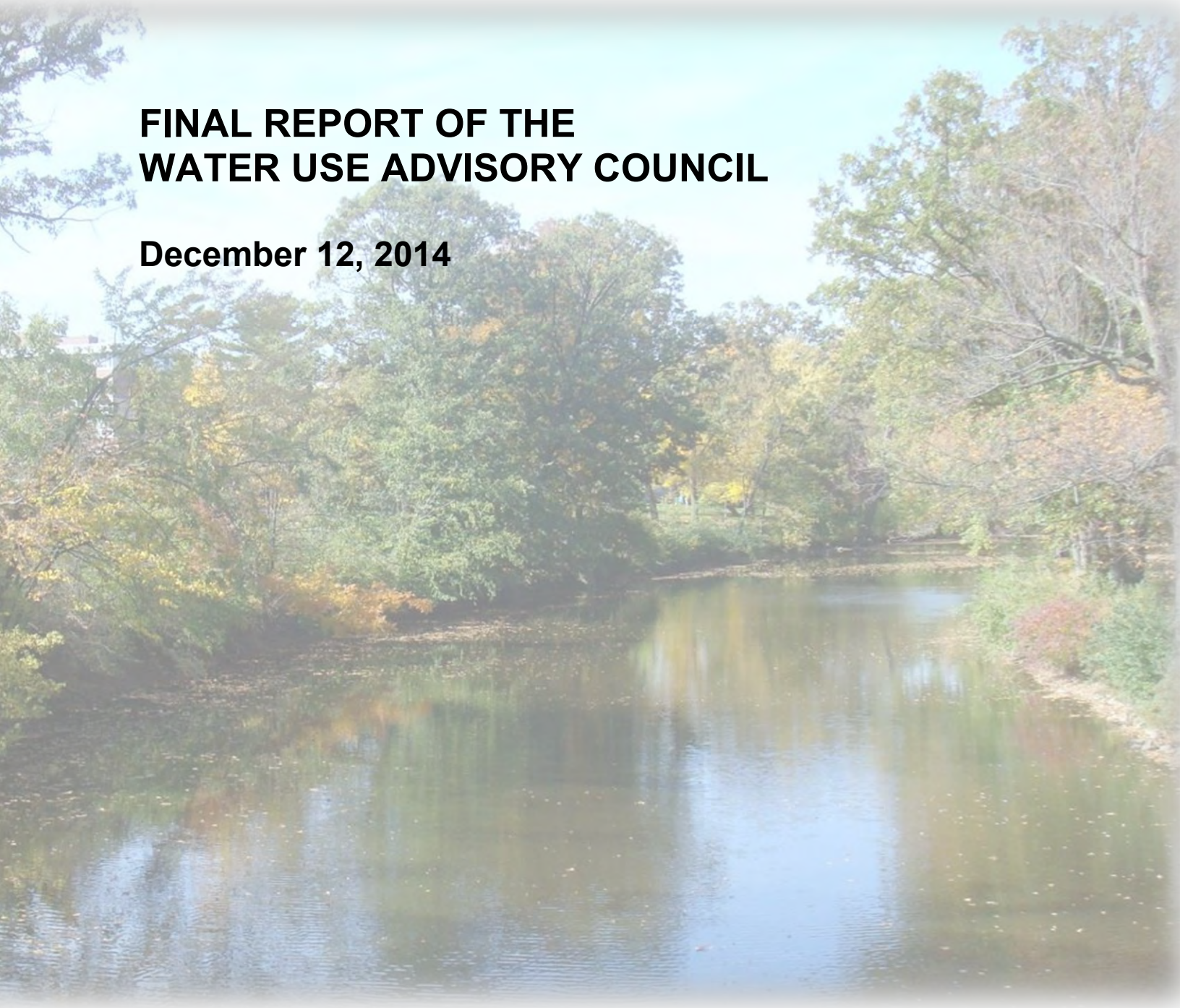

FINAL REPORT OF THE WATER USE ADVISORY COUNCIL

December 12, 2014

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List of Acronyms and Terms

APA	Administrative Procedures Act
ARI	Adverse resource impact
AWE	Alliance for Water Efficiency
AWWA	American Water Works Association
CANR	MSU College of Agriculture and Natural Resources
CDRP	Community dispute resolution program
CLMP	Cooperative Lakes Management Program
DEM	Digital elevation model
DEQ	Michigan Department of Environmental Quality
DNR	Michigan Department of Natural Resources
DOT	Michigan Department of Transportation
DTMB-CSS	Michigan Department of Technology, Management and Budget – Center for Shared Solutions
FRWC	Flint River Watershed Coalition
FTE	Full-time equivalent
GIS	Geographic Information System
GPD	Gallons per day
GPM	Gallons per minute
GWCAC	Groundwater Conservation Advisory Council
IJC	International Joint Commission
ISGS	Illinois State Geologic Survey
KRWC	Kalamazoo River Watershed Coalition
LPI	Lean process improvement p31
LQW	Large quantity water withdrawal
MDARD	Michigan Department of Agriculture and Rural Development
MGREE	Michigan Geological Repository for Research and Education
MGS	Michigan Geological Survey
MGWA	Michigan Ground Water Association
MiCorps	Michigan Clean Water Corps
MITU	Michigan Trout Unlimited
MMD	USGS Miscellaneous Measurements Database
MSU	Michigan State University
MSUE	Michigan State University Extension
NHD	National Hydrography Dataset
NHDH	National Hydrography Dataset, High Resolution
NREPA	Natural Resources and Environmental Protection Act
ODWMA	DEQ Office of Drinking Water and Municipal Assistance
OOGM	DEQ Office of Oil, Gas and Minerals
PERM	Partnership for Ecosystem Research and Management
PPL	Project Priority List
Program	Michigan's Water Use Program (water withdrawal assessment program)
PSA	Public service announcement
QOL	Quality of Life (agencies)
RRD	DEQ Remediation and Redevelopment Division
SSR	Site specific review
UIC	Underground Injection Control
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey

WMA	Watershed Management Area
WRAEAC	Water Resources Assessment and Education Committees
WRCAC	Water Resources Conservation Advisory Council
WRD	DEQ Water Resources Division
WUAC	Water Use Advisory Council, Council
WUC	Water Users Committee
WWAP	Water withdrawal assessment process
WWAT	Water Withdrawal Assessment Tool, Tool

EXECUTIVE SUMMARY

The Water Use Advisory Council (Council) was established in December 2012 by the Department of Environmental Quality (DEQ) Director Dan Wyant to advise the Quality of Life (QOL) agencies (DEQ, Department of Natural Resources, Department of Agriculture and Rural Development) on the State's Water Use Program. The Council was charged to provide advice in the following areas:

- Water conservation and efficiency goals, objectives and voluntary measures
- Technical underpinnings of the process, tools, data, assumptions and decision end-points used to determine whether proposed water withdrawals can be authorized
- Technical and compliance assistance
- Methods and tools to assist water users in resolving and preventing conflicts
- Environmental monitoring to identify and help reconcile potential discrepancies between the program's decision making and data management protocols and the real world impacts of withdrawals
- New and emerging water use categories
- Outcomes and metrics for determining the program success

With respect to these tasks, the Council offers the following 69 recommendations. The Council recognizes that implementing any number of these recommendations will require additional support for the DEQ and other QOL agencies in terms of staff, funding, partnerships, and other resources. Specifically, nine recommendations explicitly call for new staff support for the Water Use Program. Four of these recommendations could instead be implemented through contract work. Furthermore, seven recommendations state that existing staff could meet the required work load. Three of these recommendations could instead be implemented through contract work. Another 27 recommendations call for DEQ staff time but do not specify whether additional staff are needed.

Of the 43 recommendations that explicitly discuss staffing needs, 17 involve a one-time process to develop one of the following: criteria, protocols or standards; methodologies or metrics; and training or outreach initiatives. Once developed, general oversight by the DEQ staff may be required for some of these recommendations. It is important to note that implementing a number of all 69 recommendations will likely require additional staff support, regardless of whether or not individual recommendations explicitly discussed staffing needs and/or called for additional support.

There are, however, some recommendations that will not affect DEQ staffing levels. Eight of the 69 recommendations are best implemented through external entities such as universities or consultants and five recommendations require no action at this time.

Twenty-two recommendations explicitly call for stakeholder engagement. Fourteen of these recommendations refer to the formation of a multi-interest stakeholder group, which may or may not include a successor to the Water Use Advisory Council. It is important to note that many of these recommendations deal with the development of protocols and standards, broad-reaching programs for Michigan, or complex technical work that will significantly benefit from stakeholder involvement.

CONTINUATION OF THE WATER USE ADVISORY COUNCIL

The Director of the DEQ should re-establish and maintain the Water Use Advisory Council, or a similar stakeholder group, for the foreseeable future in order to provide input on issues related to the implementation of Part 327, P.A. 451.

TECHNICAL UNDERPINNINGS OF WITHDRAWAL DECISION MAKING

TU 1.1 As quickly as possible, the Program should partner with Michigan NHD Steward to edit the NHDH, attributing all segments as intermittent that are symbolized as intermittent on the most current version of the 1:24,000 topographic maps.

TU 1.2 As soon as an edited version of the NHDH is available, the DEQ should eliminate all intermittent segments and adopt this revised file as the hydrography used by the Program in both the WWAT and during site specific reviews.

TU 1.3 Recognizing that such an effort could be lengthy, the Council recommends that the DEQ use a phased approach by giving first priority to those regions of the State where the majority of the current water withdrawal registrations have occurred.

TU 2.1 Modify the WWAT's coding to use the top-of-bedrock depth from the WWAT's glacial thickness map GIS data layer at the proposed well location instead of using an average top-of-bedrock depth for the Watershed Management Area.

TU 2.2 Make the WWAT registration number a required field in Wellogic (and on paper well logs) for high-capacity wells.

TU 2.3 Permanently discontinue use of the "Bedrock Auto Pass" feature. The WWAT should be reconfigured in the areas that originally used the "Bedrock Auto Pass" feature. The WWAT should use bedrock aquifer characteristics to calculate streamflow depletion when bedrock is selected. As an interim measure, until the bedrock aquifer calculation is implemented, the DEQ should use glacial aquifer characteristics in the WWAT when bedrock is requested. If that triggers a SSR, the DEQ should use bedrock aquifer characteristics to calculate streamflow depletion.

TU 3.1 The process for checking the compliance of "as built" well construction details with WWAT and/or SSR registrations of groundwater LQWs should be automated. Discrepancies between these should be flagged for follow up by staff.

TU 3.2 The DEQ should work with stakeholders to increase the understanding of Part 327 requirements for owners of newly constructed large capacity wells, and increase compliance with the requirement to report differences between registered and "as built" well characteristics.

TU 4.1 The DEQ should write up the procedures and criteria used to modify index flows. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.

TU 4.2 The DNR should write up the procedures and criteria used to modify stream classification. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.

TU 4.3 The DEQ/DNR should use Table TU-1 as a guide to determine what level of approval is needed to make modifications within the Water Withdrawal Assessment Process.

TU 5.1 Continue to use the index flow estimation model for the initial values in the WWAT that are then modified by SSRs.

TU 5.2 Continue to use the current analytical solution (Hunt, 1999) in the WWAT to compute streamflow depletion.

TU 6.1 Work with stakeholders to develop criteria describing site specific data analyses to estimate potential streamflow depletion by a new well. The criteria should specify desired quality assurance and quality control processes for the program.

TU 7.1 Work with stakeholders to develop criteria describing the required features of groundwater-flow models to be used in the water-withdrawal assessment process focusing on streamflow depletion.

ENVIRONMENTAL MONITORING

EM 1.1 To ensure prevention of adverse resource impacts, and to reduce potential for water user conflicts, the DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of stream flow data in high water withdrawal areas or areas of potential conflict.

EM 1.2 We recommend the DEQ invest resources to reasonably ensure continuous progress towards filling streamflow measurement data gaps.

EM 1.3 Protocols and standards for the collection and use of stream flow data for use in this program should be developed by the DEQ, approved by the WUAC and approved through the appropriate statutory process, and clearly published on its website.

EM 1.4 When the DEQ receives or acquires data of the quality and standards that would prompt the Department to change a Tool parameter for a Watershed Management Area, the DEQ should not wait until a registration request triggers an SSR in that Watershed Management Area. The DEQ should incorporate those new data and make any appropriate changes at least bi-annually.

EM 1.5 The DEQ should develop a facilitation program for streamflow data collection by non-agency persons. This program should provide data collection procedures and guidance, explanation of how the data can be used, provide for training opportunities, and provide for the collection, storage and accessibility of the data collected.

EM 1.6 The DEQ and DNR should invest in the strategic acquisition of research and/or monitoring to assess the real-world impacts of existing large-quantity water withdrawals.

EM 1.7 We recommend that an overall statistical update of all index flows is not yet necessary. The need to perform this statistical update should be reviewed by the DEQ at least every 5 years.

EM 2.1 We recommend a database be created to gather and collate data on glacial geology, static water levels and aquifer characteristics collected by state and federal agencies, as well as by universities and private industry. It should utilize a common set of accepted geologic and hydrogeologic terms and fields. Organizations or agencies collecting this data should have the ability to submit information to be entered into the database, and the data submitted shall conform to State program requirements. This database should be publicly viewable.

EM 2.2 The State should publish its protocols and standards for the collection and use of groundwater data and glacial geology on its public websites.

EM 2.3 The DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of groundwater data in areas receiving or anticipated to receive high levels of water withdrawal registrations.

EM 2.4 The DEQ should use high quality data it receives, acquires, or collates from the data submitted to the groundwater database and integrate those data into the SSRs, develop numerical models to better understand the hydrogeology of certain areas, and develop better tools to predict streamflow depletion in those areas. Collection of these data and using updated models can ultimately inform and upgrade the screening tool once sufficient data is collected for the associated Watershed Management Areas.

EM 2.5 The DEQ should continue to collaborate with Michigan Geological Survey and water well drillers on new tools and training programs being developed to improve the geologic data entered into Wellogic records, and should make necessary changes to Wellogic forms to facilitate the entry of more accurate geologic data into Wellogic.

WATER USERS GROUPS

WU 1.1 The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding into the formal list of registered and permitted users those noncompliant large quantity users who were making large quantity withdrawals prior to 2006. This process should not include a debiting of the water accounting system for the pre-2006 withdrawals.

WU 1.2 The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding noncompliant large quantity users who have initiated withdrawal since February 28, 2006, without going through the required screening process into the formal list of registered and permitted users. Designing this process will require careful consideration of whether a distinction should be made between those withdrawals initiated prior to October 1, 2008, and those initiated after that date with respect to any decision to require the formal application and screening process to be undertaken by these users.

WU 1.3 The DEQ and MDARD should partner to develop and maintain a system for cross-checking annual water use reports against lists of registered and permitted users to monitor compliance with water use reporting requirements.

WU 2.1 The DEQ should invest resources to produce and maintain an online set of resources (as described in Table WU-2) to provide technical, organizational and financial information to water users groups to support the formation and functioning of Water

Resources Assessment and Education Committees (WRAECs) and Water Users Committees (WUCs).

WU 2.2 The DEQ should invest resources to produce a brochure that explains the role of WUCs in Michigan's Water Use Program. The brochure should describe the conditions under which the input from a WUC might be needed, benefits to water users of being part of a WUC, and benefits of creating a WUC before a Zone D request is made or an ARI is observed.

WU 2.3 The DEQ should enclose a copy of the brochure in letters sent to all registered and permitted users and associated local governments when a Zone C (or Zone B for a cold transitional stream) withdrawal is approved after a site specific review and in letters that are mailed to all registered and permitted users and associated local governments when a negative SSR occurs.

WU 2.4 We recommend that the DEQ undertake the initial convening of a WUC in two scenarios: a) if a recipient of a negative SSR requests help with contacting and convening large quantity water users within the catchment of concern, and b) if an ARI is suspected.

WU 2.5 The DEQ should develop a protocol to be used for the initial convening of WUCs. The protocol should include the specific tasks the DEQ will undertake at the first WUC meeting.

WU 3.1 At the request of a WUC (registered and permitted water users in a watershed), the DEQ and MDARD should be prepared to share with the WUC the following information:

- Contact information for all registered and permitted water users in the watershed
- The cumulative withdrawals in the watershed
- The legally available amount of streamflow depletion for the watershed.

WU 4.1 Financial commitment should be made to support the facilitation of water user group negotiations.

WU 4.2 Financial resources should be committed to fund a position which would provide technical assistance to the WUCs and DEQ, serve as liaison between the WUC and DEQ, and assist with the analysis (including analysis of the expected impacts of alternative scenarios that the WUC might consider).

WATER CONSERVATION AND USE EFFICIENCY

WC 1.1 Michigan should improve its water use-related data management program. This includes improving the quality of current water use reporting, the capacity to track water usage, the result of conservation measures, and the development of water demand analysis for individual water use sectors. In particular, each water use sector should design the appropriate data sets in order to track water use, progress on water efficiency and conservation, and develop demand analysis. Development of these data sets must balance the need to be generally applicable to a sector or sub-sector and the ability to be tracked over time with the complexities of the circumstances faced by each particular user. The state-specific outcomes described in Recommendation WC

5.1 can inform the development of these data sets. Ideally, these data sets could be recommended for Great Lakes Basin-wide use.

WC 1.2 Based on the water use trends, more focus needs to be placed on conservation and efficiency in the Irrigation Sector. MDARD has developed comprehensive guidance in the form of Generally Accepted Agricultural and Management Practices (GAAMPs), which includes guidance in preparing a water conservation and efficiency plan. MDARD and Michigan State University (MSU) Cooperative Extension should continue to provide and expand training and outreach to the Irrigation Sector to increase the use of these GAAMPs.

WC 1.3 The DEQ should incentivize water conservation and efficiency in the public sector by rewarding the implementation of water conservation and efficiency measures when applying for State funding for water infrastructure projects. This could be accomplished by providing significant points to project plans from water systems that already have a water conservation and efficiency plan, thereby increasing the likelihood that the project will be funded.

WC 1.4 Michigan should also enhance programs to address the supply side of the water equation. For example, the DEQ should continue and expand programs to support development of green infrastructure and review rules and regulations associated with the beneficial reuse of wastewater/process water/storm water to promote more development in this area.

WC 2.1 The DEQ should undertake a process to update the current generic and sector-specific conservation measures. This process should include direct involvement by multi-interest stakeholder groups and broader public involvement.

WC 2.2 Michigan should revise its water conservation program to: 1) further inform and encourage water conservation, and 2) assess and document the nature and extent of water conservation practiced by large water users. This program should consist of the following components:

WC 2.2a Michigan should convene a multi-interest workgroup to identify existing and new opportunities to incentivize water conservation. This effort should target all water users and encourage conservation generally, the adoption of specific practices, and contribution to improved data collection.

WC 2.2b Among the specific practices encouraged should be a water auditing program. For public supplies, the water audit should be in conformance with the American Water Works Association (AWWA), M36 Water Audits and Loss Control Programs. Water users should be encouraged to develop a water conservation program based on the results of the audit. While each water user is able to determine the nature and extent of its conservation program, incentives should specifically encourage a component on metrics for evaluating the performance of the program and reporting of results to the DEQ or MDARD. Providing information to employees or water customers on the water user's conservation programs and policies should also be encouraged.

WC 2.2c To facilitate the above set of activities, the DEQ and MDARD should develop, or arrange for the development of, templates for water audits and conservation plans. These instruments should be considered by the multi-interest group.

WC 2.2d The multi-interest workgroup should also be charged with developing a process for evaluating the results of the incentive-based system. This process should include metrics and data collection and evaluation methodologies. Ideally, metrics should be based on outcomes (e.g., volume of water conserved) rather than outputs (e.g., number of conservation practices adopted).

WC 2.3 Michigan should improve the administration of its current water conservation requirements. Specifically, the DEQ and MDARD should evaluate the efficacy of current requirements that farms submit conservation plans (if reporting usage to MDARD) and new registrants in Zone C self-certify compliance with generic or sector-specific conservation measures. The efficacy of these requirements should be considered with reference to the current lack of agency follow-up, the potential for and outcomes of actual enforcement of those requirements, and the opportunities provided by the incentive-based program described above.

WC 3.1 The Alliance for Water Efficiency Scorecard provides some valuable information on different tools available for addressing water efficiency and conservation in the municipal sector. However, it is not a good metric to evaluate Michigan's Water Use Program overall or the municipal sector of Michigan's Water Use Program in particular. The workgroup does not recommend its use as a metric.

WC 3.2 Michigan should develop Water Use Program metrics based on state-specific Water Conservation Program Goals and Objectives, which are recommended for development in Recommendation WC 5.1.

WC 3.3 Beyond metrics based on state-specific goals and objectives, Michigan should encourage the development of regional metrics tied to the Regional Goals and Objectives developed by the Great Lakes Compact Commission.

WC 4.1 Michigan should coordinate a statewide campaign and marketing effort to encourage water conservation action, or wise water use, across water use sectors and among individuals.

WC 4.2 Michigan should invest in hiring a marketing firm to conduct the necessary research to develop a common theme (similar to "Pure Michigan") and consistent message appropriate to target audiences upon which sectors can build actionable messages appropriate to their client base/members.

WC 4.3 Michigan should tap into and partner with successful local sector and non-profit campaigns for examples of creative and effective messaging regarding responsible water use.

WC 5.1 Response to Comment: Michigan should adopt state-specific goals and objectives for its Water Conservation and Efficiency Program.

WC 5.2 Response to Comment: Michigan should be doing more to manage water resources on the basis of long-term sustainability, including consideration of climate change.

WC 5.3 Response to Comment: Michigan should include current users in programs encouraging adoption of water conservation measures.

WC 6.1 This report contains a variety of recommendations for updating Michigan's water conservation program. When the program has been updated, a periodic evaluation of the program must take place to ensure its effectiveness and plan for improvement.

WC 6.2 A full program assessment and update should take place every five years, using data compiled from measurable objectives that have been established for each of the program components. This data should be gathered on an annual basis where applicable.

WC 7.1 Pursuant to the terms of the Tribal State Water Accord, Michigan should consult twice yearly with the Tribal Governments in the state to share respective progress on individual and joint efforts to manage Michigan's water resources in furtherance of shared interests in protecting and preserving the Great Lakes basin waters. The discussion should specifically address the coordination of Michigan's accounting-based water management program and tribal water management programs.

PREVENTING ADVERSE RESOURCE IMPACTS IN INLAND LAKES AND PONDS

IL 1.1 The DEQ should review, and work with DNR, on the development of protocols and procedures for collecting bathymetric data so that data collected under these standards can be used to develop inland lake and pond maps that include information about lake and pond depth and volume. The Departments should publish and make available to the public these protocols and standards so that non-agency persons can participate in bathymetric data collection for inland lakes and ponds.

IL 1.2 The DEQ should develop training modules through such means as its existing MiCorps program and crowd hydrology projects to encourage citizen participation in lake and pond water level data collection, and ensure that data collection is conducted according to protocols agreed upon by the DNR and DEQ for both documenting changes in water levels over time as well as to create bathymetric maps from which mean depth and hypsographic curves can be derived.

IL 2.1 The ARI definition for inland lakes and ponds in MCL 324.32701 (1) (a) (vii) does not need to be amended at this time. Inland lakes and ponds may need protection to prevent ARIs from indirect (groundwater) withdrawals, as well as direct withdrawals. However, our knowledge of interactions between groundwater and surface water of inland lakes and ponds is insufficient to develop a statewide assessment procedure to efficiently and reliably screen lakes for the potential for an ARI caused by a given withdrawal proposal. Data and further research are needed to support an agency determination of an ARI for lakes and ponds potentially affected by LQWs. Once a screening procedure is established and validated, statutory changes may be made to Part 327 to protect inland lakes and ponds from both direct and indirect withdrawals. An ARI determination should include the recognized and legally protected uses of lakes and ponds.

IL 2.2 The State of Michigan's Quality of Life agencies (DEQ, DNR, and MDARD), in collaboration with the United States Geological Survey (USGS), should work with the successor to the current Water Use Advisory Council to:

IL 2.2a Prioritize additional data collection and research to better characterize and classify inland lakes and ponds in Michigan with respect to their vulnerability to ARIs caused by groundwater and surface water LQWs.

IL 2.2b Develop an on-line screening tool capable of assessing whether a proposed surface or groundwater withdrawal is likely to cause an ARI in an inland lake or pond; allow the water user to register LQWs that pass the screening tool; and require a SSR by the DEQ for any proposed LQWs that cannot be passed by the screening tool.

IL 2.2c Develop a SSR procedure for the DEQ to determine whether a proposed surface or groundwater LQW is likely to cause an ARI in an inland lake or pond. The procedure should be publicly available on the DEQ's website.

IL 3.1 A collaborative effort should be made to utilize public and private funds to install staff gauges in inland lakes and ponds in Michigan. Recognizing that some private groups may want to have staff gauges installed in lakes of interest to them, the staff gauges should be installed first in those inland lakes that are at high and medium risk for ARIs. We recommend using the decision tree in Appendix C as an initial predictive tool for identifying the relative ARI risk for inland lakes and ponds. The staff gauges should be tied into upland elevation benchmarks. The staff gauge elevations should be annually resurveyed due to the potential for damage from ice and other factors.

COUNCIL BACKGROUND AND CHARGE

Water Use Program Background

The Water Use Program was established through Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act in 2008 to carry out obligations of the Great Lakes - St. Lawrence River Basin Water Resources Compact. The program is administered by the Water Resources Division (WRD) of the Department of Environmental Quality (DEQ). The Department oversees the assessment process of the Water Use Program, which includes but is not limited to: registering large quantity water withdrawals (LQWs), conducting site specific reviews of proposed LQWs, issuing permits for LQWs, convening registered and permitted users when an adverse resource impact (ARI) has occurred, managing annual water use reporting, and handling program compliance. Additional responsibilities outlined in Part 327 include adding verified data and/or conducting technical modifications to the Water Withdrawal Assessment Tool (WWAT) using an approved methodology, and developing protocols or procedures for the collection of streamflow measurements by non-agency staff.

The water withdrawal assessment process was heavily shaped by previous legislative advisory councils: the Water Resources Conservation Advisory Council (WRCAC) and the Groundwater Conservation Advisory Council (GWCAC). Each Council identified items to be considered for future work to improve the water withdrawal assessment process. Main issues of concern identified by the Department for this Council regarding the Water Use Program include water availability, data collection and evaluation, decision-making tools, conflict resolution, and water conservation goals.

Council Charge

The Water Use Advisory Council (Council) was established in December 2012 by the DEQ Director Dan Wyant to provide advice on the State's Water Use Program. The Council was charged to provide advice in the following areas:

- Water conservation and efficiency goals, objectives and voluntary measures
- Technical underpinnings of the process, tools, data, assumptions and decision end-points used to determine whether proposed water withdrawals can be authorized
- Technical and compliance assistance
- Methods and tools to assist water users in resolving and preventing conflicts
- Environmental monitoring to identify and help reconcile potential discrepancies between the program's decision making and data management protocols and the real world impacts of withdrawals
- New and emerging water use categories
- Outcomes and metrics for determining the program success

Membership

The Council comprised of 22 members and 9 ex-officio members representing a diverse group of water use stakeholders across Michigan. Members were appointed for a two year term. Stakeholder groups represented on the Council included water use sectors (e.g., utilities, agriculture, non-agricultural irrigators, business and manufacturing, public water supplies), environmental and conservation groups, well drillers, watershed groups, universities, tribes, local governments, and state agencies. All members were invited to name an alternate member to ensure their interests and perspectives were represented in all discussions and decisions. For a complete list of Council members and alternates, please refer to Appendix A.

Three members were elected to serve as tri-chairs of the Council. A Leadership Committee was established consisting of the tri-chairs, three other elected Council members, and two ex-officio members from the DEQ. The Leadership Committee responsibilities included setting meeting agendas and organizing other meeting logistics, tracking progress of Council work, and initiating draft materials for the Council among other duties.

Council Operations

Council members provided input to a draft scope of work offered by the DEQ and identified specific issues of concern to themselves and their constituents. From this broader list of issues, members were asked to indicate what they considered to be the most important and urgent issues to be addressed by the Council. Thirteen members and three ex-officio members provided feedback to the DEQ. The DEQ staff examined the responses from the thirteen members and created an initial prioritization list along with input from the Quality of Life (QOL) agencies. The Leadership Committee reviewed the list, combined similar topics and narrowed it to the seven general priorities listed below:

1. Technical underpinnings of the process, tools, data, assumptions and decision end-points used to determine whether proposed water withdrawals can be authorized

2. Environmental monitoring to identify and help reconcile potential discrepancies between the program's decision making and data management protocols and the real world impacts of withdrawals

3. Methods and tools to assist water users in resolving and preventing conflicts

4. Technical and compliance assistance

5. "New" categories of water use, including fracking and lake augmentation wells

6. Water conservation and efficiency goals, objectives and voluntary measures

7. Outcomes and metrics for determining the program success

The Council established several workgroups to address these general issues and members were actively involved in refining detailed charges for each workgroup and developing work plans (see Appendix B). Workgroups were formed around Technical Underpinnings of Withdrawal Decision Making, Environmental Monitoring, Water Users Groups, and Water Conservation and Use Efficiency. The Leadership Committee drafted initial workgroup charges, which were reviewed by the Council. Members were assigned their first choice for workgroup preference, and one DEQ WRD staff person was assigned to participate on each workgroup as an ex-officio member. A workgroup was later established to examine ARIs from direct withdrawals on inland lakes given the complexity of the issue. Workgroups were responsible for self-organizing and making recommendations to the full Council to be considered for "will-live-with" consensus.

Full Council, in person meetings were held approximately bi-monthly during the first year and monthly during the second year. It was agreed that decisions would be made using "will live with" consensus. Furthermore, past decisions would not be revisited. This would include instances in which a Council member was unable to attend a meeting and did not send an alternate in his or her place. Council members could, however, submit a dissenting opinion if they were unable to live with a particular recommendation.

Inclusion and transparency were strong operating principles of the Council. Members were strongly encouraged at several meetings to seek input from their constituents as work progressed. All Council meetings were also open to the public, and meeting agendas and notes were posted on the DEQ's Council website (www.michigan.gov/wateruse). Members of the public were provided with opportunities to comment at the beginning and end of each Council meeting at a minimum. Non-members were often included in Council discussions at the discretion of the Chair. Workgroup meetings were also open to the public and meeting times were posted on the Council website. Non-members participating on the workgroups were not included when reaching consensus on a recommendation.

While only Council members participated in seeking consensus on recommendations, several external stakeholders and experts were invited to present at both full Council and workgroup meetings. These presentations served to inform Council members of broader water use related work (e.g., the Michigan Water Strategy) and specific efforts, research or knowledge relating to aspects of the water withdrawal assessment process (e.g., detailing the WWAT accounting database). Workgroups also regularly sought expertise from external stakeholders to accomplish their tasks. A list of external stakeholders who presented to the full Council is provided in Appendix G.

Council meetings were hosted across the state by various organizations and water use stakeholders. This provided an opportunity for stakeholder groups to share their experiences relating to water use in Michigan. In two instances, tours were offered prior to Council meetings for an in-depth look at regional water use concerns. These tours examined the recreation and tourism industry in northwestern Michigan and agricultural irrigation in southwest Michigan.

