A New Approach to Managing Water in the State of Michigan:

Assessing the Feasibility of Integrated Watershed Commissions

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I. EXECUTIVE SUMMARY

Historically, water management has been approached as a localized issue in Michigan. As a result, the state's current water management system is a fragmented arrangement of agencies and organizations, most of which are organized according to political, as opposed to watershed, boundaries. Michigan lacks a statewide mechanism to coordinate management structures at the watershed level, which inhibits strategies to achieve desired outcomes for all users of shared water resources, and potentially results in redundant services and fiscal inefficiencies. Given the economic, cultural, and social importance of Michigan's water resources, it is important that water is managed in a more coordinated and strategic manner.

We propose **Integrated Watershed Commissions** (IWCs) as vehicles to coordinate water resource management and decision-making at the watershed level. We develop two alternate visions for IWCs: 1) a "constrained" strategy to coordinate decision-making and management while operating, for the most part, within the state's *existing* governance structures; and 2) a "blue sky" approach representing our idealized recommendations for an alternative water management system in Michigan, unconstrained from present political and management limitations. Our findings include state policy recommendations to enable IWC-led watershed management and financing strategies; we also propose five steps for reform, short of IWCs, aimed at improving watershed-based coordination and collaboration in Michigan.

A CONSTRAINED VISION FOR INTEGRATED WATERSHED COMMISSIONS

Our constrained proposal for IWCs calls for 15 watershed-based management commissions statewide. Organized through a committee structure, IWCs would: 1) identify and clarify desired resource conditions; 2) coordinate planning and implementation activities; 3) facilitate science-based decision-making; 4) serve as fiduciaries for watershed funding/financing programs; and 5) host public discussion forums for decisions that impact water resources. County drain commissioners and representatives from affected county commissions and intergovernmental planning agencies would be automatic members; municipal and tribal governments could opt in as equal partners. All agreed-upon management strategies would be implemented through coordination among IWC members.

A BLUE SKY VISION FOR INTEGRATED WATERSHED COMMISSIONS

Organized around six regional consolidations of Michigan's major watershed boundaries, "blue sky" IWCs would have comprehensive responsibilities essential to the coordinated management of water quantity and quality in all surface and groundwater systems statewide. Each IWC would be overseen by an independent, five-member citizen governing board; an executive director would oversee operations of each IWC. Strategies to achieve broad objectives in regional-scale watershed plans would be implemented by IWC personnel, and through coordination with state and local governments.

BENEFITS OF INTEGRATED WATERSHED COMMISSIONS

IWCs would plan water use and manage resources in a more coordinated fashion than Michigan's current system. IWCs could generate a range of benefits, including: economic gains associated with improved ecological conditions (e.g., increased property values, increased revenues from recreation and tourism); economic efficiencies because of improved management strategies (e.g., science-based decision-making to avoid or minimize costly future impairments and litigation); improved coordination among units of government; and providing a valuable baseline of Michigan's water resources that can guide management decisions over time.

II. INTRODUCTION

BACKGROUND

Water is one of the most valuable resources in Michigan. This is reflected in recent federal and state legislation (e.g., Great Lakes Compact, MI Water Withdrawal Assessment Tool), litigation over bottled water plants, the Flint water crisis, debates over water use in the hydraulic fracturing process, and the recent attention paid to water by Michigan's Office of the Great Lakes, the University Research Corridor (URC), the state's philanthropic foundations, among others, to highlight this resource as an economic driver.

Challenges managing Michigan's water resources are on the rise as a function of emerging microconstituents (e.g., pharmaceutical products, microplastics); harmful algal blooms; increased urbanization and stormwater runoff; intensified agricultural practices; and failing or insufficient infrastructure, which results in both inefficient water usage and an increased risk of waterborne diseases. These challenges and others are multifaceted, and their human and ecological impacts are often not well understood.

These complex challenges unfold across political boundaries, often involving issues that affect multiple entities. Hence achieving desired conditions for water resources involves coordinating management strategies across governmental and nongovernmental stakeholders in the landscape. Although the watershed has been recognized as the practical management unit for organizing such strategies, Michigan currently lacks a statewide system for integrating management at the watershed level.

INTEGRATED WATERSHED MANAGEMENT

A watershed, also called a drainage basin or catchment, is an area of land within which surface waters (streams, lakes, wetlands, reservoirs) and shallow ground waters drain to a common outlet, such as the mouth of a river or bay. Integrated watershed management is a process of organizing people to manage and develop water resources in a sustainable and balanced way in a defined watershed area; it accounts for various social, environmental, and economic interests. This integrated approach emphasizes strategies for achieving desired resource outcomes for all users through upstream-downstream coordination within watershed boundaries, as opposed to political boundaries. Integrated watershed management recognizes that stakeholders have identifiable interests that must be reconciled within the limits of watershed resources, so that the needs of all water users can be met for future generations.

INTEGRATED WATERSHED COMMISSIONS

Integrated Watershed Commissions would coordinate management at watershed scales so that desired conditions can be achieved for all users of Michigan's water resources. This report develops and evaluates two visions for IWCs: 1) a "constrained" strategy to coordinate decision-making and management on a watershed basis while operating, for the most part, within the state's *existing* governance structures; and 2) a "blue sky" approach representing our idealized recommendations for an alternative water management system in Michigan, unconstrained from present political and management limitations.

IWCs would account for water use and manage resources in a more coordinated fashion than Michigan's current system, which could produce a range of benefits, including: economic gains associated with improved ecological conditions (e.g., increased property values, increased revenues from recreation and

tourism); economic efficiencies because of improved management strategies (e.g., science-based decision-making to avoid or minimize costly future impairments and litigation); improved coordination among disparate units of government; and development of a baseline of Michigan's water resources that can guide management decisions.

III. METHODS

We (the authors of this report, DK and AS) collected input for the Integrated Watershed Commission project from October 2015 to January 2017 through three strategies: 1) creating and collaborating with a project team of Michigan's water-related thought leaders and decision makers; 2) analyzing Michigan's current water governance system; and 3) exploring alternative water governance models.

PROJECT TEAM COLLABORATION

A cross-sectoral project team with more than 70 members provided guidance and feedback throughout our research process, from October 2015 to December 2016. Participants included leaders from state and local government (including drain commissioners), intergovernmental planning agencies, nonprofit organizations, industry/user groups, and Michigan's research community.

Project team members convened at GVSU's Downtown Grand Rapids campus for two larger events and one smaller review session[1]. Participants in these events provided input about challenges in Michigan's current water management system[2], generated proposals for improving water management, and provided feedback on preliminary findings and recommendations. Additionally, we met either in person or via phone with project team members and other experts, resulting in more than 40 additional individual and small group discussions on targeted topics.

Project team members were consulted only to gather information, and their participation in IWC-focused events or discussions should not be interpreted as their support for recommendations in this report. Policy experts from the Michigan Department of Environmental Quality, the Michigan Department of Agriculture and Rural Development, the Association of County Drain Commissioners, and The Nature Conservancy conducted final reviews of this report.

ANALYZING MICHIGAN'S CURRENT WATER MANAGEMENT SYSTEM

We analyzed both governmental and nongovernmental roles at all levels (e.g., federal, state, county, municipal, watershed) in Michigan's current water governance system to assess policy implications of IWCs. Information was gathered mainly through input from project team members and other water management professionals. We reviewed Michigan's statutory framework for water governance (e.g., Michigan Drain Code, watershed management enabling legislation) to inform decisions about potential structures and functions of IWCs.

EXPLORING ALTERNATIVE MODELS

We gained insights into designing a watershed-based management system for Michigan by exploring model approaches used in other U.S. states and abroad. Watershed management strategies used in five states[3], representing a range of approaches used across the U.S., were analyzed for relative strengths, weaknesses, and suitability to Michigan's needs. Information on alternative models was collected mainly through literature reviews; we interviewed representatives from Florida and Minnesota with firsthand knowledge of management systems in those states.

[1] Reports from these events are included in Appendix A and D.

[2] See Appendix B for details about Michigan's major water management challenges.

[3] See Appendix C for details about watershed management strategies used in five U.S. states.

IV. A CONSTRAINED VISION FOR INTEGRATED WATERSHED COMMISSIONS IN MICHIGAN

This *constrained* vision for Integrated Watershed Commissions is a strategy for enhancing the management of Michigan's water resources through watershed-based coordination while operating primarily within the state's *existing* governance and decision-making structure. This constrained approach to IWCs provides a mechanism for better integrated water management statewide without major policy or structural overhauls, as opposed to an unconstrained approach (see next section), which we refer to as our blue sky vision.

This version of IWCs provides a strategy for change that might be viable in today's political climate, and identifies a starting point for statewide integrated watershed management in Michigan that may mature over time. Below we provide a summary of the state's current water management system, describe our proposal for a new water management system, and highlight new roles and responsibilities for IWCs that would differ from the current system. We also discuss the implications this approach may have for state policy.

CURRENT WATER MANAGEMENT SYSTEM

Management by watershed is regarded by many as the optimal model water management system (GWP 2009, Stein et al. 2013, OECD 2015); however, Michigan currently has no statewide watershed management system. The state's current approach is a complex, often uncoordinated patchwork of agencies and organizations, most of which are arranged according to political jurisdictions that are unaligned with natural watershed boundaries. Michigan has a long history of managing water resources at the local level, and local management capacity varies statewide.

Michigan's county drain commissioner system is unique among U.S. states. Drain commissioners, some of whom are also called "water resources commissioners" and "public works commissioners"[4], are public officials who manage primarily water quantity issues (e.g., flood control, stormwater) in waterways that are designated county drains. Drain commissioners create drainage districts according to needs for drainage projects, and assess property owners and local governments for the costs incurred in maintaining and improving drains. Drain commissioners oversee extensive infrastructure statewide in county drains that vary in type, including agricultural ditches, natural streams, gray infrastructure, and other forms.

Drain commissioners can manage water resources only within the limitations of the Michigan Drain Code (PA 40 of 1956), and within the boundaries of the county in which they serve. Drainage districts that span more than one county are overseen by an intercounty drain board, composed of drain commissioners from affected counties plus a representative from the Michigan Department of Agriculture and Rural Development (MDARD). Several larger cities in Michigan are authorized to function independently of the county drain commissioner, and manage and finance their drainage needs independently.

[4] "Water resources commissioner" and "drain commissioner" are synonymous titles, while "public works commissioners" are additionally responsible for drinking water and sanitary systems in their county.

At the state level, the Michigan Department of Environmental Quality (MDEQ) is the agency primarily responsible for a range of water management areas, including all of Michigan's water quality regulatory programs[5]. Key MDEQ responsibilities include: implementing federal Clean Water Act and Safe Drinking Water Act requirements; wetlands management; overseeing large quantity water withdrawals; and administering Great Lakes protection and restoration programs. Also at the state level, the Michigan Department of Natural Resources (MDNR) manages fisheries and state-owned public land, among other functions. And as previously mentioned, MDARD oversees and participates in the intercounty drains. At local levels, municipal governments manage water resources through decisions about community master planning, economic development, and land use planning; local governments frequently own and operate drinking water, stormwater, and sanitary systems.

Historically, water use and impacts have been viewed as localized issues in Michigan. As a result, the state's current water management system is disjointed, which inhibits developing and implementing watershed-level strategies aimed at achieving desired outcomes for all users of shared waters. Water quantity and water quality topics are not addressed together in a systematic fashion, and hydrologically connected surface and groundwater resources are often not managed together conjunctively. Although Michigan has a wealth of nonprofit organizations that coordinate watershed stakeholders, all watershed collaboration is voluntary, incentives to participate can be insufficient, and watershed organizations have limited institutional capacity. Hence integrated watershed management strategies are implemented sporadically, and decisions about water resources are often made in geographic and administrative isolation[6].

PROPOSED WATER MANAGEMENT SYSTEM (CONSTRAINED)

Integrated Watershed Commissions would provide a statewide mechanism for managing Michigan's water resources in a coordinated and holistic fashion according to watershed, as opposed to political, boundaries. In this constrained vision, IWCs would be public entities composed of existing local and regional water management structures organized at a regional watershed scale. The IWC approach to watershed management would involve ongoing processes of information sharing, collaborative decision making, and coordinated project implementation.

IWCs could generate management efficiencies, promote cost savings and other economic benefits over both the short and long term, and provide a systematic approach to achieving desired outcomes for Michigan's water resources. To produce these benefits without major policy or management overhauls, we propose that IWCs have the following roles:

1. **Organizing watershed stakeholders to identify and clarify desired outcomes for water resources.** IWCs would assemble water managers and engage stakeholders, including the public, to identify water uses and interests so that desired watershed conditions can be achieved.
2. **Planning and implementing integrated management strategies at a regional watershed scale.** IWCs would lead planning and joint implementation activities at a meaningful ecological scale. This role would promote efficient strategies to achieve desired resource outcomes by coordinating decisions and leveraging resources on a watershed basis.
3. **Enhancing scientific/technical management capacity, including coordinated monitoring programs, to facilitate science-based decision-making.** IWCs would coordinate or directly

[5] See http://www.michigan.gov/deq for details on MDEQ's water management roles and responsibilities.
[6] Michigan's water management challenges are described in greater detail in our IWC Challenge Framework document, Appendix B.

oversee water quality and quantity monitoring programs for all surface and groundwater systems within their boundaries. IWCs would also ensure that all water managers have access to critical resources, such as geospatial technology and licensed engineers, to guide decision-making.

4. **Serving as a fiduciary for watershed-scale financing strategies.** IWCs would promote cost efficiencies through an integrated watershed financing approach that would include performance-based financing programs organized at watershed scales, and coordinating/combining funding for interrelated resource issues.
5. **Hosting public discussion forums.** IWCs would promote democratic participation and transparent decision-making by hosting public deliberation sessions in which representatives from government agencies and communities would be required to bring forward any pending permits, development plans, or regulatory actions of consequence in the watershed.

PROPOSED BOUNDARIES

We propose an arrangement of 15 IWCs organized as regional consolidations of Michigan's 8-digit Hydrologic Unit Code (HUC-8) watershed boundaries (Fig. IV.1). IWCs would encompass entire surface and hydrologically connected groundwater systems, from headwaters to Great Lakes receiving waters, which would enable the outcome-based governance of complete water systems. These proposed boundaries could be adjusted, if necessary, to address human-made drainage structures that might counteract natural hydrology, or other considerations. Although IWCs include land area only within the State of Michigan, IWCs ideally would coordinate with bordering states (i.e., OH, IN, and WI) on strategies to co-manage interstate watersheds.

We considered several alternative scales for IWCs, and concluded that under the state's current political and management structure, an arrangement of 15 IWCs was optimal for coordinating across entire water systems. This scale is large enough to promote management efficiencies through regional coordination but is small enough that strategies could be organized across multiple, or even all, IWCs with relative ease. Additionally, this proposed regional scale would not preclude IWC members from organizing management strategies at smaller watershed scales within IWCs. We explored organizing IWCs at the major watershed (HUC-8) scale, but this approach yields 59 IWCs statewide, which would inhibit administrative efficiency and cross-IWC coordination.

There are clear differences in land use/land cover among the IWCs, with a greater percentage of undeveloped land in the northern-most regions, and more agriculture and urban development in the southern-most IWCs (Fig. IV.2, Table IV.1). Information on the alternate (but rejected) arrangement of 59 IWCs organized at the HUC-8 watershed scale is in Appendix E.

MEMBERSHIP STRUCTURE

IWCs would be formed of current regional, county, and municipal water managers (Table IV.2) within proposed IWC boundaries. Drain commissioners, county commission representatives, and intergovernmental planning agency representatives would be automatic members. Additional local, regional, and tribal government representatives would be invited to join as equal members. Under this approach, IWCs would blanket entire watersheds with management structures that are both locally-based and consistent statewide. IWCs would be adaptive to local needs through the inclusion of management compositions particular to each of Michigan's watersheds. State agencies would agree to coordinate with IWCs to facilitate watershed management strategies consistent with state laws and

programs, but IWCs themselves would be composed only of local, county, and regional management structures.

Figure IV.1. Proposed boundaries for IWCs (constrained).

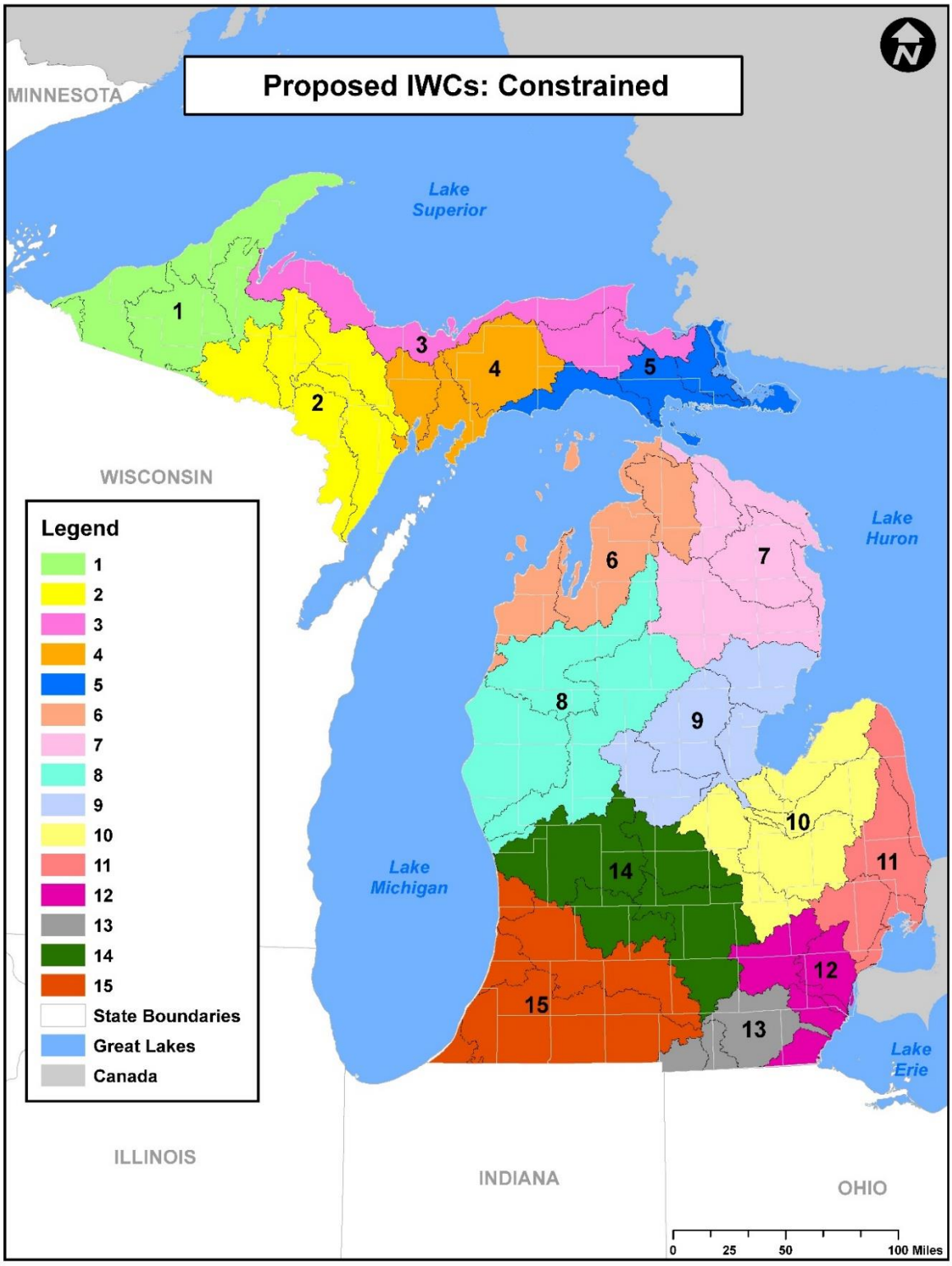


Figure IV.2. Land cover in proposed IWCs (constrained).

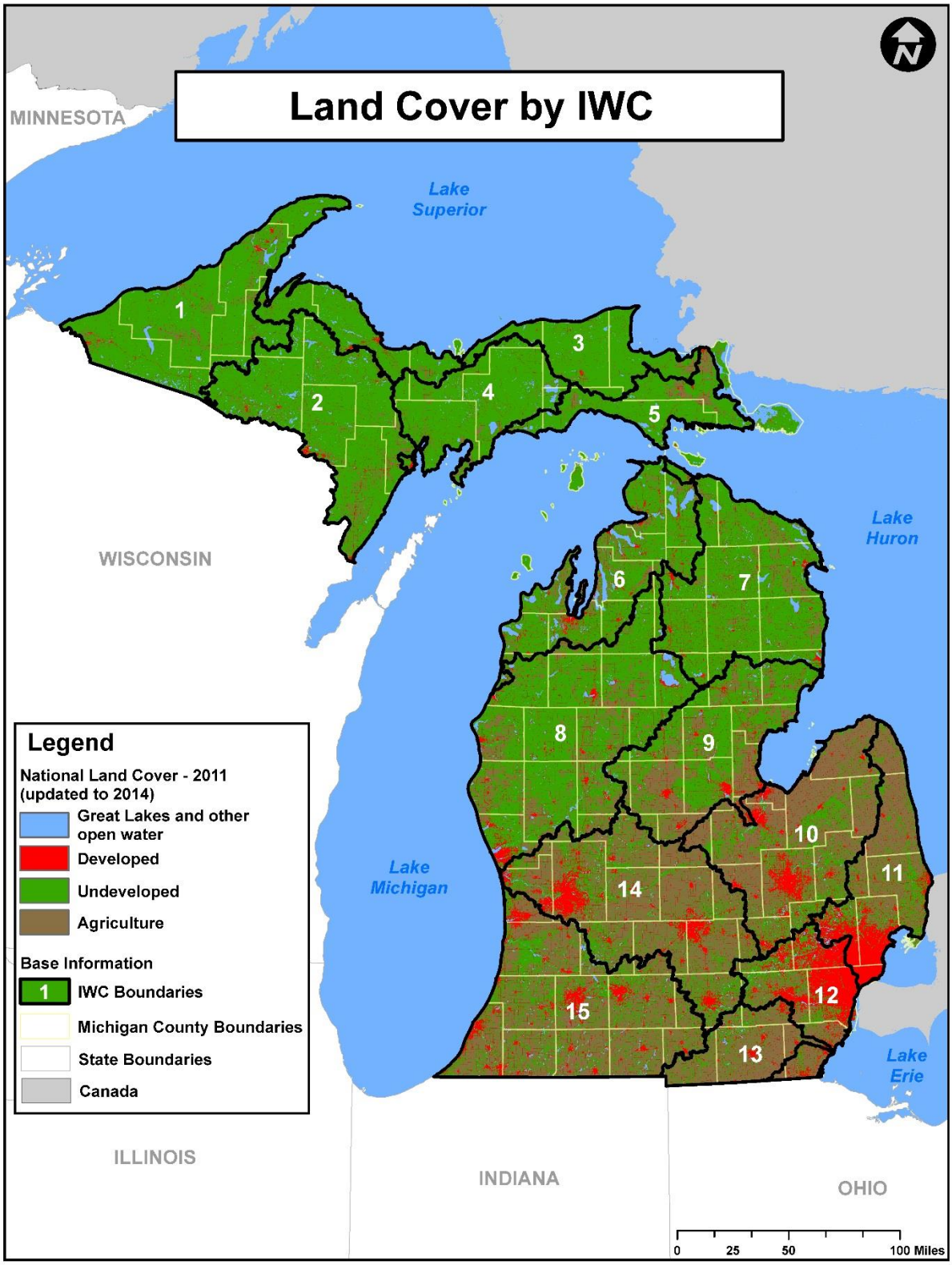


Table IV.1. Proposed IWCs, affected watersheds, land area, counties, and land cover. Counties in bold font each account for at least 5% of IWC total area. Land cover figures do not include open water. Sources: NHDPlus (2016); National Land Cover Database 2011, updated 2014 (Homer et al. 2015).

