

# Building Consensus

Securing Protection of Michigan's Groundwater

**FLOW**  
FOR LOVE OF WATER  
JUNE 2022



## A Report on the Proceedings and Recommendations of the Michigan Groundwater Table

Michigan's groundwater is an underappreciated and poorly understood part of the state's abundant water endowment. The source of drinking water for 45 percent of Michigan's residents, groundwater also provides approximately 25 percent of the volume of the Great Lakes and supports agricultural irrigation, manufacturing, cold-water trout streams, and endangered and threatened flora and fauna.

Great Lakes scientists have described groundwater as an enigma to the public because it is out of sight and therefore largely out of mind.<sup>[i]</sup> Its invisible nature has contributed to its widespread degradation. Thousands of groundwater contamination sites in Michigan are testimony to a century of poor stewardship.<sup>[ii]</sup> So are an estimated 130,000 failing septic systems, thousands of private wells tainted by harmful nitrate pollution, and regions of the state where excess groundwater demand

has drawn naturally occurring arsenic and chlorides toward the surface.<sup>[iii][iv]</sup>

In a [series of reports](#) dating back to 2018, FLOW has called attention to the gap between the importance of groundwater to Michigan's health and welfare and the state's inconsistent, fragmented groundwater policies. Understanding that Michigan residents and key stakeholders value stewardship of all water, including groundwater, FLOW in January 2021 launched and convened the Michigan Groundwater Table composed of diverse membership and perspectives.

The purpose of the Michigan Groundwater Table, which completed its work in March 2022, was to explore how scientific knowledge and data could be used to advance groundwater reform and management, enhance public understanding of groundwater-related issues and challenges, develop consensus-based

findings for groundwater protection, and help secure needed resources to better protect human health and environment. The project impaneled a group of 22 knowledgeable and influential stakeholders from local governance, academia, regulatory agencies, and public interest and justice organizations.

Six bimonthly presentations—ranging from an overview of Michigan’s groundwater, to the need for better groundwater monitoring and data, to the challenge of failing septic systems—informed Michigan Groundwater Table members of key concerns. Based on this information and their own knowledge, Groundwater Table members largely agreed\* on a consensus statement that includes findings about the state of Michigan’s groundwater resources and programs, as well as technical and state policy recommendations.

## TOP-LINE RECOMMENDATIONS

Michigan Groundwater Table members recommend that the state of Michigan implement a broader, comprehensive approach by the state to groundwater stewardship. This approach is based on elevating groundwater as a priority public-policy concern and on taking specific, measurable steps toward implementing that priority. The Michigan Groundwater Table’s recommendations include:

- **Polluter Pay**—Requiring those legally responsible for groundwater contamination to contain and better control it at the source to prevent it from spreading.
- **Private Wells**—Providing funding for rural groundwater testing of private wells on residential properties.
- **Agricultural Stewardship**—Promoting environmentally sound agricultural fertilizer and animal-waste management practices.
- **Statewide Septic Code**—Developing a statewide initiative to enable inspections and repair of septic systems, including funding to assist homeowners in replacing failing systems and to empower local health agencies to conduct periodic inspections and facilitate compliance.
- **Public Education**—Advancing groundwater awareness among Michigan residents through

**Michigan Groundwater Table members favor a broader, comprehensive approach by the state to groundwater stewardship. This approach is based on elevating groundwater as a priority public-policy concern and on taking specific, measurable steps toward implementing that priority.**

innovative visualization and information tools to incorporate conservation and environmental protection into personal and institutional practices.

- **Data Tools**—
  - » Provide funding for improving water management decision-making that furthers the understanding and oversight of hydrologic systems through centralized access to comprehensive hydrologic data, analyses, and regional modeling in priority areas.
  - » Supporting the Michigan Geological Survey, which facilitates basic and applied geological research to promote the best use of Michigan’s geological resources, by expanding geotechnical information and data-gathering capabilities.
  - » Better integrating existing databases and monitoring capabilities.

The Michigan Legislature and Governor Whitmer have taken a first step in that direction by agreeing in March 2022 on \$10 million in new funding to implement Michigan Water Use Advisory Council (WUAC) recommendations, improve water management decision-making, and promote understanding and oversight of hydrologic systems.

While promising, this new funding is far from enough. Michigan cannot attain full status as a model of water management—which it must do to secure its future—unless each of the above recommendations comes to fruition.

