



Michigan's Path to a Prosperous Future: Environmental Challenges and Opportunities

Paper 4a in a Five-Part Series

Eric Lupher, Robert Schneider,
and Eric Paul Dennis

Citizens Research Council of
Michigan

38777 Six Mile Road, Suite 208

Livonia, MI 48152

(734) 542.8001

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About the Series

Altarum and the Citizens Research Council of Michigan have joined forces to present a realistic, data-informed vision of Michigan's future based on current trends and trajectories across multiple dimensions – economic, demographic, workforce, infrastructure, environment, and public services. The papers are available on both organizations' websites.

Research for this project was conducted in two phases. Phase I involved a landscape scan of existing resources and expert knowledge of trends and challenges. For each domain, published and grey literature were reviewed and interviews with stakeholders were conducted to answer questions such as:

- Where is Michigan now – strengths, weaknesses, major challenges?
- What data is available to characterize the current situation and to track progress? Are there existing forecasts, either descriptive or data-driven?
- How does Michigan compare to other states, especially in the Midwest?
- What path are we on currently, and where are opportunities to shift the path through policies and investment?

Phase 2, as represented in an Executive Summary and a series of five papers, built on Phase 1 to include data and context.

Altarum (altarum.org) is a nonprofit organization focused on improving the health of individuals with fewer financial resources and populations disenfranchised by the health care system.

The Citizens Research Council (crcmich.org) works to improve government in Michigan by providing factual, unbiased, independent information concerning significant issues of state and local government organization, policy, and finance.

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Report Highlights

- Michigan’s environment and natural amenities could be a core asset to attract new residents and investments. Michigan’s water resources, in particular, are unmatched by any other state. Leveraging these assets will require increased attention to environmental protection and related human health impacts.
- It is very difficult to develop a comprehensive assessment of environmental quality in Michigan or elsewhere. The complex nature of environmental systems and related data precludes confident assessment of trends and meaningful comparisons to other states. However, it is clear that Michigan has many environmental issues that negatively impact ecosystems and human health.
- Air quality in Michigan has drastically improved in the decades since the adoption of the federal Clean Air Act. Most Michigan counties are currently in compliance with federal air quality standards. However, many historical urban neighborhoods are frequently subjected to toxic emissions, impacting quality-of-life and imposing myriad health issues.
- By most measures, water quality in Michigan is better than it has been in over a century. However, Michigan’s industrial legacy has left the state with hundreds of contaminated sites that continue to leach pollution into groundwater and surface waters. An additional concern is nutrient pollution from industrial farming operations, which can rapidly degrade water quality and promote growth of toxic blue-green algae.
- Light pollution and noise pollution are underrated detriments to environmental and human health. State policy related to these issues is practically non-existent.
- Invasive species have already caused irreversible ecological damage in Michigan, such as sea lampreys, zebra mussels, and Dutch elm disease. Dozens more invasive species are proliferating across the state, imposing complex changes to the environment that reduce species diversity, impose economic costs, and even threaten human health. Most management programs are local and volunteer-based. Increased state coordination and resources would provide substantial benefits for residents’ quality of life and help maintain Michigan’s natural beauty.
- Many urban neighborhoods near industrial facilities are subject to multiple environmental stressors: air, water, noise, and light pollution, as well as invasive species. In some cases, none of these issues independently require regulatory remediation responses, but the culmination of pollutants imposes extremely detrimental consequences to people living in these neighborhoods. Such areas have been referred to as “sacrifice zones,” as the health and well-being of the residents have been sacrificed for perceived economic benefit. These areas could become centers of urban renewal and economic development, but only if the local environment is remediated and protected such that living there does not make people ill.

Introduction

In recent decades, people increasingly relocate not for jobs, but for quality-of-life amenities such as healthy ecosystems, natural resources, and recreational opportunities. Michigan's reputation as a post-industrial rust-belt state inhibits many approaches to economic and community development. Environmental protection in Michigan has historically been seen as antithetical to economic output. Attention to environmental policy to protect and restore Michigan's natural resources could improve the health and wellbeing of Michiganders while attracting new residents, visitors, and investments. Alternately, disregarding Michigan's environment could continue to burden Michigan communities with myriad health problems, shortened life expectancies, and detrimental cost and quality of life.

Environmental quality in Michigan has improved in many ways following the environmental movement of the 1960s and subsequent federal and state legislation. However, historical, ongoing, and emergent issues threaten the health, safety, and quality of life of Michigan residents. For the purposes of this paper, environment means the measurable quality of land, air, water, and associated ecosystems.

Air Quality and Pollution

Some aspects of air quality are regional and global. This became obvious in the summer of 2023 as wildfires across Canada produced smoke plumes that severely degraded air quality across the Midwest and eastern United States, including Michigan.¹ Air pollution from industrial centers can also have regional impacts. For example, western Michigan frequently experiences air pollution that drifts cross Lake Michigan from the Chicago area.²

However, the most frequent and persistent air pollution problems result from local emissions due to traffic and industrial activity. Additionally, these local emissions are within the scope of state policy to address, while emissions that drift from outside of the state are not. As such, this paper focuses on local sources of air pollution that are within the ability of state policy to address.

The federal Clean Air Act (CAA) of 1970 is the primary regulatory framework that covers air pollution. Michigan is responsible to meet national ambient air quality standards (NAAQS) as determined by the Clean Air Act and related federal Environmental Protection Agency regulations.³ Areas in which air pollution levels persistently exceed air quality standards may be designated "nonattainment." Michigan Department of Environment, Great Lakes, and Environment (EGLE) is responsible to monitor criteria air pollutants and regulate polluting sources to bring non-attainment areas into attainment.⁴

The criteria air pollutants are described below.

CAA Criteria Air Pollutants:

Carbon Monoxide (CO)

Lead (Pb)

Nitrogen Dioxide (NO₂)

Particulate Matter (PM₁₀ and PM_{2.5})

Ozone (O₃)

Sulfur Dioxide (SO₂)

Carbon Monoxide (CO) is a toxic gas most often created as a product of combustion. As internal combustion engines have become much cleaner burning in recent decades,⁵ carbon monoxide pollution is no longer a major issue.⁶

Lead (Pb) is a toxic metal with many potential adverse health effects. Concentrations of lead particulates in air were drastically lowered, primarily by removing lead additives from motor vehicle gasoline.⁷ A few industrial processes still put lead into the air, occasionally resulting in harmful concentrations of airborne lead in industrial areas. This was historically most notable in Southwest Detroit, but

also a problem near metal extrusion facilities in the Grand Rapids area.

The entire state has been in attainment status for lead since 2018.⁸

¹ Jakkar Aimery and Mark Hicks. "Report: Detroit has world's worst air quality amid drifting Canadian wildfire smoke." The Detroit News. June 27, 2023.

² Tracy Samilton. "EPA: Michigan, other states comply with 2008 cross-state border pollution rule." Michigan Radio. December 7, 2018.

³ Charles Andrew Miller. "Fifty years of EPA science for air quality management and control." *Environ Manage.* 67(6): 1017–1028. 2021.

⁴ EGLE. Air Quality Annual Report 2020.

⁵ Conversion of CO to CO₂ is the primary function of a catalytic converter. This equipment became standard on combustion-powered vehicles as a result of federal Clean Air Act requirements.

⁶ EGLE. Air Quality Annual Report. 2020. pp. 14-17.

⁷ EPA. Lead in Outdoor Air.

While lead as air pollution is temporary, its impact is long-term. Decades of lead deposition from combustion of leaded gasoline and coal power plants have permanently polluted soil and water across Michigan. In addition to contaminating soil, high winds can dislodge contamination as dust, contributing to lead air pollution.⁹ This remains a problem in many urban communities.¹⁰

All areas of Michigan have been in attainment status for lead air pollution since 2018. However, legacy pollution has deposited lead contamination in soil and water across the state.

Nitrogen dioxide (NO₂) can react with other substances in the atmosphere to form particulate matter or acidic products that are deposited in rain (acid rain). Nitrogen dioxide as air pollution is most frequently problematic in areas whose geology prevents frequent air-turnover, such as mountain valleys.¹¹ Nitrogen dioxide levels in Michigan have always met Clean Air Act standards.¹²

Particulate Matter is a general term used for a mixture of solid particles and liquid droplets (aerosols) suspended in the air. When inhaled, particulate matter can travel deep into lung tissue and even infiltrate the cardiovascular system.¹³ Exposure to particulate matter increases multiple health risks.¹⁴ The state is in compliance for all particulate quality standards; however, Michigan has had past nonattainment issues in Southeast Michigan, and localized concentrations of particulate matter frequently exceed levels deemed healthy for vulnerable populations.¹⁵

Recently, significant particulate matter pollution has come to Michigan from outside its borders. Devastating wildfires have been increasingly common in western states, and the prevailing western wind frequently transports the smoke to the Midwest and Great Lakes, where particulate matter can sink towards the surface and impact air quality.¹⁶ In the summer of 2023, Michigan experienced historically severe levels of air pollution from wildfires across Canada, prompting EGLE to issue its first ever statewide air quality alert.¹⁷

In 2023, the EPA proposed lowering the primary annual particulate matter standard.¹⁸ This adjustment could result in areas of Southeast Michigan being found in non-attainment status, requiring EGLE to adopt additional pollution control rules. Additional pollution control measures would likely have secondary benefits of reducing emissions of other criteria and non-criteria pollutants, resulting in measurable health benefits to residents in and around impacted areas.¹⁹

Ozone (O₃) near the Earth's surface is a completely different phenomenon than stratospheric ozone (i.e., 'the ozone layer'). High concentrations of ground-level ozone are usually created by reactions involving nitrogen oxides, volatile organic compounds, and other pollutants. The primary source of anthropogenic nitrogen oxides and volatile organic compounds is combustion and vapors from fossil fuels.²⁰

Exposure to ozone can irritate airways, reduce lung function, aggravate asthma and chronic lung diseases like emphysema and bronchitis, and inflame and damage the cells lining the lungs. Ozone may also reduce the immune system's ability to fight off bacterial infections in the respiratory system. Repeated exposure to ozone can cause permanent lung damage.²¹

⁷ EPA. Lead in Outdoor Air.

