Risk-Based Management of Groundwater Contamination in Michigan

An Analysis of Part 201 of the Natural Resources and Environmental Protection Act

---

Prepared For:
State of Michigan's Department of Environment
Great Lakes, and Energy
Office of the Great Lakes

Advised By:
Dr. Paul Seelbach and Dr. Allen Burton
University of Michigan
School for Environment and Sustainability

Prepared By:
Morgan Beeler (MPP/MS '20)
Iqra Nasir (MPP/MS '21)
Matt Willig (MS '20)
University of Michigan
School for Environment and Sustainability

[This page left intentionally blank]

Table of Contents

[This page left intentionally blank]

Acknowledgements

We would like to express our most sincere gratitude to State of Michigan personnel at EGLE and DHHS for their efforts and contributions to our project. Their hard work and generosity were greatly appreciated and helped us develop a successful and enlightening report. Additionally, we are very grateful for the work of EGLE's 2019 summer legal interns in helping us gather statute information on other states' use of institutional controls.

We also thank the many professors at the University of Michigan who assisted in developing our interview methodology and our understanding of GIS data and software for analysis.

We extend special thanks to our client – EGLE Office of the Great Lakes' Emily Finnell, Christina Pastoria, and James Clift – and our advisors – Dr. Paul Seelbach and Dr. Allen Burton – for sharing their expertise, contact networks, and thoughtful feedback as they guided our exploration and analysis of this project.

Finally, we thank the University of Michigan School for Environment and Sustainability and EGLE for their financial support of this project.

***Disclaimer**: This paper represents the opinions of the authors and is the product of academic research to meet Master's degree requirements for the University of Michigan's School for Environment and Sustainability. It is not meant to represent the position or opinions of the University of Michigan or its members. Any errors are the fault of the authors. Information provided in the report is not an alternative to legal or policy advice from an appropriately qualified professional. Specific questions regarding any legal or policy matters should be directed to an appropriately qualified professional.*

Executive Summary

Restrictive management actions are used across the State of Michigan to address groundwater contamination; however, the long-term impacts of these management choices have not been fully assessed. The 2016 Michigan Water Strategy recommends developing a comprehensive groundwater management strategy to better protect Michigan's valuable water resources, but the lack of understanding regarding long-term impacts of restrictive management actions poses a major barrier to developing an effective management strategy.

Building a deeper understanding of the impacts of restrictive management actions was identified as a priority for cross-agency collaboration by the State of Michigan Interdepartmental Water Team, comprised of representatives from the Department of Environment, Great Lakes, and Energy (EGLE), Department of Natural Resources (DNR), Michigan Economic Development Corporation (MEDC), Department of Agriculture and Rural Development (MDARD), Department of Health and Human Services (MDHHS), and Department of Transportation (MDOT). An Interagency Long-Run Risk Working Group comprised of members of the Interdepartmental Water Team was created to develop a plan to address the issue. Through several months of meeting, the working group developed a draft plan to evaluate the long-term economic cost of the risk management strategy by comparing the actual costs incurred at current sites to the expected cost when the management action was selected.

While the Interagency Long-Run Risk Working Group recognized the importance of evaluating the long-term economic costs of restrictive management actions, it became clear that the regulatory framework in place for implementing these actions must be understood. Without a full understanding of the regulatory framework, it would be difficult to offer recommendations for policy change if it is later determined that the current risk management approach requires modification. The Office of the Great Lakes developed an interim project team of three master's students from the University of Michigan's School for Environment and Sustainability to analyze Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA). Part 201 outlines the process for environmental remediation through use of restrictive management actions to mitigate risks associated with groundwater contamination. Other statutes, including NREPA Parts 111[1] and 213[2], also pertain to groundwater contamination and restrictive management actions. However, the processes for implementing restrictive management actions are more clearly defined under these statutes than for Part 201. Therefore, developing a better understanding of the Part 201 process, including its strengths and weaknesses, is critical to developing future recommendations and intervention strategies after the full economic analysis is completed.

The project team conducted an analysis of NREPA Part 201, including amendments to the law between 1995 and 2015, while investigating other state statutes to identify key similarities or differences in their management of contaminated aquifers. Further, the project team conducted

[1] NREPA Part 111: Hazardous Waste Management
[2] NREPA Part 213: Leaking Underground Storage Tank Program

a spatial analysis of current land or resource use restrictions (LRURs, synonymously referred to as institutional controls) using geographic information systems (GIS) data and tools. Groundwater modeling protocols for projecting the fate and transport of groundwater contaminants were also investigated to identify ways to increase data availability and accessibility across the state. The project team also conducted in-person interviews with EGLE and DHHS staff to understand how Part 201 is implemented in practice and to identify any challenges associated with enforcing the statute. The project team then used this research to develop recommendations for enhancing the effectiveness of inter-agency collaboration to manage of groundwater contamination.

The project team found that while amendments to Part 201 were initially intended to aid in the development of brownfield sites and limit urban sprawl, the law has consequently been used to further restrict groundwater resources even outside of urban centers. The law also makes it difficult for state agencies to fully track contamination under the present reporting requirements and the ability for liable parties to self-implement cleanup measures without notifying the state, unless an institutional control is placed on the property. While institutional controls provide flexibility to owners and operators, allowing them to maintain operations on contaminated properties if the risk is managed, no attempt has been made to measure the associated long-run economic or social costs. Continued restriction of groundwater resources warrants measuring the long-run costs of maintaining risk management focused cleanup criteria.

Michigan is not unique in their process for risk mitigation; most states follow similar protocols. In the project team's comparative analysis of Michigan, Minnesota, Wisconsin, and Wyoming's environmental protection statutes, several trends emerged. Most notably, no states require property owners to disclose contamination if the release quantity is below the reportable quantity. All states allow use of institutional controls, but the level of state involvement (e.g., review and approval) and how institutional controls could be used varied. While these states allow the use of institution controls, the analysis could not measure whether institutional controls effectively manage groundwater contamination or what the associated long-run costs are.

Interviews with State of Michigan employees resulted in a deeper understanding and identification of the value of institutional controls and the range of obstacles to addressing groundwater contamination. Interviewees, who have worked for years on the issue, offered recommendations to improve prevention and management of groundwater contamination in the State of Michigan. Interviewees explained that due to current legal statutes, cleaning to appropriate land use-based criteria or background is not always a viable option. However, institutional controls are valuable because they are cost-effective and mitigate public health risks. There are however, a range of obstacles, such as tracking and monitoring, to effectively addressing groundwater contamination. For example, many interviewees stated that the current datasets needed to address contamination are incomplete or out of date. Others stated that limited funding has hindered comprehensive mapping of Michigan's groundwater resources and, by extension, tracking of contamination. Interviewees recommended updating data and sources, creating a more user-friendly platform that allows for easy navigation of the data, adding

additional layers of data, and providing training materials for use of the Remediation and Redevelopment Division's (RRD) Environmental Mapper (see section 2.4).

The project team's interviews with staff and online research indicate that data available to staff is disparate across agencies. Most staff use agency or division specific systems for collecting and coding data. For example, Environmental Mapper uses site IDs while the Drinking Water and Environmental Health Division's (DWEHD) WellLogic uses parcel IDs (see section 2.4). Because sites are identified differently, sites with institutional controls on them could be overlooked during the well permitting process; therefore, it would be beneficial if Environmental Mapper included parcel IDs in its site data. Another example is the Water Resource Division's (WRD) MiWaters database (see section 2.4). Even after a thorough search of WRD's website for coding descriptions, the project team was unable to understand what much of the data were describing. Further, during the project team's interviews, some staff stated that MiWaters contained information on Part 201 sites. Subsequent data queries showed that identifying Part 201 sites was particularly onerous because the documents were housed with the permit documents and not explicitly identified or searchable. Given the difficulties in navigating the MiWaters data and challenges expressed to the project team from staff during interviews, improvements could be made to MiWaters to make it more user friendly. Lastly, some of the databases are missing critical information including site addresses and well records. This could make it difficult for staff from other agencies to find information about a specific site. Missing data can be attributed to the use of paper versus electronic records and that not all district staff provide the same level of detail when entering records into a database.

Analysis of groundwater modeling protocols revealed three areas of weakness: lack of sufficient funding to complete priority modeling, lack of authority to enforce modeling standards, and lack of statewide database to house and access groundwater models and associated data. Increased rule-making authority would allow the department to require groundwater models submitted with Remedial Action Plans to adhere to these standards, ultimately aiding the creation institutional controls that accurately reflect the state of contamination. Securing additional funding would empower the Department to complete modeling on all sites without a PRP to ensure that all contamination across the state is monitored and potential contamination risks are fully understood. To enable accurate forecasting of groundwater quantity and quality across the state, a statewide data management system should be developed to house groundwater models and groundwater data to feed those models.

Given these analyses, recommendations were given to promote enhanced data availability and accessibility as well as enhanced decision-making and resources for management. Improvements to data continuity and improved processes for record keeping could be undertaken by state agencies without approval or funding from the Michigan legislature. However, to institute more strict reporting and management requirements where the professional judgement of EGLE staff sees fit, Part 201 would need to be amended by the legislature. Further, additional appropriations are needed from the legislature to ensure comprehensive mapping of Michigan's aquifers and increase EGLE's capacity to address contamination and reduce risks of human exposure.

1. Introduction

The State of Michigan is fortunate to enjoy abundant, accessible groundwater resources in most parts of the state. Precipitation and snowmelt infiltrate a porous, glacial landscape dominated by sand and gravel deposits, filling subsurface aquifers that are readily accessible by digging wells. These aquifers undergird the state of freshwater resource security that supports the livelihoods of millions of people across the state. Furthermore, Michigan's porous landscape enables connectivity and recharge of streams, rivers, and lakes, further supporting the state's economy and quality of life. However, this hydrologic connectivity creates significant challenges in preventing degradation of Michigan's freshwater supply. Contaminants discharged into the subsurface are readily transported as groundwater migrates downslope through the porous subsurface. These plumes of contaminated water threaten public health, are difficult to contain, and are costly to remediate.

In Michigan, the present legal framework attempts to minimize remedial obligation, and thus costs, allowing groundwater contamination to be addressed through restrictive management practices. These are commonly referred to as land and/or resource use restrictions (LRURs) or institutional controls, which restrict or ban use of groundwater in zones of contamination to eliminate potential public exposure to contaminants. This framework facilitates redevelopment of contaminated properties that cannot feasibly be remediated to background levels or unrestricted residential criteria. Institutional control use is widespread, yet no clear framework exists to determine when use is appropriate and the long-term impacts associated with their use have not been fully assessed. The de facto removal of these aquifers from future use may pose long-term risks to freshwater resource security and public health as the frequency of this practice increases. Therefore, to ensure perpetual abundance of usable state groundwater resources, it is essential to understand how risk-based management actions and institutional controls are used by the state to protect this critical resource.

The analyses presented in this report achieve three objectives put forward by the project team. Foremost, the project team sought to understand the legal foundation and process for risk-based management of contaminated groundwater using Part 201 of the Natural Resources and Environmental Protection Act (NREPA), including how institutional controls are used and enforced. A literature review, comparative analysis of environmental protection statutes in 16 states, and interviews with state employees were conducted to map the Part 201 process from start to finish. Next, the project team inventoried the available resources that support state and local agencies in managing groundwater and groundwater contamination. Analyses of available data revealed potential knowledge gaps and identified areas where cross-agency collaboration may reduce delays in addressing groundwater contamination. The project team then investigated geographic patterns of contamination across the state using GIS analyses to identify hotspot areas for contamination and the use of restrictive management actions. Lastly, the project team integrated the findings into recommendations for enhancing data availability and accessibility as well as the steps needed to support enhanced decision making at the agency and division levels.

1.1. Background

The Natural Resources and Environmental Protection Act (NREPA) is the umbrella legislation for the State of Michigan to ensure responsible use of state resources for the enjoyment of future generations and details management actions for addressing contamination. In particular, Part 201, section 21(8) of NREPA allows for the implementation of restrictive management actions that address groundwater contamination. In many cases, this constitutes a de facto removal of the aquifer or portion of the aquifer from use for the foreseeable future. Over 2,000 sites in the State of Michigan (some estimates include up to 7,000 sites) apply various types of restrictive management actions to control groundwater contamination. Despite the widespread and pervasive nature of restrictive management, long-term implications and effects of these actions have not been assessed in detail and no clear framework exists for determining appropriate scenarios to use them. This lack of knowledge is a major barrier to developing a comprehensive groundwater management strategy, as recommended by the 2016 Michigan Water Strategy. Building a deeper understanding of the impacts of this policy was identified as a priority for cross-agency collaboration by the State of Michigan Interdepartmental Water Team, comprised of representatives from the Department of Environment, Great Lakes, and Energy (EGLE), Department of Natural Resources (DNR), Michigan Economic Development Corporation (MEDC), Department of Agriculture and Rural Development (MDARD), Department of Health and Human Services (MDHHS), and Department of Transportation (MDOT). An Interagency Long-Run Risk Working Group made up of members of the Interdepartmental Water Team was created to develop a plan to address the issue.

The working group consists of staff from the EGLE's Office of the Great Lakes (OGL), Remediation and Redevelopment Division (RRD), Water Resources Division (WRD), Drinking Water and Environmental Health Division (DWEHD), and MDHHS:[3]

Emily Finnell (EGLE-OGL)
Christina Pastoria (EGLE-OGL)
Mitch Adelman (EGLE-RRD)*
Dan Rockafellow (EGLE-RRD)
Patty Brandt (EGLE-RRD)
Dan Gough (EGLE-RRD)
Eric Chatterson (EGLE-WRD)
Matt Gamble (EGLE-DWEHD)
Steve Crider (MDHHS)

Through several months of meeting, the working group developed a draft plan to evaluate the long-term economic cost of the risk management strategy by comparing the actual costs incurred at current sites to the expected cost when the management action was selected. The group developed a draft request for proposals (RFP), which can be referenced in Appendix A.

While the Interagency Long-Run Risk Working Group recognized the importance of evaluating the long-term economic costs of restrictive management actions, it became clear that the regulatory framework in place for implementing these actions must be understood. Without a full understanding of the regulatory framework, it would be difficult to offer recommendations for policy change if it is later determined that the current risk management approach requires

[3] (*) denotes recent retirement

modification. The OGL developed an interim project team of three master's students from the University of Michigan's School for Environment and Sustainability to analyze Part 201 of NREPA. Part 201 outlines the process for environmental remediation through use of restrictive management actions to mitigate risks associated with groundwater contamination. Other statutes, including NREPA Parts 111[4] and 213[5], also pertain to groundwater contamination and restrictive management actions. However, the processes for implementing restrictive management actions are more clearly defined under these statutes than for Part 201. Therefore, developing a better understanding of the Part 201 process, including its strengths and weaknesses, is critical to developing future recommendations and intervention strategies after the full economic analysis is completed.

1.2. Literature Review

To understand the nature of restrictive management and why it emerged as an alternative to remediation of groundwater to background levels, a literature review was conducted. The review summarizes the State of Michigan's groundwater resources, explains how development of hydrologic sciences influenced legislative actions to protect groundwater (see Figure 1), and introduces the present legal framework for managing contaminated groundwater.

The State of Michigan relies heavily on groundwater resources to support public and private sector demands, withdrawing approximately 700 mgd (million gallons of water daily) from subsurface aquifers.[6] Industrial wells withdraw approximately 180 mgd, while agriculture and aquaculture demands total approximately 169 mgd.[7] Providing safe drinking water to Michigan residents also places significant demand, approximately 188 gallons per capita per day, on Michigan's groundwater resources. Approximately 1.25 million private household wells[8] serve approximately 2.6 million citizens while public groundwater supply systems serve approximately 1.7 million citizens.[9] These resources are supplied by influxes of precipitation and snowmelt that infiltrate a porous, sand and gravel-dominated landscape and accumulate in subsurface aquifers[10]. Michigan's present climate regime and porous landscape has allowed the state to enjoy the security of virtually unlimited freshwater resources, which support the vibrant economy that millions of people depend on.

Despite this dependence and apparent security, Michigan has struggled to adequately protect this precious resource from contamination.[11] The porous landscape that enables rapid recharge of aquifers also enables rapid transport of contaminant plumes downslope through the subsurface, leaving much of the state vulnerable to contamination. Severe groundwater contamination presently inhibits designated uses at over 3,000 known sites across the state. In these areas, local or state governments may restrict or ban groundwater use to manage

[4] NREPA Part 111: Hazardous Waste Management
[5] NREPA Part 213: Leaking Underground Storage Tank Program
[6] National Ground Water Association, 601 Dempsey Rd., Westerville, OH 43081-8978.
[7] *Ibid.*
[8] Michigan Department of Environment, Great Lakes, and Energy; Drinking Water & Municipal Assistance Division.
[9] National Ground Water Association, 601 Dempsey Rd., Westerville, OH 43081-8978.
[10] USGS. (2013). *Ground Water And Surface Water A Single Resource*. doi: https://pubs.usgs.gov/circ/circ1139/
[11] Dempsey, D. (2018) The Sixth Great Lake: The Emergency Threatening Michigan's Overlooked Resource. *F.L.O.W.*

ongoing contamination from sources including urban and agricultural runoff, abandoned wells, chemical contamination, failing septic systems, fracking, leaking underground storage tanks, and legacy contamination.[12] Moreover, predicting the impact of climate change on groundwater quality remains an ongoing challenge. Increased frequency of precipitation and extreme weather events may increase mobility of contaminants in the subsurface, reducing available groundwater supplies across the state[13], amplifying the impact of present de facto losses by restrictive management practices. These challenges necessitate development of an increased understanding of the long-term risks and costs associated with the current restrictive risk management approach to groundwater contamination.

Water System Context

Groundwater constitutes an essential component of Michigan's hydrologic budget. However, the importance of groundwater has been historically undervalued because it resides in the subsurface, stored in spaces between soil particles, sediment particles, and rock fractures, and functionally invisible to the public. Like surface water, groundwater flows generally downslope with a direction and rate determined by complex interactions between differential pressure, gravity, surface topography, subsurface geology, well pumping activity, and other variables.[14] Michigan's porous landscape hydrologically links groundwater and surface water into a single system[15]. Thus, human activities that discharge pollutants into groundwater are likely to create mobile contamination plumes; these can migrate several meters to several kilometers and diffuse into surface waters magnifying the potential for human exposure. Therefore, providing equal protections for groundwater and surface water is crucial to reducing potential contamination of public water supplies.

Historic Scientific Understanding of Groundwater Contamination

In Michigan, legal protections for groundwater historically lagged behind surface water protections. Hydrologic science was comparatively underdeveloped prior to the 1950's[16], facilitating treatment of the resource as a virtually limitless wastebasket. United States public health officials first recognized that bacteriological contamination from sewers and drains could migrate via subsurface water into surrounding public wells and threaten public health in the 1870's.[17] By the early 1900's, scientific consensus established that groundwater contamination could migrate through the subsurface into surrounding streams and rivers. During this time, hydrologic studies determined that groundwater flows through porous substrate, that shallow groundwater and surface water are hydrologically linked as part of a single system[18], and that

---

[12] *Ibid.*

[13] Cherkauer K.A., Sinha T. (2010) Hydrologic impacts of projected future climate change in the Lake Michigan region. Journal of Great Lakes Research 36:33-50. DOI: 10.1016/j.jglr.2009.11.012.

[14] Colten, C. (1991). A Historical Perspective on Industrial Wastes and Groundwater Contamination. *Geographical Review,81*(2), 215-228. doi:10.2307/215985

[15] Winter, T. C., Harvey, J. W., Franke, O. L., & Alley, W. M. (1998). *Ground water and surface water; a single resource* (No. 1139). US Geological Survey.

[16] Colten, C. (1991). A Historical Perspective on Industrial Wastes and Groundwater Contamination. *Geographical Review,81*(2), 215-228. doi:10.2307/215985

[17] Colten, C. "Groundwater Contamination: Reconstructing Historical Knowledge for the Courts." Applied Geography, vol. 18, no. 3, Elsevier Ltd, 1998, pp. 259–73, doi:10.1016/S0143-6228(98)00017-4.

[18] Winter, T. C., Harvey, J. W., Franke, O. L., & Alley, W. M. (1998). *Ground water and surface water; a single resource* (No. 1139). US Geological Survey.

groundwater could leach and mobilize organic and inorganic compounds from surrounding substrate.[19]

Soon thereafter, a landmark 1927 study[20] used monitoring wells to track bacterial and chemical constituents in the subsurface, concluding that contamination plumes can be mapped and monitored as they migrate through the subsurface. In the 1930's, industrial engineering texts, geological reports, and government groundwater publications began to incorporate these findings and advise against dumping pollutants into seepage pits in the vicinity of public water supplies.[21] However, groundwater contamination by industrial pollutants, which do not degrade as they flow through the subsurface and can travel much further from the source than biological contaminants, was not scrutinized in Michigan until the 1940s when a chemical factory in Lansing, MI polluted the municipal water supply. The company dumped trinitrophenol into a pit, contaminating the local aquifer and associated municipal wells[22], ultimately requiring intermittent pumping until the early 1960s to remediate. Despite the dangers to human health by this contamination, no policy changes were instituted to regulate industrial groundwater inputs. By 1960, groundwater scientists were capable of developing models predicting flow paths of subsurface contamination.[23] While advances in groundwater science highlighted the mobility of industrial contaminants, discharges of untreated waste into seepage pits, lagoons, or deep-well injections continued[24] until regulations in the late 1970's prohibited the practice.

Legal and Regulatory History of Groundwater Protection (1949-1995)
Before 1949, the lack of statutory groundwater laws allowed widespread dumping of pollution into Michigan's groundwater. Polluters could be sued for damages under correlative rights, which prohibit landowners in Michigan from interacting with groundwater in ways that reduce the quality or quantity of available groundwater for surrounding landowners[25]; however, before groundwater science was sufficiently developed and accepted, plaintiffs in groundwater contamination court cases (*e.g*. *1889, Upjohn v. Richland Twp; 1938, Joldersma v. Muskegon Development Co.*) often failed to conclusively prove that the defendant had contaminated the water supply.

The first major step towards establishing statutory protections for state groundwater resources came in 1949, after public outcry was sparked by winter pileups of thousands of dead, oil-covered duck carcasses along the heavily industrialized and polluted Detroit River banks. The

[19] Colten, C. (1991). A Historical Perspective on Industrial Wastes and Groundwater Contamination. *Geographical Review,81*(2), 215-228. doi:10.2307/215985
[20] Stiles, C. W. *Experimental bacterial and chemical pollution of wells via groundwater, and the factors involved*. No. 147. US Government Printing Office, 1927.
[21] Colten, C. "Groundwater Contamination: Reconstructing Historical Knowledge for the Courts." Applied Geography, vol. 18, no. 3, Elsevier Ltd, 1998, pp. 259–73, doi:10.1016/S0143-6228(98)00017-4.
[22] Deutsch, M,. Ground-Water Contamination and Legal Controls in Michigan. United States Department of the Interior, Geological Survey, 1963.
[23] Colten, C. "Groundwater Contamination: Reconstructing Historical Knowledge for the Courts." Applied Geography, vol. 18, no. 3, Elsevier Ltd, 1998, pp. 259–73, doi:10.1016/S0143-6228(98)00017-4.
[24] Colten, C. (1991). A Historical Perspective on Industrial Wastes and Groundwater Contamination. *Geographical Review,81*(2), 215-228. doi:10.2307/215985
[25] Colten, C. "Groundwater Contamination: Reconstructing Historical Knowledge for the Courts." Applied Geography, vol. 18, no. 3, Elsevier Ltd, 1998, pp. 259–73, doi:10.1016/S0143-6228(98)00017-4.

state legislature amended Act 245 of 1929 to create the Michigan Water Resources Commission (WRC), tasked with regulating and restricting pollution of surface and subsurface waters.[26] In 1958, the WRC responded to increasing reports of groundwater contamination pollution from WWII-era factory sites and former mining areas by attempting to pass regulations requiring treatment of hazardous waste before discharge into groundwater.[27] However, national attention to groundwater contamination, galvanized by the New York Love Canal contamination in 1978, ultimately forced federal and state legislatures to properly protect groundwater resources. Michigan passed solid waste management and hazardous waste management laws in 1978 and 1979, respectively, and instituted the 1958 regulations proposed by the WRC in 1980.[28] Simultaneously, the U.S. Congress passed the 1980 Superfund law to provide funds for remediation of contaminated sites identified by each state. These laws reduced threats of groundwater contamination posed by landfills and hazardous materials.

Michigan's state legislature went further to protect groundwater resources in 1982 by, passing Michigan Environmental Response Act (MERA), which mirrored the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). MERA established strict liability for contaminated sites and included "polluter-pays" provisions that required cleanup of contamination to non-detectable, background levels. These provisions held owners and operators of contaminated sites liable for cleanup costs whether they represented the original source of contamination or not.[6] In 1990, MERA was amended to categorize sites by cleanup standards. Type A sites were cleaned to background levels, Type B sites were cleaned to risk-based criteria, and Type C site cleanups eliminated exposure potential through restrictive management actions but would not necessarily remove contaminants. Today, MERA is known as the Natural Resource and Environmental Protection Act (NREPA) Part 201.