Council Support

The DEQ received a grant from the Joyce Foundation to facilitate Council activities. To lend credibility to the process and support the Council's work, the Department sought outside assistance. A memorandum of understanding was signed with the Michigan State University Institute of Water Research to carry out the grant and ensure effective operation of the Council. The Joyce Foundation funding supported administrative assistance, research and information gathering, facilitation, and meeting incidentals.

FINDINGS AND RECOMMENDATIONS

Introduction

This section contains the complete set of recommendations and findings by the Council, organized by workgroup topic area. The end of this section contains work items that were unable to be addressed by this Council, but should be considered for future work. Each recommendation contains the following:

1. The charge reference number to which the recommendation applies. The charges are numbered in the detailed charge documents in Appendix B and in the recommendation matrix in Appendix D.
2. An issue statement and background that describes the problem, issue or question that is being addressed by the recommendation, and any relevant background information.
3. A description of any findings developed by the workgroup that relate to the issue described above.
4. The recommendation(s) developed by the workgroup.

5. If applicable, general resources needed to implement the recommendation.

As noted earlier in the report, recommendations were approved by the Council using a “will-live-with” consensus approach. In instances where recommendations did not receive unanimous support, Council members were offered the opportunity to submit a written dissenting opinion, which are included in Appendix E. Individual recommendations that did not receive unanimous support are noted in this section.

CONTINUATION OF THE WATER USE ADVISORY COUNCIL

Charge

- The Leadership Committee of the Water Use Advisory Council will provide the overall *process* management of Council activities, including setting Council meeting dates and establishing the agendas for these meetings.
- The Leadership Committee of the Water Use Advisory Council will provide an overall vision for the Council and its activities.

Issue

Through its various workgroups, the Water Use Advisory Council has made substantial progress in

- Identifying the most important issues associated with the current and near-term future implementation of the Water Withdrawal Assessment Program.
- Recommending technical and procedural improvements to numerous aspects of the Water Withdrawal Assessment Program.

However, the important work of the Water Use Advisory Council will remain unfinished at its established closure date in December 2014.

Recommendation

The Director of the DEQ should re-establish and maintain the Water Use Advisory Council, or a similar stakeholder group, for the foreseeable future in order to provide input on issues related to the implementation of Part 327, P.A. 451.

Background

In December of 2012, the Director of the DEQ invited numerous stakeholder groups to participate in the Water Use Advisory Council. Since such participation involved a considerable volunteer time commitment, the Council was designed to function for two years, providing its final report to the Director in December 2014.

Findings

The Water Use Advisory Council established five workgroups, each dealing with a different set of thematic topics. Several of the workgroups originally identified important topics that they have been unable to fully explore within the two-year time frame. As a result, no recommendations concerning these topics will be forthcoming, yet the DEQ will need to address most of these in the near-term. In addition, as the workgroup and full Council discussions have evolved, several important, highly nuanced and interrelated topics have crystalized. Most of these topics have no easy solution. Such complex issues deserve the insights that can be gained from a broad stakeholder review and comment process. At the same time, however, the complexity and interrelatedness of many of these issues also requires an educated stakeholder body composed of members having a deep understanding of the statutory, technical, environmental and societal aspects of the Water Withdrawal Assessment Program.

TECHNICAL UNDERPINNINGS OF WITHDRAWAL DECISION MAKING

1. Best available digital hydrography for use in the Water Withdrawal Assessment Tool (WWAT) and Site Specific Reviews

Charge TU-C

Issue statement and background
The base digital hydrography used for the WWAT is the 1:100,000 USGS NHD-Plus, which was the best-available, national standard, stream base map at the time the WWAT was developed (Bondelid et al., 2006; Hamilton and Seelbach, 2011). The November 2009 Report of the *Water Resources Conservation Advisory Council* contained the following recommendation:

> *All aspects of the Process should be moved from the 1:100,000 to the 1:24,000 map scale when feasible to best align the scale of the statewide Screening Tool with the on-the-ground scale of policy decisions. Future decisions regarding scale and structure of the base map should be sensitive to efforts of regional partners to construct a consistent Great Lakes basin-wide mapping platform for water management.*

A newer, high-resolution NHD (National Hydrology Dataset), called ***NHDH*** and based on 1:24,000-scale topographic mapping, is currently available nationwide (USGS, 2013). NHDH, therefore, is the most current, best-available, national standard, stream base map. In light of the recommendation of the previous Council, the workgroup evaluated the spatial fidelity of the hydrography in the 1:100,000 NHD-Plus compared to the 1:24,000 NHDH and found that they are essentially equivalent to one another in the context of how they are used in the WWAT. As such, workgroup concluded that the scale of the hydrography is not a pressing issue for the Program.

However, neither the 1:100,000 NHD-Plus nor the 1:24,000 NHDH meet the needs of the Water Withdrawal Assessment Program because both datasets classify flowing water segments as either “Canal/Ditch” or “Stream/River.” Although the Stream/River class is sometimes further subdivided between “Perennial” and “Intermittent,” no such subdivision is provided for the canal/ditch class. While numerous canal/ditch segments across Michigan are perennial, a large number of them are intermittent.

The workgroup determined that the current hydrography in the WWAT inappropriately includes both perennial and intermittent streams. The Water Withdrawal Assessment Process as established by Part 327, P.A. 451 only applies to perennial streams (*i.e.*, those with an index flow > 0). The presence of numerous intermittent streams in the current hydrography of the WWAT results in erroneous stream depletion calculations within the Watershed Management Areas.

Recommendations
Consensus was reached but with one objection to this set of recommendations (TU1.1 – 1.3).

TU 1.1 As quickly as possible, the Program should partner with Michigan NHD Steward to edit the NHDH, attributing all segments as intermittent that are symbolized as intermittent on the most current version of the 1:24,000 topographic maps.

TU 1.2 As soon as an edited version of the NHDH is available, the DEQ should eliminate all intermittent segments and adopt this revised file as the hydrography used by the Program in both the WWAT and during site specific reviews.

TU 1.3 Recognizing that such an effort could be lengthy, the Council recommends that the DEQ use a phased approach by giving first priority to those regions of the State where the majority of the current Water Withdrawal Registrations have occurred.

Findings

a) The spatial fidelity of the hydrography in the 1:100,000 NHD-Plus and the 1:24,000 NHDH are essentially equivalent in the context of how they are used in the WWAT. As such, the scale of the hydrography is not a pressing issue for the Program.

b) According to the Topographic Instructions of the USGS, *perennial* hydrographic features contain water throughout the year except for infrequent and extended periods of severe drought, while *intermittent* hydrographic features contain water only part of the year. The Instructions specify that perennial water features be symbolized by solid blue lines, while intermittent water features are mapped with broken blue symbolization.

c) All 1:24,000-scale topographic quadrangles compiled by the USGS involved extensive field work. According to the USGS Topographic Mapping Booklet, "*Field personnel use aerial photographs to mark and verify map features. A field check is necessary because information on an aerial photograph can often be ambiguous. For example, a worker in the field can indicate the difference between a perennial stream and one that dries up at certain times of the year*."

d) After checking with the USGS, the State of Michigan Geological Survey, the DEQ, the DNR, the DOT and several university mapping experts, the workgroup concluded that the USGS 1:24,000-scale topographic map series is the most authoritative mapping source that systematically differentiates between perennial and intermittent streams. While it is true that all of the 1:24,000-scale quadrangles in Michigan are old (publication dates: 2.3% pre-1960; 11.4% 1960 – 1969; 33.4% 1970 – 1979; and 52.9% 1980 – 1989), there are no alternative, statewide, authoritative geospatial sources that systematically differentiate between perennial and intermittent streams. It has been noted that some County Drain Commissioners have digital data describing the legally-defined drains they administer, but most County Drain offices do not have such digital data, and a large number of intermittent streams in Michigan are not legally-defined drains. It has been suggested by some that recently-acquired, high-resolution imagery could be interpreted to distinguish between perennial and intermittent streams. There are no credible, science-based studies that support such an opinion. Just the opposite - most remote sensing and image interpretation experts, including the USGS Mapping Branch, conclude that perennial and intermittent streams cannot be accurately distinguished from imagery, in most circumstances.

e) Both the 1:100,000 NHD-Plus and the 1:24,000 NHDH fail to classify all flowing water segments as either "Perennial" or "Intermittent."

f) Of 295 stream segments in the current WWAT from a 4-township sample area in south-central St. Joseph County, 32% of them were determined (by comparison to the 1:24,000-scale topographic maps) to be intermittent.

g) Of 416 stream segments in the current WWAT from a 4-township sample area in northwest Tuscola County, 86% of them were determined (by comparison to the 1:24,000-scale topographic maps) to be intermittent.

h) The presence of large numbers of intermittent streams in the WWAT is unacceptable because they result in erroneous depletion calculations.

Program Effects

- Eliminating numerous intermittent streams in the WWAT will call into question the current water use allocations among the various Watershed Management Areas. While in many areas the net result will likely be to make more water available, it is possible that larger depletions may be allocated to the neighboring catchments which could result in an over-allocation.
- Recalculating all previous registrations in light of a revised hydrography would appear to be prudent due diligence, but will add a work effort burden of unknown magnitude for Program staff.

Resources needed

- Relying on the Site Specific Review process to edit the NHDH hydrography in the WWAT "on the fly" will place an unrealistic effort burden on the Program staff. Additionally, the lack of a broad-area, intensive effort to correct the WWAT hydrography will exacerbate the lack of confidence that many regulated water users already have concerning the WWAT.
- A limited test was conducted in two, contrasting, four-township areas, one with low stream density, but high lake and wetland density, the other with high stream density, but low lake and wetland density. On the basis of this test, the average work effort necessary to remove intermittent segments from the NHDH vector line work is 107.4 square miles per hour. At this rate, it would take a single, 40 hr/week worker 8.1 years to edit just the southern half of the Lower Peninsula. Scaling up to the whole of the Lower Peninsula, it is estimated that a single, 40 hr/week worker would take 12.6 years to edit the NHDH. Obviously, more than one 40 hr/week worker will be required in order to finish this important task in a reasonable period of time.
- The W.E. Upjohn Center for the Study of Geographical Change at Western Michigan University has conducted some very preliminary studies involving digital image processing techniques to extract the intermittent stream symbols from *regular* 1:24,000-scale topographic maps. These techniques hold great promise to facilitate the computer-assisted editing of the NHDH hydrography at a cost that may be significantly less than the manual approach outlined above. However, it is not likely that these image processing methods will work for the 370 *provisional* quadrangles in Michigan (out of a total of 1,257 quadrangles). The bulk of these *provisional* quadrangles occur in northwest Lower Michigan and the Tip-of-the-Mitt area.
- There are numerous other programs in the DEQ, DNR and DOT that would also be interested in having a statewide, authoritative hydrographic map that distinguished perennial from intermittent streams. The USGS NHD Program Office and the Michigan NHD Steward (DTMB, CSS) also have abiding interests in enhancing and maintaining the NHD. As such, it seems plausible that funding the recommended NHDH editing project could be accomplished within a partnership framework.

Relationship to other recommendations
The current hydrography in the WWAT contains a large number of intermittent streams which cause erroneous calculations of catchment depletion by proposed withdrawals. These intermittent streams must be eliminated. Since the digital hydrography is the foundation of the Water Withdrawal Assessment Process, it must be as accurate as possible. Therefore, editing the NHDH should be one of the highest priority tasks for the DEQ.

References
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Hamilton, D. A. and P. W. Seelbach. 2011. Michigan's Water Withdrawal Assessment Process and Internet Screening Tool. Michigan Department of Natural Resources, Fisheries Special Report 55, Lansing, 37 p.

USGS. 2013. NHD User Guide (online). http://nhd.usgs.gov/userGuide/Robohelpfiles/NHD_User_Guide/NHD_User_Guide.htm (accessed Nov 2013).

USGS. ND. Topographic Mapping Booklet (online) http://pubs.usgs.gov/gip/topomapping/topo.html (accessed Jan 2014)

2. Water Withdrawal Assessment Tool (WWAT) and Bedrock Auto Pass

Charges TU-C, TU-G, TU-H

Issue
Changes need to be made to the WWAT's user interface and "Bedrock Auto Pass" feature to minimize the potential for adverse resource impacts (ARI) to occur when a groundwater withdrawal that was authorized by the WWAT or a site specific review (SSR) as a bedrock well is actually completed as a glacial well in a watershed that is depleted to the point where an ARI is likely to occur.

Background
The water quality and yield from bedrock aquifers in Michigan varies depending on the water user's location in Michigan and the bedrock well's depth. The WWAT recognizes four different types of bedrock aquifers (Reeves, et al., 2009):

1. Bedrock aquifers that typically have limited hydraulic connection with streams and are potentially saline (e.g., the Jurassic "red bed" formations in West Central Michigan).
2. Bedrock formations that typically don't have sufficient yield (e.g., the Coldwater Shale in the Lower Peninsula and bedrock formations in the western Upper Peninsula).
3. Bedrock aquifers that typically only have limited hydraulic connection with streams (e.g., the Saginaw and Marshall Formations in the Lower Peninsula).
4. Bedrock aquifers that are in hydraulic connection with streams (e.g., in the eastern Upper Peninsula and the northern Lower Peninsula).

The WWAT was designed with a “bedrock auto pass” feature to automatically authorize bedrock wells completed in aquifers falling in the first and third categories. The user is informed that the WWAT’s evaluation is not a guarantee of groundwater quantity or quality. The user proposing a well in the second bedrock category is informed that bedrock aquifers in this area aren’t typically used for high-capacity wells and the proposed well is evaluated using glacial aquifer properties. The WWAT evaluates the pumping of wells proposed in the fourth category using bedrock hydraulic properties.

The WWAT’s user interface informs the potential well user of the average depth to bedrock for the Watershed Management Area where the proposed well is located, the average well depth, the percentage of glacial wells in the Watershed Management Area and the percentage of bedrock wells in the Watershed Management Area. The WWAT’s user interface asks for the well depth, not the depth to the bottom of the well casing.

Findings

Areas with complex bedrock geology (e.g., deep bedrock valleys, the margins of bedrock formations) present special problems. Areas with deep, narrow bedrock valleys can have glacial wells completed in valley deposits and bedrock wells completed at roughly the same depth interval within a fraction of a mile from each other. The property owner may not know whether his/her well is completed in a glacial or bedrock aquifer until the well driller provides him/her with the well log. The well driller is required to submit a copy of the well log to the property owner and the local health department within 60 days of completion. The local health department is required to submit a copy to the DEQ within 30 days after receiving the well log so the DEQ may not receive the well log for up to 90 days after completion.

Property owners are not notifying the DEQ when their wells are completed differently than they were authorized by the WWAT or a SSR, as required by MCL 324.32706b (5) and 324.32706c (7). The DEQ often does not discover these well completion violations until the DEQ attempts to match WWAT registrations with Wellogic well logs during the review of a subsequent SSR request in the same or adjacent Watershed Management Areas. This may be months or even years after the well was put into operation. The well is likely to have been in operation during that period increasing the potential for these glacial wells to deplete the watersheds beyond the point where an ARI is likely to occur.

During a SSR for a proposed groundwater withdrawal, the DEQ matches water well logs in Wellogic with WWAT registrations in the same watershed as the proposed well and in adjacent watersheds. Approximately 90 percent of the water well logs reviewed by the DEQ are different than authorized by the WWAT registrations. The differences can be in the well’s location, whether it’s a glacial or bedrock well, the well’s screened interval depths, the pumping rate or some combination of these. The DEQ is able to resolve most of those discrepancies by registration modifications incorporating the changes when there is sufficient water available. The DEQ is currently working to resolve eleven instances where wells were completed differently than authorized, and when “as built” well information is used, they are likely to cause ARIs.

In response to this problem, the DEQ decided to stop using the “bedrock pass” feature and treat all high capacity wells in categories one and three as glacial wells. This increased the number of site specific reviews in these areas and lengthened the approval process time. However, the site specific review may be as simple as verifying from the well log that the well was completed in bedrock.

Discussion of Recommendations:

TU 2.1 Modify the WWAT's coding to use the top-of-bedrock depth from the WWAT's glacial thickness map GIS data layer at the proposed well location instead of using an average top-of-bedrock depth for the Watershed Management Area.

The glacial thickness map of Michigan (Lusch, 2008) was developed from 265,312 point observations of the top-of-bedrock (roughly 56 percent of those points in the Lower Peninsula). These observations included electronic and paper water well logs, oil & gas well logs from the DEQ, miscellaneous Department of Natural Resources records, and select soil database records from the Natural Resources Conservation Service and the Delta-Menominee District Health Department for areas where the bedrock is close to the ground surface. The depth-to-bedrock value at each point was calculated by subtracting the extracted top-of-rock elevation from the surface elevation at that location as recorded in the USGS National Elevation Dataset Digital Elevation Model. These depth-to-bedrock values were interpolated statewide onto an output grid with 500 x 500 meter cells using ordinary kriging. The initial output glacial thickness raster was subsequently smoothed using a 3 grid cell x 3 grid cell averaging filter.

This GIS data layer reflects the known locations of bedrock valleys. Using the depth to bedrock at the proposed well location instead of an average depth to bedrock for the Watershed Management Area will better avoid masking areas where bedrock formations pinch out on their margins.

This modification will provide the well driller and the property owner with a more accurate estimate of the depth to bedrock at the proposed well location. This should reduce the chance of glacial wells being mistakenly registered as bedrock wells. This modification isn't expected to negatively impact water users.

Resources needed: Implementing this recommendation will require the Michigan Department of Technology, Management and Budget's Center for Shared Solutions (DTMB-CSS) to host this GIS data layer on the State of Michigan's network, update the WWAT's coding to query this GIS data layer and output the results in the WWAT's user interface. This recommendation would probably take one year to implement, although implementing several recommendations involving recoding the WWAT concurrently could lengthen this process. The DTMB-CSS would have to provide a detailed cost estimate.

TU 2.2 Make the WWAT registration number a required field in Wellogic (and on paper well logs) for high-capacity wells.

The WWAT registration number is currently an optional field in Wellogic and on paper well logs. Well logs with WWAT registration numbers are flagged for priority entry into Wellogic when they are received at the DEQ. Making the WWAT registration number a required field will require the well driller to obtain the WWAT registration number from the property owner or else register the well themselves (acting as the property owner's agent). This modification will not address well logs that were previously entered into Wellogic without their corresponding WWAT registration numbers.

Outreach efforts should be conducted with well drillers and local health departments to inform them of the need for this change. Collaboration with organizations such as the Michigan Ground Water Association, Michigan Environmental Health Association,

Farm Bureau, Michigan Agri-Business, Michigan State University (MSU) Extension Service, MSU Institute of Water Research, and the Michigan Department of Agriculture and Rural Development will enhance education and outreach activities.

Resources needed: If this recommendation and TU 3.1 are not implemented, a systematic matching of water well logs in the Wellogic Database with WWAT registrations would require additional labor by DEQ staff, student interns or contractors. The DEQ's Water Use Program staff currently only has time to do this on a case by case basis as they review SSR requests.

This recommendation could be implemented within one year. The Wellogic Database currently has a field for the WWAT registration number. A field for the WWAT registration number will have to be added to the paper well log form. The revised well log form will need to be posted on-line and distributed to well drillers, local health departments and other interested parties. The well driller will need to ask the property owner for the WWAT registration number, if the well driller doesn't register the well using the WWAT him/herself. Increased communication between the property owner and the well driller is an opportunity for a full service well driller to inform the property owner of his/her obligations under Part 327 of the NREPA as well as informing him/her about the geological and hydrogeological settings of his/her property.

Relationship to other recommendations: This recommendation should be grouped with the Technical Underpinnings workgroup's recommendations on "Checking Compliance with Registration for Large Quantity Groundwater Withdrawals" (Recommendations TU 3.1 and 3.2). The issue of property owners failing to notify the DEQ when wells are completed differently than were authorized by the WWAT or by a SSR applies to both glacial and bedrock wells. It should be implemented before Recommendations TU 3.1 and 3.2 because making the WWAT registration number a required field for both electronic and paper water well logs is a prerequisite for automating the process of comparing WWAT registrations with water well logs.

TU 2.3 Permanently discontinue use of the "Bedrock Auto Pass" feature. The WWAT should be reconfigured in the areas that originally used the "Bedrock Auto Pass" feature. The WWAT should use bedrock aquifer characteristics to calculate streamflow depletion when bedrock is selected. As an interim measure, until the bedrock aquifer calculation is implemented, the DEQ should use glacial aquifer characteristics in the WWAT when bedrock is requested. If that triggers a SSR, the DEQ should use bedrock aquifer characteristics to calculate streamflow depletion.

The USGS' MODFLOW model of the tri-county region (Luukkonen, 2010) was used to test potential streamflow depletion by wells pumping in bedrock aquifers (Reeves, 2012). The model was used to simulate the effects of pumping wells screened over the entire saturated thickness of the Saginaw Formation bedrock aquifer on the stream flow in tributaries of the Red Cedar and Looking Glass Rivers. After five years of simulated pumping, the stream flows in these tributaries were depleted by approximately 20 gallons per minute (gpm) and 10 gpm, respectively.

While these values are much less than if the wells were completed in glacial material, the model's results suggest that the Saginaw Formation aquifer may not be as hydraulically isolated from streams as was believed during the WWAT's design.

Further study is needed to evaluate the effects of pumping glacial and bedrock wells on nearby streams. However, permanently discontinuing the "Bedrock Auto Pass" feature appears to be a prudent measure to prevent the WWAT from authorizing large quantity withdrawals (LQWs) that have the potential to cause ARIs.

Until this recommendation can be fully implemented, running the WWAT's groundwater model using glacial aquifer characteristics (e.g., transmissivity, storage coefficient) will generally be more conservative (i.e., it will predict greater stream flow depletions) than running the model using bedrock aquifer characteristics. The more appropriate bedrock aquifer parameters can be used during the SSR.

The reconfigured WWAT will no longer assume that pumping a bedrock well has no effect on stream flow. The WWAT will use the appropriate bedrock characteristics to estimate the stream flow depletions. This will not solve the problem of the WWAT user registering glacial wells as bedrock wells.

Resources needed: Recoding the WWAT to use bedrock aquifer characteristics to calculate stream flow depletions will also require the DTMB-CSS to host the GIS data layer(s) with these bedrock aquifer characteristics on the state's network. This recoding should be relatively straightforward because it is applying existing code in another area. The length of time could be extended if this request for coding changes is lumped with other more complicated changes.

References

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Carol L. Luukkonen, 2010, "Model refinement and simulation of groundwater flow in Clinton, Eaton, and Ingham Counties, Michigan: U.S. Geological Survey Scientific Investigations Report 2009-5244, 53 p., also available at http://pubs.usgs.gov/sir/2009/5244/.

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3. Checking Compliance with Registrations for Large Quantity Groundwater Withdrawals (LQW)

Charge TU-H

Issue

Due to a variety of factors, the final well completion details (e.g., location, screened interval depth, rated pump capacity) often differ from what was authorized by the on-line WWAT or by a SSR. Part 327 requires the property owner in these cases to notify the DEQ of the changes, but that is rarely done. The DEQ Water Use Program staff usually don't discover the discrepancies

between the well construction details and the LQW registration until a compliance check is done during the review of a subsequent SSR. This is often months or possibly years after the well was completed and put into operation. The Council made an earlier recommendation to require the WWAT registration number be submitted with the well logs for high-capacity wells. This will make possible an automated process to compare "as built" to registration in a timely manner. A process needs to be designed and implemented to accomplish this.

Background

There are a variety of factors that result in a well for a proposed groundwater LQW being completed differently than what was authorized either by the WWAT or SSR. The property owner (or authorized agent) usually obtains the WWAT or SSR authorization before the well is drilled. Unforeseen events (e.g., auger refusal, failure of the well to provide sufficient water yield) can cause the driller to change the well location. Other causes (access for equipment, providing electrical power to the well) may also require changing the well location. The driller may also set the well screen at a different depth interval in order to provide the optimum yield based on the glacial and/or bedrock geology at that location and depth.

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA), places the liability for complying with the statute solely on the property owner. The property owner, however, is usually unfamiliar with the glacial and bedrock geology at his/her property. The property owner may not know the details of his/her well's construction until the well driller provides him/her with the well log. The property owner may also be unfamiliar with the requirements of Part 327 of the NREPA.

Findings

The well driller is required to submit a copy of the well log to the property owner and the local health department within 60 days of completion. The local health department is required to submit a copy to the DEQ within 30 days after receiving the well log so the DEQ may not receive the well log for up to 90 days after completion.

Property owners are not notifying the DEQ when their wells are completed differently than they were authorized by the WWAT or a SSR, as required by MCL 324.32706b (5) and 324.32706c (7). The DEQ often does not discover these well completion violations until the DEQ attempts to match WWAT registrations with Wellogic well logs during the review of a subsequent SSR request in the same or adjacent Watershed Management Areas. This may be months or even years after the well was put into operation. The well is likely to have been in operation during that period creating the potential for an ARI to occur without the DEQ's knowledge.

During a SSR for a proposed groundwater withdrawal, the DEQ matches water well logs in Wellogic with WWAT registrations in the same watershed as the proposed well and in adjacent watersheds. Approximately 90 percent of the water well logs reviewed by the DEQ are different than authorized by the WWAT registrations. The differences can be in the well's location, whether it's a glacial or bedrock well; the well's screened interval depths, the pumping rate or some combination of these. The DEQ must resolve these discrepancies and ensure an ARI is not likely to be caused by the water withdrawal.

Discussion of Recommendations

Consensus was reached but with one objection to recommendation TU 3.1.

TU 3.1 The process for checking the compliance of "as built" well construction details with WWAT and/or SSR registrations of groundwater LQWs should be

automated. Discrepancies between these should be flagged for follow up by staff.

TU 3.2 The DEQ should work with stakeholders to increase the understanding of Part 327 requirements for owners of newly constructed large capacity wells, and increase compliance with the requirement to report differences between registered and "as built" well characteristics.

Eliminating the delays in the process is more of a concern than cost savings, although cost savings (in terms of reduced staff labor) will also result from implementing an automated process. The goals of the recommendations are: a) reducing delays between the submittal of well logs to the DEQ and the compliance check against the WWAT or SSR registrations; b) increasing the compliance rate for property owners notifying the DEQ of changes in the well construction; and c) increasing the communication between property owners, licensed well drillers, local health departments, DEQ, Office of Drinking Water and Municipal Assistance (ODWMA), and DEQ, Water Use Program staff.

The process for checking the compliance of well construction details with WWAT or SSR registrations affects external stakeholders as well as DEQ agency staff. In order to be effective, the DEQ should consider pulling together a team of external and internal stakeholders, including property owners (or their representatives), licensed well drillers, local health departments, the DEQ ODWMA and DEQ Water Use Program staff that are involved in the various process steps. External stakeholders are more likely to take ownership in the redesigned process if they are part of the project team.

Implementation Considerations
The requirement to include the WWAT registration number on the well log submissions should be implemented before an automated compliance check can be implemented.

A process improvement methodology (such as Lean Process Improvement (LPI)) should be used to engage stakeholders in designing the automated compliance check, and developing outreach efforts to increase understanding of Part 327 requirements. The DEQ has found using LPI results in saved time and money, increased compliance, and increased communication between agency staff and external stakeholders. LPI projects achieve the best results when the LPI project team is composed of agency staff and external stakeholders so that at least one team member is familiar with every step in the process. The DEQ and other state agencies have trained LPI facilitators.

4. Water Withdrawal Assessment Tool (WWAT) procedures to modify index flow and stream classification, and approval levels to make modifications to the process

Charges TU-D, TU-H

Issue
The amount of water available to be directly or indirectly withdrawn from a stream without causing an ARI is defined in statute based on the index flow and classification of the stream. These can be modified during a SSR and the results can significantly affect the water available

for large quantity withdrawals. Process users and the interested public do not know what procedures are used, which can lead to questioning the validity of the process.

There have been questions about who has the authority to make modifications to the Water Withdrawal Assessment Process. The mechanisms to modify the many parts of the process are not clear.

Background
Reports describing the entire Water Withdrawal Assessment Process (1), development of the stream depletion model (2), fish response model (3) and the hydrology model (4) are cited below. These models are used in the automated WWAT and describe the initial conditions used the process, they do not describe how the SSR works, or how modifications are made.

The SSR is designed to bring together all pertinent data about a site to determine whether a proposed withdrawal is likely to cause an ARI.

Findings
The workgroup met with DEQ staff and discussed in detail how index flow is calculated, the methods used to incorporate streamflow measurements, and how they are related to USGS gages and their flow statistics. The workgroup was satisfied with the process used by the DEQ.

The workgroup understands that the DNR has only changed a stream classification to correct an initial error in assigning the proper classification to a stream. The DNR is working on a procedure to modify stream classification, including what data are needed and how they are interpreted.

The DEQ is preparing a document that outlines the steps used in the SSR, and creating a checklist that will document what information is used and how each SSR decision is made.

The statute describes certain changes that can only be done by following methodologies approved by the Natural Resources Commission (now the DNR director.) To date, no methodologies have gone through this process.

Discussion of Recommendations
Consensus was reached but with two objections to this set of recommendations (TU 4.1- 4.3).

TU 4.1 The DEQ should write up the procedures and criteria used to modify index flows. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.

The statute anticipates that index flows will be modified through the SSR process, but does not specify what methods are to be used. The DEQ professional staff is using standard hydrologic methodologies. The workgroup was satisfied with the process used by the DEQ, and our recommendation is that the DEQ write it up and have it appropriately approved and published.

We believe the Department should seek input from the Council, or a similar broad based stakeholder group, as it develops any new procedures and criteria. This input will add value to the Department process by making sure the changes are workable from a variety of perspectives, and members can help educate and build acceptance by user groups.

Resources needed: Primarily staff time, existing staff involved in this practice currently.

Relationship to other recommendations: This recommendation has some relation to, or could/should have relation to Recommendation E.M. 1.3 (protocols and standards for collection of streamflow data). As such, there may be benefit to doing this T.U. 4.1 recommendation after E.M. 1.3.

TU 4.2 The DNR should write up the procedures and criteria used to modify stream classification. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.

Modification of stream classification is a significant issue. The statute allows for this modification based "upon a scientific methodology adopted by order of the commission" (DNR director by executive order, with public notice). The DNR is aware of this requirement, and they may have a river they would like to reclassify. They are gathering data on the river, and are preparing a procedure to modify stream classifications.

We believe public notice is essential before adoption of significant modifications to the process. The affected public should have an opportunity to review the proposal and express their views before a final action is taken. These procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the DNR. Once finalized and approved, this procedure document should be published on the DNR and DEQ web sites.

Resources needed: Staff time (moderate – significant), and engagement of stakeholders. This issue is not just one of simple data collection standards or protocols, but will require discussion and contemplation of data interpretation and temporal considerations. As such, this effort could be expected to require a moderate amount of time for staff to undertake successfully. A future iteration of the WUAC could also be used to accomplish this recommendation.

Relationship to other recommendations: Related to many others in topic, but not necessarily dependent on others for sequencing.

TU 4.3 The DEQ/DNR should use Table TU-1 as a guide to determine what level of approval is needed to make modifications within the Water Withdrawal Assessment Process.