\* Consensus was not achieved on all groundwater policy options, but several recommendations commanded the support of most Table members.



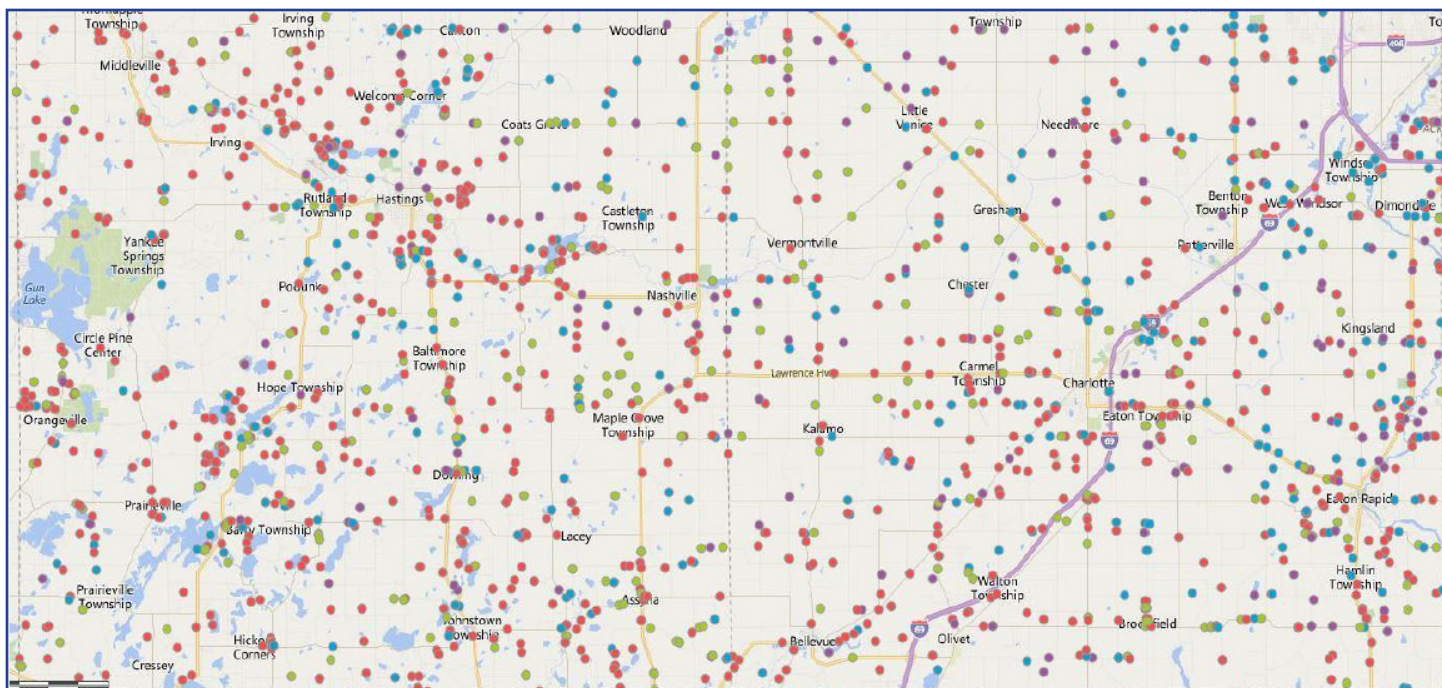
# What We Know

Michigan Groundwater Table members agreed on most of these key findings regarding the state of Michigan's stewardship of groundwater, as well as on most of the recommendations covered in the next section.

- Michigan's groundwater, which provides drinking water to 45% of Michigan's population, as well as providing water for agricultural and job-creating manufacturing uses, is a critical and often overlooked resource.
- Groundwater flow to surface water is important to cold-water fisheries, stream ecology, and wetlands, and can account for up to 25% of the total water inflow to the Great Lakes via groundwater inflow into tributaries.
- Michigan has underinvested in monitoring, mapping, and reporting groundwater quantity and quality.
- Despite the abundance of Michigan's groundwater,

localized withdrawals have caused conflicts and fostered water quality problems.