⁸ EGLE. Air Quality Annual Report 2020. pp. 18-22.

⁹ Eléonore Resongles et al. Strong evidence for the continued contribution of lead deposited during the 20th century to the atmospheric environment in London of today. PNAS. June 21, 2021.

¹⁰ Rukiya Colvin. "Getting the lead out of Detroit's soil." Planet Detroit. August 12, 2021.

¹¹ U.S. EPA. Technical Bulletin: Nitrogen Oxides (NO_x), why and how they are controlled. November 1999.

¹² EGLE. Air Quality Annual Report 2020. Pp. 23-27.

¹³ Idem pp. 44-59.

¹⁴ EPA. Particulate Matter (PM) Pollution.

¹⁵ EGLE. Air Quality Annual Report 2020. p. 59.

¹⁶ US Government Accountability Office. Wildfire Smoke: Opportunities to strengthen federal efforts to manage growing risks. March 2023.

¹⁷ Sheri McWhirter. "Unprecedented month of poor air quality in Michigan from wildfire smoke." MLive. June 30, 2023.

¹⁸ US EPA (Regulations.gov). Review of the National Ambient Air Quality Standards for Particulate Matter. Docket: EPA-HQ-OAR-2015-0072.

¹⁹ Notably, there are open questions about how the EPA will determine non-attainment areas, as interpretation of the data is likely to be complicated by the impact of wildfire smoke from other regions.

²⁰ VOCs are most concerning when emitted from industrial processes but are also emitted by vegetation. Research is underway to better understand the contribution of biological VOCs in surface level ozone. (E.g., Fitzky et al. "The Interplay Between Ozone and Urban Vegetation—BVOC Emissions, Ozone Deposition, and Tree Ecophysiology." Front. For. Glob. Change, 06 September 2019 Sec. Forests and the Atmosphere. 2019.)

Ozone also impacts vegetation, including agricultural crop and forest yield reductions, diminished resistance to pests and pathogens, and reduced survivability of seedlings.²²

Ozone air quality standards were updated in 2015 and several counties in Southeast Michigan were initially found to be in non-attainment in 2018. However, EGLE submitted a request²³ to exclude certain data from one of their ozone monitoring stations,²⁴ and to redesignate the Detroit area from non-attainment to attainment.²⁵ After deliberation, the EPA approved EGLE's request, and southeast Michigan is currently in borderline attainment status.²⁶

In the summer of 2023, southeast Michigan experienced an unprecedented spike in ozone pollution, likely amplified by drifting smoke from Canadian wildfires.²⁷ It is unclear how the EPA will interpret 2023 data to determine future attainment status.

Portions of Allegan and Muskegon County remain in ozone non-attainment. This is primarily from air pollution drifting across Lake Michigan from industrial activity around Chicago. Under a new "Good Neighbor Plan" regulation adopted by the EPA, Illinois will be responsible to reduce the airborne pollutants that impact west Michigan counties. Under this same provision, Michigan will be responsible to reduce emissions that impact ozone levels in downwind states. The State of Michigan, through EGLE, will be required to implement additional pollution controls on power generation plants and other industrial activities.^{28,29} This will have the added benefit of reducing local pollution, regardless of the recent finding of attainment status for southeast Michigan.³⁰

Sulfur Dioxide (SO₂) is linked to multiple health and environmental issues.³¹ Coal power plants are the largest source of sulfur dioxide, though the pollutant can be emitted by several industrial processes. The Detroit area remains under non-attainment status for sulfur dioxide. After Michigan law was found insufficient to enforce pollution controls that would achieve attainment status under sulfur dioxide air quality standards adopted in 2010, the federal EPA was brought in to enforce the federal Clean Air Act. The EPA is now working with EGLE to reduce sulfur dioxide under a federal implementation plan.³²

Other Pollutants of Concern

In addition to the six criteria pollutants discussed, EGLE monitors non-criteria pollutants that may be "harmful to public health or the environment when present in the outdoor atmosphere in sufficient quantities and duration."³³

As an enforcement mechanism, EGLE has the authority to issue citations under federal and state law for "odors" that create "unreasonable interference with the comfortable enjoyment of life and property." This has recently become a notable issue due to frequent and ongoing complaints related to a handful of industrial facilities, such as the Stellantis Detroit Assembly Complex.³⁴

To describe these emissions as "odors" understates the health hazard to the community. When you smell something, that is because you are inhaling molecules of a substance. Substances being emitted from an industrial facility are not likely innocuous. These odors indicate a combination of criteria and non-criteria hazardous and toxic air pollutants, exposure to which may have serious health consequences. For example, residents of a Kalamazoo neighborhood have complained of

²¹EGLE. Air Quality Annual Report 2020. Pp. 34-43.

²²Ibid.

²³EGLE. Wildfire Exceptional Event Demonstration for Ground-Level Ozone in Southeast Michigan – East 7-Mile Monitor. January 2023.

²⁴Federal Register. Air Plan Approval; Michigan; Clean Data Determination for the Detroit Area for the 2015 Ozone Standard, a Proposed Rule by the Environmental Protection Agency. 03/06/2023.

²⁵Federal Register. Air Plan Approval; Michigan; Emissions Statement Program and Base Year Emissions Inventory. A Rule by the Environmental Protection Agency on 07/06/2022.

²⁶EPA. News Release: EPA Determines Detroit Metro Area Now Meets Federal Ozone Standard; Approves Michigan's Plan to Maintain Air Quality. May 16, 2023.

²⁷Hannah Mackay. "Detroit region's 'worst ozone summer in a decade' reopens pollution debate." The Detroit News. July 5, 2023.

²⁸Garrett Ellison. "Michigan among 23 states which must curb smog under new rule." MLive. March 19, 2023.

²⁹EPA. Final Rule: Federal "Good Neighbor Plan" for the 2015 Ozone National Ambient Air Quality Standards. June 5, 2023.

³⁰Nicholas Leonard. Comments on ozone data exclusion. Great Lakes Environmental Law Center. January 18, 2023.

³¹EPA. Sulfur Dioxide Basics.

³²Federal Register. "Approval and Promulgation of Air Quality Implementation Plans; Michigan; Federal Implementation Plan for the Detroit Sulfur Dioxide Nonattainment Area." A Proposed Rule by the Environmental Protection Agency on 06/01/2022.

³³EGLE. Air Quality Annual Report. Pp. 60-63.

³⁴Air Quality Enforcement Action: FCA US LCC (Stellantis) - Detroit Assembly Complex Mack – 10/19/2022

“foul odors” since 2008. A 2023 investigation by the Michigan Department of Health and Human Services found that the neighborhood is frequently inundated with harmful hydrogen sulfide gas and volatile organic compounds, leading to acute local health impacts including elevated asthma rates.³⁵

Sacrifice Zones

Regulatory measures put in place to prevent harmful amounts of pollutants often do not appropriately capture the cumulative effect of multiple polluters. The Michigan Department of Environment, Great Lakes, and Energy (EGLE) considers air pollution permits “on a permit-by-permit, pollutant-by-pollutant basis. The cumulative impact of new or increased pollution levels being added to the existing air mix, including emissions from all nearby industries, typically does not determine permit approval.”³⁶ The culmination of impacts in industrial areas results in what has been termed “sacrifice zones.”³⁷

Since its enactment in the 1970s, the federal Clean Air Act has been highly successful at reducing air pollution. However, the monitoring and compliance measures that have been adopted may not capture very localized pollution issues.^{38,39} Multiple areas in Michigan suffer health consequence from industrial pollution, with an economic impact of billions of dollars every year.⁴⁰ Southwest Detroit is among the most severe of Michigan’s sacrifice zones.^{41,42,43}

Southwest Detroit is among the most severe of Michigan’s (and the nation’s) “sacrifice zones.” EGLE permits air pollution discharges on a permit-by-permit basis, ignoring the cumulative effects of multiple pollutants emitted by multiple facilities within the same neighborhood.