IWC #	Watersheds	Total Area (km^2)	Counties	Area by County (km^2)	County Area as % of IWC	IWC Land Cover		
						Type	Area (km^2)	% of IWC
1	Bad-Montreal Black-Presque Isle Flambeau Keweenaw Peninsula Ontonagon Sturgeon Upper Wisconsin	11067.67	**Baraga** **Gogebic** **Houghton** Iron **Keweenaw** **Ontonagon**	860.61 2932.36 2687.31 266.71 881.78 3438.90	7.78% 26.49% 24.28% 2.41% 7.97% 31.07%	Agriculture Developed Undeveloped	346.28 328.76 10094.49	3.13% 2.97% 91.21%
2	Brule Cedar-Ford Escanaba Menominee Michigamme	11607.71	Baraga **Delta** **Dickinson** Gogebic **Iron** **Marquette** **Menominee**	575.73 717.35 2010.19 32.33 2869.44 2680.50 2722.17	4.96% 6.18% 17.32% 0.28% 24.72% 23.09% 23.45%	Agriculture Developed Undeveloped	519.05 473.28 10332.56	4.47% 4.08% 89.01%
3	Betsy-Chocolay Dead-Kelsey Tahquamenon Waiska	8285.46	**Alger** **Baraga** **Chippewa** Houghton **Luce** Mackinac **Marquette** Schoolcraft	1303.30 937.84 1758.08 9.09 2155.27 178.12 1943.27 0.50	15.73% 11.32% 21.22% 0.11% 26.01% 2.15% 23.45% 0.01%	Agriculture Developed Undeveloped	137.60 302.78 7690.51	1.66% 3.65% 92.82%
4	Fishdam-Sturgeon Manistique Tacoosh-Whitefish	6971.24	**Alger** **Delta** Luce Mackinac Marquette **Schoolcraft**	1065.32 2319.26 225.35 226.56 215.96 2918.79	15.28% 33.27% 3.23% 3.25% 3.10% 41.87%	Agriculture Developed Undeveloped	172.01 251.24 6351.87	2.47% 3.60% 91.12%
5	Brevoort-Millecoquins Carp-Pine St. Marys	4263.56	**Chippewa** Luce **Mackinac** **Schoolcraft**	1794.01 18.05 2208.69 242.82	42.08% 0.42% 51.80% 5.70%	Agriculture Developed Undeveloped	370.86 195.66 3620.96	8.70% 4.59% 84.93%
6	Betsie-Platte Boardman-Charlevoix Cheboygan	8690.89	**Antrim** **Benzie** **Charlevoix** **Cheboygan** **Emmet** **Grand Traverse** **Kalkaska** **Leelanau** Manistee **Otsego**	1236.19 893.25 981.50 1157.82 1246.37 1028.46 550.14 875.30 200.18 521.68	14.22% 10.28% 11.29% 13.32% 14.34% 11.83% 6.33% 10.07% 2.30% 6.00%	Agriculture Developed Undeveloped	1092.43 734.86 6209.43	12.57% 8.46% 71.45%
7	Au Sable Black Lone Lake-Ocqueoc	12229.95	**Alcona** **Alpena** **Cheboygan**	1798.54 1535.41 902.74	14.71% 12.55% 7.38%	Agriculture Developed Undeveloped	759.76 881.39 10243.06	6.21% 7.21% 83.75%

	Thunder Bay		**Crawford** Emmet Iosco Kalkaska **Montmorency** Ogemaw **Oscoda** **Otsego** **Presque Isle** Roscommon	1289.42 1.40 417.29 22.26 1456.62 390.00 1479.34 753.96 1772.35 410.62	10.54% 0.01% 3.41% 0.18% 11.91% 3.19% 12.10% 6.16% 14.49% 3.36%			
8	Manistee Muskegon Pere Marquette-White	17494.44	Antrim Benzie Clare Crawford Grand Traverse **Kalkaska** **Lake** **Manistee** **Mason** **Mecosta** **Missaukee** Montcalm **Muskegon** **Newaygo** **Oceana** **Osceola** Otsego Ottawa **Roscommon** **Wexford**	122.49 6.44 649.95 168.63 239.53 904.24 1486.33 1243.14 1320.19 1080.25 1485.18 348.25 1063.02 2055.41 1413.67 1409.25 86.43 7.19 915.74 1489.14	0.70% 0.04% 3.72% 0.96% 1.37% 5.17% 8.50% 7.11% 7.55% 6.17% 8.49% 1.99% 6.08% 11.75% 8.08% 8.06% 0.49% 0.04% 5.23% 8.51%	Agriculture Developed Undeveloped	2804.91 1353.51 12872.66	16.03% 7.74% 73.58%
9	Au Gres-Rifle Kawkawlin-Pine Pine Tittabawassee	10309.91	**Arenac** **Bay** **Clare** **Gladwin** **Gratiot** **Iosco** **Isabella** Mecosta **Midland** Montcalm **Ogemaw** Osceola Oscoda Roscommon Saginaw	951.22 831.11 839.15 1335.36 528.17 1048.93 1494.85 340.60 1280.35 189.98 1098.25 73.57 0.19 174.84 123.38	9.23% 8.06% 8.14% 12.95% 5.12% 10.17% 14.50% 3.30% 12.42% 1.84% 10.65% 0.71% 0.00% 1.70% 1.20%	Agriculture Developed Undeveloped	3222.17 957.71 5982.98	31.25% 9.29% 58.03%
10	Cass Flint Pigeon-Wiscoggin Saginaw Shiawassee	12053.09	Bay Clinton **Genesee** Gratiot **Huron** **Lapeer** **Livingston** Midland Oakland **Saginaw** **Sanilac** **Shiawassee** **Tuscola**	330.51 0.07 1681.33 399.48 1476.77 1263.38 639.08 86.33 439.95 1988.48 846.96 793.42 2107.33	2.74% 0.00% 13.95% 3.31% 12.25% 10.48% 5.30% 0.72% 3.65% 16.50% 7.03% 6.58% 17.48%	Agriculture Developed Undeveloped	7038.27 1637.08 3248.78	58.39% 13.58% 26.95%

11	Birch-Willow Clinton Lake St. Clair St. Clair	7082.20	**Huron** **Lapeer** **Macomb** **Oakland** **Sanilac** **St. Clair** Wayne	687.52 452.56 1251.64 965.43 1649.38 1827.88 247.79	9.71% 6.39% 17.67% 13.63% 23.29% 25.81% 3.50%	Agriculture Developed Undeveloped	3312.16 1943.68 1757.11	46.77% 27.44% 24.81%
12	Detroit Huron Ottawa-Stony	5318.98	Ingham Jackson Lenawee **Livingston** **Monroe** **Oakland** **Washtenaw** **Wayne**	45.20 9.24 73.83 547.99 1071.60 942.77 1307.29 1321.08	0.85% 0.17% 1.39% 10.30% 20.15% 17.72% 24.58% 24.84%	Agriculture Developed Undeveloped	1476.01 2333.46 1385.61	27.75% 43.87% 26.05%
13	Raisin St. Joseph-Maumee Tiffin	3903.52	Branch **Hillsdale** **Jackson** **Lenawee** **Monroe** **Washtenaw**	7.28 905.15 195.30 1896.65 363.29 535.85	0.19% 23.19% 5.00% 48.59% 9.31% 13.73%	Agriculture Developed Undeveloped	2584.86 397.22 863.37	66.22% 10.18% 22.12%
14	Lower Grand Maple Thornapple Upper Grand	14432.48	Allegan **Barry** Calhoun **Clinton** **Eaton** Gratiot Hillsdale **Ingham** **Ionia** Isabella **Jackson** **Kent** Livingston Mecosta **Montcalm** Muskegon Newaygo **Ottawa** Shiawassee Washtenaw	14.56 1022.38 5.34 1486.86 1159.15 551.65 28.95 1405.89 1501.14 0.19 1265.50 2227.21 328.12 57.44 1327.24 302.51 174.89 940.41 606.56 26.50	0.10% 7.08% 0.04% 10.30% 8.03% 3.82% 0.20% 9.74% 10.40% 0.00% 8.77% 15.43% 2.27% 0.40% 9.20% 2.10% 1.21% 6.52% 4.20% 0.18%	Agriculture Developed Undeveloped	7714.07 2135.98 4360.43	53.45% 14.80% 30.21%
15	Black-Macatawa Kalamazoo Little Calumet-Galien St. Joseph	15048.69	**Allegan** Barry **Berrien** **Branch** **Calhoun** **Cass** Eaton Hillsdale Jackson **Kalamazoo** Kent Ottawa **St. Joseph** **Van Buren**	2166.40 471.10 1484.44 1337.85 1853.80 1316.15 340.41 636.86 402.32 1502.11 29.54 545.61 1348.76 1613.35	14.40% 3.13% 9.86% 8.89% 12.32% 8.75% 2.26% 4.23% 2.67% 9.98% 0.20% 3.63% 8.96% 10.72%	Agriculture Developed Undeveloped	7870.6 1895.11 4957.94	52.30% 12.59% 32.95%

Table IV.2. IWC proposed membership composition.

	IWC Membership
Drain commissioners from counties with ≥ 5% IWC land area	**Automatic**
One county commission representative from each county with ≥ 5% IWC land area	**Automatic**
One representative from each intergovernmental planning agency serving counties with ≥ 5% IWC land area	**Automatic**
Drain commissioners, county commissioners, and intergovernmental planners serving counties with < 5% IWC land area (with exceptions)	Opt in
One local government representative	Opt in
One tribal government representative	Opt in
One official from local or regional public agencies/organizations not represented by the above structures	Opt in

Drain commissioners: Drain commissioners are proposed as automatic IWC members because of their important roles in protecting and improving Michigan's water resources. Michigan's county drain commissioners oversee 35,000 miles of county drains that serve more than 17 million acres (21st Century Infrastructure Commission Report 2016), accounting for nearly one fifth of the state's land area. The total value of infrastructure in intercounty drainage projects alone, meaning only drainage projects that cross county lines, exceeds $2 billion (Gregg 2012). Drain commissioners have extensive responsibilities in managing surface waters, and their work has major impacts on statewide public health and economic prosperity.

The Michigan Drain Code enables commissioners to implement projects and strategies for a range of water management topics. However, management approaches vary by county, commissioners vary in their backgrounds and expertise, commissioners describe the intercounty procedures governed by the Drain Code as cumbersome, and commissioners lack an efficient mechanism to engage across entire watersheds with other water managers. IWCs would promote the strategic and efficient management of entire watersheds through upstream-downstream coordination among county drain commissioners, and promote coordination among drain commissioners and other managers.

Drain commissioners from counties with land amounting to at least 5% of IWC total area would be automatic IWC members, and commissioners from counties below the 5% threshold could opt in[7]. Some Michigan counties overlap more than one IWC, and these drain commissioners would participate in the corresponding IWCs. The 5% land threshold would promote administrative efficiency by limiting the number of IWCs that individual drain commissioners would be required to join, although commissioners from counties with relatively little land within IWC boundaries still would be invited to opt in. In northern counties or other areas where drain commissioner roles may be less pronounced, the county commission representative (see below) or perhaps a representative from a different county agency (e.g., road commission) may be appropriate.

[7] Counties that account for less than 5% of the IWC land area but include locations of strategic importance, such as headwaters or watershed outputs, could also be automatic members.

County commissioners: County commissions provide leadership and accountability for all public services organized at the county level; many of these services (e.g., operating drinking and wastewater systems, managing runoff from roads, regulating private wells and septic systems) impact water resources. We propose that IWCs automatically include one representative from each county board of commissioners.

This role would provide a common mechanism for county governments to coordinate services impacting water resources, which may vary in type and organizational structure by county, to support IWC-led goals and strategies. This role would also promote administrative efficiency by allowing a county commissioner to represent appropriate county departments and managers, versus extending IWC membership to each relevant department, agency, or manager. Additionally, county commissioners would represent the general public, although IWCs include mechanisms for public input and engagement through a committee structure (see pp. 17-18 below). County commission representatives would participate in IWCs based on the same 5% land area threshold described for drain commissioners.

Intergovernmental planning agencies: Intergovernmental planning agencies facilitate coordination among local governments for a range of issues relevant to water resources, and all Michigan counties and their corresponding municipal governments are served by at least one of these organizations. All of Michigan's 14 regional planning agencies are designated water quality management planning agencies by the state under the Clean Water Act[8]. Additionally, intergovernmental planning agencies often broker partnerships among local governments and nongovernmental organizations committed to Michigan's natural resources, such as watershed councils/groups.

We propose that one representative from each intergovernmental planning agency within the proposed boundaries receive automatic IWC membership. These individuals would bring capacity to evaluate and coordinate all state, county, and community level planning activities across IWCs that impact water resources. This role would allow IWCs to better coordinate current use of watershed resources, and plan for future demand according to the needs of all users, the limitations of watershed resources, and anticipated land use/land cover and climate changes. We also envision that stakeholder partnerships developed through planning agencies would carry over to IWCs. Intergovernmental planners would participate in IWCs based on the 5% land area threshold for counties they serve.

Additional members: Local governments use water resources for community and economic development purposes, and they often own and operate drinking water, stormwater, and sewer systems. One representative from each local and government within the proposed boundaries would be invited to join the IWC. Additionally, IWC membership would be offered to tribal government representatives, and any other local or regional public agency/organization that may not be represented by this proposed set of IWC members.

IWCs would be composed of representatives from all local management structures particular to each regional watershed area (see example below), ensuring that community knowledge and interests would be incorporated into IWCs. This membership strategy also provides a mechanism for efficient implementation, whereby local officials would carry out collaborative watershed management strategies through their respective authorities and responsibilities.

[8] For more information on Michigan's regional planning agencies and their involvement with water resources, see http://www.miregions.com

Table IV.3. Example of full membership structure in proposed IWC #15 (Fig. IV.1): Black-Macatawa**,** Kalamazoo**,** Little Calumet-Galien, and St. Joseph River watersheds. Automatic IWC members, totaling 21, are in bold font.

	Participation	Members
Drain commissioners	**Automatic (8)**	**Allegan, Berrien, Branch, Calhoun, Cass, Kalamazoo, St. Joseph, Van Buren**
County commission representatives	**Automatic (8)**	**Allegan, Berrien, Branch, Calhoun, Cass, Kalamazoo, St. Joseph, Van Buren**
Intergovernmental planning agency representatives	**Automatic (5)**	**Grand Valley Metropolitan Council** **Macatawa Area Coordinating Council** **Southcentral Michigan Planning Council** **Southwest Michigan Planning Commission** **West Michigan Planning Commission**
Drain commissioners, county commissioners, and intergovernmental planners serving counties with < 5% IWC land area	Opt in (15)	Barry, Eaton, Hillsdale, Jackson, Kent, and Ottawa Counties; Region II Planning Commission Tri-County Regional Planning Commission West Michigan Shoreline Regional Development Commission
Tribal government representatives	Opt in (4)	Pokagon Band of Potawatomi Indians Gun Lake Band/Match-E-Be-Nash-She-Wish Band of Pottawatomi Huron Potawatomi/Nottawaseppi Huron Band of Potawatomi Little River Band of Ottawa Indians
Local government representatives	Opt in	All municipalities in the Black-Macatawa, Kalamazoo, Little Calumet-Galien, and St. Joseph River watersheds

IMPLEMENTATION STRUCTURE

The full IWC membership structure would convene as needed for major policy and management decisions. Each IWC member would have one vote, and decisions would be made through majority rule. The full membership would also vote on decisions affecting organizational structure, such as the selection of IWC officers (see below).

Given the potentially large number of participants in the full IWC membership structure, for administrative efficiency we propose that IWC operations be organized according to five standing committees: 1) executive; 2) finance; 3) science-technical; 4) public engagement and education; and 5) a water users advisory committee. IWCs could self-organize additional committees as needed. Details about committee responsibilities would need to be established through program rules or bylaws.

Executive Committee: The Executive Committee would provide leadership and oversight for IWCs. Committee members would be responsible for strategic planning, overseeing expenditures, staff supervision, among other leadership duties. We propose a five-member Executive Committee for each IWC, composed of three officers and two additional members: (3) the Chair, Vice-Chair, and Treasurer, elected by the full IWC body for three-year terms, eligible for one renewal term; and (2) additional voting members who participate on a rotating basis for three-year terms, organized to reflect geographic and membership diversity (i.e., a mixture of regional, county, municipal, tribal representatives from across the IWC).

Finance Committee: The Finance Committee would monitor IWC expenditures and revenues, prepare budgets and financial statements, and other duties as appropriate. The IWC Treasurer would head this committee, which would include additional voting members.

Science-Technical Committee: This committee would be responsible for building IWC scientific/technical capacity to inform management decisions. Duties may include overseeing scientific monitoring and data management systems, developing and sharing decision support tools, coordinating with Michigan's research community, among other strategies to enhance science-based decision-making.

Public Engagement and Education Committee: This group would lead strategies to increase public engagement and awareness of water resources. The committee would coordinate initiatives to educate citizens about benefits of improved water management, and expand opportunities to engage citizen volunteers and participation in water stewardship activities. Activities would aim to foster long-term appreciation for scientific knowledge, and promote connections between people and water.

Water Users Advisory Committee: Participants in this committee would include IWC members and representatives from various nongovernmental stakeholders, including Michigan's business community. This purpose of this committee would be to provide input, feedback, and generate recommendations on IWC management initiatives and decisions. The Water Users Advisory Committee would be a strategy for the overarching goal to incorporate public knowledge, values, and perspectives into decisions about watershed resources.

NEW ROLES AND RESPONSIBILITIES

Michigan's current system enables strategies for intergovernmental watershed management, and there are many examples of successful watershed collaboration statewide. However, well-coordinated watershed management is sporadic. Watershed collaborations have limitations, such as: they are all-voluntary; incentives to participate can be insufficient; watershed alliances and organizations have limited authorities and capacities; and not all areas of the state have active watershed-scale initiatives. Hence strategies to identify and achieve desired outcomes for entire water systems do not occur in a systematic fashion statewide.

We propose five new roles and responsibilities for IWCs that would differ from the current system: 1) IWCs would organize watershed stakeholders on a statewide basis to identify and clarify desired outcomes for water resources; 2) IWCs would plan and implement coordinated watershed management strategies at a regional scale to achieve desired resource outcomes; 3) IWCs would enhance scientific/technical management capacity, including through coordinated monitoring programs, to facilitate science-based decision-making; 4) IWCs would serve as fiduciaries for watershed-scale financing strategies; and 5) IWCs would host public discussion forums for decisions about water resources.

BENEFITS OF INTEGRATED WATERSHED COMMISSIONS

IWCs would organize water managers to plan and implement integrated strategies aimed at achieving desired outcomes for all users of watershed resources. This role would promote efficiencies by providing a coordinating mechanism for water managers to establish baseline environmental conditions in watersheds, analyze resource stressors, develop targets for desired watershed conditions, and

implement coordinated strategies for making progress from existing conditions toward desired conditions.

Improved water management has been shown to produce a range of both short term and long term economic benefits, including increased property values; increased revenues from tourism, fishing, and recreation; reduced costs of treating drinking water; avoidance of costly future impairments; and enhanced quality of life in communities (Isely et al. 2011, EPA 2012, Austin and Steinman 2015). IWCs would use the following integrated watershed management strategies to capture these benefits *and* promote management efficiencies.

Leveraging resources: Water managers often have incomplete knowledge of resources and management initiatives currently underway in large-scale watershed areas. IWCs would coordinate municipal, county, and regional management structures to share information about monitoring programs, decision support tools, asset management strategies, private sector initiatives, and other resources (e.g., GIS) that could be coordinated to increase the likelihood of achieving desired outcomes. Leveraging management capacity to achieve watershed goals could reduce redundancies and save short term costs, while also pursuing long term goals for entire water systems in an economical fashion.

For example, water managers are often unaware of the full scope of water quality and quantity monitoring activities conducted by nearby nongovernmental organizations and other units of government. IWCs would provide a mechanism to identify, coordinate, and calibrate monitoring efforts currently underway across watersheds, and connect monitoring activities to management strategies so that outcomes can be measured. Leveraging existing monitoring activities for watershed-level goals would be a cost-effective step in developing comprehensive monitoring programs through IWCs.

Integrated planning: Michigan has many MDEQ-approved watershed management plans. However, watershed plans are often coordinated around nonpoint source pollution issues only, and rarely incorporate community and economic development plans. In addition, some areas of the state are left uncovered by watershed plans, and planning activities are often disconnected from implementation and financing strategies.

To address these limitations, IWCs could house and evaluate all existing watershed, state, and community level plans affecting water resources within their boundaries, reconciling potential differences among them and addressing any conflicting goals for shared waters. This integrated planning approach would enable water managers and communities to identify mutually beneficial strategies that would promote desired outcomes for all users; planning may also help identify and prevent future conflicts. IWCs could choose to develop new comprehensive management plans for their regional watersheds, if needed or desired.

Coordinated implementation of projects/programs: IWC members would self-determine cost-efficient strategies for promoting desired water outcomes. Participating members would then adopt implementing ordinances, rules, and management practices consistent with strategies, plans, or resource targets developed through IWC collaboration. This focus on coordinated implementation would enable water managers and communities to make predictable, efficient progress toward desired watershed conditions.

All initiatives would require unanimous support among implementing members, and no IWC member would be required to implement strategies they do not support. Projects and programs would directly

benefit only implementing members, and strategies could be implemented at various watershed scales within and across IWCs, as appropriate. Thus participating governments and agencies would preserve autonomy, but they would be obligated to implement commitments made through collaborative decision-making processes.

IWC implementation strategies would be formalized yet flexible, adapted to watershed circumstances that vary across space and time (Heathcote 2008). Example initiatives may include: coordinating upstream-downstream land use planning to address impairments and prevent future ones; administering stormwater management programs across multiple units of government; and pooling technical resources.

WATERSHED FUNDING AND FINANCING

Michigan's current approach to funding water resources is based often on localized initiatives financed by local governments and agencies, undertaken in an isolated fashion. This patchwork approach lacks a financing strategy for achieving system-level goals for shared waters. Additionally, Michigan currently has no sustainable funding stream at the state level for watershed management.

We propose that IWCs serve as fiduciaries for watershed-based financing strategies, which could result in cost savings over both the short and long term. IWCs would leverage funds for an integrated water management approach aimed at achieving system-level goals for water resources, and for coordinating/combining funding for interrelated resource issues. This role could generate short-term savings by enabling local water managers and communities to finance bundled projects/programs; in the long term we anticipate that IWCs would generate savings through improved management, avoiding the costly impair-then-repair paradigm (Dlugolecki 2012). Moreover, given that the fundamental purpose of IWCs would be to improve conditions of water resources, they would play a critical role in supporting Michigan's far-reaching Blue Economy (Austin and Steinman 2015).

Although a thorough analysis of funding mechanisms and financing strategies is beyond the scope of this study, we envision that IWCs could serve the following roles: 1) overseeing watershed-scale special assessment districts; 2) administering off-site mitigation, in lieu of fee, or other alternative financing programs; and 3) strengthening private investment in Michigan's water resources.

Watershed-based special assessment districts: The recently released West Michigan Watersheds Collaborative Sustainable Funding Study (PSC 2016) explores the feasibility of establishing and administering special assessment districts for watershed management services at a watershed rather than municipal scale. Under this strategy, property owners would be assessed fees for watershed management services proportionate to their relative contribution to water quality impairments and the benefits received from having healthy waterways. Assessing properties based on watershed contributions and benefits received would ensure fairness, and provide performance-based incentives to improve management practices on private property. Elements of this approach can be seen in the Van Buren County Smart Assessment Program (Meersman et al. 2015) and the Ann Arbor Stormwater Utility[9].

[9] For more information on the Ann Arbor Stormwater Utility, see http://www.a2gov.org/departments/systems-planning/planning-areas/water-resources/Pages/Stormwater.aspx

IWCs would be a governance structure suited to administering watershed-based property assessments. IWCs would be composed of all local and regional water management structures, enabling them to streamline a common funding source for interrelated projects and services. For example, to achieve water quality targets across entire watersheds, IWCs could use a single funding source to strategize wetland conservation and construction, maintain and improve agricultural ditches, implement green infrastructure projects, among other strategies to achieve water quality goals. This approach could be a more cost-efficient financing method for achieving desired resource conditions, compared to the current approach based on fragmented funding sources that are rarely (if ever) coordinated across entire watersheds around strategic goals.

Off-site mitigation, in lieu of fee, or other alternative financing programs: IWCs could organize watershed-scale programs involving the trading or selling of water quantity or quality credits or payments into a fund to pay for watershed restoration projects. Elements of this approach may include point-nonpoint nutrient trading programs, groundwater withdrawal and recharge programs, and other transactional tools that promote desired watershed conditions. Programs like these have been shown to produce a range of benefits, such as: improving ecosystem function across entire watersheds while reducing total spending on water management; reducing permitting costs for individual businesses and property owners; generating fiscal incentives for improved management practices; and promoting an understanding of connectedness among water users that can increase public knowledge and stewardship of water resources (PDEP 2008, Parker et al. 2009).