- Michigan's groundwater quality has deteriorated over the last century because of anthropogenic impacts, leading to more than 15,000 contamination sites and thousands of contaminated private wells; current policies often result in perpetuation of groundwater contamination that forecloses options for use of groundwater by future generations.
- The nature of groundwater makes contamination difficult and expensive to clean up, underscoring the need for pollution prevention.
- The state's current contamination cleanup program and policies have been significantly weakened in recent years, putting health and the environment at risk.
- All Michiganders have a common interest in sound stewardship of the state's groundwater resources.



Failing septic systems are polluting Michigan's groundwater, but there are no statewide requirements for routine inspection, maintenance and replacement of such systems. Some counties and townships have enacted local septic system inspection and maintenance ordinances. For example, between November 2007 and August 2017, the Barry-Eaton District Health Department, located west of Lansing and southeast of Grand Rapids, inspected wells and septic systems under a local ordinance requiring inspections at the time of sale or transfer of property. Implementation of the ordinance revealed hundreds of sites (dots on the map) where sewage was identified at the ground surface, no sewage system was found, or illicit sewage discharges were found. Over the 10-year period, 27 percent of inspections revealed a septic system that needed major or minor repair. *Source: Jay VanStee, Barry-Eaton District Health Department.*

# What We Should Do Next

## 1. Addressing Inadequate Monitoring and Data Collection

It is difficult to manage a resource when basic data are lacking and poorly coordinated. Addressing groundwater data needs was a focus of the Michigan Water Use Advisory Council (WUAC), a state body appointed by the governor and legislative leadership. The Council determined there are significant needs for improvement in the quality and coordination of groundwater databases.<sup>[v]</sup>

“What data have been collected were frequently ‘compartmentalized’ to meet the needs of narrowly defined programs,” the Council observed in its 2020 report. “Therefore, existing data are found in many locations and formats. The creation of an Integrated Water Management Database will increase the effectiveness and efficiency of all water related programs in Michigan by making all these data easily accessible and in a common geospatial format.”

WUAC recommended the creation of the Michigan Hydrologic Framework, a statewide “smartmap” that describes the distribution, abundance, status, and trends of the linked atmospheric, surface water, and groundwater systems. A better understanding of the subsurface geology in critical areas requires subsurface geologic mapping.<sup>[vi]</sup>

The information and data capabilities established under these two major recommendations will not only provide a means of informing and supporting water-related programs, but will also yield technical information, tools, data, assumptions, and decision endpoints used to assist water users in resolving and preventing water conflicts. In so doing, WUAC’s recommendations also will benefit the agricultural community and municipal, county, and township governments.

The Michigan Groundwater Table concurred with WUAC’s findings and recommendations regarding data. In a November 2021 communication with the governor and key members of the legislature’s appropriations committees, Groundwater Table members called funding of WUAC’s recommendations “a modest yet vital appropriation considering the benefits that



Scientists from the U.S. Geological Survey drill wells as part of the National Water-Quality Assessment, one of several federal and state programs devoted to water monitoring and evaluation. At the state level, groundwater data have been fragmented and inconsistently maintained, a problem that must be resolved if Michigan is to improve groundwater stewardship.

will accrue to Michigan’s environment, economy, and public health. As further legislative appropriations are considered, prioritizing funding for the WUAC’s recommendations will help ensure that all governmental water-related programs will be informed by the best data and informational systems available.”

### Recommendations:

- Improve water management decision-making and further the understanding and oversight of hydrologic systems through centralized access to comprehensive hydrologic data, analyses, and regional modeling in priority areas.
- Support the Michigan Geological Survey by expanding geologic information and data-gathering capabilities.
- Better integrate existing databases and monitoring capabilities.

Consistent with the Michigan Groundwater Table’s recommendations, on March 30, 2022 Governor Whitmer



signed into law an appropriations bill providing \$10 million to implement the Michigan Hydrologic Framework and the much-needed integration of the state's water-related databases.

## 2. Addressing Inadequate Private Well Testing

The fact that over four million Michiganders rely on groundwater as a drinking water source should make analysis of its quality a top concern of policy makers and the public. But there is no routine monitoring of private wells. Because pollution of well-water is not necessarily indicated by taste and odor, it can go unnoticed. Further, many residents of rural areas, especially recent arrivals from urban areas, may assume their well water is monitored. But the quality of water in private wells is typically tested only when the well owner or user submits a sample for laboratory testing.