Current Regulatory Framework (1995-Present)

In 1995, the state legislature shifted to a risk-based management framework that no longer required cleaning of contaminated sites to background levels. The 1995 overhaul of NREPA Part 201 raised the burden of proof to hold a potentially responsible party (PRP) liable for the cost of remediation activities at contaminated sites with a history of multiple owners and limited evidence to identify which contaminated the site. The present framework manages groundwater contamination by allowing the option to ban the use of groundwater in zones of contamination to remove potential pathways for public exposure to contaminants. These relaxed regulations, which enable expedited redevelopment of contaminated properties[29] that cannot feasibly be cleaned up to background levels, have left thousands of sites without a PRP and with only public funding for remediation activities. Consequently, the state and private entities have a short-term financial incentive to pursue restrictive management, rather than remediation, of sites with contaminated groundwater because of the comparatively low initial cost of implementation. Moreover, the state is only legally obligated to mitigate, rather than completely eliminate, unacceptable risks to public health. Restrictive management actions, which constitute a de facto

[26] Deutsch, M,. Ground-Water Contamination and Legal Controls in Michigan. United States Department of the Interior, Geological Survey, 1963.
[27] Dempsey, D., (2019). "Michigan Groundwater Policy: A History." *FLOW*, 15 Mar. 2019.
[28] *Ibid.*
[29] *Ibid.*

removal of that portion of the aquifer from future use, may carry unexpected long-term public health and freshwater supply risks as their frequency of use increases. Moreover, long-term costs of restrictive management practices, which often include structural barriers[30] to contain contaminants, have not been estimated and complications that bear significant additional costs may occur. As such, it is unclear whether current practices represent a more cost-effective strategy than remediation.

Restrictive management practices are carried out by placing land and/or resources use restrictions (LRURs) on contaminated properties. LRURs are more commonly referred to as institutional controls and restrict site use, modify user behaviors, and alert residents to the presence of contamination, ultimately keeping residents and the surrounding environment safe from the release of contaminants. Beyond simply limiting or restricting activities that expose humans to contamination, institutional controls are intended to facilitate safe reuse of a contaminated site and reduce development of uncontaminated properties where possible. In practice, institutional controls may prevent drilling of wells in contaminated aquifers, construction of residential areas on top of contaminated soils, public access to contaminated areas, and any practices that expose humans to contamination levels above state or federal standards.

1.3. Institutional Controls

Section 20121 of NREPA authorizes the use of LRURs to restrict contaminated land or resource uses that may result in public exposure to toxic groundwater contaminants.[31] Institutional controls are legal, non-engineering instruments that place restrictions on the use of sites with contaminated groundwater and are synonymous with LRURs.[32] The legal authority for institutional controls is derived from statutory laws, English common law, and local land use controls. These include, but are not limited to, the following**:**

easements: legal documents granting the holder, not necessarily the property owner, the right to use (*affirmative*) or restrain (*negative*) use an area of land

conservation easements: legal documents filed in the local county deed registry that grant a governmental entity, charitable or educational association, corporation, trust, or other legal entity the ability to legally restrict property owners from significantly modifying the present state of an area of land (e.g., by property redevelopment)

local government controls*:* a variety of tools used to control land use by local governments. These include: *planning and zoning maps, subdivision plats, building permits, siting restrictions, groundwater use restrictions via drilling prohibitions or well-use permits*

ordinances: legislation enacted by a municipal authority. *Zoning ordinances* regulate permitted land-use practices while *subdivision ordinances* regulate land-use conversions

restrictive covenant: An enforceable promise between the state and property owners to refrain from certain land use practices or maintain an exposure barrier (e.g. clay cap,

[30] Schnapf, L. P. (2002). How to Use Institutional Controls for Contaminated Sites (pp. 25-37, Rep.).
[31] MCL 324.20121 (8)
[32] English, M. R., & Inerfeld, R. B. (1999). Institutional controls for contaminated sites: Help or hazard. Risk, 10, 121.

parking lot). Restrictive covenants are executed by documents filed in the local county deed registry

The primary objectives of using an institutional control are reducing or restricting exposure to hazardous substances, eliminating potential contamination exposure pathways, assuring the effectiveness and integrity of containment or exposure barriers, and assuring the effectiveness and integrity of remediation activities undertaken at a contaminated site.[33] Sites with institutional controls may be redeveloped, provided the property owner adheres to the restrictions placed on that property. In Michigan, restrictive covenants are the most common form of institutional control used by the state to close off contaminated sites.[34] Restricted properties are documented by RRD and displayed on Michigan's public-facing database, Environmental Mapper.

[33] MCL 324.20121 (1)
[34] Schnapf, L. P. (2002). How to Use Institutional Controls for Contaminated Sites (pp. 25-37, Rep.).

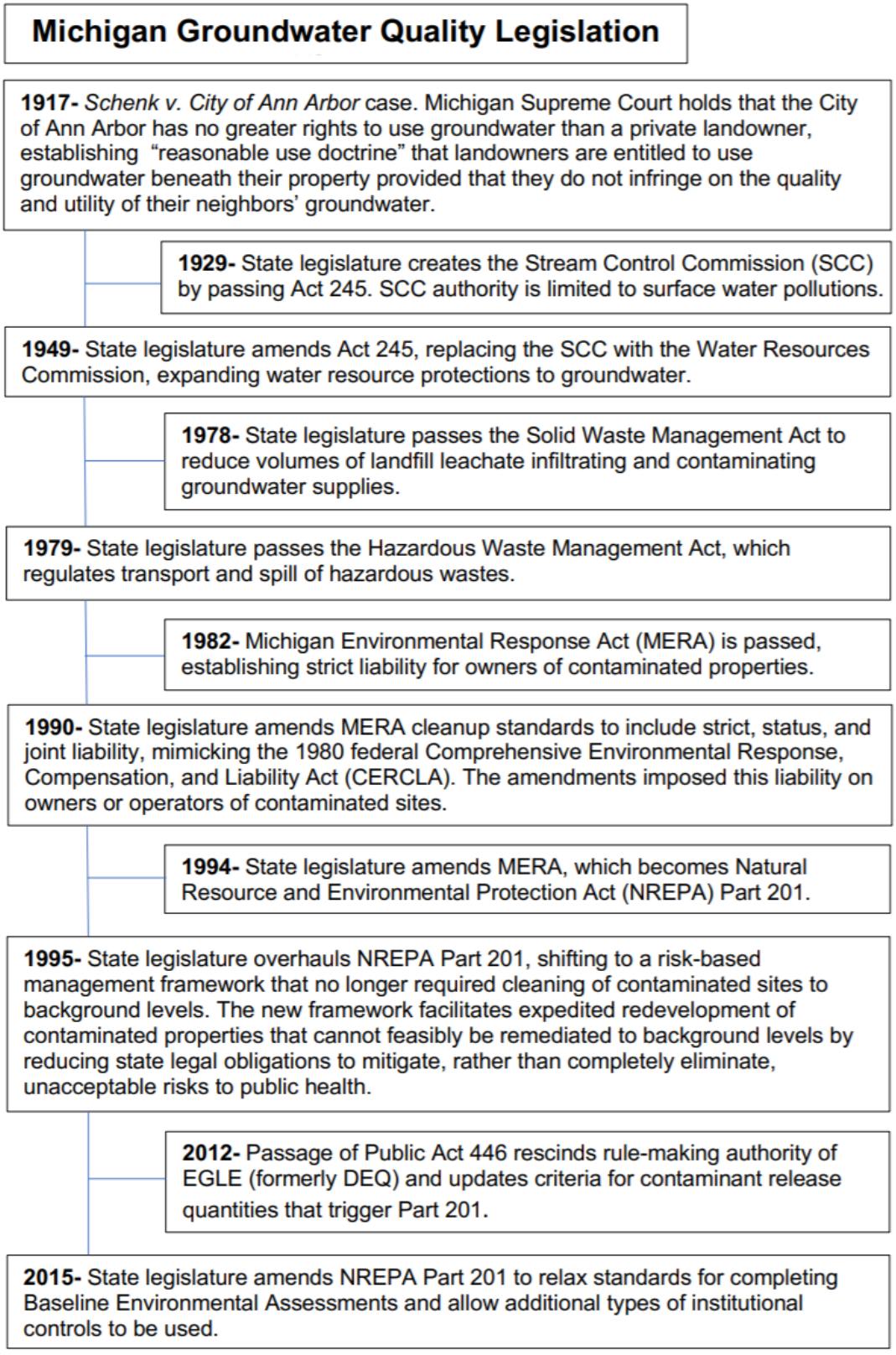


Figure 1. Summary of critical legislative actions taken to protect quality of Michigan groundwater resources.

2. Analyses & Findings

To understand the process Michigan uses for detecting and managing contamination, the project team conducted statute analyses of NREPA Part 201 as well as the states of Minnesota, Wisconsin, and Wyoming. Further, to develop an understanding of how Part 201 is implemented in practice and to identify any challenges translating the statute into action, the project team conducted interviews with 15 employees at the state and local levels in Michigan. Given the importance of data in tracking contamination, the project team also developed a data source inventory that documented the data availability from state agencies such as EGLE and MDHHS. Additionally, the data source inventory included geospatial information, which the project team used to develop thematic maps to better understand where contamination exists in conjunction with other factors, such as population centers and wellhead protection areas.

2.1. Statute Analysis: State of Michigan NREPA Part 201

Before Michigan's Natural Resources and Environmental Protection Act (NREPA) Part 201[35] was enacted, it was preceded by the Michigan Environmental Response Act (MERA).[36] MERA was enacted in 1982 as the state-law counterpart to the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[37] and ensured state eligibility for funds from the federal Superfund program. MERA created a list of contaminated sites; however, it did not include liability provisions. 1990 amendments to MERA imposed liability on owners and operators, which enabled more rapid response to the releases of hazardous substances into the environment (e.g. water, soil, air) by extending government rights to issue cleanup orders, implement cleanups, and recover the cleanup costs from parties assigned strict-status liability.

After the 1990 amendments, Michigan legislators became concerned that strict-status liability under MERA burdened property transactions, obstructed real estate development, and was leading to negative environmental impacts through increased urban sprawl. As such, in 1992 a working group made up of stakeholders from three development and investment interests[38], three local governments[39], and 12 members of the legislature[40] was created to discuss recommendations for amendments to MERA. Their charge was as follows:

> "... examine the impacts of state environmental laws and policies on urban sprawl, review current progress in developing approaches for reuse of contaminated urban properties, and make findings and recommendations to the Special Ad Hoc Committee on Revitalizing Our Michigan Cities that encourage private reinvestment in our older

[35] Michigan Natural Resources and Environmental Protection Act (NREPA), Part 201: Environmental Remediation. Act 451 of 1994.
[36] Michigan Environmental Response Act (MERA). Act 307 of 1982, Repealed.
[37] Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). 42 U.S. Code Chapter 103.
[38] Development/Investment: Ted Gatzaros (400 Monroe Associates), Larry Marantette (ANR Development Corporation), and Ronald Waybrant (Fishbeck, Thompson, Carr, Huber)
[39] Local Government: Ron Flies (City of Detroit), George Korthauer (City of Petoskey), and Dewey Henry (Wayne County)
[40] Michigan House Representatives: Tom Alley, J.M. Middaugh, Morris W. Hood Jr., Ken Sikkema, Curtis Hertel, Jan C. Dolan, James A. Kosteva, Bill Bobier, Kirk A. Profit, and Tom L. Hickner

urban areas without sacrificing environmental protection or public health."[41]

The working group met over eight months and developed a series of 10 recommendations for amendments to MERA that encourage redevelopment of brownfields and reinvestment in cities.[42] In response to recommendations developed by the working group, the legislature amended MERA in 1995, known today as NREPA Part 201, to include limited liability for purchasers of contaminated property and their lenders and approval for use of institutional controls.

Rather than a strict status-liability law[43] like MERA and CERCLA, Part 201 focused on causation liability in conjunction with risk management. The idea was to make it easier for people to own, re-develop, and transfer contaminated property without the fear of incurring potentially substantial liability, specifically in the urban industrial core areas. Prior to the MERA amendments, a new property owner could be held liable for contamination of the property, even if the contamination originated from activities of a previous owner or migration from another property. Lending institutions could also be held liable if the current property owner was unable to remediate the contamination. Similar to Part 201, 2002 amendments to CERCLA[44] also provided for limitations of liability for people purchasing contaminated property – bona fide prospective purchases (BFPPs).[45] The risks on the property must still be managed by either the purchaser or through an agreement with the EPA, which is consistent with the amendments to MERA. Therefore, through the BFPP, "the purchaser agrees to provide full cooperation, assistance, and facility access to the persons that are authorized to conduct response actions at the facility (including the cooperation and access necessary for the installation, integrity, operation, and maintenance of any complete or partial response action at the facility), is in compliance with any land use restrictions established or relied on in connection with the response action at a facility, and does not impede the effectiveness or integrity of any institutional control employed at the facility in connection with a response action."[46]

The following explains when Part 201 is triggered and how it affects liability, obligation, response, and enforcement.

---

[41] Michigan House of Representatives, Special Ad Hoc Committee on Revitalizing Our Michigan Cities. Citizen Advisory Group, Findings and Recommendations State Environmental Policies. January 1993.

[42] *Ibid.*

[43] Strict status-liability holds the PRP responsible for contamination regardless of intent or perceived legality. In other words, the PRP cannot claim it was not negligent or that is was within industry standards to avoid liability.

[44] USEPA. "Memorandum: Bona Fide Prospective Purchasers and the New Amendments to CERCLA." May 31, 2002.

[45] USEPA defines bona fide prospective purchaser as "a person, or tenant of that person, who acquires ownership of a facility after the date of enactment of the Brownfields Amendments, January 11, 2002, and by a preponderance of the evidence that establishes 1) disposal at the facility occurred prior to acquisition, …, 4) the person exercises "appropriate care" and "reasonable steps" to deal with the hazardous substance."

[46] 42 USC Ch. 103: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY. Par. (35)(A). Pub. L. 107–118, §223(1)

2.1.1. *Triggers*

Part 201 is "triggered" – or put into action – when an owner or operator becomes aware of the facility (i.e., when concentrations of a hazardous substance are greater than the criteria for unrestricted residential use). Therefore, until soil or groundwater concentrations are found to exceed a land use criterion, no other obligations are triggered, which is almost always long after the initial release. It is important to understand the definitions of hazardous substance, release, and facility.

> Part 201 defines "hazardous substance" as "any substance that the department demonstrates, on a case by case basis, poses an unacceptable risk to the public health, safety, or welfare, or the environment, considering the fate of the material, dose-response, toxicity, or adverse impact on natural resources."[47]
>
> A list of substances that are considered "hazardous" can be found on the EPA's website.[48] It is important to note that the substance must be deemed hazardous to be controlled under CERCLA and NREPA. For the most part, Part 201 refers to CERCLA in its definition of hazardous substances, however, there are two exceptions: 1) Part 201 defines "hazardous substance" more broadly than CERCLA to include petroleum[49], and 2) Part 201 exempts "fruit, vegetable, [and] field crop residuals [and] processing by-products, [and] aquatic plants, that are applied to the land for agricultural use or for use as an animal feed, if the use is consistent with generally accepted agricultural management practices developed pursuant to the Michigan right to farm act" from the definition.[50]
>
> Emerging contaminants are not necessarily included in CERCLA's hazardous substances, unless they have been given a hazardous designation by the EPA. For example, although it is widely known that PFAS[51] chemicals may have negative health consequences, they have not been designated as a hazardous substance by the EPA.[52] In the current Congress (116th), multiple bills – H.R. 2500, H.R. 535, and S. 638 – have been introduced to direct the EPA to designate PFAS as hazardous substances under CERCLA, but none of the bills have been passed to-date. However, Part 201 gives EGLE-RRD the authority to designate hazardous substances if they pose a risk to public health or the environment and as such, PFAS has been declared a hazardous substance. It should be noted that because this a more stringent approach than the EPA, the state cannot require the EPA to provide federal funds to clean up PFAS

[47] MCL 324.20101(1)(x)(*i-iv*)
[48] US EPA. "Consolidated List of Chemicals Subject to EPCRA, CERCLA, and CAA." June 2019
[49] MCL 324.20101(1)(x)(*iv*)
[50] MCL 324.20101(1)(x)
[51] According to the Environmental Protection Agency, PFAS represents per- and polyfluoroalkyl substances (including PFOA and PFOS) which are a group of man-made chemicals manufactured since the 1940s. PFOA and PFOS are very persistent in the environment and in the human body – meaning they don't break down and they accumulate over time – and there is evidence that exposure to PFAS can lead to adverse human health effects.
[52] Congressional Research Service. "Regulating Drinking Water Contaminants: EPA PFAS Actions." August 6, 2019.

contamination. Much of the pressure from states to the EPA to declare PFAS as hazardous substances stems from the additional funding and remediation efforts that would be made available under CERCLA.

Part 201 defines “release” as “any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous substance into the environment, or the abandonment or discarding of barrels, containers, and other closed receptacles containing a hazardous substance.”[53]

Part 201 defines “facility” as “any area, place, parcel or parcels of property, or portion of a parcel of property where a hazardous substance in excess of the concentrations that satisfy the cleanup criteria for unrestricted residential use has been released, deposited, disposed of, or otherwise comes to be located.”[54]

Cleanup criteria are set by EGLE’s Remediation and Redevelopment Division (RRD). Groundwater cleanup criteria for residential and nonresidential land use can be found in Table 1 of Michigan’s Administrative Code R 299.4[55] and were most recently updated in June 2018.

If response activities are undertaken and the property meets the cleanup criteria for unrestricted residential use, the property is no longer considered a facility.[56] Further, the property is no longer considered a facility if: 1) the property has been split, subdivided, or divided from a facility and does not contain hazardous substances in excess of concentrations that satisfy the cleanup criteria for unrestricted residential use[57] or 2) natural attenuation or other natural processes have reduced concentrations of hazardous substances to levels at or below the cleanup criteria for unrestricted residential use.[58] To put it simply, for a property to not be considered a facility, hazardous substances cannot be in excess of the cleanup criteria *if* the intended use of the property is unrestricted residential use. If hazardous substances are in excess of cleanup criteria and an institutional control is put in place, the property is considered a facility in perpetuity.

2.1.2. *Liability*

Potentially Responsible Persons (PRPs) are liable when there is knowledge of the facility and have joint and several liability[59] for all response activity costs incurred by the state relating to implementation of the response activity. PRPs can be made to provide "the full value of injury to,

---

[53] MCL 324.20101(1)(pp)(*i-vii*)
[54] MCL 324.20101(1)(s)(*i-vi*)
[55] Part 201 Generic Cleanup Criteria and Screening Levels. Table 1. Groundwater: Residential and Nonresidential.
[56] MCL 324.20101(1)(s)(*i*)
[57] MCL 324.20101(1)(s)(*v*)
[58] MCL 324.20101(1)(s)(*vi*)
[59] The Legal Information Institute defines joint and several liability as “two or more parties that are independently liable for the full extent of the injuries.”

destruction of, or loss of natural resources, including the reasonable costs of addressing the injury, destruction, or loss resulting from [a] release."[60]

The following people are liable under Section 26 of Part 201:[61]

- The owner or operator of a facility if the owner or operator is responsible for an activity causing a release or threat of release.
- The owner or operator of a facility at the time of disposal of a hazardous substance if the owner or operator is responsible for an activity causing a release or threat of release.
- An owner or operator of a facility who becomes an owner or operator on or after June 5, 1995.
- A person who by contract, agreement, or otherwise arranged for disposal or treatment, or arranged with a transporter for transport for disposal or treatment, of a hazardous substance owned or possessed by the person, by any other person, at a facility owned or operated by another person and containing the hazardous substance.
- A person who accepts or accepted any hazardous substance for transport to a facility selected by that person.
- The estate or trust of a person described above.

Part 201 defines "owner" as "a person who owns a facility"[62] and defines "operator" as "a person who is in control of or responsible for the operation of a facility."[63]

As with most laws, there are exemptions to Part 201's liability standards. Exemptions include: 1) owners and operators who conduct a baseline environmental assessment (BEA), 2) owners and lessees of severed subsurface mineral rights, 3) owners and occupants of residential real property,[64] 3) persons who did not know and had no reason to know that the property was a facility (e.g. lessees of retail, office, and commercial space), 4) occupiers and operators of property for the purpose of siting, constructing, operating, or removing a wind energy conversion system or related components, and 5) owners and operators of property onto which contamination has migrated.[65]

Lastly, it is important to address the various defenses to Part 201 liability. For example, an owner or operator of a facility is not liable if the release was caused by "an act or omission of a third party other than an employee or agent of the person or a person in a contractual relationship existing either directly or indirectly with a person who is liable."[66] The last two liability defenses include acts of God and acts of war. Part 201 defines "acts of God" as "an unanticipated grave natural disaster or other natural phenomenon of an exceptional, inevitable,

---

[60] MCL 324.20126a(1)(*a*-*c*)
[61] MCL 324.20126(1)(*a*-*e*)
[62] MCL 324.20101(1)(kk)(*i*-*iii*)
[63] MCL 324.20101(1)(jj)(*i*-*ii*)
[64] Law Insider defines residential real property as "property, including vacant land, occupied by, or intended to be occupied by, in the aggregate, one to four families as their residence."
[65] MCL 324.20126(3)(*a*-*l*)
[66] MCL 324.20126(4)(d)(*iii*)

and irresistible character, the effects of which could not have been prevented or avoided by the exercise of due care or foresight,"[67] however, does not define “acts of war.”

2.1.3. *Obligations*

Part 201 states that liable owners and operators are obligated to disclose contamination to the state within 24 hours after obtaining knowledge of the release if “the release is of a reportable quantity of a hazardous substance” under CERCLA (reportable quantities are published in the Code of Federal Regulations).[68] It should be noted that Part 201 does not adopt CERCLA’s petroleum exclusion as Part 213 has its own process for disclosure of petroleum constituents[69] for owners of underground storage tanks. Further, liable owners and operators are required to notify the state within 30 days if they have reason to believe a concentration of hazardous substance exceeding the criterion for unrestricted residential use has migrated off their property. In addition to the reporting requirements above, Section 14 of Part 201 imposes the following obligations on liable owners and operators:[70]

- Immediately stop or prevent an ongoing release at the source.
- Immediately implement measures to address, remove, or contain hazardous substances that are released after June 5, 1995 if those measures are technically practical, are cost effective, and abate an unacceptable risk to the public health, safety, or welfare or the environment. At a facility where hazardous substances are released after June 5, 1995, and those hazardous substances have not affected groundwater but are likely to, groundwater contamination shall be prevented if it can be prevented by measures that are technically practical, cost effective, and abate an unacceptable risk to the public health, safety, or welfare or the environment.
- Immediately identify and eliminate any threat of fire or explosion or any direct contact hazards.
- Initiate a remedial action that is necessary and feasible to address unacceptable risks associated with residual NAPL saturation, migrating NAPL, and mobile NAPL using best practices for managing NAPL, including, but not limited to, best practices developed by the American society for testing and materials or the interstate technology and regulatory council.
- Diligently pursue response activities necessary to achieve the cleanup criteria established under this part. Except as otherwise provided in this part, in pursuing response activities under this subdivision, the owner or operator may do either of the following: conduct self-implemented response activities or obtain departmental approval.

Because Part 201 aims to eliminate unacceptable risks to public health, safety, or welfare – not eliminate contamination completely – the law requires all owners and operators to manage

[67] MCL 324.20101(1)(a)
[68] MCL 324.20114(1)(b)(i)
[69] Petroleum constituents are defined as component substances such as benzene, toluene, and xylenes, plus any additives (e.g., MTBE, lead).
[70] MCL 324.20114(1)(c-g)

exposure to hazardous substances at the facility. Therefore, even if a party is not found liable, they are still responsible for undertaking due care obligations.[71]

Due care obligations are actions that are necessary to protect against human exposure to contamination in soil, groundwater, and subsurface vapor. Actions must be taken to ensure safe use of property that is contaminated and that affected parties are properly notified if there is a likelihood of exposure (e.g. contamination migration onto another an adjacent property). Due care obligations include:[72]

- Prevent anyone using the property from unacceptable exposures to the existing contamination.
- Prevent anyone from taking actions that cause exacerbation of the existing contamination, such as migration from your property.
- Take reasonable precautions against the foreseeable acts of third parties, such as contractors, utility workers, etc.
- Cooperate with and provide access to the person responsible for cleaning up the existing contamination and don't interfere with their actions.
- Be aware of and comply with any land or resource use restrictions placed on the property due to the existing contamination. An example might be to prevent the installation of a drinking water well into contaminated groundwater.