Strengthening private investment: Even robust public funding strategies may prove insufficient to fully finance watershed restoration and conservation efforts. IWCs would aim to increase private investment in Michigan's water resources through mechanisms such as public-private partnerships (cf. Project Clarity). IWCs would engage Michigan's business community and industry organizations (e.g., Michigan Agri-Business Association, Michigan Brewers Guild), facilitating discussion and promoting water resources as they relate to commercial uses and interests.

PUBLIC DISCUSSION FORUMS

The infusion of public values, knowledge, and perspectives into decisions about water resources is widely considered a fundamental element of effective water governance (Ostrom 1990, Trachtenberg and Focht 2005, von Korff et al. 2012). IWCs would facilitate the identification and incorporation of these values, knowledge, and perspectives into water governance by hosting discussion forums as needed to discuss any pending permits, development plans, or regulatory actions of consequence in the watershed. Representatives from all local governments, public agencies, and relevant stage agencies would attend, and participation would be open to the public.

These forums would ensure that decisions about shared water resources are made transparently, and coordinated among administrative and geographic entities. Forums would also create opportunities for gathering stakeholder input, sharing information, promoting local water resources, and facilitating discussion among all watershed stakeholders, including Michigan's business community. Properly designed and executed, these events could help build public awareness and engagement with their local water resources.

POLICY AND LEGAL IMPLICATIONS

Although this constrained vision for IWCs aims to improve water management without major legislative changes, not all elements of this approach may be aligned with current state law. Two policies in particular may require review and/or revision to enable this proposed system for watershed management: 1) Michigan's Watershed Alliance Act (PA 451 of 1994, Section 324.31201, amended 2004); and 2) Chapter 22 of the Michigan Drain Code (PA 40 of 1956, Sections 280.551-583).

WATERSHED ALLIANCE ACT

This proposed IWC governance structure is consistent with the framework described in Michigan's enabling legislation for Watershed Alliances, which allows all local governments and public agencies to opt in to a watershed-based management entity. However, the Watershed Alliance Act enables a watershed governance organization to oversee funds based only on contributions from participating municipal budgets; it prohibits Watershed Alliances from administering their own assessment programs.

The Watershed Alliance Act may prevent IWCs from serving as fiduciaries for watershed financing strategies. IWCs would likely be unable to administer performance-based assessment programs on a watershed basis, and IWCs may be prevented from overseeing credit trading and other market-based financing programs. The Watershed Alliance Act may require reform to enable IWCs to use watershed-based financing tools that could generate short and long term savings on water management.

CHAPTER 22 OF THE MICHIGAN DRAIN CODE

Chapter 22 of the Drain Code describes a process for establishing and administering water management districts, which are drainage districts organized across three or more contiguous counties. This strategy to manage drainage across large watershed areas could be consistent with our proposed IWC boundaries for scaling-up coordination among drain commissioners. However, the IWC approach to integrated watershed management may not align with all Chapter 22 language, or perhaps other Drain Code sections.

IWCs may lack authority to implement holistic water management strategies if they were organized as water management districts under current law. Chapter 22 language describes multicounty watershed projects only "for purposes of flood control or drainage" (Section 280.552). This limitation may conflict with our proposed integrated and collaborative approach to watershed management, which would combine drainage with other management topics into strategies developed through local government collaboration. Chapter 22, and perhaps other sections of the Drain Code, may require review and revision to enable IWCs to implement comprehensive and collaborative watershed management strategies.

OTHER LEGAL CONSIDERATIONS

In addition to the policy implications above, IWCs may require enabling legislation because they would be new public entities not addressed by current state law. Also, all IWC financing strategies would need to be consistent with: 1) the Headlee Amendment to the Michigan Constitution, which requires voter approval for new local taxes or tax increases; 2) the *Bolt v. City of Lansing* (1998) Michigan Supreme Court decision, which establishes criteria for fees that are not designated taxes; and 3) Michigan's legal framework for special assessment districts.

SUMMARY

This constrained vision for Integrated Watershed Commissions is designed to be an effective and efficient alternative to Michigan's current system, by coordinating decision-making and management activities to assure they meet community needs and contribute to achieving agreed upon outcomes at the watershed scale. IWCs would assemble water managers and other stakeholders to: 1) identify and clarify desired resource conditions; 2) coordinate planning and implementation activities; 3) facilitate science-based decision-making; 4) serve as fiduciaries for watershed funding/financing programs; and 5) host public discussion forums for decisions that impact water resources. IWCs would lead strategies to address the interests of all watershed stakeholders, working to generate cost savings over both the short and long term *and* improve conditions of Michigan's water resources.

While this approach to IWCs is envisioned as a strategy for improving water management without major policy or management overhauls, not all aspects of this proposal may be concordant with current law. Establishing and implementing IWCs may require updating Michigan's Watershed Alliance legislation and the Michigan Drain Code, in addition to the possibility of new enabling legislation, for a more collaborative and integrated water management system.

If implemented, this constrained version of IWCs may open a pathway to a more thoroughly integrated water management system over time. In the next section, we offer our recommendations for a highly integrated system through an *unconstrained* vision for Integrated Watershed Commissions.

V. A BLUE SKY VISION FOR INTEGRATED WATERSHED COMMISSIONS IN MICHIGAN

This "blue sky" vision for Integrated Watershed Commissions represents our recommendations for an alternative water management system in Michigan, unconstrained from present political and management limitations. Here we propose a multi-stakeholder, ecosystem-based governance system that would harmonize administrative and watershed boundaries, allowing for a more integrated and strategic management approach than the state's current system.

We recognize that this vision may not be viable in today's political climate, but we present it to: 1) offer a bold new governance strategy aimed at securing the sustainable use of Michigan's water resources; 2) provoke discussion regarding what may represent an alternative future; and 3) identify the challenges inherent in attempting to operationalize this vision. Below we provide an overview of this vision, describe potential benefits of this alternative approach, and discuss implications for current policy.

PROPOSED MANAGEMENT SYSTEM (UNCONSTRAINED)

In this blue sky vision, IWCs would be comprehensive water management agencies that unite Michigan's water management activities within a common governance framework, using best available science to inform water management decisions at the broad watershed scale. IWCs would lead water management activities at a range of ecological scales across the complete hydrological cycle to achieve desired outcomes and a balance among competing demands for Michigan's water resources.

IWCs would have holistic water management responsibilities essential to the management of water quantity and quality in all surface and groundwater systems statewide. Areas of responsibility may include the following:

- Comprehensive planning
- Ecological restoration and conservation activities
- Land acquisition and management
- Scientific research and technical activities geared to Michigan's water management needs
- Scientific monitoring and data management systems
- Oversight of water quantity and quality regulatory programs
- Leading public and private financing strategies for water resources
- Coordination of public engagement, education, and citizen science activities

In the long-term, IWCs are intended to: 1) generate cost savings by integrating water management activities at large watershed scales; 2) achieve improved ecological outcomes while reducing overall water management costs statewide; and 3) provide an important baseline of our state's water resources, allowing us to assess change over time and determine if management strategies need revision.

This vision for an alternative water management system is deliberately idealized and does not aim to account for all of Michigan's existing management institutions and programs; in some cases, IWCs would replace or absorb existing water management structures, as appropriate. Although this approach represents a transition from Michigan's county drain commissioner system, we envision that drain

commissioners, drain office staff, and other water and natural resource management professionals who have appropriate training and skill sets could transition to IWC personnel.

PROPOSED BOUNDARIES

We propose a structure of six IWCs in Michigan (Fig. V.1) organized according to regional consolidations of the state's 8-digit Hydrologic Unit Code (HUC-8) watershed boundaries. These boundaries would encompass entire surface and hydrologically connected groundwater systems, from headwaters to Great Lakes receiving waters. The boundaries for this unconstrained version of IWCs are organized at a larger watershed scale than those proposed in our Constrained Vision. As comprehensive water management agencies with increased institutional capacity, this version of IWCs may generate additional efficiencies by operating at larger scales.

These proposed IWC boundaries are small enough to incorporate local and regional values into democratic decisions about water resources but are large enough to promote the institutional capacity needed to manage entire water systems at large landscape levels. The specific number of IWCs and corresponding boundaries could be subject to revision, but either too few or too many IWCs would disrupt the goal of balancing system effectiveness with democratic legitimacy (Moss and Newig 2010).

As shown in the constrained approach to IWCs, there are also clear differences in land use/land cover among the IWCs in this 6-unit arrangement, with a greater percentage of undeveloped land in the northern-most regions, and more agriculture and urban development in the southern-most IWCs (Fig. V.2, Table V.1).

GOVERNANCE STRUCTURE

Each IWC would be overseen by an independent, citizen governing board that would provide accountability for how water resources are managed in each region. Governing boards would provide a mechanism for public oversight and input, while enabling science to inform water management specific to the people, environment, and interests in each IWC. Governing boards would have responsibility over IWC policy and funding matters. They also would be responsible for hiring Executive Directors, who would be subject to State Senate confirmation, to implement IWC programs and initiatives.

We propose a five-member governing board for each IWC. Each board would be composed of three appointed and two elected members (Fig. V.3). IWC governing boards would incorporate the strengths of both appointments and elections. Officials elected to public oversight boards are likely to pursue policies that align with the perceived preferences of the electorate (Burden et al. 2010), which serves as a democratic check on administrative power. However, political appointments for public oversight boards allow for the selection of individuals with the skills and expertise to make well-informed decisions in complex policy areas, which can result in more effective and cost-efficient services delivered to the public (Whalley 2013).

The three appointed members would be nominated by the Governor and confirmed by the State Senate, and they would represent the geographic areas and various water use interests (e.g., agricultural, industrial, commercial, natural areas) in each IWC. Elected members would be chosen through popular elections on a non-partisan, at-large basis in the IWC. Under this approach, governing boards would assemble members whose collective knowledge would shape a wide-angle view of the water issues and management needs across each region.

Figure V.1. Proposed boundaries for “blue sky” IWCs.

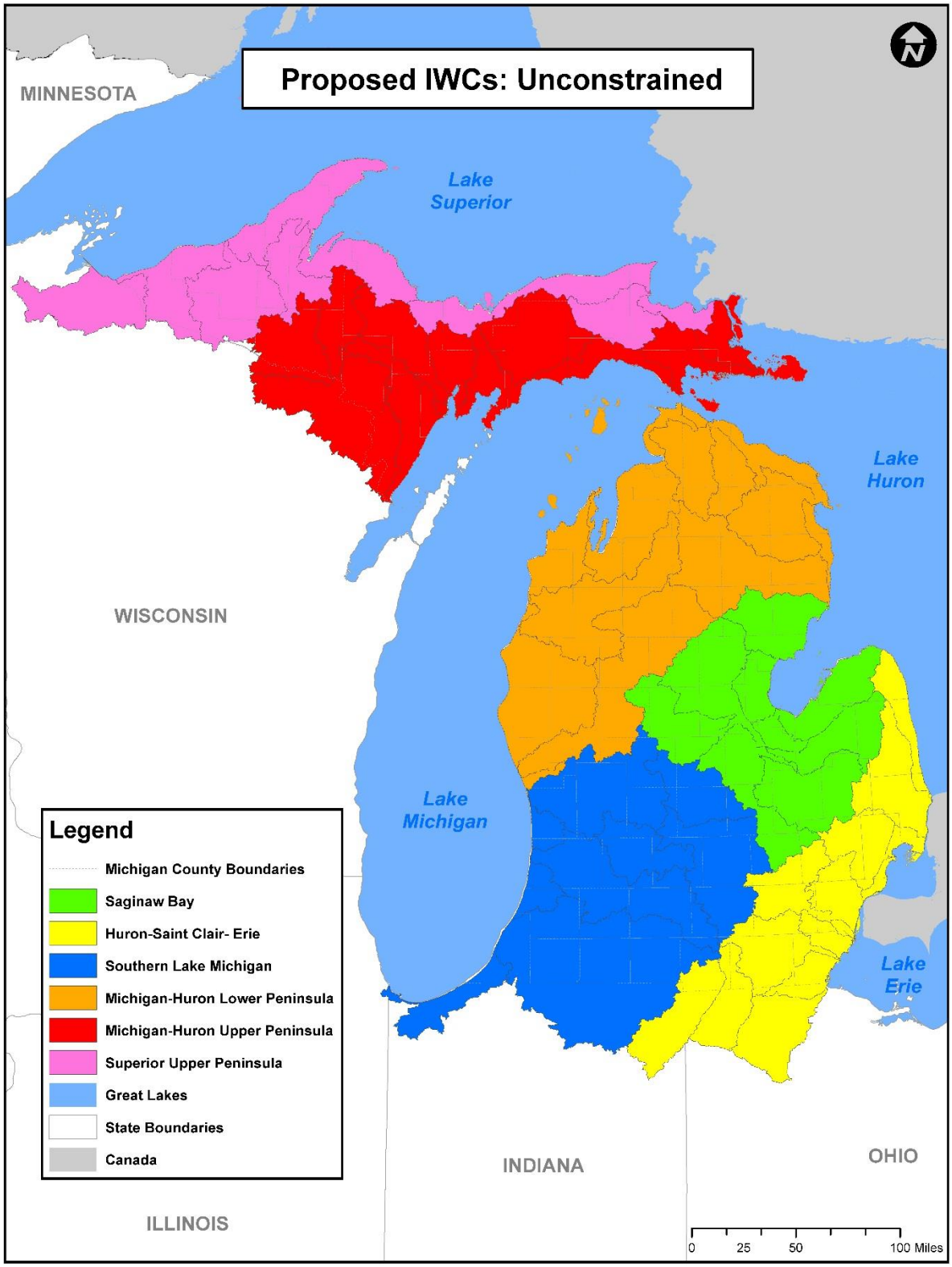


Figure V.2. Land cover in proposed IWCs (unconstrained).

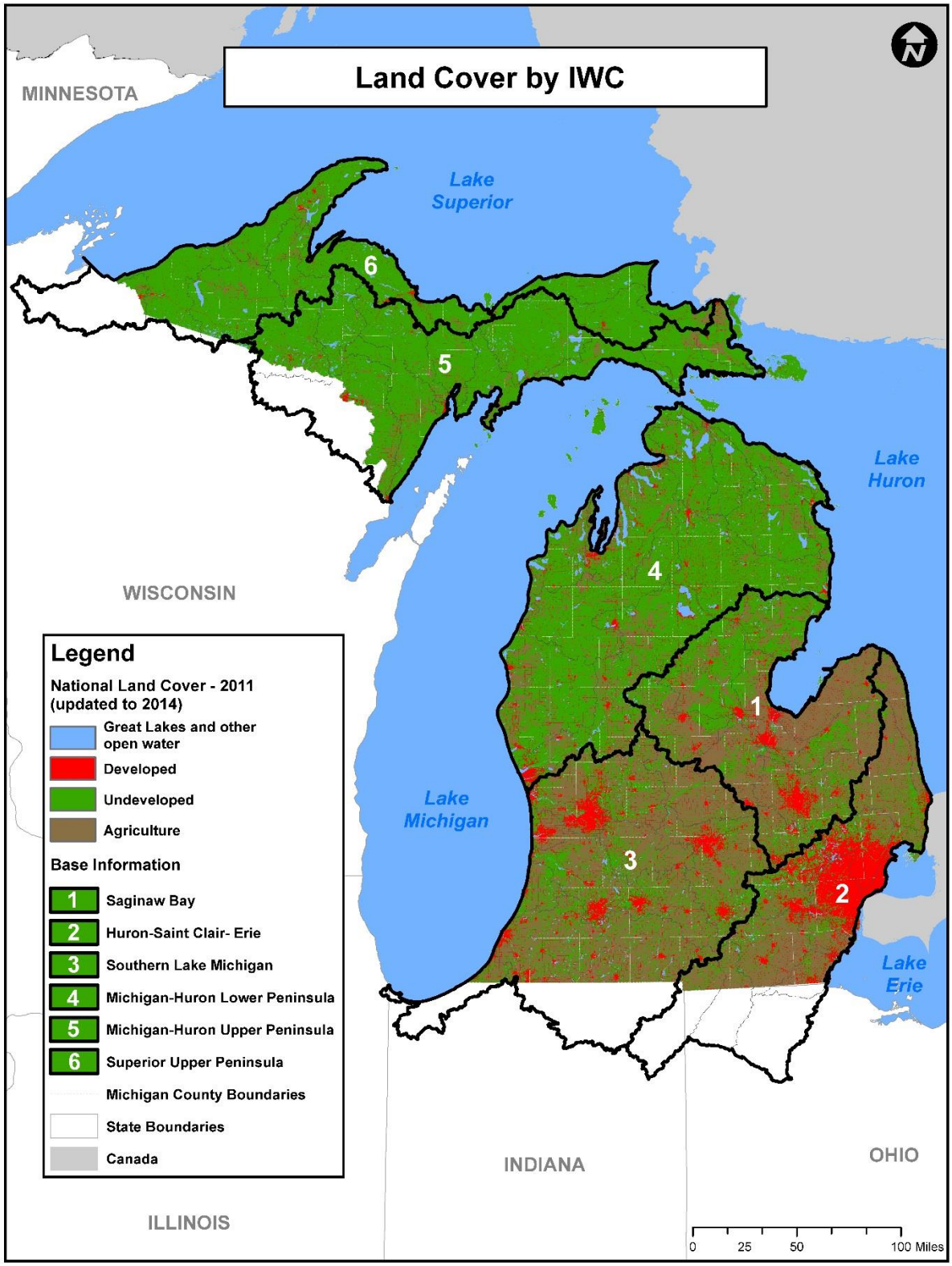


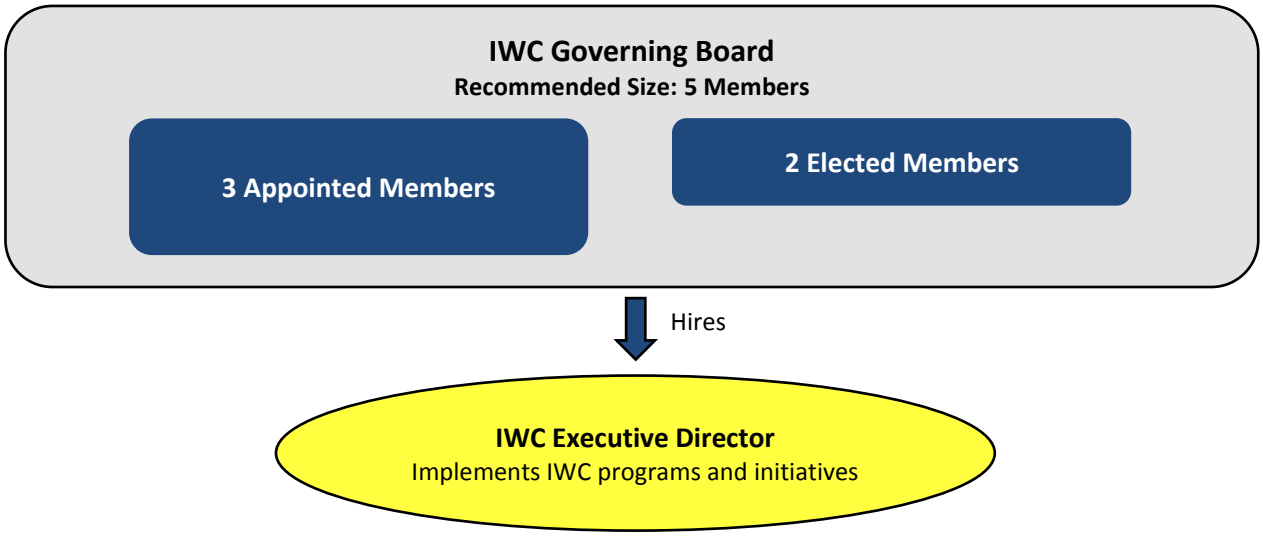
Table V.1. Proposed IWCs (unconstrained), affected watersheds, land area, counties, and land cover. Land cover figures do not include open water. Sources: NHDPlus (2016); National Land Cover Database 2011, updated 2014 (Homer et al. 2015).

IWC	Watersheds	Total Area (sq km)	Counties	Area by County (sq km)	County Area as % of IWC	IWC Land Cover		
						Type	Area (sq km)	% of IWC
1. Saginaw Bay	Au Gres-Rifle	22362.99	Arenac	951.22	4.25%	Agriculture	10260.44	45.88%
	Cass		Bay	1161.62	5.19%	Developed	2594.79	11.60%
	Flint		Clare	839.15	3.75%	Undeveloped	9231.76	41.28%
	Kawkawlin-Pine		Clinton	0.07	0.00%			
	Pigeon-Wiscoggin		Genesee	1681.33	7.52%			
	Pine		Gladwin	1335.36	5.97%			
	Saginaw		Gratiot	927.65	4.15%			
	Shiawassee		Huron	1476.77	6.60%			
	Tittabawassee		Iosco	1048.93	4.69%			
			Isabella	1494.85	6.68%			
			Lapeer	1263.38	5.65%			
			Livingston	639.08	2.86%			
			Mecosta	340.60	1.52%			
			Midland	1366.68	6.11%			
			Montcalm	189.98	0.85%			
			Oakland	439.95	1.97%			
			Ogemaw	1098.25	4.91%			
			Osceola	73.57	0.33%			
			Oscoda	0.19	0.00%			
			Roscommon	174.84	0.78%			
			Saginaw	2111.86	9.44%			
			Sanilac	846.96	3.79%			
			Shiawassee	793.42	3.55%			
			Tuscola	2107.33	9.42%			
2. Huron-St. Clair-Erie	Birch-Willow	16304.69	Branch	7.28	0.04%	Agriculture	7373.03	45.22%
	Clinton		Hillsdale	905.15	5.55%	Developed	4674.36	28.67%
	Detroit		Huron	687.52	4.22%	Undeveloped	4006.09	24.57%
	Huron		Ingham	45.20	0.28%			
	Lake St. Clair		Jackson	204.53	1.25%			
	Ottawa-Stony		Lapeer	452.56	2.78%			
	Raisin		Lenawee	1970.47	12.09%			
	St. Clair		Livingston	547.99	3.36%			
	St. Joseph-Maumee		Macomb	1251.64	7.68%			
	Tiffin		Monroe	1071.60	6.57%			
			Monroe	363.29	2.23%			
			Oakland	1908.19	11.70%			
			Sanilac	1649.38	10.12%			
			St. Clair	1827.88	11.21%			
			Washtenaw	1843.13	11.30%			
			Wayne	1568.87	9.62%			
3. Southern Lake Michigan	Black-Macatawa	29481.17	Allegan	2180.95	7.40%	Agriculture	15584.67	52.86%
	Kalamazoo		Barry	1493.49	5.07%	Developed	4031.09	13.67%
	Little Calumet-Galien		Berrien	1484.44	4.54%	Undeveloped	9318.37	31.61%
	Lower Grand		Branch	1337.85	4.54%			
	Maple		Calhoun	1859.14	6.31%			
	St. Joseph		Cass	1316.15	4.46%			
	Thornapple		Clinton	1486.86	5.04%			
			Eaton	1499.56	5.09%			

	Upper Grand		Gratiot	551.65	1.87%			
			Hillsdale	665.81	2.26%			
			Ingham	1405.89	4.77%			
			Ionia	1501.14	5.09%			
			Isabella	0.19	0.00%			
			Jackson	1667.82	5.66%			
			Kalamazoo	1502.11	5.10%			
			Kent	2256.75	7.65%			
			Livingston	328.12	1.11%			
			Mecosta	57.44	0.19%			
			Montcalm	1327.24	4.50%			
			Muskegon	302.51	1.03%			
			Newaygo	174.89	0.59%			
			Ottawa	1486.01	5.04%			
			Shiawassee	606.56	2.06%			
			St. Joseph	1348.76	4.57%			
			Van Buren	1613.35	5.47%			
			Washtenaw	26.50	0.09%			
4. Michigan-Huron LP	Au Sable Betsie-Platte Black Boardman-Charlevoix Cheboygan Lone Lake-Ocqueoc Manistee Muskegon Pere Marquette-White Thunder Bay	38415.29	Alcona	1798.54	4.68%	Agriculture Developed Undeveloped	4657.10 2969.76 29325.15	12.12% 7.73% 76.34%
			Alpena	1535.41	4.00%			
			Antrim	1358.68	3.54%			
			Benzie	899.69	2.34%			
			Charlevoix	981.50	2.55%			
			Cheboygan	2060.56	5.36%			
			Clare	649.95	1.69%			
			Crawford	1458.05	3.80%			
			Emmet	1247.77	3.25%			
			Grand Traverse	1267.99	3.30%			
			Iosco	417.29	1.09%			
			Kalkaska	1476.64	3.84%			
			Lake	1486.33	3.87%			
			Leelanau	875.30	2.28%			
			Manistee	1443.31	3.76%			
			Mason	1320.19	3.44%			
			Mecosta	1080.25	2.81%			
			Missaukee	1485.18	3.87%			
			Montcalm	348.25	0.91%			
			Montmorency	1456.62	3.79%			
			Muskegon	1063.02	2.77%			
			Newaygo	2055.41	5.35%			
			Oceana	1413.67	3.68%			
			Ogemaw	390.00	1.02%			
			Osceola	1409.25	3.67%			
			Oscoda	1479.34	3.85%			
			Otsego	1362.07	3.55%			
			Ottawa	7.19	0.02%			
			Presque Isle	1772.35	4.61%			
			Roscommon	1326.36	3.45%			
			Wexford	1489.14	3.88%			
5. Michigan-Huron UP	Brevoort-Millecoquins Brule Carp-Pine Cedar-Ford Escanaba Fishdam-Sturgeon Manistique	22842.50	Alger	1065.32	4.66%	Agriculture Developed Undeveloped	1061.92 920.18 20305.39	4.65% 4.03% 88.89%
			Baraga	575.73	2.52%			
			Chippewa	1794.01	7.85%			
			Delta	3036.62	13.29%			
			Dickinson	2010.19	8.80%			
			Gogebic	32.33	0.14%			
			Iron	2869.44	12.56%			
			Luce	243.40	1.07%			
			Mackinac	2435.24	10.66%			

	Menominee Michigamme St. Marys Tacoosh- Whitefish		Marquette Menominee Schoolcraft	2896.46 2722.17 3161.61	12.68% 11.92% 13.84%			
6. Superior UP	Bad-Montreal Betsy-Chocolay Black-Presque Isle Dead-Kelsey Flambeau Keweenaw Peninsula Ontonagon Sturgeon Tahquamenon Upper Wisconsin Waiska	19353.13	Alger Baraga Chippewa Gogebic Houghton Iron Keweenaw Luce Mackinac Marquette Ontonagon Schoolcraft	1303.30 1798.45 1758.08 2932.36 2696.41 266.71 881.78 2155.27 178.12 1943.27 3438.90 0.50	6.73% 9.29% 9.08% 15.15% 13.93% 1.38% 4.56% 11.14% 0.92% 10.04% 17.77% 0.00%	Agriculture Developed Undeveloped	483.88 631.54 17785.00	2.50% 3.26% 91.90%

Figure V.3. Proposed IWC governance structure (unconstrained)



Although it is envisioned that IWCs would operate relatively independently, a mechanism would be needed at the state level to generate efficiencies by coordinating appropriate programs across IWCs. For example, the administration and implementation of a statewide water quality and quantity monitoring program for surface and groundwater systems by IWCs could be efficiently organized through a single entity at the state level. While each IWC would have independent operating authority, it is vital that there be accountability at the state level.