Legislation that the Michigan Senate approved in December 2021 ([Senate Bill 565](#)) contained \$50 million for testing of samples from private drinking water wells, but the provision was eliminated in a final version of the bill approved by the legislature and signed into law by Governor Whitmer.<sup>[vii]</sup> Because cost is a barrier to some in securing well water quality testing, the state should fund such testing in part. This not only will protect human health, but also contribute important information to the state's groundwater database.

### Recommendation:

- Provide funding for rural groundwater testing of private wells on residential properties.

## 3. Stopping the Spread of Groundwater Contamination

The Department of Environment, Great Lakes and Energy (EGLE) reported to the Michigan Groundwater Table on the current status of Michigan's approach to environmental contamination, indicating there are over 15,000 known contamination sites in Michigan, the vast majority of which contain groundwater contamination. EGLE can address [only 200 to 300 sites per year](#) because of resource limitations. These sites involve immediate health or environmental risks.

The environmental and human health risks at approximately 12,000 of the sites are unknown. The statutory provisions and regulations that apply to contaminated sites have been weakened, are internally inconsistent, and do not provide for transparency or finality.

Michigan law requires parties responsible for contamination to "diligently pursue" response activities until certain containment and clean-up criteria are met. EGLE's Joshua Mosher and Groundwater Table member Andrew Hogarth—who headed the state remediation program until 2009—called for a clearer definition of this statutory requirement. Importantly, they urged that state policy and law be amended to clearly establish that groundwater contamination should be controlled and cleaned as close to the source as possible, preventing the migration of pollutants that contaminate additional groundwater.

### Recommendation:

- Require those legally responsible for groundwater contamination to contain it and clean it up at the source to prevent it from spreading.

## 4. Curing Michigan's Lack of a Statewide Sanitary Code

Michigan remains the only state in the country without statewide minimum standards for site criteria, construction, maintenance, and repair of septic systems. This is true even though Michigan is surrounded by 20 percent of the world's fresh surface water and 95 percent of all fresh surface water in the United States. Moreover, [a study showed](#) that microbial contamination from humans can be found in the overwhelming majority of rivers and water systems in Michigan's Lower Peninsula.<sup>[viii]</sup> There is a strong correlation between the presence of septic systems and fecal coliform bacteria counts in sampled water bodies.

Failing septic systems also often release chemicals from domestic use into groundwater. A 2017 nationwide synthesis study of septic system waste found that four nonprescription pharmaceutically active compounds, five personal care product ingredients, two alkylphenols, and three biochemicals were detected in at least 90 percent of samples tested.<sup>[ix]</sup>

At the same time, many homeowners in rural areas do not even realize they own a septic system, thinking they are connected to sewage plants. A survey of residents of the upper Maple River watershed in mid-Michigan found that 30% were not aware they owned septic systems.<sup>[x]</sup>

The infrastructure legislation signed into law by the governor in March 2022 includes \$35 million to establish a loan fund for the replacement of failing septic systems. The legislation calls on EGLE to “establish and support a loan program that provides low or no interest loans to municipalities, residents, and other entities deemed necessary by the Department of Environment, Great Lakes, and Energy to protect public health and the environment through addressing failing septic systems.” EGLE must define criteria and mechanisms for issuing loans.

One of the obstacles to adoption of a statewide sanitary code has been concern about the financial impact on property owners of replacing failing septic systems. Replacement costs can exceed \$10,000. With the influx of state and federal funding opportunities and the establishment of a loan program, this may be a particularly opportune time to revisit statewide solutions.

Although Groundwater Table members did not discuss the details of a desirable statewide sanitary code as it relates to septic systems, there is consensus on the need for legislative action on the issue.

#### Recommendation:

- Develop a statewide initiative to enable inspections and repair of septic systems, including funding to assist homeowners in replacing failing systems and to empower local health agencies to conduct periodic inspections and facilitate compliance.

## 5. Increasing Groundwater Awareness

In a [2021 paper](#) based on a groundwater summit convened by the Robert B. Annis Water Resources Institute at Grand Valley State University, authors observed that “Groundwater is a natural resource in peril, in Michigan and throughout the world. This likely is because we cannot see it, we do not measure its stocks and flows in a coordinated and consistent manner, and

## The infrastructure legislation signed by the governor in March 2022 includes a \$35-million loan fund for the replacement of failing septic systems.

we have done a poor job of communicating its value to society at large.”<sup>[xi]</sup> Indeed, there is no systemic K-12 groundwater education in Michigan.