The recommendations from an earlier council (5) on this topic were reviewed and found to be consistent with the statute, and carefully thought out. With only minor word changes to reflect executive reorganization of authority exercised by the Natural Resources Commission and the director of DNR, we reproduce them in Table TU-1.

Resources needed: None.

Relationship to other recommendations: Is relevant to T.U. 4.1 and 4.2. Not sequencing sensitive.

References

(1) Hamilton, D. A., and P. W. Seelbach. 2011. Michigan's Water Withdrawal Assessment Process and Internet Screening Tool. Michigan Department of Natural Resources, Fisheries Special Report 55, Lansing.

(2) Howard W. Reeves, David A. Hamilton, Paul W. Seelbach, and A. Jeremiah Asher, 2009, "Ground-Water-Withdrawal Component of the Michigan Water-Withdrawal Screening Tool", Scientific Investigations Report 2009-5003, U.S. Geological Survey

(3) Zorn, T. G., P. W. Seelbach, E. S. Rutherford, T. C. Wills, S. Cheng, and M. J. Wiley. 2008. A Regional-scale Habitat Suitability Model to Assess the Effects of Flow Reduction on Fish Assemblages in Michigan Streams. Michigan Department of Natural Resources, Fisheries Research Report 2089, Ann Arbor.

(4) Hamilton, D. A., R. C. Sorrell, and D. J. Holtschlag. 2008. A regression model for computing index flows describing the median flow for the summer month of lowest flow in Michigan. U.S. Geological Survey, Scientific Investigations Report 2008-5096, Reston, Virginia.

(5) Findings and Recommendations - A Report of the Water Resources Conservation Advisory Council. A Requirement of P.A. 189, acts of 2008. November 2009, 56p. (http://www.michigan.gov/deq/0,4561,7-135-3313_3684_64633-305354--,00.html)

Table TU-1.

Type of Change	Review and Approval Process	Decision Maker
1. Correct technical errors or make minor technical revisions. Examples: Watershed boundary, minor calculation error, correction to withdrawal registration, improved index flow estimate resulting from site specific review, or changes to the web user interface.	DEQ & DNR technical staff to make changes as appropriate. Each change will be documented and an annual compilation will be made available online. DEQ program staff will check on effects to any registered users and notify these accordingly. An annual update will be provided to the Council. DEQ will develop internal procedure for accepting and verifying additional flow measurements. DEQ staff may revise specific segment estimates of Index Flow in the Accounting Database, based on site specific review.	[Level 1] DNR & DEQ technical staff.
2. Technical modifications. Adjustments related to considerations of temperature, hydrology, and steam or river flow based on methodology adopted by order of the NRC.	DEQ & DNR technical staff to make changes as appropriate. Each change will be documented with annual compilation available online. DEQ program staff will check on effects to any registered users and follow up as appropriate. An annual update will be provided to the Council.	[Level 1] DEQ & DNR technical staff.
3. River segments. Revise the ecological type or boundaries for a river segment.	Recommended revisions developed by DEQ & DNR technical staff will be presented to the Council for review with Council submission to NRC for review and decision by the DNR Director. Each approved change will be documented and made available annually online. DEQ program staff will determine effects to any registered users and follow up as appropriate. An annual update will be provided to the Council.	[Level 2] NRC.
4. Methodologies. Revise methodologies related to considerations of temperature, hydrology, and stream or river flow.	Recommended revisions developed by DEQ & DNR staff for review by Council. This should occur not less than every 5 years. Recommendations from the Council are presented to the NRC for review and decision by the DNR Director.	[Level 2] NRC.
5. Modify or add statutory definitions or process. Example: Revise the characteristic and thriving fish curves based on updated analyses.	Recommendations developed by agencies technical staff for Review by Council. Recommendations presented by Council to the DEQ/DNR directors and legislative leadership to pursue legislative changes.	[Level 3] State legislature.

5. Water Withdrawal Assessment Tool (WWAT) models and allocation between Watershed Management Areas (WMAs)

Charges TU-C, TU-F,TU-H

Issue
There are locations in the state where the index flow values initially used in the WWAT over predict how much water is available in the WMAs. There is concern that a watershed could be depleted to the point where an ARI is likely to occur by withdrawals automatically authorized by the screening tool before a SSR is triggered.

The WWAT uses an algorithm (sometimes referred to as the "1/2 max rule") to allocate the effects of a water withdrawal among the source WMA and neighboring WMAs. The algorithm only depletes streamflow from any of these WMAs if the calculated amount is at least ½ the maximum amount calculated among all of these local WMAs. The way the algorithm is currently applied may reduce the total amount of stream depletion attributable to each individual well. The algorithm is also frequently used to apply the results from a SSR. The question is how to more realistically apportion the streamflow depletions in the screening tool, and for some SSRs.

Background
The original report (1) indicates that after the 50% "safety factor" is applied, 10% of the index flow estimates used in the screening tool would be greater than the actual value. Some examples of this have been found in small headwater trout streams in northern Lower Michigan. The concern is the automated screening tool might authorize enough withdrawals to cause an ARI before a site specific review is triggered.

Groundwater withdrawals develop a "cone of depression" and "capture" groundwater that may have otherwise flowed to several nearby streams. This is affected by the amount of the withdrawal, hydraulic properties of the aquifer, the connection between the streams and aquifer, depth of the well, and proximity of streams to the proposed well. A model (2) was developed for the WWAT to broadly account for these factors. All neighboring WMAs are identified that touch the source WMA. A streamflow depletion is calculated for each one based on the distance from the well to the nearest stream segment in each WMA. In some cases, this method can yield nonsensical results, such as calculating depletions from streams that are far away when a major stream is nearby, or on the other side of a major stream. To minimize these problematic situations and more faithfully honor the hydrogeologic fact that drawdown cones stabilize when they reach stream boundaries that can satisfy the withdrawal demand, the withdrawal depletions from individual WMAs are evaluated and withdrawals are applied in the WMA accounting only if the estimated depletion is more than half the maximum estimated depletion. This reduces the number of streams affected by a groundwater withdrawal to those closest to the withdrawal point and limits the evaluation to those having the greatest potential to significantly contribute to the withdrawal. However, as currently constructed, the depletion allocation routine in the WWAT ignores all the calculated depletions that are less than half the maximum, resulting in under prediction of the total depletion attributable to each proposed withdrawal. The attachment following this discussion illustrates how this algorithm works.

The current streamflow depletion calculation occurs in three steps. First, all neighboring WMAs are identified that touch the source WMA. Second, a streamflow depletion is calculated for each of these WMAs based on the distance from the proposed withdrawal to the nearest stream segment in each WMA. Third, the withdrawal depletions from these source + neighboring

WMAs are evaluated and only those estimated depletions that are more than half the maximum depletion value from the entire group of WMAs under scrutiny are recorded in the WMA accounting database (those calculated depletions that are less than 50% of the maximum value for the group are discarded).

Findings

The WWAT is generally functioning well as a screening tool, as designed. While it is likely a better hydrology model could be developed, it was decided that it is not a high priority at this time. Minor adjustments will be proposed for the WWAT, but our major focus is on making sure the SSR process has the necessary models, information and process for it to be efficient and effective.

The first issue, model over prediction of index flow, can largely be handled through other recommendations made by the Council regarding monitoring streamflows and initiating SSRs in areas with the most concern.

There is concern about requiring a SSR when it is not needed, because of under prediction, but this is not a major ongoing issue. The areas where large numbers of new high capacity wells are installed, have generally already had SSRs and are using these revised index flow values for future screening tool decisions.

WMA boundaries are based on surface watershed divides. Groundwater withdrawals can often deplete water from several nearby streams, effectively crossing over into several adjacent WMAs. We reviewed how the “inverse distance weighting” method was selected to calculate effects of wells on nearby streams. We found this to be an acceptable choice and it is working satisfactorily. The question remained about how to select which of the neighboring streams should be included in the depletion accounting.

The depletion calculations were examined for 30 actual registered wells. The calculated stream depletions were reviewed for all of the neighboring WMAs. Using the current algorithm (1/2 max rule) in the WWAT, 74% of the total calculated depletions were included in the water accounting system. The range for individual wells was a high of 99% accounted to a low of only 49% of the total calculated depletion accounted. Review of the individual siting of the wells relative to the stream network, indicate the algorithm does a reasonable job of identifying which streams should be debited. But it became clear that the amount of the debit should be recalculated based on the selected streams, not all of the neighboring streams. This will generally increase the total amount of water depleted from nearby streams in the accounting database.

Howard Reeves, USGS, is working with a group of stakeholders to review possible modeling approaches to better approximate streamflow depletion. They plan to develop recommendations of how the DEQ could improve streamflow depletion allocations and apply them as necessary in SSRs.

The DEQ provided an analysis to the Environmental Monitoring workgroup of how percent change in exceedance flows have varied with gage station records from 2007-2012 compared with long-term data obtained prior to 2007. These data are useful in determining whether the long-term median flows used to derive the index flows for the WWAT have changed significantly since enactment of Part 327, thus indicating whether an overall statistical update of median flows is warranted at this time. The results show that the existing gaging stations provide information for 63.2% of the land area of Michigan. Of this 63.2% of land area, 23% had between -1% and +1% change in exceedance flows for August (used here to illustrate typical

“lowest median flow months, albeit the lowest flow month of record varies for many rivers); 20.2% increased between 1.1 – 4.9%, and 15.7% decreased between -1.1% to -4.9%. Taken together, 58.9% (i.e., 93% of the land area gaged) showed that 2007-2012 August flows did not change from the previous long-term percent exceedance flows by more than plus or minus 5%. While several specific gaged watersheds did have percent exceedance flows that are changed by more than 5%, the majority are not altered significantly with the 2007 -2012 flow data.

The Environmental Monitoring workgroup concluded “given that the majority of gaged watersheds showed little change in low flow trends with the 2007 -2012 incorporated data, as compared to data collected prior to 2007, **we recommend that an overall statistical update of all index flows is not yet necessary.** The need to perform this statistical update should be reviewed by the DEQ at least every 5 years. A small percentage of gaged watersheds did show larger changes in index flows, both increases and decreases, from prior to 2007. More in depth analysis of these changes in specific watersheds is needed before recommendations on updating their index flows can be made.” The Technical Underpinnings workgroup concurs with this recommendation.

Discussion of Recommendations

TU 5.1 Continue to use the index flow estimation model for the initial values in the WWAT that are then modified by SSRs.

This is adequate for the screening tool function.

TU 5.2 Continue to use the current analytical solution (Hunt, 1999) in the WWAT to compute streamflow depletion.

The methodology generally works well, our focus is on improving the allocation of depletion among neighboring WMAs.

We anticipate work will continue to develop better models of streamflow depletion. As they are developed, they may give additional insight to the physical process of streamflow depletion and lead to improvements in the streamflow depletion algorithm used in the WWAT.

References

(1) Hamilton, D. A., and P. W. Seelbach. 2011. Michigan’s Water Withdrawal Assessment Process and Internet Screening Tool. Michigan Department of Natural Resources, Fisheries Special Report 55, Lansing.

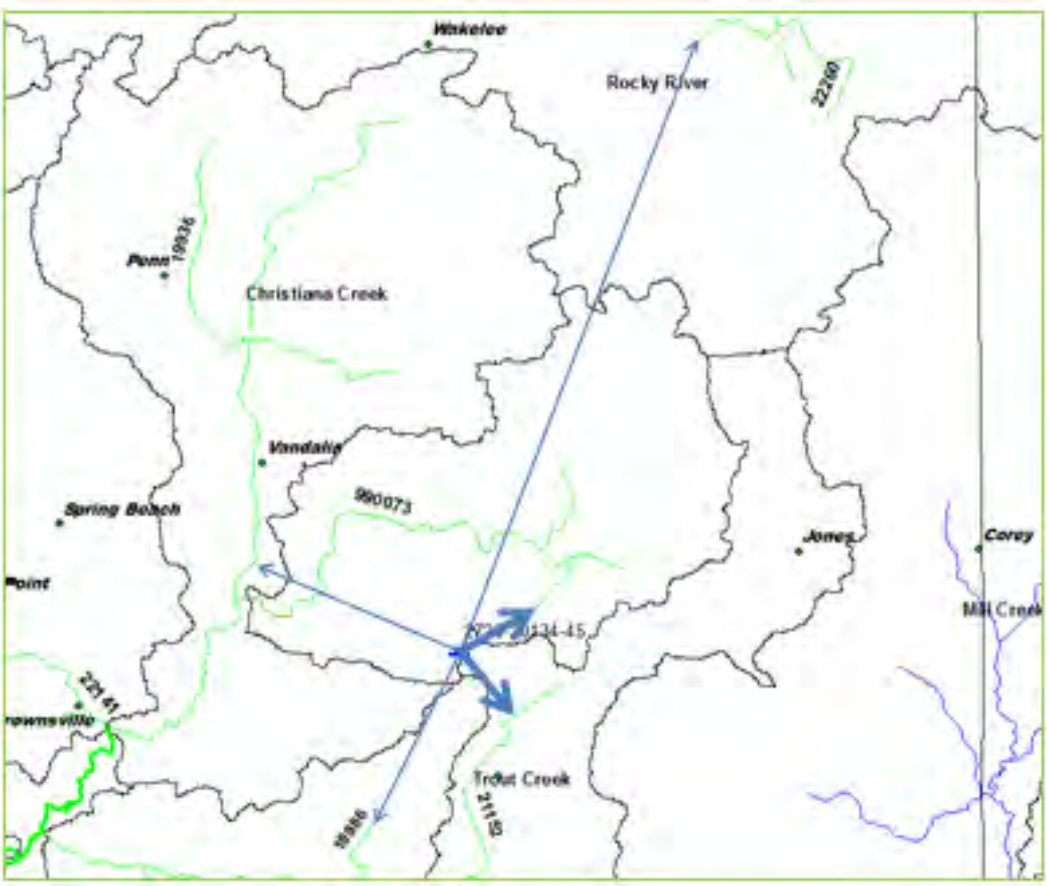
(2) Howard W. Reeves, David A. Hamilton, Paul W. Seelbach, and A. Jeremiah Asher, 2009, “Ground-Water-Withdrawal Component of the Michigan Water-Withdrawal Screening Tool”, Scientific Investigations Report 2009-5003, U.S. Geological Survey

(3) Hamilton, D. A., R. C. Sorrell, and D. J. Holtschlag. 2008. A regression model for computing index flows describing the median flow for the summer month of lowest flow in Michigan. U.S. Geological Survey, Scientific Investigations Report 2008-5096, Reston, Virginia.

(4) Hunt, Bruce, 1999, Unsteady stream depletion from ground water pumping: Ground Water, v. 37, no. 1, p. 98–102.

Attachment: Example of applying the stream depletion algorithm

The well is located in Cass County in WMA 990073, a tributary to Christiana Creek. It is roughly equidistant, almost a mile away, from the tributary to Christiana Creek and Trout Creek (WMA #21152). The pump has a capacity of 900 gpm, the casing depth is 126 feet, and the well is registered for intermittent use (12 hours/day, 4 days/week during June through August). The algorithm searches for neighboring WMAs and calculates the distance to the closest stream in each WMA. In this case, the distances for the other WMAs range from 2 to 7 miles. A depletion is calculated from each stream. The maximum depletion is identified and any that are less than half the maximum value are dropped. The depletions (28 and 29 gpm) are subtracted from the two closest stream's available water in the water accounting table. The lower values are discarded. In this example, a total of 72 gpm is calculated for this well, but only 57 gpm (79%) recorded in the water accounting table. Based on review of 30 registered wells, an average of 74% of the total calculated depletion is deducted.



WMA #	Distance from well (miles)	Current (gpm)
990073	.9	28
21152	.9	29
19986	2.1	8
19936	2.5	6
22260	7.1	0.8
Total:		72

6. Data Analysis Criteria

Charges TU-G, TU-H

Issue

Collection of field data including aquifer-test analysis has been proposed as an option in site specific review to more accurately assess the potential impact of a proposed well on nearby streams. Criteria for data analysis submitted for consideration in the site specific review process or used by Quality of Life agencies for planning or decisions are needed to ensure timely review of information and to communicate the basis for decisions.

Background

Many types of field data may be collected as part of a site specific analysis to estimate the potential streamflow depletion by a new well. These field data can vary from simple to sophisticated with a wide range in cost. Identification of the most useful field data for the water-withdrawal assessment process will help make the program more efficient.

There are a myriad of analytical solutions available to analyze data from aquifer tests. Other solutions consider the effects of storage of water within the wellbore, wells that are not screened over the entire thickness of the aquifer, water released from storage in semi-confining layers, and improved simulation of processes in the unsaturated zone for unconfined aquifers. Streamflow capture can produce either leaky-confined or unconfined (delayed-yield) response. Methods to assess the importance of streamflow capture based on field data should be outlined to assist with water-withdrawal assessments.

Discussion of Recommendation

TU 6.1 Work with stakeholders to develop criteria describing site specific data analyses to estimate potential streamflow depletion by a new well. The criteria should specify desired quality assurance and quality control processes for the program.

Many options exist for evaluating aquifer test data, the Quality of Life agencies and stakeholders should develop an approach appropriate for the water-withdrawal assessment process. Recent work on the design of pumping tests for assessment of potential streamflow depletion should be considered in the development of this approach (Christensen and others, 2009, 2010; Hunt, 2014).

A group of technical professionals, representing a range of practical and academic experience, will be needed to address this topic.

Resources needed: Staff time (moderate), and engagement of stakeholders. This effort could be expected to require a moderate amount of time for staff to undertake successfully.

Relationship to other recommendations: Can begin work on this recommendation immediately; but this recommendation could rely upon the outputs from recommendations E.M. 1.3, T.U. 4.1, T.U. 4.2, and E.M. 2.2.

References Cited

Barlow, P.M., and Moench, A.F., 2011, WTAQ version 2—A computer program for analysis of aquifer tests in confined and water-table aquifers with alternative representations of drainage from the unsaturated zone: U.S. Geological Survey Techniques and Methods 3-B9, 41 p.

Christensen, Steen; Zlotnik,V.A.; and Tartakovsky, D.M., 2009. Optimal design of pumping tests in leaky aquifers for stream depletion analysis. Journal of Hydrology, v. 375, no. 304, p. 554-565.

Christensen, Steen; Zlotnik,V.A.; and Tartakovsky, D.M., 2010. On the use of analytical solutions to design pumping tests in leaky aquifers connected to a stream: Journal of Hydrology, v. 381, no. 3-4, p. 341-351.

Hunt, Bruce, 2014, Review of stream depletion solutions, behavior, and calculations: Journal of Hydrologic Engineering, v. 19, no.1, p. 167-178.

Reed, J.E., 1980, Type curves for selected problems of flow to wells in confined aquifers: U.S. Geological Survey Techniques and Methods 3-B3, 113 p.

7. Groundwater-Flow Model Evaluation Criteria

Charges TU-G, TU-H

Issue
Use of groundwater-flow-model results has been proposed as an option in site specific review to more accurately assess the potential impact of a proposed well on nearby streams. Criteria for groundwater-flow models submitted for consideration in the site specific review process or used by Quality of Life agencies for planning or decisions are needed to ensure timely review of groundwater-flow model results and to communicate the basis for decisions.

Background
Groundwater-flow modeling is used to estimate the change in the groundwater system that results from the introduction of new wells, climate change, or other external changes imposed on the system (Bredehoeft, 2002). Changes in groundwater levels and to the groundwater-flow budget are estimated, and the time required for these changes also may be evaluated. Models have many different forms and are developed for different reasons (Anderson and Woessner, 1992), therefore clear criteria for evaluation of groundwater-flow models will help the Quality of Life agencies and stakeholders.

Discussion of Recommendation
Consensus was reached but with two objections to recommendation TU 7.1.

TU 7.1 Work with stakeholders to develop criteria describing the required features of groundwater-flow models to be used in the water-withdrawal assessment process focusing on streamflow depletion.

Groundwater-flow models may be physical analog models, analytical models, or numerical models. Simple models can provide useful information, particularly for sites with limited field data. The discussion of the use of model results to support the site

specific review process is focused on numerical models; but many computer codes are available to develop a groundwater-flow model for a site. Establishment of criteria would help guide model selection, improve model implementation, and clarify documentation and reporting. Important questions that should be addressed in the criteria include (Anderson and Woessner, 1992; Reilly, 2001; Reilly and Harbaugh, 2004):

- Purpose of the model, what is the model designed to answer? Will the model design achieve the stated purpose?
- Conceptual model of the site, what is the setting for the site? What data are available to construct the numerical model? Is the conceptual model reasonable given the available data and purpose of the model?
- Selected computer code, what model is used in the analysis? Has the model been verified? Are the performance indicators of the model for the specific case available and reasonable, for example, mass-balance results?
- Model design, does the numerical model adequately represent the conceptual model? Are the boundary conditions appropriate? Is the temporal and spatial resolution appropriate for the conceptual model and purpose?
- Calibration, if necessary, is the model calibrated to field observations? Describe why calibration is not necessary if it is not needed.
- Sensitivity analysis, will this be needed for site specific review?
- Prediction, how should the analyst report the simulated response to proposed wells?

The purpose for using a ground water flow model in the site specific review process is to more accurately estimate stream flow depletions in the more complicated situations. To this end, any model used in evaluating potential impacts must provide detailed information on the mass balance impact to stream segments within the modeled area.

The purpose of developing these criteria is to ensure a variety of modeling tools are available, and will be appropriately applied, to accurately represent streamflow depletion in the Water Withdrawal Assessment Process. As part of developing criteria, it will be important to identify those model codes that meet the predictive requirement and provide itemized output on depletions from individual stream segments within the model.

In addition to these issues, questions related to ownership of data and model files should be resolved. Will applicants be required to submit model files and will these files be subject to information requests? Must computer codes used in the analysis be selected to allow agency staff to run the models and assess results? Will models developed by Quality of Life agencies be made generally available to stakeholders and by what process?

A group of technical professionals, representing a range of practical and academic experience, will be needed to address this topic.

References

Anderson, M.P., and Woessner, W.W., 1992, Applied groundwater modeling— simulation of flow and advective transport: San Diego, Academic Press, 381 p.

Bredehoeft, J.D., 2002, The water budget myth revisited— why hydrogeologists model: Ground Water, v. 40, no. 4, p. 340–345.

Reilly, T.E., 2001, System and boundary conceptualization in ground-water flow simulation: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter B8, 26 p., also available at *http://pubs.usgs.gov/twri/twri-3_B8/*

Reilly, T.E., and Harbaugh, A.W., 2004, Guidelines for evaluating ground-water flow models: U.S. Geological Survey Scientific Investigations Report 2004-5038, 37 p., also available at *http://pubs.er.usgs.gov/publication/sir20045038*

ENVIRONMENTAL MONITORING

1. Stream flow data and monitoring recommendations

Issue statement and background
Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act requires the development and implementation of an assessment tool that is dependent on the availability of defensible scientific information on groundwater and aquifer characteristics, stream/river flow and temperatures, and characteristic fish populations. The DEQ is required to add verified data about the state's water resources to the assessment tool's database and to make technical modifications to the tool related to considerations of temperature, hydrology and stream/river flow based on an approved methodology. When a site specific review or a permit is required, the DEQ must rely on site specific data and information. Adverse Resource Impact (ARI) is defined in Part 327 for rivers, streams, lakes and ponds. Water resources and biological data are needed to fine tune and verify predictions that large quantity withdrawals will or will not cause adverse resource impacts, and to determine whether an ARI has occurred. Part 327 requires the DEQ to develop a quality assured protocol for the collection of stream/river flow measurements by persons other than the DEQ staff, and that the data collected pursuant to the protocol may be used in the implementation of the program.

Charges EM-B, EM-D, EM-E

Findings
The Environmental Monitoring workgroup attempted to identify any available sources of stream flow data that had been acquired since Part 327 was enacted, that would be relevant and useful to the charges of the workgroup. It did this by surveying its members as well as members of the entire WUAC. The workgroup then made contact with all possible sources identified, and invited those sources to present their information directly to the workgroup. The following sources of new applicable information were identified: United States Geological Survey (USGS), DEQ, Michigan Trout Unlimited (MITU), Todd Feenstra from Tritium, Inc, and Dr. David Hyndman (Geology Department) Michigan State University (MSU). The presentations of each source were provided and saved by the workgroup, and are posted for reference on the WUAC website. A summary of each is provided here.

<u>USGS:</u> The USGS has been actively pursuing additional stream flow monitoring data in southwest Michigan. In cooperation with the DEQ, USGS has installed and is continuing to collect data at two gaging stations, one on the Dowagiac River at state highway 51 (#04101535), and one on Mill Creek at Quaker Street (#04098980). A shallow piezometer was installed near the gaging station on the Prairie River near Nottawa, MI (#04097540). Installation of a new stream gage on the Prairie River upstream of the existing stream gage at Nottawa at the US-12 crossing is planned for the near future. In addition discrete discharge measurements were collected three times each summer at 29 locations in southwest Michigan during 2010-2013, and additional discrete measurements are planned for 2014. The DEQ uses information from the discrete measurements to estimate index flows as described in the next section. This effort is slated to end on September 30, 2014 with the completion of funding distribution for this program.

<u>DEQ:</u> The DEQ provided several presentations. First, was an overview of the process the DEQ follows in assessing index flows during the site specific review (SSR) process. Generally, during

an SSR, DEQ staff will look for all available flow data near the stream segment in question. They look in the "USGS Miscellaneous Measurements Database" (MMD), which houses information gathered from discrete discharge measurements conducted following USGS standards. If no data of this type is available, they use a drainage area ratio adjustment from the nearest applicable USGS stream gages (USGS gage network includes 169 sites with continuous data up till 2007, and 78 sites with discontinuous data for 10 years or more of record). The MMD contained discrete discharge measurements for >3,750 sites by 2007; of these, 1111 sites had 4 or more discrete measurements per site. Following 2007, the DEQ had assessed gaps in the MMD and priority locations for acquisition of additional discrete discharge measurements. From 2009 -2011, the USGS collected discrete discharge measurements at 24 sites, primarily in southwest Michigan; and the DEQ collected discrete discharge measurements at 30 sites, primarily spread across the southern Lower Peninsula. Analysis of how these discrete discharge measurements compared with predicted index flows was not provided.

Second, the DEQ illustrated how original index flow predictions have been modified through SSR's for all that have been conducted (N=294). This analysis did not include consideration on amount or type of data that was available for each index flow modification; however it showed that overall, 38% of the SSR's had resulted in decreased index flows, 28% resulted in no change in index flows, and 34% resulted in increased index flows. Thirty-nine percent of SSR's resulted in index flow adjustments between -10% to 10%. Nine percent of SSR's resulted in index flow modifications 50% or less than the original predicted index flow (the magnitude of the screening tool's "safety factor").

Lastly, the DEQ provided an analysis of how percent change in exceedance flows have changed with gage station records from 2007-2012 compared with long term data obtained prior to 2007. This data is useful in determining whether the long term median flows used to define index flows have changed significantly since enactment of Part 327, thus indicating whether an overall statistical update of median flows is warranted at this time. The results show that the existing gaging stations provide information for 63.2% of the land area of Michigan. Of this 63.2% of land area, 23% had between -1% and +1% change in exceedance flows for August (used here to illustrate typical "lowest median flow months, albeit the lowest flow month of record varies for many rivers); 20.2% increased between 1.1 – 4.9%, and 15.7% decreased between -1.1% to -4.9%. Taken together, 58.9% (93% of the land area gaged) showed that 2007-2012 August flows did not change the previous long term percent exceedance flows by more than plus or minus 5%. While several specific gaged watersheds did have percent exceedance flows that are altered more than 5%, the majority are not altered significantly with the 2007 -2012 flow data.

<u>MITU:</u> MITU provided a presentation and two reports with information on a program for index flow monitoring designed for non-governmental agencies that it developed, and also an analysis of the results from the first two years of that program's efforts. Multiple discrete discharge measurements were conducted at sites on 30 "cold" or "cold-transitional" tributaries of the Pigeon, Rogue, Platte, Big Sable, and Pere Marquette watersheds. Sites were located at the downstream boundaries of each stream segment to closely approximate the index flow predictions' locations. The results of these were presented in detail in report form. Gage stations on the watersheds sampled, showed that in the month and year sampled, flows at gaging stations on these watersheds were between 3 and 28% higher than long term median flows for that month. Taken as a whole, comparison of the repeated discrete measurements to predicted index flows did not show a clear overall skew or bias. Some watershed to watershed differences in predictions were apparent however, and many stream segment specific

discrepancies were significant. For example, in the Pere Marquette watershed, 12 stream segments were monitored and the gage station indicated August flows in the year sampled, were 7% higher than the long term median for that month. Even with generally higher flows for that month, the average discrepancy for all sites was lower (-5.2%) indicating possible index flow overprediction; 6 sites deviated greater than 25% below predicted index flows; while 3 sites deviated greater than 20% over predicted index flows. While comparing individual measurements with the index flow is not conclusive, patterns such as these suggest additional evaluation is appropriate. Improving index flow estimates on streams with large discrepancies from existing index flow predictions can both help prevent adverse resource impacts and help reduce water user conflicts, and based on results of index flow monitoring compared to predictions, there appears to be a significant percentage of stream segments where this is warranted.

MITU presented the framework and protocols associated with their "tiered" program for assessing index flows. Volunteers or interns are trained and directed to take discrete discharge measurements repeated at specific stream segments sites, using an "affordable" flow meter (a Global Flow Probe, ~$700 per unit cost was used by MITU). The results are analyzed by staff, and if a significant discrepancy is identified relative to predicted index flows, a professional staff member conducts follow-up discrete discharge measurements there following USGS protocols and instrumentation. The tiered approach is designed to "screen and assess" measurements from a larger number of stream segments than staff following USGS protocols could achieve, while focusing those more intensive efforts on stream segments showing more severe discrepancies in index flow estimates. They developed the protocols, tested and compared instrumentation, and successfully piloted the program for two years.

MSU: Dr. David Hyndman from the Geology Department at MSU has installed *in situ* gage devices at 38 locations in the Upper Manistee and Au Sable River watersheds. Over that time, he collected multiple discrete discharge measurements at the sites to create stage-discharge relationships for each site. These results provide two main important insights. First, these data indicate that measured flows for August 2012 for these 38 sites were significantly lower than predicted index flows from the WWAT. These data need to be adjusted for the measured catchment area versus the stream segment boundaries, and for the year of sampling versus long-term flow conditions at nearby gages, in order to more accurately compare them with the index flow predictions for these streams. Secondly, MSU's data provided the only case the workgroup found, of documented flow data from before, during and after a large quantity water withdrawal (LQW). Results of flow measurements from the North Branch of the Manistee River were provided that corresponded with a LQW for the purpose of hydraulic fracturing. Those results showed a period generally during the LQW, where flows dropped below the ability of the in situ gages to record them. This unique Before-After data offers an opportunity to compare measured flow response to predicted response, to gain insight into the accuracy of the WWAT's modeling assumptions for cone of depression effects.