BENEFITS OF INTEGRATED WATERSHED COMMISSIONS

Blue sky IWCs would be comprehensive water management agencies organized at a large watershed scale, and they would use best available science to inform management decisions aimed at producing desired outcomes for all water users. The recommendations for improving water management in this unconstrained approach are based on analysis of the state's current management challenges and needs, and research on alternative models from other U.S. states and abroad.

Our research identifies five key factors (Table V.2) that are present in systems with effective water governance (Trachtenberg and Focht 2005, Sabel and Zeitlin 2008, GWP 2009, Huitema et al. 2009, von Korff et al. 2012, Pahl-Wostl and Knieper 2014, OECD 2015). Below we discuss new roles and responsibilities for IWCs, designed in coordination with these five elements, which could generate a range of management efficiencies, economic benefits, and improved environmental outcomes.

Table V.2. Five elements present in systems with effective water governance.

1.	**Integrated Watershed Management** – Whole water systems are managed using best available, science-based approaches in coordination with related ecological, social, and economic factors.
2.	**Aligned Scales** – Management decisions at all levels (e.g., binational, federal, state, county, municipal, watershed, subwatershed) promote the strategic governance of complete water systems.
3.	**Institutional Capacity** – Water institutions have the necessary technical, human, financial, and regulatory capabilities to carry out complex management functions.
4.	**Adaptive Governance** – Water institutions adapt to uncertain and changing conditions through iterative processes of provisional goal setting, routine monitoring, experimental problem-solving, measuring results, and learning from experience.
5.	**Democratic Participation** – Public values, knowledge, and perspectives are infused in collaborative decision making processes between governmental and nongovernmental stakeholders.

INTEGRATED WATERSHED PLANNING

Similar to planning strategies used in Minnesota, Georgia, and the European Union[10], IWCs would develop and implement comprehensive, integrated plans for water resources in large-scale watersheds. IWC planning processes would involve collaborative partnerships with various governmental and nongovernmental stakeholders in order to treat all water resources as "one water" (cf. City of Los Angeles 2015), recognizing the inherent interconnectedness among aquatic ecosystems and water for various human uses. Examples of this integrated planning approach may include coordinating with road commissions to co-manage runoff issues, engaging natural resource managers to prioritize aquatic habitat conservation and restoration projects, and partnering with public outreach organizations to make nature accessible to all Michigan residents.

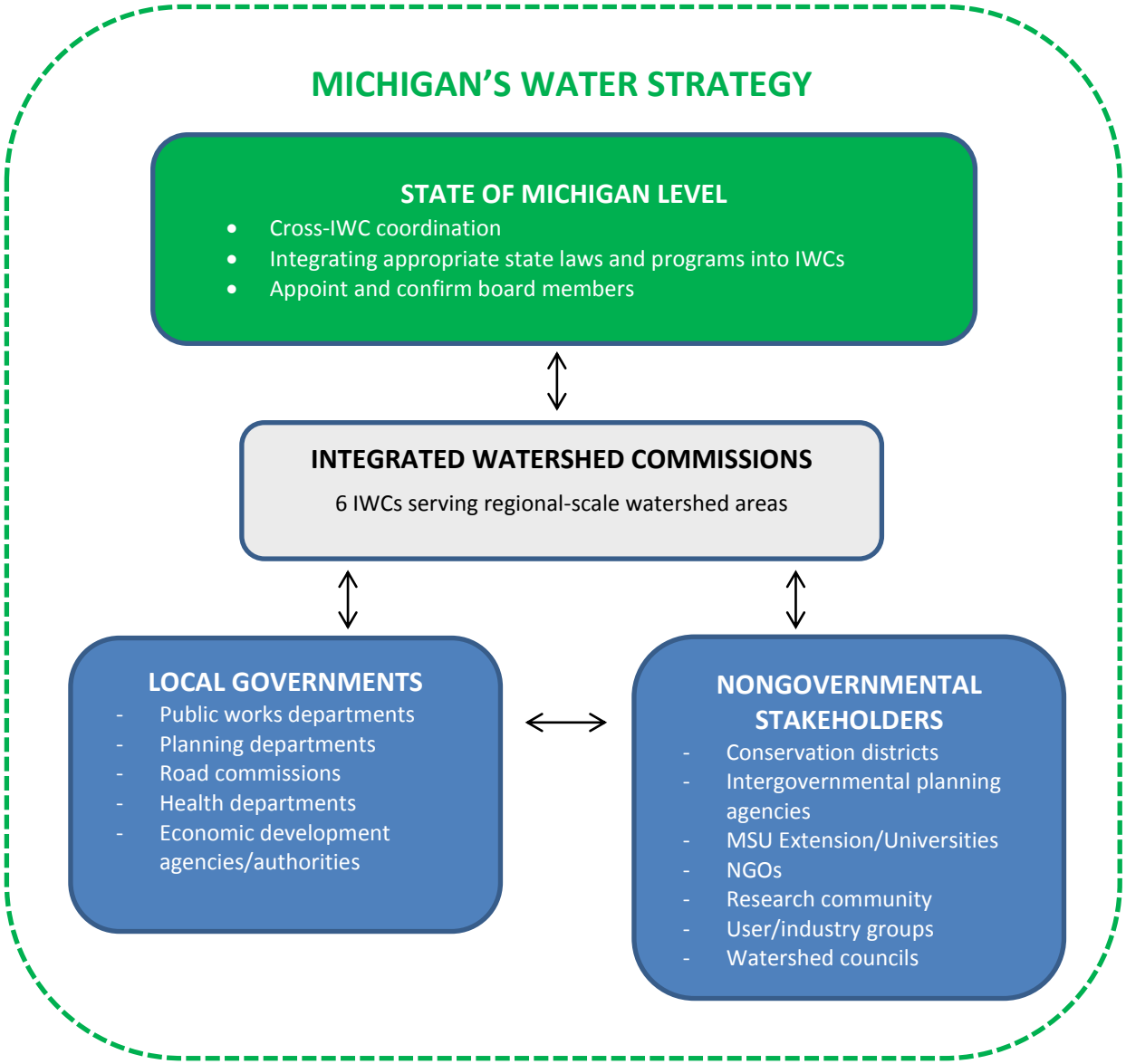
ALIGNING DECISION-MAKING

Michigan's *Water Strategy* (MOGL 2016), recently issued by the Michigan Office of the Great Lakes, provides a 30-year strategic vision for the sustainable use of the state's water resources. This vision can serve as a foundation to guide water planning and management activities in a proposed statewide,

[10] For details on water planning in Minnesota, see: http://www.bwsr.state.mn.us/planning/1W1P/index.html; for Georgia, see http://northgeorgiawater.org/what-is-the-metro-water-district/what-is-water-planning/; and for the EU, see: http://ec.europa.eu/environment/water/water-framework/info/intro_en.htm

multi-scale water governance schema (Fig. V.4). In this arrangement, IWCs would be key elements in a strategy to coordinate state, regional, and local decision-making to support strategic goals for water resources statewide.

Figure V.4. Michigan's proposed water governance schema. Arrows indicate coordinated water management activities.



IWC comprehensive plans would establish broad goals for entire water systems, in a manner consistent with the *Water Strategy,* accounting for the various uses and interests in each IWC region. Under this tiered approach, local governments and water users would have flexibility to use water resources within the framework of the broad objectives in each IWC comprehensive plan, and local uses would also support Michigan's statewide vision. Hence decisions at all levels in Michigan would be aligned to support desired outcomes for all water users. This approach offers a broad strategy for aligning decision-making about water resources across all levels of government in Michigan; specific roles and

responsibilities among IWCs and state and local governments would need to be clearly identified if IWCs were to be implemented.

Additional efficiencies might be generated by aligning IWCs with Michigan's quality of life agencies and offices on a watershed basis. For example, if MDEQ had designated staff to work on a watershed basis, IWCs could coordinate with perhaps only one point person from the agency on restoration projects and other initiatives, as opposed to multiple staff and offices. Similarly, Michigan's 77 Conservation Districts are currently organized on a county basis. By reorganizing or integrating Conservation Districts within IWCs, conservation district staff could more effectively engage at ecosystem scales and coordinate seamlessly with IWCs.

MANAGEMENT CAPACITY

IWCs would have the necessary technical, human, financial, and regulatory capabilities to carry out efficient and economical strategies for achieving desired resource conditions across large watershed areas. We propose that IWCs perform the following roles to facilitate this management capacity: 1) build scientific and technical capabilities; 2) administer cost-efficient financing strategies; and 3) coordinate regulatory activities.

Scientific and technical activities: IWCs would use best available science to inform management decisions about complex water challenges across Michigan. IWCs would monitor and manage for pressing problems such as water withdrawal, aquatic invasive species, harmful algal blooms, climate change, and emerging microconstituent contaminants, among others, using sound scientific principles at ecosystem scales. Through a robust monitoring and research agenda, IWCs would help protect and restore hydrologic and ecosystem functions in the state's water resources, and support the long-term sustainability of their various human uses.

We propose that each IWC maintain in-house scientific capacity; the actual size and composition may vary among IWCs depending on need. Having in-house technical expertise has several benefits. First, scientific activities can be coordinated around issues as they exist on the ground across Michigan, making it more responsive to the state's water management needs. Second, in-house staff allow for immediate deployment if critical issues or crises emerge, as opposed to university faculty, for example, who may have other obligations. Finally, in-house staff provide institutional knowledge of systems and community players, minimizing the time to "come up to speed" and to build relationships. We envision that IWCs would include a variety of scientific positions, from field technicians to positions such as "Distinguished Scientist", which would range in skill levels and compensation.

IWCs would partner with universities and other research-based institutions in the private sector. We envision that IWCs would collaborate and assist in funding research scientists who have specialized expertise to address management needs within each IWC. In addition, IWCs may help fund postdoctoral positions, and bring in academics and other experts for various purposes as appropriate, such as independent reviews. IWCs might have a pool of subject area experts pre-contracted on retainer, such as scientists working on emerging contaminants, invasive species, agricultural runoff, or key policy issues. This partnership strategy would help connect scientific research more closely to Michigan's water management needs, increasing both the efficiency and capacity of science-based water management activities across the state.

We acknowledge that this vision for IWC scientific/technical proficiency would result in increased short-term costs. We also believe these expenses would be recovered in the long run through benefits

associated with sustainable water supplies, such as: increased commerce because of improved water quality and quantity; cost savings by using science-based decision-making to prevent future conflicts and litigation; and increasing social/community benefits, including those not easily monetized, because of improved ecological conditions.

Cost-efficient financing: An unconstrained version of IWCs may use the same watershed funding and financing strategies as proposed in the Constrained Vision (see pp. 20-21): 1) performance-based property assessments; 2) credit trading programs and other transactional tools; and 3) increasing private investment in water resources, including through public-private partnerships. Fully integrated into public law and administration, IWCs would also be able to bond for specific projects, which would allow them to spread funding over time for particular purposes. Additionally, we anticipate this unconstrained version of IWCs may generate more economic benefits and long-term cost savings than the constrained approach because of their increased management capacity and integrated agency structure.

Streamlining regulatory duties: IWC activities may span a range of water quality and water quantity regulatory roles that would facilitate holistic management strategies to achieve ecosystem level goals. Activities may include: overseeing water quality and quantity regulatory programs; generating regional policy frameworks to guide regulatory decisions made at local levels; and incorporating appropriate federal and state regulations into IWC management activities.

IWCs need the ability to administer water quality regulations consistent with regional policy objectives for water resources, and there are two basic approaches for accomplishing this. First, IWCs could be the designated permitting agencies for water quality regulatory programs. Under this strategy, IWCs would assume full responsibility for federal Clean Water Act programs currently administered by the Michigan Department of Environmental Quality. This substantive change to regulatory duties may require legislative approval, as opposed to administrative action only, particularly if IWCs were to receive state funds. The second approach involves IWCs incorporating existing state and federal water quality programs into their management functions. Under this collaborative arrangement, IWCs would coordinate with state and federal agencies to administer water quality regulatory programs aimed at achieving desired outcomes at watershed scales. These two regulatory options for addressing water quality are not mutually exclusive, and IWCs may use both strategies depending on the issue.

IWCs would also need the capacity to enforce rules affecting water quantity so that desired outcomes for entire water systems could be achieved. IWCs would establish broad frameworks for flood control, groundwater recharge, and other water quantity topics at watershed scales according to resource conditions and uses. All potential IWC water quantity regulatory programs would support state and national rules and agreements, such as those in the Great Lakes-St. Lawrence River Basin Water Resources Compact and Michigan's Water Withdrawal Assessment Tool.

ADAPTIVE GOVERNANCE

Michigan's waters face a range of challenges associated with climate change, emerging contaminants, invasive species, and other issues whose human and ecological impacts are often not well understood. For example, research on microplastics in the Great Lakes was nonexistent before 2012. Today we know that concentrations of microplastics in Lake Erie are higher than even the most polluted areas of oceans (Erikson et al. 2013, Mason 2015), and that much of the material enters the Great Lakes through tributaries as plastic fibers (Baldwin et al. 2016), although their ecological impact is still being investigated.

Technically proficient IWCs would address new and emerging challenges by connecting in-house dedicated monitoring and research with management initiatives. This type of flexibility and responsiveness is often impossible for state and federal agencies. Additionally, IWCs could accelerate the development of effective stressor management strategies by encouraging experimentation at local levels, perhaps offering prizes, awards, or other incentives to communities that implement innovative strategies in response to widespread challenges.

INCREASING DEMOCRATIC PARTICIPATION

In addition to strategies described in the Constrained Vision, such as coordinating public education/outreach activities, hosting discussion forums, and implementing a water users advisory group, blue sky IWCs could facilitate collaborative water management activities that require both technical capacity and the ability to engage at large watershed scales.

For example, IWCs could assist in participatory modeling workshops that would enhance public involvement in planning activities for large restoration projects, such as the current Grand River initiative in Grand Rapids. In this example, whitewater paddlers, anglers, conservationists, local governments, and other stakeholders would provide input that IWC staff would incorporate into models describing resource outcomes under various conditions. This workshop process could allow stakeholders to negotiate tradeoffs, break down barriers, and eventually reach common ground. Through assisting in these democratic processes, or leading them if asked, IWCs would help integrate the public into technical activities by providing science-based tools to inform community-determined goals for water resources. IWCs could help build public trust in government precisely where it has been weakened in Michigan by the Flint water crisis by helping the public engage in technical aspects of water management.

POLICY AND LEGAL IMPLICATIONS

Establishing and implementing this unconstrained version of IWCs would almost certainly require major overhauls to existing state law (e.g., Michigan Drain Code) and organizational responsibilities (e.g., MDEQ and other state agency roles). In two U.S. states with watershed-based natural resource management agencies, Nebraska and Florida[11], major changes to water management roles and responsibilities were enacted through state legislation. Both Florida and Nebraska implement integrated watershed management strategies through state policy, while Michigan currently does not (Table V.3).

FLORIDA WATER MANAGEMENT DISTRICTS

In Florida, the 1972 Water Resources Act (Chapter 373) created five Water Management Districts organized according to watershed boundaries. These agencies were given broad responsibilities for water management and environmental protection at a regional scale. Water Management Districts are headed by non-paid citizen boards appointed by the Governor, employ full-time professional staffs, and are self-financed through ad valorem property taxes. The Florida Legislature also passed three other major pieces of legislation in 1972 to promote managing land use, population growth, and water issues in coordination with one another (Purdum 2002).

NEBRASKA NATURAL RESOURCE DISTRICTS

In 1969 the Nebraska Legislature established the state's Natural Resource Districts (LB 1357 of 1969), which are multi-purpose natural resource management agencies organized according to watershed boundaries. State legislation consolidated 154 special purpose districts statewide into 23 Natural

[11] See the IWC Model Case Study document in Appendix D for details on strategies used in Nebraska and Florida.

Resource Districts with designated roles and responsibilities, and implementation took three years. Districts are led by locally-elected citizen boards, employ full-time professional staffs, and are self-financed through property taxes (Bleed and Babbitt 2015).

Table V.3. Integrated watershed management strategies used in three U.S. states. For Michigan, we show the strategies both as currently structured and as they would appear with blue sky IWCs.

Integrated watershed management strategies organized by state policy	Florida	Nebraska	Michigan (current)	Michigan (with IWCs)
Watershed-based agencies	Yes	Yes	No	Yes
Scientific research	Yes	Yes	No*	Yes
Coordinated scientific monitoring programs	Yes	Yes	No*	Yes
Regulatory duties	Yes	Yes	No	Yes
Integrated planning	Yes	Yes, required only where surface-ground waters connect	No	Yes
Aligned decision-making scales	Yes	Yes	No	Yes
Watershed-based financing strategies	Yes	Yes	No	Yes

*MDEQ has a five-year rotating watershed monitoring system, but state policy does not coordinate this program with other watershed management activities.

SUMMARY

This blue sky vision for IWCs lays out an institutional approach for how to manage Michigan's water in a highly integrated fashion. Although we refer to it as unconstrained, we have attempted to ground the proposal in some political reality. For example, we do not discuss consolidation of local units of government, which also would result in greater efficiencies and would very likely facilitate the implementation of IWCs. Nonetheless, this vision represents a large leap from Michigan's current management system. Problems resulting from insensitivity to existing political and management structures can become pitfalls for efforts to redesign water governance (Blomquist and Schlager 2005), and the Constrained Vision for IWCs, presented in the preceding section of this report, aims to avoid those pitfalls.

IWCs would use best available science to inform democratic water management at regional watershed scales, generating efficiencies through coordinated management of water quantity and quality across the complete hydrologic system. In the long-term, we believe IWCs would: 1) generate cost savings by engaging water management activities at regional watershed scales; 2) achieve improved ecological outcomes while reducing overall water management costs statewide; and 3) provide an important baseline of our state's water resources, allowing us to assess change over time and determine if management strategies need revision. This vision for IWCs is aimed at achieving water management efficiency alongside democratic legitimacy, using science-based strategies to serve the needs and interests of Michigan's residents and communities.

VI. CONCLUSION

SUMMARY

Integrated Watershed Commissions would coordinate decision-making and management on a watershed basis so that desired conditions may be achieved for all users of Michigan's water resources. This coordination can produce a range of benefits, including: economic gains because of improved water quantity and quality; short and long-term cost savings because of management efficiencies and science-based decision-making; improved coordination among units of government; and providing a valuable baseline of Michigan's water resources that can guide management decisions over time.

The two visions we offer for IWCs represent two basic approaches to implementing a statewide integrated watershed management system in Michigan: 1) a coordinating mechanism to organize existing management structures on a watershed basis statewide; and 2) introducing comprehensive watershed management agencies with new roles and responsibilities. Although the two approaches differ in terms of scope and scale (Table VI.1), both visions offer a pathway to securing benefits of improved water management. Given the economic and social importance of the Michigan's water resources, it is important that water is managed in a coordinated and strategic manner.

Table VI.1. Major features of constrained and unconstrained versions of IWCs

	Constrained IWCs	Unconstrained IWCs
Proposed boundaries/scale	15 watershed-based units statewide	6 watershed-based units statewide
Governance approach	Watershed coordinating mechanism for current management structures	New comprehensive watershed management agencies
Leadership	5-member executive committee composed of current water managers	5-member governing board
Scientific/technical capacity	Coordinating and leveraging current resources	IWC-housed scientific/technical expertise, plus strategies in constrained vision
Financing strategies	Self-financed through performance-based property assessments, credit trading programs, public-private partnerships	Same strategies as constrained version, plus option to bond for specific projects
Planning strategies	Coordinate existing plans; option to develop new integrated plans	Develop integrated plans; align implementation across state-regional-local governments/stakeholders
Regulatory authorities	None; decisions implemented by each IWC member	May directly oversee regulatory programs and/or coordinate with federal and state regulatory programs
Democratic participation strategies	Implement public education/outreach activities, discussion forums, water users advisory group	Same strategies as constrained version, plus resources for public involvement in technical activities
Policy implications	Revise current policy; no major overhauls	Major overhauls likely

FIVE NEXT STEPS

We recognize that Integrated Watershed Commissions may represent major change for some, or many, of Michigan's water managers and stakeholders. Even our constrained vision for IWCs may present challenges to those unaccustomed to working on a watershed basis, or across agency and political boundaries. Operationalizing either version of IWCs may require incremental steps to improve the current system. We propose five next steps, short of IWCs, that in the long term may lead to a better coordinated and more efficient water management system in Michigan:

1. **Organize a workgroup to engage the Michigan Legislature on revising Chapter 22 of the Michigan Drain Code for a more efficient mechanism to plan and implement drainage management in watersheds across three or more counties.** The current Chapter 22 process for coordinating drainage management across regional watershed areas is rarely implemented due, in part, to administrative complexity. Drain commissioners, MDARD, the Michigan Farm Bureau, and other stakeholders should advise legislators on reducing statutory barriers to planning and implementing drainage management strategies coordinated among county and municipal governments in regional watershed areas.

2. **Develop a mechanism to improve state agency coordination and community engagement on a watershed basis for topics affecting water resources.** Water managers and organizations that currently work on a watershed basis often face barriers by coordinating with multiple staff and offices from individual state agencies. Watershed projects and initiatives could be implemented more efficiently if MDEQ and MDARD, for example, each had one point person with a watershed-level view who could engage communities and stakeholders on topics for which each agency is responsible.

3. **Identify an administrative home and funding source for a statewide water quality and quantity real-time monitoring strategy for surface and groundwater systems, including a data management system.** Although our recommendation is to have IWCs lead a statewide water monitoring and data management strategy, we recognize that other watershed-based approaches may also be viable. For example, the Minnesota Pollution Control Agency partners with federal, state, and regional agencies to oversee a water monitoring and assessment program that includes permanent flow and chemistry monitoring stations at the outlets of each of the state's 81 major watersheds (MNPCA 2008).