Community organizations in Michigan, as well as EGLE, have recently stepped-up air monitoring activities to better inform regulatory pollution reduction and mitigation efforts.⁴⁴ Unfortunately, existing environmental regulations provide limited tools to address sacrifice zones. Additionally, Michigan’s economic development policies often run counter to environmental goals. Many of Michigan’s most severe contributors to local air pollution have received state and local tax incentives. For example, the Marathon oil refinery in Southeast Detroit (Figure 1) has received nearly \$200 million in property tax abatements from Detroit and state tax credits for pollution control. The refinery has been cited multiple times by EGLE for air quality violations⁴⁵ and in 2023 filed a permit to expand operations, which may result in additional pollution.⁴⁶

The human health socioeconomic impacts of air pollution are too frequently discounted. One study estimates that air pollution in Southeast Michigan is responsible for more than 10,000 disability-adjusted life years (DALYs) per year, causing an annual monetized health impact of around \$6.5 billion each year.^{47,48}

Air pollution is not the only issue in these sacrifice zones. These neighborhoods typically also suffer the effects of contaminated soil and water pollution, excessive light and noise pollution, unmaintained blighted areas overgrown with invasive and nuisance species, and a whole host of socioeconomic challenges. These neighborhoods are typically located near economic centers with established infrastructure, and could be wellsprings of urban renewal and economic growth. Un-

³⁵ Michigan Department of Health and Human Services. Health Consultation: Evaluation of Reduced Sulfur Compounds (RSCs) and Volatile Organic Compounds (VOCs) in Communities near the Graphic Packaging International, LLC. And Kalamazoo Water Reclamation Plant. April 6, 2023.

³⁶ Keith Matheny and Kristi Tanner. “Michigan’s poorer, minority neighborhoods become ‘sacrifice zones’ for increased pollution.” Detroit Free Press. Dec 30, 2021.

³⁷ Tom Ramstack. Detroit Residents Ask Congress to Eliminate ‘Environmental Racism.’ The Well News. August 25, 2022.

³⁸ United States Government Accountability Office. “Air Pollution: Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System.” November 2020.

³⁹ Tim McLaughlin, Laila Kearney, Laura Sanicola. “Special Report: U.S. air monitors routinely miss pollution - even refinery explosions.” Reuters. Dec 1, 2020.

⁴⁰ Sheena E. Martenies, et al. “Disease and Health Inequalities Attributable to Air Pollution Exposure in Detroit, Michigan.” Int J Environ Res Public Health. Oct 19, 2017.

⁴¹ John Hartig. Great Lakes Moment: Ecosystem restoration needs more environmental justice.” Great Lakes Now. July 6, 2021.

⁴² Steve Neavling. “Struggling to breath in 48217, Michigan’s most toxic zip code.” Detroit Metro Times. Jan 8, 2020.

⁴³ Sydney C. Warner et al. “Community’s Perception on Ambient Air and Noise Pollution: A Qualitative Study in Southwest Detroit.” Environmental Justice. Aug 18, 2022.

⁴⁴ Carol Thompson. “New air quality monitors detect pollution hotspots in and near Detroit.” The Detroit News. August 26, 2022.

⁴⁵ Steve Neavling. “Struggling to breath in 48217, Michigan’s most toxic zip code.” Detroit Metro Times. Jan 8, 2020.

⁴⁶ Carol Thompson. “Marathon seeks to operate Detroit refinery at full capacity.” The Detroit News. July 4, 2023.

⁴⁷ Sheena Martenies et al. “Disease and Health Inequalities Attributable to Air Pollution Exposure in Detroit, Michigan.” Int J Environ Res Public Health. 14(10): 1243. October 2017.

⁴⁸ This study assesses only air pollution, and only in Metro Detroit. The full impact of pollution in Michigan is difficult to estimate but is underappreciated.

fortunately, these communities are often dismissed, and seen as less important than the large industrial facilities nearby. For example, residents around the Stellantis Mack Assembly Plant have complained about noxious industrial odors since the plant opened in 2021. The Detroit City Council has suggested that Stellantis purchase the homes around the Mack Assembly Plant to move residents away from the most concentrated air pollution.

Suggesting that people move away from manufacturing facilities to avoid pollution does not reflect well on Detroit or Michigan. The technology to remove these contaminants exists. For Michigan to rebuild blighted urban neighborhoods, environmental quality and human health must be prioritized. Michigan's environmental regulator, EGLE, should be sufficiently resourced and supported to bring these facilities into quick compliance. Michigan's economic development policy should consider environmental and human health impacts of the facilities that are subsidized, possibly including incentive claw-backs for environmental regulatory non-compliance.

Water Quality and Pollution

Historically, natural water resources were viewed primarily as industrial resources. Wastes were removed from industrial facilities and communities by dumping them into streams, rivers, and lakes. Wetlands, which act as natural filters, were filled-in or drained to make additional land available for development. Eventually, water quality was destroyed. The federal Clean Water Act (CWA) of 1972⁴⁹ has substantially restored water quality in Michigan and elsewhere, but weaknesses in the CWA have become apparent.

Environmental policy in Michigan must work not only to remediate and mitigate existing pollution, but also prevent new contamination from occurring.

Water Quality Monitoring

Michigan has 57 major watersheds (Figure 1). In any given year, EGLE actively monitors about 10 to 12 of these on a rotating five-year cycle. It is not feasible to monitor every pond, stream, and wetland within Michigan, but EGLE uses probabilistic and targeted sample locations to assess potential problem areas and capture the overall condition of the watershed.⁵⁰ Water pollution monitoring in Michigan is highly dependent on volunteer efforts. Partnerships with non-profits and environmental groups are leveraged to obtain better coverage.^{51,52} Often, water monitoring results are only brought to attention only after problems are identified by volunteer groups or concerned citizens.⁵³

Existing Conditions and Trends

It is difficult to comprehensively describe the state of water quality in Michigan because it is not feasible to assess all waterbodies across the state consistently or for all possible pollutants.⁵⁴ The Clean Water Act requires that waters that are found to be polluted must be reported to the EPA with a plan to address the problem. But the methods of identifying, addressing, and tracking water pollution issues can vary drastically between and even within states.

⁴⁹U.S. EPA. Summary of the Clean Water Act.

⁵⁰EGLE. Clean Water Act Integrated Report. 2022. p. 31.

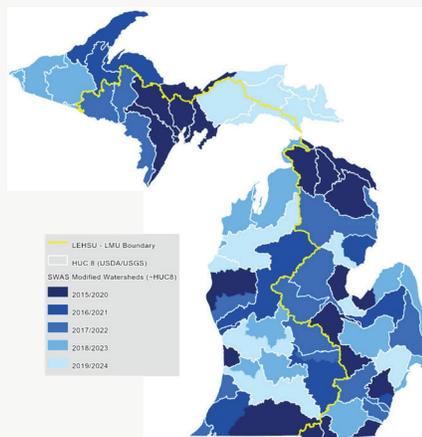
⁵¹James Polidori and P. Schurr. "Bridging the implementation gap: Designing a course of action with Michigan Public Advisory Councils." *Journal of Great Lakes Research*. 2022.

⁵²<https://micorps.net/>

⁵³Concerned citizens may request water quality testing by submitting to EGLE's targeted monitoring program.

⁵⁴Research identified a 2013 document that provides a reasonable summary of useful water quality metrics to the extent that data is available. An updated version of this document is not known to exist. (Department of Environmental Quality Water Resources Division Measures of

Figure 1: Michigan's 57 Watersheds



Source: America's Health Rankings, available at <https://www.americashealthrankings.org/explore/annual>

Michigan's most recent Clean Water Act report was published May 2022.⁵⁵ Per the Clean Water Act, when a body of water in Michigan is found not to meet environmental criteria for a designated use, EGLE must adopt a total maximum daily load (TMDL), and enforce pollution control measures. Michigan currently lists 134 TMDLs.⁵⁶

Broadly, many of Michigan's surface waters continue to be impacted by polychlorinated biphenyls (PCB) and mercury such that wildlife and fisheries are negatively impacted. Mercury and PCB pollution results mostly from atmospheric deposition (air pollution that becomes soil and water pollution).

Nutrient pollution of surface waters is a re-emerging concern in many of Michigan's watersheds and the Great Lakes. Nutrient pollution refers mainly to nitrogen and phosphorus. These are considered "macronutrients" because they are essential for life in relatively significant quantities. However, excess nutrients in water can create thick algae blooms and deplete the dissolved oxygen in the water. In some cases, nutrient pollution can create blue-green algae blooms. This 'algae' is actually a bacteria called cyanobacteria. Some strains of cyanobacteria produce a waste product called cyanotoxins, which, when ingested can cause sickness and organ damage.^{57,58} Removal of cyanotoxins from drinking water is difficult and costly.⁵⁹

Lake Erie, particularly the western portion of Lake Erie, has become highly polluted by nutrients.^{60,61} This was a problem in the mid-20th century, but appeared solved, until algal blooms began reappearing regularly around the year 2000.⁶² This is a complex problem with many contributing causes including more intense farming methods, ecosystem changes related to invasive species, and climate change.⁶³

Commercial livestock farms, known as concentrated animal feeding operations are the primary suspect in the resurgence of nutrient pollution and harmful algal blooms. These facilities have increased in number and size in recent decades. The animal waste (manure) is nutrient-rich and is often spread on nearby fields as fertilizer. However, the waste production is far in excess of the ability of crops to uptake the nutrients, which leach into the soil and waters as nutrient pollution.⁶⁴

Lakes Superior, Michigan, and Huron are generally free of excessive nutrients. However, Saginaw Bay contains high nutrient pollution due to agriculture pollution and the relatively low rate of water turnover in the bay.⁶⁵ One of the recent enforcement provisions adopted by EGLE under the authority of the CWA is the finding that Saginaw Bay is "impaired" due to nutrient pollution.⁶⁶

The nutrient pollution problem may be getting worse.⁶⁷ The Clean Water Act—the most critical regulatory tool to address water quality issues—was not designed to efficiently regulate "non-point-source pollution" such as is emitted by concentrated animal feeding operations.⁶⁸

Combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) are another source of nutrients (and other pollutants). SSOs occur after heavy rainfalls when water in saturated soil leaks into older sanitary sewers, creating more volume than the wastewater treatment plant is able to process. CSOs are discharges from older sewer systems that were designed to carry both domestic sewage and storm water, collectively referred to as combined sewage. CSOs typically occur when wet weather conditions overwhelm the capacity of the wastewater treatment plant, and so raw sewage overflows directly into receiving waters. These sewage outfalls are built-into the system as an intentional failure mode (sort of a pressure-release valve) to prevent raw sewage backing up into basements.