Tritium, Inc.: Todd Feenstra from Tritium, Inc. presented results from a studied it conducted in southwest Michigan, to the full WUAC, but not the Environmental Monitoring workgroup. Specific details related to stream flow monitoring were not presented, and are not available in report form for consideration. The presentation did verbally include reference to stream flow measures taken as part of that study showing systematic under-prediction of index flows, but details were not provided for the workgroup to consider and evaluate.

Discussion of Recommendations

EM 1.1 To ensure prevention of adverse resource impacts, and to reduce potential for water user conflicts, the DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of stream flow data in high water withdrawal areas or areas of potential conflict. Stream flow monitoring consisting of both stream gages and discrete measurements, for the purpose of refining index flows, is urgently needed in areas of the state currently receiving high demand for large quantity water withdrawals, and areas where high demand are predicted in the near future. Currently, mid and southwest Michigan are experiencing high demand for expanded water use for agriculture purposes. The Northern Lower Peninsula is experiencing high demand for water withdrawal due to multiple purposes. Projections indicate that demand for new withdrawals will continue to rise in these areas. Both of these regions of the state require high priority in data collection efforts. To address immediate issues where site specific reviews are increasing, the DEQ should prioritize and establish stream flow monitoring. To anticipate areas of future increases in LQWs, the DEQ should use geographic projections for water withdrawal expansion from state and federal agencies, industry organizations, and university research.

Resources needed: This effort will require additional resources beyond those currently available to the DEQ. This data could be collected through the acquisition of new DEQ monitoring staff; and/or through contracts with external entities for its acquisition. This effort is needed in the areas with the greatest level of anticipated demand for water use, and the cost and resources needed to acquire this data will depend on the precise manner in which this is defined and its geographic scope. This would constitute a moderate to significant cost, with new funds required to support this program. A subsequent stakeholder council could contribute knowledge of likely development patterns for increased water use geographically by sector. Many members will bring detailed local knowledge of watersheds and the breadth of interests represented can reflect the relative importance attributed to certain geographic areas, these will assist in developing statewide priorities.

Relationship to other recommendations: Data collected under this recommendation, should follow USGS standards so it has immediate full use and affect in all aspects of this program, as these are areas of high anticipated demand. As such, this effort does not have to be sequentially tied to EM 1.3, but can begin immediately. This effort however, should be integrated with recommendation EM 2.3, which is the equivalent of this recommendation, but for groundwater and glacial geology information.

EM 1.2 We recommend the DEQ invest resources to reasonably ensure continuous progress towards filling streamflow measurement data gaps. Throughout the state, there is a need to systematically improve our base of stream flow data. We recommend that the DEQ identify critical gaps in stream flow data (based on stream segments lacking streamflow data and areas of current and projected water use expansion), and create a prioritization scheme for the collection of additional data to fill those gaps.

Resources needed: Additional dedicated monitoring staff, and/or funding for contracting this work to external organizations. “Reasonable” continuous progress at validating and refining streamflow estimates is needed, so the level of effort towards this can be strategically designed, and moderately priced.

Relationship to other recommendations: This recommendation could benefit from the results of recommendation EM 1.3, and could be made more cost-efficient by integrating this effort with recommendation EM 1.5 (the citizen flow collection program), by using the information derived from that program to help focus the data collection efforts under this recommendation. Some element of the work on streamflow should be linked with the work to better define groundwater resources (EM 2.3). Information that documents where and how much groundwater feeds into streams will allow further refinement and increased accuracy of the analyses used in this program.

EM 1.3 Protocols and standards for the collection and use of stream flow data for use in this program should be developed by the DEQ, approved by the WUAC and approved through the appropriate statutory process, and clearly published on its website. These protocols and standards should be clear and detailed, and paired with description of the acceptable use of data collected following a particular protocol or standard. We recommend the DEQ develop these with multiple tiers considered. For example, the top level tier would be full and complete adherence to USGS protocols and standards (including trainings, reporting, instrumentation, etc.), with that tier resulting in data collected being useable in all applications of the program. Subsequent tiers may deviate from the USGS standards and protocols, and would have specific protocols for how the data will and will not be used in the program.

For instance, some data, after DEQ review, may be incorporated into the site specific review process where full USGS measurement results are unavailable. An example of a secondary tier would be flow data collected primarily following USGS protocols, but deviating in a minor manner that precludes it from full USGS acceptance (e.g., collected by someone not receiving USGS sanctioned training, or not reported within accepted time periods to USGS for their review). Use of data collected under this tier would need to balance confidence in the new data with confidence in existing index flow predictions in the absence of it. Another possible tier might be for in-situ flow gages, which gather flow measures at finer time intervals throughout a year. For this tier, protocols for the establishment of stage-discharge relationships would also need to be developed.

For all of these tiers, a protocol needs to be developed and published for how to adjust flow measures within a year, to be comparable to long-term median flow conditions; as well as how to adjust for drainage area differences between the stream segment boundaries versus locations sampled. Each will also need to address the quantity of flow measurements collected. We recommend the DEQ develop these protocols and standards, and engage involvement of WUAC members in developing them. If the WUAC is still commissioned, this should be developed with approval of the WUAC; if it is not, members of the WUAC should be engaged in the development of them. Approval of this will be acquired via the appropriate statutory process.

Resources needed: This will require moderate to significant staff time from existing staff positions at the DEQ and stakeholder engagement. This effort would be made less staff time intensive with re-creation of the WUAC and its ownership of this for implementation. But, this effort will require several meetings and research and writing. Not all of the components of this are in existence already, significant discussion and evaluation are needed to complete this recommendation.

Relationship to other recommendations: This recommendation is not sequentially dependent on others. However, it is similar in nature to many others that involve discussing, identifying, and communicating protocols and policies for data acquisition and use (EM 2.2, TU 4.1, 4.2, 6.1 and 7.1).

EM 1.4 To ensure both the prevention of adverse resource impacts, and to ensure the utility of the screening tool in reducing the number of required annual SSR's, **when the DEQ receives or acquires data of the quality and standards that would prompt the Department to change a Tool parameter for a Water Management Unit, DEQ should not wait until a registration request triggers an SSR in that Water Management Unit. The DEQ should incorporate those new data and make any appropriate changes at least bi-annually.**

Resources needed: Staff time needed should be minimal and able to be covered by existing staff. At this point in time, it is unlikely that the DEQ will receive data such as this in a widespread fashion from sources independent of an existing SSR. Further, they will likely receive the data only once per year (as it likely has to be collected annually during summer months). Their processing of it would be similar to an SSR process, but with less data received and without the regulatory 10 day period to complete the review. As such, they should be able to integrate these into their work schedules and accomplish them with a minimal amount of extra time required.

Relationship to other recommendations: Not dependent on other recommendations to execute. This recommendation may benefit from completion of recommendation EM 1.3. (and perhaps EM 2.2, and TU 4.1, 4.2).

EM 1.5 **Citizen data collection protocol and trainings.** To aid in the implementation of Part 327's provisions for non-agency stream flow data collection, and to facilitate the collection of useful and needed stream flow data acquisition in Michigan, the **DEQ should develop a facilitation program for streamflow data collection by non-agency persons. This program should provide data collection procedures and guidance, explanation of how the data can be used, provide for training opportunities, and provide for the collection, storage and accessibility of the data collected.** One possible means to incorporate citizen data collection is for the DEQ to build the tiered framework developed by MITU into their "MiCorps" program for citizen monitoring. Another means is for the DEQ to develop and fund an ongoing program through the USGS to provide training of third parties to make streamflow measurements, review their summited measurements, and store acceptable measurements on its streamflow measurement database.

Resources needed: This effort should require moderate to significant staff time from existing staff at the DEQ. This can be alleviated to some degree by using a general framework such as that developed and piloted in Michigan by Trout Unlimited, and through use of the MiCorps program and its resources (and contractors). It will require ongoing staff time similar to management of other MiCorps programs.

USGS maintains a data base of streamflow measurements that are accepted as accurate for all uses. The DEQ reached an agreement with the USGS to allow 3rd party measurements in the data base if they meet all USGS requirements. With proper funding, it may be possible to have regularly scheduled training sessions for 3rd parties. In addition to funding the training, the DEQ could consider maintaining extra

flow meters that could be loaned to groups that want to be very active in taking streamflow measurements, have been trained by USGS, and are committed to following the appropriate protocols.

Relationship to other recommendations: Implementation of this recommendation may benefit from EM 1.3. being done first, or discussion of this recommendation being integrated with EM 1.3. discussions. Significant assistance for implementing this one can be acquired through Trout Unlimited staff, and through the MiCorps program platform. Implementing this program will be very beneficial to efficiently and effectively implementing EM 1.2 .

EM 1.6 **The DEQ and DNR should invest in the strategic acquisition of research and/or monitoring to assess the real-world impacts of existing large-quantity water withdrawals.** The workgroup was able to identify only limited data appropriate for evaluating real-world measured impacts of large quantity water withdrawals in Michigan. No fisheries data was identified to this end, and only one relatively short-term Before-After withdrawal stream flow dataset, presented by MSU, was identified. USGS data acquisition offers promise to this end, but is not available at this time. Targeted research and monitoring should be evaluated and pursued. In addition, the MSU data set on stream flows before-during- and after a large quantity water withdrawal, should be fully evaluated by the DEQ (and WUAC Technical Underpinnings Workgroup), as it offers the only data set we identified for evaluating real-world impacts and to assess the groundwater model in the WWAT and its assumptions on pumping impacts. Also, the DNR should assess statewide meta-data on streamflows, streamflow reductions from withdrawal, and available fisheries data to discern if any real-world impacts from water withdrawals are identifiable.

Resources needed: Tying groundwater pumping to reductions in stream flows is the most feasible approach to improving our knowledge of “real-world impacts of large-quantity water withdrawals”. We found limited data on this subject – but some. We recommend that the MSU (Hyndman Study) be fully evaluated for this purpose. That would require existing staff time, and perhaps engagement of external stakeholders (or a next iteration of the WUAC). Other research possibilities include review of pumping and stream flow data recently received from the DEQ from a site in southern Michigan, or new research focusing on individual parts of the groundwater pumping – fish pathway, which could have utility for better understanding of real-world impacts.

This recommendation may be best to pursue through collaborations with external entities. Universities, consultants, and non-profits may be well suited to pursue this research, and funding for it, as compared with the DEQ. This opportunity should be pursued by the DEQ.

Relationship to other recommendations: none.

EM 1.7 Given that the majority of gaged watersheds showed little change in low flow trends with the 2007 -2012 incorporated data, as compared to data collected prior to 2007, **we recommend that an overall statistical update of all index flows is not yet necessary. The need to perform this statistical update should be reviewed by the DEQ at least every 5 years.** A small percentage of gaged watersheds did show larger changes in index flows, both increases and decreases from prior to 2007. More in

depth analysis of these changes in specific watersheds is needed before recommendations on updating their index flows can be made.

Resources needed: none at this time; eventually, a minor amount of existing staff time, would be needed, as the analysis used for this recommendation development was done by DEQ staff.

Relationship to other recommendations: none.

2. Groundwater Recommendations

Issue statement and background
Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act requires the development and implementation of an assessment tool that is dependent on the availability of defensible scientific information on groundwater and aquifer characteristics, stream/river flow and temperatures, and characteristic fish populations. The DEQ is required to add verified data about the state's water resources to the assessment tool's database and to make technical modifications to the tool related to considerations of temperature, hydrology and stream/river flow based on an approved methodology. When a site specific review or a permit is required, the DEQ must rely on site specific data and information. Adverse Resource Impact (ARI) is defined in Part 327 for rivers, streams, lakes and ponds. Water resources and biological data are needed to fine tune and verify predictions that large quantity withdrawals will or will not cause adverse resource impacts, and to determine whether an ARI has occurred.

Charges EM-B, EM-E

Findings
The Environmental Monitoring workgroup reviewed available sources of groundwater and glacial geologic data that had been acquired since Part 327 was enacted, that would be relevant and useful to the charges of the workgroup. It surveyed workgroup and Water Use Advisory Council members as well as university resources. The workgroup then made contact with all possible sources identified, and invited those sources to present their information to the workgroup. The following sources of applicable information were identified: Michigan Geologic Survey (MGS), Illinois State Geologic Survey (ISGS), DEQ, and Michigan State University (MSU). A summary of each is provided here.

<u>MGS:</u> Alan Kehew and John Yellich from MGS presented information on several occasions to the workgroup and to the whole Water Use Advisory Council. Dr. Kehew made a presentation on glacial geology and hydrogeology, highlighting an opportunity to improve the quality of input data utilized in the WWAT models. With little geologic mapping available, the glacial geology of Michigan is poorly understood. He gave examples from an ongoing mapping project in Calhoun County showing the state Quaternary geologic map's (Farrand and Bell, 1982) misinterpretation of both landforms and surficial materials. He expressed that inaccuracies in assigned hydrogeologic properties could impact decisions made by both the WWAT and site specific review process.

Dr. Kehew and Mr. Yellich pointed out potential problems with the WWAT's reliance upon Wellogic records for geologic data, including well drillers' lack of training and consistency in describing materials. They identified concerns that Wellogic may lose accuracy due to limited or

no field validation in log locations, lack of uniform geographic distribution of records, missing data for glacial material deeper than the aquifers accessed for water wells, and a lack of validation of the confined aquifer identification. They recommended the use of focused 3-D geologic mapping to more accurately describe glacial geology and aquifers in those areas experiencing a high number of WWAT applications, and the use of pilot projects in areas of restrictions or initial rejections of applications being forced to submit to the SSR process based on the WWAT.

Mr. Yellich discussed with the workgroup a project MGS has started with the Michigan Groundwater Association and the DEQ, to provide training, manuals, and additional tools to well drillers to help them better identify types of glacial materials encountered during a well drilling operation. Use of these training session and tools could help well drillers submit more accurate data into Wellogic, which will improve the state's ability to interpret and model transmissivity and aquifer units.

ISGS: Mr. Richard Berg, Interim Director of the ISGS, gave an overview of water management projects in Illinois, including 3-D mapping and modeling of glacial drift in selected counties. He discussed the ISGS work in McHenry County, which used borings to bedrock and groundwater monitoring, field work, remote sensing (DEM), and only validated existing water well logs to create a 3-D model of the subsurface. This allowed ISGS staff to identify specific aquifer and aquitard units, create a 3-D model, and then use that to build a 3-D groundwater flow model. The state can use this information in their geologic data base to assess water resources and predict future impacts from changing demands.

ISGS reported on detailed geologic mapping conducted in Kentucky from 1961 to 1978 in a response to the need for mineral development but which has now become a valuable resource for water management, contamination monitoring, permitting, land acquisition, and infrastructure development. The 1:24,000 scale Quadrangle maps were created in cooperation by the Kentucky Geologic Survey and USGS, and their subsequent value to the state has risen beyond the cost of their production 20 times over, making the cost of their production highly worth the investment.

DEQ, RRD: Robert Wagner and Sara Pearson from the Remediation and Redevelopment Division (RRD) reported to the workgroup that the RRD monitors static water level, subsurface flow, water quality, elevations, and other data for tens of thousands of locations across the state of Michigan, for the purpose of managing and monitoring contaminated sites. Some monitoring locations have data stretching back decades. The data the RRD collects on these contaminated sites could greatly enhance the State's understanding of glacial geology because of the information they collect on static water levels and the movement of water in aquifers. While highly detailed and long term, the RRD's data is currently of limited usefulness to the Department, because the majority of its records are not stored or available electronically and are not geocoded or digitized for use by other programs.

The RRD now collects more data electronically and is investigating ways to scan historic data records and use optical character recognition programs to make those records searchable. The RRD's primary goal for this is to position the division for responding to requests for information under the Freedom of Information Act, but Mr. Wagner and Ms. Pearson were interested in pursuing the use of the data in a database or mapping system to help their own staff connect geologic data from multiple contaminated sites, as well as make the data available for use by other agencies. They discussed with the workgroup some of the other DEQ offices that may also have useable geologic data through monitoring wells and water data they maintain,

including the Office of Oil, Gas and Minerals, the Office of Drinking Water and Municipal Assistance, and the Office of Waste Management and Radiological Protection. Further, they discussed other potential sources of aquifer, static water level, and geologic data, including county health departments and oil and gas exploration companies.

MSU: Dr. David Lusch gave a presentation on digital groundwater data use in Michigan, beginning with the Statewide Groundwater Database, which was expanded from a SW Michigan Groundwater Survey with the DEQ's WellKey program. MSU's C-Map program digitized water well locations, and applications for cross sections and water table mapping were developed. This digital groundwater database was used in the 1990s to develop a federally-required wellhead protection program, and included collecting GPS coordinates for all public supply wells in Michigan. Groundwater protection was assessed by classification of materials on water well logs as confining or partially confining based on lithologic descriptions.

Wellogic was developed in 2000 as an Internet-based data entry program for water well information. It standardized lithologic terminology, classified materials as aquifer, marginal aquifer, partially confining material, or confining material, and assigned hydraulic conductivity values to lithologic units. WellKey records were transferred to Wellogic, and water well drillers submitted data for entry into the system. Wellogic now contains over 530,000 well records.

Recent improvements to Wellogic-2 include enhanced data sets for hydraulic conductivity, transmissivity and aquifer and aquitard unit thickness. This allows calculation of transmissivities for both confined and unconfined aquifers. The water well viewer was developed to access records on-line as well as older scanned records not in the database. The Groundwater Mapping Project was developed beginning in 2003 by the DEQ, USGS, and MSU to estimate yields from wells in glacial and bedrock aquifers.

Discussion of Recommendations

EM 2.1 We recommend a database be created to gather and collate data on glacial geology, static water levels and aquifer characteristics collected by state and federal agencies, as well as by universities and private industry. It should utilize a common set of accepted geologic and hydrogeologic terms and fields. Organizations or agencies collecting this data should have the ability to submit information to be entered into the database, and the data submitted shall conform to State program requirements. This database should be publicly viewable. State and federal agencies, university researchers, and private industry groups conduct geologic studies and surveys in Michigan. However, their information is not shared, collated, or made available to other programs in a widely uniform and accessible format. Many organizations including but not limited to the USGS, MGS, DEQ RRD, DEQ Wellhead Protection Program, DEQ Office of Drinking Water and Municipal Assistance, DOT, DNR, MSU, Western Michigan University, oil and gas exploration companies, and other private industries, would benefit from access to a common database. This database should be created and housed by a state agency. One possibility for creation and housing of the database would be the Michigan Geological Survey, a scientific body operating through Western Michigan University, Geosciences Department, with designated responsibility under Public Act 167. The Geological Survey is the unbiased resource for developing and assessing the geologic and groundwater information and data. Information can be stored and used across those programs, so long as commonly identified fields are included and users submit only data which meets State program requirements.

Making such validated scientific data available in a usable format could benefit several Departments by providing access to this geologic and scientific data. Further, much of this data could support the evaluation of water use in Michigan, research by organizations, and more importantly for use by the general public today and into the future. These files are located in state regulatory offices and may also be co-located or deposited in local County or City files.

A cursory survey of data collection by a state agency revealed more than 500,000 scientific data sets that are not easily accessible in their current format. Much of this is validated scientific geologic and water data. There is a need to bring available scientific geologic and water data into a standardized database that can be used for not just water resource assessments, but also other subsurface water-related programs that have a direct impact on the societal issues facing Michigan citizens.

This data includes but is not limited to the following validated scientific data resources:

A. Michigan 201 and 213 contaminated cleanup sites for RRD.
    1. Over 500,000 drilling and sampling data points (drill holes).
        a. Included with these data points is at least one if not multiple water level measurements and water chemistry analyses for each data point.
        b. Some of these scientific data sets have been inspected and tested continuously for 5 to 20 years.
            i. NOTE: RRD Director Bob Wagoner has begun the process of working with the Michigan Geological Survey (MGS) to review data capture and searchable document program(s) for developing searchable data from the RRD paper and obscure data sources.
B. MDOT drills hundreds of core holes and drill holes every year where geological engineers and engineers log those core holes and can provide geologic information.
    1. In addition, water levels are noted on the logs as well as depth to bedrock.
C. Oil and gas exploration companies drill wells through glacial material and follow specific protocols for setting casings, which is specifically at least 100 feet into the first bedrock immediately below the glacial material. There are over 60,000 oil and gas wells in Michigan.
D. Michigan has more than 10,000 community high capacity drinking water supply wells that have been drilled and logged by geologists and geological engineers. Water level measurements have been taken over time, but the information may not be in a standard format for use by many departments.
E. Michigan has more than 1500 permitted Underground Injection Control (UIC) deep disposal wells (Class 1 Hazardous and non-hazardous; Class II, and III), drilled to EPA specifications, where depth of the glacial material is noted and cased to prevent any contamination.
    1. Many of these well records have electronic/geophysical logs with the reports, similar to those logs completed for the oil and gas industry.
F. Michigan DNR develops many areas of the state for parks and other facilities, and consultants submit reports on the geology, subsurface conditions and depth to groundwater. Most of this data is not available in a standard format.
G. Michigan has more than 78 permitted sanitary and industrial landfills that are required to complete surface water and aquifer (groundwater) studies to monitor water quality during their operating life and after closure.

1. This data may represent 10 to 30 years of groundwater levels and basic water chemistry on an annual or more frequent basis.

H. County health departments maintain records on City or private high capacity wells, and information on water quality studies initiated by Counties. Much of this is on paper and many of the programs have not been continuous, but the data is available.

I. Water quality data is collected for quarterly or annual monitoring programs for public drinking water supplies.

The Michigan Geologic Survey has been collecting and managing geologic data for nearly 30 years in the form of oil and gas data at the Michigan Geological Repository for Research and Education (MGRRE). Much of this industry data has been in various formats that were not useable, such as paper copies of both type written and hand written reports on standard forms, data on drilling information, geologic logs, water chemistry and other associated exploration or production well information. Today, one of the greatest assets that MGRRE provides is a searchable database for these paper files which have been scanned and converted to searchable data files. Subsequently, some of the data has been entered into databases that provide this previously unusable data to the general public for their use.

RRD has begun the process of meeting with MGS to review the MGRRE data files, present an example of the data compilations completed for industry files, and present test results of some RRD files that have been converted to searchable data to begin establishing a process and protocol for digitizing this large data set. A strategy for prioritizing will be discussed and presented to the DEQ.

The RRD in concert with OOGM, WRD, MGS and any other divisions that have control of geologic and water-related data within the DEQ shall determine a priority by County and or department. The DNR and MDARD should also be polled to determine if there are data files that could be integrated into the overall program.

Files are located in DEQ offices in Lansing and throughout the State and many of the files are located in City and County offices. One option to collate and capture these data sources is to work with MGS to collaborate with the primary recipients of the data to provide the database for geological information, which would be made available for the State programs. This would be similar to databases currently in use in adjoining States.

A potential first priority would be the geologic data and this would primarily reside in the RRD data sets. RRD also has groundwater quality data and this would be incorporated into the same data recovery program. Similar data on water levels and surface water quality can be found in the WRD data files and these could be copied or transferred to a common data file for input to the same data base. Landfill permits and monitoring has been ongoing for tens of years and this data would provide a regional, long-term data file on water levels, including groundwater quality.

Resources needed: DEQ staff time would be involved in prioritizing, then establishing the data format for input and recovery, perhaps a 2 to 6 month period. Concurrently, a pilot program could be done on the scanning and digitizing for converting to searchable documents in one location and test data sets would be done in the same time frame. This program could primarily be done by work-study students with some oversight by MGS and with support from the DEQ. Once a protocol and procedure is

established, MGS could establish collaboration with local colleges for work-study students to scan and compile the data in their local areas.

Database development would collect all useable data and determine what outputs are most critical, to be included in the recovery of the searchable data.

This program is expected to take up to a year, however, information from priority areas would be the first data sets targeted. Then resulting searchable records would be identified, data will be entered and served publicly within the first 3 months.

EM 2.2 **The State should publish its protocols and standards for the collection and use of groundwater data and glacial geology on its public websites.** While Part 327 specifically addresses data quality standards for collection of streamflow data, it does not similarly address data quality standards for collection of geologic or groundwater data for use in the WWAT program. The DEQ currently works with well registrants undergoing site specific review on plans of work for groundwater data collection on a case by case basis using Department guidance, and should continue this practice. However, several different agencies and organizations collect groundwater data under different standards depending on their statutory or program-related requirements. Despite those differing standards, the data collected may be useful to the State to enhance the accuracy of geologic or groundwater information currently available through Wellogic and the WWAT process. Therefore, in order to make that information available to the program, the State should clarify its protocols and standards for data collected by state offices, and federal, university, and private industry resources, for data acceptable for use in the WWAT program. We recommend the State make its protocols and standards publicly available with the engagement of the WUAC if it remains commissioned, or WUAC members if the Council itself is disbanded.

EM 2.3 **The DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of groundwater data in areas receiving or anticipated to receive high levels of water withdrawal registrations.** Groundwater and geologic data collection, including but not limited to focused 3-D geologic mapping, groundwater level monitoring, aquifer testing, soil borings, seismic or other geophysical surveys, and gamma ray logs to classify geologic formations and aquifer and aquitard characteristics, is urgently needed in areas of the state currently receiving and projected to receive high demand for large quantity water withdrawals. Mid- and southwest Michigan currently experience high demand for expanded water withdrawal for agricultural use, and the northern Lower Peninsula is experiencing high demand for expanded water withdrawal for multiple purposes including oil and gas exploration. Greater knowledge about groundwater resources and response to withdrawals will help the state to better understand and prevent adverse resource impacts in surface waters while accommodating withdrawals. Therefore, the State should prioritize and establish groundwater and geologic data collection in areas with current high demand for withdrawals. To identify future demands, the State should use geographically based projections for water withdrawal expansion from state and federal agencies, industry organizations, and university research.

Resources needed: The need for additional DEQ staff to implement this recommendation is not anticipated as data collection and mapping activities are expected to be contracted to outside entities. However, implementation would require additional funding as well as partnerships between the DEQ and other public and

private organizations. For instance, MGS is proposing a USGS matching-funds project for mapping the surficial geology of Cass County; one area of the state where the number of water withdrawal registrations is high and expected to increase but information about the subsurface geology is limited. Based on the MGS proposal, the project would incorporate existing geologic information with drilling, soil sampling, passive seismic – bedrock determination, and gamma-ray logging to produce a composite surficial geologic map of the county that includes bedrock topography, glacial drift thickness and static water-elevations.

Cass County is comprised of twelve (12) 7.5 minute quadrangles and the anticipated cost to complete two (2) of these quadrangles is approximately $161,343, which includes a State of Michigan match of $44,000. The geologic mapping of the entire County over a period of 3 to 6 years, depending on funding is expected to be in the order of magnitude of a million dollars; however, conducting the work in smaller phases, such as on an as needed quadrangle or watershed basis, can make results more focused and the cost more manageable and ultimately, if private studies are integrated into the State-MGS program, costs and time frame to complete could be reduced.

Relationship to other recommendations: This recommendation is not sequentially dependent upon the other recommendations and could be implemented immediately as funding becomes available. However, prioritizing and planning data collection efforts would be facilitated by a greater understanding of and access to existing data (EM 2.1 and 2.5). This recommendation is also closely related to EM 1.1 and the Water Use Program would benefit greatly from studies evaluating stream flow and glacial geology concurrently for a given area/watershed, to better understand the relationship between surface water and groundwater.

EM 2.4 The DEQ should use high quality data it receives, acquires, or collates from the data submitted to the groundwater database and integrate those data into the SSRs, develop numerical models to better understand the hydrogeology of certain areas, and develop better tools to predict streamflow depletion in those areas. Collection of these data and using updated models can ultimately inform and upgrade the screening tool once sufficient data is collected for the associated Watershed Management Areas. This will help to prevent adverse resource impacts and ensure the utility of the screening tool as well as minimize the number of site specific reviews, by ensuring the most accurate groundwater and geologic information is available for use by the WWAT program.

EM 2.5 The DEQ should continue to collaborate with Michigan Geological Survey and water well drillers on new tools and training programs being developed to improve the geologic data entered into Wellogic records, and should make necessary changes to Wellogic forms to facilitate the entry of more accurate geologic data into Wellogic. With the acknowledgment that the WWAT program uses Wellogic data along with a number of other agencies, the more accurate the information being submitted is, the better utility those records will provide for geologic and aquifer data. The MGS, Michigan Groundwater Association, and DEQ have collaborated to develop a suite of training tools for well drillers to use that can improve the data they enter into Wellogic. This program should continue to make the best possible information available for use in the WWAT program.

This training and review program could be made available to both the drilling community and the general geologic community, to emphasize the need for standardization of geologic information. The overview and training would be online and the format and process would be agreed to by the DEQ, MGS and the MGWA. Once established, a training program would be part of not just the MGWA but could be presented as a unit of the National Ground Water Association for the Great Lakes drilling industry.

MGS, with the support from MGWA, initiated a trial program to present the case for the relevance of sample descriptions for the entire depth of the water well, not just the zone of aquifer production. Conducting three glacial material workshops with rotosonic core material at MGRRE/MGS, Alpena and Roscommon- RAM Center (DEQ-Geologists Outreach), MGS confirmed that well drillers are concerned with meeting clients' needs and County permit requirements when finding water production zones and they give little relevance to those unproductive zones in the glacial material. Further, the geologists (DEQ-Outreach) do see the differences, because they are trained to differentiate clays by feel and rolling the sample. However, both groups did not use the terms clay or clayey in their descriptions. If this information were then input to Wellogic, over 70% of the data would be classified as sandy or sand and input to Wellogic. Many drillers have progressed to more detailed information submitted in Wellogic on the glacial material and this occurs when a driller is in the same area for some time and they see the uniqueness of the glacial material.

MGS will work with the DEQ in establishing both an online training program and re-training program going forward to benefit the drilling industry and emphasize the importance of differences in glacial material, and will further suggest the geologic community embrace standardization of recording geologic materials on well logs to increase the value of the information input to Wellogic and to the State's geologic database. The training program would be directed by a collaboration of the MGWA, DEQ and MGS and draft program in place by mid-2015.

WATER USERS GROUPS

The order in which the recommendations are listed below is intended to reflect, so far as possible, the observations of the Water Users Groups workgroup about the relative timing and importance of the various recommendations.

Also, in the following materials, relationships among these recommendations are noted. In addition, all of these recommendations are closely related to the Technical Underpinnings Committee recommendations TU1.1, TU 1.2 and TU 1.3. Modifying the line data to eliminate intermittent segments may result in situations in which the accounting system shows ARIs for some catchments. Having plans in place for how the DEQ will undertake its work with Water Users Committees before this happens seems advisable.

1. Ensuring the Success of Water Users Committees: Addressing Noncompliance Issues

Charge WU-F

Background and Issue
Part 327 requires the DEQ to convene a meeting of registered and permitted large quantity water users (referred to henceforth as WUC) within a watershed when it has determined that adverse resource impacts are occurring or are likely to occur due to one or more large quantity withdrawals. The purpose of the meeting is to attempt to facilitate an agreement on voluntary measures to prevent adverse resource impacts.

Anecdotal evidence suggests that a significant number (perhaps 20-30%) of large quantity withdrawals are not being reported to the DEQ as required by law. This means that in some regions efforts to convene a WUC will be hampered by incomplete information on all of the large quantity withdrawals. Not all of the individuals who are responsible for helping to manage the water resource to avoid or eliminate ARIs are known, and not all large quantity withdrawals have been accounted for.