The Michigan Groundwater Table agreed that it is important to “advance groundwater awareness among Michigan residents through innovative visualization and information tools to incorporate conservation and environmental protection into personal and institutional practices.”

A model from Michigan’s past is the Groundwater Education in Michigan (GEM) program. Initiated in 1987 through a partnership between W.K. Kellogg Foundation and Michigan State University, the 10-year, \$21 million dollar grant program made more than 50 grants to 35 different organizations. The grants supported local groundwater education and protection efforts. GEM Regional Centers at universities provided technical support.

State government has an interest and obligation in increasing public awareness and understanding of groundwater as a vital part of the state’s water resources. The Michigan Groundwater Table calls on the governor and legislature to develop and implement critical groundwater awareness programs.

#### Recommendation:

- Advance groundwater awareness among Michigan residents through innovative visualization and information tools to incorporate conservation and environmental protection into personal and institutional practices.

# Conclusion

Michigan's groundwater is a critical part of Michigan's present and future. Increasing population, a changing climate, and limited public funding for prevention and cleanup of contamination will continue to stress groundwater resources. Unless policymakers **and the public** make a lasting commitment to groundwater protection and stewardship, Michigan will suffer from a degraded resource unable to serve the state's needs.

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## APPENDIX MICHIGAN GROUNDWATER TABLE PROCEEDINGS

The Michigan Groundwater Table was established in January 2021 to explore how scientific knowledge and data could advance groundwater reform and management, enhance public understanding of groundwater-related issues and challenges, develop consensus-based findings for groundwater protection, and help secure needed resources to better protect human health and environment. The project impaneled a group of 22 knowledgeable and influential stakeholders from local governance, academia, regulatory agencies, and public interest and justice organizations. The Table's ambition was to use expert information and data to inform thoughtful stakeholder discussions to guide water users, local communities, and regulatory agencies to improve our collective stewardship of groundwater resources. The objectives of the project were to:

- Identify and prioritize needed groundwater policies.
- Build consensus on the need for comprehensive protection.
- Educate and build public support for enhanced groundwater governance.
- Develop strategies to assist state and local government in meeting programmatic needs.
- Identify data gaps and informational needs.
- Elevate groundwater management as an essential component of water resource stewardship.

To achieve consensus among influential stakeholders regarding critical groundwater issues, the Table, over the course of a year, held a series of virtual meetings in which experts presented scientific information and data directed at developing a common understanding of the nature and extent of Michigan's groundwater resources.

The six bimonthly presentations began in May 2021. This section provides a summary of each of the six presentations and facilitated discussions.

### Meeting 1, May 5, 2021—

#### *Groundwater Under Threat: Understanding the How, Why, When, and Where*

Dr. Alan Steinman, the Allen and Helen Hunting Director of the Robert B. Annis Water Resources Institute at Grand Valley State University, provided an introductory overview of Michigan's groundwater resources, including groundwater's relationship to surface water and stream flows, uses of groundwater (residential, agricultural, and industrial uses; municipal systems), groundwater's connection to surface water, an explanation of confined and unconfined aquifers, and ways in which groundwater is sustainably replenished. Dr. Steinman indicated that the lack of public awareness of groundwater issues translates into an underappreciation of groundwater resources. His presentation illustrated the dependence of public water authorities, supplies, industry, agriculture, and aquatic and wetland ecosystems on groundwater resources, indicating that inadequate funding for groundwater science, management, and protection remains a persistent problem. Ideally, a state program would be working proactively to manage all of Michigan's groundwater by inventorying, monitoring, and mapping and integrating scientific information and data. Dr. Steinman also reviewed groundwater availability and salinity issues in Ottawa County and the potential for groundwater shortages and conflicts. He also suggested that key strategies for groundwater protection include education and integrating behavioral change.

