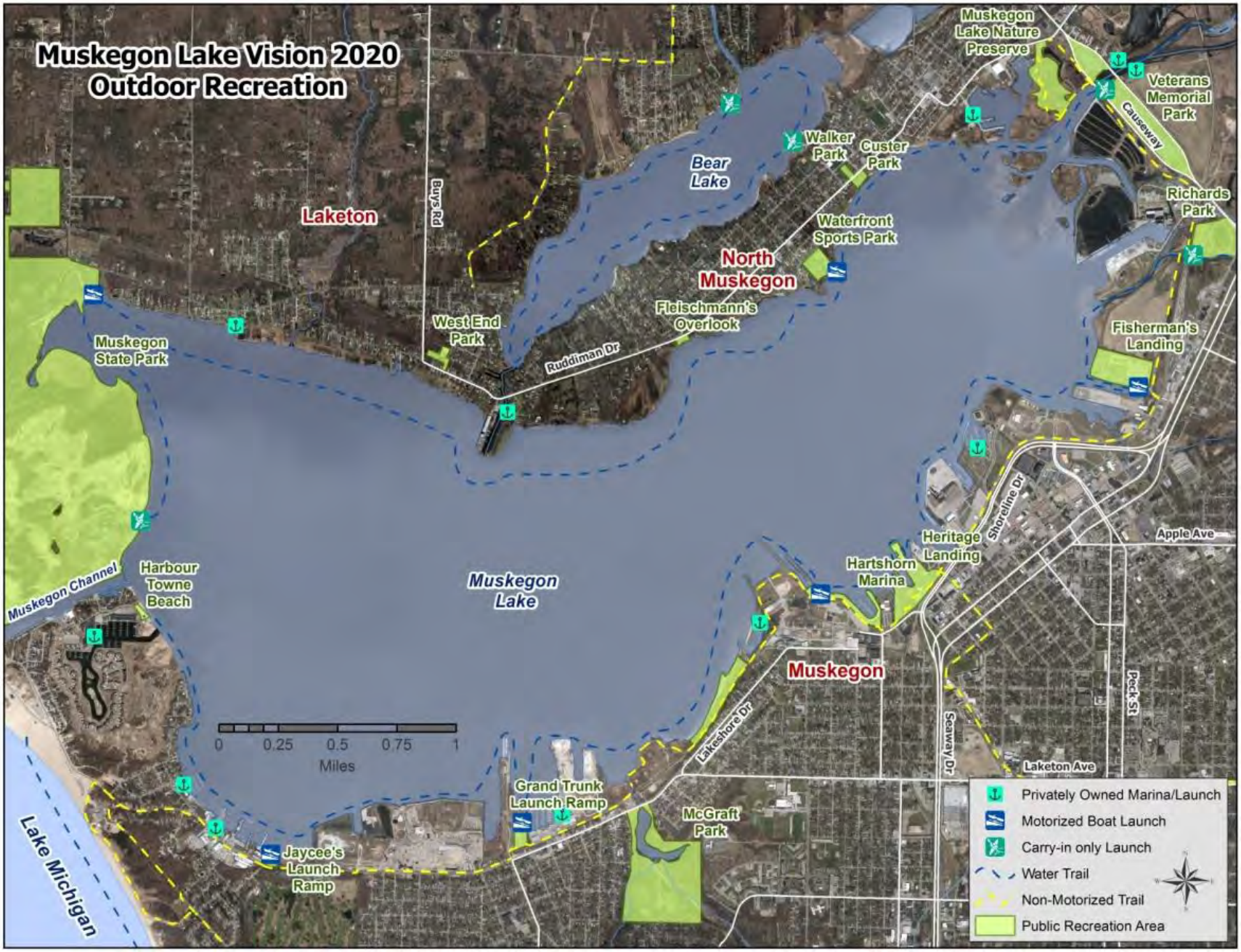
Background, Need and Status:

Public access to natural resources provides people with an opportunity to appreciate, enjoy, understand and value the benefits of natural resources. This connection with nature promotes a stewardship ethic for communities, residents and those who use the resource for recreation and commerce.

The **Muskegon Lake Vision 2020** planning process identified a strong community desire to link the protection of natural resources with enhanced recreational opportunities that would promote human interaction with the lake and its tributaries. The City of Muskegon's 2018 **Imagine Muskegon Lake** plan also identifies public access needs.