Incentives for members of a WUC to deliberate and negotiate in good faith are reduced by the absence of large quantity water users from the discussion, especially if members of the WUC know that there are large quantity water users in the watershed who appear to be getting away with not following statutory requirements and yet not suffering any repercussions as a result. Especially, members of the WUC will question why they should bear the burden of eliminating an ARI when others in similar situations have not been contacted. There are two significant issues here. The first is finding the large quantity water users who have not registered (or obtained a permit) as required. The second is deciding how large quantity withdrawals that are not currently accounted for will be brought into the system.

There are two different groups of unaccounted for water users -- those who never reported large quantity water withdrawal capacity that existed and was used prior to February 28, 2006, and those who have initiated a large quantity withdrawal since then but did not go through the required screening process.

Findings
WUC deliberations will be hampered by the existence of large quantity water users who are generally known to registered and permitted users but are unknown to the DEQ. In the event that a WUC is convened and asked to address an ARI (or respond to requests from a potential water user whose application for withdrawal has not been authorized), it is likely that the WUC members will be aware of some large quantity water users who have not been contacted by the DEQ and invited to attend the meeting. If large quantity users are not contacted, that is because they are neither on the list of water users who are permitted, the list of registered users who registered by reporting withdrawal capacity existing prior to February 28, 2006, nor the list of those who have applied for and been approved for a large quantity withdrawal since February 28, 2006.

As WUC work proceeds, those absent water users will be identified in one way or another, either by WUC members or by the DEQ at the request of the WUC. Once those noncompliant large quantity water users are identified, the DEQ will need to have in place a process for how those users and their withdrawals will be accounted for in the Water Use Program. The two different types of noncompliant water users represent unique challenges, and the implications of choosing any particular approach for addressing the challenges should be carefully considered.

For the first group of water users, those who were making large quantity withdrawals prior to February 28, 2006, but have never registered by reporting, two general options for addressing the noncompliance were discussed by the workgroup. First, these users could be required to go through the screening process and, if approved, their withdrawals would be subtracted from the legally available streamflow depletion for the affected stream reach(es). In the event that their withdrawals could not be authorized, they would be required to seek a remedy just as would any other potential user whose proposed withdrawal is not approved. However, in principle, the index flows established as of October 1, 2008, should reflect all large quantity withdrawals that were being made prior to that time. This suggests that requiring the screening process and debiting the water accounting system for those withdrawals would, in a sense, be double-debiting the system. The second option would be to simply add these users to the list of registered water users, with the reporting requirements impressed upon them, and their compliance with reporting requirements monitored.

This set of choices surfaces discomfort in two major ways. First, there is a general sense that these users were given ample time (extended beyond original deadlines) to report withdrawals and establish baseline capacity. Failure to report water withdrawals since then means that they are in violation of the law. As such, there is discomfort with the idea of giving them a pass by simply adding them to the list of registered users and making the reporting requirement clear; there should be some cost associated with breaking the law. Second, there is a view that the primary goal of getting these users into the system is important enough to accept an amnesty approach because of the benefits to all other users and to the resource. Also, existing and potential future compliant water users will be penalized if, in fact, the withdrawal was originally accounted for in the index flow and then deducted from the accounting system.

There is some evidence that a broad cross-section of stakeholders would find it acceptable to add these users into the system without reducing available streamflow depletion. This approach was included among the consensus items in the Southwest Michigan Water Resources Council final report. Whether these water users' withdrawals are, in general, reflected in index flows is an open question. However, equally important, whether the water resource will benefit significantly if these users go through the screening process and their withdrawals debit the accounting system is also an open question. Nevertheless, on balance, the workgroup

concluded that adding these existing users into the accounting system without debiting the system for their withdrawals is the preferable approach.

There is general agreement that the second set of users, those who have initiated large quantity withdrawals since February 28, 2006, without seeking authorization for those withdrawals, warrant a different approach. Granted, it could be argued that not all water users were aware of the requirements, especially in the early period. Nevertheless, the idea of requiring all users initiating withdrawals after the 2006 date to undergo the application and screening process for those withdrawals has not surfaced objections in Council, workgroup, and stakeholder discussions. In some regions, this process could result in a number of cases where stream reaches are oversubscribed, triggering or exacerbating problems to be addressed by WUCs. Again, this likelihood suggests that the DEQ should have a series of processes in place in preparation for the issues that arise when noncompliant large quantity water users are identified.

There is a gray area, however. Index flows were defined as of October 1, 2008. That suggests that, technically, any large quantity withdrawals initiated between February 28, 2006, and October 1, 2008, in any given watershed are equally likely to be reflected in index flows as those withdrawals occurring prior to February 1, 2006. **This is a difficult issue, and the process established for this category of users will require considerable deliberation.**

Discussion of Recommendations
Consensus was reached but with two objections to this set of recommendations (WU 1.1- 1.3).

WU 1.1 The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding into the formal list of registered and permitted users those noncompliant large quantity users who were making large quantity withdrawals prior to 2006. This process should not include a debiting of the water accounting system for the pre-2006 withdrawals.

Getting all large quantity water users into the system is of paramount importance to the success of WUC deliberations. The process of doing so will be facilitated by adding those making withdrawals prior to February 28, 2006, into the system without reducing available streamflow depletion in the affected watersheds. It is possible that not all such withdrawals are accounted for in the established index flows. However, given the general level of noise in the system, it is not clear that accepting this approach will cause any greater risk to the resource and to water users generally than other known problems. Thus, the trade-off implied by this approach is acceptable.

Resources needed: The principle resource needed for this recommendation is Water Use Program staff time. However, obtaining input from external stakeholders is advisable, especially in building support for a process that could potentially be controversial. It is possible that a statutory change could be required, depending upon interpretation of relevant sections of Part 327.

Relationship to other recommendations: This is one of the very first programmatic decisions that should be made by the Water Use Program. If this process has not been established before the DEQ begins to convene registered and permitted water users, then the DEQ will be unprepared to deal with the discovery of noncompliant water users identified during the WUC process. Deciding on a process on the fly risks

inconsistency of application across different situations as well as the absence of stakeholder input and acceptance.

WU 1.2 The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding noncompliant large quantity users who have initiated withdrawal since February 28, 2006, without going through the required screening process into the formal list of registered and permitted users. Designing this process will require careful consideration of whether a distinction should be made between those withdrawals initiated prior to October 1, 2008, and those initiated after that date with respect to any decision to require the formal application and screening process to be undertaken by these users.

A different approach to dealing with these noncompliant large quantity water users raises the question of why one group should be treated differently than another. However, discussions have uncovered no objections to this approach.

Resources needed: The principle resource needed for this recommendation is Water Use Program staff time. However, obtaining input from external stakeholders is advisable, especially in building support for a process that could potentially be controversial. As noncompliant water users are identified, this process may well create a number of ARI situations, so many of the other recommendations related to convening water users will come into play and the demands placed on Water Use Program staff will grow substantially.

Relationship to other recommendations: Along with the previous recommendation, this is one of the very first programmatic decisions that should be made by the Water Use Program. If this process has not been established before the DEQ begins to convene registered and permitted water users, then the DEQ will be unprepared to deal with the discovery of noncompliant water users identified during the WUC process. Deciding on a process on the fly risks inconsistency of application across different situations as well as the absence of stakeholder input and acceptance.

WU 1.3 The DEQ and MDARD should partner to develop and maintain a system for cross-checking annual water use reports against lists of registered and permitted users to monitor compliance with water use reporting requirements.

Efforts to bring noncompliant water users into the system are undercut by the lack of any system of monitoring for compliance with water use reporting requirements. Especially, noncompliant water users who are brought into the system should be subjected to a closer degree of scrutiny, and monitoring reporting of water use is one relatively low cost way of achieving that.

Resources needed: While databases of registered users, permitted users and water use exist, they are not currently connected. As noncompliant water users are discovered and added into the formal lists of registered and permitted users, staff time will be required to connect the list of registered and permitted users and the reporting data that enables cross-checking that to be sure that the newly added water users are complying with reporting requirements. Also, staff time will be required on a regular basis, at least annually, to monitor compliance. However, this recommendation is specifically related to those individuals who are brought into the formal list of registered

and permitted because of their history of noncompliance, so the staff time needed for the cross-checking will be small until the number of identified noncompliant water users begins to grow significantly. Water Use Program staff should be able to monitor the rate at which the noncompliant users are being added into the system so they can plan for the additional time that will be required for monitoring the reporting by these users.

Relationship to other recommendations: This recommendation is connected to the previous two and should be addressed as soon as noncompliant water users begin to be accounted for and added into the list of registered and permitted users. The history of noncompliance suggests that monitoring these new additions to assure compliance going forward will be important.

2. Convening and Resourcing Water Users Groups

Charge WU-B

Background and Issue Statement
Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act allows for the formation of three types of local water users groups in different circumstances:

- *Water Resources Assessment and Education Committees* may be formed by local entities on notification by the DEQ that a zone B (cold transitional) or zone C withdrawal has been authorized by the WWAT, a permit issued under Part 327 or a permit issued under the Safe Drinking Water Act. The purpose of these committees is to assess trends in water use in the vicinity of the withdrawal, educate water users, and provide recommendations related to long-term water resources planning, use of conservation measures, drought management activities and other topics related to water use identified by the committee. Part 327 says the DEQ shall assist in the formation of the committees and may provide technical information regarding water use and capacity within the vicinity aggregated at the stream reach level.
- *Water Users Committees* may be formed by water use registrants, permit holders and local governments to evaluate the status of current water resources, water use, and trends in water use within the watershed and to assist in long-term water resources planning. The statute requires the DEQ to notify all registrants, permit holders and local units of government officials within a watershed when it authorizes a zone B withdrawal in a cold-transitional river system or a zone C withdrawal and of the authority to establish WUCs. The statute authorizes the DEQ to provide technical information regarding water use and capacity within the vicinity aggregated at the stream reach level.
- *Ad hoc subcommittees* may be created by a local government official who is participating on a WUC to obtain information and advice from residents in that local governmental unit on water resources, water use, and trends in water use within the local unit of government.

Part 327 also requires the DEQ to convene a meeting of registrants and permit holders within a watershed when it has determined that adverse resource impacts are occurring or are likely to occur due to one or more large quantity withdrawals and there is no WUC. The purpose of the meeting is to attempt to facilitate an agreement on voluntary measures to prevent adverse resource impacts.

Issue: The DEQ is required by Part 327 to undertake a series of activities with which it has limited experience, including convening and facilitating the work of WUCs as they seek a solution to an adverse resource impact (ARI). The DEQ has more experience with providing technical resources to the public. Although the DEQ has had some successes working with small numbers of water users on a case-by-case basis to resolve water use issues, the Department has limited resources and expertise to achieve similar successes with larger groups. This is especially true because of the daunting challenges that exist for facilitating WUCs to a successful outcome. Also, the array of technical, organizational and financial resources likely needed by the various water users groups is large and the groups may not know where to get resources they need or how to use them effectively.

Findings

Part 327 refers to WUCs that can be formed by water users and local government representatives and to a convening of registered and permitted water users by the DEQ. For the purposes of the workgroup, the label of WUC will be used for both cases.

<u>DEQ experience with registered and permitted water users with Zone C (Zone B for cold transitional streams) approvals and negative site specific review results</u>

The Water Users Group workgroup reviewed the activities of the DEQ's Water Use Program that relate to the support of water users groups described in Part 327. Prior to formation of the Water Use Advisory Council, the DEQ initiated and assisted with the formation of the Southwest MI Water Resources Council. The charge to that council differed substantively from the activities that would be undertaken by the three types of water users groups described in Part 327, and the DEQ's role differed as well.

On a case-by-case basis, Water Use Program staff have worked with up to 3 water users to facilitate registrations in water-scarce catchments. This work has primarily involved negotiating with individual water users who are able to reduce their registered water withdrawals (because their actual need and reported withdrawals over time have consistently been below the registered amount; e.g., an irrigator who has registered for a larger quantity of water than is actually needed) in order to enable registration of a new or increased withdrawal. Beyond this effort, the DEQ's Water Use Program does not have experience with creating, convening or facilitating groups of water users vested with the kinds of opportunities and responsibilities described in Part 327.

When Water Use Program staff send a letter authorizing a Zone C (Zone B for cold transitional streams) withdrawal in a catchment after a site specific review, a copy of the letter is sent to all registered and permitted users in the catchment. The letter informs the authorized user that the DEQ is required to notify all registrants, permit holders, and local government officials within the catchment of the withdrawal and of the authority provided for the users to create a WUC. Also, when Water Use Program staff conduct a site specific review (SSR) and are unable to authorize a withdrawal, a letter is sent notifying the applicant that the proposed withdrawal cannot be authorized. That letter is also copied to all registered and permitted users and local governments in the catchment at risk of an ARI. Anecdotal evidence suggests that, in many cases, registered and permitted users and local government representatives do not understand the purpose of the letters and discard them.

Additionally, even though these letters refer to a WUC, most registered and permitted users likely have little to no knowledge of the language in Part 327 about WUCs, the authority afforded to WUCs, or the type of efforts that would be required of a WUC. This is especially true for those large quantity water users who registered their baseline capacity by reporting their withdrawals

prior to April 1, 2009 and have had no further contact with the DEQ (agricultural use is reported to MDARD). Most registered and permitted users also have limited understanding of Michigan's common law of water rights and its implications for how users' rights are affected by water scarcity.

Water Resource Assessment and Education Committees

If a WRAEC is formed, both leadership and resources will be required. The workgroup looked for groups around the state that may be doing work similar to that envisioned for WRAECs and would have experience with both leadership and resource issues. In particular, watershed councils and coalitions were identified as watershed-based organizations that are citizen-led. Representatives from two such groups met with the workgroup: Rebecca Fedewa, Executive Director of the Flint River Watershed Coalition, and Jamie McCarthy, Watershed Coordinator for the Kalamazoo River Watershed Council.

The Flint River Watershed Coalition (FRWC) was formed in 1997. It has one full time and five part time staff persons. The FRWC was originally a collaboration of organizations and interest groups but has evolved to a larger membership-based organization funded by money from members, grants and gifts. (Members are anyone who gives financial or in-kind support.) Much of the group's work involves stewardship and education, including activities such as water quality testing, river clean-ups, storm drain stenciling, organized canoe and kayak trips, and work with school groups. Over the last two or three years, the FRWC has become more involved in advocacy work around issues in the watershed. Examples of such issues include removal of a City of Flint-owned dam, leachate from landfills adjacent to the river, and pipeline proposals. The FRWC has also collaborated on research projects with MSU researchers on topics such as green infrastructure, stormwater management, area lakes, struggling neighborhoods, and redevelopment initiatives. Water use has not traditionally been part of the organization's portfolio. However, they did come out as a strong proponent of the Karegnondi Water Authority project to bring Lake Huron water to Genesee County. Their concern arose from observations that Flint and areas of Genesee County were looking for an alternative water supply to replace their reliance on the City of Detroit water system and the possibility that the Flint River could be harmed if it became the sole source of drinking water for the region. Their most recent strategic planning effort did not raise water use as an area of work, but Rebecca did not rule out their interest, given the Karegnondi involvement and some concerns about wells in the vicinity of the river.

The Kalamazoo River Watershed Council (KRWC) grew out of the advisory council for the Kalamazoo River Area of Concern. After ten years, the advisory council expanded its mission to address more water quality issues and became the KRWC. They still work with the Area of Concern on contaminated sediment issues, superfund issues, and the like. They also work on water quality in the river, including water sampling, and with stormwater management, land conservation projects, and with Conservation Districts in the region. The KRWC does not have a general membership beyond its board members. The board has not addressed water use issues per se, although they have been involved with wellhead protection programs in the region.

Both organizations would need to access additional resources and expertise if they were to expand their work to "assess trends in water use in the vicinity of the withdrawal, educate water users, and provide recommendations related to long-term water resources planning, use of conservation measures, drought management activities…" as described in Part 327.

The workgroup concluded that, like watershed-based organizations that have formed to respond to other specific issues – usually water quality, WRAECs are likely to form organically as individuals or organizations within watersheds identify the need for such a body. Also, it is likely that existing watershed groups will take on activities envisioned for WRAECs if they identify water use as important work in their area and can access necessary resources. One benefit of existing groups filling this role is their experience with organizational management, volunteer management, and fund-raising. This suggests that the DEQ's role could be limited to providing technical information, much like the support generally provided to other watershed-based groups.

Water Users Committees

In some areas a WUC may form organically if a particular water-related conflict arises. For example, in a well-to-well conflict, if failure of one well cannot be tied to water withdrawals from another individual well but, instead, is likely caused by cumulative withdrawals from several wells in proximity to the failed well, a WUC might be the structure within which large quantity water users could work collectively toward a resolution of the conflict. However, the workgroup concluded that WUCs are not likely to form widely unless the registered and permitted users are brought together by the DEQ. Also, the incentives for members of the WUC to work toward "agreement on voluntary measures to prevent adverse resource impacts", as envisioned in Part 327, are not immediately obvious.

The workgroup identified two scenarios under which a WUC might be convened by the DEQ to address a water use issue arising from Water Use Program requirements.

1. The results of a SSR leave an applicant unable to make the desired withdrawal and the applicant wishes to engage other water users in the catchment in discussion about how their water use might be adjusted to enable the applicant to exercise his/her common law water rights.

2. When the DEQ determines that an ARI is occurring.

Scenario 1

Part 327 specifies that common law water rights are not altered by the statute, but otherwise does not address Scenario 1. Water Use Program staff have facilitated agreements similar to the kind that might be expected to arise from the work of a WUC in Scenario 1. In cases where a withdrawal cannot be authorized after a SSR, staff have approached other registered users one-by-one in the vicinity of the proposed withdrawal and asked if they would consider reducing their registered withdrawals if their reported withdrawals are consistently lower than the registered amount (e.g., an irrigator who has registered for more water than is actually needed). They have had several successes with this approach. However, they have not convened a catchment-wide group of registered and permitted users for this purpose.

Although DEQ involvement in this scenario is not addressed in Part 327, the workgroup concluded that, because it is a public agency, DEQ involvement would be an important public service. If asked by the potential water user whose application was not authorized, the DEQ could convene the WUC (including the potential water user) and explain the purpose for the meeting, describe the interdependencies of water users under the common law water rights structure in Michigan, and describe technical resources as well as facilitation, mediation or conflict resolution assistance that may be available. The DEQ could also describe its successes working with individual water users to reduce registered capacities and enable authorization of a proposed withdrawal that would otherwise cause an ARI.

In the event that some or all members of the WUC in Scenario 1 find that they are able to address the problem through similar adjustments to registrations, an agreement that is satisfactory for the potential water user may be reached fairly easily. However, if current water users are unwilling to voluntarily make changes that would reduce total withdrawals so that the new application could be approved, the potential water user could exercise the option of seeking legal action to enforce common law water rights. The outcome of such action would be uncertain, and whether risks associated with such action would be sufficient to encourage members of the WUC to negotiate to an agreement is unknown. Most registered and permitted water users have limited understanding of Michigan's common law that defines water rights and associated duties.

Scenario 2

Part 327 specifies that the DEQ is to convene a WUC if it determines that an ARI is occurring or is likely to occur. The process envisioned is that members of the WUC would work together to decide who would undertake what voluntary measures so that less total water is withdrawn and the ARI is corrected. If the members of the WUC are unable to reach agreement within 30 days, the DEQ can suggest a solution that would correct the ARI. However, nothing in the law compels members of the WUC to agree to a solution suggested by the DEQ or proposed within the WUC.

Initially, the workgroup focused in Scenario 2 on situations where an ARI is reported to or discovered by the DEQ. This scenario does not include situations where the DEQ discovers that water resources within a catchment have been oversubscribed based the WWAT accounting system. If all uses are screened at the time of application, then theoretically this should not occur. However, workgroup members are keenly aware of possibilities that new information related to stream types (e.g., perennial vs. intermittent or size/temperature classification) could lead to a discovery that, based on old information, the DEQ has authorized large quantity withdrawals that have cumulatively reduced water availability below the zone D threshold. After considerable discussion, the workgroup concluded that, in practice, the recommendations made for a scenario 2 situation should apply to this special case as well.

Because the DEQ's recommended solution is not binding and because of the absence of clear repercussions for WUC members if the WUC fails to reach an agreement to correct an ARI, whether there is sufficient incentive for WUC members to work toward a solution is an open question. After lengthy discussions about incentives and the issues that both the DEQ and WUCs will face in Scenario 2, the workgroup concluded that a satisfactory resolution within 30 days of convening the WUC is unlikely. Even with the DEQ's assistance, access to technical information may be challenging and the WUC members would have to figure out how to pay if facilitation or mediation assistance is needed and comes with a fee.

Members of the workgroup concluded that if the presence of an ARI was demonstrated in a way that showed streamflows or lake levels below the level required to avoid negative impacts on the resource, members of the WUC would likely recognize the need to take some type of action. The work in SW Michigan shows interest on the part of water users to contribute to a better understanding of the hydrologic situation in their watershed. This suggests that if the DEQ engaged WUC members in efforts to demonstrate the presence of an ARI, with agreement between the DEQ and WUC members about how excessively low streamflows or lake levels would be verified, then willingness to work toward a resolution would be greater. This could result in collective work to undertake voluntary measures, with the burden of reducing total

withdrawals distributed across the WUC membership in a way that the members themselves propose and agree to.

The workgroup recognizes three challenges with making the distinction between a suspected ARI and a demonstrated ARI. First, whether the DEQ would be required by the statute to demonstrate that streamflow is too low in order to legally establish an ARI is an open question. Second, there is some risk that "excessively low streamflows or lake levels" might be interpreted as meaning merely that streamflow or lake level would be so low that it would be obvious to a casual observer. However, if this kind of visible evidence occurs, streamflow or lake level will likely already be below the ARI threshold, and damage to the resource may have already occurred. This excessive dewatering of streams and lakes is what the statute and the WWAT are intended to avoid. (Work of the Council's Inland Lakes workgroup is intended to assist the DEQ with determining whether an ARI has occurred in a lake, so larger questions about recognizing and verifying an ARI in a lake remain.) Finally, the technical aspects of confirming that withdrawals are causing excessively low streamflows or lake levels would require significant resources and unique expertise. Nevertheless, workgroup members have concluded that the odds of a WUC working effectively to eliminate an ARI are much higher if water users understand and are convinced of the problem.

If the WUC were convened when an ARI is suspected, but before it is verified, members of the WUC would have more time to gather resources, learn to work together, build relationships and consider options for resolution. If the ARI is verified and the DEQ again meets with the WUC as required by Part 327, resolution within 30 days is still unlikely but the time required may be shorter than it would be if the WUC were not engaged early.

When the DEQ initially convenes the WUC, it would explain why the group has been convened, the authority provided for the WUC, the requirements that the DEQ faces, the need to verify the excessively low streamflow or lake level, and opportunities for the WUC to be involved in verifying streamflow or lake level. Then, if an ARI is verified, WUC members will have already met at least once. The DEQ would reconvene the group, explain the ecological impacts of and the need to correct the ARI, the benefits of coming to a solution, and the availability of resources of various types that the group is likely to need. While the DEQ might be in a position to suggest a process that the group could follow in doing its work, the workgroup concluded that DEQ efforts to serve as a formal facilitator throughout the WUC's deliberations would not likely be productive. A number of facilitation and mediation services are available that the DEQ could identify for WUCs.

A large body of research indicates factors that will increase or decrease the likelihood of success when groups of resource users attempt to prevent or manage conflict (e.g., Araral 2009; Agrawal 2001; Cox, Arnold & Tomas 2010; Dietz, Ostrom & Stern 2003; Ostrom 1990). Factors that make reaching agreement less difficult and are likely important in this context include:

- Smaller size of resource
- Well-defined boundaries of resource
- Predictability of impacts of human actions on resource
- Indicators of common problem among resource users
- Smaller number of resource users
- Clarity of who is included in resource user group
- Social capital among users
- Common interests among users
- High levels of dependence on resource

- Fairness in allocations of resource benefits
- Lower external pressures from market forces
- Power and authority for governance vested with user group
- Supporting rules at higher levels of governance

Research evidence is clear that the likelihood of success for a WUC will decline as the size and heterogeneity of the group rises. The attached Table WU-1 shows the distribution of registered and permitted users across catchments as of June 2014 (e.g., 609 catchments have one registered or permitted user, 25 catchments have 10 registered or permitted users, 1 catchment has 50 registered or permitted users).

Ad hoc subcommittees

If a WUC is formed, local government representation is indicated. A local government representative may choose to create an ad hoc subcommittee that would help provide information that may assist the WUC with its work to "evaluate the status of current water resources, water use, and trends in water use within the watershed and to assist in long-term water resources planning". The workgroup concluded that the DEQ would have a limited role with these ad hoc committees, except to the extent that they ask for the same kind of technical information that a WRAEC might or WUC request. The ad hoc committee could be an avenue by which larger community goals related to long term water planning could be conveyed to the WUC.

Resource Needs of Water Users Groups

All types of water users groups are likely to need technical, organizational and financial resources to undertake the types of activities envisioned in Part 327. The workgroup explored what kinds of needs would likely be expressed, especially by WRAECs and WUCs.

WRAECs: If these groups form in association with or under the leadership of existing watershed organizations, they will already have basic information on how to form a community organization. However, they will likely approach the DEQ for technical information to assist them with assessing water use trends and undertaking long-term water planning. The DEQ's provision of this information is required by Part 327. There will be some types of information that will be common across all requests, but there will also be information unique to each community. In many cases, the best approach for the DEQ will likely be to provide references to sources of information, rather than the information itself. Similarly, the DEQ could provide references to possible sources of financial support. Watershed organizations are accustomed to seeking financial support from corporate and non-profit sponsorships and grants; however, the list of sources with interests in water use could differ from the list of sources interested in water quality if the perceived need differs.

WUCs: While individual members of WUCs will likely have experience as members of other groups (e.g., civic clubs, church-related committees, local government bodies, professional organizations, etc.), their experience with the kinds of work envisioned for WUCs will be limited or non-existent. As a result, they will be much more dependent upon the DEQ for initial provision of basic resources on how to organize and build cohesion within a group, how to facilitate discussions, and how to access technical information. More importantly, these are groups are unlikely to have a source of funding to support their work. The decision of a group of users in SW Michigan to contribute funds to support water research in their area is one example of interested parties committing resources to address a problem of common concern. However, absent a strong incentive for the WUC to successfully respond to a demonstrated problem, similar financial commitments by WUC members are unlikely. Again, corporate or non-profit

sponsors could be found, but this would be made more difficult by the small geographical area affected by the work of the WUC. The workgroup discussed briefly whether creation of a grant program to support WUCs might be desirable or feasible, but workgroup members were not optimistic enough about that potentiality to explore it in detail.

Technical resources and references to other sources of information are made available online by a number of DEQ programs. Examples from the Water Resources Division include:

- Nonpoint source pollution: http://www.mi.gov/deq/0,4561,7-135-3313_3682_3714---,00.html provides information and education resources, technical assistance resources, and grant application information.
- Abandoned wells: http://www.mi.gov/deq/0,4561,7-135-3313_3675_3689---,00.html provides general information, laws and rules and technical information
- Biosolids: http://www.mi.gov/deq/0,4561,7-135-3313_3683_3720---,00.html provides general information, laws and rules, and links to other sources of information

While these programs' websites provide lists of resources, they do not explain which resources may be useful for what purposes or in what contexts. Technical resources for WUCs would be more beneficial if they were accompanied by descriptions of how they might be useful to WUCs. Examples of the types of information or information sources that would be useful to both WRAECs and WUCs are shown in Table WU-2.

Discussion of Recommendations

WU 2.1 The DEQ should invest resources to produce and maintain an online set of resources (as described in Table WU-2) to provide technical, organizational and financial information to water users groups to support the formation and functioning of Water Resources Assessment and Education Committees (WRAECs) and Water Users Committees (WUCs). Both WRAECs and WUCs will need access to a wide range of resources. Making such resources (or information on how to access such resources) available in a single spot will make it easier for the DEQ to respond to requests for information from WRAECs. It can also be made available to WUCs when they are initially convened as part of assisting them with formation and facilitating their work. Simply providing a list of resources will not be sufficient. Narrative explanations of why water users groups (especially WUCs) may find them useful will also be needed and should accompany the list. Unlike online lists provided by other DEQ programs, this would be more like a manual available online. Proposed topics and resources (not an exhaustive list) are provided in Table WU-2 at the end of this set of recommendations.

Resources needed: The work to complete this website will include gathering the information, writing the narrative, and creating the website. Cost could be calculated based on the number of hours that this work is likely to take, but the workgroup is not able to estimate how much time would be required. Cost per hour will depend upon who does the work. Options include existing DEQ staff, either within or outside of the Water Use Program, a student intern working with the DEQ, a consultant, or possibly a graduate student at one of Michigan's universities where students may be studying in a related area.

Relationship to other recommendations: This recommendation is the first in this set; the remaining recommendations are listed according to the sequence in which the workgroup believes they should be addressed. Creating the website before proceeding

to the remaining recommendations below is important because, for example, the brochure described in the next recommendation can then refer readers to the website.

WU 2.2 The DEQ should invest resources to produce a brochure that explains the role of WUCs in Michigan's Water Use Program. The brochure should describe the conditions under which the input from a WUC might be needed, benefits to water users of being part of a WUC, and benefits of creating a WUC before a Zone D request is made or an ARI is observed.

Resources needed: This brochure could be written and designed by someone at the DEQ or by a consultant. As an example of potential costs, charges by a consultant would likely be in the neighborhood of $1500.00. Approximately 4000-5000 copies per year are likely to be needed, based on the number of letters the DEQ has mailed in recent years. For that size order, printing costs would likely be in the neighborhood of 15-20¢ per copy. The material in the brochure will need to be reviewed at least every two years and revised as necessary, so the number of copies printed for any two year period should be conservative.

Relationship to other recommendations: This brochure should be produced after the website described in the previous recommendation is completed and be mailed to registered and permitted water users. The brochure can direct water users to the website for more information.

WU 2.3 The DEQ should enclose a copy of the brochure in letters sent to all registered and permitted users and associated local governments when a Zone C (or Zone B for a cold transitional stream) withdrawal is approved after a site specific review and in letters that are mailed to all registered and permitted users and associated local governments when a negative SSR occurs.

The purpose of the brochure would be to provide information about WUCs directly to those who are likely to be engaged in such a group and to encourage such groups to form in advance of a water conflict. This approach would, at a minimum, introduce to registered and permitted water users the basic information so that if and when the DEQ convenes the WUC, the issue and process would perhaps not be totally foreign. Including the brochure in the letters mailed to registered and permitted users in the event of Zone C (or Zone B) withdrawals or negative SSR results would be a way to get this information out to users before a WUC is needed. These letters represent a common touch point for registered and permitted water users who would be involved with a particular WUC at the time when need for a WUC could be approaching. There is some evidence that these letters are merely discarded and not read, but an attractive brochure could catch the attention of recipients and would more likely be read.

Resources needed: This recommendation follows the previous two and refers to how the brochure should be distributed. Since Water Use Program staff are already sending the letters referred to in this recommendation, the added cost of distributing the brochure is likely to be very low. Postage costs should not be affected if a simple three-fold brochure is designed.