To ensure due care obligations are met, completion of a Baseline Environmental Assessment (BEA) is recommended during, or immediately following, a property transaction. BEAs allow property owners liability exemptions; however, they must be conducted within 45 calendar days of the property purchase date and submitted to EGLE within six months.[73] Before the 2010 amendments to Part 201, BEAs were defined as "an evaluation of environmental conditions which exist at a facility at the time of purchase, occupancy, or foreclosure that reasonably defines the existing conditions and circumstance[s] at the facility so that, in the event of a subsequent release, there is a means of distinguishing the new release from existing contamination."

Since the 2010 amendments, Part 201 defines BEA as "a written document that describes the results of an all appropriate inquiry and the sampling and analysis that confirm that the property is a facility."[74] There is some ambiguity in the definition of "all appropriate inquiry." Part 201 relies on Part 312 of the Code of Federal Regulations – Innocent Land Owners, Standards for Conducting All Appropriate Inquiries to define what is appropriate.[75] The federal standard refers to “all appropriate inquiry” as "an evaluation of environmental conditions at a property at the time of purchase, occupancy, or foreclosure that reasonably defines the existing conditions and circumstances at the property in conformance with 40 CFR 312."[76]

---

[71] MCL 324.20107a(1)
[72] Department of Environment, Great Lakes, and Energy. “What is Due Care and what are Your Obligations?”
[73] MCL 324.20101(1)(f)
[74] MCL 324.20101(1)(f)
[75] MCL 324.20101(1)(c)
[76] Code of Federal Regulations: 40 CFR 312

Although BEAs were originally included in the statute to establish an environmental "baseline," the law as it currently stands no longer requires a property owner to differentiate existing contamination from new. No longer requiring potential purchasers to establish this differentiation saves time and money; however, it could pose potential long-term risk to purchasers. For example, if the contamination worsens over time or if they cannot prove they did not cause contamination due to a lack of understanding of the environmental baseline, innocent property owners could be found liable with little liability defense to protect them if the contamination migrates off-site or if they try to sell the property. Additionally, emerging contaminants, or contaminants that are not currently a concern but may be found to pose risks later, are more likely to go unreported in the absence of a BEA. PFAS is an example of an emerging contaminant that has existed for many years but has recently been found to pose risk to human health. Without detailed BEAs, it is likely PFAS contamination exists in places that are currently unknown to property owners and the state. The project team found no existing assessment of whether this change has impacted the effectiveness of the program; however, future studies may provide greater insight.

In some cases, EGLE may find contamination on a site where the liable party is unknown or no longer exists, and subsequent owners have exemption from liability. These sites are referred to as "orphan sites" and become the tax-payers burden. Based on 2018 estimates, there are around 3,000 orphan sites in Michigan.[77] Funding allocation for the cleanup of orphan sites is not explicitly stated in the statute; therefore, the department with regulatory purview determines where funds will come from for cleanup, and in some cases may need to appeal to the Michigan legislature to fund cleanup of priority orphan sites. Generally, the department with regulatory purview prioritizes orphan sites based on the level of risk they pose to human health, safety, welfare, and the environment, determining what subsequent actions to take based on cost-benefit analyses. When the state takes remedial action on a site, they incur the costs. Site remediation has often been paid for through the Clean Michigan Initiative since 1998; however, most of those funds have been expended. In rare circumstances, the state may be able to use cost recovery if they can prove who the original liable party was; however, the liable party must still be in business or living.

2.1.4. *Response*

Part 201[78], coupled with EGLE administrative rules[79], is used to determine how to implement response activities in order to achieve applicable cleanup criteria. EGLE's RRD is charged with establishing cleanup criteria based on the category of land use: residential or nonresidential. Liable owners and operators are not required to disclose contamination on their property to EGLE if the release is under the reportable quantity. However, liable owners and operators who have knowledge a property is a facility are required to notify EGLE and affected property owners if they have reason to believe that contamination has migrated beyond their property boundary.[80]

[77] Malewitz, Jim. (2018) "Michigan has 7,300 toxic sites. Money for cleanups is almost gone." Bridge Magazine.
[78] MCL 324.20120a
[79] EGLE, Remediation and Redevelopment Division, Administrative Rules
[80] MCL 324.20114(1)(b)(ii)

In addition to Section 14 and due care obligations, liable owners and operators of a facility are generally required to perform the following response activities:[81]

- Undertake measures as are necessary to prevent exacerbation;
- Exercise due care by undertaking response activity necessary to mitigate unacceptable exposure to hazardous substances, mitigate fire and explosion hazards due to hazardous substances, and allow for the intended use of the facility in a manner that protects the public health and safety;
- Take reasonable precautions against the reasonably foreseeable acts or omissions of a third party and the consequences that foreseeably could result from those acts or omissions;
- Provide reasonable cooperation, assistance, and access to the persons that are authorized to conduct response activities at the facility, including the cooperation and access necessary for the installation, integrity, operation, and maintenance of any complete or partial response activity at the facility. Nothing in this subdivision shall be interpreted to provide any right of access not expressly authorized by law, including access authorized pursuant to a warrant or a court order, or to preclude access allowed pursuant to a voluntary agreement;
- Comply with any land use or resource use restrictions established or relied on in connection with the response activities at the facility; and,
- Not impede the effectiveness or integrity of any land use or resource use restrictions employed at the facility in connection with response activities.

Liable owners and operators are required to initiate response activities even if they are not required to disclose their activities to the EGLE.[82] Often times, liable owners and operators choose to self-implement response activities rather than secure prior approval from EGLE. Because of this, many refer to Part 201 as a self-implementation statute.[83] Section 14 of Part 201 does give EGLE-RRD the authority to request the liable owner or operator to provide a response activity plan, submit a no further action report, and pursue additional response activities to protect public health, safety, welfare, and the environment, regardless of self-implementation.[84] When the response activity is done under an administrative order, agreement, or judicial ruling, prior department approval and submission of a response activity plan is required by the liable party.[85] After a party completes response activities that satisfy Part 201 cleanup criteria, whether self-implemented or ordered, they may submit a no further action report to EGLE documenting their response activities and proving the hazardous substances fall within the acceptable threshold for land use.[86] It is unclear from the statute if EGLE is required to verify cleanup standards for voluntary actions; however, they do verify cleanup standards for ordered remediation.

---

[81] MCL 324.20107a(1)(a-f)
[82] MCL 324.20114(1)(g)
[83] MCL 324.20114(2)
[84] MCL 324.20114(1)(h)(i-vi)
[85] MCL 324.20114(2)
[86] MCL 324.20114(2)

No further action reports must clearly document the response activities undertaken at the facility and include a signed affidavit from the owner/operator and environmental consultant confirming the accuracy of the information provided in the report.[87] If the response activities satisfy EGLE's cleanup criteria for unrestricted residential use, the owner/operator is not required to provide a postclosure plan or develop a postclosure agreement with the state.[88]

If a no further action report has been submitted to EGLE that requires land use or resource use restrictions, a postclosure plan is required.[89] A postclosure plan describes the land use or resource restriction at a facility upon completion of response activities. Part 201 requires that all postclosure plans include the land use or resource use restriction(s) relied upon (e.g. restrictive covenant, exposure barrier), as granted by Section 20121.[90] Additionally, the postclosure plan must describe the permanent markers used to indicate the restricted areas.[91] Permanent markers are not required when groundwater is being restricted or if exposure controls (e.g. clay cap) have been used to reduce the risk of exposure.[92]

A postclosure agreement is developed between EGLE and the liable owner or operator when monitoring is required at the facility after the remedial actions are completed. The agreement must include the liable owner or operator's plans for monitoring, operating, and maintaining the effectiveness of the remedial actions in addition to financial assurance to pay for those plans, unless the financial assurance is found to be an insignificant amount.[93] While monitoring of groundwater is not always required, monitoring provides benefits to assuring long-term compliance with the institutional control.

2.1.5. *Compliance and Enforcement*

Part 201 grants EGLE the authority to undertake response activities at facilities as well as recover costs of cleanup from liable parties, which can incentivize liable parties to comply. The authorities granted come in a few different forms, including: information requests, access to facilities, state-initiated response activities, civil or criminal actions, and administrative orders.

Although liable owners and operators are not required in all cases to disclose contamination to the state, the state may request specific information about the site and activities at the site if they have reason to believe that contamination may exist.[94] Additionally, Part 201 grants EGLE the authority to access and investigate a property if they have a reasonable belief that the site is a facility.[95] If an owner/operator refuses to comply with the information request or allow EGLE access to the facility, the attorney general, on behalf of EGLE, can obtain a warrant from the

[87] MCL 324.20114d(1, 5)
[88] MCL 324.20114d(3)(a)
[89] MCL 324.20114d(3)(b)
[90] MCL 324.20114c(2)(a)
[91] MCL 324.20114c(2)(b)
[92] MCL 324.20114c(2)(b)(*i-iv*)
[93] MCL 324.20114d(3-4)
[94] MCL 324.20117(1)
[95] MCL 324.20117(3)

local jurisdiction or file a civil suit.[96] It should be noted that “reason to believe” is not defined in the statute and would therefore be up to the discretion of state employees.

If EGLE finds contamination at the site that may be an endangerment to public health or the environment, classifying it as a facility, the owner/operator may be liable for response activities to clean up the contamination in accordance with Section 27 of Part 201 (see 2.1.2. above).[97] EGLE has a compliance and enforcement policy the begins with compliance assistance and eventually escalates enforcement actions. If the liable party refuses to comply with the required response activities the state may initiate response activities, issue an administrative order[98], and file a civil action against the liable party seeking relief and recovery of costs and damages.[99] The civil fine for liable owner and operators refusing to comply with required response activities can be up to $25,000.00 per day depending on the severity of the contamination and risks to public health and the environment.[100]

While civil actions are most often sought, in some cases criminal actions may be pursued. A liable owner or operator may be found guilty of a felony if: 1) they knowingly released contamination that could cause personal injury or property damage; 2) they intentionally made false statements or representations in state applications, records, reports, or other documents; 3) they intentionally provide inaccurate readings of monitoring devices or inaccurately record information required by Part 201; or 4) they misrepresent their held qualifications.[101] If a person is found guilty of a felony, they can face fines anywhere from $2,500.00 to $25,000.00 for each day the release occurred.[102] In circumstances where this is the liable parties’ second offense, they can face fines up to $50,000.00 for each day the release occurred.[103]

[96] MCL 324.20117(7)(a-b)
[97] MCL 324.20126a(6)
[98] MCL 324.20119(1-2)
[99] MCL 324.20126a(7)
[100] MCL 324.20126a(4)(a-b)
[101] MCL 324.20139(2)(a-d)
[102] MCL 324.20139(2)
[103] MCL 324.20139(3)

2.2. Comparative Analysis: Minnesota, Wisconsin, and Wyoming

To better understand the State of Michigan's laws regarding groundwater contamination and the use of institutional controls, the project team looked at other states in the Great Lakes Basin and across the United States. The findings can be used to 1) to better understand how other states manage groundwater resources, and 2) find similarities and differences in the State of Michigan's management of groundwater contamination. While practices from other states could be applied to Michigan's process for dealing with groundwater contamination, the state would need to negotiate with the legislature to amend NREPA Part 201 or grant EGLE rulemaking authority to make any substantial changes.

CERCLA is a federal umbrella policy and after it was enacted, nearly every state wrote a similar state statute aimed at dealing with contamination of natural resources. States were encouraged to do this not only to have the ability to hold PRPs liable for cleanup, but also so they could access Federal Superfund funds for remediation of specific sites within the state. In accordance with US Federal Law, all states must comply with CERCLA requirements for Federal properties; however, states are empowered to implement their own CERCLA-like laws that apply to all properties within their borders. As long as state law is not more stringent for Federal facilities than private facilities, Federal properties can be held to the state standards.

To understand the broader context of state remediation laws, the project team considered Great Lakes Basin states as well as a geographic range of other states. In total, the project team looked at fifteen states: California, Florida, Illinois, Indiana, Minnesota, Missouri, Montana, New Jersey, New York, Ohio, Pennsylvania, Texas, Washington, Wisconsin, and Wyoming. States were selected based on geography, groundwater use, and recommendations from EGLE staff.

The project team looked at six major tenets of each state's law: 1) Whether the state had a specific process for dealing with groundwater contamination; 2) whether property owners were required to disclose groundwater contamination and if so, to whom; 3) if an initial assessment of cleanup costs was required; 4) whether the state gave preference to partial/full remediation, if deemed feasible; 5) if monitoring (long- or short-term) of the contaminated site was required; and 6) whether the state allowed for or required the use of institutional controls. The research concluded that 13 out of 16 states had a specific process for dealing with groundwater contamination, while the other three states' statutes had more broad environmental contamination language. Further, only seven states had explicit requirements for reporting groundwater contamination to the state, while two states (Michigan and Wisconsin) had reporting requirements in specific circumstances and six state statutes did not have clear language on reporting requirements. Montana and Missouri were the only two states that did not have explicit monitoring requirements for contaminated sites after remedial actions had been taken, while the other 14 states either required monitoring in all or some cases. Lastly, nearly every state allowed for the use of institutional controls, with the exception of Ohio. A complete summarized comparison can be found in Table 1.

Table 1: Summarized comparison of key tenets of environmental contamination and cleanup statutes for the states of California, Florida, Illinois, Indiana, Michigan, Minnesota, Missouri, Montana, New Jersey, New York, Ohio, Pennsylvania, Texas, Washington, Wisconsin, and Wyoming

		The statute…					
State	**Statute (Title, Ch., Sec.)**	**has a specific process for dealing with groundwater contamination**	**requires property owners to disclose groundwater contamination**	**requires an assessment of cleanup costs**	**prefers partial/full remediation if feasible**	**requires monitoring of the contaminated site**	**allow for/require the use of institutional controls**
California	California Water Code	X	X	X	X	X	X
Florida	Natural Resources; Conservation, Reclamation, and Use (Ch. 376)	X	?	X	X	X	X
Illinois	Illinois Environmental Protection Act - Illinois Groundwater Protection Act (Title 415, Ch. 55)	X	X	X	X	X	X
Indiana	Environment (Title 13, Ch. 17)	X	X	?	O	X	X
Michigan	Natural Resources and Environmental Protection Act (Title 324, Ch. 201)	X	XO	O	O	XO	X
Minnesota	Minnesota Environmental Response and Liability Act (MERLA) (Ch. 115B)	O	O	X	O	O	X
Missouri	Missouri Clean Water Law (Ch. 640, 644) and Missouri Environmental Covenant Act (Ch. 260, Sec. 10)	X	X	X	X	O	X
Montana	Environmental Protection (Title 75, Ch. 5)	O	O	O	O	X	?
New Jersey	Waters and Water Supply (Title 58, Ch 10)	X	X	X	X	X	X
New York	Department of Environmental Conservation - Environmental Remediation Programs (Title 6, Ch. 4, Sec. 375)	X	O	X	X	XO	X
Ohio	Water Supply, Sanitation, and Ditches - Water Pollution Control (Title 61, Ch. 61111)	O	O	O	?	X	O
Pennsylvania	Land Recycling and Environmental Remediation Standards Act (Title 35)	X	X	X	X	X	X
Texas	Texas Water Code (Ch. 26)	X	O	O	X	X	X
Washington	Model Toxics Control Act (Title 70, Ch. 70)	X	X	XO	X	XO	X
Wisconsin	Groundwater Protection Standards (Ch. 160)	X	XO	X	O	X	XO
Wyoming	Wyoming Environmental Quality Act (Title 35, Ch. 11)	X	O	X	X	X	X

Key: X = Yes, Required; O = No, Not Required; XO = Unclear, Circumstantial; ? = Not found

Due to time and resource constraints, it was not feasible to complete a full comparative analysis of all fifteen states against the State of Michigan; therefore, after taking a broad look at each state's statute, the project team used USGS data on groundwater use by sector to determine which states' water use profiles and population served by groundwater were comparable to Michigan (see Table 2). From this information, the project team determined that Minnesota, Wisconsin, and Wyoming had similar water use profiles and percentage of their population

served by groundwater to constitute a reasonable comparison. Minnesota, Wisconsin, and Wyoming statutes were compared to Michigan, each state analysis concludes with a brief summary comparison table.

Table 2: Comparison of total daily groundwater withdrawals and population served by groundwater for the states of California, Florida, Illinois, Indiana, Michigan, Minnesota, Missouri, Montana, New Jersey, New York, Ohio, Pennsylvania, Texas, Washington, Wisconsin, and Wyoming

State	Size (miles^2) (US Census)	Population (US Census)	Public Supply: Groundwater (population, millions) (USGS)	% of Population Served (USGS)	Public Supply: Groundwater (Mgal/d) (USGS)	Total Groundwater Withdrawals (all sectors, Mgal/d) (USGS)
California	155,779.22	39,557,045	33,623,488.25	85	2313.05	17412.15
Florida	53,624.76	21,299,325	16,320,915.00	77	1908.67	3774.09
Illinois	55,518.93	12,741,080	3,300,068.00	26	367.02	891.23
Indiana	35,826.11	6,484,061	4,279,480.00	66	339.37	698.82
Michigan	**56,538.90**	**9,884,117**	**4,447,852.65**	**45**	**209.31**	**766.9**
Minnesota	**79,626.74**	**5,611,179**	**3,083,937.00**	**55**	**336.31**	**775.78**
Missouri	68,741.52	6,126,452	296,431.00	5	281.59	1737.48
Montana	145,545.80	1,062,305	329,977.00	31	83.32	204.64
New Jersey	7,354.22	8,908,520	3,429,771.00	38	378.59	568.64
New York	47,126.40	19,542,209	4,658,412.00	24	614.17	890.5
Ohio	40,860.69	11,689,442	2,708,107.00	23	449.58	865.7
Pennsylvania	44,742.70	12,807,060	2,305,864.00	18	227.4	628.09
Texas	261,231.71	28,701,845	5,323,000.00	19	1153.42	7197.09
Washington	66,455.52	7,535,591	4,521,354.60	60	521.19	1526.52
Wisconsin	**54,157.80**	**5,813,568**	**2,316,892.00**	**40**	**265.22**	**771.6**
Wyoming	**97,093.14**	**577,737**	**237,833.00**	**41**	**54.51**	**748.47**

2.2.1. Minnesota

Minnesota is a Great Lakes State, with its northeast corner residing within the Basin and containing some of Lake Superior's coastline. The state has a surface area of nearly 80,000 square miles and a population of 5.6 million.[104] According to USGS data collected in 2015[105], approximately 55% of Minnesota's population is served through municipal or private wells.[106] The following discussion explains Minnesota's process for addressing groundwater contamination, requirements for disclosing contamination, requirements for cleanup cost assessment and remediation, requirements for monitoring, and permitted uses of institutional controls as compared to NREPA Part 201. Table 3 then provides a summary of the key similarities and differences between Minnesota and Michigan.

Process for Addressing Groundwater Contamination

Chapter 15B of the Minnesota Environmental Response and Liability Act (MERLA) has provisions for the Minnesota Pollution Control Agency (MPCA) to instigate remedial actions to combat any contaminant release which presents a danger to health, welfare or the

[104] U.S. Census Bureau QuickFacts: Minnesota

[105] USGS groundwater and surface water use data is collected every five years; therefore, 2015 is the most up-to-date data available.

[106] USGS. "Water Use Data for the Nation" Updated: 2015

environment.[107] While this provision would seemingly include groundwater contamination, it is not as explicitly stated in MERLA as it is in NREPA Part 201. Exclusion of specific groundwater language could be a benefit, as the statute can be more widely applied to contamination of various mediums; however, it could also serve as a loophole for PRPs. Section 115B.171 of MERLA addresses private well testing, but the section is brief and only applies to wells in Minnesota's East Metropolitan Area.[108] Specifically, section 171 requires the MPCA to maintain a webpage about poly-fluorinated chemicals (PFC) in the East Metropolitan Area and detail the process for private and public well PFC sampling. In addition to these requirements, the MPCA provides an online interactive map system (MN Wells). This is similar to the State of Michigan's Environmental Mapper and WellLogic (see section 2.4); however, housed in a single website.

Requirements for Disclosing Contamination

Before the transfer of any property, the owner must disclose any site contamination if the owner knew, or should have known, the property was subject to contamination by the release of a hazardous substance. To do this, the owner is required to provide the county recorder with an affidavit containing a legal description of the property that discloses to any potential transferee: (1) that the land has been used to dispose of hazardous waste or that the land is contaminated by a release of a hazardous substance; and (2) the identity, quantity, location, condition and circumstances of the disposal or contamination to the full extent known or reasonably ascertainable.[109] The county recorder is then required to record the affidavit whereas if a potential purchaser ran a title search it would be disclosed. If the owner fails to file an affidavit before the transfer of property, they can be fined up to $100,000.00.[110]

There is no requirement that the owner notify the state (e.g. MPCA) of contamination, in other words they may self-implement and remediate the contamination without approval from the state. As is the case with Part 201, if MPCA requests information from a property owner regarding a potential release, the property owner is required to provide necessary information related to the release or potential release.[111]

Requirements for Cleanup Cost Assessment and Remediation

There was no explicit requirement that the PRP or MPCA do an assessment of cleanup costs, but portions of the statute allude to the MPCA conducting a cost determination in some circumstances. For example, MPCA is empowered to relocate residents, businesses, and community facilities if it determines that relocation is the most "cost-effective" solution over methods such as transportation, storage, or treatment.[112] MERLA also alludes to the determination of costs in section 115B.20, which explains the ways in which MPCA can use the remediation fund; however, "… before implementing a project to rehabilitate; the commissioner

[107] MSA 115B
[108] The East Metropolitan Area refers to the cities of Afton, Cottage Grove, Lake Elmo, Maplewood, Newport, Oakdale, St. Paul Park, and Woodbury; the townships of Denmark, Grey Cloud Island, and West Lakeland have a potential for significant groundwater pollution from PFCs.
[109] MSA 115B.16(2-3)
[110] MSA 115B.16(4)
[111] MSA 115B.17(3)
[112] MSA 115B.17(1)

of natural resources shall provide written notice of the proposed project to the chairs of the senate and house representatives committees with jurisdiction over environment and natural resources."[113] It is likely that MPCA conducts an assessment of the cleanup costs in order to provide the legislature with a full picture of the proposed plan and how funds will be used.

Similar to NREPA Part 201, MERLA requires that cleanup standards be based on the planned use of the property where the contamination occurred (e.g. residential, industrial).[114] However, it does not give preference for full or partial remediation. If the property belongs to the state and is using state appropriated funds for response activities, they must provide public notice of the proposed response actions and open a public comment period.[115] In theory the public could provide comments urging for partial or full remediation, but as stated above, in order to use the remediation fund written notice of the response activities must also be given to the Senate and House.

Requirements for Monitoring

Monitoring is not required by MERLA, but instead left to the discretion of the MPCA. The MPCA may require "monitoring and maintenance" of a contaminated site if it chooses to do so.[116]

Permitted Use of Institutional Controls

MERLA does allow for the use of institutional controls. Institutional controls include restrictions, conditions, or controls enforceable by contract, easement, restrictive covenant, statute, ordinance, or rule, including official controls such as zoning, building codes, and official maps.[117] The affidavit required under section 115B.16(2), or a similar notice of a release recorded with property records, is also considered an institutional control although it does not technically place any restrictions on the property. Further, the statute does not outline criteria for the use of institutional controls; rather, similar to monitoring, it is left to the discretion of the MPCA to determine the criteria for use. Currently, the State of Minnesota has 1,631 institutional controls in place across the state.[118]

Table 3: Summarized comparison of key similarities and differences of environmental contamination and cleanup statutes for Michigan and Minnesota

	The statute…					
State	**has a specific process for dealing with groundwater contamination**	**requires property owners to disclose groundwater contamination**	**requires an assessment of cleanup costs**	**prefers partial/full remediation if feasible**	**requires monitoring of the contaminated site**	**allow for/require the use of institutional controls**
Michigan	Yes: the process has specific groundwater provisions.	Circumstantial: only required to disclose when the release is above the reportable quantity as set by CERCLA	No: assessment of cleanup costs are not required.	No: only requires cleanup criteria consistent with intended land use	Circumstantial: monitoring is only required if an institutional control has been used on the site to mitigate risk.	Yes: institutional controls are allowed to manage risk on properties. In some cases, institutional controls are required if the cleanup does not meet specific land use requirements.
Minnesota	No: the process is not specific to groundwater, but likely includes groundwater in broader. There are specific provisions for well testing.	No: there are not any provisions in the statute that address the requirement of property owners to disclose contamination	Yes: MPCA is empowered to require cost assessments to determine the most "cost-effective" remedial actions for facilities.	No: only requires cleanup criteria consistent with intended land use	No: monitoring is not required by statute, rather it is left to the discretion of the MPCA to determine if monitoring is necessary.	Yes: institutional controls are allowed to manage risk on properties, but it is unclear from the statute if they are ever required.