The lower Muskegon River/Muskegon Lake coastal wetland marsh was identified in Muskegon Lake Vision 2020 as important for public access and to improve connectivity between the Muskegon River, Muskegon Lake and its former wetland floodplain habitat. The MLWP and WMSRDC are collaborating with Consumers Energy on their plan to clean out the former B.C. Cobb plant coal ash ponds. A full cleanout of the bottom ash settling ponds may facilitate a future wetland restoration.

Access to natural areas, including lakes and wetlands, provides low-income, urban, and minority populations with economical, recreational, educational, stress-reducing and healthy quality-of-life activities. Access improvement needs include areas for shore angling, ADA accessibility, walkability from neighborhoods to shorelines, motorized launches, recreational boating and sailing, small boat, canoe, and kayak launches, public parks and picnic areas, boardwalks, fishing, and birding platforms, bike paths, water trails and hiking trails. Communities that value and prioritize access areas that maintain and enhance natural areas are more resilient and their economies are more sustainable. The availability of public access to Muskegon Lake and the water resources throughout its watershed enhances quality of life, economic, and cultural values.

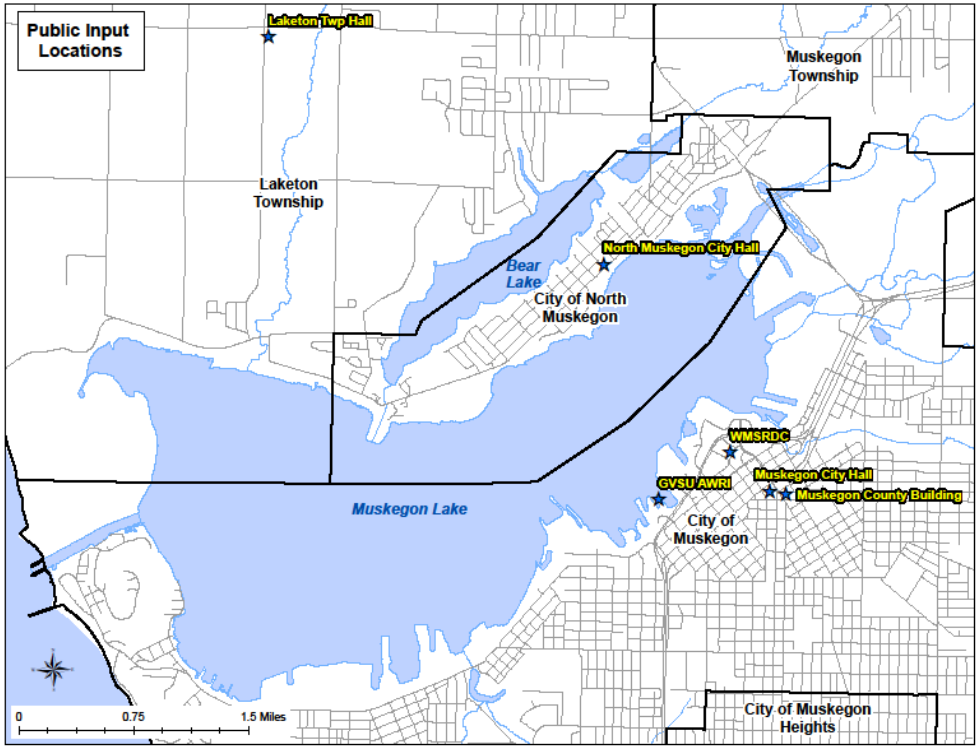

Muskegon Lake Vision 2020
Outdoor Recreation
Muskegon Lake Nature Preserve
Veterans Memorial Park
Causeway
Walker Park
Custer Park
Bear Lake
Richards Park
Laketon
Buys Rd
Waterfront Sports Park
North Muskegon
Fleischmann's Overlook
West End Park
Ruddiman Dr
Fisherman's Landing
Muskegon State Park
Shoreline Dr
Heritage Landing
Apple Ave
Hartshorn Marina
Muskegon Channel
Harbour Towne Beach
Muskegon Lake
Muskegon
Lakeshore Dr
Seaway Dr
Peck St
Laketon Ave
0 0.25 0.5 0.75 1
Miles
Grand Trunk Launch Ramp
McGraft Park
Lake Michigan
Jaycee's Launch Ramp
Privately Owned Marina/Launch
Motorized Boat Launch
Carry-in only Launch
Water Trail
Non-Motorized Trail
Public Recreation Area