Distribution of this brochure could increase the demand for assistance from the DEQ, which will increase the workload of current Water Use Program staff. The magnitude of that increase is difficult to anticipate.

Relationship to other recommendations: This recommendation is the third step of three. Clearly, it cannot proceed until the brochure is prepared.

WU 2.4 We recommend that the DEQ undertake the initial convening of a WUC in two scenarios: 1) if a recipient of a negative SSR requests help with contacting and convening large quantity water users within the catchment of concern, and 2) if an ARI is suspected. Convening a WUC if a recipient of a negative SSR requests help is beyond the scope of work envisioned under Part 327. However, the DEQ has access to the list of registered and permitted water users in a catchment and should undertake this activity as a public service to water users. The DEQ should convene WUC members if an ARI is suspected but before it is verified and engage WUC members in efforts to verify streamflow. This means that in these cases the DEQ would convene the WUC earlier than indicated in Part 327. Agreement among WUC members that there is, in fact, a problem will be necessary before WUC members have any incentive to cooperate, since legal repercussions of not cooperating are not clear.

Resources needed: Part 327 requires the DEQ to convene registered and permitted water users in the event of a suspected ARI. As the limits on withdrawals become binding constraints for water users, this process will begin to place considerable burdens on Water Use Program staff. Given that program staff are likely to remain involved in some capacity with WUCs, providing technical assistance for example, the workload could be high and add to the implementation work currently being done by program staff. At some point, additional staff will likely be required to meet this workload.

If the DEQ decides to convene registered and permitted water users if a recipient of a negative SSR requests help, this will place even more demand on the limited program staff. Again, additional program staff will be needed to undertake this work.

Relationship to other recommendations: This recommendation is related to the next recommendation. Ideally, the protocol to be used for convening these meetings will be established in advance of actually needing it. However, realistically, given current resource constraints in the Water Use Program, the workgroup suspects that such a protocol will likely be developed when it is actually needed. This will place added pressure on program staff.

WU 2.5 The DEQ should develop a protocol to be used for the initial convening of WUCs. The protocol should include the specific tasks the DEQ will undertake at the first WUC meeting. This would include a protocol for WUCs convened under both Scenario 1 and Scenario 2. There would be some similarities between them: the DEQ's responsibilities under Part 327 and the Water Use Program, the role described in Part 327 for water users in WUCs, the interdependencies of water users, suggestions of how the WUC might proceed, and available technical and facilitation or mediation resources. For initial WUC meetings in the event of scenario 2, the protocol should also include an approach for engaging WUC members in the process of verifying the ARI. If the ARI is verified, then the DEQ would meet with the WUC again

to explain the ecological impacts of the ARI, the need to correct it, and the benefits of coming to a solution. Sample agendas for kick-off meetings under both Scenarios 1 and 2 are included in Appendix C.

Resources needed: The workgroup recommends a protocol such as that suggested by the draft meeting agendas in Appendix C. Each of the items needs to be fleshed out. Some of the agenda items will be very similar, regardless of where the meeting is held and who is there. Other items will require specialized attention for each group of water users.

Relationship to other recommendations: Ideally, this protocol will be developed so that Water Use Program staff are prepared in the event that they must convene water users to address an ARI or to assist a recipient of a negative SSR if so requested.

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Table WU-1. Distribution of Registered and Permitted Users across 1,600 Catchments (3,989 catchments have no registered or permitted users), June 2014
(e.g., 609 catchments have 1 registered or permitted user, 311 catchments have 2 registered or permitted users, etc.)

Number of R/P users	Number of catchments
1	609
2	311
3	161
4	109
5	98
6	70
7	48
8	31
9	18
10	25
11	15
12	17
13	15
14	8
15	6
16	7
17	8
18	3
19	5
20	4
21	2
22	2
23	4
24	4
25	2
26	1
28	4
29	2
31	2
33	2
35	1
39	1
42	2
43	1
44	1
50	1

Table WU-2. Information or information sources that would be useful to WRAECs and WUCs

Water Law	• Explanation of common law water rights (riparian and ground water), including the reasonable use doctrine and rule of correlative rights • Interpretation of information on water rights in terms of rights and duties of water users
Information to assess current and potential future uses of water	• Current water users and quantities used, subject to statutory restrictions • Current land use, including residential development served by private wells • Local planning and zoning information and economic development plans that will influence future water needs • Location, distribution and condition of water and wastewater infrastructure • Consumptive uses and return flows
Information to assess current status (availability) of water resources	• Surface water and ground water maps and inventories and other hydrologic information • Water Use Program data on water availability • Geologic information • Water quality programs and data
Information on water conservation measures	• Irrigation GAAMPs *(The link provided was broken and has been removed.)* • Best management practices for non-agricultural irrigation http://www.michigan.gov/documents/deq/deq-wb-dwehs-wu-conservmeas-nonagirrigation_231922_7.pdf • Turf grass irrigation for golf courses https://www.canr.msu.edu/uploads/236/68615/Turfgrass_Irrigation_Module.pdf • Business water use https://www.canr.msu.edu/uploads/236/68615/Turfgrass_Irrigation_Module.pdf • EPA website https://www.epa.gov/greeningepa/water-conservation-epa
Potential sources of financial resources	• Local community foundations • Local governments • Federal and/or state grant programs, depending upon purpose of request
Resources for facilitation, mediation and conflict resolution	• Community Dispute Resolution Program http://courts.mi.gov/administration/scao/officesprograms/odr/pages/community-dispute-resolution-program.aspx

3. Convening and Resourcing Water Users Committees: Accessing Water User Information

Charge WU-B

Background and Issue
Part 327 requires the DEQ to convene a meeting of registered and permitted large quantity water users (referred to henceforth as WUC) within a watershed when it has determined that adverse resource impacts are occurring or are likely to occur due to one or more large quantity withdrawals. The purpose of the meeting is to attempt to facilitate an agreement on voluntary measures to prevent adverse resource impacts.

Once the WUC is convened, a key piece of information that the WUC will need is data on the current water use situation. The DEQ provides online a list of Water Withdrawal Assessment Tool registration requests, but it does not indicate which requests have been approved and built. There is not a similar list of users who registered by reporting prior to February 28, 2006 or of permitted users. Water users who registered through the Water Use Program and those who registered by reporting prior to February 28, 2006 are required to submit annual reports on water use. However, the DEQ and MDARD are prohibited by law from making public information about agricultural irrigators' water withdrawals. Each of the participating WUC members could provide to the WUC his or her withdrawal information (purpose of use, source, location, registered amount), but going through that process will use precious time.

Findings
WUC members do not have legal access to the complete list of registered and permitted water users from which they can obtain key information that the WUC will need in order to understand the current situation in the watershed: who should be part of the WUC, how much water is being used by each WUC member (including baseline capacity and amount reported annually), the location of the withdrawal, and the water source. Each WUC member should have at his or her disposal this information about his or her withdrawals. However, work of the WUC will proceed more quickly if they are able to gain access to a single report with the information included. (This is especially true since, for some types of water users such as municipalities or self-supplied industries, the individual attending the WUC in a decision-making capacity may not be the individual who is familiar with such records.) In addition, the WUC will need information on current cumulative withdrawals and the legally available amount of streamflow depletion for the watershed.

Once the WUC members have agreed to proceed with the process of pursuing an agreement on how to eliminate an ARI, they could ask for this information from the DEQ. The workgroup recognizes, though, that the DEQ and MDARD are prohibited by law from releasing an individual agricultural irrigator's information without his or her permissions.
Discussion of Recommendation

WU 3.1 At the request of a WUC (registered and permitted water users in a watershed), the Department of Environmental Quality and Department of Agriculture and Rural Development should be prepared to share with the WUC the following information:

- **Contact information for all registered and permitted water users in the watershed**
- **The cumulative withdrawals in the watershed**

- **The legally available amount of streamflow depletion for the watershed.**

The WUC cannot proceed without this information. The fact that the WUC needs the information for all registered and permitted users means that the WUC's work will be stymied by the inability to access information for users not participating in WUC discussions. However, the work of the WUC will, nevertheless, be facilitated by ready access to these three types of information.

Resources needed: This is a relatively easy and inexpensive task. The information needed is available in existing databases within the DEQ and MDARD. Some staff time will be required to create a common database from which requested information would be made available and to produce a report and send it to a WUC.

Relationship to other recommendations: This work could be completed soon and having it done would facilitate the convening of water users.

4. Convening and Resourcing Water Users Committees: Facilitation and Technical Assistance

Charge WU-B

Background and Issue
Part 327 requires the DEQ to convene a meeting of registered and permitted large quantity water users (referred to henceforth as WUC) within a watershed when it has determined that adverse resource impacts are occurring or are likely to occur due to one or more large quantity withdrawals. The purpose of the meeting is to attempt to facilitate an agreement on voluntary measures to prevent adverse resource impacts.

Because of the sensitive nature of the discussions to be undertaken by the registered and permitted users (referred to henceforth as WUC) and because most members will not have previous experience with the kinds of negotiations required, formal facilitation of the discussion process will be necessary in most cases. This is especially true for a WUC with more than six or so members. Formal facilitation for WUC deliberations will increase the likelihood of a timely and successful outcome. Facilitation by DEQ Water Use Program staff is not likely to be successful, since they will not be viewed as an impartial facilitator.

The initial convening of the WUC by the DEQ is likely, in most cases, to result in a discussion of the evidence that an ARI is occurring. The willingness of WUC members to work toward resolution of an ARI cannot be expected if they do not believe that there is a problem that needs to be addressed. As a result, how best to verify that an ARI is occurring can be expected to be an early and important part of the WUC discussions. Resolving this issue will require considerable technical expertise.

Findings
Facilitation
Workgroup members' experiences with group processes, especially when difficult decisions are required, led the group to agree that formal facilitation of WUC discussions will likely be necessary in order to assist the WUC with moving through its work in a timely fashion.

Facilitation will also reduce the likelihood of excessive conflict during group discussions. A facilitator would help the group:

- manage meetings and meeting logistics
- discover and obtain technical information
- conduct orderly discussions
- maintain a record of its discussions
- etc.

The workgroup met with Doug van Epps, Director of the Office of Dispute Resolution within the State Court Administrative Office. His office oversees and funds the Community Dispute Resolution Program (CDRP), which is a network of nonprofit organizations that provide mediation and facilitation support. The funds from the court system (civil court filing fees) were initially intended to provide for mediation services for court-ordered mediation in small claims cases (e.g., credit disputes, neighbor disputes, family conflicts). Over the years, the program has expanded to handle circuit court disputes, domestic disputes, special education disputes (whether a child qualifies and scope of qualification). There are 18 CDRP centers located around the state so that, in principle, residents of every county have access. A detailed list of these centers is included in Appendix C.

Mediators that work through the centers are almost exclusively volunteers. Before someone can become a volunteer affiliated with CDRP, he or she must undergo 40 hours of training through the Office of Dispute Resolution, complete a supervised internship, and apply to and be accepted to the program. Many but not all volunteers are attorneys. Ongoing training or continuing education is required for volunteers. Subject matter expertise on the part of the mediator is generally not needed, but this is addressed on a case-by-case basis.

Experience with mediation taught that some disputes might have been settled before the parties stopped speaking to one another had some sort of facilitated discussion occurred early on. So CDRP volunteers also do formal facilitation as requested. They will also do trainings to help groups learn how to function independently (facilitate themselves) going forward. Subject matter expertise on the part of the facilitator is generally not needed, but good facilitators will work to educate themselves about the purpose of the facilitated discussions, special vocabulary, unique potential sources of potential conflict, etc.

Neither the mediation nor the facilitation services are provided free of service, but the hourly rates charged are significantly less than those charged by private mediators or facilitators. The charges are made to offset the often substantial investment in logistics and other details. Centers do have a sliding scale for charges based on ability to pay.

An agricultural mediation program, supported by funds from the U.S. Department of Agriculture (USDA), is operated by the Association of Community Mediators through the CDRP Center in Grand Rapids. Agricultural mediation services are made available free of charge to anyone who has a dispute with a USDA agency or program. This program would not be available to WUCs involving agricultural water users because it is expressly for disputes involving USDA.

Over the years, different organizations or programs have provided funds to the CDRP to support mediation services for special needs, such as mental health, foreclosures and the Americans with Disabilities Act. In some cases, the funder worked with the Office of Dispute Resolution to provide training for mediators (and facilitators) on any unique situations, special vocabulary, etc.

that volunteers might need to know about. However, in many of those cases, no disputes ever arose. This means that the funds and the volunteers' time were wasted.

The possibility of providing funds to the CDRP to assist with facilitation and/or mediation of WUCs was raised, but van Epps suggested that it would be better to consider such a move once it is clear that the CDRP services would be needed and called upon. He suggested that being able to consistently expect two to three cases needing facilitation and/or mediation per year would create a situation in which additional financial support of the CDRP would be needed.

MSU Extension, in its current reduced size, no longer has sufficient staff in a position to take on significant facilitation roles on an ongoing basis. There are still some individuals who will do one-time meeting facilitations. However, MSUE does offer a facilitator training course.

Technical Expertise

In earlier findings, the workgroup shared the following:

> Members of the workgroup concluded that if the presence of an ARI was demonstrated in a way that showed streamflows or lake levels below the level required to avoid negative impacts on the resource, members of the WUC would likely recognize the need to take some type of action. The work in SW Michigan shows interest on the part of water users to contribute to a better understanding of the hydrologic situation in their watershed. This suggests that if the DEQ engaged WUC members in efforts to demonstrate the presence of an ARI, with agreement between the DEQ and WUC members about how excessively low streamflows or lake levels would be verified, then willingness to work toward a resolution would be greater. This could result in collective work to undertake voluntary measures, with the burden of reducing total withdrawals distributed across the WUC membership in a way that the members themselves propose and agree to.

The workgroup recognizes three challenges with making the distinction between a suspected ARI and a demonstrated ARI. First, whether the DEQ would be required by the statute to demonstrate that streamflow is too low in order to legally establish an ARI is an open question. Second, there is some risk that “excessively low streamflows or lake levels” might be interpreted as meaning merely that streamflow or lake level would be so low that it would be obvious to a casual observer. However, if this kind of visible evidence occurs, streamflow or lake level will likely already be below the ARI threshold, and damage to the resource may have already occurred. This excessive dewatering of streams is what the statute and the WWAT are intended to avoid. (Work of the Council’s Inland Lakes workgroup is intended to assist the DEQ with determining whether an ARI has occurred in a lake, so larger questions about recognizing and verifying an ARI in a lake remain.) Finally, the technical aspects of confirming that withdrawals are causing excessively low streamflows or lake levels would require significant resources and unique expertise. Nevertheless, workgroup members have concluded that the odds of a WUC working effectively to eliminate an ARI are much higher if water users understand and are convinced of the problem.

Whether WUC members pursue an agreed upon course of action or partner with the DEQ to collect data and/or conduct analyses to verify an ARI, the presence of a neutral technical expert to assist the process will increase the likelihood of a successful WUC outcome.

Discussion of Recommendations
Consensus was reached but with three objections to this set of recommendations (WU 4.1 and 4.2).

WU 4.1 Financial commitment should be made to support the facilitation of water user group negotiations.

One could expect that members of a WUC will bear a number of different kinds of costs as a result of their participation with the WUC and the results of the group's deliberations. The costs of facilitation services is just one example, but it is an example that is likely to be among the first realized. In some cases, WUC members may not be aware of the value of facilitation in group processes. Making WUC members aware of facilitation resources and reducing the costs of obtaining this kind of assistance would be an important way of enhancing, early in the process, the likelihood of an effective and successful WUC outcome.

While the facilitation assistance might be provided by a staff person in a Quality of Life agency, workgroup members are sensitive to the fact that facilitation by a staff person from the Water Use Program would not be successful. A successful facilitator is a neutral party who does not have a stake in the outcome of the process. Although it could be argued that the goal of the WUC and the Water Use Program are the same -- an agreed-upon way to eliminate an ARI (or in some cases, reduce cumulative water withdrawals so that a new user can be accommodated), members of the WUC are still potentially in the position of having to satisfy the Water Use Program. As a result, the WUC members would not see someone from the Program as a neutral party.

There is precedent for Quality of Life agencies partnering with Universities to assure attention to technical issues of importance to the state. For example, the DNR has partnered with MSU Extension (MSUE) to create positions with specific subject matter or audience responsibilities. DNR also partnered with MSU's College of Agriculture and Natural Resources (CANR) to create the Partnership for Ecosystem Research and Management (PERM), through which DNR provides salary dollars for faculty who work in areas jointly identified by DNR and CANR as needing specific research and/or outreach programs. (See: https://www.canr.msu.edu/fw/partners/partnership_for_ecosystem_research_and_management_perm/index)

Resources needed: The cost to hire private facilitators ranges as high as $500 per hour or more. The State's Community Dispute Resolution Program makes facilitation services available through its volunteer facilitators at a much reduced cost. A good facilitator will spend as much time preparing for a meeting as he or she spends running the meeting, especially early in a multiple meeting situation. Some facilitators will bid for a specific job rather than by the hour. There are a number of ways that facilitation assistance could be made available and supported by the state. For example, state funds could be dedicated to:

- fund a staff position placed within a quality of life agency (but not in the DEQ Water Use Program because perceived conflicts could make the facilitator ineffective),
- fund a staff position in partnership with a university program or other non-profit,
- creation of a fund from which resources are made available to WUCs who apply for facilitation support, or

- support provided to the Community Dispute Resolution Center volunteer facilitation and mediation services so that water users have access to their services.

Providing resources to the Community Dispute Resolution Center is not advisable until it can expect regular requests for its services.

Relationship to other recommendations: This recommendation should be considered and plans made before conflicts in Watershed Management Areas require water users to convene and negotiate to a solution. If a Watershed Management Area has only two or three water users involved, then the need for facilitation will be less. However, one might expect that conflicts are more likely to occur sooner in Watershed Management Areas that contain a large number of withdrawals and, relatedly, a larger number of users.

WU 4.2 Financial resources should be committed to fund a position which would provide technical assistance to the WUCs and DEQ, serve as liaison between the WUC and DEQ, and assist with the analysis (including analysis of the expected impacts of alternative scenarios that the WUC might consider.)

Creation of a faculty position with research and outreach responsibilities, possibly as part of PERM, would provide for a neutral technical expert who could be called upon by both the WUCs and DEQ when dealing with challenges related to gaining a better understanding of the water body at issue.

Resources needed: If, for example, a research position was created within a state agency or a university, the costs for salary and benefits could easily approach $200,000 per year. Partnering with a university would make available an independent expert who would work with water users and with the DEQ. The Partnership for Ecosystem Restoration and Management is an example of a partnership between the state and MSU where research and Extension programs focus on issues that assist DNR with implementation of fish and wildlife programs. Private consultants could provide this expertise, as could new technical expertise within the DEQ. However, the independence issue will surface as water users question the objectivity of DEQ and DEQ questions the objectivity of a consultant -- unless, for example, the DEQ and water users collectively agree on a consultant to engage. Creating a position, whether in the DEQ or in partnership with a university, will provide for consistency and continuity that working with private consultants may not.

Relationship to other recommendations: The availability of this expertise will become important as soon as a group of registered and permitted water users begins to explore options for reducing cumulative withdrawals to resolve an ARI or to enable a new or increased water withdrawal to be approved.

WATER CONSERVATION AND USE EFFICIENCY

Introduction

A fundamental underlying reason that we address the issue of water conservation is that we **love the Great Lakes and the ground water systems upon which they rely. We may ask ourselves** - why do we do this work to preserve the water? Why do we attend the meetings and conference calls? The answer lies in the fact that unlike many other endeavors where failure may be inconvenient but otherwise has little effect on our lives, failure in this work that we are doing will have major negative impacts. If we are not able to develop the process for the shift in how our State and our communities use, conserve, protect and restore the water resources in the Great Lakes region our failure will impact our lives and the lives of our children, grandchildren and generations beyond.

The indigenous nations of the Great Lakes region have traditional teachings that guide them to seek balance in personal, family, community and national life. The strengths and perils of Fire, Wind, Earth and Water and the balance among them are of fundamental importance. These teachings inform that when people disrespect this balance, our collective future is endangered. Water is the life-blood of Mother Earth; it flows in her veins and fills her oceans, lakes, rivers and streams. It is essential for the plants and animals with whom we share this wonderful creation. It surrounds us all in our Mothers' wombs before we are born; without it, life as we know it could not exist on Earth.

Framing our discussion on water around generous supplies or on scarcity misses an essential point: water is life, water deserves the same respect whether it is plentiful or scarce. We have utilized this concept of respect as a lens through which we consider our charge to facilitate the development of systems that can reduce conflict between competing uses and users as we implement long term water management programs. This respect should drive a purposeful and deliberate approach to conservation. Michigan's approach to conservation need not be based on the exigencies of immediate scarcity. We have the opportunity and responsibility to develop an integrated system of water conservation.

Our work recommends such an integrated system[1]. It is comprised of processes to set objectives for our conservation practices and policies, develop metrics that can be used to evaluate progress toward those objectives, determine data needs for measuring water use, inform and encourage conservation practices, document and assess the nature and extent of water conservation, and adaptively manage these processes to improve over time.

Successfully adopting and implementing this system depends on two key principles. First, we must consciously attend to the political, policy, and public inertia created by the perception of water abundance. While localized conflicts over water availability may temper that perception, we should not and need not wait for such conflicts to drive change. We need to literally and figuratively look far downstream.

Second, system components must be developed collaboratively. There is no one right way to design and implement each of the system components we recommend. Integrating the wisdom, values, and needs of interested parties into the development of each component will improve

[1] The key recommendations that comprise this integrated system are highlighted in **bold** text under each of the charges given to the Water Conservation workgroup.

program content and foster program implementation by affording legitimacy. Of particular concern is the nexus between energy use and its production, with the water resources upon which we rely. Millions of gallons of water are utilized in the production, transportation and use of energy. And extensive amounts of energy are used in the development and distribution of water. Any conservation plan needs to achieve a balance between protection of resources and our need for energy to power our homes and industry. We also need to recognize that conservation of water results in conservation of energy.

Data collection and analysis are important as a foundation for these systems. Identifying what data we need to fill gaps in our current knowledge base and amassing this data for analysis are key components of lessening the incidence of arbitrary and situational decisions. The goal of the Water Conservation workgroup is to create and operate an open and impartial data driven system as a foundation for achieving and maintaining the highest quality of life, while safely utilizing and protecting the shared water resources within our region and the world. The recommendations of our work are structured to systematically and iteratively grow both our data systems and conservation practices.

If we truly are to respect the water, we must respect and conserve it not only during times of shortages and crises, but also when we are surrounded by its splendid abundance. That abundance has afforded us the luxury of basing water management on the riparian doctrine of "reasonable use". Inherent in the concept of reasonable use is a responsibility for avoiding waste, for conservation. Conservation measures, regulations and laws need to be data-driven as well as based on the simple concept of respect for the water and all that it represents in our lives and societies. Together, the Great Lakes region waters make up an immense interconnected ecosystem that supports diverse wildlife, plant communities, industry and the many human endeavors that contribute to a fulfilling forward looking quality of life. We all have a responsibility to protect these resources for today and for the coming generations.

Response to Charges

1. Evaluate water use trends and make recommendations for future water conservation and efficiency activities based on projected trends (Charge WC-B).

Recommendations

WC 1.1 Michigan should improve its water use-related data management program. This includes improving the quality of current water use reporting, the capacity to track water usage, the result of conservation measures, and the development of water demand analysis for individual water use sectors. In particular, each water use sector should design the appropriate data sets in order to track water use, progress on water efficiency and conservation, and develop demand analysis. Development of these data sets must balance the need to be generally applicable to a sector or sub-sector and the ability to be tracked over time with the complexities of the circumstances faced by each particular user. The state-specific outcomes described in Recommendation WC 5.1 can inform the development of these data sets. Ideally, these data sets could be recommended for Great Lakes Basin-wide use.

Resources needed: Much of this work is on-going. It is important to note that MDARD currently has no dedicated funding for staff to run the Water Use Reporting

Program for agriculture and this will eventually have to be addressed. The implementation of the on-line water use reporting system, beginning in 2012, has and will continue to improve the ability of the State to track and generate reports on water use and conservation measures implemented, especially in the agricultural sector. With that said, improvements to just the agriculture portion of the database are necessary at this time and estimated costs for making these updates are $50,000. To initiate similar tracking capability on conservation practices in other sectors, after WC 5.1 is completed, would mean additional updates to the system at another $50,000-$60,000 minimum.

WC 1.2 Based on the water use trends, more focus needs to be placed on conservation and efficiency in the Irrigation Sector. MDARD has developed comprehensive guidance in the form of Generally Accepted Agricultural and Management Practices (GAAMPs), which includes guidance in preparing a water conservation and efficiency plan. MDARD and Michigan State University (MSU) Cooperative Extension should continue to provide and expand training and outreach to the Irrigation Sector to increase the use of these GAAMPs.

Resources needed: This is on-going. Michigan State University and Purdue Extension jointly support an irrigation educator who holds workshops for and works directly with producers in both Indiana and Michigan on a regular basis. Producers are informed on proper maintenance of irrigation systems, appropriate water use for crop needs and conservation measures, among other things. An additional FTE is recommended to augment this work and expand outreach. To cover this FTE plus the expansion in workshops and materials will be and additional $200,000 per year. To increase messaging and impact further, agriculture should be an integral part of the outreach and marketing campaign developed in WC 4.1-4.4.

WC 1.3 The DEQ should incentivize water conservation and efficiency in the public sector by rewarding the implementation of water conservation and efficiency measures when applying for State funding for water infrastructure projects. This could be accomplished by providing significant points to project plans from water systems that already have a water conservation and efficiency plan, thereby increasing the likelihood that the project will be funded.

Resources needed: The Drinking Water Revolving Fund Project Priority List (PPL) is derived from criteria identified in PA451 of 1994, and ranks projects using the following factors:

- Drinking water quality
- System reliability as outlined in Act 399
- Population
- Disadvantaged community status
- Consolidation with a regional system

The following criteria should be made explicit by adding it to the list of ranking factors: Implementing water conservation and efficiency measures in the project plan. This may require amending the criteria identified in Part 451 to add this expectation. Some staff time may be spent upfront defining what this means for applicants for inclusion in the application package and a re-design of the application form. Once implemented, however, the conservation and efficiency plans should be straight forward and should

require little in additional staff time and effort when evaluating and ranking completed project packages for selection.

WC 1.4 Michigan should also enhance programs to address the supply side of the water equation. For example, the DEQ should continue and expand programs to support development of green infrastructure and review rules and regulations associated with the beneficial reuse of wastewater/process water/storm water to promote more development in this area.

Resources needed: This recommendation would require DEQ staff time to review the beneficial reuse rules and regulations.

Findings

The existing water use data compiled by the State are of limited value in completing this charge. Unfortunately, the workgroup could not locate any alternative sources of data that are State-wide and cover all sectors. Therefore, the workgroup attempted to complete the charge with the data that were available.

The DEQ Water Use Program compiles the State annual water use data and submits it to the Great Lakes Commission. This information is stored in a database and can be accessed at https://waterusedata.glc.org/. The collection of this data has evolved over time and some sectors have better data than others. Historical data from 1998-2011 are of limited value as a whole because of the data collection issues in some of the sectors. For example, the data for the Irrigation Sector were estimated using a model from 1998 – 2004. Between 2004 and 2006, a combination of the model and reported usage was documented. After 2007, the reported usage was employed. In 2012, the power sector changed from three subsectors to four subsectors, making historical trending difficult. The data from 2012 have the best accuracy in the data set.

Another problem with this data is that they are summarized on an annual basis. See Figure 1. In reality, most Sectors will experience seasonal fluctuations in their water usage, with the summer months being the peak usage.

Despite these challenges, there are some trends that are apparent in the data.

- The Public Supply Sector has experienced a reduction in usage over the past 14 years. The workgroup examined some data from specific Michigan utilities and this trend held true. The reduction in usage is also consistent with national trends. Some of the causes of this reduction include an increased use of efficient water fixtures and appliances, improvements in metering technology, and a concerted effort on the part of businesses to reduce water usage to reduce their utility expenses.[2]

[2] An excellent description of model water conservation practices and policies focused on the Great Lakes Region can be found in "Great Lakes/St. Lawrence Water Conservation Model Policies & Measures: State/Provincial Model, Water Utility Model" by the Alliance for the Great Lakes. http://www.greatlakes.org/Document.Doc?id=939,

- The Agricultural Sector has experienced a clear expansion of water withdrawal registrations since initiation of the Michigan Water Use Program. See Figure 2.[3] There has been a corresponding increase in irrigated acres, from 467,000 in 2008 to 532,157 in 2013, a 14% increase. It is assumed that the increase in irrigated acreage has resulted in increased production of agricultural products. Improved technology has also allowed increased irrigation efficiency.

- The Industrial Sector has experienced generally steady water usage. There have been some peaks and valleys in the data, but that may be due to the data collection methodology. Based on the investigations from the workgroup, this Sector has an economic incentive to use water efficiently. It would be helpful to have data based on SIC codes to further analyze this Sector for trends.

- The Power Sector has experienced generally steady water usage, with some erratic data the past few years. Based on the investigations from the workgroup, this Sector also has an economic incentive to reduce water usage, due to the power requirement to move water. There is also a new corporate culture that is driving the efficient use of water, due to the desires of the investors.

Projecting future water use by Sector will be difficult, given the lack of detail in the data. These projections would also be of limited value without having an overall water budget for Michigan, which would provide some context to the numbers. Therefore, the workgroup focused on recommendations to increase water conservation and efficiency throughout all Sectors.

[3] The workgroup thanks Steve Miller of the Cooperative Extension Service and Jon Bartholic and Jeremiah Asher of the Institute of Water Research, both organizations of Michigan State University, for this information.