⁵⁵EGLE. Michigan Clean Water Act Integrated Report. 2022.

⁵⁶EGLE. EPA Approved TMDLs.

⁵⁷American Water works Association and Water Research Foundation. Managing Cyanotoxins in Drinking Water: A Technical Guidance Manual for Drinking Water Professionals. September 2016.

⁵⁸CDC. Multi-agency Collaboration in Michigan Identifies Cyanobacteria as Likely Cause of Dog Deaths.

⁵⁹EPA. Ground Water and Drinking Water. Summary of Cyanotoxins Treatment in Drinking Water.

⁶⁰Great Lakes Commission. Blue Accounting. 2022.

⁶¹GLWQA Progress Report 2022. P. 39.

⁶²EGLE. Clean Water Act Integrated Report. 2022.

⁶³John McCracken. "Study: Warming winters will thaw frozen manure, further polluting U.S. waters." Grist. October 7, 2022.

⁶⁴Keith Schneider. "Danger Looms Where Toxic Algae Blooms." Circle of Blue. September 8, 2022. (and subsequent publications in 6-part series)

⁶⁵Kelly House. "As Saginaw Bay pollution grows, farmers urge other farmers to change ways." Bridge Michigan. June 13, 2022.

⁶⁶Michigan Department of Environment, Great Lakes, and Energy. Water Quality and Pollution Control in Michigan 2022; Sections 303(d), 305(b), and 314. Integrated Report. May 2022.

⁶⁷Keith Schneider. "Danger Looms Where Toxic Algae Blooms." Circle of Blue. September 8, 2022. (and subsequent publications in 6-part series)

⁶⁸Dave Strayer. Fifty-year-old law proves we can address environmental challenges. Great Lakes Echo. June 29, 2022.

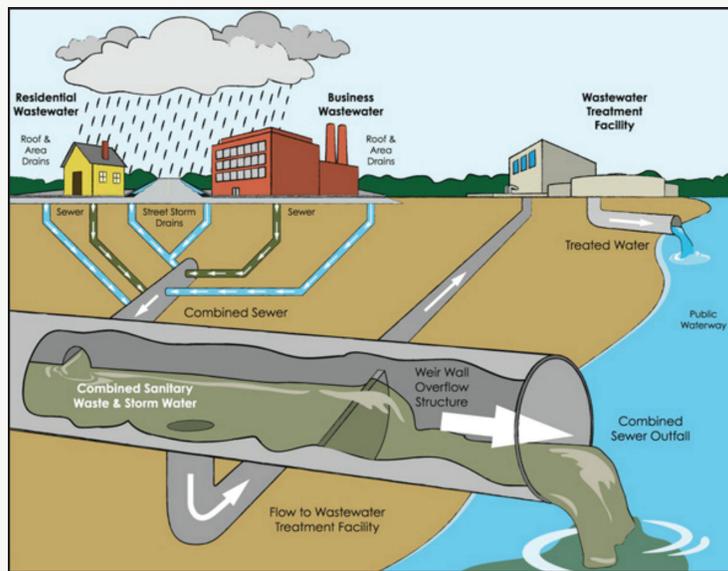
As described in the Michigan's Path to a Prosperous Future: Infrastructure Challenges and Opportunities paper of this series, some of Michigan's historic urban areas are subject to periodic flooding during heavy precipitation events. Stormwater and wastewater infrastructure that was installed decades ago is aging and is often undersized to accommodate additional stormwater that has resulted from additional development in suburban areas around central cities.

Michigan is the only state without a uniform sanitary code covering residential septic systems. Local authorities are tasked to regulate leaking septic systems, often with minimal resources.

Acting on regulatory guidance related to the Clean Water Act and Great Lakes Water Quality Agreement, Michigan municipal wastewater treatment plants have made infrastructure and process investments that substantially reduced CSOs in recent years. However, CSOs still occur. In 2020, nearly four billion gallons of untreated combined sewage was reported, mostly in Wayne County.⁶⁹ CSOs from Oakland County may have contributed to nutrient pollution in Lake St. Clair and the St. Clair River and encouraged excessive algae growth that is filling canals and marinas in a process called accelerated eutrophication—what was previously open water is quickly becoming a swamp through a nutrient driven process called accelerated eutrophication.⁷⁰

Nutrients and pathogens can also come from residential septic systems. Michigan is the only state without a uniform sanitary code, leaving it to local officials to deal with leaking septic systems.^{71,72} The contribution of failing septic systems to the state's nutrient problem is unknown, but likely significant. As of August 2023, there is legislation in committee that would establish a statewide septic code.^{73,74}

Figure 2: Combined Sewer Overflows (CSOs) occur when there is more combined sewage in the system than the WWTP can treat.



Source: Office of New York State Comptroller. "A Partially Treated Problem: Overflows from Combined Sewers." 2018, <https://www.osc.state.ny.us/files/local-government/publications/pdf/combined-sewers.pdf>.

The discharge of untreated sewage introduces many contaminants beyond nutrient loads that are harmful to the environment and human health, including toxic chemicals and pharmaceuticals.⁷⁵

Escherichia coli (E. coli) bacteria are practically ubiquitous in the environment. Most strains of E. coli are harmless, but a few can cause acute illness (i.e., they are pathogenic).

⁶⁹Michigan EGLE. Act 451 Legislative Report. CSO, SSO, and RTB Discharge 2020 Annual Report.

⁷⁰Anna Liz Nichols. "From 'million dollar view' to rotting mats of goo: Algae takes over Lake St. Clair." The Detroit News. October 10, 2022.

⁷¹Kelly House. "As septic pollution roils Higgins Lake, Michigan lawmakers consider reform." Bridge Michigan. September 29, 2022.

⁷²FLOW. "Michigan Legislature on Wednesday Will Consider Bill to Control Waste from Septic Systems." FLOW. September 27, 2022.

⁷³Kelly House. And Lauren Gibbons. "Flush with cash, Michigan lawmakers try again to pass state septic code." Great Lakes Now. May 4, 2023.

⁷⁴Michigan lawmakers have considered a statewide septic code in the past. Opponents include the Michigan Retailors Organization, citing concerns about inspections being tied to home sales. (Sheri McWhirter. "Michigan septic inspection bill to protect water from leaks may spill into next legislative session." October 11, 2022.)

Since E. Coli pollution is transient, it is difficult to know the extent of E. Coli pollution in Michigan. It is not feasible to collect data on every public beach for every event. However, the data that is available highlights areas of concern.

Michigan's EPA Integrated Report states that EGLE is monitoring 635 Michigan public beaches on the Great Lakes and connecting channels. Of these, 116 were monitored in 2020, the most recently available reporting year. Of those, 24 (4 percent of the beaches) experienced at least one closure due to E. coli contamination.

A study by Environment America pulled data from the National Water Quality Monitoring Council,⁷⁶ and found that of 209 Michigan Great Lakes beaches tested for E. coli in 2022, 90 of them (43 percent) tested positive for unsafe E. Coli levels at least one day. Three beaches in Macomb county tested positive on multiple days, implying that these beaches are frequently unsafe for swimming.⁷⁷ While E. Coli contamination can occur naturally (e.g., from goose feces), this data from Macomb County suggests that sewage overflows may be a likely contributor.

Monitoring of beaches for e. coli is often voluntary. E. coli testing at public beaches is typically performed by county health departments. There is a statewide platform available to aggregate this data called BeachGuard.⁷⁸ However E. coli contamination is not tracked or reported consistently enough to have a great understanding of if instances of contamination and beach closures are getting better or worse.

Bioaccumulative Contaminants in Fish. Fish in the Great Lakes and inland waters are routinely tested for contaminants, as to advise safe eating guidelines. Some contaminants like mercury, PCBs, Dioxins, and toxaphene are widespread.^{79,80} Most of this contamination entered the lakes over 20 years ago. But these chemicals can remain in the environment for decades or longer. Some smaller inland bodies of water can be remediated by dredging and removing contaminated sediment. For Great Lakes fisheries, it is unclear if consumption limits can ever be lifted.⁸¹ New contaminants such as PFAS are also imposing safe eating restrictions.

Because testing of pollutants in fish is one of the most consistent and widespread monitoring efforts, this is a useful metric for evaluating water conditions statewide. However, additional research would be required to analyze this data and understand historical trends in pollutants based on fish monitoring.