8. Public Access to Natural Resources – Goal: An increase in the public's understanding of, appreciation for and stewardship of the watershed's natural resources. The public has access to natural areas and enhanced opportunities for interaction with the Muskegon Lake/Muskegon River/Lake Michigan ecosystem			
Outcome: The public has access to abundant open space, shorelines, water resources and natural features			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	The public has access to abundant open space, shorelines, and natural areas	Number of acres and access points available to the public	Local governments, Private landowners, Schools
2	The public has enhanced opportunities for interaction with the Muskegon Lake watershed ecosystem	Number of events and educational opportunities available to the public	Local governments, MDNR, MERES
3	Expand real-time monitoring of beaches	Reduction in no contact warnings/beach closings	Health Departments, MDEQ, Public landowners
4	Develop and implement a water trails system	Citizen use	Lake Michigan Water Trail Partners, Local governments, WMSRDC, MDNR, National Park Service, Businesses
5	Develop a comprehensive strategy to prevent nuisance and harmful blue green algal blooms	Number of algal blooms, area of impacted waters, residential complaints	GVSU-AWRI, MDEQ, Local governments, Lake Boards, Lake Associations, Landowners
6	Provide fishing access points from shorelines and tributaries	Angler hours, creel census	Local Governments, MDNR, Great Lakes Fisheries Trust, Michigan Land Trust
7	Opportunities are available for non-extractive / non-motorized recreation (e.g., birding, biking, hiking, canoeing, kayaking)	Recreational and educational usage	Audubon, Local Governments, MERES, MDNR – State Game Area & State Parks, USFS
8	Public small boat access throughout watershed	Number of public landings	General Public, Anglers, Boaters
9	Information Clearinghouse for public site & access Information	Media hits and inquiries	Muskegon County, Chamber of Commerce
10	Access signage at key locations	Signage at locations	Local Governments

9. Public Involvement and Input for Sustainable Decision-Making

Background, Need and Status:

The MLWP provides opportunities for the public to become involved in decision-making for a healthy Muskegon Lake ecosystem. Opportunities include monthly public meetings, committees, planning sessions, hand-on volunteer events and social media platforms.



Historically, the MLWP has engaged a diverse audience of watershed stakeholders to set achievable targets for the removal of AOC Beneficial Use Impairments and the delisting of Muskegon Lake as a Great Lakes AOC.

As a result of this community engagement process, there have been noticeable increases in local ownership and environmental stewardship among a broad array of stakeholders, including community leaders and shoreline landowners. In fact, during the development of the **Muskegon Lake Vision 2020** plan, the majority of participants stated that the restoration and protection of Muskegon Lake should be a local responsibility.

The MLWP will carry on this legacy and continue to plan for a healthy ecosystem into the future. As part of the planning process, the MLWP will continue to assist community groups with engagement in local resource issues.

The Muskegon Lake Watershed Partnership provides a sustainable community forum for addressing watershed issues and concerns.

9. Public Involvement and Input for Sustainable Decision-Making – Goal: Collaborative ecosystem management is in place and supporting social, environmental and economic health and ecosystem services			
Outcome: There are opportunities for collaborative decision-making and public input to local, state and federal agencies and decision-makers			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	Action Alerts / notification of opportunities for timely public input (e-mails, texts, social media)	Number of notifications sent out and responses	MLWP Volunteers, NGOs, Local Government, Media Outlets
2	Methods for providing public input to decision makers (social media, websites, Youtube video)	Number of comments, hits, visitors	Internet, Facebook, Twitter, E-mail
4	App to engage people to interface, provide input, rank projects (gamification to make it fun)	Number of officials, youth, public, using/engaged	MLWP Volunteers
5	Face to face engagement with officials, (breakfast meetings, speaking engagements, happy hours)	Number of events and participants	Chamber Breakfasts, Local Governments, WMSRDC, Public
6	Support participation in sustainability programming and environmental justice initiatives (social, environmental, economic)	Numbers and diversity of people involved	Local, State, Federal Governments
7	Host an annual State of Muskegon Lake Forum	Number of forums and participants; Evaluations	WMSRDC, GVSU-AWRI, Muskegon County
8	Create integrated system water management at the local level (water quality and quantity)	Establishment of multi-stakeholder system	Local, State, Federal Governments, WMSRDC, Business, Power, NGOs
9	Link to existing public input notifications (public hearings, permits, legislation)	Notifications are timely, fair and legal	Local Government, Partners, Media
10	Attend local government council and board meetings to learn about issues and provide input	Number of participants and officials reached at meetings	Local Government, General Public
11	Pass a statewide sanitary code and inspection requirements		
12	Implement outcome-based asset management plans	Progress toward true cost of service for water utilities	
13	Trainings on effective input and support for elected officials	Number of trainings and participants	Community Foundations, Private Consultants, Universities