[113] MSA 115B.20(4)
[114] MSA 115B.17(2a)
[115] MSA 115B.17(2b)
[116] MSA 115B.17(16.3b)
[117] MSA 115B.02(9a)
[118] MPCA Institutional Controls

2.2.2. Wisconsin

Wisconsin is a Great Lakes State, with its eastern edge bordering Lake Michigan and its northern edge butting up to Lake Superior. The state has a surface area of nearly 54,000 square miles and has a population of 5.8 million.[119] According to USGS data collected in 2015, approximately 40% of Wisconsin's population is served through municipal or private wells.[120] The following discussion explains Wisconsin's process for addressing groundwater contamination, requirements for disclosing contamination, requirements for cleanup cost assessment and remediation, requirements for monitoring, and permitted uses of institutional controls as compared to NREPA Part 201. Table 4 then provides a summary of the key similarities and differences between Wisconsin and Michigan.

Process for Addressing Groundwater Contamination
The State of Wisconsin has two primary statutes that address groundwater contamination response: Groundwater Protection Standards (Wis. Stats 160) and Remedial Action (Wis. Stats 292). The Groundwater Protection Standards were put in place to empower the WiDNR to develop and enforce standards for minimizing groundwater pollution.[121] Remedial Action is broader, requiring any person who causes the discharge of a hazardous substance to take the actions necessary to restore the environment to the "extent practicable" and minimize negative air, land or water impacts.[122] Both statutes empower the WiDNR to hold property owners liable for contamination and provides them latitude in determining the best regulation, as the statute sets standards but not a specific process. Under the Groundwater Protection Standards, WiDNR is empowered to establish any type of regulation, including preventative action limits, so long as they ensure regulated facilities and activities will not cause the concentration of a substance in groundwater to exceed enforcement standards.[123]

Requirements for Disclosing Contamination
The Groundwater Protection Standard establishes requirements for groundwater monitoring, threshold limits, and WiDNR response to threshold violations.[124] However, it does not explicitly state that property owners are to disclose groundwater contamination. Conversely, the Remedial Action statute is very explicit about notifications hazardous discharges and requires the WiDNR be notified "immediately of any discharge not exempted."[125] Lastly, WiDNR is required to maintain a public database of contaminant discharges and update it regularly.[126]

Requirements for Cleanup Cost Assessment and Remediation
Assessment of cleanup costs is only required when using money from the state environmental fund. If WiDNR decides to use the state fund, they must perform a cost assessment.[127]

---

[119] U.S. Census Bureau QuickFacts: Wisconsin
[120] USGS. "Water Use Data for the Nation" Updated: 2015
[121] Wis. Stats 160.001
[122] Wis. Stats 292.11(3)
[123] Wis. Stats 160.001(4)
[124] Wis. Stats 160.21(1-2)
[125] Wis. Stats 292.11(2)
[126] Wis. Stats 292.31(1)
[127] Wis. Stats 292.25(d)

The Groundwater Protection Standards provides a flexible approach to remediation by considering local circumstances, conditions, effect on the public and natural resources, health risks, and history of the site. Chapters 160.23 and 160.25 affirm that the department should to the greatest extent "feasible", seek to remedy environmental damage; however, they also emphasize the importance of remediating where "technically and economically feasible."[128] Unique to Wisconsin statute, WiDNR may "establish by rule additional points of standards application which the regulatory agency determines are necessary to protect future groundwater uses and the public interest in the waters of the state."[129]

Requirements for Monitoring

Specifically for groundwater, the WiDNR is required to set up a monitoring system using the best available technology and methodology to determine whether preventive action limits and enforcement standards have been violated.[130] The required monitoring is extensive and must include criteria to identify hazardous substances, problem assessment monitoring, regulatory monitoring, at-risk monitoring, management practice monitoring, and an overarching umbrella monitoring system that contains the aforementioned monitoring. Additionally, it is the responsibility of the WiDNR to contact other state agencies needed for coordination and exchange of technical information. Lastly, through the Remedial Action statute, facilities must undergo "long-term care," which requires monitoring during operations and after closing.[131]

Permitted Use of Institutional Controls

Wisconsin allows some residual contamination to remain after a cleanup of contaminated soil or groundwater. While the Groundwater Protection Standards do not discuss the use of institutional controls, the Remedial Action statute allows for the use of "continuing obligations."[132] Continuing obligations are legal requirements and apply to a property even after the ownership changes. Individuals purchasing a property with a continuing obligation accept responsibility for maintenance (e.g. maintaining engineering controls). The Remedial Action statute requires that the WiDNR provide notice to the public by adding the property and continuing obligation documents to the Wisconsin Remediation and Redevelopment Database (WRRD). Currently, the State of Wisconsin has 10,499 sites with continuing obligations.[133]

Table 4: Summarized comparison of key similarities and differences of environmental contamination and cleanup statutes for Michigan and Wisconsin

	The statute…					
State	**has a specific process for dealing with groundwater contamination**	**requires property owners to disclose groundwater contamination**	**requires an assessment of cleanup costs**	**prefers partial/full remediation if feasible**	**requires monitoring of the contaminated site**	**allow for/require the use of institutional controls**
Michigan	Yes: the process has specific groundwater provisions.	Circumstantial: only required to disclose when the release is above the reportable quantity as set by CERCLA	No: assessment of cleanup costs are not required.	No: only requires cleanup criteria consistent with intended land use	Circumstantial: monitoring is only required if an institutional control has been used on the site to mitigate risk.	Yes: institutional controls are allowed to manage risk on properties. In some cases, institutional controls are required if the cleanup does not meet specific land use requirements.
Wisconsin	Yes: the process has specific groundwater provisions through their Groundwater Protection Statute.	Circumstantial: only required to disclose when the release is "not exempted."	No: assessment of cleanup costs are not required unless funds from the state environmental fund are being used.	No: only requires cleanup criteria consistent with intended land use	Yes: monitoring is required on contaminated sites.	Circumstantial: the Remedial Action statute allows for the use of continuing obligations; however, the Groundwater Protection Standards do not discuss the use of institutional controls.

[128] Wis. Stats 160.23(1)
[129] Wis. Stats 160.21(2b)
[130] Wis. Stats 160.27
[131] Wis. Stats 292.01(10)
[132] Wis. Stats 292.12(2)
[133] WiDNR Open Data. "Continuing Obligations Apply."

2.2.3. Wyoming

Wyoming is a western state covered by seven river basins: Bear, Green, Northeast WY, Platte, Powder/Tongue, Snake/Salt, and Wind/Bighorn.[134] The state has a surface area of nearly 97,000 square miles and a population of 580,000.[135] According to USGS data collected in 2015[136], approximately 41% of Wyoming's population is served through municipal or private wells.[137] While Wyoming's population is quite small compared to Michigan, their daily groundwater withdrawals are very similar - 748.5 mgal/day and 767 mgal/day, respectively.[138] The following discussion explains Wyoming's process for addressing groundwater contamination, requirements for disclosing contamination, requirements for cleanup cost assessment and remediation, requirements for monitoring, and permitted uses of institutional controls as compared to NREPA Part 201. Table 5 then provides a summary of the key similarities and differences between Wyoming and Michigan.

Process for Addressing Groundwater Contamination
Wyoming's Public Health and Safety Statute (Title 35) chapter on Environmental Quality (WEQA) enables the Wyoming Department of Environmental Quality (WDEQ) to prevent, reduce and eliminate pollution, as well as to preserve and enhance Wyoming's natural resources.[139] In Article 16, the statute specifically lays out provisions for WDEQ to establish scientific, ecological, and health-based standards, while allowing for their modification based on site-specific factors, for remedial efforts as part of both voluntary remediation and nonvoluntary remediation.[140] Voluntary remediation is used to encourage development of formerly contaminated sites and is not applicable for newly contaminated sites.

Requirements for Disclosing Contamination
In certain circumstances, property owners are required to notify the WDEQ if a known or suspected release occurs. Underground storage tank owners/operators and radioactive waste site owners/operators are required under law to report[141]; however, it is not required of other types of property owners or facility operators. For other types of property owners, the statute does not address the requirements for disclosing contamination.

Requirements for Cleanup Cost Assessment and Remediation
The statute does not explicitly address whether property owners must do an assessment of cleanup costs. However, the WDEQ is required to implement a fee system applicable to the preliminary remediation agreements, remedy agreements, certificates of completion and no further action letters. Fees are intended to cover WDEQ's direct and indirect costs of

[134] Wyoming Water Development Office. "River Basin Available Groundwater Determination Technical Memorandum."
[135] U.S. Census Bureau QuickFacts: Wyoming
[136] USGS groundwater and surface water use data is collected every five years; therefore, 2015 is the most up-to-date data available.
[137] USGS. "Water Use Data for the Nation" Updated: 2015
[138] *Ibid.*
[139] W.S. 35-11-102
[140] W.S. 35-11-16
[141] W.S. 35-11-1421

participation, but the statute does not indicate how the fees are to be calculated or provide a definition of "participation," leaving determination of both to the discretion of the WDEQ.[142] In the case of orphan sites or sites with imminent risk, the WDEQ director can expend funds from the "Orphan Site Remediation Account" to conduct site evaluations and testing, evaluate remedial measures, select remediation requirements, and construct, install, maintain and operate systems to remedy contamination in accordance with a remediation work plan.[143] However, if a liable party is identified post remediation, they are required to reimburse the WDEQ three times the expended amount, which is then returned to the account.[144] Funds for the Orphan Site Remediation Account are at the discretion of the WDEQ director, who can transfer funds into the account from the general fund. However, the amount transferred can only be equal to the fees collected by the agency, there are no dedicated annual appropriations for the fund.[145] This differs from Michigan, as EGLE does not seem to have a dedicated revenue stream for their Clean Michigan Initiative fund.

For sites not eligible for the voluntary remediation program, remediation requirements for sites are ultimately at the discretion of the WDEQ director, but may include returning contaminated soil and water to background contaminant levels.[146] If background contaminant levels are not technically practicable, property owners must employ the best available remediation technology.[147] Notably, property owners will not be provided with a liability release until they have removed all continuing sources of contamination, demonstrated that groundwater standards have been met and are safe for any potential future use of the site.[148]

For voluntary remediation sites, the exposure factors used by the director to establish site-specific, risk-based standards for groundwater must assume that groundwater may be used as a drinking water source.[149] Additionally, the WDEQ director is to consider whether remediation poses a "substantial and disproportionately high cost for implementation and completion." The director shall compare the costs of remedies proposed by the property owner considering the degree of risk reduction that is afforded by each remedy.[150]

Requirements for Monitoring

Monitoring is required at both involuntary and voluntary remediation sites. Specifically, for groundwater, compliance with groundwater standards must be monitored on the property or near the site boundary and is up to the discretion of the WDEQ director. The monitoring sites and type of monitoring to be conducted are to be selected based on the evaluation of the properties of the aquifer, the proximity of existing and reasonably anticipated points of

[142] W.S. 35-11-1612
[143] W.S. 35-11-1701
[144] W.S. 35-11-1701(g)
[145] W.S. 35-11-1701(h)
[146] W.S. 35-11-1613
[147] *Ibid*
[148] W.S. 35-11-1613(i-iv)
[149] W.S. 35-11-1605(a)(ii)(B)
[150] W.S. 35-11-1605(b)(viii)

groundwater withdrawal or discharge to the surface, the location of the contaminant plume relative to the site or use control area boundary, and the toxicity of the contaminant.[151]

Permitted Use of Institutional Controls

Beginning in 2000 Wyoming made amendments to WEQA to allow for the use of institutional controls under certain circumstances through the use of a remedy agreement, which includes the remedial action plan and proof of financial assurance (e.g. bond) to ensure the long-term performance and maintenance of engineering controls as well as provide for any monitoring activities required in the remedial action plan.[152] Before an owner can enter into a remedy agreement that includes long-term restriction or institutional control on the site, the owner must obtain a use control area designation, which indicates the appropriate land uses allowed on the site.[153] Once the control area designation is obtained, the owner must submit a remedy agreement that contains a remedial action plan, including the remediation standards and objectives for the site or use control area, the remediation standards and objectives for adjacent property, a description of the intended engineering or institutional control, a schedule for the required remediation activities, and conditions for the effective and efficient implementation of the remedy agreement.[154]

While Wyoming requires groundwater to be cleaned up to unrestricted use levels, the WDEQ allows for some use institutional controls during the cleanup process, given the extended timeframe that can be required for groundwater remediation.[155] WDEQ considers the expected life cycle performance of any engineering controls, monitoring systems, and institutional controls when determining which is best suited to protect further human and environmental exposure. The institutional controls to be applied at a site are then described in the remedial action plan, which is part of the remedy agreement for the site.[156] No changes to institutional or engineering controls contained in a remedy agreement can be made without the prior written consent of WDEQ.[157]

Table 5: Summarized comparison of key similarities and differences of environmental contamination and cleanup statutes for Michigan and Wyoming

	The statute…					
State	**has a specific process for dealing with groundwater contamination**	**requires property owners to disclose groundwater contamination**	**requires an assessment of cleanup costs**	**prefers partial/full remediation if feasible**	**requires monitoring of the contaminated site**	**allow for/require the use of institutional controls**
Michigan	Yes: the process has specific groundwater provisions.	Circumstantial: only required to disclose when the release is above the reportable quantity as set by CERCLA	No: assessment of cleanup costs are not required.	No: only requires cleanup criteria consistent with intended land use	Circumstantial: monitoring is only required if an institutional control has been used on the site to mitigate risk.	Yes: institutional controls are allowed to manage risk on properties. In some cases, institutional controls are required if the cleanup does not meet specific land use requirements.
Wyoming	Yes: the process has specific groundwater provisions.	No: there are not any provisions in the statute that address the requirement of property owners to disclose contamination, unless they are underground storage tank or radioactive water operators	Yes: a cost assessment is required to be completed to determine if the costs of remediation pose a "substantial and disproportionately high cost of implementation and completion"	Yes: groundwater standards must be met for all land uses for the PRP to be released from liability.	Yes: monitoring is required on both involuntary and voluntary remediation sites.	Yes: institutional controls are allowed to manage risk on properties through the use of a remedy agreement with the WDEQ. No changes to institutional controls may occur without the consent of WDEQ.

[151] W.S. 35-11-1605(e)(i)
[152] W.S. 35-11-1607(b)
[153] W.S. 35-11-1607(a)
[154] W.S. 35-11-1607(bi)
[155] WDEQ Voluntary Remediation Program. "Institutional Controls, Engineering Controls, and Use Control Areas." May 2016.
[156] W.S. 35-11-1607
[157] W.S. 35-11-1607(f)

2.3. Practitioner Perspectives: Qualitative Insights Into the Process of Using Institutional Controls

The project team conducted interviews to gain a better understanding and explore interviewees' opinions on the use of institutional controls in the State of Michigan. These interviews provided the project team with better insights as to the advantages of institutional controls and the potential impacts on state groundwater resources in the future through the lens of those who have worked on the topic for years. Since the interviewees are employees at the state and local agencies who frequently interact with the use of institutional controls, the interviews allowed the project team to understand the employees' experiences, and the open-ended question style allowed for in-depth information to be collected (see Appendix B for interview questions).

Method

The research project involved conducting semi-structured, face-to-face interviews with 12 State of Michigan employees and three local Michigan health department employees from two counties. The project team used a structured, nondirective approach to collect and analyze interview data, and to identify patterns in how the State of Michigan addresses groundwater contamination and use of institutional controls.

Participants and Recruitment

In the initial phase of the interview process, the project team met with the Deputy Director of EGLE to provide an overview of the project and corresponding goals. The Deputy Director then provided a list of division directors and assistant division directors within EGLE. The project team contacted these individuals to provide them with briefings of the project and to ask them to facilitate the contact with their staff in regards to the project. Staff from the Office of the Great Lakes (OGL) suggested additional contacts at the Department of Health and Human Services. Two individuals identified were members of the Interagency Long-Run Risk Working Group, which formed following the release of the 2016 Michigan Water Strategy.

The project team contacted the division directors and assistant division directors of the Remediation and Redevelopment Division (RRD), the Water Resources Division (WRD), and the Drinking Water and Environmental Health Division (DWEHD). The team met with assistant division directors and/or staff from these divisions, alongside OGL staff and the Deputy Director to present the team's research project. At the end of each meeting, the participants identified staff within their division who have expertise in groundwater contamination and/or institutional controls. The project team then chose potential interviewees from the contacts identified by the OGL staff, the Deputy Director, and the assistant division directors.

The project team recruited employees to participate in the project through individual email invitations which outlined our research aims, specific areas of the employees' work portfolio of interest to our project, and the interview process. The email also included a two-pager outlining the research project and its overarching goals. In addition, participants received guiding discussion questions prior to their interview (Appendix C). Following the conclusion of each interview, interviewees suggested potential colleagues both within and outside of their division

or at another agency as valuable additions to the research. This resulted in a snowball sampling method, wherein interviewees recommended colleagues for interviews, and allowed for a greater number of participants for the research. In total there were 13 interviews conducted for this this research project with a total of 15 participants.

Interview Design

To uncover rich, descriptive data on the personal experiences and institutional knowledge of participants, the project team built a semi-structured interview process, which provides flexibility with open-ended lead questions, while retaining continuity and focus by asking similar lead questions to all participants.[158] This open-ended design allowed the discussion to move from general to more specific topics.

To develop the interview script and questions, the project team divided the interview into four sections: 1) introductory questions, (2) questions regarding participants' professional work experience, (3) questions regarding data availability at the participants' division/agency, and (4) closing questions. The project team developed open-ended questions intentionally to: allow for descriptive answers; participants with language commonly used; avoid leading questions; and prevent framing questions with negative or positive biases. The interview began with simpler topics and moved into more complex and detailed questions.

The project team disclosed to participants that the interview would retain their anonymity, and audio recordings would be destroyed following transcription. This is in accordance with the Institutional Review Board[159] guidelines which state, "To best protect research participants, IRB requires that any such recordings [audio, video, or digital] be destroyed within a definitive timeframe."[160]

Interview Process

Prior to beginning the interview, each team member introduced themselves, the participant introduced themselves, and the project team explained the research and gained the participant's consent to audio-record. The interviews were loosely structured: The project team began by asking interviewees whether they had questions about the research project.[154] The interviewer then asked the interviewees about their role at the division/agency and why they chose to participate in the interview. For the remaining time, the project team asked interviewees to describe the process of addressing groundwater contamination at their division and/or agency and the use of institutional controls. Additionally, the project team asked participants about data use and availability; and collaborations across their division, in the agency, and outside of the agency. The interviewer asked open-ended questions to allow for unanticipated statements. Therefore, the project team used probes, reworded questions when appropriate, and followed up with additional questions when interviewees expressed interesting

[158] Handbook of Practical Program Evaluation. Chapter 19, Conducting Semi-Structured Interviews.
[159] The Institutional Review Board is an administrative body established to protect the rights and welfare of human research subject recruited to participate in research activities.
[160] IRB Audio/Video/Digital Recording of Research Participants.

or less common opinions.[154] Interviewees were encouraged to use jargon, acronyms, and policy language freely to feel more comfortable throughout the process.

Each interview lasted 40-75 minutes and was audio-recorded for later transcription.
All of the interviews were conducted in-person with all project team members present. Only one interview was conducted via telephone. The project team sent email follow-up questions to six interviewees to clarify statements and to request resources mentioned during the interviews.

One consistent project team member led the interview development process and conducted all interviews. If a participant provided an answer relating to a question that hadn't yet been asked, the interviewer noted such and avoided repeating the question.

Interview Analysis
The interviews were recorded using an audio recording device and later transcribed to digital documents verbatim. The data collection and analysis processes were grounded in that our findings emerged from listening to the interview data and from comparing data across the interviews. In order to facilitate an iterative process, following each interview the project team discussed the results of the interview to understand whether additional questions or re-phrasing of questions needed to be added.

The project team decided to use a deductive coding methodology once all the interviews were transcribed.[161] The project team read all of the transcriptions to develop the codebook for analyzing the interviews. The coding process included identifying patterns of information exhibited by the interviewees and seeing how the categories related to each other.[156] The project team undertook the process of integration – the process of identifying a core theme or element from the data.[156] Through this analysis, the project team identified four themes including (1) addressing groundwater contamination, (2) capacity and resources, (3) obstacles, and (4) parties/agencies notified or actively involved in the process of addressing contamination. Each theme included 6 to 26 sub-themes or codes, shown in Table 6 below.

[161] Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development.

Table 6: Codes and Sub-Codes Utilized for Coding Subject Interviews

Addressing Groundwater Contamination
Cleaning to background is impractical and financially prohibitive
Cleaning to background is not possible because of current law
Cost Recovery potential for the State, but depends on circumstance
Department of Environmental, Great Lakes, and Energy makes decisions on institutional control
DHHS or local health department is first to receive complaint regarding contamination
Institutional controls create long-term costs because groundwater is contaminated and aquifer is unavailable for consumption
It is cost-effective to use institutional controls
It takes a long time to address groundwater contamination
Legal action is taken immediately
Level of communication with the State depends on potentially responsible party
Local health department has authority on decision of IC
No, there is not an advantage to using institutional controls
Orphan Sites - State assumes liability and remediation costs
Potentially responsible party has decision-making authority on what institutional controls to use
Potentially responsible party is responsible for all costs
Potentially responsible party is responsible for monitoring
Process for addressing contamination varies by agency
Public image drives PRP actions
Public is notified when contamination is severe
Recommendation offered
State is responsible for monitoring
There are pending reference numbers, therefore unaddressed contamination
There is contamination we are unaware of
There is no direct procedure on what should happen when contamination is discovered
Time varies to address groundwater contamination depending on extent of contamination
Time varies to address groundwater contamination depending on resources available
Typically provide assistance to PRP when asked of or situation is an imminent threat to public health
Use of ordinance
Use of restrictive covenant
Yes, there is an advantage to using institutional controls
Capacity and Resources
Agency or district records data in their own data inventory or mapping tool
Agency or district uses their own tool or data inventory
Cross agency collaboration

Current record is not or may not be up to date
Data scattered across multiple sources
Experience and use of GIS maps and layers
Experience and use of groundwater contamination data
Frequently used or directed individuals to Environmental Mapper
Have all the data and information necessary to make decisions
Inadequate functionality of data management system
Lack of in situ characterization
Limited funding
Limited staffing
Missing or unavailable data
Obstacles and limitations regarding data availability
State agencies provide resources to PRP
Obstacles
Facilities may refuse to provide data to the State
Inaccurately located contamination site
Lack of partnerships and/or collaborations
Lack of PRP involvement delays process
Lack of state agency involvement
RRD unaware of post closure plan due to voluntary program, non-mandatory report
State lacks legal authority to intervene
State of Michigan may not have up to date information because it is not electronic and/or in District office
Time to address contamination varies frequently
Unaware of exact location and size of plume due to lack of mapped aquifers and potential
Voluntary compliance under NREPA Part 201
Parties or Agencies Notified or Actively Involved
Community members
Consultant
Department of Environmental, Great Lakes, and Energy – Main Office
Department of Health and Human Services
EGLE District Office
Impacted property owner
Local health departments

The project team used NVivo, a qualitative analysis software to code the interviews. To remove any potential bias during the process, two project team members coded all the interviews simultaneously. One interview file was lost during the process and is not included in the interview analysis (note: the specific interview will not be disclosed to ensure anonymity). In

addition, one of the interviews was conducted with two individuals and is therefore being counted as one interview for analysis purposes and due to limitations of the qualitative software. Once all the interviews were coded, the results were analyzed using NVivo and Excel software.

Findings

The interviews resulted in a deeper understanding and identification of (1) the value of institutional controls and (2) the range of obstacles in the way of addressing groundwater contamination.

1. The Value of Institutional Controls

The following section outlines the interviewees' perspectives and recommendations on the use of institutional controls to improve the prevention and management of groundwater contamination in the State of Michigan. Because the focus of this research is the process of treating and preventing groundwater contamination, and its decision-making framework, the project team provides discussion and relevant recommendations in section three ("Discussion and Recommendations").

When asked about groundwater contamination, nearly half of interviewees agreed that, because of current legal statutes, cleaning to natural background is not a viable solution. In addition, 31% considered it cost-effective to use institutional controls, particularly because of the high cost associated with cleaning contamination, especially when it is widespread and extensive.

As explained by interviewee P6:

> P6: *To put it in perspective, to potentially clean up a plume of that [large] magnitude estimates between $22 and $99 million, and none of those [options] were ever guaranteed to actually restore the water to uncontaminated levels.*

Likewise, interviewee P8 exclaimed:

> P8: *There's a big challenge in terms of how clean, clean should be.*

With such high costs associated with cleaning contamination, the use of institutional controls benefits both the state and the responsible party, who can alleviate burdensome costs by restricting the use of groundwater and therefore continuing to ensure public health. However, it remains unclear whether the long-term social costs of retaining groundwater contamination will exceed clean-up cost estimates.

In contrast, 15% of interviewees believe that the responsible party should bear all costs associated with the contamination. In certain circumstances, however, there are sites with no viable party responsible for causing or contributing to the contamination. In these cases, the

State of Michigan may take ownership of remediation and clean-up efforts depending on the severity of the contamination.