Per- and polyfluoroalkyl substances (PFAS) are a large group of synthetic chemicals that include perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). PFAS are used in multiple manufacturing processes and are present in thousands of industrial and consumer products. PFAS is known as a "forever chemical," as it is extremely slow to degrade, potentially persisting for hundreds of years.⁸² PFAS have been used in consumer products and industrial processes for over 65 years. Industry researchers uncovered the negative health impacts of PFAS in the early 1980s, but this was not disclosed to the public until the early 2000s.⁸³

Michigan learned of widespread PFAS pollution in 2012.⁸⁴ In 2017, it created the Michigan PFAS Action Response Team (MPART) to begin testing drinking water across the state for PFAS.⁸⁵ Michigan was one of the first states to recognize the importance of PFAS awareness and testing.⁸⁶ Its leadership continued in 2020 when EGLE set a maximum limit of PFAS in drinking water.⁸⁷ The criteria are in line with a draft health advisory from the U.S. EPA.⁸⁸ EGLE has also established Water Quality Value (WQV) standards for PFAS in surface waters.⁸⁹

⁷⁶National Water Quality Monitoring Council, Water Quality Portal.

⁷⁷Environment America. "Unsafe for Swimming?" Report. July 5, 2023.

⁷⁸EGLE. BeachGuard.

⁷⁹Ryan Lepak et al. Mercury source changes and food web shifts alter contamination signatures of predatory fish from Lake Michigan. PNAS. 2019.

⁸⁰Michigan Department of Health and Human Services. Eat Safe Fishing Guide. 2022.

⁸¹Consumption limits are available from: Michigan Department of Health and Human Services – Safe Fish Guidelines. <https://www.michigan.gov/mdhhs/safety-injury-prev/environmental-health/topics/eatsafefish/find-your-area>

⁸²Michigan MPART.

⁸³Phillippe Grandjean. "Delayed discovery, dissemination, and decisions on intervention in environmental health: a case study on immunotoxicity of perfluorinated alkylate substances. Environmental Health. 17. 2018.

⁸⁴Robert Delaney. "Michigan's Contaminant Induced Human Health Crisis." MDEQ. August 16, 2012.

⁸⁵Michigan is one of many states that have taken action to understand and address PFAS pollution. The State University of New York (SUNY) maintains a state policy dashboard: <https://rockinst.org/issue-areas/climate-environment/pfas-policy-dashboard/>

⁸⁶Elizabeth Burns. "The Role Model of Environmental Protection: Revisiting the Michigan Environmental Protection Act in Light of Per- and Polyfluoroalkyl Substances." Michigan Environmental Law Journal. Vol. 37, No. 1. 106. Summer 2019. Pp. 23-38.

⁸⁷Michigan EGLE. PFAS Drinking Water Generic Cleanup Criteria Revision. August 6, 2020.

⁸⁸US EPA. Proposed Rule: Per- and polyfluoroalkyl substances (PFAS): Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS) National Primary Drinking Water Regulation Rulemaking. EPA-HQ-OW-2022-0114.

Under the leadership of MPART and EGLE, Michigan has become a national and global leader in understanding and addressing PFAS contamination in drinking water and the environment. A Citizen's Advisory Workgroup also provides input and advice to MPART.⁹⁰

Groundwater is a crucial part of the water cycle.⁹¹ It is replenished by precipitation that percolates into soil, but flows through underground aquifers, often to emerge as surface waters in wetlands, streams, rivers, and lakes. Nearly 70 percent of the water in Michigan's rivers comes from groundwater.⁹²

Groundwater is not especially well-protected from pollution by Michigan regulatory frameworks. A culmination of factors—both historical and ongoing, have contributed to what some consider to be a statewide “groundwater emergency.”⁹³ At the core of this issue is the Michigan Natural Resources and Environmental Protection Act, Public Act 451 of 1994. Per this law, when contamination by hazardous substances is discovered on an industrial or commercial parcel, the responsible person can propose to remedy the situation – not by removing the contaminant, but by adopting a “restrictive covenant”—a legal agreement to limit current and future uses of the property as to reduce human exposure to the hazardous substance.⁹⁴

A restrictive covenant typically includes things like access for inspections and limitations on residential use. In extreme cases, the restriction may completely prohibit future access and use of the property. In other words, polluters are often allowed to pollute their own property and never clean it up so long as they can argue that the pollution is unlikely to make people sick.⁹⁵

EGLE can challenge such plans to leave contaminants in place. However, there is a high burden on EGLE to show that the hazardous material on the site poses an “unacceptable ... human health risk” via “reasonable and relevant exposure pathways.” To force a polluter to clean up their hazardous materials from the site, EGLE has to prove in court that not doing so will make people sick. This burden of proof is high, and EGLE's resources are limited.⁹⁶ Ecosystem health does not enter the equation. As a result, it is very common that the solution to pollution is to try to contain it in-place, put a fence around it, and let it be. This lowers the cost burden on the polluting business but may also prevent parcels from being put into productive use in the future. Remediating contaminated sites for redevelopment often becomes a burden on Michigan taxpayers.⁹⁷ Many environmental interests have advocated for Michigan to adopt a “polluter pay” law that would require polluters to cover the cost of remediation.⁹⁸

To complicate matters, contamination often does not stay on site (Figure 3). Contaminants leach from soil into groundwater and surface waters.⁹⁹ Groundwater flows offsite, spreading contamination underground through hidden ‘plumes.’¹⁰⁰ Floods come and go, spreading hazardous material across the region.¹⁰¹ Abandoned wells often provide a direct path for contaminants to pollute drinking water aquifers. Even wind-blown dust can distribute pollutants if the site is not properly “capped.”¹⁰² Often, by the time restricted properties become an obvious human health risk that would compel the polluter to remediate the site, that person or business responsible often no longer exists.¹⁰³

⁹⁰Michigan PFAS Action Response Team, Citizens Advisory Workgroup (CAWG).

⁹¹NOAA: Water Cycle.

⁹²Alan D. Steinman et al. “Groundwater in a crisis? Addressing Groundwater Challenges in Michigan (USA) as a Template for the Great Lakes.” Sustainability. 2022.

⁹³Eric Paul Dennis. “Latest Pollution Discharge into Huron River Highlights Need to Reform Michigan's Pollution Control Policies.” Citizens Research Council of Michigan. September 2, 2022.

⁹⁴MCL Chapter 324, Act 451 of 1994, Natural Resources and Environmental Protection Act.

⁹⁵Stacy Gittleman. “Cleaning up the toxic sites in state, Oakland County.” Downtown Newsmagazine. Birmingham-Bloomfield. August 23, 2022.

⁹⁶Carol Thompson. “How Michigan piled up thousands of toxic sites with cash shortfall for cleanup.” The Detroit News. April 18, 2022.

⁹⁷Robert A. Jones and William Welch. Michigan Brownfield Redevelopment Innovation: Two Decades of Success. 2010.

⁹⁸Brian Allnutt. “What a return to ‘polluter pay’ could mean for Michigan.” Planet Detroit. May 9, 2023.

⁹⁹USGS. Contamination of Groundwater. Water Science School. June 6, 2018.

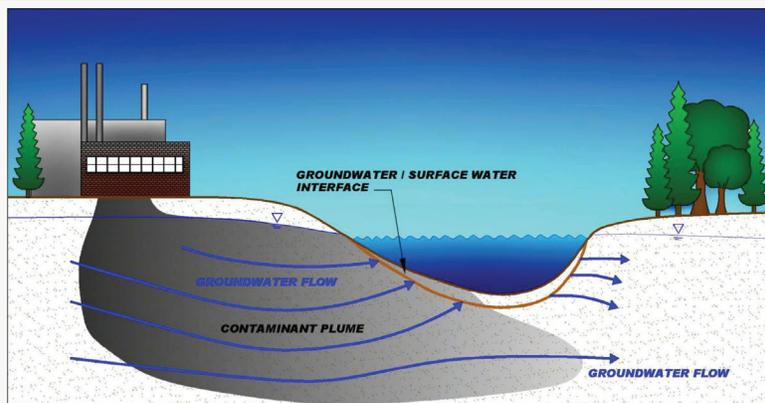
¹⁰⁰U.S. EPA. “Getting Up to Speed: Ground Water Contamination.” August 2015.

¹⁰¹U.S. Federal Emergency Management Agency (FEMA). Flood | Awareness of Related Subsequent Hazards (Avoid Floodwater Contamination).

¹⁰²U.S. EPA. A Citizen's Guide to Capping. April 2015.

¹⁰³Stacy Gittleman. “Cleaning up the toxic sites in state, Oakland County.” Downtown Newsmagazine. Birmingham-Bloomfield. August 23, 2022.

Figure 3: Polluted soil can spread over time into groundwater aquifers and surface waters



Source: Michigan DEQ (EGLE). Groundwater/Surface Water Interface pathway Compliance Options, remediation and redevelopment division resource materials (draft). June 2014. <https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Programs/RRD/Groundwater-Modeling/GSI-Pathway-Compliance-Options-Reference.pdf?rev=2380e2b2d8044190beadcd0c7bc84da5>

There are over 24,000 known contaminated sites in Michigan. Over 300 of these are determined to have “immediate risks” to human health.¹⁰⁴ An EGLE database lists over 3,200 individual parcels where soil or water contamination by hazardous materials is intentionally being left in place.¹⁰⁵ Contaminated and polluting sites are often clustered together such that the cumulative impact turns entire neighborhoods into “sacrifice zones.”¹⁰⁶ New sites are frequently uncovered by whistleblowers and citizen investigations, and many never will be.¹⁰⁷ It is impossible to know how widespread and hazardous the problem is, but EGLE has stepped-up efforts to better understand and quantify the extent and risk of site contamination and groundwater pollution.