## **Meeting 2, July 7, 2021—**

### *Modern Challenges to Groundwater: Policy, Science, and Practice*

Dr. Anthony Kendall, Assistant Professor, Earth and Environmental Sciences, Michigan State University, focused on point source and nonpoint source pollutants in groundwater, highlighting the policy shortfalls and technology challenges making these contamination issues so difficult to address. Nonpoint source pollution—from diffuse sources—has not received the same level of legal and public policy protection, scientific attention, or implementation, he said. While groundwater science has made significant advances, groundwater policy remains fragmented and too weak to deal with complex contaminants that are neglected in practice. Dr. Kendall illustrated how contaminants are transported with groundwater flow in aquifers and their various properties and impacts. He contextualized the present PFAS crisis, the threat posed by antibiotics and endocrine disruptors, nitrogen and phosphorus loading from agriculture and other nonpoint sources, and septic system problems, and the relationship of agricultural inputs to elevated nitrate levels and harmful algae blooms.

## **Meeting 3, September 1, 2021—**

### *Modern Challenges in Groundwater Contamination*

Ben Tirrell, Associate Legislative Counsel at Michigan Farm Bureau, and David Hamilton, formerly with The Nature Conservancy, provided a summary of the findings and recommendations of the Michigan Water Use Advisory Council (WUAC), a statutorily-established expert body charged with the responsibility to inform and guide Michigan's water-use programs and make water-related scientific recommendations to the Department of Natural Resources, the Department of Environment, Great Lakes, and Energy (EGLE), and the Department of Agriculture and Rural Development. Among the recommendations of the WUAC is the development of the Michigan Hydrologic Framework, conceived as a statewide "smartmap" that would describe the distribution, abundance, status, and trends of the inextricably linked atmospheric, surface water, and groundwater systems. Implementing the WUAC's recommendations would enable creation of groundwater/surface water models to improve water management decision-making through centralized access to up-to-date hydrologic data, comprehensive hydrologic analysis, and incorporation of uniform data management protocols. It would also benefit the agricultural community and municipal, county, and township governments by facilitating environmental monitoring, providing technical and compliance assistance, and preventing and resolving water conflicts.

## **Meeting 4, November 4, 2021—**

### *Existing Groundwater Databases and Monitoring Capabilities*

EGLE staff: Jim Milne, Supervisor, Water Use Assessment Unit; Sara Pearson, Supervisor, Source Water Unit; and John Esch, Geology Specialist, Environmental Mapper Project, provided a summary of groundwater data sources used by EGLE, including a detailed description of EGLE's groundwater evaluation capabilities, software, measurement, and visualization capabilities. The team presentation demonstrated how EGLE's data development and analysis efforts enable support for aquatic natural resources, understanding stream flows and their effect on fish populations, and the public trust value of these natural resources. EGLE staff identified the challenges and opportunities that EGLE sees looking forward, among them the need for standardization of data collection and data entry protocols and the need to rectify and enhance existing databases.

## **Meeting 5, January 5, 2022—**

### *Management of Groundwater Contamination in Michigan*

Presenters were Joshua Mosher, Assistant Chief of the Remediation and Redevelopment Division (RRD) of EGLE; Chris Flaga, former supervisor of the Toxicology Unit of the RRD; and Andrew Hogarth, retired Chief of the RRD of the Michigan Department of Environmental Quality (EGLE's predecessor). Chris Flaga provided a tutorial on the development and use of risk-based cleanup criteria for soil and groundwater contamination, analysis of exposure pathways (direct contact, ingestion, inhalation), and how toxicity values are determined. Andy Hogarth provided an historical review of Michigan's cleanup program, including the evolution of the state's cleanup requirements from active remediation of hazardous substances to the present reliance on institutional controls to limit exposures. He also contextualized the broad scope of groundwater contamination problems in Michigan. Joshua Mosher reported on the current status of Michigan's approach to sites of environmental contamination, noting that there are over 15,000 known sites in Michigan. EGLE is able to address only 200–300 sites per year because of significant funding limitations. Further, the environmental and human health risks at approximately 12,000 of these sites are unknown and the statutory provisions and regulations that apply to contaminated sites have been weakened, are internally inconsistent, and do not provide for transparency or finality.



## Meeting 6, March 2, 2022— *Statewide Septic System Regulation: Issues and Challenges*

This session featured four reports relating to Michigan’s need for comprehensive state legislation governing septic systems. The presenters were Jay Van Stee, Environmental Health Director, Barry-Eaton District Health Department; Jeremy Hoeh, EGLE, Unit Supervisor for the Onsite Wastewater Program; Matt Bolang, Michigan Association of Local Environmental Health Administrators; and Brad Ward, Vice President of Public Policy & Legal Affairs of Michigan Realtors.