Over 50% of interviewees agreed there is no advantage to using institutional controls. On this subject, several interviewees raised concerns that once institutional controls are in place, there will be no incentive or requirement to clean up contamination because the responsible party has adhered to state laws. Similarly, because of NREPA Part 201, a majority of interviewees (60%) believe there is contamination that the State of Michigan is unaware of. Furthermore, aquifers are rare and highly valued in the world, leaving contamination in place raises concerns regarding the long-term social costs associated with the use of institutional controls on these vital resources. As interviewee P4 explained:

> P4: *What I am concerned with is that, in some ways, we are writing off aquifers. If we're not actively cleaning up a groundwater plume, then we are writing off this portion of the aquifer in perpetuity. I have concerns about that because some of our plumes [and] contamination sites are very well characterized and some of them are horribly characterized.*
>
> P5: *Groundwater is not getting cleaned up.*
>
> P1: *The downside is that once you put [institutional controls] in place, there is no incentive to actually clean [contamination] up.*

Thirty-one percent of interviewees said there are no direct procedures following contamination discovery. This is why the project team suggests a decision-making framework to assist the State as it moves forward in addressing contamination.

2. The Range of Obstacles to Addressing Groundwater Contamination

When asked about data availability and upkeep, 54% of interviewees believe that the current record is not or may not be up to date. Sixty-two percent of interviewees claimed that the data needed to address groundwater contamination is scattered across multiple sources. Only 15% of interviewees said they have all the data and information necessary to make decisions about addressing groundwater contamination.

Many obstacles to addressing groundwater contamination at the State level relate to capacity and available resources. Fifty-four percent of interviewees reported limited staffing and missing or unavailable data and 46% mentioned limited funding. Lack of resources makes mapping groundwater contamination that much more difficult. Regarding district offices and partnering agencies, such as DHHS, interviewee P13 exclaimed:

> P13: *Since we use parcel IDs, it is a large time consumption when we receive data from the State [EGLE] because there is a list of [one] thousand sites that you're getting, and*

> *you can't just control-find for the parcel number because they don't identify them using parcel IDs.*

The EGLE main office provides a large file of data to its partners; however, EGLE and its partners use different identifying information, and therefore it is difficult and time intensive for partners to sort through this information. This reveals a need for more consistent data entry methodologies by State agencies. This will cut staff time spent finding crucial information, provide more time to address the contamination, and reduce the potential for inaccuracies which may cause a site to be overlooked or missed.

In addition, interviewees identified the following factors that prohibited or affected their response to contamination: Over 60% of interviewees were unaware of the exact location of the contamination and the size of the plume that was there due to a lack of mapped aquifers. Although the project team members are aware that contamination moves and is thus difficult to map, the State of Michigan needs to consider ways to provide up-to-date information through increased reporting, and updated methodology and technology. Furthermore, 23% of interviewees recalled that the contamination site was inaccurately located. Similarly, 8% of interviewees said that facilities refused to provide data about the contamination to the State. The interviewees did not state how often these inaccuracies occur.

Eight percent of interviewees believe that the State of Michigan may not have current information on groundwater contamination because the data are not digitized or are located in the District offices. Although 69% of interviewees acknowledged that the District office is notified and/or actively involved during contamination, broad and consistent access to data is critical to efficiency and effectiveness in protecting public health and the environment. Similarly, 38% of interviews noted that DHHS was notified and/or actively involved in the process of addressing contamination, while only 23% of interviewees said that EGLE main office in Lansing, MI was involved. With public health at the crux of these agencies' missions, the project team believes that both departments need to be made aware of the issue, no matter the scale of the contamination.

Furthermore, there appears to be miscommunication about the use of institutional controls among local health department members and members across agencies. Whereas 15% of interviewees said that their local health department has authority over which institutional control is implemented, 85% acknowledged that the potentially responsible party has decision-making authority over which institutional controls to use. Therefore, it would be useful to clarify in which circumstances the agency has authority to make decisions, and to increase cross-agency collaboration and communication when decisions are made.

Finally, none of the interviewees discussed NREPA Part 201 provisions stating that liable owners and operators are obligated to disclose contamination to the State if a release over a 24-hour period results in a quantity of hazardous substance that meets or exceeds the reportable quantities as determined by CERCLA. Therefore, although disclosure is required, in practice it may not occur.

Recommendations on How to Improve Addressing Groundwater Contamination

The following are recommendations offered directly from interviewees:

1. *I think EGLE needs a hydro-geology subcommittee to evaluate things like the waters developed to promote the regional water table-mapping, just to have a little more science in the room when we are talking about PFAS [and] more science in the room when we're talking about hydrogeology datasets. I've been trying to convince our upper management that EGLE needs a hydrogeology work group. I think our upper management thinks that these decisions are being made just fine as it is, and I can say they're not. They're not being made consistently.*

2. *I think Environmental Mapper is an excellent tool for people to use, but people's knowledge of its existence is fairly minimal. One way to provide the general public with that information might be a small webinar that the department puts on a website, or some other forward-facing practice to at least identify that this is a resource that can be used.*

3. *A lot of times, we're looking to see what was there, what the status of the cleanup is, how it is being cleaned up. That [information] isn't all in there [and readily available for use and analysis], so we usually contact our local RRD rep to look up site information. They are usually pretty responsible about that.*

4. *That is the biggest complaint I hear about it, that [Environmental Mapper] is more of a GIS site than just a friendly move-around on it. It was made for a reason. It was made that way because county health departments use that to assign well permits.*

5. *The best we can do is put a dot on a map for where the restriction is. There are no good boundaries. There are for individual plumes, but statewide, there is not. I think that it would be incredibly useful [to have boundaries], but I think that at this point it would still be very difficult to do.*

6. *I really think that we lost a lot when the department no longer had to approve [institutional controls] because we typically found errors or omissions, things that they did not do correctly or things were missing.*

7. *The cost-savings, from both our perspective and on the private side, would be monumental if we had the geology of Michigan mapped out, with the aquifers, knowing where all of this is and understanding what the resource is used for and whether some of these aquifers are highly sensitive and need to be protected. [Also] if we have a release there that we need to get in there, and we need to deal with it and we need to remediate it and prioritize it versus other areas.*

8. *We haven't invested [in mapping aquifers]. Other states have invested. If you look at Indiana, Ohio, New Jersey--New Jersey has classified their aquifers. They've got three tiers of aquifers and have invested. They have taken advantage of federal match money to do their geological mapping.*

9. *I think the timing is the biggest issue. I would just like to see [data] in more real-time.*

10. *It would always be good to see parcel layers [in Environmental Mapper].*

With 77% of interviewees using or directing individuals to Environmental Mapper, major themes from these recommendations include:

- updating data and sources;
- creating a more user-friendly platform that allows for easy navigation of the data;
- adding additional layers of data; and
- training on the use of Environmental Mapper.

Because 23% of interviewees state that their agency or District office records data on groundwater contamination in their own inventory or mapping tool, the project team believes a central portal must merge the data to maintain continuity and accuracy. In addition, the project team believes that mapping the aquifers and contamination as a long-term effort will enable deeper understanding of the geology of the State of Michigan and the state's continued effort to address contamination and protect water resources for future generations.

2.4. Data and Visualizations

Data on groundwater contamination, wells, wellhead protection areas, as well as the geographic information associated with these datasets are important for tracking and managing the state's resources. Maps provide a better visual understanding of geographic patterns of institutional controls in relation to other demographic and natural resource data. It is important to recognize that multiple state and local agencies have a hand in managing water resources and contamination; therefore, state and local agencies rely on the upkeep and sharing of various data by and with one another. The following section inventories the data available to state and local agencies on groundwater and groundwater contamination as well as compiles the geospatial data available to show visual representation in the form of maps.

Data Source Inventory

Through discussions with EGLE and DHHS staff as well as extensive online research, a data source inventory (Appendix D) was developed to provide an overarching view of the data available on groundwater contamination and institutional controls in the State of Michigan.

Overview of Applicable Datasets

RRD: All information on institutional controls is managed by RRD and held in its respective databases (e.g. ERNIE, RIDE). The Environmental Response Networked Information Exchange (ERNIE) currently hosts all Part 201 and 213 site information and is not public facing, meaning one must be granted access to view the database. ERNIE has approximately 77,732 entries of Part 201 and 213 sites; however, its use is being phased out and replaced by the Remediation Information Data Exchange (RIDE). RIDE is an enhanced data management system and allows staff to view information on appropriations, authorizations, and grants for sites as well as keep detailed electronic document records. While RIDE is not currently public facing, RRD plans to make it public once all records have been transferred from ERNIE. The final database RRD manages is the Known Environmental Remediation Mapping Information Tracking (KERMIT) that feeds into Environmental Mapper, an online GIS-based system. Environmental Mapper is public facing and contains data on institutional controls, baselines environmental assessments, and notices of corrective action. Other EGLE divisions, state departments, and local health departments utilize Environmental Mapper for many day-to-day work activities. For example, local health departments use Environmental Mapper during the well permitting process to ensure wells are not permitted on a site with groundwater restrictions.

DWEHD: There is no Part 201 data housed in DWEHD databases; however, DWEHD manages WellLogic, which contains water well and pump records for the entire state. Local health departments utilize WellLogic in tandem with Environmental Mapper during well permitting. It is important to note that until January 1, 2000, not all water well records for new wells in Michigan were entered into WellLogic. Inclusion of wells drilled before 2000 varies from county to county.

WRD: MiWaters is a data management system managed by WRD. This multiuse platform enables the creation and management of permit applications and service requests, as well as the ability to report spills, pollution, and unauthorized activities. Further, the public facing

interface allows people to find public notices, hearings, and documents related to permit applications and search for combined sewer overflow, retention treatment basin, and sanitary sewer overflow discharge events. Part 201 documents can be found in MiWaters for specific sites that have facility status; however, Part 201 documents are not readily identifiable in a search.

Overview of Geographic Information System (GIS) Data

GIS data collected from the State of Michigan, U.S. Census Bureau, U.S. Geological Survey, and U.S. Department of Agriculture were used to develop thematic maps. Some maps represent the spatial extent of Michigan's institutional controls layered over population data or wellhead protection areas, while others represent geographic patterns in use of institutional controls and an analysis of statewide vulnerability to contamination. The maps are provided in (Appendix E) with detailed descriptions and explanations of methodology below. The maps are not meant to infer causation or correlation, but instead visualize geographic patterns of institutional controls in relation to other demographic and natural resource data.

To ensure the layers perfectly aligned, each dataset layer used below was geographically transformed be in the Hotine Oblique Mercator projection as well as the North American Datum 1983. The Hotine Oblique Mercator projection was used because it ensures the least amount of shape and size distortion, providing the most accurate depiction of the State of Michigan.

Part 201 Sites of Environmental Contamination and Population Density by County

Description: This map shows county population density data overlaid with current Part 201 sites of environmental contamination. Population density and industry are often positively correlated, as industry relies on a robust transportation and employment sector. It should be noted that because population density was normalized by county area, some counties with small cities and large rural areas appear to have overall lower population density; therefore, these counties may still have contamination hot spots associated with the small cities. As indicated by the map legend, lighter hues of blue represent low population density while deeper hues of blue represent high population density.

Methodology: State of Michigan county data were downloaded from the state's GIS Open Data portal, population data were downloaded from the US Census Bureau, and Part 201 sites of environmental contamination were downloaded from Environmental Mapper. All three datasets were uploaded to ArcGIS Pro and prepared as separate layers. To calculate population density, the county and population data was joined by their unique county ID. After the join, population density was calculated as people per square mile using the math function. Population density was then symbolized using a graduated color scheme. The data were classified using natural breaks because it best represented the variations in the population density data between rural and urban counties.

Heat Map: Part 201 Sites of Environmental Contamination

Description: This map shows the density of Part 201 sites of environmental contamination across the State of Michigan. As indicated by the map legend, the density parameters range from sparse to dense, where the most sparse areas appear light blue and the most dense areas appear yellow. The most dense areas are in Detroit and Grand Rapids, while rural areas have more sparse sites.

Methodology: State of Michigan county data were downloaded from the state's GIS Open Data portal and Part 201 sites of environmental contamination were downloaded from Environmental Mapper. All three datasets were uploaded to ArcGIS Pro and prepared as separate layers. Density of sites was calculated using the kernel density function in ArcGIS Pro. The kernel density function calculates the magnitude-per-10 square miles from a point. Density was symbolized using a graduated color scheme.

Part 201 Sites of Environmental Contamination and Restrictive Covenants – Wayne County

Description: This map shows a close up of the Part 201 sites of environmental contamination and restrictive covenants in Wayne County, Michigan. Given the density of Part 201 sites in Wayne County depicted in the heat map, it was decided that an additional map showing the extent of Part 201 sites and restrictive covenants would be beneficial. While the majority of residents in Wayne County, especially in the City of Detroit, are provided municipal water from Lake Huron, vapor intrusion remains a concern for households in the area and could pose a public health risk if not sufficiently managed. Part 201 sites are depicted by dark red points while restrictive covenants are shown as purple polygons. The City of Detroit is outlined in light blue for reference.

Methodology: State of Michigan county data were downloaded from the state's GIS Open Data portal, and Part 201 sites of environmental contamination and restrictive covenants were downloaded from Environmental Mapper. All three datasets were uploaded to ArcGIS Pro and prepared as separate layers. To isolate Wayne County, the county data was clipped. Additionally, the select by location feature was used to isolate Part 201 sites and restrictive covenants and create two new layers specific to Wayne County. Part 201 sites and restrictive covenants were then symbolized using a categorical color and shape scheme.

Part 201 Sites of Environmental Contamination and Wellhead Protection Areas

Description: This map shows wellhead protection areas in each county in relation to Part 201 sites of environmental contamination. Wellhead protection areas are specific areas that contribute groundwater to wells serving public water supply systems, which communities rely on for drinking water. The areas require additional management strategies to protect public water supply wells from groundwater contamination, which is

why it is particularly important to understand what sites of environmental contamination may currently exist in or near these areas. As indicated by the map legend, wellhead protection areas are represented by the light blue polygons and Part 201 sites are dark red points.

Methodology: State of Michigan county data and wellhead protection areas were downloaded from the state's GIS Open Data portal and Part 201 sites from Environmental Mapper. County and wellhead protection data did not have to be joined by their unique county ID because each wellhead protection area includes a unique set of geographic coordinates. Wellhead protection areas and Part 201 sites were then symbolized using a categorical color and shape scheme.

Vulnerability Index: Surface and Groundwater Contamination

Description: This map shows a vulnerability index for the State of Michigan, identifying areas that may be at lower or higher risk to surface and groundwater contamination if a spill of hazardous materials was to occur. The risk index is categorical and varies from low to high risk. These categories were developed using the slope of the area, soil drainage, and proximity to a water source (e.g. river, lake). The map provides a general overview of some of the regions of interest and can be compared with the location of current restrictive covenants to see where mitigation efforts could take place. As is shown on the map, the sandier soils of central Michigan have a higher drainage rate and therefore demonstrate higher vulnerability on the risk index.

Methodology: The vulnerability index was created following a methodology similar to Bergen (2019).[162] Three primary layers were factored into the index: slope, hydrologic soil group, and distance from hydrological features (i.e. river and lakes). Slope was derived from a DEM layer downloaded from USGS using the 'range' function of a focal statistics tool. Hydrologic soil groups were obtained from the USDA's STATSGO2 soil data set and reclassified as a raster. The hydrological features shapefile obtained from the State of Michigan's GIS Open Data portal. Distance from streams was calculated using the Euclidean distance tool. All layers (slope, soil group, and distance from water) were reclassified and normalized on a scale of 0-100. Lastly, a raster calculator function was used to apply the following formula with each variable given a different weight: (Soil Group * 0.4 + Slope * 0.2 + Proximity to Water * 0.4). The output risk raster was then categorized into three major groups as based on a natural breaks classification.

[162] Bergen, K. et al. "Raster Suitability Mapping – EAS 531 – Principles of Geographic Information Systems." Fall 2019.

2.5 Groundwater Models

Groundwater modeling is an essential tool for predicting potential impacts of proposed remedial actions at facilities with environmental contamination.[163] Groundwater models are computer models that use mathematical equations and facility-specific geologic data to simulate local hydrologic dynamics. These models provide the modeler with a working understanding of how far and how fast groundwater moves locally and how groundwater contaminants are transported away from their initial discharge site towards potential downhill sites. When properly calibrated, groundwater models estimate the fate and transport of groundwater contaminants, which allows proper design of hydrologic containment and pump-and-treat systems, and evaluation of groundwater monitoring networks.[164] As such, groundwater models are critical components of Remedial Action Plans submitted to EGLE by parties liable for contamination under Part 201. Proper modeling of a contaminated area also enables selection of appropriate institutional controls to mitigate contamination. In the State of Michigan, groundwater modeling efforts are supported by the Groundwater Modeling Program (GMP), housed within the Remediation and Redevelopment Division and established in 1980, and funded through federal EPA grants.[165]

Many models of varying complexity exist to describe the hydrogeological settings of contaminated sites. Analytical models (e.g., BIOSCREEN, BIOCHLOR, etc.), which return one-dimensional solutions for groundwater flow and contaminant are most appropriate for sites with relatively homogeneous hydrogeologic conditions or for preliminary site assessments when high accuracy is not necessary.[166] Analytical Element Models (e.g., GFLOW, WinFlow, etc.) return two-dimensional groundwater flow solutions and are also appropriate for primary assessments or sites with minimal hydrogeologic complexity.[167] Analytical and Analytics Elements models are sometimes preferred because they require comparatively little computing power to run. Modeling assessments where high accuracy is necessary, or on sites with high hydrogeological complexity, rely on numerical models (e.g., MODFLOW, BIOPLUME II, BIOPLUME III, etc.) that compute highly complex equations to return three-dimensional groundwater flow solutions.[168]

Groundwater modeling efforts in Michigan are funded by a mixture of public and private sources. Groundwater modeling completed by private firms is funded by the party seeking use of an institutional control to restrict groundwater use or by a person seeking an exemption to use or install a well within or near a restricted area. Review of these models, completed by EGLE, is supported by federal and state funds. In rare cases, EGLE may directly fund groundwater modeling on a site-specific basis for projects undertaken by the agency or in support of enforcement actions.

To facilitate proper reporting of modeling methods and results EGLE provides guidance documents (Appendix F). Proper reporting of modeling results is crucial to developing effective

[163] Department of Environment, Great Lakes, and Energy. (2014). *Groundwater Modeling*. (pp. 1–48)
[164] *Ibid.*
[165] *Ibid.*
[166] *Ibid.*
[167] *Ibid.*
[168] *Ibid.*

institutional controls and remediation strategies. Presently the most significant challenge that EGLE faces with regards to groundwater modeling efforts is the submission of reports that do not meet the minimum standards outlined by the guidance documents.[169] To address this challenge, EGLE staff have begun rejecting reports lacking the minimum standards and demonstrated model verification. Accepted submissions are reviewed by a Groundwater Modeling Technical Assistance and Program Support (TAPS) team, which subsequently provides recommendations to EGLE district offices that inform final decisions to approve a proposed institutional control.

Groundwater modeling is not inherently required for all institutional controls. In defining an area where groundwater restrictions are appropriate for the purpose of restricting potential exposure to hazardous substances, EGLE's district technical staff may request that the person proposing the institutional control perform groundwater modelling to determine the stability of the groundwater contaminant plume and contaminant fate and transport of hazardous substances within a groundwater contaminant plume. Responsible party engagement with groundwater modeling specialists is mandated at the discretion of EGLE technical staff overseeing a specific project. Any need to develop a groundwater model is determined based on site-specific information and circumstances of the project. For example, when determining whether use or installation of a well may result in an unacceptable exposures or influence hazardous substance fate and transport within an aquifer that degrades groundwater resources, the department may require groundwater modeling to make recommendations regarding use or installation of a well within or near a restricted use area. Need to develop a groundwater model is also specific to the type of institutional control proposed by the responsible party. Restrictive covenants, which restrict the use of groundwater specific to individual properties, are based on exceedances of criteria on the property and not any modeling. Groundwater use ordinances, which restrict the use of groundwater in an area, rely on models to assist in determination of an appropriate buffer zone.

Once groundwater modeling efforts are finished, no statewide database presently exists to house and access the completed models. Many groundwater models created by project consultants working for a PRP ultimately become inaccessible to the state and the public; consequently, state efforts to build a broad base of modeling knowledge via incorporation of existing models and the nesting of models at multiple spatial scales are hindered by the present situation. Therefore, to enable accurate forecasting of groundwater quantity and quality across the state, a statewide data management system should be developed to house groundwater models and groundwater data to feed those models.

[169] *Ibid.*

3. Discussion & Recommendations

The research shows that while the 1995 amendments to Part 201 were initially intended to aid in the redevelopment of brownfield sites and prevent urban sprawl, the law has been used to further restrict groundwater resources even outside of urban centers and made it harder for the state to track instances of contamination. Additionally, amendments have increased the burden of proof necessary to impose liability, loosened standards for BEAs, and allowed liable parties to choose the type of institutional control used to restrict groundwater use. Therefore, the current process for detecting and managing contamination as outlined by Part 201 provides a lot of latitude to owners and operators. Implementation of the statute is further complicated by language that creates opportunities for contamination to go undetected, both legally and illegally, and leaves the state with limited response options. The following are three key aspects of Part 201 that make tracking and response challenging:

- Triggering the Statute: Part 201 Section 14 obligations are only triggered when an owner/operator becomes "aware" of the contamination. While hazardous substance releases above the reportable quantity would clearly incite some type of response given the large quantity released, most of the state's Part 201 sites are not the result of a reportable release.
- Establishing Liability: Liable parties are permitted to self-implement cleanup measures without notifying the state once they become "aware" of the contamination. While liable parties do need to notify the state if an institutional control is being placed on the property to mitigate risk, the state has no way to verify if this occurs if they were never notified of the contamination in the first place.
- Enforcing Obligations: Part 201 does not give EGLE-RRD the authority to force liable parties to take on specific response activities as long as the response taken sufficiently mitigates the risk, which is likely to lead to more use of institutional controls than attempts to fully remediate. Additionally, Part 201 gives EGLE-RRD the ability to enforce Section 14 obligations on a liable party, but they can only do so when they suspect the property is a facility. The department may learn of contamination through a BEA or a complaint, but this is more often long after the release occurred.

These aspects of the statute make it difficult to determine the true extent of groundwater contamination in the State of Michigan. Without a full picture of the current state of groundwater contamination, it is difficult to put in place a comprehensive management strategy. Further, it is impossible to determine the long-run risk and costs that are associated with groundwater contamination and restricting groundwater use if there is not a complete understanding of where it is occurring. While institutional controls provide flexibility to owner/operators, allowing them to maintain operations on contaminated properties if the risk is managed, all instances of hazardous substance release should be reported to the state. Stricter reporting requirements would 1) provide better tracking of contamination, allowing the state to comprehensively measure the long-run economic and social costs of current restrictive management actions and determine whether Part 201 is most cost effective regulatory framework and 2) improve decision-making about contaminant response in the future. To change the current process for groundwater contamination management, EGLE needs more control over the process. To

institute more strict reporting and management requirements where the professional judgement of EGLE staff sees fit, Part 201 would need to be amended by the legislature.

Michigan is not unique in its process for risk mitigation, as most states follow a similar protocol. Table 6 summarizes the key differences discussed in Section 2.2 between Michigan, Minnesota, Wisconsin, and Wyoming. Most notably, none of the states had a requirement for property owners to disclose contamination if the release was below the reportable quantity and Wyoming only required disclosure from underground storage tank and radioactive waste operators. Additionally, all states allowed for the use of institutional controls, but the level of state involvement (e.g., review and approval) or what institutional controls could be used for varied. While these states allow for the use of institution controls, the analysis could not measure whether institutional controls effectively manage groundwater contamination or what the associated long-run costs are. Michigan is uniquely situated at the center of the Great Lakes region, which represents 20% of the world's fresh surface water resources. With 3,288 miles of Great Lakes coastline and given what is known about ground-surface water interactions (GSI), contaminated groundwater will eventually interact with surface water. Michigan's surface waters are a vital drinking source for citizens and contribute to the state's economy through tourism and industry. Knowing this, it is important to have a comprehensive understanding of the state's resources through utilizing geologic mapping, key GSI points, and current and potential contamination sites and pathways.