Two policy options stand out as opportunities to substantially improve water quality:¹⁰⁸

1. Amend the Michigan Natural Resources and Environmental Protection Act (NEPA) to require polluters to clean up hazardous waste spills if it is feasible.
2. Provide EGLE with the support and resources needed to better enforce existing environmental protection laws, including working with businesses to remediate contaminated sites to the extent feasible.

The Great Lakes. All of Michigan’s inland waters and groundwater aquifers are part of the Great Lakes basin, so environmental issues that impact inland waters, wetlands, and groundwater also impact the Great Lakes. In addition to Clean Water Act monitoring of Great Lakes waters, the lakes are assessed under the binational Great Lakes Water Quality Agreement (GLWQA). Regulatory agencies from U.S. and Canada jointly publish an annual assessment of Great Lakes water quality.¹⁰⁹ A key enforcement provision of the GLWQA is the identification of areas of concern (AOCs) where pollution is found to impair beneficial uses of the Great Lakes, including as a source of drinking water, fishing, swimming, or habitat. Once an AOC is identified, a remedial action plan is adopted, along with monitoring and reporting.¹¹⁰ This process is independent from the provisions under the U.S. Federal Clean Water Act.

In the history of the GLWQA, nine AOCs have been delisted following successful remediation, including two in Michigan.¹¹¹

¹⁰⁴Carol Thompson. “How Michigan piled up thousands of toxic sites with cash shortfall for cleanup.” The Detroit News. April 18, 2022.

¹⁰⁵Data is available via the EGLE Environmental Mapper. The master spreadsheet that supplies this data was provided to CRC by EGLE August 2022.

¹⁰⁶Keith Matheny and Kristi Tanner. “Michigan’s poorer, minority neighborhoods become ‘sacrifice zones’ for increased pollution.” The Detroit Free Press. January 3, 2022.

¹⁰⁷Sara Talpos. “Citizen sleuths exposed pollution from a century-old Michigan factory, with nationwide implications.” Science. May 16, 2019.

¹⁰⁸Eric Paul Dennis. “Latest Pollution Discharge into Huron River Highlights Need to Reform Michigan’s Pollution Control Policies.” Citizens Research Council of Michigan

¹⁰⁹Environment and Climate Change Canada and the U.S. Environmental Protection Agency. State of the Great Lakes 2022 Technical Report. 2022.

¹¹⁰Canada - U.S. Great Lakes Water Quality Agreement. Areas of Concern (Annex 1).

¹¹¹U.S. and Canada, Great Lakes Water Quality Agreement 2022 Progress Report of the Parties. 2022.

Figure 4: Great Lakes Water Quality Agreement Areas of Concern



Source: U.S. and Canada, Great Lakes Water Quality Agreement 2022 Progress Report of the Parties. 2022. <https://binational.net/wp-content/uploads/2022/07/2022-Progress-Report-of-the-Parties.pdf>

Shoreline erosion and protection is especially challenging along many Great Lakes shorelines. While many inland rivers and lakes also have erosion concerns, the Great Lakes can generate large destructive waves and shoreline erosion can be very dynamic. As the Great Lakes reached near-record high water levels in 2020, permits were approved for “hard stabilization” projects, such as boulder revetments and iron sea walls.¹¹² Ideally, these measures should be used only as a last-resort to protect valuable infrastructure or structures. Hard stabilization measures degrade natural habitats and re-direct the energy from waves to other areas of the shoreline, redirecting and amplifying bank erosion issues rather than solving them.¹¹³

When permitting shoreline construction, EGLE must often balance public and ecological needs against the wishes of property owners.¹¹⁴ As one example, Figure 5 shows a Lake Michigan Beach House that was built near the high water mark. When lake levels reached record highs, EGLE permitted the property owner to construct an iron sea wall. Such structures restrict public access to the beach and impose costs on adjacent property owners by redirecting wave energy to adjacent properties.¹¹⁵

Wetlands are a critical part of the water cycle. Wetlands absorb water like a sponge, decreasing flooding and filtering pollutants. Michigan is one of only three states to have received federal authorization to administer the federal wetland program. Because of this approval, wetlands, lakes, and streams permits issued by EGLE under state law also provide federal approval.¹¹⁶ Michigan is obligated to enforce regulations at least as strictly as EPA regulations require. Michigan’s administration of the program has been challenged in the past for being too permissive, but the EPA has not revoked Michigan’s regulatory authority.¹¹⁷ Michigan has also been challenged for being too restrictive.¹¹⁸

Prior to European settlement, Michigan had around 11 million acres of wetland. There are now around six million acres, with most of the loss concentrated in developed and agricultural areas in southern Michigan. This has disrupted watersheds and floodplains, imposing challenges with polluted runoff and flooding.

¹¹²Jim Olson. “High Water, Public Rights, and Michigan Shoreline Protection.” FLOW. June 22, 2020.

¹¹³FEMA. Draft Programmatic Environmental Assessment. Great Lakes Shoreline Stabilization Projects. March 2021.

¹¹⁴It is possible that state environmental regulations prevent EGLE from denying construction permits without risking litigation. This may be a target area for a more in-depth policy analysis. Another factor is that beachfront property owners are often politically connected and can influence regulatory priorities.

¹¹⁵FEMA. Draft Programmatic Environmental Assessment. Great Lakes Shoreline Stabilization Projects. March 2021. (p. 3-5.)

¹¹⁶<https://www.michigan.gov/egle/about/organization/water-resources/wetlands>

¹¹⁷Sharon R. Newton. “The Past, present, and Future of Wetlands Permitting in Michigan.” Michigan Bar Journal. June 2014.

¹¹⁸Philip L. Ellison. Michigan Wetlands have Complicated Compliance Regulations. 2016.

Figure 5: Lake Michigan Beach House, 2015 & 2022



Source: Google Earth

In 2018, EGLE adopted a policy to work towards net zero wetland loss.¹¹⁹ Wetlands are currently being lost at a rate of about 1,000 acres per year in Michigan.¹²⁰ While any loss portends loss of ecosystem function, this is a historically small rate of loss, and represents less than 0.02 percent of existing wetlands lost each year.

A recent U.S. Supreme Court decision limited the ability of the Clean Water Act to protect wetlands.¹²¹ Michigan's unique status as the delegated authority over wetland development permitting implies that the ruling does not necessarily impact Michigan law.¹²² However, without federal backing, future state regulatory changes could weaken permitting requirements protecting Michigan wetlands.

¹¹⁹MDEQ (EGLE) Wetland Program Plan (2019-2024).

¹²⁰EGLE webinar, October 2022.

¹²¹Sackett v. EPA determined that a more stringent test must be applied to wetlands covered under the Clean Water Act. (Amy Howe.

"Supreme Court curtails Clean Water Act. SCOTUSblog. May 25, 2023.)

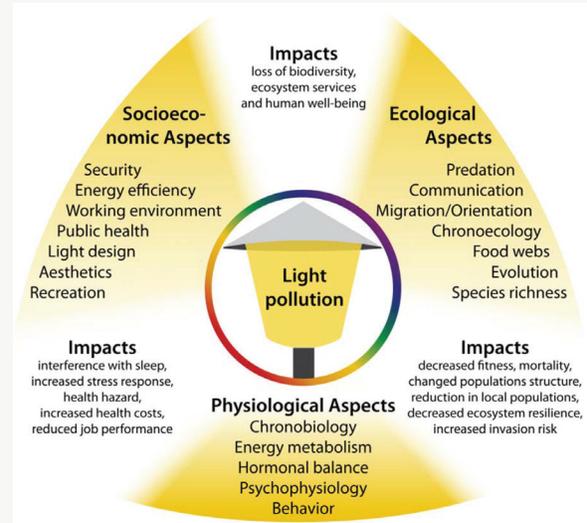
¹²²Garret Ellison. "Michigan law shields wetlands from Supreme Court decision impact." MLive. June 13, 2023.

Light Pollution

Light pollution may be one of the most underrated detriments to ecosystems. Artificial night lighting imparts physiological stress on a plethora of plants and animals, including humans.¹²³ The issue of light pollution has not become a notable statewide issue, but some communities are beginning to address it. For example, Ann Arbor passed a light pollution ordinance in 2021.¹²⁴ Some cities such as Lansing include light pollution limitations within the zoning code, though in such cases streetlights are exempt.¹²⁵

As with other types of pollution, light pollution degrades the health and quality of life of residents in urban areas. While night-lighting is often needed for safety and security, unnecessary and excessive lighting should be avoided.¹²⁶ Minimizing light pollution can even be a cultural amenity¹²⁷ and tourist attraction.¹²⁸

Figure 6: Impacts of Light Pollution



Source: WLS Lighting. What is Light Pollution?
<https://wslighting.com/what-is-light-pollution/>

Noise Pollution

Prolonged noise exposure has detrimental human health impacts. Research shows that long-term exposure to noise pollution can literally drive you crazy (i.e., increase risk of dementia and cognitive decline).^{129,130}

As with many pollution issues in Michigan, low income and minority communities are especially at risk.¹³¹ High-speed traffic is the most consistent source of noise pollution. Addressing traffic noise pollution in urban areas is not typically a priority for road agencies in Michigan. MDOT only installs noise abatement measures when legally required. For example, MDOT has resisted installing sound barriers as part of the I-75 modernization project despite pressure from residents and lawmakers.¹³² As a matter of policy, MDOT does not consider adding sound barriers to freeways that are already constructed, even when reconstruction projects increase road noise.^{133,134}

State policy should recognize that noise pollution, as with other types of pollution, is a significant human health and quality-of-life issue.