10. Research and Monitoring

Background, Need and Status:

Research and monitoring will be needed to continue to inform natural resource management planning for the restoration and protection of the Muskegon Lake ecosystem. Monitoring is also needed to assess the results of previously implemented AOC remediation and restoration projects. Although each AOC project included short-term, pre and post project monitoring, most will require several years of post-project monitoring to gain a true understanding of a project's long-term ecological benefit. Although funding for long-term monitoring of AOC projects has not been readily available, a number of programs and funding sources have been sought to fill this critical gap. Monitoring is needed to assess how the project goals are being met and what type of adaptive management may be required to ensure their ecological integrity into the future. In 2012, the **Muskegon Lake Habitat Restoration Macrophyte Assessment** was completed by AWRI under a WMSRDC NOAA ARRA grant project. This study will be duplicated to assess long-term restoration progress into the future.

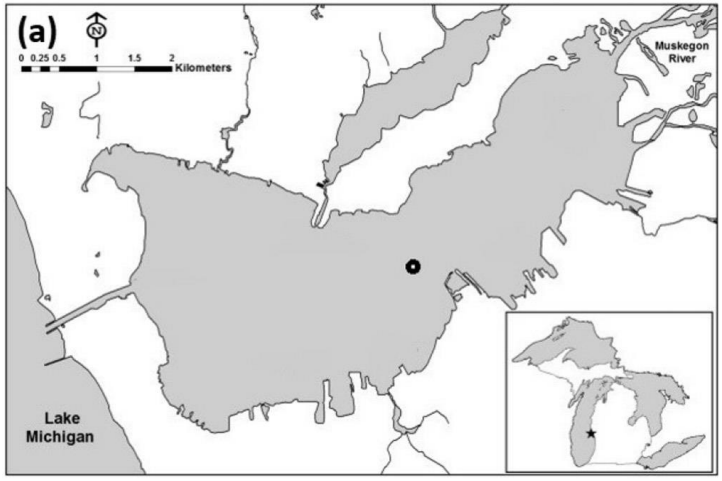
In 2003, GVSU Annis Water Resources Institute (AWRI) initiated a long-term monitoring program to determine the ecological status of Muskegon Lake. The program has indicated that, overall, the water quality of Muskegon Lake has improved over the past 30 years, but environmental challenges still exist, including contaminated sediments, loss of natural habitat, and invasive species.

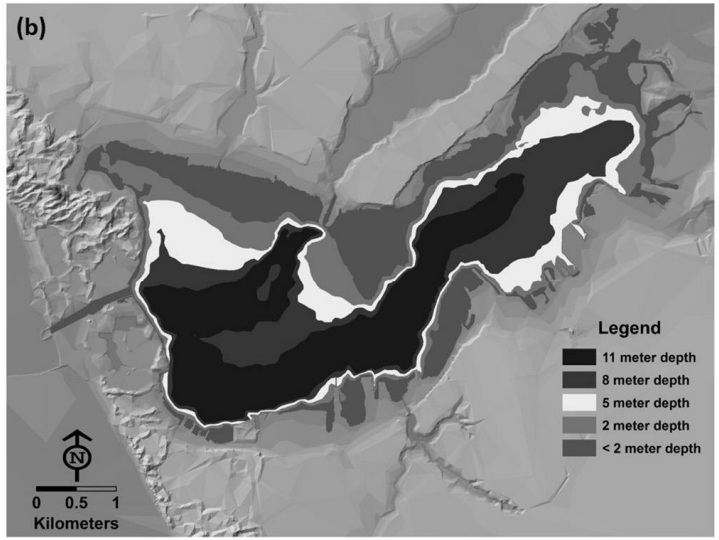
It is also important to understand how Muskegon Lake relates to the nearshore of Lake Michigan. Nearshore monitoring is a key goal of the Lake Michigan Lake Action Management Plan (LAMP. The Lake Michigan Monitoring Coordination Council completed a Lake Michigan Nearshore Monitoring Assessment in 2013.