Figure 1
Michigan Consumptive Water Use by Sector

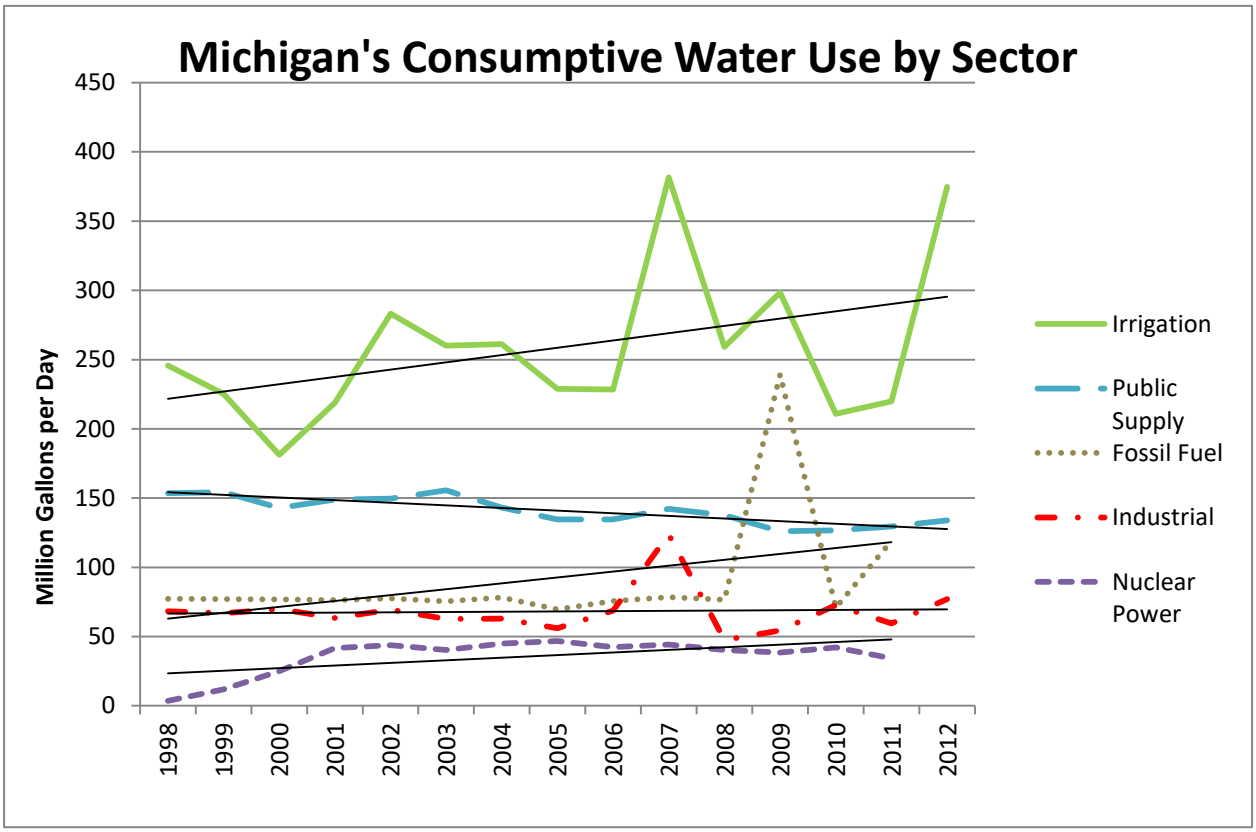
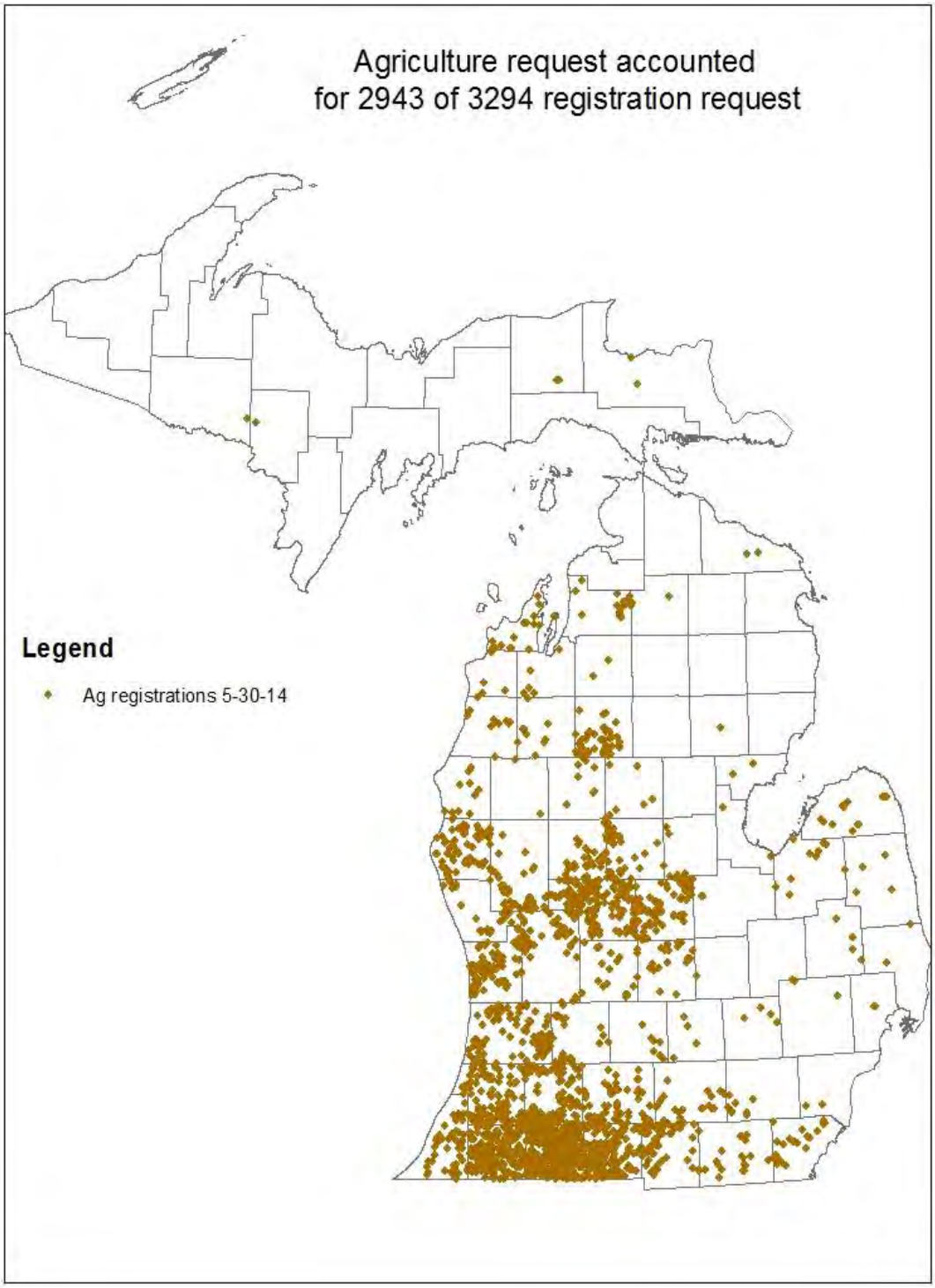


Figure 2
Water Use Registrations from 2008 to May, 2014



2. Review conservation practices in other jurisdictions and propose updates to the Michigan water conservation practices (Charge WC-C)

Recommendations

WC 2.1 The DEQ should undertake a process to update the current generic and sector-specific conservation measures. This process should include direct involvement by multi-interest stakeholder groups and broader public involvement.

Resources needed: This recommendation would require DEQ and MDARD staff time to organize the stakeholder groups and to participate in the discussion.

WC 2.2 Michigan should revise its water conservation program to: 1) further inform and encourage water conservation, and 2) assess and document the nature and extent of water conservation practiced by large water users. This program should consist of the following components:

WC 2.2a Michigan should convene a multi-interest workgroup to identify existing and new opportunities to incentivize water conservation. This effort should target all water users[4] and encourage conservation generally, the adoption of specific practices, and contribution to improved data collection.

Resources needed: This recommendation would require DEQ and MDARD staff time to organize the stakeholder group and to participate in the discussion.

WC 2.2b Among the specific practices encouraged should be a water auditing program. For public supplies, the water audit should be in conformance with the American Water Works Association (AWWA), M36 Water Audits and Loss Control Programs. Water users should be encouraged to develop a water conservation program based on the results of the audit. While each water user is able to determine the nature and extent of its conservation program, incentives should specifically encourage a component on metrics for evaluating the performance of the program and reporting of results to the DEQ or MDARD. Providing information to employees or water customers on the water user's conservation programs and policies should also be encouraged.

Resources needed: This recommendation would require DEQ and MDARD staff time to promote water conservation programs and to provide water users with the tools necessary to conduct a water audit or to prepare a plan.

WC 2.2c To facilitate the above set of activities, the DEQ and MDARD should develop, or arrange for the development of, templates for water audits and conservation plans. These instruments should be considered by the multi-interest group.

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[4] Michigan's current water use management program is essentially limited to those who directly withdraw over 100,000 gallons per day of water. However, the opportunity to consider necessary water conservation practices is not limited to those who withdraw water directly. It also applies to those who are supplied by the direct withdrawal, for example those subsidiary water supply systems and large users supplied by public water supply systems. It is also not limited to those who use large volumes.

Resources needed: This recommendation would require DEQ and MDARD staff time to promote water conservation programs and to provide water users with the tools necessary to conduct a water audit or to prepare a plan.

WC 2.2d The multi-interest workgroup should also be charged with developing a process for evaluating the results of the incentive-based system. This process should include metrics and data collection and evaluation methodologies. Ideally, metrics should be based on outcomes (e.g., volume of water conserved) rather than outputs (e.g., number of conservation practices adopted).

Resources needed: This recommendation would require DEQ and MDARD staff time to organize the stakeholder group and to participate in the discussion.

WC 2.3 Michigan should improve the administration of its current water conservation requirements. Specifically, the DEQ and MDARD should evaluate the efficacy of current requirements that farms submit conservation plans (if reporting usage to MDARD) and new registrants in Zone C self-certify compliance with generic or sector-specific conservation measures. The efficacy of these requirements should be considered with reference to the current lack of agency follow-up, the potential for and outcomes of actual enforcement of those requirements, and the opportunities provided by the incentive-based program described above.

Resources needed: This recommendation would require DEQ and MDARD staff time to evaluate the work of the stakeholder group and review the current practices described above. Since some of these practices are part of existing law, there may need to be an effort to change the existing law.

Findings

Water use management programs, including approaches to conservation practices per se, vary significantly both nationally and regionally. The primary variables considered in the workgroup's review of these programs was the regulatory threshold (i.e., whether and at what level of withdrawal a regulatory authorization was required) and whether conservation-related provisions were mandatory or voluntary.

As might be expected, the most highly regulated and conservation focused programs exist in the relatively water-poor (and prior appropriation-based) western region. Beyond that region, almost all reviewed jurisdictions in the eastern United States (based on the riparian system) and the Canadian Great Lakes provinces required governmental approval for a withdrawal above a specific threshold. With respect to conservation practices, the northeastern states tended toward mandatory provisions. That is, water users were both required to employ conservation practices and specific criteria governed the adequacy of these practices. States and provinces in the Great Lakes Region were more evenly split between mandatory- and voluntary-based conservation provisions. Minnesota, New York and Wisconsin tend toward mandatory provisions. Wisconsin, for example, requires most all large withdrawals from the Great Lakes Basin to: conduct a water audit and undertake a leak detection program, educate staff or customers about water conservation practices, and measure all sources of water. Larger volume withdrawals are also required to adopt specific conservation practices such as reducing water use for cleaning and cooling. Ohio and Indiana, on the other hand, have entirely voluntary programs. See Appendix C for a more complete summary of the water management programs in other jurisdictions.

Michigan's water conservation program is almost entirely voluntary in that it only asks most water users to merely consider water conservation practices. The only exceptions are: 1) farms must report usage either to the DEQ or MDARD; those that choose to report usage to the MDARD must include a conservation plan with that report, and 2) permit applicants and new registrants in the Water Withdrawal Assessment Process Zone C[5] must self-certify compliance with generic or sector-specific conservation measures. However, neither the DEQ nor MDARD evaluate whether or to what extent conservation plans or conservation measures are actually implemented. As a result, Michigan has virtually no understanding of the extent to which users actually consider adopting conservation practices and to what extent they are implemented.

Michigan does provide to water users both generic conservation measures developed by the DEQ and some sector-specific conservation measures developed by those sectors. Both can be found at the Water Use Program home page: http://www.mi.gov/deq/0,4561,7-135-3313_3684_45331---,00.html. Both sets of conservation measures were developed around 2007 and, to the workgroup's knowledge, have not been updated. While the DEQ invited public comment on the generic conservation practices, sector-specific practices were apparently adopted without input from non-sector parties. Significantly, the workgroup could find no information on whether and to what extent these listings of available conservation practices were actually employed by water users.

We find that sector-specific conservation practices would be improved if developed through a process similar to that used for the development of GAAMPs. That is, the list of practices is developed by experts and practitioners and then modified, as appropriate, through comment by other interested parties.

Just as described in the previous section, Water Used Trends, there is little data in Michigan to draw specific conclusions about the adoption or effect of conservation practices. However, the workgroup believes, based on our review of available literature and discussions with parties representing various water users and interests that water use efficiency is, on the whole, increasing. This results from a variety of general factors such as economic forces (including source water, energy and wastewater costs), building code updates requiring increased appliance and fixture efficiency, and a trend toward business adoption of sustainability practices.

Based on this same information, the workgroup recognizes the significance of context in planning for and implementing specific conservation measures. That is, the specific conservation measures that could be considered feasible and appropriate depend on the economic, social, and environmental circumstances of a particular user. While New York, for example, requires each user to adopt a conservation program, it recognizes that program must "consider the particular facilities and processes involved, taking into account the environmental impact, age of equipment and facilities involved, the processes employed, energy impacts, and other appropriate factors."

Michigan's water conservation program could be improved through a model that avoids waste and increases water user understanding of their water use practices (an audit component), purposeful consideration and implementation of conservation practices without mandating specific conservation practices (retaining the water user's ability to adopt a conservation program appropriate to their circumstances), and an adaptive management approach (a

[5] See Section 324.32701(vv) of the Natural Resources and Environmental Protection Act, 1994 PA 451 as amended

concerted effort to evaluate, document and learn from how Michigan uses and conserves water).

Wisconsin has adopted such a program, requiring that all large water users conduct audits, develop and implement conservation plans, and provide conservation information to employees or water supply customers. Wisconsin's experience could provide useful information on the content and practice of a similar program in Michigan. However, the workgroup is not comfortable recommending a mandatory program for Michigan. Instead, the workgroup believes that: 1) incentives can be used to encourage such practices, and 2) transition to a mandatory program is available over time if evaluation of the incentive-based program and the totality of water management circumstances support it.

Ideally incentives should be developed for all water use sectors. To this point, the workgroup has identified some incentives that could be developed to encourage water conservation include in the industrial and water supply sectors:

- Qualification for Michigan's Clean Corporate Citizen program
- Award extra points to Water Systems with Conservation/Efficiency Plans in place when applying to the State Drinking Water Revolving Fund.
- Requiring reliability studies to review/comment on Conservation/Efficiency Plans
- Providing a grant program to help municipalities develop a Conservation/Efficiency Plan

3. Identify and evaluate existing metrics for water conservation and use efficiency and recommend metrics for Michigan's program. (Charge WC-D)

Recommendations

WC 3.1 The Alliance for Water Efficiency Scorecard provides some valuable information on different tools available for addressing water efficiency and conservation in the municipal sector. However, it is not a good metric to evaluate Michigan's Water Use Program overall or the municipal sector of Michigan's Water Use Program in particular. The workgroup does not recommend its use as a metric.

WC 3.2 Michigan should develop Water Use Program metrics based on state-specific Water Conservation Program Goals and Objectives, which are recommended for development in WC 5.

Resources needed: This recommendation will require DEQ and MDARD staff time to develop metrics.

WC 3.3 Beyond metrics based on state-specific goals and objective, Michigan should encourage the development of regional metrics tied to the Regional Goals and Objectives developed by the Great Lakes Compact Commission.

Resources needed: This recommendation will require DEQ and MDARD staff time to lobby the partners in the Great Lakes Compact for new regional objectives.

Findings

Metrics, or standards of measurement, are critical to evaluating program and project progress. Water conservation and use efficiency program evaluation can use metrics as succinct as Ontario's Schedule 1 – Implementation of Water Conservation in accordance with Best Management Practices and Standards for the Relevant Sector which is submitted with all applications for Permit to Take Water. (See https://dr6j45jk9xcmk.cloudfront.net/documents/931/3-4-3-form-water-measure-conservation-en.pdf). The schedule refers to three entities which publish best management practices, Ontario Water Works Association (Municipal sector), Ontario Ministry of Agriculture (Fact Sheets and Guides) (agriculture), and other sector associations. The applicant is instructed to indicate what conservation measures and practices are currently implemented or will be implemented, and to "State your goals for reducing the use, loss or waste of water or for increasing the efficiency of water use (e.g. litres per day per unit of production or litres per day per capita for the residential sector)".

Developing metrics requires understanding functions and processes in order to determine the need for and use of water. For example, the Council of Great Lakes Industries has developed a tool that industries in this region can use to evaluate their water use practices and policies. (See "A Water Stewardship Tool for Great Lakes Industries" 2014. CGLI, LimnoTech, NCASI, and nicholas-h2o). Metrics may also be considered for indirect effects, e.g., reduction of water use ensures against stream flow reductions and protects fisheries in stressed watersheds. In many cases the indirect effects pertain to larger goals, while direct effect metrics pertain to objectives supporting the goals.

It is difficult to develop meaningful metrics for Michigan's current Water Use Program. Michigan's program goals and objectives are sufficiently general that any attempt to derive metrics will necessarily be reduced to a conversation of "what are we really trying to accomplish?" That is, what are our specific goals and objectives? Accordingly, Michigan should first develop specific goals and objectives (as described in Recommendation WC 5.1) and then determine the appropriate metrics to evaluate progress.

The Alliance for Water Efficiency (AWE) conducted a national survey in 2009 to identify and assess state-level water efficiency and conservation laws and policies. This 11-question survey was expanded to 20 questions in 2011 and was the basis for the Scorecard. The questions asked and the responses gathered provide some valuable information on how different regions of the United States are handling some aspects of water efficiency and conservation. However, the conversion of these 20 questions into a letter grade does not provide a sufficient value as a metric for Michigan for the following reasons:

a. The AWE is programmatically focused on the municipal water supply sector, as is the Scorecard itself. Because the Scorecard does not address other sectors, it necessarily presents an incomplete picture of a water use program.

b. The Scorecard uses uniform criteria for evaluation across the country. However, different regions of the country have different needs and challenges with respect to water conservation and efficiency. While specific conservation measures may be necessary and appropriate in the context of one region, they may not be in another.

c. The Scorecard survey questions were each given points and states were graded on their response to each of these questions. There was no evaluation of the cost/benefit of whether or not a particular regulation or policy had an overall positive impact on water efficiency or conservation given all considerations.

d. The Scorecard evaluates and scores equally provisions at both the program level (e.g., does the state require conservation activities as part of its water permitting process or water right permit?) and activity level (does the state have a water consumption regulation for toilets that is more stringent than the federal standard?). This creates the potential for inaccurate scoring since a state with an otherwise strong program may be significantly downgraded because it does not address those specific activities that AWE chose to score.

e. While AWE should be complimented for the rigor of its survey and follow-up, the scope and complexity of the effort necessarily involves error. For example, evapotranspiration microclimate information is very important to irrigators in the arid Southwest. This information is not as important in Michigan. However, even though Michigan was judged to not qualify under this criteria, evapotranspiration for Michigan is provided by MSU Extension.

4. Public outreach and education approaches (Charge WC-E)

Recommendations

WC 4.1 Michigan should coordinate a statewide campaign and marketing effort to encourage water conservation action, or wise water use, across water use sectors and among individuals.

Resources needed: This recommendation will require the MDARD and the DEQ to work jointly to compile water conservation policies, procedures and best practices across all industries as well as for the general public. They should partner to create a one stop shop website where this information can be easily accessed and used by specific industries in order to better educate their members. This would require DEQ and MDARD staff time to compile and organize the data and to build a website and maintain it. This would also likely require additional FTE(s) in one or both Departments. To cover the additional staff time, FTE(s), and the development and maintenance of a website an additional $750,000 would be needed.

WC 4.2 Michigan should invest in hiring a marketing firm to conduct the necessary research to develop a common theme (similar to “Pure Michigan”) and consistent message appropriate to target audiences upon which sectors can build actionable messages appropriate to their client base/members.

Resources needed: This recommendation will require MDARD and the DEQ to work jointly on a multi-year marketing project that will see them work with a third-party marketing or advertising agency. While the cost for this type of project can vary widely, it is estimated that roughly $1.6 million per year will be sufficient to create a statewide “buzz” around the issue of water conservation as well as sector specific messages. It is our recommendation that this initially be a multiple year project with the goal in mind to find a stable, long term funding source so that it can remain permanently. A recent example of a similar project can be found within the Michigan Department of Natural Resources with the newly created Michigan Wildlife Council. This council has similar goals, albeit a different industry, and can serve as a model for this recommendation.

WC 4.3 Michigan should tap into and partner with successful local sector and non-profit campaigns for examples of creative and effective messaging regarding responsible water use.

Resources needed: This will require DEQ and MDARD staff time to work on partnerships.

Findings

Michigan is perceived as a water resource rich state. It will be hard to get people to realize that water conservation is truly important. How do you motivate change – in this case, concrete actions that reduce or conserve water use both individually and by sector – without impetus to do so?

In Canada and Florida, similarly perceived as "water rich" regions, it is recognized that this perception "masks other realities regarding the ready availability of these resources for human use". *(The link provided was broken and has been removed.)*

In Michigan, one of these realities is that its greatest time of water need, the summer growing season, also tends to be its time of seasonal water deficit. The result can be regional areas of conflict between groundwater and surface water uses that impact agriculture, recreation and the ecosystems that rely on them.

Successful water conservation programs and initiatives are founded upon informed decision-making with respect to problem identification, goals, objectives, available alternatives and expected benefits. They also incorporate a good understanding of water conservation's important linkages to other sustainable development initiatives (ex. Energy use/ Greenhouse gas reductions)

Effective conservation communications are not a single initiative but rather a portfolio of often interrelated but independently operated programs targeting specific behaviors and market segments. Conservation outreach efforts should focus on bridging the gap between thought and action to induce behaviors.

A coordinated campaign allows the opportunity to present a clear, consistent, conservation message throughout the state. Having water suppliers and different water use sectors speak with one voice or common message will reduce public confusion and heighten public interest in wise water use.

Most environmental awareness programs rely on traditional education and communication with limited success. Examples are seeking free media coverage, producing public service announcements (PSAs), giving presentations to community groups, hosting seminars, etc. These methods are successful in reaching a certain segment of the population but they are not enough to reach the majority of people to convince them of their role in the big picture.

Long used in the public health sector, many successful environmental campaigns have turned to Social Marketing to propel water conservation, and other behavior, into action. It is a marketing technique that combines commercial marketing practices with social change and communication to change targeted behaviors. Part of the goal of a social marketing project is to benefit the selected target audience, not just the marketer or proponent for the environment.

Florida and Arizona felt that this type of broad-based communication was needed to educate, motivate and change public behavior regarding water conservation. Marketing firms were hired to do research on their populations and to develop multi-media campaigns based on their findings. Arizona's successful "Water Use It Wisely Campaign" conducted studies prior to their marketing campaign effort. They found consistently that citizens were saying "Don't tell us to save water. Show us how to save". Based on this finding they catalogued 100 simple water-saving devices and/or actions and highlighted the number one water saving device as the consumer him/herself. The messages were simple. People found they could choose what they were able to do or afford to make a positive personal contribution to water conservation.

Many agencies are nevertheless reluctant to invest in quantitative research because of perceived cost. Research, however, generally represents less than 10% of communications-related expenditures and pays for itself by optimizing communications tactics. Successful campaigns found that it is better to invest in information first than to discover after expending a full budget whether or not the outreach assumptions are true.

Similarly, a study conducted with seven utilities across the U.S and Canada found that water use patterns differ by region and customer, but the end uses (toilet flushing, bathing, washing clothes, food preparation/processing, landscape/agricultural irrigation, etc.) remain consistent across. As such, the conservation behaviors promoted by water utilities are often similar (e.g., replacing inefficient toilets and faucets, improving irrigation efficiency, turning off water to brush one's teeth). The key differences were the delivery channels and messages by which utilities chose to promote water conservation and the response to those messages. The study found, among many other things, that:

- Residential water customers view those persons or organizations with a financial interest in either water equipment or plumbing or commerce as being less credible on matters of water conservation than those who do not have such an interest.

- A broad multi-modal communication approach to conservation messaging may be more effective in the long run than short sharply focused messages.

- Increase in the message "dosage" (frequency of being heard or read, different than frequency of being said or shown) is inversely proportional to water use: the more the dosage, the less the water use.

This last point is particularly important. In developing Florida's "Water Use It Wisely" campaign, Jeff Hoffman of the Hoffman Agency, a public relations firm in Jacksonville, FL offered this consideration: "The secret in all advertising is repetition…It takes at least three exposures to recognize it and seven to own it." (See Jesperson, Kathy. "There's an easier way to save water - Accentuate the Positive: How Social Marketing Makes a Difference". *On Tap*. Fall 2005, Volume 5, Issue 3. National Environmental Services Center. p. 20.
(The link provided was broken and has been removed.)

If Michigan is to take the wise use of its water resources seriously it must be willing to invest that message fully and over the long haul.

5. Public comments on Michigan's Water Conservation and Efficiency Program[6] (Charge WC-F)

Background
Under the Great Lakes Compact, a state's "water conservation and efficiency program" includes elements beyond those embodied in the traditional notion of conservation of use. These include, for example, the goals and objectives of the "program," systems for evaluating water use against ecological objectives (e.g., Michigan's water withdrawal assessment process), monitoring, and support of technological development. See Michigan 2012 Water Conservation and Efficiency Annual Program Review at:
(The link provided was broken and has been removed.)

In August, 2013, the Water Conservation workgroup recommended to the Water Use Advisory Council the responsibilities of each workgroup for addressing each comment within their area of expertise and a process for comprehensive consideration of all proposed responses. The Advisory Council discussed this recommendation at its August 22, 2013, meeting and decided that the issues raised in public comment were, for the most part, embodied in the charges to workgroups. As a result, the proposed responses to these comments would be contained within the Advisory Council's final report. Each workgroup was cautioned, however, to compare its work against the public comments and address individually any comments not otherwise covered by its work.

Recommendation
The workgroup has identified three major public comments that are not otherwise addressed by this report. These comments, recommended responses, and the rationale for that response are as follows:

WC 5.1 Comment: **Michigan should adopt state-specific goals and objectives for its Water Conservation and Efficiency Program.**

Proposed response: Michigan agrees with this comment and will convene a multi-stakeholder process to propose state-specific goals and objectives and make those goals and objectives available for public comment before adoption.

Rationale: The Water Conservation and Efficiency Goals and Objectives submitted by Michigan to the Regional Body on December 8, 2010 substantially reiterated the Regional Body's goals and objectives, developed in 2008. The regional goals and objectives were general, designed to be adapted by states to reflect each state's specifics of water use and priorities. Michigan's adoption of those regional goals and objectives reflects that generality. Adoption of more specific goals and objectives will help guide the development and implementation of Michigan's Water Use Program. For example, the development of specific water objectives for water conservation would inform the adoption of related metrics, programs to encourage meeting those objectives, evaluation of those programs, and program improvement.[7]

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[6] This section is formatted differently from others in this report because of the need to provide context to the charge as a whole and background within the body of each recommended response.
[7] See, for example, Wisconsin's program goals and objectives at
dnr.wi.gov/topic/wateruse/documents/wdnr_statewide_wce_objectives_2011.pdf - 14k - 2011-08-30

In sum, state-specific goals and objectives will create a transparent set of benchmarks to guide Michigan's annual assessment of its conservation and efficiency programs and help measure progress in achieving the five regional goals. Developing state-specific goals and objectives through a multi-stakeholder process and public comment ensures the result will reflect the broadest possible set of interests and thus will facilitate successful implementation.

Resources needed: This recommendation would require DEQ and MDARD staff time to organize the stakeholder group and to participate in the discussion.

WC 5.2 Comment: Michigan should be doing more to manage water resources on the basis of long-term sustainability, including consideration of climate change.

Proposed response: We agree that long-term sustainability should be the overall goal of the water conservation and efficiency program. In fact, the convening of the Water Use Advisory Council was a specific step in that direction. The work of the Council will outline further measures to improve decision-making under the water withdrawal assessment process as well as furthering water conservation. Michigan will also develop state-specific water conservation and efficiency program goals and objectives through a public process. Developing state-specific goals and objectives will further guide program implementation, assessment, and improvement. The impacts of climate variation and climate change will be considered in this process. The range of historic climate variation is represented in meteorological records and the records of corresponding Great Lakes levels. Approximations of prehistoric climates and corresponding Great Lakes water levels can also be found in the U.S Geological Survey's Circular 1311 (http://pubs.usgs.gov/circ/2007/1311/). There are also regional and global climate models developed to predict the sign and magnitude of climate change, but to date, these models do not mesh well with current and historic climatic data for the Great Lakes. (International Upper Great Lakes Study: Lake Superior Regulation: Addressing Uncertainty in Upper Great Lakes Water Levels. Final Report to the International Joint Commission. March 2012). This report can be found at: *The link provided is no longer valid. This online document was revised 2/11/2019*. See especially Chapter 4 Hydroclimatic Conditions: Past, Present, and Future.

The IJC's Upper Great Lakes Study cited above reviewed both historic lake level variability and the chief Global Climate Change and Regional Climate Change models. They concluded that all existing regional and global models being used to predict Great Lakes water levels were deficient in that they did not include the recapture of evaporating surface water in the Great Lakes basin and thus overestimated the amount of variability. The models were also found to lack certain essential data that will require additional sampling on an enhanced monitoring grid to provide the data for climatic analysis. The scientists in this IJC-commissioned study recommended that current data on historic climate variability be used as a basis for Great Lakes water level management and related activities for the next 30 years, all the while improving climate prediction models and gathering additional monitoring data to inform these models. In parallel, that the body of historic climate variability data be used to inform infrastructure and treatment system design over the next 30 years and that Michigan and other states in the Great Lakes Compact should support efforts of the IJC to strengthen both regional and global climate models and to create an enhanced monitoring network to supply data to the models. Enhanced climate models are needed to inform long-term adaptive strategies and may also be necessary to modify the stated recommendation toward the end of the 30 year period. The development of enhanced climate models is critical to assuring the development of an adaptive strategy for addressing climate variability and climate change and for cost-effective water infrastructure and treatment design in an uncertain future.

Rationale: The overall work of the Advisory Council recognizes the need for an on-going effort to improve many aspects of Michigan's Water Use Program. The nature of this need is reflected in the topic areas of the workgroups: data collection and management, the technical aspects of the water withdrawal assessment process, water conservation per se, and community involvement. Michigan's Water Use Program is already based on a sustainability model and explicit recognition and refinement of this approach will benefit all of Michigan's citizens. There are uncertainties associated with the precise impact of climate change in Michigan, but these uncertainties should not diminish the need to recognize that impacts will continue to occur. The best way to address these uncertainties in the near term is to work collaboratively with organizations like the IJC to share and promote the science necessary to develop the adaptive management tools needed to assure a sustainable response to climate variability and climate change. Michigan should also actively support the development of these tools and should affirmatively incorporate these tools in a manner that will allow their adoption by both the public and private sectors.

With respect to adaptive management, we note the importance under the Great Lakes-St. Lawrence River Basin Water Resources Compact of monitoring as a component of this approach. (Great Lakes - St. Lawrence River Water Resources Regional Body and Great Lakes - St. Lawrence River Basin Water Resources Council, "Cumulative Impact Assessment of Withdrawals, Consumptive Uses and Diversions, 2006 - 2010, p. 36). Michigan's response to climate variation and climate change at this point will only be adequate if it includes a monitoring program that is designed, funded, and implemented to support the concept and practice of adaptive management.

Resources needed: This recommendation will require the DEQ and MDARD to become familiar with and promote with sustainability practices.

WC 5.3 Comment: Michigan should include current users in programs encouraging adoption of water conservation measures.