¹²³Catherine Rich and Travis Longcore (editors). *Ecological Consequences of Artificial Night Lighting*. Island Press. 2005.

¹²⁴Navya Gupta. "A step against light pollution: City Council increases outdoor lighting regulations." Sept 7, 2021.

¹²⁵Lansing, MI, Code of Ordinances. 1250.04.03. Street Lighting.

¹²⁶Paul Bogard (ed). "Let There Be Night." University of Nevada Press. 2008.

¹²⁷Michigan Dark Skies.

¹²⁸Emily Bingham. "8 cool spots to find dark sky parks in Michigan." MLive. May 3, 2022.

¹²⁹Jennifer Weuve et al. "Long-term community noise exposure in relation to dementia, cognition, and cognitive decline in older adults." *Alzheimer's and Dementia*. October 2020.

¹³⁰Notably, while prolonged exposure to traffic noise is correlated to cognitive health issues, the same population is also exposed to air pollution from traffic, thus it is difficult to disaggregate the causal mechanism.

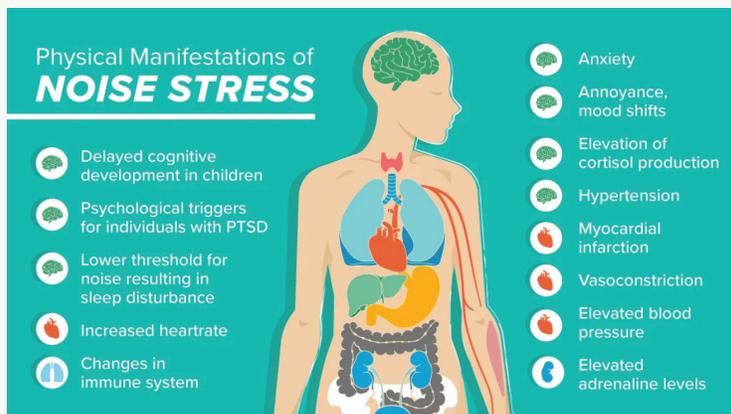
¹³¹Stuart Batterman et al. "A community noise survey in Southwest Detroit and the value of supplemental metrics for truck noise." 2021.

¹³²Bill Laitner. "\$300K tucked into Michigan budget will fund I-75 noise tests." *Detroit Free Press*. Sept 23, 2021.

¹³³MDOT. Noise Abatement FAQs.

¹³⁴Ryan Stanton. "Ann Arbor residents fed up with 'deafening' M-14 highway noise." MLive. August 17, 2022.

Figure 7: Impacts of Noise Pollution



Source: Stephanie Booth. "Loud noises aren't just annoying, they're bad for your health." Healthline. June 14, 2018. <https://www.healthline.com/health-news/loud-noises-bad-for-your-health>

Biodiversity and Invasive Species

Michigan hosts a remarkable biodiversity of species across the state's land, soil, water, and even the air. Michigan's fascinating ecosystem is a valuable amenity for residents and visitors. However, Michigan's ecosystem has been negatively impacted by habitat loss and invasive species. Climate change and newly introduced species will require active management to maintain biodiversity in many areas.

Michigan now hosts hundreds of species that were not present before European settlement of the region. The majority of introduced species have become integrated into the ecosystem without notable detriment. Some are even beneficial. However, a few introduced species can cause harm to existing ecosystems, threatening native species, natural resource economies, and even human health. Invasive and nuisance species can be considered as biological pollutants. Like chemical pollutants, they have the potential to negatively impact ecosystems and human wellbeing.

Past Impacts of Invasive Species

The threat posed by invasive species is not hypothetical. Some of Michigan's most infamous invasive species disasters include the following:

Dutch Elm Disease. The American Elm was once ubiquitous as a street tree in Detroit. Able to grow quickly into tall, stately, long-lived specimens, elm canopies once shaded urban neighborhoods. American Elms were brought to the brink of extinction by Dutch Elm Disease, a fungal infection native to Asia that is spread primarily by a beetle native to Europe.¹³⁵ Some of Michigan's urban neighborhoods still have not recovered the leafy canopy that once existed, amplifying the effect of urban heat islands, increasing cooling costs, and risking health impacts on vulnerable residents.

Dutch Elm Disease and Emerald Ash Borer have devastated urban forests in many Michigan cities.

Emerald Ash Borer. Multiple species of ash trees are native to Michigan, and all are susceptible to emerald ash borer. This small insect is native to China and was first discovered in Michigan in 2002. It has since become ubiquitous across the state and has killed hundreds of millions of mature ash trees, further eroding urban canopies and decreasing diversity of species in Michigan forests.¹³⁶

Sea Lamprey. Sea lampreys are estimated to have arrived in the Great Lakes basin around 1920. This invasive eel-like fish

¹³⁵US Department of Agriculture Invasive Species Information Center. Dutch Elm Disease.

¹³⁶Michigan Department of Agriculture and Rural Development. Emerald Ash Borer.

nearly collapsed Great Lakes fishing. Before government control programs were instituted in the 1950s, it is estimated that sea lampreys annually killed over five times more fish than were taken by commercial fishing. The Great Lakes lamprey population has been brought under control by ongoing mitigation efforts that now cost about \$30 million annually.^{137, 138}

Zebra and Quagga Mussels. Mussels are aquatic bivalves, like clams. Zebra mussels were first discovered in the Great Lakes basin in the late 1980s and have since become widespread. Closely-related quagga mussels were discovered in Michigan in the early 1990s. Together, these filter feeders have drastically altered aquatic ecosystems¹³⁹ and have cost billions of dollars in mitigation and control efforts.^{140, 141} The arrival of these exotic mussels was the basis of a 1996 federal law, the National Invasive Species Act, which established task forces across the country to study and control aquatic invasive species.¹⁴²

These are only four of the best known and most economically impactful examples of invasive species that have already permanently and negatively altered Michigan's environment. Until an exotic species becomes established in a new environment, it is difficult to predict what impact it will have on the ecosystem. Given the remarkable biodiversity around the planet and potential for species to be introduced to new locations, it is difficult even to know what species to watch out for. The Midwest Invasive Species Information Network (MISIN) lists over 500 exotic species with the potential to become nuisance invasives.¹⁴³

Current Priorities

EGLE and the Michigan Department of Agriculture and Rural Development have created a watch list of species with "immediate and significant threat to Michigan's natural resources."¹⁴⁴ The list includes:

- Six tree diseases
- One mammal (nutria, a giant rodent native to South America)
- Seven terrestrial plants
- Ten aquatic plants
- Eight aquatic animals (four of these being species of invasive carp)

The species on the watch list have not yet become established in Michigan, but have significant potential to disrupt habitats. Some of the species featured on previous versions of the watch list, such as the autumn olive,¹⁴⁵ have been removed because they have now become widely established. It is too late to prevent many such invasive species from becoming established in Michigan, but they can be mitigated and managed in high-value areas.

Introduced and invasive species can have surprisingly vast ecosystem impacts. For example, non-native earthworms, while beneficial to gardeners, have drastically changed the ecology of Michigan's forests,¹⁴⁶ impacting the environment, economic productivity, and human health (Figure 8).¹⁴⁷ Michigan is being further threatened by new invasive earthworm species (*Amyntas* spp., or "Crazy Jumping Worms") that are harmful to gardeners and agriculture as well as native ecosystems.¹⁴⁸

¹³⁷Rebecca Williams. "A never-ending \$28 million battle against a Great Lakes parasite." Michigan Radio. June 18, 2015.

¹³⁸Margaret Osborne. "Bloodsucking Sea Lampreys Made a Comeback in the Great Lakes During Covid." Smithsonian. July 11, 2023.

¹³⁹Brian Owens. "Mercury Levels Maintained: Invasive mussels keep mercury levels high in Great Lakes fish." GreatLakesNow.org. Nov 19, 2019.

¹⁴⁰Natasha Blakely. "Zebra Mussels: A guide to the good and bad of these Great Lakes invaders." GreatLakesNow.org. February 28, 2020.

¹⁴¹State of Michigan. Status and Strategy for Zebra and Quagga Mussel Management.

¹⁴²Andrew Blok. "30 Years Later: Mussel invasion reaches far beyond Great Lakes." GreatLakesNow.org. February 2, 2021.

¹⁴³<https://www.misin.msu.edu/>

¹⁴⁴Michigan's Invasive Species Watch List

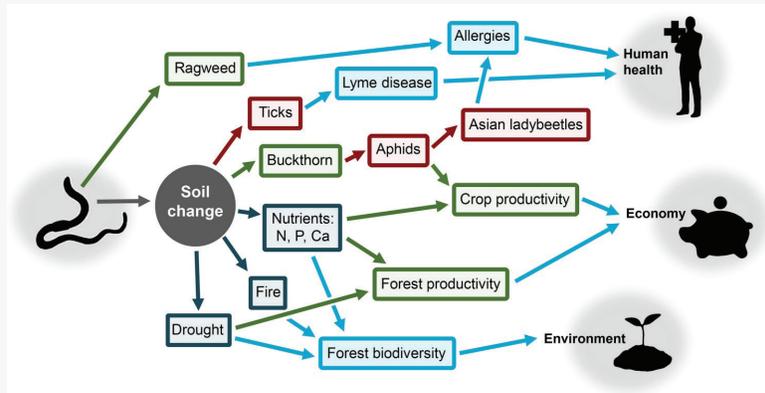
¹⁴⁵Michigan Invasive Species: Autumn Olive

¹⁴⁶Dean Solomon. The "dirt" about earthworms. Michigan State University Extension. November 14, 2013.