In 2015, NOAA identified Muskegon Lake as one of 9 **Habitat Focus Areas** in the United States. One of the major NOAA objectives of the **Muskegon Lake Habitat Focus Area Implementation Plan** is the provision of scientific research to fill critical information gaps in our understanding of the Muskegon Watershed ecosystem, including its connection to the adjacent Lake Michigan nearshore area. This objective can be accomplished more effectively through strategic partnerships with other research entities focused on Muskegon. A key activity for NOAA to achieve this objective under this plan is identifying the challenges to develop and maintain a coherent, interdisciplinary and integrated science program, as well as ideas to overcome these challenges. In particular, emphasis should be given to development and implementation frameworks that will promote collaboration and coordination between scientists, managers, and stakeholders. As such, NOAA, GVWU AWRI, WMSRDC and MLWP propose that Habitat Focus Area continue to support the development of a Muskegon Science Collaborative by tracking its progress, providing personnel assistance in organizing workshops and deliverables, and working to connect new NOAA research efforts that emerge in the next five years to the Science Collaborative.

The **NOAA Muskegon Lake Habitat Focus Area Implementation Plan** Implementation Team is seeking to formalize a NOAA-AWRI led research collaboration framework over the next five years. As a major science entity in Muskegon, AWRI research and monitoring activities are compatible with NOAA goals and priorities on several fronts. Coordinating NOAA and AWRI monitoring efforts across the Muskegon River, Muskegon Lake, and Lake Michigan will allow for a comprehensive watershed to nearshore monitoring strategy that leverages resources from both AWRI and NOAA. This will provide more comprehensive data on a broad suite of parameters and advance several research priorities. These include monitoring the long term effects of habitat restoration, potential ecosystem impacts of climate change, and the development of a hydrodynamic model for Muskegon Lake.

Fyke Net Fisheries Monitoring
Photo and Maps, Courtesy of GVSU AWRI





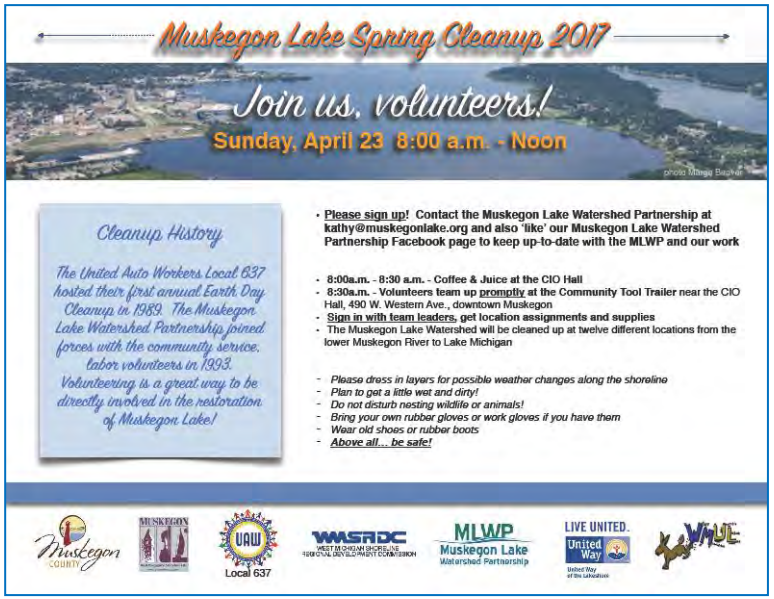
10. Research and Monitoring – Goal: We have enough information, data, understanding, and indicators to inform the decision-making process			
Outcome: Research and monitoring in the Muskegon Lake Watershed supports management decision-making			
#	**Implementation Recommendations**	**Indicators**	**MLWP with Partners**
1	Monitoring systems are in place at a scale and frequency to ensure water quality and quantity are maintained to support diverse uses and values	3-D hydrodynamic model	GVSU, NOAA, GLERL, MDNR, WMSRDC
2	Real-time monitoring of beaches is implemented	Expansion and frequency of monitoring	Public Health Muskegon County, GVSU, MDEQ
3	Develop a water conservation and reuse strategy	Numbers and quantities of water withdrawals and number of integrated water systems plans	Local governments, regional planning, water systems managers, universities
4	Groundwater and surface waters are monitored and reported to the public	Funding support is available and utilized	MDEQ, USGS, GVSU, Health Departments
5	Engage volunteers in citizen scientist monitoring programs – Great Lakes Marsh Monitoring Program, MI Corp River & Stream Monitoring, Clean Lake Monitoring Program, Others	Useable data produced, number of volunteers involved	MiCorp, MRWA, MLWP, Bird Studies Canada, WMGLSI, Issac Walton League, MSU, MSUE, GVSU-AWRI, MISIN,
6	Volunteer Invasive Plant Monitoring (Aquatic and Terrestrial) and early detection and response to invasive species	Public is engaged and using MISIN	MISIN, MRWA, MLWP, MAISD, MCC
7	Pre and post-AOC contamination cleanup and habitat restoration monitoring and reporting out	Monitoring data determines AOC site status and informs stakeholders/partners	WMSRDC, GVSU-AWRI, MDEQ, USEPA, NOAA, Muskegon County Health Dept.
8	Track and monitor the amount and integrity of native habitat (natural shorelines, wetlands, forests, fish, wildlife, benthos)	Land coverage change; Community ordinances	USDA-USFS, USDA-USFW, MDNR, AWRI, WMSRDC
9	Research and evaluate the availability and effectiveness of water quality improvement technologies. Example: Incremental Sampling Methodologies	Stakeholders informed of most cost effective BMPs and technologies	MDEQ, NOAA, AWRI, MSU, U of M