4. **Develop a pilot program in a proposed IWC area to test and refine recommendations for IWCs.** Michigan's water management system is complex and variable locally; often not even experts can identify key roles and responsibilities. Through continued research in an IWC pilot program, we would: 1) identify all water managers in a regional-scale watershed area; 2) understand roles and inefficiencies; 3) clarify strategies to achieve better coordinated management, including those which may require policy reforms; and 4) refine recommendations for IWCs.

5. **Continue dialogue to develop a more collaborative network of water-related thought leaders and decision-makers in Michigan.** Leaders from various sectors across the state have sat down together in small groups at IWC-focused events for dialogue on shared concerns about Michigan's water resources. Many of these individuals would otherwise have limited (if any) face-to-face interaction with one another or the organizations that they represent. A strategy to

continue this dialogue would help facilitate coordination across sectors and agencies for issues related to Michigan's water resources.

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APPENDIX A: KICK-OFF PROJECT MEETING SUMMARY

The IWC kick-off meeting was held on November 24, 2015 in Grand Rapids, MI at GVSU's Seidman College of Business. A diverse group of more than 60 leaders and practitioners from various sectors assembled to generate early input and guidance for the IWC project. Stakeholders from state and local government, nonprofits, industry, and Michigan's research community were present. Participants in this meeting were introduced to the project, and provided their feedback on the major opportunities and challenges associated with developing and implementing an integrated watershed-based management system in Michigan.

At the opening of the meeting, participants addressed the question: *What's one thing about today's topic that brings you to this session?* Six themes emerged from the participants' responses: 1) general curiosity; 2) desire to explore the potential of integrated approaches; 3) desire to improve water management; 4) need for water resource coordination; 5) the role of county drain governance; and 6) implementation of the State Water Strategy.

WORLD CAFÉ CONVERSATION FEEDBACK

Participants engaged in three rounds of table group conversation lasting 20 minutes each. Each participant had the opportunity to give input on the following three questions:

Question 1: *After hearing today's presentations, what is your initial impression of this project? Please share any views and/or questions you might have about the general idea of managing Michigan's waters using a watershed-based approach.*
Question 2: *What are your recommendations for improving how water is managed in Michigan?*
Question 3: *What aspects of the existing management system should not be changed? Why?*

Participants were given the option to offer individual written feedback prior to meeting adjournment. Three themes were noted from this feedback: 1) this meeting offered a promising start to the project based on the ideas that were shared in round table discussions; the challenge going forward will be to translate this dialogue into actionable steps and results; 2) there is a need for thoroughly defining/diagnosing the existing water management system; and 3) the drain commission perspective was dominant in the conversations.

SUMMARY

The IWC kick-off meeting generated feedback about opportunities and challenges associated with improving Michigan's current water management system. Participants identified both general and specific topics relevant to using a watershed-based approach to enhance the strategic management of Michigan's waters. This information provided a starting point for shaping possible structures and functions of IWCs.

Ideas and recommendations ranged across geographic, social, economic, policy, engineering, and scientific scales. This was expected given the intentionally diverse group of participants. However, certain themes did emerge from the collated information, which we divide into substantive and process categories:

Substantive themes:

- Integrated watershed management is a highly desirable goal, and is currently being done in some locations throughout Michigan, but not on a coordinated, statewide level.
- Implementation of a statewide integrated watershed management program will be complex and difficult, given existing structures.
- The path of least resistance may be modifying the current drain commissioner structure to identify opportunities for collaboration, coordination, and pooled resources; this may result in both economic efficiencies and guaranteed standards for contractors/consultants.

Process themes:

- Meeting participants expressed a nearly unanimous desire for further involvement in the project.
- The cooperative effort demonstrated by leaders at the meeting can serve as a foundation and model for the collaborative approach that will ultimately be required for thriving Integrated Watershed Commissions in Michigan.

NEXT STEPS

Individual and small group meetings were organized around targeted aspects of the IWC project in the year following this event. There was one additional large group stakeholder meeting held in Grand Rapids in August 2016 (see Appendix D).

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APPENDIX B: IWC CHALLENGE FRAMEWORK

As we began to assess the feasibility of managing Michigan's waters in a more integrated, watershed-based approach, the challenges facing us were clearly multi-faceted and often, quite stakeholder-specific. This, of course, is not very surprising, and is consistent with many natural resource problems. Based on input collected from water management professionals at the Integrated Watershed Commission kick-off meeting (November 2015), small group meetings, individual discussions, and additional research, we identified five areas that encompass Michigan's overarching management challenge areas. Associated challenges, gaps, and research needs are categorized within these five, non-mutually exclusive areas:

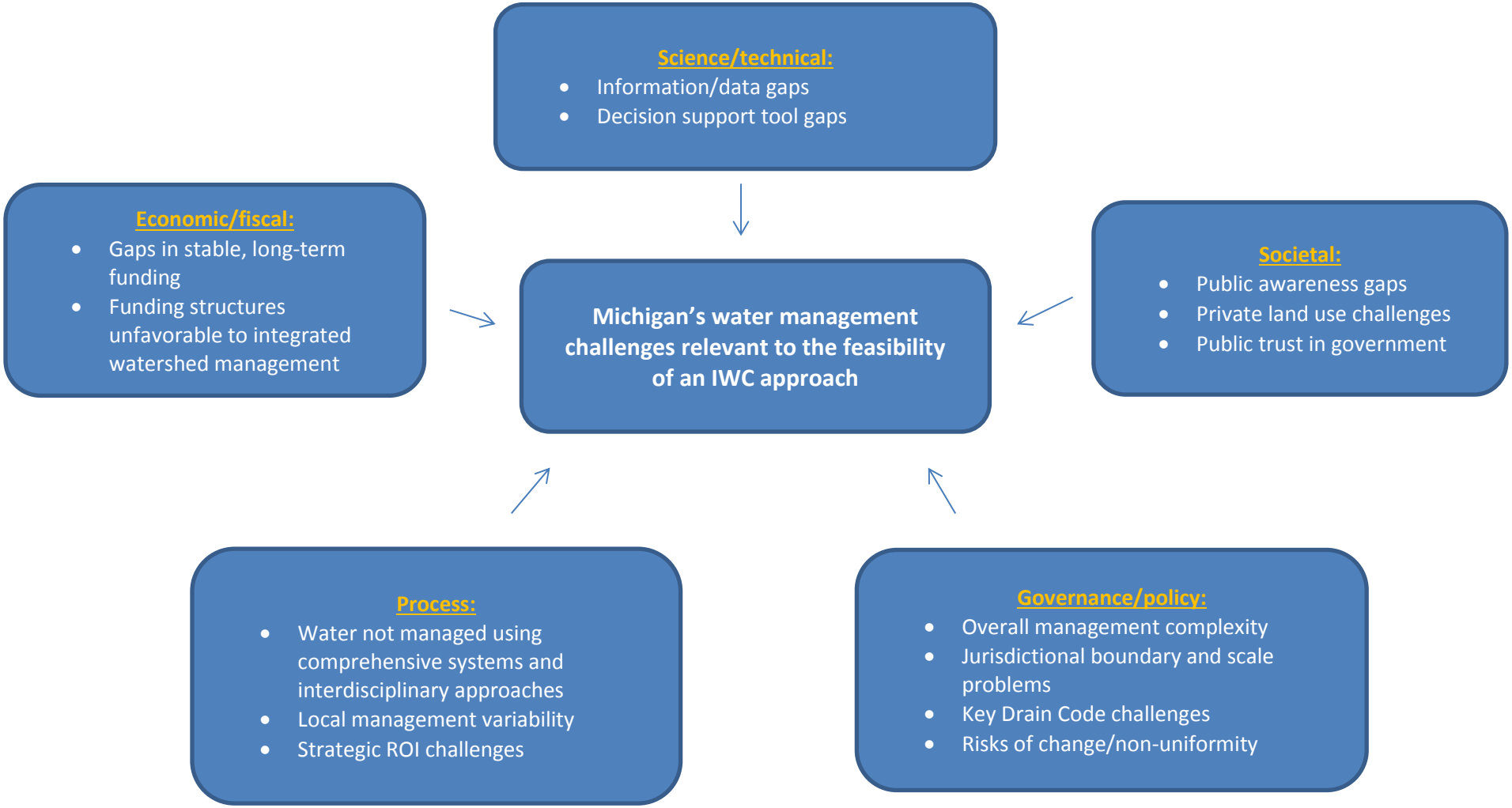
1. Science/technical
2. Societal
3. Economic/fiscal
4. Governance/policy
5. Process

The ensuing framework provides a summary of Michigan's water management challenges. The framework focuses on topics relevant to the feasibility of a statewide Integrated Watershed Commission approach; it is not intended to be an exhaustive list of every water management challenge across the state. Our purpose was to identify a finite set of statewide water management challenges to serve as a foundation as we explored the feasibility and viability of IWCs in Michigan.

The framework uses a hierarchical approach to summarize Michigan's water management challenges. The first tier, represented by the boxes in Fig. Appendix B.1 and numbered points below (in no particular order), describes the five overarching challenge areas. The next tier is a set of summarizing points about the major challenges in each of the five overarching areas. The third tier is composed of statements highlighting key management challenges in their respective categories. Additionally, included at the end of each numbered section is a set of recommended actions arising from the topics described in each of the five categories. Note that challenges and recommendations do not correspond one-to-one.

We are particularly focused on the third tier, addressing specific management challenges related to the idea of using an IWC approach in Michigan. This framework does **not** include a comprehensive analysis of potential legal barriers to a statewide IWC approach. Legal research was later conducted on specific issues that emerged through continued research.

Fig. Appendix B.1. Diagram identifying 5 management challenge areas and associated major topics.



SCIENCE/TECHNICAL CHALLENGES

A. Information/data gaps present barriers to science-based, best management approaches.

- Current knowledge of Michigan's water resources (supply) and use trends (demand) is incomplete, limiting our ability to identify possible conflicts in the future or plan appropriately.
- Causes of known water challenges are often misinterpreted or not well understood (e.g., assumptions and disputes about *E. coli* sources in specific waterways, or initial responses to Flint drinking water contamination), leading to poor resource management and possible litigation.
- Water monitoring activities across the state happen in an uncoordinated fashion and often lack integration with respect to adaptive management.

B. Use and formulation of decision support tools need revision and improved data to provide science-based, best management approaches.

- Insufficient data, along with a lack of refined hydrologic models for regional scale analysis, prevent the development of decision support tools that are needed to reliably diagnose and avoid impacts, conflicts, or other problem situations at local scales.
- Many county and local level water managers lack user-friendly decision support tools, including the capacity to translate data into usable knowledge.
- Limitations in local management capacity, including turnover in local offices, can hinder efforts to use shared decision support tools over the long term.
- The Water Withdrawal Assessment tool represents progress, but it is a coarse-scale screening tool that is focused only on groundwater, and does not explicitly address recharge.

Science/technical recommended actions:

A. Develop a state-wide water quality and quantity real-time monitoring strategy for surface and ground water systems, which recognizes these systems are hydrologically connected, and includes a data management system with open-source/public features.

B. Develop analytical decision support tools that provide critical guidance for integrated water resource management at local and regional watershed scales.

SOCIETAL CHALLENGES

A. The public lacks sufficient awareness of Michigan's water challenges, as well as the benefits of improved management – "there's not a problem until there's a problem":

- Too often only crisis attracts public attention and resources, leading to reactive thinking that often results in additional expense.
- Citizens and elected officials generally lack water literacy, including knowledge of local waters and linkages to the Great Lakes, constraining the state's capacity to protect, restore, and sustainably use its water resources.
- A lack of public appreciation/knowledge of science hinders understanding and support for science-based natural resource management, which can lead to misconceptions that create barriers for effective public engagement in water management activities.
- Water infrastructure is often located underground and out of visible sight, which hinders public awareness and appreciation of operation and maintenance needs.

B. Private land use has wide-ranging effects on shared water resources, resulting in inevitable tensions between private property rights and water management efforts.

- It can be difficult to get property owners to change behaviors impacting shared water resources; successful outcomes depend, at least in part, on effective communication between property owners and water managers.
- There is a general disconnect between public desire for clean water and knowledge/acceptance of how individual actions affect water resources, which creates barriers to sustainable water practices.
- Voluntary BMP programs have mixed results, implementation does not always happen in the optimal locations, and monitoring to assess the success of the BMPs is rare, all of which makes the cost-effectiveness of BMP programs difficult to assess.

C. Efforts to improve water management in Michigan face challenges associated with public attitudes about government.

- Public trust in government is undermined by occurrences of both environmental injustice (i.e., when disadvantaged populations are disproportionately affected by environmental and health hazards), and perceived indifference by government workers to the concerns of the citizenry.
- Public knowledge, values, and perspectives are often insufficiently incorporated into water planning and policy-making processes, which weakens management through perceptions of being top-down and illegitimate.

Societal recommended actions:

A. Start coordinated initiatives to educate citizens about benefits of improved water management, and expand opportunities to engage citizen volunteers and participation in water stewardship activities.

B. Develop public education and outreach initiatives that foster long-term appreciation for scientific knowledge and promote connections between people and nature.

C. Develop a strategy for diverse stakeholder engagement to build public trust in water governance, and to strengthen democratic participation in managing Michigan's water resources.

ECONOMIC/FISCAL CHALLENGES

A. There is a lack of stable, long-term funding for managing Michigan's waters.

- It is difficult to find new sources of statewide tax revenue in Michigan, thus new funds for improved water management typically require local public and/or private investment.
- Chasing money at small scales for individual projects is inefficient and fails to capture potential economic gains by leveraging funds at larger scales.
- Michigan's heritage of treating water as a free and unlimited resource is a barrier to quantifying the values of water itself and water-related environmental services.
- Michigan currently underinvests in drinking water infrastructure from $284 to $563 million annually, and an undetermined dollar amount in sewer infrastructure[12].

B. Current funding structures are generally not conducive to integrated watershed management.

- Constraints associated with competing interests in local government budgets are barriers to coordination efforts around shared water resources.

[12] See: *Michigan's Water Infrastructure Needs*, a report prepared for the Michigan Infrastructure and Transportation Association, April 2016.

- State funds for water resources are subject to the balance of competing interests in state government budgets.
- Interrelated resource issues are not (or rarely) coordinated around combined funding strategies for integrated, ecosystem-based goals.
- An uncoordinated patchwork of projects focused on shared issues creates competition over funds, making ecosystem-level goals difficult to achieve.
- Community capital improvement projects and budgets are rarely aligned with watershed planning and implementation activities.

Economic/fiscal recommended actions:

A. Develop a strategy for leveraging funds for an integrated water management approach aimed at achieving system-level goals for water resources, coordinating/combining funding for interrelated resource issues, and incorporating water quality into economic development opportunities.

B. Start a state-wide maintenance fund for water infrastructure.

C. Develop a strategy for strengthening both public and private investment in Michigan water resources, including public-private partnerships (cf. Project Clarity).

D. Explore alternative financing vehicles such as off-site mitigation or in lieu of fee programs, involving the trading or selling of water quantity or quality "credits" or payments into a fund overseen by the IWC structure, in both cases to be used for investment in restoration projects at scale.

GOVERNANCE/POLICY CHALLENGES

A. Michigan's complex arrangement of water management structures yields a wide range of coordination challenges:

- There are often too many units of government involved in water management activities, resulting in redundancies, inefficiencies, and other challenges that drive increased transaction costs for coordinated management of water resources.
- Internal state agency coordination challenges are barriers to interagency coordination efforts around water-related topics (e.g., the "silo" effect).
- Michigan's various water-related DEQ permitting procedures are extensive, confusing, and can generate disincentives to "do the right thing" (e.g., demonstrating permit compliance can be more costly than implementing improved management strategies).
- Inconsistent watershed planning and implementation wastes time, money, and other resources.
- Water-related data are often ineffectively shared and interpreted; and there is no person, institution, or system for managing existing data and collection activities.
- Current system complexity and uncertainty might be a deterrent to new business.

B. Existing political and administrative boundaries, as well as current water management scales, pose barriers to integrated watershed management statewide.

- The boundaries of Michigan's various water governance structures – state agencies, county drain offices, county road commissions, local governments, among others – are not strategically aligned with water resources. Additionally, there are often insufficient coordinating mechanisms for these structures.

- Water management is often done at fragmented scales, as opposed to deliberate arrangements of strategic scales.
- Coordination of land use rules across political and administrative boundaries based on shared water resources happens inconsistently, not in a systematic fashion statewide.

C. Michigan's Drain Code system poses barriers to integrated watershed management statewide:

- The legal definition of a "drain" is broad, unscientific, and leaves geographic gaps of waters excluded from Drain Code management.
- The Drain Code is aimed at achieving efficient drainage (i.e., managing for water quantity), and seldom addresses other management strategies, such as water quality topics or whole systems management. As a result, this legal framework does not accurately reflect current thinking in water and natural resource management; although it provides latitude for commissioners to use strategies aimed at topics other than water quantity, commissioners must use the Drain Code creatively to avail themselves of that ability.
- The Drain Code does not provide sufficient accountability structures for problems or disputes arising from drainage work, and elections by the populace are the sole mechanism for selecting or removing Drain Commissioners.

D. Government agencies face risks associated with change and non-uniformity, which hinders agencies' capacities to adapt to current and emerging water challenges.

- Michigan's approach of managing all waters for all uses (a uniform approach based on average water conditions) can result in diminished public engagement with water resources because stakeholders are often excluded from shaping goals/priorities and the associated tradeoffs for local waters.
- There can be unintended negative consequences associated with uniform and rigid guidelines for water-related regulatory activities (e.g., NPDES stormwater permitting incentivizes development horizontally away from urban centers, which further stresses water resources).

Governance recommended actions:

A. Develop strategies for all levels of government to work cooperatively on watershed-scale projects.

B. Review and overhaul, where appropriate, of Michigan Drain Code and other statutes where applicable, to reflect advances in our understanding in water resource management and governance.

C. Create watershed commissions to integrate appropriate water management functions under one administrative framework.

PROCESS CHALLENGES

A. Water resources are not managed on a whole systems basis or in coordination with related environmental, economic, and social factors.

- Water quality and quantity are not managed together in a coordinated fashion, yet they are integrally related.
- Surface and ground waters are not managed conjunctively in a coordinated fashion, yet they are hydrologically connected and directly influence each other.
- Water resources are rarely managed as whole system units whenever jurisdictional boundaries divide them, limiting the coordinated management of entire water systems.

- Integrated water and land use management happens sporadically and not in a coordinated fashion, limiting Michigan's ability to address persistent water and land use challenges on a statewide basis.

B. Local water managers across the state have widely variable resources and capabilities.

- Resources are highly variable among county drain offices, and some offices lack critical technology such as GIS, limiting their ability to effectively manage water resources.
- Some smaller communities face human capital gaps, as local water managers and related officials often perform a variety of duties.
- Successful outcomes depend heavily on the involvement of local champions, especially individuals who are willing to work for a range of water-related causes and not just their primary interests; because this varies from county to county, efficacy of water management is not consistent throughout the state.
- System managers in economically disadvantaged communities face significant challenges, and the greater good suffers with perceptions that it's only "their" problem.

C. Water managers at all levels face challenges associated with the strategic investment of limited resources in order to maximize returns.

- Local water managers are often unconnected to a statewide strategic vision that could guide local priorities and goal setting.
- Some small communities need better information and other resources to avoid repeating the mistakes of others.
- Many communities have inadequate information about conditions of water-related infrastructure, which limits prioritized decision-making about competing interests in public budgets.

Process recommended actions:

A. Develop incentives for all water management institutions, governmental and nongovernmental, to work cooperatively on watershed-scale projects.

B. Create watershed commissions to integrate environmental, social, and economic issues under one administrative framework.

APPENDIX C: IWC MODEL CASE STUDIES

We gleaned insights into designing an alternate water management system for Michigan by examining approaches used in other U.S. states. The five examples analyzed below (California, Florida, Minnesota, Nebraska, and Washington) each use different statewide, watershed-based management strategies that represent a range of approaches. By examining what has worked well and what hasn't worked well in these five examples, we designed a more informed approach to address Michigan's water management needs, as identified in our IWC Challenge Framework.

Our analytical approach was to first identify five key factors that are present in systems with effective water governance: 1) institutional capacity; 2) integrated watershed/basin management; 3) aligned scales; 4) adaptive governance through experimental problem-solving; and 5) democratic participation (Trachtenberg and Focht 2005, Sabel and Zeitlin 2008, GWP 2009, Huitema et al. 2009, von Korff et al. 2012, Pahl-Wostl and Knieper 2014, OECD 2015). We then rank, on a scale of 1-3, the degree to which each of these five factors are being implemented in five U.S. states that implement watershed management strategies (see below).

Rating guide: 1 = relatively few features of factor implemented; 2 = moderate to good implementation; 3 = very strong implementation. WMDs = water management districts; NRDs = natural resource districts; IRWM = integrated regional water management.

		FACTORS:				
		Institutional capacity	**Integrated watershed/basin management**	**Coordinated scales**	**Adaptive/ experimental problem-solving**	**Democratic participation**
States with watershed-based agencies	**Florida WMDs**	3	3	3	2	1
	Nebraska NRDs	2	3	2	2	3
States lacking watershed-based agencies	**California IRWM**	2	2	3	2	2
	Minnesota	3	2	2	3	3
	Washington	3	2	2	2	2

While we recognize there is some subjectivity to these ratings, we also view this as a qualitative exercise, and hence our final ratings are meant to be illustrative, not prescriptive. It is worth noting that each of Michigan's major water challenges identified in our IWC Challenge Framework could potentially be addressed by fulfilling these criteria for robust water governance.

Our analysis divides these five states into two basic models of statewide, watershed-based governance: (1) those with formalized, comprehensive water management agencies organized around river basin or watershed boundaries statewide (Florida, Nebraska); and (2) those lacking such agencies statewide but using various planning and coordinating strategies for integrated watershed management (California, Minnesota, Washington). Numerous U.S. states lacking formalized watershed-based management agencies use strategies similar to those seen in California, Minnesota, and Washington, whereas Florida and Nebraska are the only two states blanketed with comprehensive water management agencies organized around river basin or watershed boundaries.

FLORIDA WATER MANAGEMENT DISTRICTS (WMDS)

Established in 1972 with boundaries delineated according to the state's major watersheds, Florida's five Water Management Districts are comprehensive water management agencies. WMDs have broad authorities and responsibilities that include flood protection, stormwater management, technical investigations into water resources, water shortage plans, land acquisition and management, and regulatory programs. Districts are headed by non-paid citizen boards appointed by the governor, and WMDs employ full-time professional staffs (Purdum 2002). The Florida statutory framework that outlines WMD roles and responsibilities stresses the importance of establishing water management entities that possess expertise to make technical decisions, as opposed to judges or legislators with little specialized knowledge or experience (Regan 2003).

Institutional capacity: 3

WMDs have the necessary human, technical, financial and other resources to carry out a wide range of complex management functions (Wade 2001). All five Districts have ad valorem taxing authority and are well-financed with diverse funding portfolios, including FY 2015-2016 budgets ranging from $33 million to $749 million. Combined, they own and manage more than 1.7 million acres of land (Farr and Brock 2006, FLDEP 2016).

Integrated watershed/basin management: 3

WMDs use technically proficient, science-based approaches to develop and implement comprehensive water policies to address the hydrologic cycle in entire watersheds. District policies account for conjunctive management of surface and ground waters, as well as relationships between water quantity and quality (Regan 2003).

Aligned scales: 3

WMDs represent the basin-scale component of a coordinated water management approach that also includes local and state level stakeholders. Although Districts have relative freedom to operate, they are supervised by the Florida Department of Environmental Protection, required to support and assist local governments, and the governor has approval power over WMD budgets and expenditures (Stoa 2014). WMD Governing Boards, not staff, set District policy.

Adaptive governance through experimental problem-solving: 2

Although Florida has no official policy mandate for adaptive governance, in practice, Districts use science-based management approaches that demonstrate adaptive cycle elements. This factor could be strengthened in Florida through either formal requirements for adaptive approaches or improved communication of existing adaptive governance strategies.

Democratic participation: 1

WMDs are required to collaborate with local governments in various capacities, but Districts have not been immune to accusations that their decisions reflect special interests instead of the public interest. The tendency of political parties in Florida to favor one of its three main water users (agriculture, urban development, the environment) may contribute to inconsistent long-term water management and strategic planning (Stoa 2014, National Academies of Science 2016). Additionally, governing boards with ad valorem taxing authorities are appointed by the governor, as opposed to elected by the populace, which conflicts with the foundational principle of American government of accountability of those with taxing authority through elections (Christaldi 1996).