Michigan remains the only state in the country without statewide minimum standards for site criteria, construction, maintenance, and repair of septic systems. This is true despite the fact that Michigan is surrounded by 20 percent of the world’s fresh surface water and 95 percent of all fresh surface water in the United States.

There is interest among Michigan Groundwater Table members about moving statewide standards forward. Septic concerns are, in fact, infrastructure issues. With the influx of state and federal infrastructure funding opportunities, this may be a time to revisit statewide solutions.

## ENDNOTES

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- <sup>ii</sup> Joshua Mosher, Assistant Division Chief, Remediation and Redevelopment Division, Michigan Department of Environment, Great Lakes and Energy, presentation to Michigan Groundwater Table, March 2, 2022.
- <sup>iii</sup> Michigan Office of the Great Lakes: Sustaining Michigan’s Water Heritage: A Strategy for the Next Generation, October 2016, [https://www.michigan.gov/documents/deq/deq-ogl-waterstrategy\\_538161\\_7.pdf](https://www.michigan.gov/documents/deq/deq-ogl-waterstrategy_538161_7.pdf)
- <sup>iv</sup> Curtis, Z. K., Liao, H., Li, S., Sampath, P. V., & Lusch, D. P. (2019). A Multiscale Assessment of Shallow Groundwater Salinization in Michigan. *Groundwater*, 57(5), 784–806. <https://doi.org/10.1111/gwat.12873>
- <sup>v</sup> Michigan Water Use Advisory Council 2020 Report, [https://www.michigan.gov/documents/egle/egle-wrd-wateruse-WUAC\\_2020\\_council\\_report\\_711968\\_7.pdf](https://www.michigan.gov/documents/egle/egle-wrd-wateruse-WUAC_2020_council_report_711968_7.pdf).
- <sup>vi</sup> The Michigan Geologic Survey will conduct data collection, which can be used in multiple program areas, including the water withdrawal assessment program, PFAS tracking, waste leachate tracking, sand and gravel assessments, and others. The Survey, housed at Western Michigan University, archives the largest collection of geologic maps and documents of Michigan. The Michigan Geological Repository for Research and Education archives Michigan subsurface cores, samples, and well records in the state, including more than 500,000 linear feet of core, cuttings from 16,200 wells, wireline logs from 16,000 wells, mud logs from 4,451 wells and core analyses from 2,100 wells.
- <sup>vii</sup> “Sen. Johnson Supports Well Water Resources in \$3.3 billion water investment plan,” news release, December 2, 2021, <https://www.senatorruthjohnson.com/sen-johnson-supports-well-water-resources-in-3-3b-water-investment-plan/>
- <sup>viii</sup> Verhoughstraete, Marc, Martin, Sherry L., Kendall, Anthony D., Hyndman, David W., Rose, Joan B. Linking fecal bacteria in rivers to landscape, geochemical, and hydrologic factors and sources at the basin scale. <https://www.pnas.org/doi/full/10.1073/pnas.1415836112>
- <sup>ix</sup> Schaidler, Laurel L., Rodgers, Kathryn M., Rudell, Ruthann A. Review of Organic Wastewater Compound Concentrations and Removal in Onsite Wastewater Treatment Systems, DOI: 10.1021/acs.est.6b04778 *Environ. Sci. Technol.* 2017, 51, 7304–7317. <https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b04778>
- <sup>x</sup> Jon Beard, Public Sector Consultants, “Failing Septic Systems in Mid-Michigan: An Unseen Threat to Public Health,” presentation to Septic Summit, November 6, 2019, <https://forlo-veofwater.org/wp-content/uploads/2019/12/Michigan-Septic-Summit-2019.11.6.pdf>
- <sup>xi</sup> Steinman, A.D., *et al.* Groundwater in Crisis? Addressing Groundwater Challenges in Michigan (USA) as a Template for the Great Lakes. *Sustainability* 2022, 14, 3008. <https://doi.org/10.3390/su14053008>

## ACKNOWLEDGMENTS

FLOW thanks the participants in the Michigan Groundwater Table for their time and substantive contributions to this report.

### Members of the Michigan Groundwater Table

*Note: Affiliations are for identification only and do not indicate the endorsement of the recommendations by the organizations listed.*

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Ensuring the Waters of the Great Lakes Basin Are  
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