Table 6: Summarized comparison of key similarities and differences of environmental contamination and cleanup statutes for Michigan, Minnesota, Wisconsin, and Wyoming

	The statute…					
State	**has a specific process for dealing with groundwater contamination**	**requires property owners to disclose groundwater contamination**	**requires an assessment of cleanup costs**	**prefers partial/full remediation if feasible**	**requires monitoring of the contaminated site**	**allow for/require the use of institutional controls**
Michigan	Yes: the process has specific groundwater provisions.	Circumstantial: only required to disclose when the release is above the reportable quantity as set by CERCLA	No: assessment of cleanup costs are not required.	No: only requires cleanup criteria consistent with intended land use	Circumstantial: monitoring is only required if an institutional control has been used on the site to mitigate risk.	Yes: institutional controls are allowed to manage risk on properties. In some cases, institutional controls are required if the cleanup does not meet specific land use requirements.
Minnesota	No: the process is not specific to groundwater, but likely includes groundwater in broader. There are specific provisions for well testing.	No: there are not any provisions in the statute that address the requirement of property owners to disclose contamination	Yes: MPCA is empowered to require cost assessments to determine the most "cost-effective" remedial actions for facilities.	No: only requires cleanup criteria consistent with intended land use	No: monitoring is not required by statute, rather it is left to the discretion of the MPCA to determine if monitoring is necessary.	Yes: institutional controls are allowed to manage risk on properties, but it is unclear from the statute if they are ever required.
Wisconsin	Yes: the process has specific groundwater provisions through their Groundwater Protection Statute.	Circumstantial: only required to disclose when the release is "not exempted."	No: assessment of cleanup costs are not required unless funds from the state environmental fund are being used.	No: only requires cleanup criteria consistent with intended land use	Yes: monitoring is required on contaminated sites.	Circumstantial: the Remedial Action statute allows for the use of continuing obligations; however, the Groundwater Protection Standards do not discuss the use of institutional controls.
Wyoming	Yes: the process has specific groundwater provisions.	No: there are not any provisions in the statute that address the requirement of property owners to disclose contamination, unless they are underground storage tank or radioactive water operators	Yes: a cost assessment is required to be completed to determine if the costs of remediation pose a "substantial and disproportionately high cost of implementation and completion"	Yes: groundwater standards must be met for all land uses for the PRP to be released from liability.	Yes: monitoring is required on both involuntary and voluntary remediation sites.	Yes: institutional controls are allowed to manage risk on properties through the use of a remedy agreement with the WDEQ. No changes to institutional controls may occur without the consent of WDEQ.

The interviews resulted in a deeper understanding and identification of the value of institutional controls and the range of obstacles in the way of addressing groundwater contamination. Interviewees, who have worked for years on the issue, offered recommendations to improve prevention and management of groundwater-contamination in the State of Michigan. Interviewees explained that due to current legal statutes cleaning to natural background is not a viable solution, though this then increases the long-term social costs of leaving contamination in place. Institutional controls are valuable because they are cost-effective and mitigate public health risks. However, there are a range of obstacles, such as tracking and monitoring, to effectively addressing groundwater contamination. For example, many interviewees exclaimed that the current datasets needed to address contamination are incomplete or not up to date. Others stated that limited funding presents challenges to comprehensively mapping Michigan's groundwater resources, subsequently making tracking of contaminate movement more difficult. Interviewees recommended updating data and sources, creating a more user-friendly platform that allows for easy navigation of the data, adding additional layers of data, and training on the use of Environmental Mapper. Finally, the project team believes that mapping the aquifers and contamination as a long-term effort will enable deeper understanding of the geology of the State of Michigan and the state's continued effort to address contamination and protect water resources for future generations.

Given the project team's interviews with staff and online research, the data available to staff are disparate across agencies and divisions, most using agency or division specific systems for collecting and coding data. For example, Environmental Mapper uses site IDs while WellLogic uses parcel IDs. Because sites are identified differently, sites with institutional controls on them could be overlooked during the well permitting process; therefore, it would be beneficial if Environmental Mapper included parcel IDs in its site data. Another example is the MiWaters database, where most of the outward facing data are housed. Even after a thorough search of WRD's website for coding descriptions, the project team was unable to understand what much of the data were describing. Additionally, some of the datasets were so large that they could not be downloaded fully without reaching out to WRD for assistance. Lastly, during the project team's interviews, some staff mentioned that MiWaters contained information on Part 201 sites. The project team's subsequent analysis of the data found it was particularly onerous to identify sites Part 201 because the documents were housed with the permit documents and not explicitly identified or searchable.

Given the difficulty in understanding MiWaters data and frustrations indicated to the project team from staff during interviews, improvements could be made to MiWaters to make it more user friendly. First, the process for how to download full datasets for review should be outlined on the MiWaters website. Second, codes should be explicitly laid out in a key or document on the MiWaters or WRD website. Lastly, it appears that some of the databases are missing important information, such as addresses or well records, which could further exacerbate issues with staff from other agencies finding information about a specific site. Missing data can be attributed to the use of paper records versus electronic records in addition to the fact that not all district staff provide the same level of detail when entering records into a database. Standard operating procedures for each division should be developed to ensure that data is being entered

consistently across employees. Further, efforts should be made to ensure missing data is found, including county health departments making efforts to enter well records prior to 2000 into WellLogic.

Analysis of groundwater modeling protocols revealed three areas of weakness: lack of sufficient funding to complete priority modeling, lack of authority to enforce modeling standards, and lack of statewide database to house and access groundwater models and associated data. Increased rule-making authority would allow the department to require groundwater models submitted with Remedial Action Plans to adhere to these standards, ultimately aiding the creation institutional controls that accurately reflect the state of contamination. Securing additional funding would empower EGLE to complete modeling on all sites without a PRP to ensure that all contamination across the state is monitored and potential contamination risks are fully understood. Developing a statewide database for groundwater models would allow the state to accumulate modeling knowledge and accurately forecast groundwater quantity and quality at multiple spatial scales. A plan to create a database that accomplishes these goals has been proposed to the Water Use Advisory Council. This database, the Michigan Hydrologic Framework, would facilitate statewide management of both surface and groundwater models through centralized access to integrated hydrologic models and up-to-date hydrologic data.

Given the discussion and recommendations above, the project team has outlined the recommendations and organized them based on short- and long-run actions to better track and manage the state's groundwater resources:

Short-run Actions

<u>Enhanced data availability and accessibility</u>

a. Environmental Mapper (for EGLE RRD)
    i. Include a "Parcel ID layer" in Environmental Mapper to improve consistency between agencies databases and decrease the amount of time spent matching sites.
    ii. Add date-stamps to all future sites added to Environmental Mapper so they can start to be tracked over time.
    iii. Create and distribute an accessible webinar on the use of Environmental Mapper so local agencies and the public are able to utilize its full benefits and understand the information it provides.

b. MiWaters (for EGLE WRD)
    i. Develop a guide explaining how to download large data sets so they can be fully viewed and analyzed in Microsoft Excel or through other data analysis software.
    ii. Develop and include a key for coded data that is accessible to other agencies and the public so the information shared is able to be understood.

iii. Create and distribute an accessible webinar on the use of MiWaters so local agencies and the public are able to utilize its full benefits and understand the information it provides.

c. WellLogic (for county health departments and DWEHD)
   i. County health departments should seek funding to support paper well record transfers (prior to 2000) to WellLogic. In order to properly manage groundwater, there needs to be a complete understanding of how many active and inactive wells Michigan currently has.

d. All Agencies
   i. Standard operating procedures should be developed for each agency and division, if they do not already exist, to ensure that data is being entered consistently by employees. If standard operating procedures currently exist, they should be reviewed and updated to ensure the most stringent record keeping is being maintained. Comprehensive management of contamination aquifers cannot be maintained if records are missing or incomplete.

Long-run Actions

<u>Enhanced data availability and accessibility</u>

a. EGLE should seek funding from the legislature to support the mapping of Michigan's aquifers and groundwater contamination, beginning with high priority regions, allowing the state to determine what percentage of groundwater resources are being restricted or contaminated. This is a vital step in evaluating the long-term cost of institutional controls.
b. EGLE should develop a statewide data management system to house groundwater models and groundwater data to feed those models. (Currently, there is a proposal being considered by the Water Use Advisory Council that would fund the creation of a Michigan Hydrologic Framework, which the project team recommends further exploration and funding for.)
c. EGLE district offices should take steps to transfer recordkeeping practices from paper to electronic in order to facilitate more rapid communication between agencies.
d. All agencies that handle groundwater and groundwater contamination should develop a working group to discuss the potential of creating a central portal that hosts all groundwater contamination data to maintain continuity and accuracy.

<u>Enhanced decision making and resources for management</u>

a. EGLE should seek amendments to Part 201 from the State of Michigan legislature. The amendments should be guided by the professional expertise of

EGLE staff and written in a way that enables RRD to create and enforce more stringent rules regarding the process of addressing groundwater contamination. For example, requiring all instances of hazardous substance releases be reported to the state. While EGLE could create a framework to determine whether institutional controls are appropriate for managing groundwater contamination, without the ability to influence decisions on institutional controls this knowledge would be of little use.

b. Additional financial and staff resources should be appropriated to EGLE by the State of Michigan legislature to accomplish the tasks outlined above, which will increase EGLE's capacity to address contamination and reduce risks of human exposure.

Glossary of Terms

Act of God: An unanticipated grave natural disaster or other natural phenomenon of an exceptional, inevitable, and irresistible character, the effects of which could not have been prevented or avoided by the exercise of due care or foresight.

All Appropriate Inquiry: An evaluation of environmental conditions at a property at the time of purchase, occupancy, or foreclosure that reasonably defines the existing conditions and circumstances at the property in conformance with 40 CFR 312.

Baseline Environmental Assessment: A written document that describes the results of an all appropriate inquiry and the sampling and analysis that confirm that the property is a facility.

Conservation Easements: Legal documents filed in the local county deed registry that grant a governmental entity, charitable or educational association, corporation, trust, or other legal entity the ability to legally restrict property owners from significantly modifying the present state of an area of land (e.g. by property redevelopment).

Continuing Obligations: Legal requirements and apply to a property even after the ownership changes.

Due Care Obligations: Actions that are necessary to protect against human exposure to contamination in soil, groundwater, and subsurface vapor. Actions must be taken to ensure safe use of property that is contaminated and that affected parties are properly notified if there is a likelihood of exposure (e.g. contamination migration onto another an adjacent property.

Easements: Legal documents granting the holder, not necessarily the property owner, the right to use (affirmative) or restrain (negative) use an area of land.

Environment: Land, surface water, groundwater, subsurface strata, air, fish, wildlife, or biota within this state.

Environmental Contamination: The release of a hazardous substance, or the potential release of a discarded hazardous substance, in a quantity which is or may become injurious to the environment or to the public health, safety, or welfare.

Facility: Any area, place, parcel or parcels of property, or portion of a parcel of property where a hazardous substance in excess of the concentrations that satisfy the cleanup criteria for unrestricted residential use has been released, deposited, disposed of, or otherwise comes to be located.

Groundwater: Water in saturated zone or stratum beneath the surface of land or water.

Hazardous Substance: Any substance that the department demonstrates, on a case by case basis, poses an unacceptable risk to the public health, safety, or welfare, or the environment, considering the fate of the material, dose-response, toxicity, or adverse impact on natural resources.

Institutional Controls: Non-engineered instruments such as administrative and legal controls that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy. *Used synonymously with land and/or resource use restriction(s).*

Joint and Several Liability: When two or more parties are jointly and severally liable for a tortious act, each party is independently liable for the full extent of the injuries stemming from the tortious act.

Local Government Controls: A variety of tools used to control land use by local governments. These include: planning and zoning maps, subdivision plats, building permits, siting restrictions, groundwater use restrictions via drilling prohibitions or well-use permits.

Operator: A person who is in control of or responsible for the operation of a facility.

Ordinances: Legislation enacted by a municipal authority. Zoning ordinances regulate permitted land-use practices while subdivision ordinances regulate land-use conversions.

Orphan Sites: A contaminated site that is no longer owned by the original liable party.

Owner: A person who owns a facility.

Per- and Polyfluoroalkyl Substances: Group of man-made chemicals that includes PFOA, PFOS, GenX, and many other chemicals, which can be found in many products, including food packaging, household cleaners and nonstick cookware.

Postclosure Plan: A postclosure agreement is developed between EGLE and the liable party when additional remediation or monitoring is required at the facility after the initial response activities have been conducted and financial assurance is needed. The agreement must include the liable party's plans for monitoring, operating, and maintaining the effectiveness of the remedial actions in addition to financial assurance to pay for those plans.

Potentially Responsible Party: Means any person who may be liable pursuant to section 107(a) of CERCLA, 42 U.S.C. 9607(a), for response costs incurred and to be incurred by the United States not inconsistent with National Contingency Plan.

Release: Includes, but is not limited to, any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous

substance into the environment, or the abandonment or discarding of barrels, containers, and other closed receptacles containing a hazardous substance.

Remedial Action: Includes, but is not limited to, cleanup, removal, containment, isolation, destruction, or treatment of a hazardous substance released or threatened to be released into the environment, monitoring, maintenance, or the taking of other actions that may be necessary to prevent, minimize, or mitigate injury to the public health, safety, or welfare, or to the environment.

Restrictive Covenant: An enforceable promise between the state and property owners to refrain from certain land use practices or maintain an exposure barrier (e.g. clay cap, parking lot). Restrictive covenants are executed by documents filed in the local county deed registry.

Strict Liability: In both tort and criminal law, strict liability exists when a defendant is liable for committing an action, regardless of what his/her intent or mental state was when committing the action.

Acronyms

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DNR	Department of Natural Resources
DWEHD	Drinking Water and Environmental Health Division
EGLE	Department of Environment, Great Lakes, and Energy
EPA	Environmental Protection Act
ERNIE	Environmental Response Networked Information Exchange
KERMIT	Known Environmental Remediation Mapping Information Tracking
MDARD	Department of Agriculture and Rural Development
MDOT	Department of Transportation
MEDC	Michigan Economic Development Corporation
MERA	Michigan Environmental Response Act
MERLA	Minnesota Environmental Response and Liability Act
MHHS	Department of Health and Human Services
MPCA	Minnesota Pollution Control Agency
NREPA	Natural Resources and Environment Protection Act
OGL	Office of the Great Lakes
RIDE	Remediation Information Data Exchange
RRD	Remediation and Redevelopment Division
SCC	Stream Control Commission
WDEQ	Wyoming Department of Environmental Quality
WEQA	Wyoming Environmental Quality Act
WiDNR	Wisconsin Department of Natural Resources
WRD	Water Resources Division

Works Cited

Adams, W. C. (2015). Conducting Semi-Structured Interviews. Handbook of Practical Program Evaluation, 492–505. DOI: 10.1002/9781119171386.ch19.

Audio/Video/Digital Recordings of Research Participants. (n.d.). <https://www.umass.edu/research/guidance/audio-recordings-research-participants>.

Bails, J. (1995). “Will New Polluter Pay Law Help Michigan's Older Urban Areas?” <https://www.publicsectorconsultants.com/1995/06/02/will-new-polluter-pay-law-help-michigans-older-urbanareas/Saichon>.

Cherkauer K.A., Sinha T. (2010). Hydrologic impacts of projected future climate change in the Lake Michigan region. Journal of Great Lakes Research 36:33-50. DOI: 10.1016/j.jglr.2009.11.012.

Colten, C. (1991). A Historical Perspective on Industrial Wastes and Groundwater Contamination. Geographical Review, 81(2), 215-228. doi:10.2307/215985

Colten, C. “Groundwater Contamination: Reconstructing Historical Knowledge for the Courts.” Applied Geography, vol. 18, no. 3, Elsevier Ltd, 1998, pp. 259–73, doi:10.1016/S0143-6228(98)00017-4.

Congressional Research Service. “Regulating Drinking Water Contaminants: EPA PFAS Actions.” August 6, 2019. <https://fas.org/sgp/crs/misc/IF11219.pdf>

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). 42 U.S. Code Chapter 103. <https://uscode.house.gov/view.xhtml?path=/prelim@title42/chapter103&edition=prelim>

Dempsey, D. (2018) The Sixth Great Lake: The Emergency Threatening Michigan's Overlooked Resource. F.L.O.W. <https://flowforwater.org/wp-content/uploads/2018/09/FLOW-Groundwater-Report-2018.pdf>

Dempsey, D., (2019). “Michigan Groundwater Policy: A History.” FLOW, 15 Mar. 2019, <https://www.flowforwater.org/michigan-groundwater-policy-history/>

Deutsch, M,. Ground-Water Contamination and Legal Controls in Michigan. United States Department of the Interior, Geological Survey, 1963.

English, M. R., & Inerfeld, R. B. (1999). Institutional controls for contaminated sites: Help or hazard. Risk, 10, 121.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. International Journal of Qualitative Methods, 5(1), 80–92. DOI: 10.1177/160940690600500107.

Malewitz, Jim. (2018). “Michigan has 7,300 toxic sites. Money for cleanups is almost gone.” Bridge Magazine. <https://www.bridgemi.com/michigan-environment-watch/michigan-has-7300-toxic-sites-money-cleanups-almost-gone>

Michigan Department of Environment, Great Lakes, and Energy; Drinking Water & Municipal Assistance Division. <https://www.michigan.gov/documents/deq/deq-wd-gws-wcu-groundwaterstatistics_270606_7.pdf>

Michigan Department of Environment, Great Lakes, and Energy. “Environmental Mapper.” <https://www.mcgi.state.mi.us/environmentalmapper/>

Michigan Department of Environment, Great Lakes, and Energy - Remediation and Redevelopment Division, Administrative Rules <https://dtmb.state.mi.us/ORRDocs/AdminCode/1716_2017-041EQ_AdminCode.pdf>

Michigan Department of Environment, Great Lakes, and Energy. “What is Due Care and what are Your Obligations?” <https://www.michigan.gov/egle/0,9429,7-135-3311_4109_59851-267154--,00.html>

Michigan Environmental Response Act (MERA). Act 307 of 1982, Repealed. <http://www.legislature.mi.gov/(S(gulwn03cygsk2xxxxa5thwnx))/mileg.aspx?page=getobject&objectName=mcl-Act-307-of-1982>

Michigan House of Representatives, Special Ad Hoc Committee on Revitalizing Our Michigan Cities. Citizen Advisory Group, Findings and Recommendations State Environmental Policies. January 1993. State of Michigan Library. Print.

Michigan Natural Resources and Environmental Protection Act (NREPA), Part 201: Environmental Remediation. Act 451 of 1994. <http://www.legislature.mi.gov/(S(bv1hctalhlr4ddujvbcdtl1o))/mileg.aspx?page=GetObject&objectname=mcl-451-1994-II-7-201>

National Ground Water Association, 601 Dempsey Rd., Westerville, OH 43081-8978. <https://www.ngwa.org/docs/default-source/default-document-library/states/mi.pdf>

Schnapf, L. P. (2002). How to Use Institutional Controls for Contaminated Sites (pp. 25-37, Rep.). <https://www.environmental-law.net/wp-content/uploads/2011/09/ICs-and-Contaminated-Sites.pdf>

Stiles, C. W. Experimental bacterial and chemical pollution of wells via groundwater, and the factors involved. No. 147. US Government Printing Office, 1927.

United States Geological Survey, Estimated Use of Water in the United States in 1995, Circular 1200, 1998.

United States Census Bureau. “QuickFacts.” Updated: 2019. <https://www.census.gov/quickfacts/fact/table/US/PST045219>

United States Environmental Protection Agency. “Memorandum: Bona Fide Prospective Purchasers and the New Amendments to CERCLA.” May 31, 2002. <https://www.epa.gov/sites/production/files/documents/bonf-pp-cercla-mem_0.pdf>

United States Environmental Protection Agency. “Consolidated List of Chemicals Subject to EPCRA, CERCLA, and CAA.” June 2019. <https://www.epa.gov/sites/production/files/2015-03/documents/list_of_lists.pdf>

United States Geological Survey. “Water Use Data for the Nation.” Updated: 2015. <https://waterdata.usgs.gov/nwis/water_use/>

Minnesota Pollution Control Agency. “MN Wells.” <https://mpca.maps.arcgis.com/apps/View/index.html?appid=4ab8c82e20c24182b56f6b608d42a602&extent=-93.1182,44.8076,-92.7378,44.9861>

Minnesota Environmental Response and Liability Act. Chapter 15B. <https://www.revisor.mn.gov/statutes/cite/115B>

Winter, T. C., Harvey, J. W., Franke, O. L., & Alley, W. M. (1998). *Ground water and surface water; a single resource* (No. 1139). US Geological Survey.

Wisconsin Department of Natural Resources. “Remediation and Redevelopment Database.” <https://dnr.wi.gov/topic/Brownfields/wrrd.html>

Wisconsin Department of Natural Resources. “Open Data – Continuing Obligations.” <https://data-wi-dnr.opendata.arcgis.com/datasets/continuing-obligations-apply>

Wisconsin Groundwater Protection Standards. Chapter 160. <https://docs.legis.wisconsin.gov/statutes/statutes/160/32>

Wisconsin Remedial Action Statute. Chapter 292. <http://docs.legis.wisconsin.gov/statutes/statutes/292.pdf>

Wyoming Department of Environmental Quality – Voluntary Remediation Program. “Institutional Controls, Engineering Controls, and Use Control Areas.” May 2016. <http://deq.wyoming.gov/media/attachments/Solid%20%26%20Hazardous%20Waste/Voluntary%20Remediation%20Program/Fact%20Sheets/FS_23.pdf>

Wyoming Public Health and Safety Statute. Chapter 35. <http://wyoleg.gov/statutes/compress/title35.docx>

Wyoming Water Development Office. “River Basin Available Groundwater Determination Technical Memorandum.” <http://waterplan.state.wy.us/basins/7basins.html>

Appendices

A. Draft RFP: Economic analysis of long run risk management for groundwater resources
B. Project Team Full Interview Questions with Probes
C. Project Team Discussion Questions
D. Data Source Inventory
E. Thematic Maps
F. Suggested Groundwater Model Documentation Report Format

Appendix A.

MICHIGAN GREAT LAKES PROTECTION FUND
REQUEST FOR PROPOSALS:
ECONOMIC ANALYSIS OF LONG RUN RISK MANAGEMENT FOR GROUNDWATER RESOURCES

I. Overview

This is a request for proposals for a research project to assess the long-term economic cost of using institutional controls and other restrictive management actions to manage risks associated with groundwater contamination compared with the cost of other potential management actions. EGLE will fund a project to use economic case studies to evaluate the Michigan Department of Environment, Great Lakes, and Energy's (EGLE) current process and criteria for determining when institutional controls are the appropriate response to a groundwater contamination event.

This research project will evaluate a set of case studies to determine the cost of past uses of institutional controls and restrictive covenants and develop a decision-making framework for future instances of groundwater contamination based on a holistic prediction of long-term risk and cost. The project will seek to incorporate the risk of additional unexpected costs into this framework as well as changes in risk associated with expected demographic change and the cumulative risk of using institutional controls at many sites within the same geographic area. The grantee will be expected to:

a) Identify a set of case study sites where institutional controls have been used to manage risks associated with groundwater contamination. These cases should include sites where institutional controls have resulted in 1) low or no unexpected costs; 2) moderate unexpected costs; and 3) high unexpected costs.

   Case study site selection will be led by the grantee and will occur in consultation with EGLE staff after the grant has been awarded. The applicant is not expected to identify case study sites in the proposal but should identify some criteria or a methodology for selecting sites.

b) Evaluate the full economic cost of using institutional controls from the time of contamination to the present, including projections of future costs where feasible.

c) Compare this cost to the cost that was estimated when institutional controls were selected as the management option and to the cost of other potential management actions; and

d) Develop a decision-making framework to help EGLE determine when it is appropriate to use institutional controls and other restrictive management actions as opposed to more thorough removal of contamination from the environment, based on the anticipated economic cost of each option. This calculation should incorporate the risk of additional unexpected costs, changes in risk associated with expected

demographic change, and the cumulative risk of using institutional controls at many sites within the same geographic area.

Approximately $350,000 from the Michigan Great Lakes Protection Fund (MGLPF) will be provided to one applicant. This grant program will be funded by the MGLPF and administered by EGLE. Eligible applicants include: educational institutions; federal, state, tribal and local governments; and any other non-profit or for-profit entity with relevant experience.

II. Background

When groundwater becomes unusable due to contaminants exceeding applicable criteria, there are a number of adaptation and mitigation strategies available to manage the risk associated with the contamination. Section 324.20121 of Part 201 and Section 324.21310a of Part 213 of the Natural Resources and Environmental Protection Act (NREPA), Act 451 of 1994 authorizes the use of restrictive covenants and institutional controls to limit use of an aquifer to manage risk of exposure in lieu of actually removing contamination from the ground. In some cases, this may constitute a de facto permanent removal of that aquifer, or portions thereof, from use.

According to the Cleanup Criteria Requirements for Response Activity rules developed by the Remediation and Redevelopment Division, an "institutional control" (R 299.1, Rule 1 (q)) is "a measure which is approved by the department, which takes a form other than restrictive covenant, and which limits or prohibits certain activities that may interfere with the integrity or effectiveness of a remedial action or result in exposure to hazardous substances at a facility, or which provides notice about the presence of a hazardous substance at a facility in concentrations that exceed only an aesthetic-based cleanup criterion." In addition, Rule 299.2(a) defines land or resource use restrictions that may limit or restrict certain activities that may result in exposure to hazardous substances at a facility.