NEBRASKA NATURAL RESOURCE DISTRICTS (NRDS)

Established in 1972, Nebraska's system of Natural Resource Districts is a bioregional approach to natural resource management that is unique to the U.S. and perhaps the world. The state's 23 NRDs, delineated around river basin boundaries, are comprehensive natural resource management agencies with taxing power, and management and regulatory duties in a wide range of areas. NRDs are responsible for coordinated surface and groundwater management, flood and soil erosion control, drainage, forestry and range management, fish and wildlife habitat, and recreation. These 23 NRDs are self-governed by locally-elected citizen boards, and they employ full-time professional staffs (Jenkins 1975, Stephenson 1996).

Institutional capacity: 2

NRDs have the formal authority to carry out a wide range of management functions, but the institutional capacity of some Districts has been limited by inadequate and variable funding. NRD budgets for FY 2013-2014 ranged from $900,000 to $17 million (NENRD 2016), and there is a need for supplemental statewide funding to ensure that all NRDs have adequate baseline resources (Bleed and Hoffman Babbitt 2015).

Integrated watershed/basin management: 3

NRDs are multipurpose districts organized at the river basin scale that manage whole water systems and related natural resources. NRDs partner with state government to implement Nebraska's integrated surface and ground water management law, which prevents overharvesting of water by requiring conjunctive management in areas where surface and ground waters are hydrologically connected (Bleed and Babbitt 2015).

Aligned scales: 2

The NRD system is a large-scale, local-control management approach, and Districts have been generally successful at coordinating local governments within their borders. However, given limited state control over individual NRDs, as well as the relatively large number of Districts (23), the system as a whole faces challenges to effectively engage at multiple scales and across NRD boundaries (Bleed and Babbitt 2015).

Adaptive governance through experimental problem-solving: 2

Nebraska state law mandates adaptive management plans where surface and ground waters are connected. Some NRDs use additional management strategies that demonstrate basic adaptive cycle elements, but there are no formal adaptive management requirements for NRDs other than where surface-ground connections exist (Bleed and Babbitt 2015). Similar to Florida, this factor could be strengthened through either formal requirements for adaptive approaches or improved communication of existing governance strategies.

Democratic participation: 3

NRDs operate at scales that reflect local perspectives in water and other natural resource management decisions. Districts can set different rules for different areas within their borders, and often sub-areas are established to address issues of concern in specific locations. Governing boards with ad valorem taxing authority are determined by local elections, which serve as a public check on NRD leadership (Stephenson 1996, Bleed and Babbitt 2015).

CALIFORNIA INTEGRATED REGIONAL WATER MANAGEMENT (IRWM)

IRWM is a regional planning initiative launched in 2002 in response to challenges associated with fragmented water management across California. State agencies in California fulfill federal water quality and infrastructure management requirements, but many decisions about drinking water, flood control, irrigation, and other management functions are primarily county and local government responsibilities. IRWM aims to encourage integrated regional strategies for a range of water management activities, including drought planning, groundwater management, water quality improvement, reducing dependence on water imported from distant sources, ecosystem restoration, data management, and other goals. IRWM provides competitive grants as well as technical and facilitation services to voluntary stakeholder partnerships in self-identified geographic regions (Watson et al. 2011). These partnerships, called "regional water management groups", are free to establish their own governance structures using any combination of memorandums of understanding, ad-hoc agreements, or Joint Powers Authorities (CADWR 2015).

Institutional capacity: 2

IRWM is led at the state level by the California Department of Water Resources. IRWM is currently well-funded, including over $4 billion in voter-approved bonds and matching funds, with programs covering 87% of the state's geographic area and 99% of the state's population (CADWR 2013). However, the long-term viability of IRWM is unknown because individual programs have produced mixed results, which affects the public's long-term willingness to fund (Lubell and Lippert 2011, Hughes and Pincetl 2014). IRWM partnership structures and management activities vary widely, which makes it difficult to assess overall institutional capacity.

Integrated watershed/basin management: 2

Progress towards integrated watershed management varies widely among California's IRWM programs (Hughes and Pincetl 2014); any change from fragmented/local to integrated/regional management in California under IRWM programs would likely be incremental and evolutionary (Lubell and Lippert 2011).

Aligned scales: 3

Regional water management groups, which are the administrative bodies formed for IRWM programs, are self-organized at scales according to water management needs in particular regions, such as river basin or groundwater system boundaries. Regional planning and implementation activities happen with financial incentives, technical assistance, and guidance provided at the state level to ensure that regional and state goals are aligned (Watson et al. 2011). Evidence suggests that IRWM activities are beginning to shape water planning priorities at the local level (Hughes and Pincetl 2014).

Adaptive governance through experimental problem-solving: 2

IRWM plan standards have few formal requirements regarding adaptive governance, but they are evaluated for adaptability to climate change in particular regions, and IRWM programs often encourage innovative experimentation at local levels (Bateman and Rancier 2012). Some longer-established IRWM

groups have gone through iterative planning processes using scientific advances in modeling to better meet changing planning needs (Langridge et al. 2014).

Democratic participation: 2
Composition of IRWM stakeholder groups varies according to the size and geographic location of the region, but IRWM guidelines require that all planning groups consider and attempt to involve disadvantaged communities in their planning processes (CADWR 2015). Additional research is needed to determine if IRWM programs are more successful at infusing local knowledge and perspectives into water management decisions than existing watershed planning organizations, as this is an underexplored topic (Hughes and Pincetl 2014).

MINNESOTA
Minnesota's state level water management approach exists in an integrated governance structure of five agencies, with roles and responsibilities clearly defined by the Minnesota Water Management Framework (Lewis 2015). The state also has a long history of local watershed planning and management, dating back to the 1955 Minnesota Watershed Act that allowed for the voluntary establishment of watershed districts with taxing authority. In 2015, Minnesota launched two major initiatives: (1) the "One Watershed, One Plan program", which is an effort to cover the whole state with HUC-8 scale comprehensive watershed management plans (MNBWSR 2014); and (2) a statewide mandatory buffer requirement that applies to all lands adjacent to rivers, streams, and ditches (MNBWSR 2015).

Institutional capacity: 3
Minnesota's collaborative local-state approach to water management involves many units of government, and together they have the capacity to carry out complex water management functions statewide (Stein et al. 2013, MNBWSR 2014). In 2008 Minnesota amended its state constitution to include a $^{3}/_{8}$ percent state sales tax that secures long-term funding for various clean water initiatives (Legislative Coordinating Commission 2016).

Integrated watershed/basin management: 2
Although Minnesota lacks comprehensive water management institutions organized at the basin or watershed level, the state's approach demonstrates significant progress towards integrated water systems management. Key features include: the coordinated implementation of the state's Surface Water Quality and Groundwater Management Frameworks (Lewis 2015), watershed-based permitting processes for water-related matters, and a robust water quality monitoring and assessment program that has permanent flow and chemistry monitoring stations at the outlets of each of the state's 81 major watersheds (MNPCA 2008). The One Watershed, One Plan initiative aims to improve integrated watershed management in Minnesota, and its results are yet to be assessed.

Aligned scales: 2
Minnesota has a strong tradition of shared local and state responsibility in watershed planning and management. Local and state governments have clearly defined roles and responsibilities for administering core services in watersheds under some existing plans, and the One Watershed, One Plan program aims to expand this local-state coordination statewide (M. Lewis, personal communication, December 1, 2015).

Adaptive governance through experimental problem-solving: 3
The Minnesota Water Management Framework, which defines state agency roles and responsibilities for water resources, is organized according to an adaptive cycle (Lewis 2015). Also, Minnesota's history

is marked by various policy and management experiments, from its 1937 Soil Conservation Law to the current One Watershed, One Plan program (MNBWSR 2014).

Democratic participation: 3
The recently underway One Watershed, One Plan program is a "bottom-up" approach that enables key decisions about problems, concerns, goals, and potential strategies to originate in local communities (MNBWSR 2014). Minnesota also has a Local Government Water Roundtable, an affiliation of nearly 400 local water managers from around the state, which provides consensus recommendations to state policy makers (LGWR 2013).

WASHINGTON
A key feature of Washington's water management approach is integrated state government across agencies where management areas affect water resources. For instance, Washington manages nonpoint source pollution through coordinated implementation of regulations in four corresponding areas: water quality rules, forest practices, dairy nutrient management, and on-site sewage regulations (WAECY 2015). Another key feature of Washington's approach is the Watershed Planning Act of 1998 (Revised Code of Washington § 90.82), a law that delineates the state's major watersheds into 62 Water Resource Inventory Areas for stakeholders to voluntarily develop watershed management plans. Upon adoption by local governments and approval by the state's Department of Ecology, watershed plans become legally binding commitments among all participating governments (EPA 2002, Leach et al. 2002, Reisert et al. 2015). Twelve state agencies signed a memorandum of understanding clarifying roles and responsibilities for the Watershed Planning Act (WAECY 1998).

Institutional capacity: 3
The robust Department of Ecology is the agency primarily responsible for a wide range of water management functions at the state level, including administering grant funds that incentivize watershed planning and implementation activities under the Watershed Planning Act. Local governments have varied capacities and responsibilities statewide (WAECY 2015).

Integrated watershed/basin management: 2
Washington does not have comprehensive water management institutions organized at the watershed or basin scale, but the state's approach includes both watershed-based strategies and the integrated management of water with related environmental factors. Additionally, state law requires interdisciplinary social and natural science-based approaches to all "planning and decision-making which may have an impact on man's environment" (Revised Code of Washington § 43.21C).

Aligned scales: 2
Some local water decisions are coordinated with state level strategies through watershed-scale partnerships between local stakeholders and state agencies under the WPA (Leach et al. 2002). Other water-related management activities also indicate local-state coordination, including local land use regulation under the state's Growth Management Act, and county waste ordinances coordinated with the Washington State Water Pollution Control Act (WAECY 2015).

Adaptive governance through experimental problem-solving: 2
Various water programs housed in the Department of Ecology explicitly reference science-based, adaptive management approaches (Granger et al. 2005). As an interesting example of both adaptive and integrated resources management, Washington's forest management program uses conditions of aquatic resources as a basis for shaping its annual forestry rules (Washington Code § 222-12-045).

Adaptive water governance in Washington could be improved through either formal requirements for adaptive approaches or improved communication of existing strategies.

Democratic participation: 2
Washington's collaborative watershed planning activities infuse local knowledge and values in water decisions through extended, face-to-face deliberations that facilitate consensus and cooperation. Participants in the WPA program claim that watershed planning builds trust among citizens and government agencies (Reisert et al. 2015). Democratic participation in Washington could be strengthened with additional public engagement strategies beyond watershed planning, such as Minnesota's Local Government Water Roundtable.

CONCLUSIONS

Michigan's water management situation, including the major challenges we identify in our IWC Challenge Framework, appears to leave room for significant improvement regarding the five factors for effective water management described above:

1. Institutional capacity around the state varies widely. Some water managers face a range of challenges associated with financial constraints, information/data gaps, lack of baseline resources, and aging infrastructure.
2. Michigan does not have an integrated watershed/basin management approach. Such strategies are used sporadically, but whole water systems are not managed in a coordinated fashion statewide.
3. Michigan's water management scales are highly fragmented and poorly aligned. Decisions at all levels are rarely, if ever, aligned to promote the strategic governance of water systems across the complete hydrologic cycle.
4. Adaptive governance strategies in Michigan are limited. For example, the effectiveness of current or recent management strategies is often not assessed, and Michigan has no inventory of past watershed projects and their results. An improved statewide approach would emphasize strategies to manage for uncertain and changing conditions.
5. Michigan's long tradition of water management at the local level could be an asset for democratic participation, but the state still faces challenges related to public awareness, engagement, and willingness to fund water resources.

The idea that Michigan's water management approach could be improved is certainly not a new one, and initiatives are currently underway aimed at making improvements that pertain to all five factors for effective water governance described above. For example, the Michigan Water Collaboration Network is an online tool launched by the MDEQ and the U-M Water Center that links state quality of life agency personnel with the research community. This tool promotes increased collaboration among governmental and nongovernmental stakeholders for water-related issues. Additionally, Michigan's *Water Strategy*, recently released by the Michigan Office of Great Lakes, lays out 62 recommendations for various ecological, social, economic, and cultural goals relevant to the state's water resources. The *Water Strategy* goals relate to all five factors of effective water management, and perhaps most importantly, they provide a comprehensive vision at the state level that offers guidance for all water managers statewide.

Based on activities such as the Water Collaboration Network, the *Water Strategy*, and Michigan's Blue Economy (Austin and Steinman 2015), it is evident that there is renewed statewide recognition of how important water is to Michigan's future. While recognition and awareness of its value is a critical first

step to improving how we manage this vital natural resource, the next steps of identifying and implementing the needed changes pose significant challenges.

Our analysis explores a range of management approaches used by other U.S. states to address their challenges and work towards effective water governance. An alternative water management approach for Michigan could borrow from any number of these model strategies and others that might suit our needs, reshaping them appropriately within a vision of ideal water governance for Michigan.

APPENDIX D: IWC WORKSHOP REPORT

We began working with a broad range of water professionals in Fall 2015 to identify Michigan's major water management challenges. Input collected from the project kick-off event, as well as more than 40 additional individual and small group meetings, was incorporated into our Challenge Framework document, highlighting challenges relevant to a statewide integrated watershed management approach. A series of recommended actions was then generated in response to the identified challenges. In August 2016, 42 project team members convened in Grand Rapids for a workshop to provide feedback and input on the draft recommendations.

Workshop participants deliberated in one of four thematic breakout groups (science/technical, societal, economic/fiscal, governance/management) to accomplish two tasks: (1) identify actionable first steps to move each recommendation forward; and (2) identify gaps and/or provide additional feedback on the draft recommendations.

Following the breakout session, each item generated in the breakout groups was polled in large-group format to assess its supportability. One limitation of our polling process was the lack of time to provide an in-depth overview of each question; hence, it is possible that some negative responses may reflect a lack of understanding associated with the action, as opposed to a true rejection.

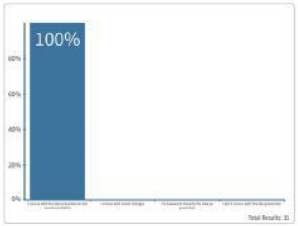
Our draft recommendations are included below in colored boxes organized by theme. The proposed steps generated by the breakout groups are numbered below our draft recommendations, followed by large-group polling results for each item. A summarizing paragraph following each of the four thematic sections highlights key findings about proposed ideas and polling feedback.

SCIENCE/TECHNICAL

Science/Technical Recommendation A:

Develop a state-wide water quality and quantity real-time monitoring strategy for surface and ground water systems, which recognizes these systems are hydrologically connected, and includes a data management system with open-source/public features.

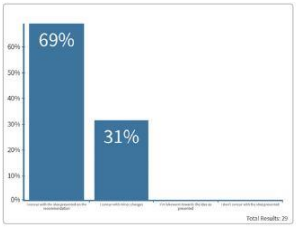
(1) Identify an owner and funding of strategy development.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	31	100%
I concur with minor changes	0	0%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

31
Responses

(2) Identify the needs that should drive the strategy.

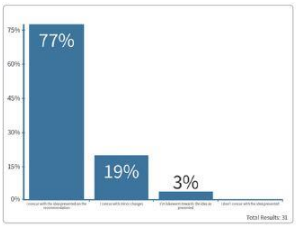


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**20**	**69%**
I concur with minor changes	9	31%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

85% Engagement

29 Responses

(3) Create an inventory of what strategies are already underway, including biological monitoring strategies.

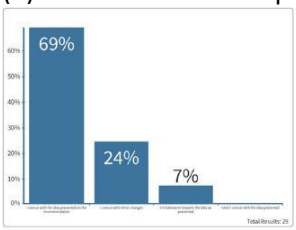


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**24**	**77%**
I concur with minor changes	6	19%
I'm lukewarm towards the idea as presented	1	3%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(4) Perform risk-based prioritization of the needs (including necessary categorizations).

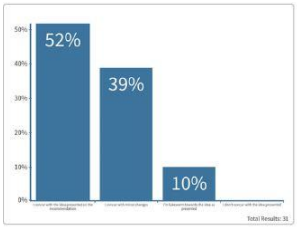


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**20**	**69%**
I concur with minor changes	7	24%
I'm lukewarm towards the idea as presented	2	7%
I don't concur with the idea presented	0	0%

85% Engagement

29 Responses

(5) Create a funding mechanism that programmatically ties in research, development, and operations.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**16**	**52%**
I concur with minor changes	12	39%
I'm lukewarm towards the idea as presented	3	10%
I don't concur with the idea presented	0	0%

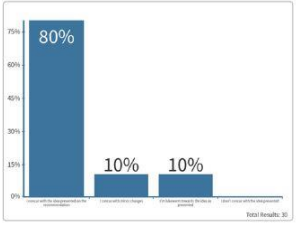
91% Engagement

31 Responses

Science/Technical Recommendation B:

Develop analytical decision support tools that provide critical guidance for integrated water resource management at local and regional watershed scales.

(1) Identify owner and funding of tool development.

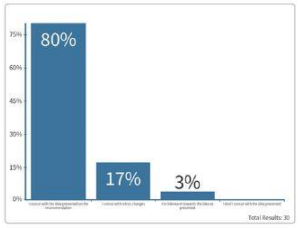


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**24**	**80%**
I concur with minor changes	3	10%
I'm lukewarm towards the idea as presented	3	10%
I don't concur with the idea presented	0	0%

88% Engagement

30 Responses

(2) Create an inventory of the tools that already exist.

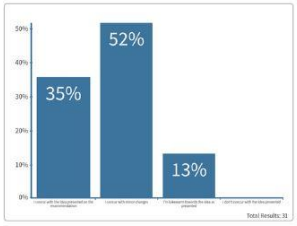


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**24**	**80%**
I concur with minor changes	5	17%
I'm lukewarm towards the idea as presented	1	3%
I don't concur with the idea presented	0	0%

88% Engagement

30 Responses

(3) Perform risk-based evaluation of the parameters that should be included in the tool.

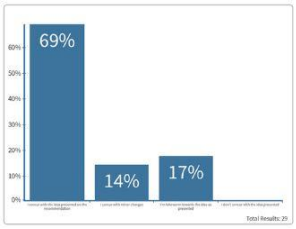


Response options	Count	Percentage
I concur with the idea presented on the recommendation	11	35%
I concur with minor changes	**16**	**52%**
I'm lukewarm towards the idea as presented	4	13%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(4) Create a funding mechanism that includes a programmatic tie to research, development, operations, education, and communication.

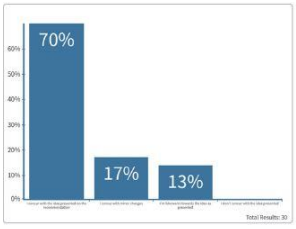


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**20**	**69%**
I concur with minor changes	4	14%
I'm lukewarm towards the idea as presented	5	17%
I don't concur with the idea presented	0	0%

85% Engagement

29 Responses

(5) Investigate alternative funding mechanisms.



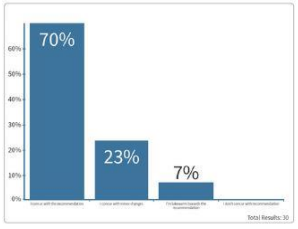
Response options	Count	Percentage
I concur with the idea presented on the recommendation	**21**	**70%**
I concur with minor changes	5	17%
I'm lukewarm towards the idea as presented	4	13%
I don't concur with the idea presented	0	0%

88% Engagement

30 Responses

Additional Science/Technical Recommendations:

(1) Concurrently design an implementation plan for the [monitoring/data management and decision support tool development] strategy.



Response options	Count	Percentage
I concur with the recommendation	**21**	**70%**
I concur with minor changes	7	23%
I'm lukewarm towards the recommendation	2	7%
I don't concur with recommendation	0	0%

88% Engagement

30 Responses

SUMMARY OF PROPOSED STEPS AND POLLING FEEDBACK – SCIENCE/TECHNICAL THEME

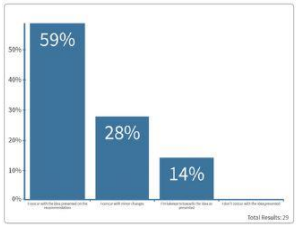
All proposed steps on the science/technical recommendations had strong (>80%) support, and not one step received a non-concurrence. The proposal to identify an owner and funding strategy for a statewide coordinated monitoring and data management system was the only item in the workshop to garner 100% concurrence without even minor changes. These results are consistent with studies that have shown widespread support of science to help resolve contentious, natural resource issues; the more telling situation occurs after the scientific studies are completed, and the findings don't support particular positions (e.g., Steinman et al. 2002).

SOCIETAL

Societal Recommendation A:

Start coordinated initiatives to educate citizens about benefits of improved water management, and expand opportunities to engage citizen volunteers and participation in water stewardship activities.

(1) Centralized information website related to water education and resources - where these resources are mapped and aligned with current curriculum standards.

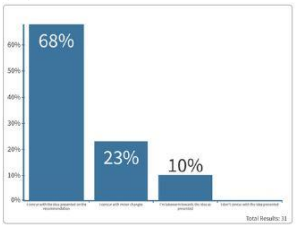


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**17**	**59%**
I concur with minor changes	8	28%
I'm lukewarm towards the idea as presented	4	14%
I don't concur with the idea presented	0	0%

85% Engagement

29 Responses

(2) Create incentives for teachers to utilize water literacy programs.

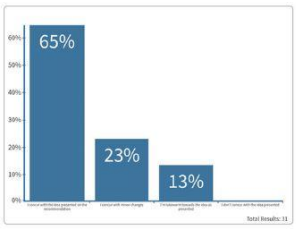


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**21**	**68%**
I concur with minor changes	7	23%
I'm lukewarm towards the idea as presented	3	10%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(3) Work to mandate curriculum for water literacy principles in all schools (much like current MI history requirements for all 4th graders).

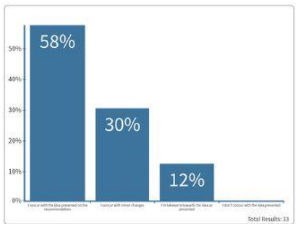


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**20**	**65%**
I concur with minor changes	7	23%
I'm lukewarm towards the idea as presented	4	13%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(4) Share watershed-specific information with the current required water quality/attainment information.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**19**	**58%**
I concur with minor changes	10	30%
I'm lukewarm towards the idea as presented	4	12%
I don't concur with the idea presented	0	0%

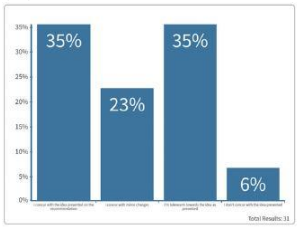
97% Engagement

33 Responses

Societal Recommendation B:

Develop public education and outreach initiatives that foster long-term appreciation for scientific knowledge and promote connections between people and nature.

(1) Create a statewide water service day.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**11**	**35%**
I concur with minor changes	7	23%
I'm lukewarm towards the idea as presented	**11**	**35%**
I don't concur with the idea presented	2	6%

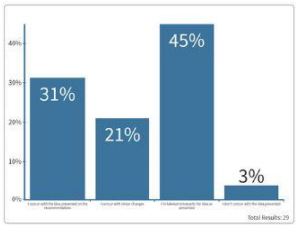
91% Engagement

31 Responses

Societal Recommendation C:

Develop a strategy for diverse stakeholder engagement to build public trust in water governance, and to strengthen democratic participation in managing Michigan's water resources.

(1) Develop and implement a water fellows program and network that acts as local champions to help facilitate building public trust in water governance.

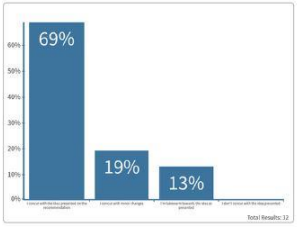


Response options	Count	Percentage
I concur with the idea presented on the recommendation	9	31%
I concur with minor changes	6	21%
I'm lukewarm towards the idea as presented	**13**	**45%**
I don't concur with the idea presented	1	3%

85% Engagement

29 Responses

(2) Engage business groups (e.g., MI Brewers Guild) in facilitating discussion and promoting resources as it relates to their craft.