10	Muskegon Lake Science Collaborative is established	Number of integrated meetings with scientists, resource managers, stakeholders	NOAA, GVSU AWRI, WMSRDC, MLWP, Public Sector, Private Sector, Universities, LMMCC
11	Economics – Use and Value (Property, Eco-system Services)	Resource values are understood within Community	AWRI, Chamber of Commerce, Realtors
12	Fish and wildlife consumption – iterative review of advisory resources	Eat Safe Fish and Eat Safe Wild Game guides	MDNR, MDDHS
13	Fish population monitoring	Fish Community Index Netting Program	MDNR, MDEQ,
14	Wildlife population monitoring	Migratory bird studies	MDNR
15	Aquatic Invasive Species Program		MDEQ
16	Sediment monitoring to support dredging activities	Review of Agency or academic data	USEPA, NOAA, academia

11. Stewardship and Hands-On Educational Opportunities

Background, Need and Status:

The Muskegon Lake Ecosystem Action Plan will be used to engage community groups in a variety of meaningful, hands-on, stewardship activities. The annual, ***Muskegon Lake Watershed Spring Cleanup*** (in April) and annual Muskegon River cleanups (in September), are coordinated locally in conjunction with **International Coastal Cleanup** and the **Alliance for the Great Lakes Adopt-a-Beach Program**. Volunteers have participated in the spring cleanup for the past 30 years. It began as an Earth Day event in 1988, under the leadership of local union workers. Many community organizations have since joined the effort.



To volunteer for the Muskegon Lake Watershed Spring Cleanup, contact the MLWP at kathy@muskegonlake.org or contact the MLWP volunteer leaders through the website at www.muskegonlake.org. To volunteer for the Muskegon River Trash Bash, contact the Muskegon River Watershed Assembly at **http://mrwa.org/mrwa-home/.**

In addition to the annual spring and fall cleanups, the MLWP works with partner organizations to host other hands-on activities, including the year-round, ***Shoreline Stewards*** program and the ***Grand Trunk Restoration Partnership*** event each May. Shoreline Stewards adopt and maintain restored shoreline habitats throughout the year. The Grand Trunk Restoration Partnership is a good example of how volunteer Shoreline Stewards can revitalize a formerly degraded shoreline with restored fish and wildlife habitat, scenic views and recreational uses.

In addition to these stewardship opportunities, the following is a list of some of the additional programs that volunteers are currently involved with:

- **West Michigan Great Lakes Stewardship Initiative** – *The Muskegon Area Intermediate School District administers this K-12 educational program. Community volunteers provide meaningful, real-world projects for student involvement.*
- **Clean Marina Program** – *Muskegon Lake marinas can become certified to implement Best Management Practices that protect water quality through this program that is supported by Michigan Sea Grant and NOAA.*
- **Bird Studies Canada Great Lakes Marsh Monitoring Program** - *Volunteers learn to monitor the health of wetland marshes, using protocols for amphibians, marsh birds and wetland marsh habitat.*
- **Aquatic Invasive Species (AIS) Educational Events** – *The State of Michigan organizes this program each summer. Volunteers are needed to distribute information and host events at parks with public boat launch sites.*
- **Eat Safe Fish Program** – *This educational program was developed by the Michigan Department of Health and Human Services. Volunteers assist by providing outlets for information at community festivals and other venues.*
- ***Midwest Invasive Species Information Network (MISIN)*** – *Volunteers report the presence of non-native invasive plants to the MISIN website with a phone app or computer. The West Michigan Conservation Network monitors the information and provides trained professionals to implement control measures, when resources are available.*
- ***Michigan Natural Shoreline Partnership*** – *This is a train the trainer program for green, native shoreline landscaping and bio-engineering.*
- ***Michigan Lakes and Streams Association*** – *This organization provides annual training programs for lake management.*