Table 1

Potential Economic Costs
• Drinking water adaptation • Ongoing monitoring • Fish and wildlife contamination • Decreased property value • Health impacts • Contaminant migration • Vapor intrusion • Venting to surface water • Forgone recreational use • Risk of additional complications

Institutional controls and other land or resource use restrictions have become a common mechanism for managing risk associated with groundwater contamination since the passage of NREPA and are currently in use at over 2,000 sites across the state. The costs and risks at these sites have many dimensions that have significantly altered the benefit structure of using institutional controls and restrictive covenants as a risk management option. In some of these cases, unexpected complications, like vapor intrusion, have occurred many years after the initial

risk management decision was made and have significantly increased the cost of using institutional controls. In other cases, contaminants have migrated to affect additional populations, also significantly increasing the cost of using institutional controls. All of these dimensions should be considered when calculating the costs and risks of using institutional controls and restrictive covenants as part of this project. A longer (but not necessarily comprehensive) list of potential economic costs is available in Table 1.

Michigan's current environmental laws do not provide guidelines or limitations on the appropriate use of these mechanisms, nor do they account for the potential complications described above. As a result, the long-term implications, risks, and costs of using institutional controls and other restrictive management actions are not well understood. This research project is intended to augment decision-making by addressing this information gap.

III. Deliverables

The deliverables of the project should be:

- An assessment of the cost of using institutional controls at each of the case study sites, compared to the cost that was expected at the time of implementation and the cost of other potential management actions, where information is available.
- An estimation of the total cumulative cost of using institutional controls in the 25 years since they became a common mechanism for managing groundwater contamination, extrapolated from the case study evaluations.
- A decision-making framework or set of criteria to help EGLE determine when it is appropriate to use institutional controls and other restrictive management actions as opposed to more thorough removal of contamination from the environment at a given site, based on the anticipated economic cost of each option.

EGLE and other State of Michigan project partners expect to work closely with research team. The team may also be asked to periodically consult with an expert panel about the methods and conclusions of the project.

IV. Funding Availability

A. Eligible Applicants

- Non-profit and for-profit entities with experience in socio-economic case study analysis
- Educational institutions
- Federal, state, tribal and local units of government

Note: Grants cannot be made out to individuals.

B. Ineligible Applicants

An applicant for whom any of the following conditions existed in the 12 months prior to the application deadline for this RFP is not eligible for funding:

- EGLE grant contract terminated

- Unresolved EGLE enforcement actions
- History of inability to manage or meet EGLE contractual terms and conditions

C. Grant Amount

Approximately $350,000 will be made available for this grant.

D. Match Requirement

Match is not required but will be considered. Match may be in the form of cash, in-kind services, or donations.

E. Project Award Period

Projects will be evaluated on project readiness and feasibility for completion within an 18-24-month time frame beginning **October 1, 2020** and ending no later than **September 30, 2022**.

F. Ineligible Uses for Grant Funds

This grant cannot be used to fund professional development activities or large-scale purchasing of equipment. This grant is intended to fund research on existing uses of institutional controls; it cannot be used to fund planning or implementation of future remediation projects. This grant cannot be used to purchase equipment to be used for purposes other than the proposed project tasks. Travel expenses should be built into the proposal budget.

G. Application Deadline

Complete applications must be received no later than **5:00 p.m. on Friday, May 15, 2020.** Save the date for a webinar about the funding opportunity on **Wednesday, April 8.**

H. Application Submittal

Applications should be submitted by e-mail. Attach the application package in Portable Document Format (PDF). The combined size of the files attached to the e-mail cannot exceed 10 megabytes.

Applications should be sent to:

Ms. Kimber Frantz
frantzk@michigan.gov

V. Information for Applicants

Proposal information will not be kept confidential. Grant proposals are considered public information under the Michigan Freedom of Information Act, PA 442 of 1976, as amended.

Successful applicants will be required to enter into a grant agreement with EGLE with standard terms and conditions which are not subject to modifications. Failure of a successful applicant to accept these obligations will result in cancellation of the grant award.

Successful applicants will also be required to provide proof of a successful financial audit for a period ending within the 24 months immediately preceding the proposal due date.

VI. Application Package

Applications can be no more than 10 single-sided pages in length with text no smaller than 10-point font size and standard 1-inch margins. Maps and illustrations may be included but will be subject to the overall application length limit. A cover letter signed by an authorized representative of the applicant on the applicant's letterhead must accompany the application but will not be included in the page limit. Applications should be addressed as described below.

A. Application Cover Page

The cover page should be addressed to Ms. Emily Finnell, EGLE, Office of the Great Lakes Senior Advisor and Strategist, and should list the project title and information about the applicant. It must clearly state the grant amount requested, match amount provided, if relevant, and total project cost, if greater than the sum of the grant and match amounts. Information about the applicant must include:

- Applicant agency or organization name and mailing address
- Authorized representative's name, e-mail address, and telephone number
- Applicant Federal ID#
- Applicant DUNS #
- Name, title, and contact information of contact person, if different from that of applicant's authorized representative
- Congressional District, State Senate District, and State House District numbers of applicant's location

B. Proposed Project Summary

Provide a brief summary (300 words or less) of the proposed project including the name of the applicant organization and partners, proposed methodology and justification for selection, and the focus and primary outcomes of the project.

C. Detailed Proposed Project Description

The following information is required in the detailed proposed project description:

- Project scope, why the project is needed, and how it addresses the focus of the grant request
- A brief overview of the planned approach and methodology for carrying out the project
- List of deliverables
- Source of match, if applicable

D. Project Tasks and Schedule

Display timelines for major tasks, target milestones for critical intermediate and final products, and key project outcomes/deliverables. The schedule must show that all tasks will

be completed within the project period. Progress will be reported semi-annually according to the table below.

Tasks	Oct 2020-Mar 2021	Apr-Sept 2021	Oct 2021-Mar 2022	Apr-Sept 2022	Outcome/Deliverable
1.					
2.					
3.					
4.					
5.					

E. Organizational Capability

Describe the qualifications of the individual(s) anticipated to work on the project and the past experience of the applicant in managing grant projects. Provide a brief overview of individual(s)' publications on related topics.

F. Detailed Project Budget

Download and use one of the budget forms below, based on your organization's approach toward project indirect costs. Reimbursement of indirect is optional and at the discretion of the grantee. Should the grantee choose to request reimbursement of indirect, rates will be calculated according EGLE policy 10-005, described below:

- The indirect rate established for the grantee organization, up to a maximum of 20 percent of the salary plus fringe costs.
- EGLE maintains the right to ask for verification of how indirect rates are determined.

Select one of the following budget forms:

- Please utilize this budget form if the project does not require any reimbursement of indirect costs: [link]
- Please utilize this budget form if the project requires reimbursement of indirect costs. This budget form will allow the applicant to select an indirect rate, not to exceed EGLE's mandated 20% cap: [link]

The completed budget spreadsheet file should be included in the e-mail with the application and will not count toward the 10-page application limit. Within the 10-page document, please provide a budget narrative that describes each line item.

G. Project Outcomes and Deliverables

Provide a description of the expected results of the project and project deliverables.

VII. Attachments

A. Proof of successful financial audit
B. Proof that applicant is not on the federal/debarment list (sam.gov)

VIII. Evaluation Criteria

EGLE strongly encourages interested applicants to contact program staff early in the proposal development process for assistance and guidance. Complete applications will be evaluated for funding based on the following considerations:

- Detailed description of proposed methodology for thoroughly evaluating the total economic cost of past uses of institutional controls, including some projected future costs
- Detailed description of a thoughtful, creative, and holistic approach for developing a decision-making framework to assess appropriate use of institutional controls at the onset of contamination in the future.
- Interdisciplinary capacity of project team, including economic and hydrogeologic expertise
- Extent to which the project leverages other financial, information, and intellectual resources
- Feasibility for completion of project within the specified grant period
- Overall quality and clarity of the application
- Organizational capability of the applicant to complete the project as proposed
- Cost-effectiveness
- Measurability of project results

IX. Reporting Requirements and Funding Disbursement

The grantee must complete and submit semi-annual financial and/or progress reports according to a form and format prescribed by the State and must including supporting documentation of eligible project expenses.

X. Program Contact

If you have any questions or comments regarding the program or the application process, please contact:

Ms. Emily Finnell
Office of the Great Lakes
Department of Environment, Great Lakes, and Energy
(c): 517-599-1330
finnelle@michigan.gov

Ms. Christina Pastoria
Office of the Great Lakes
Department of Environment, Great Lakes, and Energy
(c): 517-899-5174
pastoriac@michigan.gov

Appendix B.

Interview Questions

1. Do you have any questions for us about the project before we get started?
2. Please tell us a little bit about your work with _____ (name of agency/division)
3. Can you tell us briefly the role your agency/division plays in addressing groundwater contamination?
4. Why did you decide to engage in this project?

The following questions will be based on your professional experience.

1. Have you used and/or had experience with institutional controls and other restrictive management actions during your time at _____ (name of agency/division)?
    a. Probe: What types of controls did you use or come in contact with?
2. Can you walk us through the process of how groundwater contamination, from the moment of release to the time when all action is complete, is handled?
3. Probe: In what instances institutional controls may be implemented?
    a. Probe: What is your role?
    b. Probe: Who is involved in the process?
    c. Probe: Who makes the ultimate decision that institutional controls are appropriate?
        i. Probe: What other agencies are involved?
        ii. Probe: Is the community actively involved or aware?
    d. Probe: What is the notification process for groundwater contamination?
    e. Probe: What is the notification process for initiating use of institutional controls?
    f. Probe: Are there common breakdowns points in the process?
        i. Probe: If so, where? (i.e., where, if anywhere, is the process most likely to fail)
4. In your professional opinion, what are the advantages of using institutional controls?
    a. Probe: What is your opinion on the process for appropriate use of institutional controls?

The following set of questions will be on data availability at your agency

1. Do you use agency and/or division data sets to support your work addressing groundwater contamination?
    a. Probe: If yes, which data sets do you use?

[If they indicate a data set, we have not discussed, ask questions Q2a. through Q2f.; otherwise, move on to Q3.]

2. Can you provide us more detail on _____ data set(s)?
    a. Probe: What is the size of these data sets?
    b. Probe: How frequently do you access them?
    c. Probe: Who else has access to these data sets?
    d. Probe: When and how frequently are these data sets updated?
        i. Probe: Who is making these changes?
    e. Probe: Where is the information from these data sets gathered?
    f. Probe: Where are these data sets located?

3. How is the data used to support your work?
    a. Probe: Is it used in reports, press releases, or notifications to communities?
    b. Probe: Is it shared with agencies involved in the process?
4. Does your work ever require you to seek information or data from other divisions or agencies?
    a. Probe: If yes, how often do you seek information or data from other divisions or agencies?
    b. Probe: If yes, what information are you requesting and which agencies and/or divisions are you requesting it from?
5. Is there any data that is unavailable or missing?
6. Is there any data or information that you believe should be included or collected that currently is not?
    a. Probe: Is there a reason why this information is not included?

Ending Questions

1. Is there anything else you would like to share that you feel would help inform our research?
2. Are there any additional individuals or divisions you would recommend we reach out to in order to further inform our research?

Appendix C.

Discussion Questions

1. Do you have any questions for us about the project before we get started?
2. Please tell us a little bit about your work with _____ (name of agency/division)
3. Can you tell us briefly the role your agency/division plays in addressing groundwater contamination?
4. Why did you decide to engage in this project?

The following questions will be based on your professional experience.

1. Have you used and/or had experience with institutional controls and other restrictive management actions during your time at _____ (name of agency/division)?
2. Can you walk us through the process of how groundwater contamination, from the moment of release to the time when all action is complete, is handled?
3. In your professional opinion, what are the advantages of using institutional controls?

The following set of questions will be on data availability at your agency

1. Do you use agency and/or division data sets to support your work addressing groundwater contamination?
    a. If you answered yes to question 1, please provide us with more detail on the data sets.
2. How is the data used to support your work?
3. Does your work ever require you to seek information or data from other divisions or agencies?
4. Is there any data that is unavailable or missing?
5. Is there any data or information that you believe should be included or collected that currently is not?

Ending Questions

1. Is there anything else you would like to share that you feel would help inform our research?
2. Are there any additional individuals or divisions you would recommend we reach out to in order to further inform our research?

Appendix D.

								Information Provided		
Name of Database	Nickname	Agency/Division Owner of Database	Agency/Division Contact	Description	Number of Entries in Database	Regularity of Updates	Database Traffic	Part 201 Sites	Groundwater Contamination	Documents (e.g. remediation plans, notices)
Environmental Response Networked Information Exchange	ERNIE	EGLE/RRD	Sara Pearson	Part 201 and 213 site information; use is being phased out and replaced by RIDE. Very simplified interface with limited information (e.g. does not contain particular site documents).	77,732	Weekly/Daily	Unknown; 250 staff with access	Y	Y	Y
Known Environmental Remediation Mapping Information Tracking	KERMIT	EGLE/RRD	Nick Ekel	Holds all information on Part 201 sites in Michigan and feeds into Environmental Mapper (online GIS-based system). See GIS Data Layers tab for more information on data housed in KERMIT.	7,000	Weekly/Daily	Unknown; 250 staff with access	Y	Y	N
Remediation Information Data Exchange	RIDE	EGLE/RRD	Sara Pearson	New system that will hold all RRD data (include Part 201, Part 213, etc.). Can view information on appropriations, authorizations, contacts, contaminant classes, grants, locations, and maintenance. See RIDE tab for more detailed information.	See RIDE tab.	Weekly/Daily	Unknown; 250 staff with access	Y	Y	Y
Well Logic	Well Logic	EGLE/DWEH		Contains water well and pump records and abandoned well plugging records by county. Various layers and levels of data available - see WellLogic tab for more detailed information.	See WellLogic tab.	Monthly	Unknown	N	N	Y
MiWaters	MiWaters	EGLE/WRD		Multiuse platform: - Use to create and manage permit applications and service requests - Find public notices, hearings, documents related to Water Resources permit applications - Search for combined sewer overflow, retention treatment basin, and sanitary sewer overflow discharge events - Report spills, pollution, and unauthorized activities	349,658	Unknown	Unknown	N	N	Y

								Information Provided		
Name of Database	**Nickname**	**Agency/Division Owner of Database**	**Agency/Division Contact**	**Description**	**Number of Entries in Database**	**Regularity of Updates**	**Database Traffic**	**Part 201 Sites**	**Groundwater Contamination**	**Documents (e.g. remediation plans, notices)**
MiWaters	MiWaters	EGLE/WRD		Multiuse platform: - Use to create and manage permit applications and service requests - Find public notices, hearings, documents related to Water Resources permit applications - Search for combined sewer overflow, retention treatment basin, and sanitary sewer overflow discharge events - Report spills, pollution, and unauthorized activities	349,658	Daily	Unknown	N	N	Y

Name of Dataset	**Description**	**Number of Entries**	**Notes**
Affils	Unknown; includes site ID, site address, and type of affiliation (e.g. permit, contract)	1,048,576	*could not download entire file because it was too large
Sites	Unknown; includes site ID and name, lat/long, and siteURL	344,354	*while some sites had addresses, many did not; the siteURL does not work for any of the sites
Environmental Interests	Unknown; includes site ID, site address, start/end date for permit, type of permit, and assigned staff member	269,267	
Violations	Unknown; includes site ID, violation ID, type of violation.	81,423	*all the data was coded, making it nearly impossible for anyone outside of the division to comprehend what actions have taken place
Enforcement Actions	Unknown; includes site ID, site address, responsible program (e.g. NPDES, groundwater), enforcement action (type, notice), and status of enforcement	24,831	*while some sites had addresses, many did not
Evaluations	Unknown; includes site ID, responsible program (e.g. NPDES, groundwater), evaluation type and description	111,744	
Document Files	Includes siteID, document description, and web link to site documents (if it is available online)	1,048,576	*could not download entire file because it was too large; siteURL does not work for any of the sites
Document List	A list, document description, and web link to site documents (if it is available online)	1,048,576	*could not download entire file because it was too large; siteURL does not work for any of the sites

							Information Provided		
Name of Database	**Nickname**	**Agency/Division Owner of Database**	**Agency/Division Contact**	**Description**	**Regularity of Updates**	**Database Traffic**	**Part 201 Sites**	**Groundwater Contamination**	**Documents (e.g. remediation plans, notices)**
Remediation Information Data Exchange	RIDE	EGLE/RRD	Sara Pearson	New system that will hold all RRD data (include Part 201, Part 213, etc.). Can view information on appropriations, authorizations, contacts, contaminant classes, grants, locations, and maintenance. Each of the above must be viewed separately and is described in more detail below.	Weekly/Daily	Unknown; 250 staff with access	Y	Y	Y

Name of Dataset	**Description**	**Number of Entries**
Appropriations	Provides a query of sites that have been granted state appropriations for remediation; can also view by contracts and transactions.	1,367
Authorizations	Provides a query of sites that have requested funds and the status of requests (e.g. authorized). Also includes contracts, fund balances, and transactions for each approved funding request.	*would not allow query function
Contacts	Provides a query of associated businesses (e. g. LLC, corporation). Businesses may have more than one site location and are indicated as active or inactive.	95,081
Contaminant Classes	Provides a query of contaminant classes of concern based on business type (e.g. agriculture, gas stations, manufacturing) or contaminant class (e.g. dioxin, lead, NAPL).	Varied
Grants	Provides a query of sites receiving grant funding (e.g. O&M support, GLRI). It indicated total grant amount allotted, grant start/end dates, specified grant activity, and current grant status (e.g. closed, open).	229
Locations	Provides a query of site specific Part 201 and Part 213 cases. In includes the locations of businesses themselves (e.g. lat,long), RRD work unit and project manager, House/Senate/US Congressional Districts, risk condition (e.g. risk not determined, risk present but immediate).	77,831

							Information Provided		
Name of Database	**Nickname**	**Agency/Division Owner of Database**	**Agency/Division Contact**	**Description**	**Regularity of Updates**	**Database Traffic**	**Part 201 Sites**	**Groundwater Contamination**	**Documents (e.g. remediation plans, notices)**
Well Logic	Well Logic	EGLE/DWEH	Unknown	Contains water well and pump records and abandoned well plugging records by county.	Weekly/Daily	Unknown	N	N	Y

Name of Dataset	**Owner of Dataset**	**Contact**	**Description**	**Number of Entries**	**File Type**	**File Size (KB)**	**Regularity of Updates**	**Web Link**
Water Wells - Upper Peninsula	EGLE/DWEH	Unknown	These files provide water well information for wells in counties clustered by geographic region. The files are constructed to be easily merged, containing the same number and type of attribute fields. It is important to note that these datasets are incomplete - until January 1, 2000 not all water well records for new wells in Michigan were entered into Well Logic. Inclusion of wells drilled before 2000 is variable based on county.	46,103	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	6,360	Monthly	http://gis-michigan.opendata.arcgis.com/datasets/water-wells-upper-peninsula
Water Wells - West Central Lower Peninsula	EGLE/DWEH	Unknown		109,061		15,901		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-west-central-lower-peninsula
Water Wells - South Central & Southeastern Michigan	EGLE/DWEH	Unknown		156,343		22,027		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-south-central-southeastern-
Water Wells - Southwest Michigan	EGLE/DWEH	Unknown		117,469		17,132		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-southwest-michigan
Water Wells - East Central Lower Peninsula	EGLE/DWEH	Unknown		67,455		9,725		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-east-central-lower-peninsula
Water Wells - Northern Lower Peninsula	EGLE/DWEH	Unknown		137,228		20,030		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-northern-lower-peninsula
County-level Data	EGLE/DWEH	Unknown	These files provide water well information by county and include lithology files. Each county dataset must be downloaded separately.	Varies based on county	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	Varies based on county	Monthly	https://www.michigan.gov/som/0,4669,7-192-78943_78944_78955-427312--,00.html

PART 201

Name of Dataset	Owner of Dataset	Contact	Description	Traffic	Number of Records	File Type	Regularity of Updates	Web Link	Dataset Available to Download?
KERMIT/Environmental Mapper	EGLE/RRD	Nick Ekel	Public-accessible tool to view Part 201 and 213 sites of contamination. Sites can be displayed based on search criteria by city, county, EGLE district, and Michigan legislative district. Additionally, can view sites within a certain distance of a location, a land lot, or a stream segment. The results can be printed, with the map, or exported to an Excel spreadsheet.	800-900 unique visitors per month	Varies depending on layer	Shape	Dynamically with KERMIT updates; daily/weekly	www.mcgi.state.mi.us/environmentalmapper	Yes; each layer must be downloaded as a separate shapefile (e.g. restrictive covenant, ordinance).

	EM File Name	Description	File Type	File Formats	File Size (KB)	Projection	Datum	Projected Coordinate System
	Baseline_Environmental_Assessment	Contains parcels (lat,long) identified by new or prospective owners or operators of those parcels as being contaminated under Part 201 and or Part 213 of the NREPA.	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	65,394	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Michigan_Department_of_Transportation__Point	Contains locations of MDOT jurisdiction sites (lat,long)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	984	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Michigan_Department_of_Transportation__Polygon	Contains locations of MDOT jurisdiction sites (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,053	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Aesthetic_Impact	Contains locations of aesthetic impact notices (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,034	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Approved_Env_Remediation__Point	Contains locations of approved environmental remediation (lat, long)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	984	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Approved_Env_Remediation__Polygon	Contains locations of approved environmental remediation (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,036	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Corrective_Action__Point	Contains locations of corrective action notices (lat,long)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	985	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Corrective_Action__Polygon	Contains locations of corrective action notices (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,288	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Notice_of_Environmental_Remediation	Contains locations of environmental remediation (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	984	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Ordinance__Polygon	Contains locations of ordinances (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,068	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Other_Institutional_Control	Contains locations of institutional controls other than restrictive covenants and ordinances (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,062	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Restrictive_Covenant_Point	Contains locations of restrictive covenants (lat,long)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	985	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Restrictive_Covenant_Polygon	Contains locations of restrictive covenants (area)	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	3,305	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator
	Sites_of_Environmental_Contamination_Part_201	Contains all Part 201 site locations (lat,long); does not include BEAs	Shape	CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	10,207	Web Mercator Auxiliary Sphere	GCS North American 1983	Hotline Oblique Mercator

GEOLOGICAL/HYDROLOGICAL

Name of Dataset	Owner of Dataset	Contact	Description	Number of Records	File Type & Formats	File Size (KB)	Regularity of Updates	Web Link	Dataset Available to Download?
Michigan Bedrock Geology	SOM/DNR	Unknown	Bedrock geology polygons digitized from 1987 Michigan bedrock geology map	2,306	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	6,928	Monthly	https://gis-michigan.opendata.arcgis.com/datasets/bedrock-geology?geometry=-102.031%2C38.762%2C-65.249%2C49.731	Yes
Quaternary Geology Map	EGLE/Admin	Unknown	Glacial geology polygons	3,456	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	4,579	Unknown	https://gis-michigan.opendata.arcgis.com/datasets/quaternary-geology-map	Yes
Quaternary Geology Features	EGLE/Admin	Unknown	Glacial geology polygons	5,559	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	3,543	Unknown	https://gis-michigan.opendata.arcgis.com/datasets/quaternary-geology-features?geometry=-94.987%2C41.516%2C-76.596%2C47.017	Yes
Aquifer Characteristics of Glacial Drift	EGLE/Admin	Unknown	Derived from the 1981 publication of the Hydrological Atlas of Michigan plate 26. Three plates of the Aquifer Characteristics of Glacial Drift map were scanned, geo-rectified and used as a backdrop in the digitizing of this polygon vector file.	1,388	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	2,552	Unknown	https://gis-michigan.opendata.arcgis.com/datasets/aquifer-characteristics-of-glacial-drift	Yes