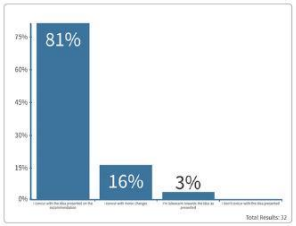


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**22**	**69%**
I concur with minor changes	6	19%
I'm lukewarm towards the idea as presented	4	13%
I don't concur with the idea presented	0	0%

94% Engagement

32 Responses

(3) Support MSU Extension and MI Sea Grant's work on "water school" for local decision-makers.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**26**	**81%**
I concur with minor changes	5	16%
I'm lukewarm towards the idea as presented	1	3%
I don't concur with the idea presented	0	0%

94% Engagement

32 Responses

SUMMARY OF PROPOSED STEPS AND POLLING FEEDBACK – SOCIETAL THEME

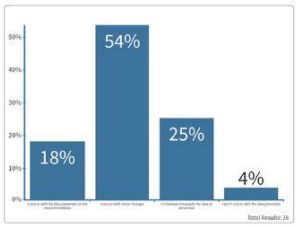
There was strong (>85%) support for all four proposed steps on Recommendation A, three of which addressed K-12 education strategies. Support for a water service day and a water fellows program was limited, perhaps due to redundancy with existing programs. Water School for local decision-makers received 31/32 (97%) supporting votes, making it the most strongly endorsed item in the Societal category. The positive feedback on Water School may stem, at least in part, from the idea that building public trust in water governance involves educating local officials to make well-informed decisions about water resources at the community level; the support also may reflect respect for MI Sea Grant and MSU Extension by the participants.

ECONOMIC/FISCAL

Economic/Fiscal Recommendation A:

Develop a strategy for leveraging funds for an integrated water management approach aimed at achieving system-level goals for water resources, coordinating/combining funding for interrelated resource issues, and incorporating water quality into economic development opportunities.

(1) Water systems managers organize around the resource under NPS, drinking water, and wastewater (for assessment, planning and funding at the appropriate scale).

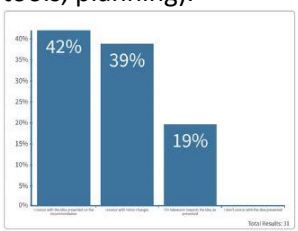


Response options	Count	Percentage
I concur with the idea presented on the recommendation	5	18%
I concur with minor changes	**15**	**54%**
I'm lukewarm towards the idea as presented	7	25%
I don't concur with the idea presented	1	4%

82% Engagement

28 Responses

(2) Develop methodology to identify intersecting water systems management opportunities (e.g., GIS tools, planning).

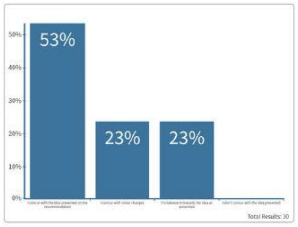


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**13**	**42%**
I concur with minor changes	12	39%
I'm lukewarm towards the idea as presented	6	19%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(3) Utilize area-wide water quality planning as a way to organize and fund integrated planning (e.g., Section 208 CWA).

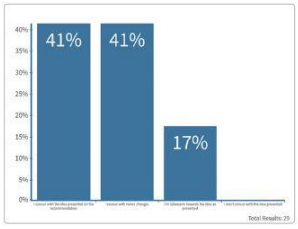


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**16**	**53%**
I concur with minor changes	7	23%
I'm lukewarm towards the idea as presented	7	23%
I don't concur with the idea presented	0	0%

88% Engagement

30 Responses

(4) Endorse WEHI funding legislation (a low-income water services funding program) at federal level.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**12**	**41%**
I concur with minor changes	**12**	**41%**
I'm lukewarm towards the idea as presented	5	17%
I don't concur with the idea presented	0	0%

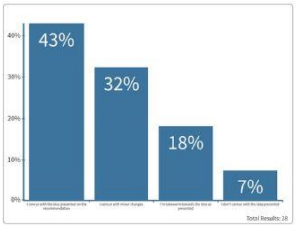
85% Engagement

29 Responses

Economic/Fiscal Recommendation B:

Start a state-wide maintenance fund for water infrastructure.

(1) [Support] Governor Snyder's 21st century infrastructure recommendations.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**12**	**43%**
I concur with minor changes	9	32%
I'm lukewarm towards the idea as presented	5	18%
I don't concur with the idea presented	2	7%

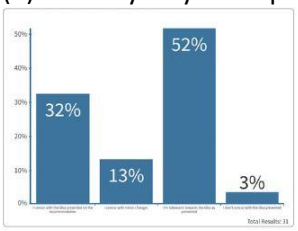
82% Engagement

28 Responses

Economic/Fiscal Recommendation C:

Develop a strategy for strengthening both public and private investment in Michigan water resources, including public-private partnerships.

(1) Identify ways to repay capital for private sector in public/private partnership investments.

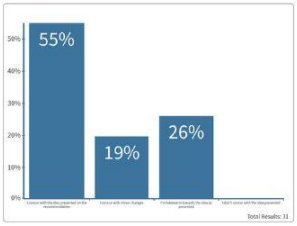


Response options	Count	Percentage
I concur with the idea presented on the recommendation	10	32%
I concur with minor changes	4	13%
I'm lukewarm towards the idea as presented	**16**	**52%**
I don't concur with the idea presented	1	3%

91% Engagement

31 Responses

(2) Do analysis of current statutory barriers to public/private partnerships.

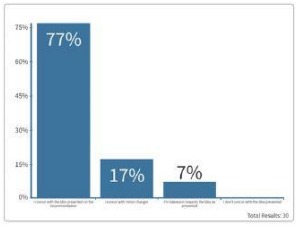


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**17**	**55%**
I concur with minor changes	6	19%
I'm lukewarm towards the idea as presented	8	26%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(3) Highlight/showcase the success of past and current public investments (e.g., GLRI, SAW).



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**23**	**77%**
I concur with minor changes	5	17%
I'm lukewarm towards the idea as presented	2	7%
I don't concur with the idea presented	0	0%

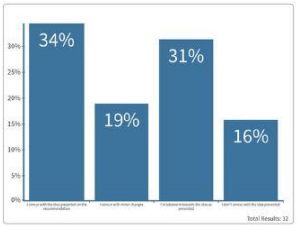
88% Engagement

30 Responses

Economic/Fiscal Recommendation D:

Explore alternative financing vehicles such as off-site mitigation or in lieu of fee programs, involving the trading or selling of water quantity or quality "credits" or payments into a fund, in both cases to be used for investment in restoration projects at scale.

(1) Increase Bottle Bill fund and expand its use.

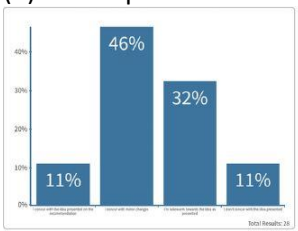


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**11**	**34%**
I concur with minor changes	6	19%
I'm lukewarm towards the idea as presented	10	31%
I don't concur with the idea presented	5	16%

94% Engagement

32 Responses

(2) Develop a statewide water-systems banking system program, and fund at the appropriate scale, TBD.

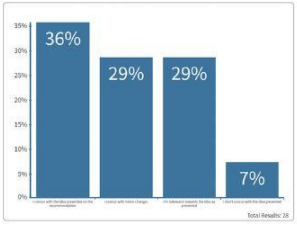


Response options	Count	Percentage
I concur with the idea presented on the recommendation	3	11%
I concur with minor changes	**13**	**46%**
I'm lukewarm towards the idea as presented	9	32%
I don't concur with the idea presented	3	11%

82% Engagement

28 Responses

(3) Develop a statewide water-systems banking program, and fund at the watershed scale.

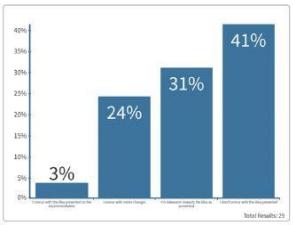


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**10**	**36%**
I concur with minor changes	8	29%
I'm lukewarm towards the idea as presented	8	29%
I don't concur with the idea presented	2	7%

82% Engagement

28 Responses

(4) Develop a statewide water-systems banking program, and fund at the Regional Prosperity Boundary scale.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	1	3%
I concur with minor changes	7	24%
I'm lukewarm towards the idea as presented	9	31%
I don't concur with the idea presented	**12**	**41%**

85% Engagement

29 Responses

SUMMARY OF PROPOSED STEPS AND POLLING FEEDBACK – ECONOMIC/FISCAL THEME

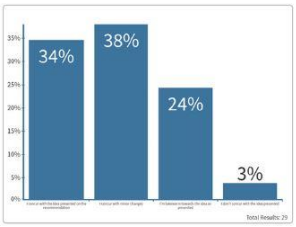
Support for proposed economic/fiscal steps was the most variable among the four categories. This might be due to the brief time (often <1 minute) allocated to explaining complex economic/fiscal topics, some of which require specific knowledge about programs and initiatives (e.g., SAW, water systems banking). Funding mechanisms was a contentious topic, and none of the four proposed steps for alternative financing vehicles received widespread support. Developing a water systems banking program at the RPI (Regional Prosperity Initiative)-scale received the most non-concurrence votes (41%) of any item polled in the workshop; as with some of the other more complex or unfamiliar ideas, this could be due to a lack of understanding of the proposals under consideration. The polarizing responses with respect to steps requiring financial resources suggest that strategies to implement Integrated Watershed Commissions need to emphasize fiscal benefits, such as reducing redundancies, more streamlined management, and enhancement of ecosystem services.

GOVERNANCE/MANAGEMENT

Governance/Management Recommendation A:

Develop incentives for all water managers, governmental and nongovernmental, to work cooperatively on watershed-scale projects.

(1) All water-related state grants (e.g., transportation, agriculture, land use, natural resources, water quality) are awarded for having numerous watershed partners and some level of commitment and/or defined role. When a project crosses political lines, define by hydrology/geology rather than political boundaries.

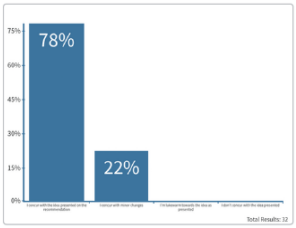


Response options	Count	Percentage
I concur with the idea presented on the recommendation	10	34%
I concur with minor changes	**11**	**38%**
I'm lukewarm towards the idea as presented	7	24%
I don't concur with the idea presented	1	3%

85% Engagement

29 Responses

(2) Identify all grant programs that can add criteria that award or give incentives for cooperative watershed-scale projects.

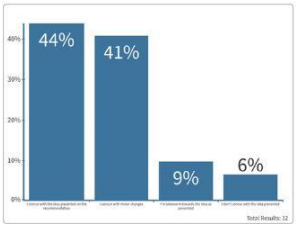


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**25**	**78%**
I concur with minor changes	7	22%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

32
Responses

(3) Support local water advocates to engage in the political/planning process:

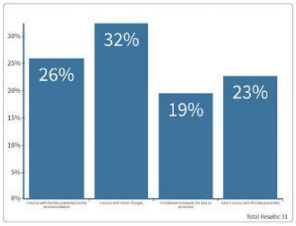
- Provide training to local citizens on how to engage local decision-making processes.
- Increase communications with public and advocacy groups.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**14**	**44%**
I concur with minor changes	13	41%
I'm lukewarm towards the idea as presented	3	9%
I don't concur with the idea presented	2	6%

32
Responses

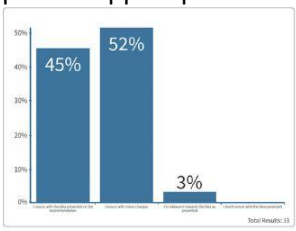
(4) Provide points in the permitting process if you engage or consult watershed councils or local advocates.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	8	26%
I concur with minor changes	**10**	**32%**
I'm lukewarm towards the idea as presented	6	19%
I don't concur with the idea presented	7	23%

31
Responses

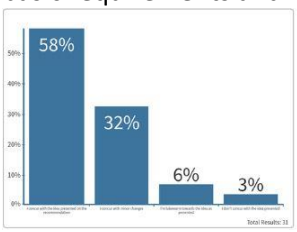
(5) Channel state/federal funds available to those working cooperatively at watershed-scale based on a public support plan.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	15	45%
I concur with minor changes	**17**	**52%**
I'm lukewarm towards the idea as presented	1	3%
I don't concur with the idea presented	0	0%

33
Responses

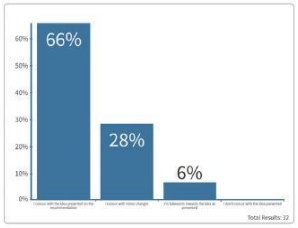
(6) Have the ability to levy local assessments only if a plan is in place that is watershed-level and meets basic requirements and issues.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**18**	**58%**
I concur with minor changes	10	32%
I'm lukewarm towards the idea as presented	2	6%
I don't concur with the idea presented	1	3%

31
Responses

(7) Utilize incentives at landowner scale by making drain assessment allocations based on amount being delivered to the drain (benefit derived).



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**21**	**66%**
I concur with minor changes	9	28%
I'm lukewarm towards the idea as presented	2	6%
I don't concur with the idea presented	0	0%

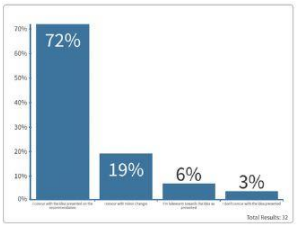
94% Engagement

32 Responses

Governance/Management Recommendation B:

Review and overhaul, where appropriate, of Michigan Drain Code and other statutes where applicable, to reflect advances in our understanding in water resource management and governance.

(1) Review past language proposed for Drain Code to allow for inter-county watershed planning that allows for more implementation authority.

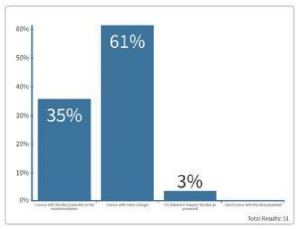


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**23**	**72%**
I concur with minor changes	6	19%
I'm lukewarm towards the idea as presented	2	6%
I don't concur with the idea presented	1	3%

94% Engagement

32 Responses

(2) Review of land use regulations to not allow exemptions for water quality/quantity.

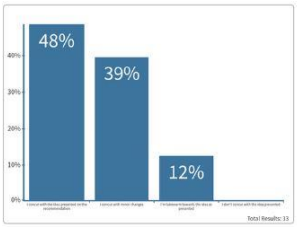


Response options	Count	Percentage
I concur with the idea presented on the recommendation	11	35%
I concur with minor changes	**19**	**61%**
I'm lukewarm towards the idea as presented	1	3%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(3) Identify statutes or regulations that allow for more joint planning and regulation on a watershed scale; prioritize changes and enact.

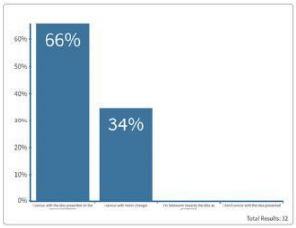


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**16**	**48%**
I concur with minor changes	13	39%
I'm lukewarm towards the idea as presented	4	12%
I don't concur with the idea presented	0	0%

97% Engagement

33 Responses

(4) Revise [Drain Code] Chapter 22 and establish watershed management districts that can facilitate the implementation of [governance/management] recommendations A and C.

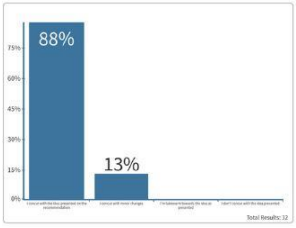


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**21**	**66%**
I concur with minor changes	11	34%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

94% Engagement

32 Responses

(5) Include in Drain Code that they [commissioners] can manage for water quality, not just quantity.

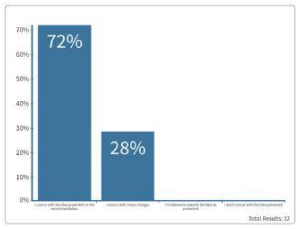


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**28**	**88%**
I concur with minor changes	4	13%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

94% Engagement

32 Responses

(6) Explore new/more timely methods on how to allocate assessments based on benefit derived with fewer barriers.



Response options	Count	Percentage
I concur with the idea presented on the recommendation	**23**	**72%**
I concur with minor changes	9	28%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	0	0%

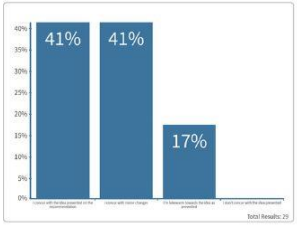
94% Engagement

32 Responses

Governance/Management Recommendation C:

Create watershed commissions to integrate appropriate water-related management areas under one administrative framework.

(1) Increase communications with focus in regional mindset → watershed mindset at public and intergovernmental arena.



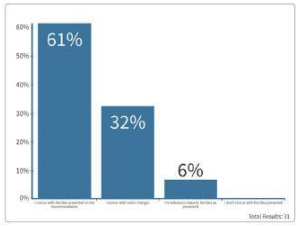
Response options	Count	Percentage
I concur with the idea presented on the recommendation	**12**	**41%**
I concur with minor changes	**12**	**41%**
I'm lukewarm towards the idea as presented	5	17%
I don't concur with the idea presented	0	0%

85% Engagement

29 Responses

(2) Define reasonable geographic scope of watershed commissions:

- Define role of commissions and functions that could come under commissions.
- Define barriers (laws and regulation) to watershed planning, implementation, and to watershed commission.

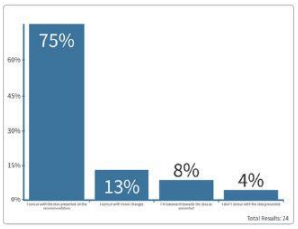


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**19**	**61%**
I concur with minor changes	10	32%
I'm lukewarm towards the idea as presented	2	6%
I don't concur with the idea presented	0	0%

91% Engagement

31 Responses

(3) Choose a pilot watershed and identify all managers, and understand roles and inefficiencies.

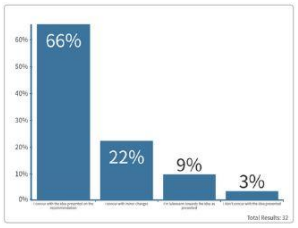


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**18**	**75%**
I concur with minor changes	3	13%
I'm lukewarm towards the idea as presented	2	8%
I don't concur with the idea presented	1	4%

71% Engagement

24 Responses

(4) Revise Chapter 22 of the Drain Code to establish watershed management districts that can assess to raise funds to do a plan.

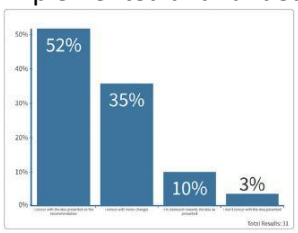


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**21**	**66%**
I concur with minor changes	7	22%
I'm lukewarm towards the idea as presented	3	9%
I don't concur with the idea presented	1	3%

94% Engagement

32 Responses

(5) Develop a public-supported watershed management plan that addresses issues that can be implemented and funded locally.

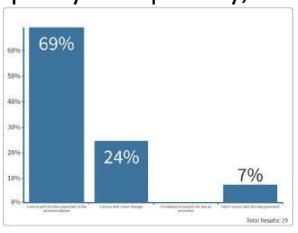


Response options	Count	Percentage
I concur with the idea presented on the recommendation	**16**	**52%**
I concur with minor changes	11	35%
I'm lukewarm towards the idea as presented	3	10%
I don't concur with the idea presented	1	3%

91% Engagement

31 Responses

(6) Figure out all the BASIC required issues that should be included that plan (groundwater, water quality and quantity, local, state, and federal requirements).



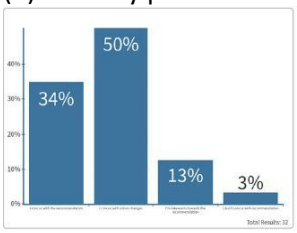
Response options	Count	Percentage
I concur with the idea presented on the recommendation	**20**	**69%**
I concur with minor changes	7	24%
I'm lukewarm towards the idea as presented	0	0%
I don't concur with the idea presented	2	7%

85% Engagement

29 Responses

Additional Governance/Management Recommendations:

(1) Identify points of leverage of existing watershed management groups.

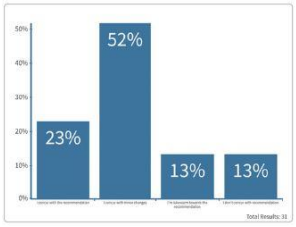


Response options	Count	Percentage
I concur with the recommendation	11	34%
I concur with minor changes	**16**	**50%**
I'm lukewarm towards the recommendation	4	13%
I don't concur with recommendation	1	3%

94% Engagement

32 Responses

(2) Appoint working group for watershed issues, or integrated in Office of the Great Lakes, in order to integrate into other state agencies and regulation.

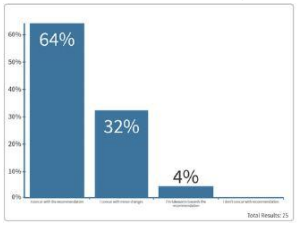


Response options	Count	Percentage
I concur with the recommendation	7	23%
I concur with minor changes	**16**	**52%**
I'm lukewarm towards the recommendation	4	13%
I don't concur with recommendation	4	13%

91% Engagement

31 Responses

(3) Revise Chapter 22 of the Drain Code. Identify a workgroup (drain commissions, Farm Bureau, MDARD, and others) to begin rewrite/re-draft.



Response options	Count	Percentage
I concur with the recommendation	**16**	**64%**
I concur with minor changes	8	32%
I'm lukewarm towards the recommendation	1	4%
I don't concur with recommendation	0	0%

74% Engagement

25 Responses

SUMMARY OF PROPOSED STEPS AND POLLING FEEDBACK – GOVERNANCE/MANAGEMENT THEME

More participants signed up for the governance/management theme than any other, resulting in two concurrent workgroups, and a wide array of comments. Although the diversity of proposals and polling responses makes it difficult to generalize about this category, there were several notable outcomes:

- The idea to award/incentivize cooperative watershed-scale projects received 100% concurrence as presented or with minor changes. A related proposal to channel state/federal funds to those working cooperatively at watershed scales based on a public support plan received 15/33 (45%) concurrence, 17/33 (52%) concurrence with minor changes, 1 lukewarm vote, and zero non-concurrence votes.
- Three proposed steps on Governance/Management Recommendation B received 100% concurrence as presented or with minor changes: (1) revising Drain Code Chapter 22 to enable the establishment of watershed management districts (proposed step #4); (2) including in the Drain Code that commissioners can manage for water quality, not just quantity (proposed step #5); and (3) exploring new methods to allocate assessments based on benefit derived with fewer barriers (proposed step #6).
- A proposal to review land use regulations and disallow for water quantity or quality exemptions received 30/31 votes in concurrence as presented or with minor changes, 1 lukewarm vote, and zero non-concurrence votes.

SUMMARY

In all, workshop participants offered 49 proposals for potentially actionable first steps on the IWC draft recommendations, and participants also introduced 4 new recommendations. Of the 53 total items polled, 21 received polling feedback with at least 90% concurrence on the ideas as presented or with minor changes.

Several caveats should be noted. Due to time constraints, the reporting out and polling process often lasted less than one minute for each proposed idea, limiting the discussion and/or understanding of each item polled. Also, participants were unable to share their reasons for support or lack thereof. Efforts were made to include a diverse range of water professionals representing Michigan's various geographic areas, but polling was done anonymously and did not include information on participant demographics (e.g., home location, sector of employment).

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APPENDIX E: IWCs AT THE HUC-8 WATERSHED SCALE

We considered organizing IWCs around each of Michigan's major watersheds (i.e., HUC-8 scale) without consolidations. This approach was rejected because it would result in 59 IWCs statewide (see below), which would hinder administrative efficiency and produce barriers to cross-IWC coordination.

Figure Appendix E.1. Proposed boundaries for IWCs organized at the HUC-8 level.