¹⁴⁷Lee Frelich et al. "Side-swiped: ecological cascades emanating from earthworm invasions." Front Ecol Environ. 2019.

¹⁴⁸Sarah Farmer. "Invasive jumping worms can change their world." US Forest Service. April 22, 2022.

Figure 8: Systemic Impacts of Non-native Earthworms



Source: Lee Frelich et al. "Side-swiped: ecological cascades emanating from earthworm invasions." *Front Ecol Environ*. 2019. <https://sci-hub.se/https://doi.org/10.1002/fee.2099>

During summer in southeast Michigan, observers will note that most unkept green spaces are basically a solid wall of woody shrubs. This is not natural, and was not the case until recent decades. Before the area was developed, Southeast Michigan was primarily wildfire-dependent forest. Native trees formed a tall canopy and the forest floor was primarily populated by a wide variety of low-growing native grasses and wildflowers.¹⁴⁹

Among other disturbances caused by development, several non-native woody shrubs that were planted for hedges escaped cultivation and spread across the region. The most notable forest invasives include:

- Shrub Honeysuckles (*Lonicera* spp.)
- Buckthorn (*Rhamnus cathartica*)
- Autumn Olive (*Elaeagnus umbellata*)
- Japanese Barberry (*Berberis thunbergii*)
- Winged Burningbush (*Euonymus alatus*)

Figure 9, below, shows a photo of the boundary line between Leslie Park in Ann Arbor and an "natural area" owned by an adjacent residential development. The forest within Leslie park (left side) is managed by the city through prescribed burning, which reduced shrubby invasive species and allows native ground covers and canopy trees to become established. The right side of the photo shows how natural areas develop in Southeast Michigan if not actively managed—an impenetrable thicket of invasive buckthorn and honeysuckle and near absence of native species.

An additional invasive is the Tree of Heaven (*Ailanthus altissima*).¹⁵⁰ This tree is not yet well established in natural areas,

Figure 9: The boundary line of an actively managed forest and an unmanaged "natural area" on private property in Southeast Michigan



Source: Citizens Research Council of Michigan

¹⁴⁹MSU Extension: Michigan Natural Features Inventory. Mesic Southern Forest.

but is becoming an expensive problem in developed areas. This fast growing tree can outcompete most native and ornamental species and has a strong root system that can penetrate concrete pavements and building foundations. Additionally, it is a primary host species for the invasive spotted lanternfly, a threat to numerous ornamental and agricultural crops.¹⁵¹ One feature of this tree is that it is difficult to remove it once established; attempts to remove the tree often result in making the problem worse as *Ailanthus* rapidly regenerates and spreads from its root network.¹⁵²

In addition to these woody invasives, an aggressive reed called *Phragmites* (*Phragmites australis*) is rapidly spreading across wetland areas in Michigan. As with the woody invasives, invasive *Phragmites* can outcompete other species and form dense impenetrable stands. The accumulation of vegetation over several years can obstruct drainage ditches and become fire hazards.

Most unmanaged green areas of Southeast Michigan are already completely inundated by these invasives. Not only are these areas ugly and undesirable for recreation, but for a variety of complex reasons they negatively impact water quality, air quality, wildlife, and even human health. For example, these invasive thickets increase the prevalence of disease-carrying mosquitoes and ticks, possibly because these insects are able to navigate the dense vegetation, but their predators are not.¹⁵³ These areas are also shade out grasses and other ground-hugging vegetation that would typically filter pollutants and protect soil from erosion. Thus, woody invasives amplify problems of stream erosion and water pollution.

In most other parts of the state, native shrub and tree species still dominate most unmanaged green areas. Ecosystems remain relatively healthy and ecologically beneficial. However, individual plants or small stands of invasive species are common. Without intervention, these pioneers will become established and multiply. If invasive vegetative species mitigation efforts are not ramped up soon, it is only a matter of time before most of Michigan's woodlands are transformed as those in southeast Michigan have been. It is difficult to predict the subsequent impacts on Michigan's tourism and recreation economy.

Michigan has two plans pertaining to the management of invasive species:

- The Michigan Terrestrial Invasive Species Management Plan (2018)¹⁵⁴
- The Michigan Aquatic Species Management Plan (2013)¹⁵⁵

Unfortunately, the implementation of these plans has been hampered by a lack of funding and attention. There are many local volunteer efforts to address invasive species, but very little coordination with any state policy or support. The plans themselves are already out of date as several new species have emerged as concerns in recent years.

Many people are working to better understand Michigan's invasive species problems, but the complexity of the issue is far greater than the resources available to address it. There is much reliance on limited-term grants and volunteer efforts. This is no substitute for trained professionals pursuing a coherent statewide plan supported by reliable long-term funding.¹⁵⁶

¹⁵⁰Midwest Invasive Species Information Network (MISIN). Tree of Heaven.

¹⁵¹Michigan Invasive Species. Spotted Lanternfly.

¹⁵²Penn State Extension. Tree-of-Heaven. 2020.

¹⁵³Allison Gardner et al. "Large-Scale Removal of Invasive Honeysuckle Decreases Mosquito and Avian Host Abundance." *Ecohealth*. 2017.

¹⁵⁴Appendix D of this Plan includes metrics for success, though most of the metrics are proxy measures, such as number of experts identified or meetings held. The plan is not detailed enough as to propose specific goals--such as successful control of particular species. It is unclear if any of the metrics are actively tracked. Plan is available at: <https://www.michigan.gov/invasives/stateresponse/terrestrial-invasive-species-management-plan>

¹⁵⁵Pages 51-67 list a series of implementation goals and associated metrics. Most goals have a target date of 2015 or earlier, reflecting the age of the plan. It is unclear if progress was tracked. Plan is available at: <https://www.michigan.gov/invasives/stateresponse/aquatic-invasive-species-state-management-plan>

¹⁵⁶A successful example is the federal Sea Lamprey control program. Control of sea lampreys were helped by the development of a chemical "lampricide" that does not harm native fish.

Summary and Discussion

As a historically industrial state, Michigan has substantial legacy pollution and entrenched interests that advocate for permissive pollution control policies that reduce the costs of industrial output. Many stakeholders in the business community believe that environmental regulations place undue burdens on economic development. No one wants to make it difficult to do business in Michigan, but corporations discharging harmful contaminants into the environment that make citizens sick and shorten life expectancy are not conducive to creating quality places that are inviting to newcomers.

Many historic urban areas are located in a confluence of legacy pollution, ongoing industrial activity, and other environmental impacts. These “sacrifice zones” are notable for their state of disinvestment and socioeconomic challenges. This has real health impacts for the residents of those neighborhoods, but also impacts Michigan’s economic prospects. Historic neighborhoods that were built-out before the era of suburbanization have the most potential to drive economic activity because public services can be delivered more efficiently, and economies of scale can be achieved more easily. But if nobody wants to live in these places because the air stinks and the local river is polluted and overgrown with invasive species, such areas will continue to be liabilities rather than assets. The cost of pollution and industrial activity is not nearly fully considered in Michigan policy.

Michigan has great potential to leverage natural amenities for economic development and improved quality of life. This is not something that can just happen with a marketing campaign; Michigan must actually invest in environmental remediation and management. Institutions are in place to do this, but it has been a very low priority and funding is limited.

- Most of Michigan is in formal compliance with the National Ambient Air Quality Standards determined by the federal Clean Air Act. However, urban neighborhoods near industrial facilities are borderline compliant with particulate matter and ozone pollution, and frequently suffer from periodic “environmental odors” that indicate the existence of a wide range of industrial emissions. Human health statistics in these neighborhoods reflect the impacts of this pollution. Financial resources and political backing are needed to earnestly enforce the provisions of the Clean Air Act and protect human and environmental health in all of Michigan’s communities.
- Successful enforcement of the federal Clean Water Act has put a stop to most overt pollution of waterways. However, legacy pollution of soil and groundwater will be an ongoing issue for the foreseeable future. Current regulations are relatively permissive in allowing landowners to contaminate soil and groundwater, further challenging environmental regulators to track and remediate harmful contaminants. Adoption of a “polluter pay” law would help to prevent further degradation of Michigan’s environment.
- Light pollution and noise pollution impose environmental degradation and human health impacts similar to chemical pollution. However, there are very few public policies that recognize these issues, and practically none that act to mitigate them.
- History has shown that invasive species are capable of substantial environmental degradation and economic losses. There are some public policies working to preclude such impacts from future invasive animals, such as invasive Asian carp. However, less notable invasives such as trees, shrubs, plants, and insects rarely attract attention until it is too late to control them. Most mitigation measures are local, volunteer-based, and fragmented. Earnest state policy for strategic mitigation of invasive species would help to avoid future impacts, improve quality-of-life for Michiganders, and could be an economic development asset.
- Environmental protection has historically been seen as antithetical to economic output. In recent decades, people increasingly relocate not for jobs, but for quality-of-life amenities such as healthy ecosystems, natural resources, and recreational opportunities. Achieving long-term economic viability for Michigan will require increased attention to pollution control and environmental protection policy.