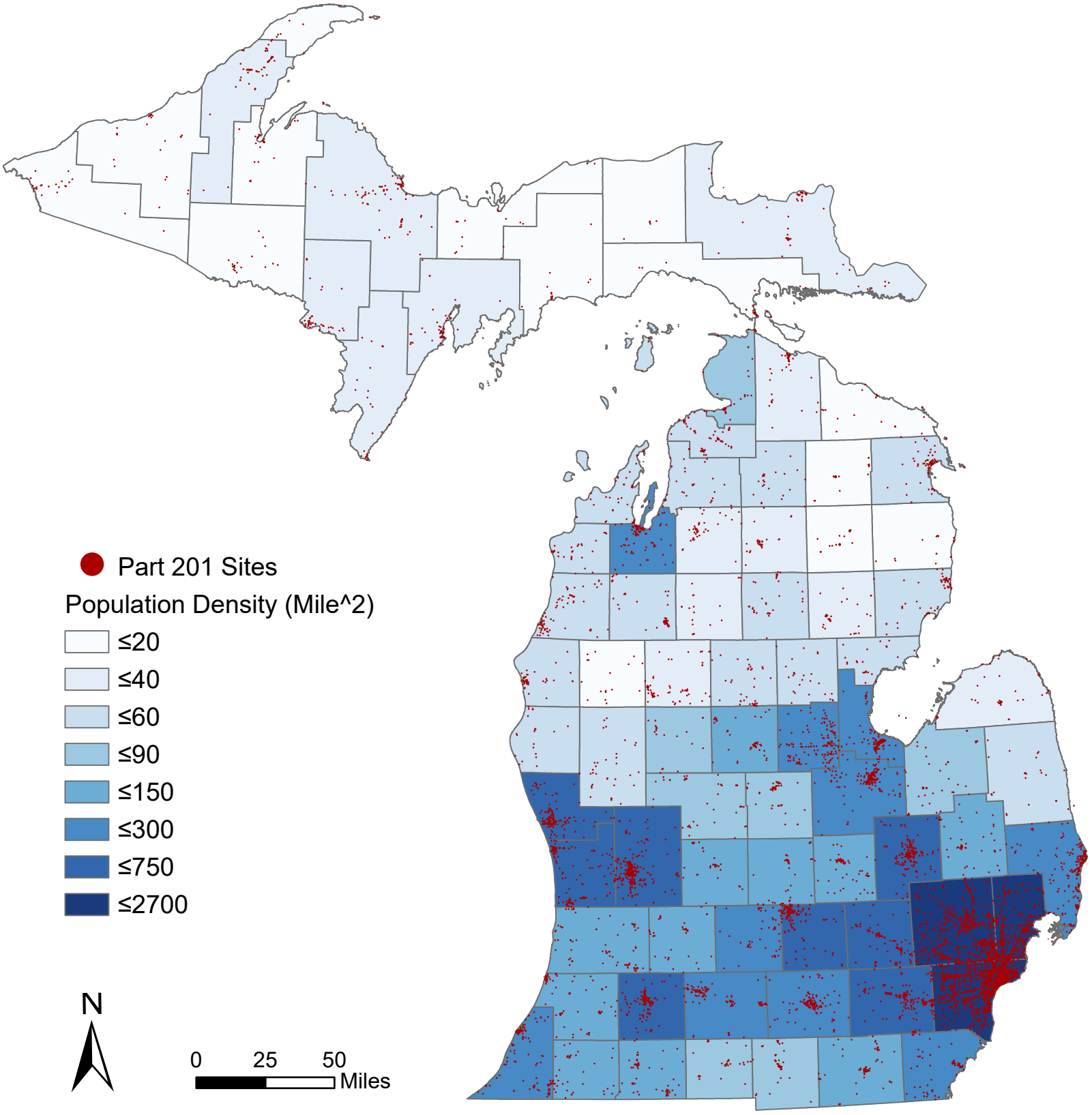
WATER WELLS

Name of Dataset	Owner of Dataset	Contact	Description	Number of Records	File Type & Formats	File Size (KB)	Regularity of Updates	Web Link	Dataset Available to Download?
Water Wells - Upper Peninsula	EGLE/DWEH	Unknown	These files provide water well information for wells in counties clustered by geographic region. The files are constructed to be easily merged, containing the same number and type of attribute fields. It is important to note that these datasets are incomplete - until January 1, 2000 not all water well records for new wells in Michigan were entered into Well Logic. Inclusion of wells drilled before 2000 is variable based on county.	46,103	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	6,360	Monthly	http://gis-michigan.opendata.arcgis.com/datasets/water-wells-upper-peninsula	Yes
Water Wells - West Central Lower Peninsula	EGLE/DWEH	Unknown		109,061		15,901		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-west-central-lower-peninsula	Yes
Water Wells - South Central & Southeastern Michigan	EGLE/DWEH	Unknown		156,343		22,027		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-south-central-southeastern-michigan	Yes
Water Wells - Southwest Michigan	EGLE/DWEH	Unknown		117,469		17,132		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-southwest-michigan	Yes
Water Wells - East Central Lower Peninsula	EGLE/DWEH	Unknown		67,455		9,725		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-east-central-lower-peninsula	Yes
Water Wells - Northern Lower Peninsula	EGLE/DWEH	Unknown		137,228		20,030		http://gis-michigan.opendata.arcgis.com/datasets/water-wells-northern-lower-peninsula	Yes
County-level Data	EGLE/DWEH	Unknown	These files provide water well information by county and include lithology files. Each county dataset must be downloaded separately.	Varies based on county	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	Varies based on county	Monthly	https://www.michigan.gov/som/0,4669,7-192-78943_78944_78955-427312--,00.html	Yes
Wellhead Protection Areas	EGLE/Admin	Unknown	Wellhead protection areas represent the land surface area that contributes ground water to wells serving public water supply systems throughout Michigan. The areas define a landscape in which management strategies are employed to protect public water supply wells from groundwater contamination.	1,046	Shape: CPG, DBF, PRJ, SBN, SBX, SHP, XML, SHX	1,420	Unknown	https://gis-michigan.opendata.arcgis.com/datasets/wellhead-protection-areas/geoservice?geometry=141.089%2C43.236%2C-135.239%2C84.220	Yes

Appendix E.

Part 201 Sites of Environmental Contamination and Population Density by County

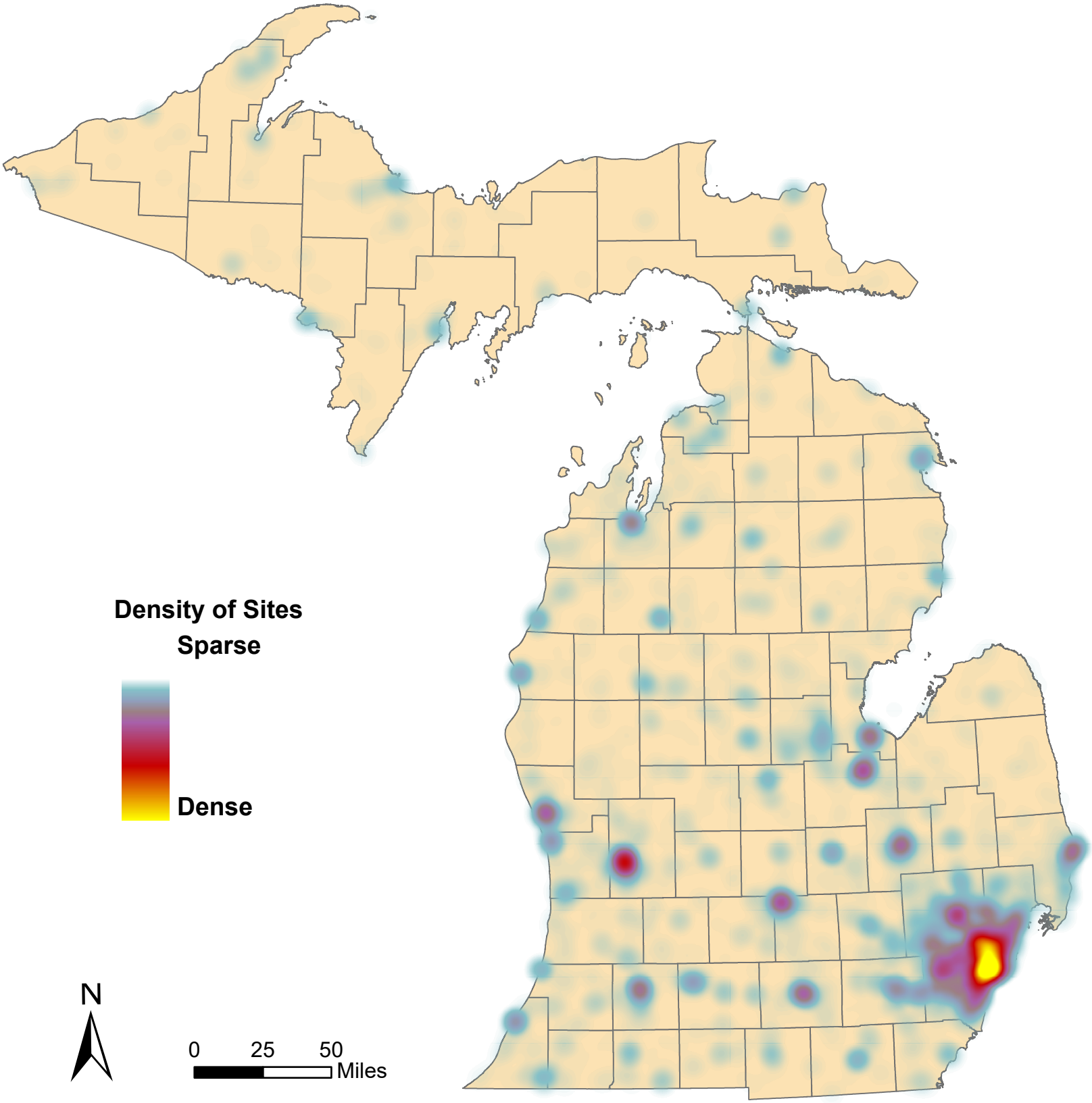
State of Michigan



Sources: Environmental Mapper,
SOM GIS Open Data, US Census Bureau
Projection/Datum: Hotine Oblique Mercator / NAD 83
Map Layout: Morgan Beeler, March 2020

Heat Map: Part 201 Sites of Environmental Contamination

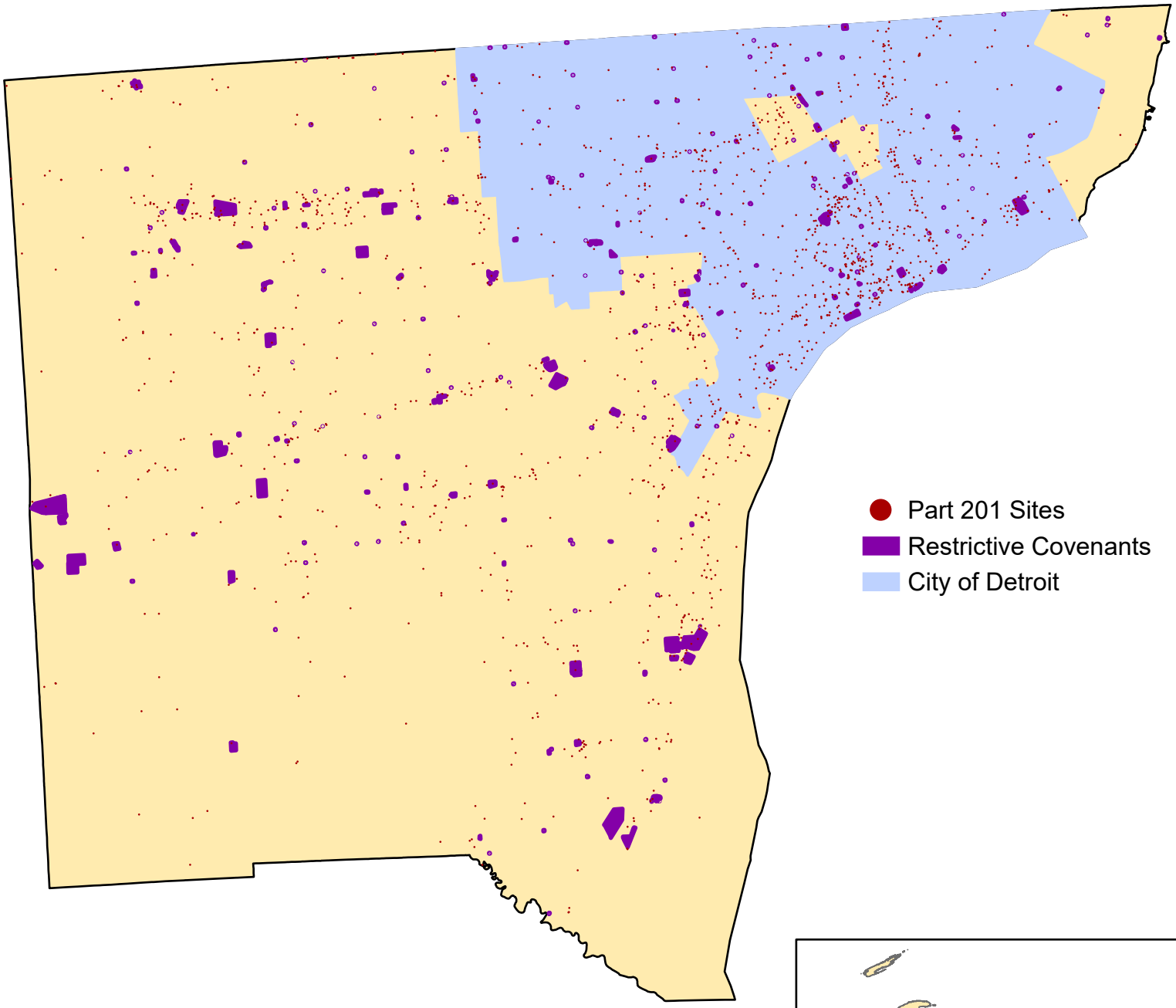
State of Michigan

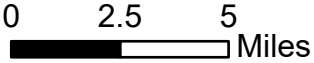


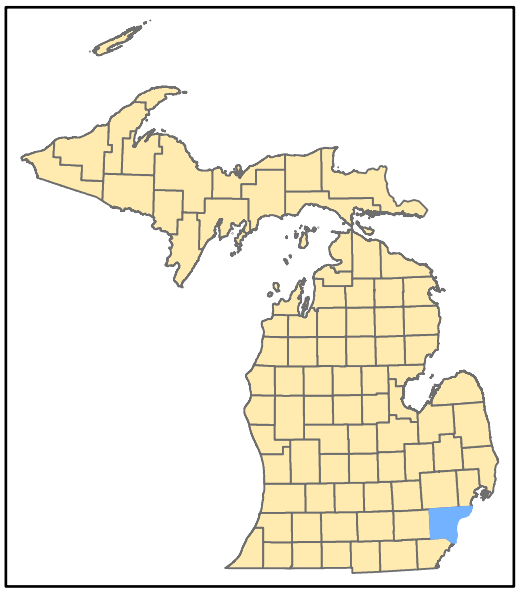
Sources: Environmental Mapper,
SOM GIS Open Data, US Census Bureau
Projection/Datum: Hotine Oblique Mercator / NAD 83
Map Layout: Morgan Beeler, March 2020

Part 201 Sites of Environmental Contamination and Restrictive Covenants

Wayne County, Michigan



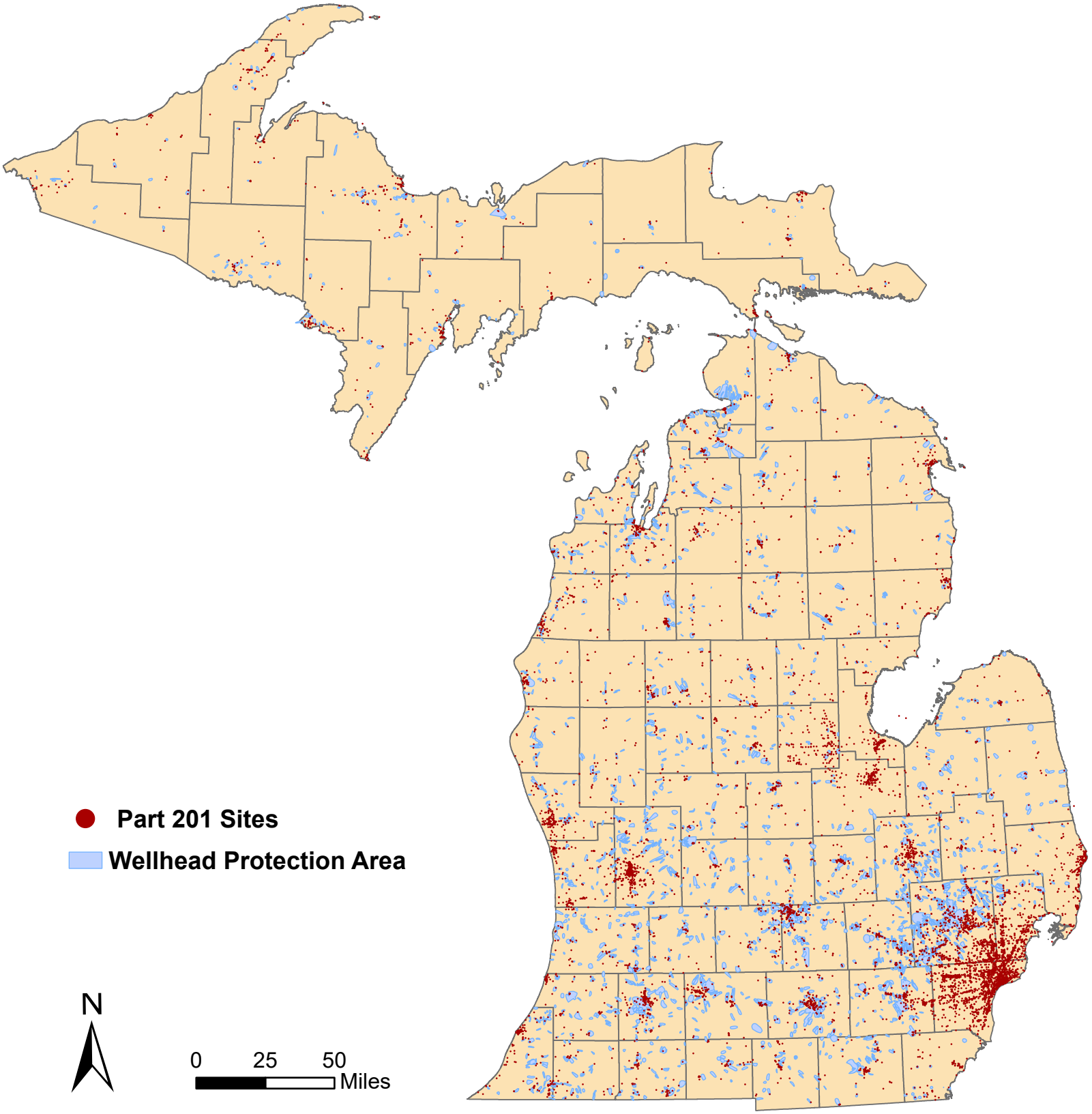




Sources: Environmental Mapper,
SOM GIS Open Data, US Census Bureau
Projection/Datum: Hotine Oblique Mercator / NAD 83
Map Layout: Morgan Beeler, March 2020

Part 201 Sites of Environmental Contamination and Wellhead Protection Areas

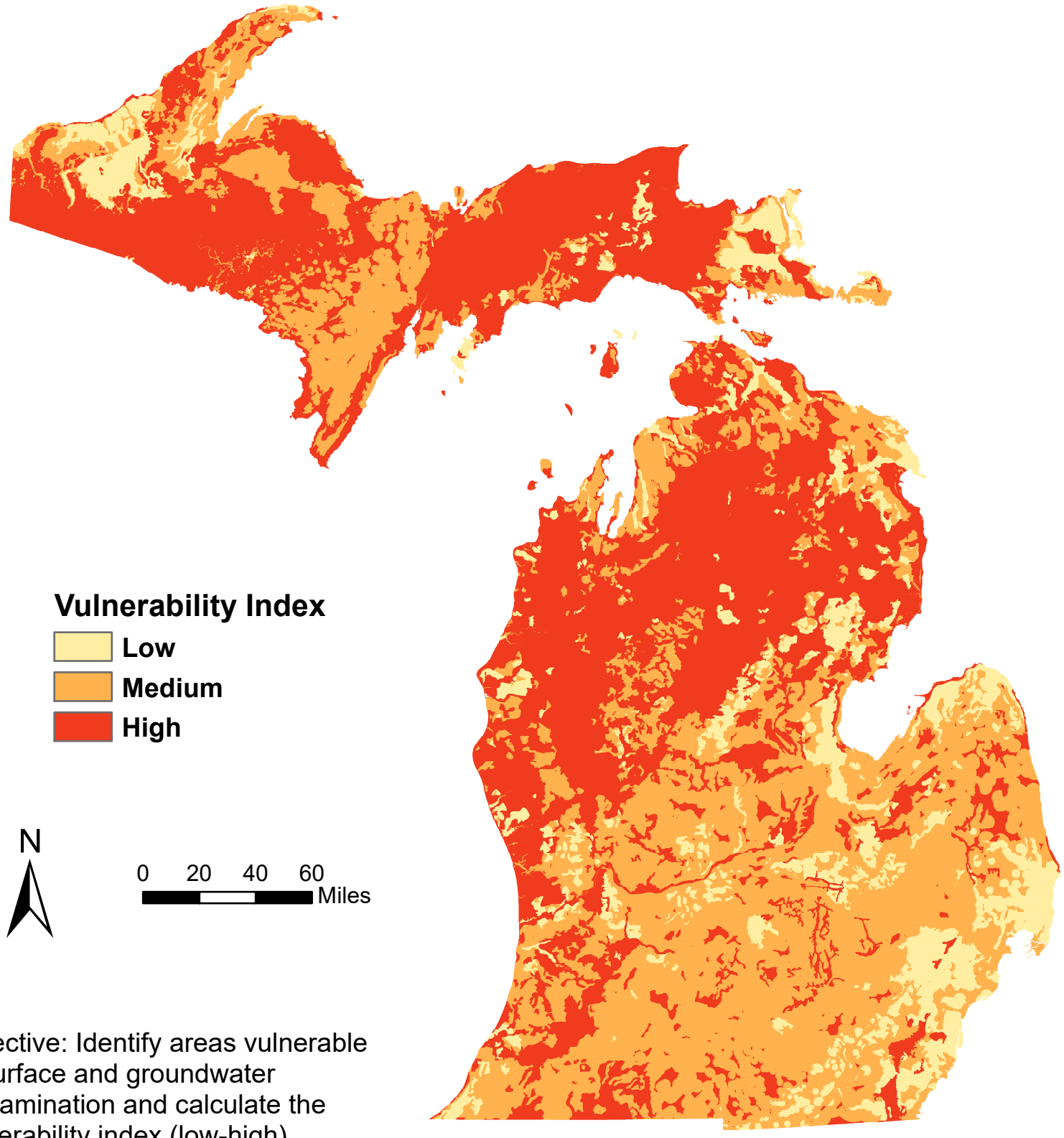
State of Michigan



Sources: Environmental Mapper,
SOM GIS Open Data, US Census Bureau
Projection/Datum: Hotine Oblique Mercator / NAD 83
Map Layout: Morgan Beeler, March 2020

Vulnerability Analysis: Surface and Groundwater Contamination

State of Michigan



Objective: Identify areas vulnerable to surface and groundwater contamination and calculate the vulnerability index (low-high).

Criteria/Weight:
- Hyrdologic Soil Group (0.4)
- Elevation (0.2)
- Proximity to Water Body Feature (0.4)

Data Sources: USDA Soil Survey, STRM DEM, SOM GIS Open Data
Projection/Datum: Hotine Oblique Mercator / NAD 83
Map Layout: Morgan Beeler, March 2020

Appendix F.

Suggested Groundwater Model Documentation Report Format

EGLE Recommended Format for Model Documentation Report

- Problem Statement and Model Application Goals - Provide a brief description of the problem(s) to be addressed and the purpose and goal of the model application.
- Hydrogeologic Characterization - Provide a detailed description, in text, tables and figures, of the hydrogeologic framework, hydrologic boundaries, hydraulic properties, hydraulic-head distribution and hydraulic stresses of the modeled area. Processes for determining hydraulic properties should be described in detail.
- Contaminant Characterization - Provide a detailed description, in text, tables and figures, of the nature (identified chemicals and media-type that are impacted) and horizontal and vertical extent of contaminants in the modeled area.
- Identification of Migration Pathways - Describe the migration of the chemicals of concern from the source area to the downgradient delineated extent of contamination. Also describe possible migration pathways beyond the extent of contamination.
- Describe the Fate-and-transport Processes – Describe, in detail, the attenuation processes that impact contaminant concentrations.
- Identify Impacted or Potentially-Impacted Receptors – All impacted receptors, or those that have the potential to be impacted, need to be identified.
- Model Conceptualization - Provide a description of the representation of hydrogeologic and/or geochemical and contaminant conditions in the facility model. Identify the source of all the input used in the modeling, whether derived from published sources or measured or calculated from field or laboratory testing. Discuss the processes by which the calculated input parameters were generated.
- Modeling Software Selection - Identify the model selected [type (e.g. analytical fate-and-transport) and software (e.g. BIOSCREEN)], its version number, and describe its applicability and limitations as they relate to the problem to be simulated. The model should be capable of simulating the hydraulic, geochemical and contaminant conditions at the facility.
- Model Calibration - Describe the process by which model input parameters were selected to achieve a match between model-simulated conditions and field conditions and describe, in text tables and figures, the degree to which modeled conditions match actual field conditions.
- History matching (model verification) – If appropriate, perform additional simulations using the calibrated model to ensure that it is capable of reproducing a different set of historical facility conditions. Discuss the results of these simulations.
- Sensitivity or Uncertainty Analysis - Report in text, tables and figures the results of a model sensitivity analysis that varies all appropriate model input parameters over a realistic range that reflects the uncertainty in the value of that parameter