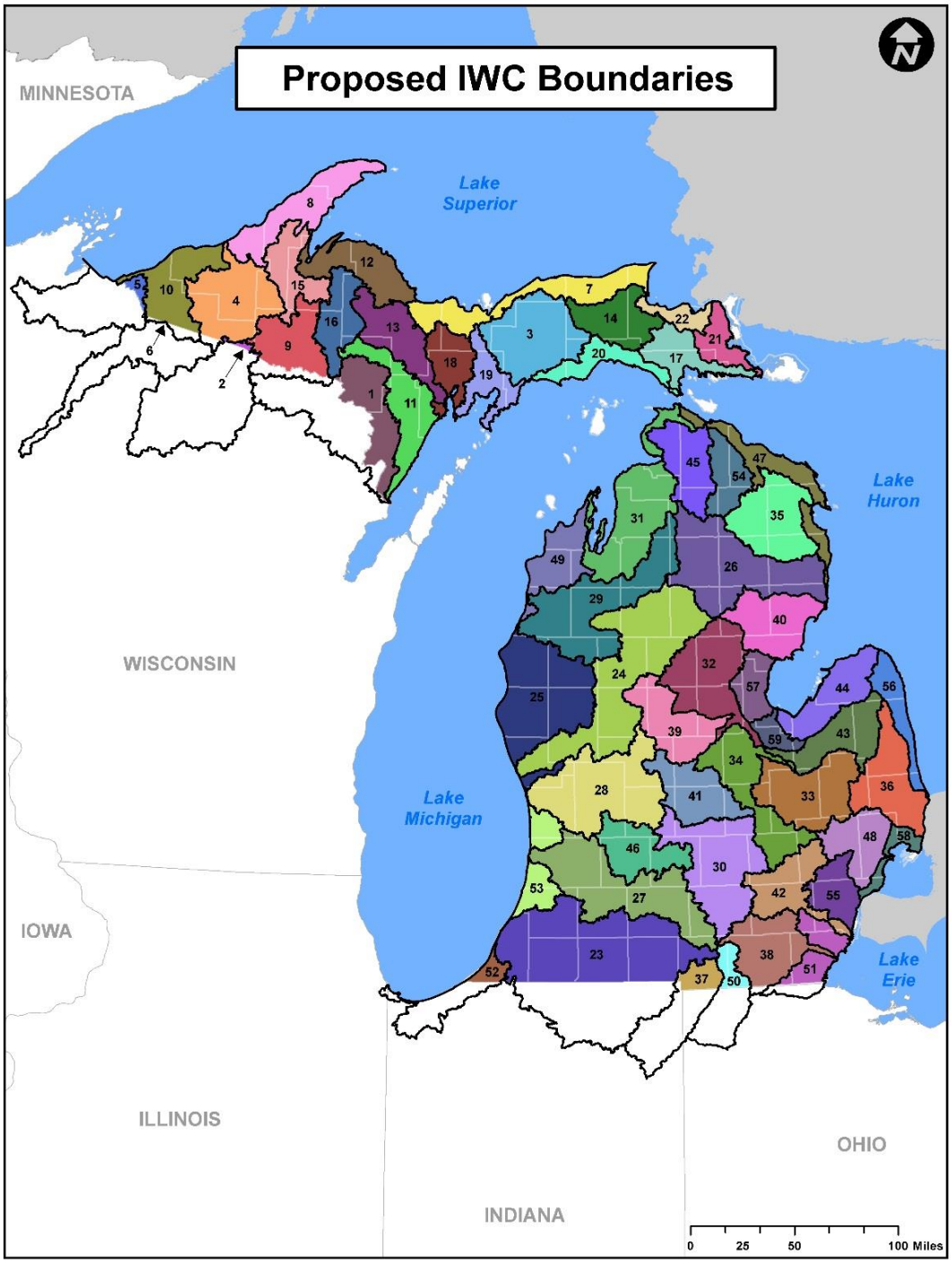

Figure Appendix E.2. Land cover in proposed IWCs organized at HUC-8 level.

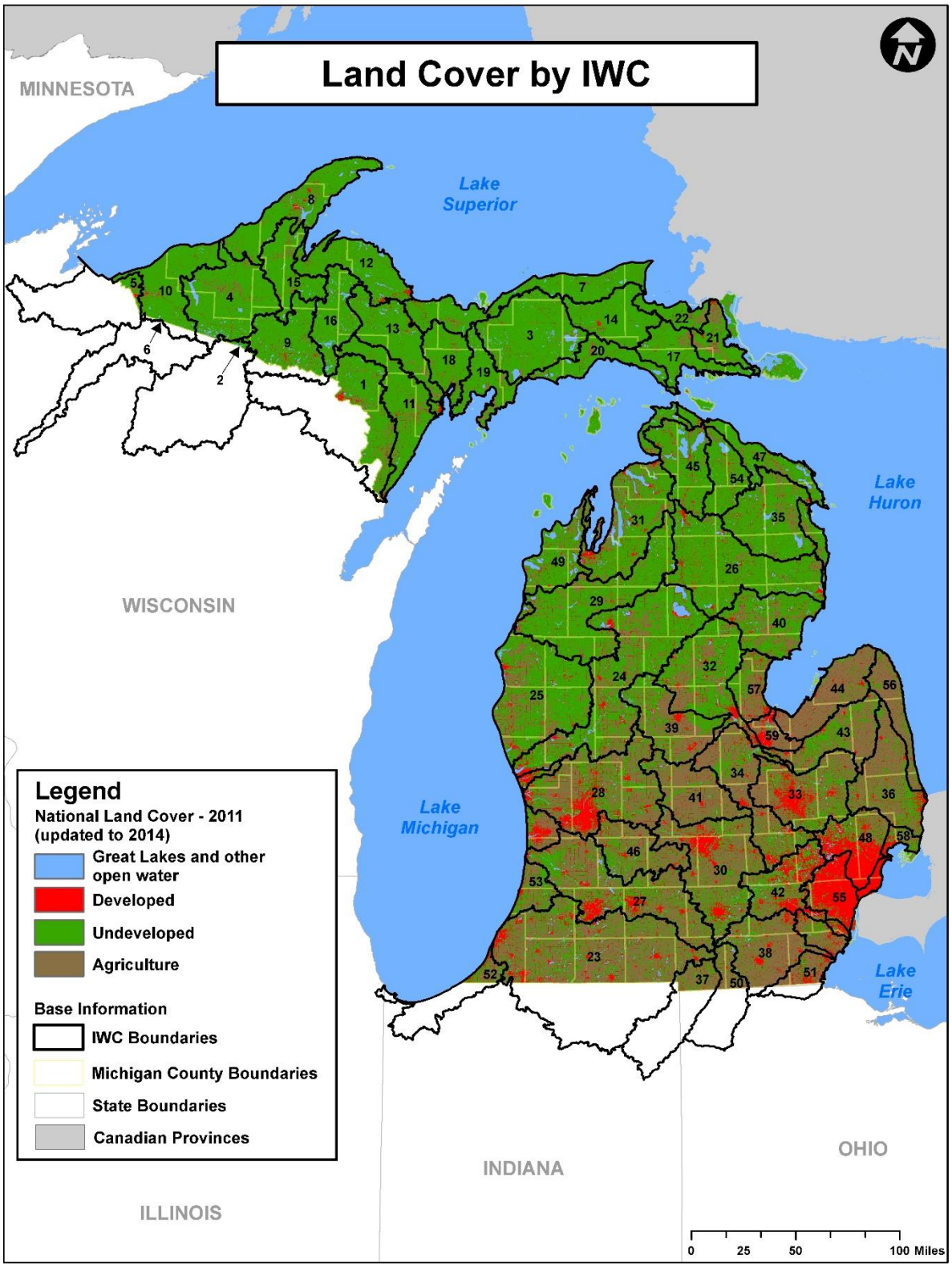
Land Cover by IWC
MINNESOTA
WISCONSIN
ILLINOIS
INDIANA
OHIO
Lake Superior
Lake Huron
Lake Michigan
Lake Erie
Legend
National Land Cover - 2011 (updated to 2014)
Great Lakes and other open water
Developed
Undeveloped
Agriculture
Base Information
IWC Boundaries
Michigan County Boundaries
State Boundaries
Canadian Provinces
0 25 50 100 Miles

Table Appendix E.1. Proposed IWC names, land area, affected counties, and land cover. Counties in bold font each account for at least 5% of IWC total area. Land cover figures do not include open water. Sources: NHDPlus (2016); National Land Cover Database 2011, updated 2014 (Homer et al. 2015).

IWC #	IWC Name	Total Area (sq km)	Counties	Area by County (sq km)	County Area as % of IWC	IWC Land Cover		
						Type	Area (sq km)	% of IWC
1	Menominee	2448.89	**Dickinson** Iron **Menominee**	1253.02 21.49 1174.38	51% > 1% 48%	Agriculture Developed Undeveloped	209.75 136.86 2055.15	9% 6% 84%
2	Upper Wisconsin	109.43	**Gogebic** **Iron**	95.77 13.66	88% 12%	Agriculture Developed Undeveloped	0.10 2.61 90.76	> 1% 2% 83%
3	Manistique	3807.20	**Alger** Delta **Luce** **Mackinac** **Schoolcraft**	567.56 96.35 225.34 226.55 2691.38	15% 3% 6% 6% 71%	Agriculture Developed Undeveloped	36.62 111.35 3488.15	> 1% 3% 92%
4	Ontonagon	3492.17	**Gogebic** **Houghton** Iron **Ontonagon**	1080.67 463.15 156.90 1791.45	31% 13% 4% 51%	Agriculture Developed Undeveloped	123.73 89.56 3148.13	4% 3% 90%
5	Bad-Montreal	253.39	**Gogebic**	253.39	100%	Agriculture Developed Undeveloped	19.22 17.63 216.02	8% 7% 85%
6	Flambeau	0.962	**Gogebic**	0.962	100%	Agriculture Developed Undeveloped	0.00 0.08 0.84	0% 9% 87%
7	Betsy-Chocolay	3021.78	**Alger** **Chippewa** **Luce** **Marquette**	1303.20 294.40 938.04 483.89	43% 10% 31% 16%	Agriculture Developed Undeveloped	40.19 98.27 2819.38	1% 3% 93%
8	Keweenaw Peninsula	2879.42	**Houghton** **Keweenaw** **Ontonagon**	1322.17 881.78 675.43	46% 31% 23%	Agriculture Developed Undeveloped	99.41 115.49 2569.98	3% 4% 89%
9	Brule	2245.44	**Baraga** Gogebic **Iron**	165.17 32.32 2047.95	7% 1% 91%	Agriculture Developed Undeveloped	63.33 80.41 2039.97	3% 4% 91%
10	Black-Presque Isle	2441.81	**Gogebic** **Ontonagon**	1501.57 940.24	61% 39%	Agriculture Developed Undeveloped	25.14 61.55 2329.71	1% 3% 95%
11	Cedar-Ford	2638.31	**Delta** **Dickinson** Iron **Marquette** **Menominee**	445.95 498.73 16.38 134.05 1543.05	17% 19% > 1% 5% 58%	Agriculture Developed Undeveloped	178.55 111.75 2338.94	7% 4% 89%
12	Dead-Kelsey	2406.39	**Baraga** Houghton **Marquette**	937.84 9.09 1459.37	39% > 1% 61%	Agriculture Developed Undeveloped	14.56 118.83 2204.15	> 1% 5% 92%
13	Escanaba	2400.85	**Delta** **Dickinson** **Marquette** Menominee	271.39 177.42 1947.24 4.72	11% 7% 81% > 1%	Agriculture Developed Undeveloped	60.87 95.15 2190.05	3% 4% 91%
14	Tahquamenon	2095.97	Alger	0.09	> 1%	Agriculture	15.00	> 1%

			Chippewa **Luce** **Mackinac** Schoolcraft	700.02 1217.22 178.12 0.49	33% 58% 8% > 1%	Developed Undeveloped	48.88 2013.48	2% 96%
15	Sturgeon	1890.50	**Baraga** **Houghton** **Iron** Ontonagon	860.60 901.98 96.14 31.75	46% 48% 5% 2%	Agriculture Developed Undeveloped	78.69 41.84 1739.05	4% 2% 92%
16	Michigamme	1874.38	**Baraga** Dickinson **Iron** **Marquette**	410.55 81.02 783.61 599.19	22% 4% 42% 32%	Agriculture Developed Undeveloped	6.55 49.11 1708.45	> 1% 3% 91%
17	Carp-Pine	1696.03	**Chippewa** **Mackinac**	783.01 912.86	46% 54%	Agriculture Developed Undeveloped	76.07 63.94 1537.64	4% 4% 91%
18	Tacoosh-Whitefish	1662.35	**Alger** **Delta** **Marquette**	324.73 1121.55 215.96	20% 67% 13%	Agriculture Developed Undeveloped	61.31 84.93 1511.76	4% 5% 91%
19	Fishdam-Sturgeon	1502.18	**Alger** **Delta** **Schoolcraft**	173.02 1101.35 227.40	12% 73% 15%	Agriculture Developed Undeveloped	74.08 54.96 1351.96	5% 4% 90%
20	Brevoort-Millecoquins	1430.31	Luce **Mackinac** **Schoolcraft**	18.04 1169.36 242.81	1% 82% 17%	Agriculture Developed Undeveloped	49.03 57.74 1268.61	3% 4% 89%
21	St. Marys	1137.47	**Chippewa** **Mackinac**	1010.99 126.46	89% 11%	Agriculture Developed Undeveloped	245.76 73.98 814.71	22% 7% 72%
22	Waiska	763.75	**Chippewa**	763.64	100%	Agriculture Developed Undeveloped	67.85 36.80 653.50	9% 5% 86%
23	St. Joseph	7796.95	**Berrien** **Branch** **Calhoun** **Cass** **Hillsdale** **Kalamazoo** **St. Joseph** **Van Buren**	1042.07 1337.85 594.01 1316.15 446.22 688.60 1348.76 1023.29	13% 17% 8% 17% 6% 9% 17% 13%	Agriculture Developed Undeveloped	4488.75 841.73 2283.89	58% 11% 29%
24	Muskegon	7056.76	**Clare** Crawford Kalkaska Lake **Mecosta** **Missaukee** **Montcalm** **Muskegon** **Newaygo** **Osceola** **Roscommon** Wexford	649.94 12.48 21.83 63.54 1080.24 1202.85 348.25 446.52 875.97 1130.72 915.74 308.63	9% > 1% > 1% > 1% 15% 17% 5% 6% 12% 16% 13% 4%	Agriculture Developed Undeveloped	1379.26 601.30 4781.05	20% 9% 68%
25	Pere Marquette-White	5391.63	**Lake** Manistee **Mason** **Muskegon** **Newaygo** **Oceana** Ottawa	870.31 27.99 1276.47 616.48 1179.43 1413.66 7.19	16% > 1% 24% 11% 22% 26% > 1%	Agriculture Developed Undeveloped	970.43 450.06 3871.13	18% 8% 72%

26	Au Sable	5305.31	**Alcona** **Crawford** **Iosco** Kalkaska Montmorency **Ogemaw** **Oscoda** **Otsego** **Roscommon**	855.62 1289.42 406.28 22.26 111.48 390.00 1221.94 597.66 410.62	16% 24% 8% > 1% 2% 7% 23% 11% 8%	Agriculture Developed Undeveloped	173.67 450.00 4576.55	3% 8% 86%
27	Kalamazoo	5258.31	**Allegan** **Barry** **Calhoun** **Eaton** Hillsdale **Jackson** **Kalamazoo** Kent Ottawa Van Buren	1612.19 471.10 1259.78 340.40 190.64 402.32 813.50 29.53 58.32 80.49	31% 9% 24% 6% 4% 8% 15% > 1% 1% 2%	Agriculture Developed Undeveloped	2523.87 719.73 1894.27	48% 14% 36%
28	Lower Grand	5232.32	Allegan **Ionia** Isabella **Kent** Mecosta **Montcalm** **Muskegon** Newaygo **Ottawa**	4.48 897.00 0.18 1925.83 57.43 929.56 302.50 174.88 940.40	> 1% 17% > 1% 37% 1% 18% 6% 3% 18%	Agriculture Developed Undeveloped	2367.23 1008.90 1753.93	45% 19% 34%
29	Manistee	5046.13	Antrim Benzie Crawford **Grand Traverse** **Kalkaska** **Lake** **Manistee** Mason **Missaukee** **Osceola** Otsego **Wexford**	122.48 6.44 156.14 239.52 882.39 552.47 1215.14 43.71 282.32 278.52 86.42 1180.51	2% > 1% 3% 5% 17% 11% 24% > 1% 6% 6% 2% 23%	Agriculture Developed Undeveloped	455.22 302.15 4220.48	9% 6% 84%
30	Upper Grand	4555.09	Calhoun **Clinton** **Eaton** Hillsdale **Ingham** **Ionia** **Jackson** **Livingston** **Shiawassee** Washtenaw	5.34 432.31 513.81 28.95 1405.88 248.57 1265.50 328.11 300.08 26.49	> 1% 9% 11% > 1% 31% 5% 28% 7% 7% > 1%	Agriculture Developed Undeveloped	2323.61 751.67 1416.84	51% 17% 31%
31	Boardman-Charlevoix	4317.14	**Antrim** **Charlevoix** Cheboygan **Emmet** **Grand Traverse** **Kalkaska** Leelanau Otsego	1236.19 889.35 63.63 573.13 765.16 550.13 172.41 66.95	29% 21% 1% 13% 18% 13% 4% 2%	Agriculture Developed Undeveloped	650.00 420.61 2964.27	15% 10% 69%

32	Tittabawassee	3746.14	Arenac Bay **Clare** **Gladwin** Gratiot **Isabella** **Midland** **Ogemaw** **Roscommon** Saginaw	28.68 11.12 744.52 1265.38 8.37 358.67 855.15 183.47 173.70 117.05	> 1% > 1% 20% 34% > 1% 10% 23% 5% 5% 3%	Agriculture Developed Undeveloped	894.70 369.91 2421.12	24% 10% 65%
33	Flint	3443.88	**Genesee** **Lapeer** **Oakland** **Saginaw** Sanilac **Shiawassee** **Tuscola**	1421.95 1197.64 270.85 222.98 7.72 230.44 92.27	41% 35% 8% 6% > 1% 7% 3%	Agriculture Developed Undeveloped	1562.76 689.92 1142.42	45% 20% 33%
34	Shiawassee	3275.72	Clinton **Genesee** **Gratiot** **Livingston** Midland **Oakland** **Saginaw** **Shiawassee** Tuscola	0.06 213.54 399.48 639.07 86.32 169.09 1202.06 562.97 3.08	> 1% 7% 12% 20% 3% 5% 37% 17% > 1%	Agriculture Developed Undeveloped	1860.10 397.22 963.47	57% 12% 29%
35	Thunder Bay	3237.21	**Alcona** **Alpena** **Montmorency** **Oscoda** **Presque Isle**	679.97 1115.45 961.69 257.39 222.69	21% 34% 30% 8% 7%	Agriculture Developed Undeveloped	338.90 194.75 2602.31	10% 6% 80%
36	St. Clair	2996.27	**Lapeer** Macomb Oakland **St. Clair** **Sanilac**	405.83 61.61 0.09 1420.74 1107.94	14% 2% > 1% 47% 37%	Agriculture Developed Undeveloped	1825.68 306.48 853.53	61% 10% 28%
37	St. Joseph-Maumee	650.70	Branch **Hillsdale**	7.28 643.42	1% 99%	Agriculture Developed Undeveloped	414.91 45.05 184.57	64% 7% 28%
38	Raisin	2682.70	Hillsdale **Jackson** **Lenawee** **Monroe** **Washtenaw**	31.63 195.30 1556.63 363.29 535.85	1% 7% 57% 13% 20%	Agriculture Developed Undeveloped	1784.52 311.96 544.80	67% 12% 20%
39	Pine	2654.21	Clare **Gratiot** **Isabella** **Mecosta** **Midland** **Montcalm** Osceola	94.62 519.79 1136.17 340.59 299.48 189.97 73.56	4% 20% 43% 13% 11% 7% 3%	Agriculture Developed Undeveloped	1234.39 224.42 1158.37	47% 8% 44%
40	Au Gres-Rifle	2653.11	**Arenac** Gladwin **Iosco** **Ogemaw** Oscoda Roscommon	687.62 0.24 1048.92 914.77 0.18 1.13	26% > 1% 40% 34% > 1% > 1%	Agriculture Developed Undeveloped	494.69 216.49 1897.36	19% 8% 72%

41	Maple	2447.68	**Clinton** **Gratiot** **Ionia** **Montcalm** **Shiawassee**	1054.54 551.65 137.33 397.67 306.47	43% 23% 6% 16% 13%	Agriculture Developed Undeveloped	1766.88 166.79 491.93	72% 7% 20%
42	Huron	2376.56	Ingham Jackson **Livingston** Monroe **Oakland** **Washtenaw** **Wayne**	45.19 9.23 547.99 24.33 527.89 1022.56 199.34	2% > 1% 23% 1% 22% 43% 8%	Agriculture Developed Undeveloped	577.31 780.93 919.73	24% 33% 39%
43	Cass	2350.45	Genesee Huron Lapeer **Saginaw** **Sanilac** **Tuscola**	45.82 71.61 65.74 134.57 836.76 1195.93	2% 3% 3% 6% 36% 51%	Agriculture Developed Undeveloped	1338.99 177.01 827.93	57% 8% 35%
44	Pigeon-Wiscoggin	2333.04	**Bay** **Huron** Saginaw Sanilac **Tuscola**	165.66 1405.15 15.56 2.47 743.92	7% 60% 1% > 1% 32%	Agriculture Developed Undeveloped	1881.39 179.47 268.04	81% 8% 11%
45	Cheboygan	2314.29	Charlevoix **Cheboygan** **Emmet** **Otsego**	92.14 1094.18 673.23 454.72	4% 47% 29% 20%	Agriculture Developed Undeveloped	190.74 156.40 1779.14	8% 7% 77%
46	Thornapple	2197.39	Allegan **Barry** **Eaton** **Ionia** **Kent**	10.07 1022.38 645.33 218.22 301.37	> 1% 47% 29% 10% 14%	Agriculture Developed Undeveloped	1256.35 208.62 697.73	57% 9% 32%
47	Lone Lake-Ocqueoc	2134.20	**Alcona** **Alpena** **Cheboygan** Emmet Iosco Montmorency **Presque Isle**	262.94 419.96 291.22 1.40 11.00 10.13 1137.42	12% 20% 14% > 1% > 1% > 1% 53%	Agriculture Developed Undeveloped	175.87 150.19 1728.45	8% 7% 81%
48	Clinton	2063.42	Lapeer **Macomb** **Oakland** St. Clair Wayne	46.72 932.74 965.33 33.09 85.50	2% 45% 47% 2% 4%	Agriculture Developed Undeveloped	378.53 1147.14 482.48	18% 56% 24%
49	Betsie-Platte	2059.62	**Benzie** **Grand Traverse** **Leelanau** **Manistee**	893.25 263.29 702.88 200.17	43% 13% 34% 10%	Agriculture Developed Undeveloped	251.69 157.85 1466.02	12% 8% 72%
50	Tiffin	570.12	**Hillsdale** **Lenawee**	230.10 340.02	40% 60%	Agriculture Developed Undeveloped	385.43 40.21 134.00	68% 7% 24%
51	Ottawa-Stony	1425.16	**Lenawee** **Monroe** **Washtenaw** **Wayne**	73.83 1047.26 197.31 106.76	5% 73% 14% 8%	Agriculture Developed Undeveloped	828.12 279.64 304.64	58% 20% 21%
52	Little Calumet-Galien	419.74	**Berrien**	419.74	100%	Agriculture Developed	191.65 57.62	46% 14%

						Undeveloped	168.09	40%
53	Macatawa	1574.20	**Allegan**	554.20	35%	Agriculture	666.33	42%
			Berrien	22.87	1%	Developed	276.03	18%
			Ottawa	487.28	31%	Undeveloped	611.69	39%
			Van Buren	509.56	32%			
54	Black	1553.35	**Cheboygan**	611.52	39%	Agriculture	71.32	5%
			Montmorency	373.31	24%	Developed	86.45	6%
			Otsego	156.28	10%	Undeveloped	1335.75	86%
			Presque Isle	412.23	27%			
55	Detroit	1517.26	**Oakland**	414.87	27%	Agriculture	70.58	5%
			Washtenaw	87.40	6%	Developed	1272.89	84%
			Wayne	1014.98	67%	Undeveloped	161.24	11%
56	Birch-Willow	1360.94	**Huron**	687.52	51%	Agriculture	984.21	73%
			St. Clair	131.70	10%	Developed	108.19	8%
			Sanilac	541.43	40%	Undeveloped	266.89	20%
57	Kawkawlin-Pine	1256.82	**Arenac**	234.91	19%	Agriculture	598.39	48%
			Bay	819.97	65%	Developed	146.89	12%
			Gladwin	69.73	6%	Undeveloped	506.13	40%
			Midland	125.71	10%			
			Saginaw	6.32	> 1%			
58	Lake St. Clair	662.47	**Macomb**	257.27	39%	Agriculture	123.74	19%
			St. Clair	242.32	37%	Developed	381.87	58%
			Wayne	162.27	24%	Undeveloped	154.21	23%
59	Saginaw	650.31	**Bay**	164.84	25%	Agriculture	395.03	61%
			Saginaw	413.30	64%	Developed	193.46	30%
			Tuscola	72.10	11%	Undeveloped	46.92	7%

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