LIVE UNITED

11. Stewardship and Hands On Opportunities – Goal: A culture of environmental stewardship is established and stewardship activities are common and undertaken by public and private organizations

Outcome: Students and adults have a variety of appropriate opportunities for stewardship-related education

#	Implementation Recommendations	Indicators	MLWP with Partners
1	Form committee to develop a strategy and establish a dedicated fund for stewardship activities	Dedicated funds are available for stewardship	CFFMC, MLNP, Neighborhood Assocations
2	Organize watershed cleanups, native plantings and monitoring activities	Volunteer hours and public participation increases	United Way, Neighborhood Associations, WMSRDC, MRWA, MCD, Jay Cees
3	Identify critical land protection and land restoration locations and opportunities	Natural areas and restored natural resources are protected	WMSRDC, GVSU AWRI, TNC, MDNR, Land Conservancy
4	Hold monthly MLWP public meetings to engage partner organizations and the public	Community meetings are held for public education and volunteer engagement	WMSRDC, GVSU AWRI, MRWA, MCECC, WMEAC, MLNP, MCD
5	Complete baseline land coverage surveys on a sub-watershed and/or neighborhood scale	Land coverage indicates “no net gain” of impervious surface	GVSU, WMSRDC, Muskegon County, MCC, Students
6	Evaluate recreation plans for public access, stewardship opportunities and community input	Residents and volunteers engaged in stewardship	Neighborhood Associations, Recreational User Groups
7	Quarterly planning sessions are held to implement Muskegon Lake Vision 2020	Multi-stakeholder, land use planning meetings	WMSRDC, Port Operators, Local Governments, CVB, Neighborhood Associations
8	Survey public perception every 3-5 years	Public perception of environmental quality	GVSU, MCC, Lakeshore Chamber of Commerce
9	Landowner Incentives are established for setbacks	Development setbacks protect water resources	Local Governments
10	Community groups and volunteers adopt sites to perform regular stewardship activities	Number of areas adopted and number of volunteers involved	K-12, Rotary, Northside Lions, Jay Cees, Businesses
11	Public notices for state and federal land and water wetland permit applications are monitored	Comments are submitted for proposed permit applications	WMSRDC, MDEQ, Local Governments
12	Monitor and control non-native invasive plants	Species are controlled	WMSRDC, MCD, TNC, MCC

Correlation of Muskegon Lake Ecosystem Master Plan Goals and Outcomes with Overarching Great Lakes Restoration and Protection Plans

Goals	Great Lakes Action Plan GLRI	Lake Mich Action Plan LAMP	MI Water Strategy	Muskegon River 319 Plan	Bear Creek Bear Lake 319 Plan	Muskegon Lake Watershed Plan Phase II MS4 Storm Water	Ruddiman Creek Ecological Restoration Master Plan - 2008	Muskegon Lake Vision 2020	Muskegon River Fisheries Mgt. Plan	Lake Michigan Water Trail Plan	NOAA Habitat Focus Area	Muskegon Lake Coastal Resiliency	Lake Michigan Fisheries Mgt. Plan
1	X	X	X			X		X			X	X	
2	X		X										
3	X	X		X			X	X	X		X	X	X
4			X	X	X		X					X	
5			X	X	X							X	
6	X	X		X	X	X	X					X	
7	X	X									X	X	X
8	X								X	X	X		X
9	X		X					X				X	
10	X	X		X	X						X	X	X
11	X	X		X	X			X	X	X	X	X	

Action Plans Topics and Related Goals and Outcomes:

1. **Coastal Resiliency & Sustainability**:
   Goal: Land use, recreation, and economic activities are sustainable and supportive of a healthy ecosystem
   Outcome: Aquatic ecosystems and natural resources are resilient, diverse and providing ecological services

2. **Great Lakes Literacy and Natural Resources-Based Education**:
   Goal: Increase the number of citizens with knowledge and an understanding of water literacy principles.
   Outcome: Individuals and communities understand their responsibility for and make informed and responsible decisions regarding water resources.

3. **Fish and Wildlife Habitat**:
   Goal: Habitats healthy, naturally diverse, and sufficient to sustain viable biological communities
   Outcome: Sustainable and abundant aquatic life – habitat and populations are stable or increasing

4. **Water Quality, Green infrastructure and Stormwater Management**:
   Goal: Surface waters within the watershed are safe for drinking, swimming and fishing
   Outcome: Surface waters meet water quality standards for being swimmable, fishable and drinkable

5. **Groundwater Resources**:
   Goal: The quality of groundwater resources improves
   Outcome: Groundwater resources support healthy aquatic habitats and drinking water supplies

6. **Site Remediation and Revitalization**:
   Goal: Pathways of contamination do not affect the integrity of the ecosystem. People, wildlife and natural resources are protected from emerging pollutants and legacy pollutants.
   Outcome: Soil and groundwater resources support the health of surface waters, wetlands and the public.

7. **Non-Native Invasive Species and Biodiversity**:

Goal: Organizations, landowners and volunteers coordinate monitoring and management activities to prevent the loss of native plant and animal biodiversity in the watershed.
Outcome: Muskegon Lake watershed supports biologically diverse, native plant and animal communities.

8. **Public Access to Water Resources**:
Goal: There is an increase in the public's understanding of, appreciation for and stewardship of the watershed's natural resources. The public has access to natural areas and enhanced opportunities for interaction with the Muskegon Lake/Muskegon River/Lake Michigan ecosystem.
Outcome: The public has access to Muskegon Lake water resources and natural features.

9. **Public Involvement and Input for Sustainable Decision-making**:
Goal: Collaborative ecosystem management is in place and results in social, environmental and economic health and an increase in ecosystem services.
Outcome: There are opportunities for public input to local, state and federal agencies and decision-makers.

10. **Research and Monitoring**:
Goal: We have enough information, data, understanding, and indicators to inform the decision-making process.
Outcome: Research and monitoring in Muskegon Lake supports management decision-making.

11. **Stewardship and Hands-on Opportunities**:
Goal: A watershed-wide, community culture of environmental stewardship is established and ecosystem stewardship activities are common and undertaken by public and private organizations.
Outcome: Students and adults have a variety of appropriate opportunities for stewardship-related education.

Guide to Frequently Used Acronyms

Federal Agencies

EPA – Environmental Protection Agency
NOAA – National Oceanic and Atmospheric Administration
USACE – U.S. Army Corps of Engineers
USFWS – U.S. Fish & Wildlife Service
USDA-NRCS – U.S. Department of Agriculture, Natural Resources Conservation Service
USDA-USFS – U.S. Department of Agriculture, U.S. Forest Service
USGS – U.S. Geological Survey
USRD - U.S. Rural Development

State Agencies

MDEQ – Michigan Department of Environmental Quality
MDNR – Michigan Department of Natural Resources
MDARD – Michigan Department of Agriculture and Rural Development
MDOT – Michigan Department of Transportation
MDHHS – Michigan Department of Health and Human Services
OGL – Office of the Great Lakes

Local, County and Regional Governmental Agencies and Organizations

GLC – Great Lakes Commission
MCD – Muskegon Conservation District
MSUE- Michigan State University Extension
PHMC – Public Health Muskegon County
WMSRDC – West Michigan Shoreline Regional Development Commission

Non-Governmental Organizations

BSC – Bird Studies Canada
IWL – Isaac Walton League

TNC – The Nature Conservancy
TU – Trout Unlimited
MAISD – Muskegon Area Intermediate School District
MERES – Muskegon Environment Research and Education Society
MRWA – Muskegon River Watershed Assembly
MLWP – Muskegon Lake Watershed Partnership
MISIN – Midwest Invasive Species Information Network
SN – Stewardship Network
WMCN – West Michigan Conservation Network
WMGLSI – West Michigan Great Lakes Stewardship Initiative

Colleges and Universities
CMU – Central Michigan University
FSU – Ferris State University
GVSU-AWRI – Grand Valley State University Annis Water Resources Institute
MCC – Muskegon Community College
MSU – Michigan State University
UM – University of Michigan