Proposed response: We agree that all water users in Michigan--both current and future--share a responsibility to adopt water conservation measures so that Michigan can always have a sustainable water supply to support economic, social and ecological needs. The Department of Environmental Quality will, therefore, pursue programs and policies that are designed to encourage additional water conservation activities by all users.

Rationale: Michigan's riparian system of water law is founded on the basis of "reasonable use." We believe inherent in the concept of reasonable use is a responsibility for conservation shared by all users. Simply: Waste, which could also be viewed as the failure to properly conserve, should not be considered "reasonable." We recognize that what is considered proper conservation is an emerging concept as circumstances and understanding change. Nonetheless, no class of users should be vested-- in the sense of being exempted from this responsibility. Accordingly, approaches to encouraging conservation should apply equally to current and future users.

Resources needed: This recommendation will require DEQ and MDARD staff time to develop the message and to contact and deliver to all current users.

6. Periodic assessment and adjustment process for conservation measures (Charge WC-G)

Recommendation

WC 6.1 This Report, as well as the other work of the Water Use Advisory Council contains a variety of recommendations for updating Michigan's water conservation program. When the program has been updated, a periodic evaluation of the program must take place to ensure its effectiveness and plan for improvement.

Resources needed: This recommendation will require DEQ and MDARD staff time to conduct periodic evaluations of the program.

WC 6.2 A full program assessment and update should take place every five years, using data compiled from measurable objectives that have been established for each of the program components. This data should be gathered on an annual basis where applicable.

Resources needed: This recommendation will require DEQ and MDARD staff time to conduct periodic evaluations of the program.

Findings

The work of the Water Use Advisory Council is essentially the first systematic assessment and adjustment of Michigan Water Use Program since its inception in 2008. As such, it will result in recommendations that will, to the extent they are adopted and implemented, result in a revised program (both structure and public/private behavior) with a corresponding effect on the Michigan's water resources. The pragmatic public policy concept of pursuing on-going improvement is best served by a systematic approach to evaluation and response.

The recommendations of this Report are specifically targeted at facilitating that evaluation. That is, it recommends an integrated system based upon desired outcomes (state-specific goals and objectives as described in Recommendation WC 5.1), agreed-upon metrics (as described in Recommendation WC 3.2), and the necessary data (water use trends as described in Recommendation WC 1.1 and conservation practices and results as described in Recommendation WC 2.3).

Until the State has developed goals and objectives for the program, specific metrics cannot be established. However, examples of the types of objectives and corresponding metrics that cascade back to the program goals are shown in Table WC-1 as follows:

Table WC-1

Goal	Objective	Measure
Update conservation measures	Involve Stakeholders	Identify groups
		Number groups contacted
		Number of groups participated
	Gain Public input	Creation of an online survey
		Website creation
		Number of survey responses, website hits
		Amount of individuals submitting comments to measures
Update Water Conservation program	Further inform and encourage water conservation	Template created for water audit
		Leak detection program template created
		Sample conservation plans created
	Assess and document the nature and extent of water conservation practiced by large water users.	Number of water audits completed
		Number of required leak detection programs completed
		Annual customer outreach reports

Once state-specific goals and objectives are developed, corresponding detailed metrics like those outlined in the example can be developed.

Periodic program evaluation should be done with involvement from stakeholders and the public. This evaluation is best accomplished by the State with support and involvement by the ongoing existence and active work of a multi-interest stakeholder group that is similar in composition and mission as the Water Use Advisory Council. Bringing different perspectives into these discussions will increase both the quality of the result and the acceptance of it by the affected interests.

7. Other Recommendations (Charge WC-I)

Recommendation

WC 7.1 Pursuant to the terms of the Tribal State Water Accord, Michigan should consult twice yearly with the Tribal Governments in the state to share respective progress on individual and joint efforts to manage Michigan's water resources in furtherance of

shared interests in protecting and preserving the Great Lakes basin waters. The discussion should specifically address the coordination of Michigan's accounting-based water management program and tribal water management programs.

Resources needed: This recommendation will require DEQ and/or MDARD staff time to attend bi-annual meetings with the Tribal Governments, to prepare for the meetings and to follow up on items discussed at the meetings.

Findings
Michigan is the home of 12 Federally Recognized Tribal governments all of which have reservation and/or trust land (land that is held by the Federal Government in trust for the respective governments).

Tribes have spent considerable time working with the eight Great Lakes States and the two Canadian Provinces on the language for the Interstate Compact and the International Agreement that is the underlying foundation for Michigan's water management program and the whole process for protecting and preserving the waters of the Great Lakes. The Tribal Governments and the Tribes they represent have fundamental beliefs of their sacred duty to protect Mother Earth and the waters upon and within her. In order to fulfill these duties Tribes must work with each other and with the other sovereigns in the Great Lakes Region.

On May 12, 2004, the State of Michigan and the 12 Tribes signed the Tribal State Water Accord as a way of acknowledging the jurisdictional issues and laying out a framework for working with each other on issues of common concern regarding the shared water resources.

Sequencing

The Water Conservation workgroup prepared the following flow charts to illustrate the sequencing of all of the recommendations. The tasks were broken into five distinct areas; Establish State Goals & Objectives, Encourage Conservation & Efficiency Actions, Convene Multi-Sector Groups, Public Outreach and Data Collection & Maintenance.

<u>Establish State Goals & Objectives:</u> The first task is WC 5.1, convene a workgroup to develop State-specific goals and objectives. After this work is complete, recommendations WC 3.2, WC 3.3, WC 5.2 and WC 5.3 could be developed and implemented concurrently.

<u>Encourage Conservation & Efficiency Actions:</u> Recommendations WC 1.1, WC 1.2, and WC 1.3 could be developed and implemented immediately and do not require sequencing.

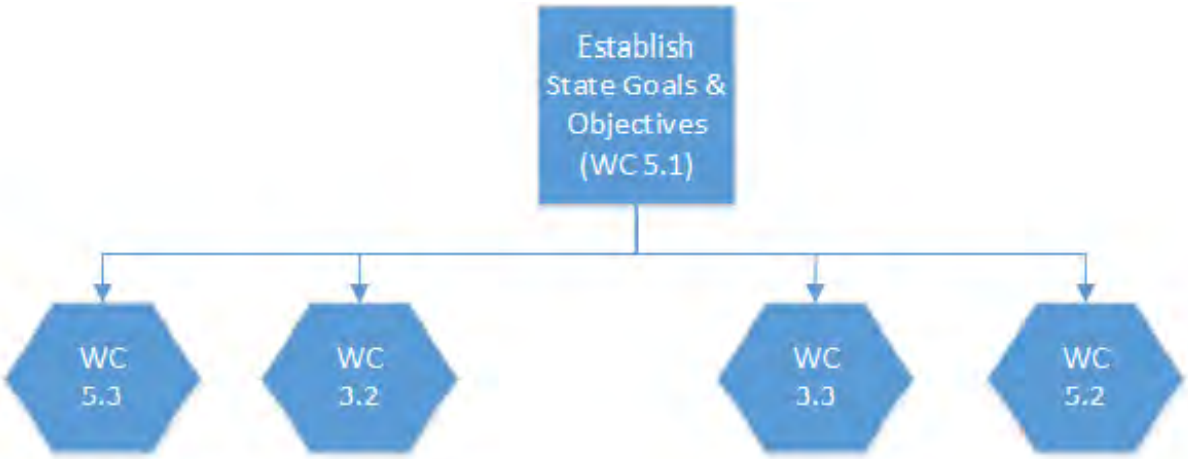
<u>Convene Multi-Sector Groups:</u> Recommendation WC 2.2a, would be the first step in this area. The workgroups would work on recommendations WC 2.1, WC 2.2b, WC 2.2c, WC 2.2d, and WC 2.3. The outcome would be recommendation WC 2.2.

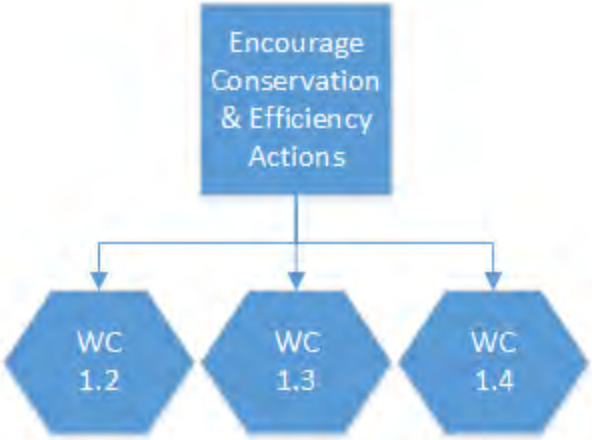
<u>Public Outreach:</u> Recommendation WC 4.1 should precede WC 4.2 and WC 4.3.

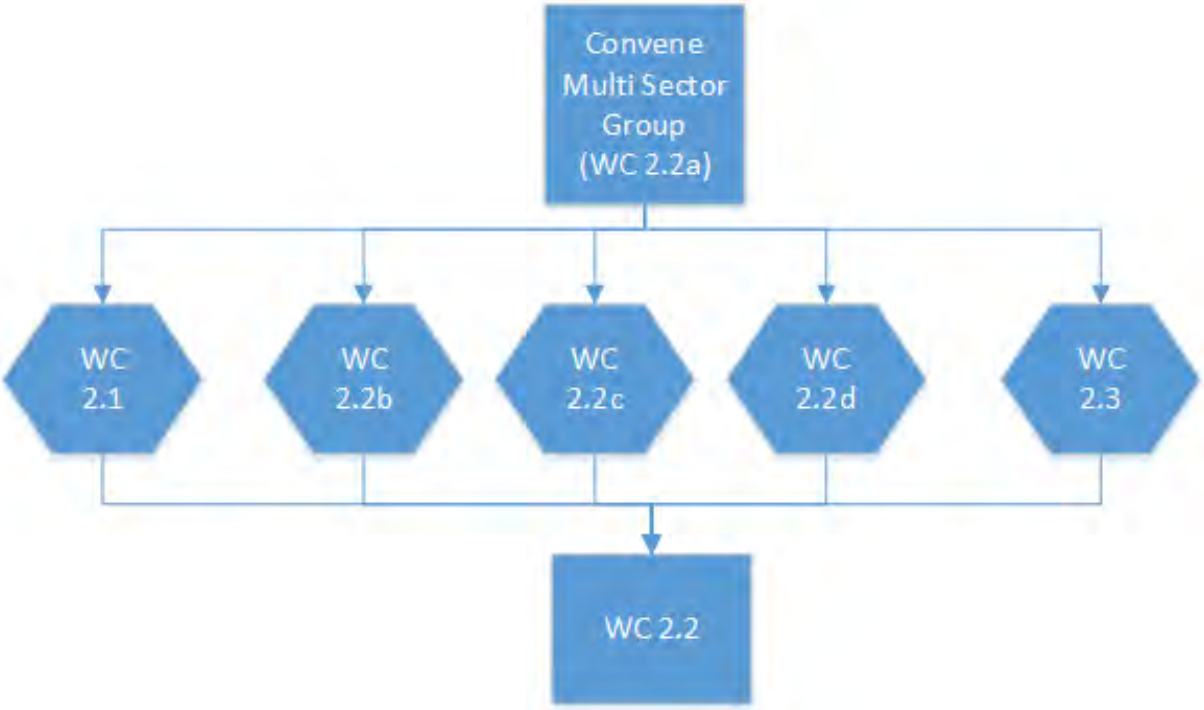
<u>Data Collection & Maintenance:</u> Recommendation WC 1.1 should precede WC 6.1, WC 6.2 and WC 7.1.

Each of these areas could be started simultaneously. However, it may be beneficial to establish the State Goals and Objectives first, as this may help to influence the other areas. When a specific area is started,

These recommendations do not have a relationship with any of the other workgroup recommendations.



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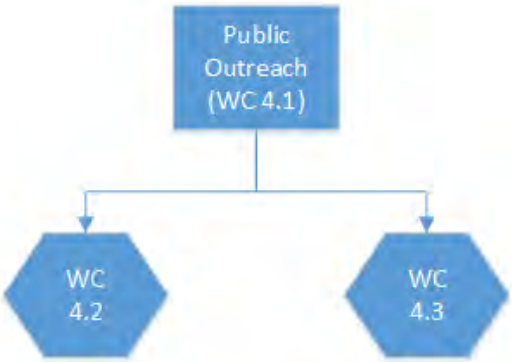
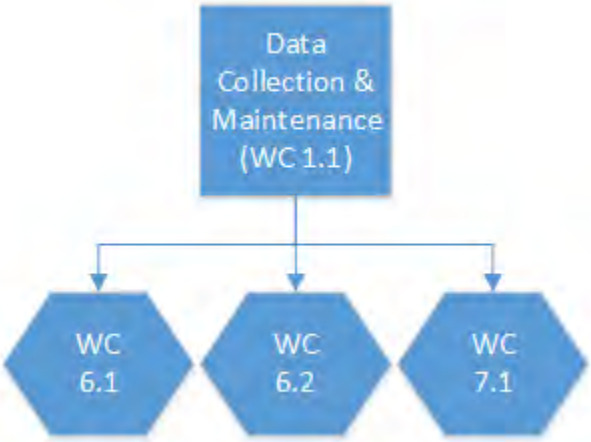
WC 2.1
WC 2.2b
WC 2.2c
WC 2.2d
WC 2.3
WC 2.2


Public Outreach (WC 4.1)
WC 4.2
WC 4.3


Data Collection & Maintenance (WC 1.1)
WC 6.1
WC 6.2
WC 7.1

PREVENTING ADVERSE RESOURCE IMPACTS IN INLAND LAKES AND PONDS

1. Quality Assurance and Control Protocols for Collecting Lake Level and Bathymetry Data

Charges IL-B, IL-C

Issue
Large quantity direct water withdrawals from lakes may have the potential to lower water levels to the point where portions of the lake bed become dry, or the water becomes shallow enough to alter vegetation growth, impede recreational uses, etc. Michigan lakes vary widely in their bathymetry (the form of the lake bottom), which determines their susceptibility to such changes with a decrease in water levels. Lakes also vary in their natural range of fluctuation in water levels, which must be understood to determine how water withdrawal may be contributing to an observed drop in water levels. Additional data needs to be collected on seasonal and interannual fluctuations in lake levels and on bathymetry of inland lakes to classify the level of risk for an ARI that the lake may experience due to a proposed direct withdrawal, and this data collection could be performed by non-agency persons (e.g., citizen monitoring programs). However, in order to build a data set that will be useful in state-wide classification of lakes as well as information on the ARI risk of specific lakes, such data need to be collected and maintained according to standards agreed upon by the DEQ and DNR.

Background
The Inland Lakes workgroup has received reports from the DEQ, DNR, USGS, MSU, and associates of the Michigan Inland Lakes Partnership in its efforts to determine the existing body of knowledge on the size, location, groundwater-surface water ratio of water sources, and bathymetry of Michigan's 65,000 lakes. Our information gathering from these agencies has revealed that bathymetric data exist for only approximately 2,700 lakes. Additionally, a high percentage of the lakes for which bathymetric data exist are large and medium sized, deep lakes with established fisheries or recreational uses. The mapped lakes are not representative of the range of lakes throughout Michigan, many of which may be small and shallow.
DNR review of mapped lakes with known mean depths has shown that mean depth correlates well with the projected loss of shallow (littoral) zone from a hypothetical water withdrawal. Bathymetric data collection in a lake gives the user more exact depth information about that lake and its percentage of shallow (littoral) zone. Being able to approximate or know exactly the amount of shallow (littoral zone) water in a lake can help the DEQ and DNR staff assess the risk of an ARI due to direct large quantity withdrawals.

MSU research indicates that lakes demonstrate a wide variation in how much their natural levels vary seasonally and over time. A relationship may exist between landscape position, relative contribution of groundwater versus surface water, and the degree of variability in lake level. Modeling work to identify the degree of lake level variability statewide has not been completed.

Further examination of state agency lake data collection revealed that no programs or protocols address systematic or statewide collection of lake level data. Over 300 lakes across the state have legally set lake levels established through a variety of court decisions and/or ordinances, and maintained by methods such as inflow or outflow control structures, augmentation wells, or

other means. Other lakes in the State also contain lake level control structures but may not have formally established legal lake levels.

No central repository of lake level data or monitoring results exist at the state level either, so the workgroup sent surveys to lake associations, drain commissioners, and other points of contact for lakes with and without legally set levels to collect any information available on those organizations' efforts to monitor lake levels over time. Results from the survey are being collected and analyzed, and will provide some useful information on procedures, protocols, frequency, and other information about lake level data collection and maintenance. Additionally, data collected on lakes without legally established levels may provide some useful information related to MSU's research on how landscape position may influence lake level variability.

As the workgroup progresses toward classifying lakes by risk for an ARI due to large quantity direct withdrawals, key information needed on inland lakes includes, at minimum, variation in lake levels over time, mean depths of the lakes, and preferably bathymetric data to generate hypsographic curves across a variety of lakes throughout the state. This information will help the DEQ and DNR determine patterns of lake level change and lakes' percentage of shallow (littoral) zone waters, to help assess which lakes might be most severely affected by a large quantity withdrawal. Data collection will be needed for any lakes subject to any direct withdrawal request, especially at locations where small lakes may be most vulnerable to water withdrawal. These data, once collected, can be applied to GIS layers maintained by the DEQ and DNR to aid staff in their decision making process if requests for direct withdrawals are made from inland lakes.

Discussion

IL 1.1 The DEQ should review, and work with DNR, on the development of protocols and procedures for collecting bathymetric data so that data collected under these standards can be used to develop inland lake and pond maps that include information about lake and pond depth and volume. The Departments should publish and make available to the public these protocols and standards so that non-agency persons can participate in bathymetric data collection for inland lakes and ponds.

Lake water level monitoring entails the installation of staff gauges that can be read manually by lake residents at a sufficient frequency to capture major patterns (weekly during the ice-free season is typically sufficient). Such gauges must be surveyed to a secure upland reference marker and checked annually to ensure that the gauge has not shifted vertically (this can happen during ice cover). Ideally the gauge datum would be surveyed to determine its absolute elevation (i.e., feet above sea level). Lakes with large fluctuations may need gauges in two locations to allow for convenient reading as the shoreline shifts.

Bathymetric data are normally collected using sonar surveys. Mapping only needs to be done once, ideally at the high end of the range in water levels, but should be referenced to the level on the staff gauge. Shallow waters may need to be mapped with better depth resolution than normal. In 2014, DNR Fisheries Division will begin to develop procedures for collecting bathymetry data and developing distribution copies of inland lake maps. The DNR will develop guidelines for hardware and software options as well as the sampling density, frequency, and spatial distribution required to produce quality maps. This standardization effort will ensure that lake depth

information is collected, processed, and distributed in a scientifically sound and cost-effective manner. This will allow both agency and non-agency persons to conduct data collection under an accepted standard, to provide usable data for the DEQ and DNR decision making and to allow for greater opportunities to collect such data throughout the state.

Resources needed: Staff from the DNR are developing a new protocol for consistent collection of lake morphology data. Existing DNR protocols for lake bathymetric mapping are based on out-of-date technology that does not incorporate the latest electronic sonar units and mapping programs, which are relatively inexpensive ($550 for a Lowrance sonar unit & $2,400 per year for unlimited mapping for private groups) and available to the general public. A lake mapping approach that is designed for citizens is described at *(The link provided was broken and has been removed)* and may be appropriate here.

The DNR and DEQ should work together and adopt common protocols for agency staff and also develop a procedure that specifies the level of survey effort necessary for use of citizen-generated data and maps by the agencies as well as the public. The use of data collected by the public or other organizations will necessitate quality control review by either DEQ or DNR staff, or MiCorps. The task will take at least a year to accomplish.

The DNR will begin utilizing the new mapping technology on a limited scale beginning in 2015 and the DEQ will explore the feasibility of adopting the protocols and procedures, procuring the necessary equipment and prioritizing the task relative to other monitoring activities. Both agencies annually survey inland lakes for status and trend monitoring as well as targeted monitoring for various reasons, and frequently lake bathymetric maps are not available. These mapping efforts by the DNR and DEQ will be conducted in conjunction with other activities and require additional staff time, but the information gained is viewed as critical by both agencies.

An effort by the DNR or DEQ staff to specifically target lakes that have been identified as vulnerable to medium or high risk ARIs and produce bathymetric maps would require additional staff, unless the mapping could be accomplished by citizens.

Relationship to other recommendations: This recommendation needs to be implemented before IL 2.2b and 2.2c.

IL 1.2 The DEQ should develop training modules through such means as its existing MiCorps program and crowd hydrology projects to encourage citizen participation in lake and pond water level data collection, and ensure that data collection is conducted according to protocols agreed upon by the DNR and DEQ for both documenting changes in water levels over time as well as to create bathymetric maps from which mean depth and hypsographic curves can be derived.

The Michigan Clean Water Corps (MiCorps) was created by Executive Order to assist the DEQ in collecting and sharing water quality data for use in water resources management and protection programs. MiCorps builds upon existing volunteer monitoring programs established by the DEQ, including the Cooperative Lakes Monitoring Program. Training offered by the DEQ to groups interested in lake monitoring should be supplemented to include training on collecting lake level and/or

bathymetric data to supplement DEQ and DNR data collection efforts. Availability and use of data collected by volunteer monitoring groups should follow protocols similar to those currently in use by other volunteer monitoring programs and should be clearly communicated to the volunteers and to the public.

Resources needed: The proposed lake data collection could begin in 2016 and be conducted through a combination of volunteer (private) efforts of lake associations or individual property owners and non-governmental organizations (e.g., watershed councils, Michigan Lake and Stream Associations). Oversight and assistance could be provided by the MiCorps Cooperative Lakes Monitoring Program (https://micorps.net/lake-monitoring/), which already has the staffing, experience, and network of volunteers conducting water quality monitoring at numerous lakes across the state.

CrowdHydrology (Lowry and Fienen, 2013) could be one source for voluntary lake level data collection at parks, public access sites and other popular locations. A small sign on the staff gage and a larger, laminated sign on shore provide a phone number for smart phone users to text the date, gage number and water level reading. The Social.Water software (Fienen and Lowry, 2012) converts the text messages to usable hydrologic data, which are then posted on the internet. The staff gage and signs cost about $150, not including the costs for annual surveys to tie the staff gage into a known upland benchmark elevation. The annual survey is necessary because of the potential for the staff gage to be moved by ice or other factors.

Lake residents could be asked to cover the costs of staff gage purchase and installation by making a persuasive case that the data collection is for their own benefit. Actual installation would best be done with assistance of a small team from the DEQ, DNR, MiCorps staff, or a university research lab, to ensure that the best locations are chosen and the installation is done properly. An upland reference marker is critical but can simply be a metal post driven well into the ground with known elevation relative to the gage. In the longer term, the DNR survey team could determine the absolute elevations of the lake gages as they work across the state on other projects.

In case there is a great deal of interest in participating in this program, a target maximum number of lakes should be set for the first couple of years, perhaps 30-50 lakes. Interested parties would apply for the program and lakes would be selected based on geographic location, morphometry and hydrology (to ensure diversity), and whether they are in regions with the greatest pressure on water resources (e.g., irrigation). Lakes and ponds that are classified as high or medium risk in the decision tree diagram found in Appendix C should be prioritized for this program.

The MiCorps program would need supplemental funding (perhaps $25,000 per year) once the monitoring program is established, and may need more for the first year. Dr. Jo Latimore (MSU and MiCorps) put together the following summary of what typically happens when MiCorps adds a new monitoring parameter to the Cooperative Lakes Management Program (CLMP; each step requires staff time and funding):

- Research existing protocols
- Develop draft protocol
- Gather input from partners, volunteers, agencies

- Pilot test protocol with a few volunteer lakes and program staff; revise as necessary
- Develop volunteer-friendly instruction document and data form(s)
- Develop training program (in-person or online)
- Update online database and user interface to accept new data
- Determine enrollment cost and method for providing necessary equipment
- Launch parameter as a pilot to a limited number of lakes (maybe not charge that first year).
- Update reporting mechanisms to summarize and report data to volunteers and partners
- Review results after first year and decide whether to (1) incorporate as a permanent CLMP parameter, (2) continue to pilot with revisions, or (3) discontinue. The decision is partly based on the level of interest from volunteers. MiCorps had to revise its invasive plant monitoring program significantly and market it hard to get to a satisfactory level of enrollment; it took 4 years to make it a permanent part of CLMP.

An MSU research lab could put together the bathymetric maps from depth surveys and compile and quality-check water level data with modest grant funding (perhaps $20,000 per year?), thus ensuring that the data are produced and checked with uniform methodology. Graduate student fellowship funding may be most attractive to MSU professors.

Federal grant support such as the US EPA's volunteer water monitoring program (http://water.epa.gov/type/rsl/datait/waters/georef/epasvmp.cfm) or the Great Lakes Restoration Initiative may help support these efforts. Also, the data may be of interest for researchers, who could seek funding from the National Science Foundation.
Lake water level data collection should be initiated as soon as possible because it takes years of observations to build an understanding of the hydrological variability of a particular lake. The ~225 lakes currently participating in the MiCorps volunteer monitoring program would be the best to recruit for the first round of monitoring. Later the set of lakes being monitored could be expanded to target underrepresented types of lakes and/or lakes in regions where water withdrawals are more likely to become an issue with lake users. In addition, the Tip of the Mitt Watershed Council manages its own lake monitoring program in the northern Lower Peninsula, and may be interested in participating.

Bathymetric mapping does not necessarily have to be linked to the water level monitoring program, although mapped depths should be referenced to elevation of the water surface at the time of mapping.

Relationship to other recommendations: This recommendation should be implemented before IL 2.2b and 2.2c.

References

Fienen, Michael N. and Christopher S. Lowry, 2012,Social.Water—A crowdsourcing tool for environmental data acquisition, Computers and Geosciences, (49): 164-169.

Lowry, Christopher S. and Michael N. Fienen, 2013, CrowdHydrology: Crowdsourcing Hydrologic Data and Engaging Citizen Scientists, Ground Water, Volume 51, Number 1: 151-156.

2. Adverse Resource Impacts (ARIs) for Inland Lakes

Charges IL-B, IL-E, IL-G

Issue

The current statutory definition of an ARI for inland lakes (MCL 324.32701 (1) (a) (vii)) reads:

> "Decreasing the level of a lake or pond with a surface area of 5 acres or more through a *direct* (emphasis added) withdrawal from the lake or pond in a manner that would impair or destroy the lake or pond or the uses made of the lake or pond, including the ability of the lake or pond to support characteristic fish populations, or such that the ability of the lake or pond to support characteristic fish populations is functionally impaired. As used in this subparagraph, lake or pond does not include a retention pond or other artificially created surface water body."

By only including direct (i.e., surface water) withdrawals, this definition excludes groundwater withdrawals that may decrease the level of a lake or pond indirectly via groundwater drawdown in the vicinity of the water body. Thus the DEQ has no authority to make an ARI determination for a lake or pond because of a proposed large-quantity withdrawal (LQW) of groundwater. Therefore groundwater LQWs that have the potential to cause an ARI in an inland lake or pond are currently exempt from Part 327.

Discussion of Recommendations

IL 2.1 The ARI definition for inland lakes and ponds in MCL 324.32701 (1) (a) (vii) does not need to be amended at this time. Inland lakes and ponds may need protection to prevent ARIs from indirect (groundwater) withdrawals, as well as direct withdrawals. However, our knowledge of interactions between groundwater and surface water of inland lakes and ponds is insufficient to develop a statewide assessment procedure to efficiently and reliably screen lakes for the potential for an ARI caused by a given withdrawal proposal. Data and further research are needed to support an agency determination of an ARI for lakes and ponds potentially affected by LQWs. Once a screening procedure is established and validated, statutory changes may be made to Part 327 to protect inland lakes and ponds from both direct and indirect withdrawals. An ARI determination should include the recognized and legally protected uses of lakes and ponds.

Characteristic fish species curves, like those used by the Water Withdrawal Assessment Tool for rivers and streams, have not been developed for inland lakes and ponds. Therefore we currently lack the tools to evaluate how much adverse impact to characteristic fish populations is acceptable for inland lakes and ponds. A determination must first be made that a water level decline is likely to be or has been caused by a surface water or groundwater LQW or whether it is due to drought or other factors (or a combination of multiple factors). Secondly, a determination that the withdrawal adversely impacted the uses of the inland lake or pond must be made. Other legally recognized uses of inland lakes and ponds include, but are not limited to:

- Drinking water;

- Navigation;
- Riparian rights of dockage (or wharfage) and access to navigable waters.
- Recreational uses and public trust values.

There are an estimated 65,000 inland lakes and ponds in Michigan, with 11,000 with surface areas of five acres or larger. The sheer number of inland lakes and ponds is further complicated by the variability in lake and pond bathymetry and shoreline development. Comprehensive assessments of these other legally recognized uses have not been completed for all of the inland lakes and ponds in Michigan, even if you limit the assessment to those lakes and ponds with surface areas ≥ five acres.

IL 2.2 The State of Michigan's Quality of Life agencies (DEQ, DNR, and MDARD), in collaboration with the United States Geological Survey (USGS), should work with the successor to the current Water Use Advisory Council to:

IL 2.2a Prioritize additional data collection and research to better characterize and classify inland lakes and ponds in Michigan with respect to their vulnerability to ARIs caused by groundwater and surface water LQWs.

The numbers of inland lakes and ponds by category in the ARI risk assessment decision tree in Appendix C are the results of initial GIS analyses of inland lakes and ponds in Michigan. Bathymetric data are only available for 2,700 of the 65,000 lakes and ponds in Michigan. Further analyses are needed to refine the estimates of how many lakes and ponds have surface water dominated vs. groundwater dominated hydrology. One possible means of assessing this lake and pond hydrology could be water chemistry analyses to test for major cations and anions that indicate groundwater inputs to the lake or pond, and comparing results to Darcy model assessments of the likelihood of significant groundwater flow through the lake basin.

The mean lake or pond depth appears to have the best available predictor of the percentage of lake or pond area that is exposed upon drawdown of the water level. However, it should be recognized that a significant drawdown in lake or pond water level can adversely affect riparian users even if the sediments are not exposed.

Very little information is available concerning the historical ranges in lake and pond levels. Most of the lakes and ponds with historical lake and pond level data are lakes that have legal lake levels established and thus have some means of regulating their levels (e.g., dams or weirs). Knowledge of historical variation in water levels in a particular lake or pond is valuable to determine the impact of a new water withdrawal, be it direct or indirect.

Resources needed: Recommendation IL 2.2a is likely to take 1-2 years to implement. The additional data collection, however, should start as soon as possible. GIS analyses, which could take one year, can be performed to refine the classification of lakes and ponds into the ARI risk assessment decision tree (Appendix C). The GIS analyses will need to be refined based on the inland lake data collected.

Relationship to other recommendations: This recommendation is related to other recommendations concerning the need for additional data collection for inland lakes and ponds (IL 1.1, IL 1.2, IL 3.1), as well as recommendations for additional data

collection for geological, hydrogeological and stream flow data (EM 1.1-1.6, EM 2.1, 2.3, 2.4). The data collection portion of IL 2.2a should begin as soon as possible.

IL 2.2b Develop an on-line screening tool capable of assessing whether a proposed surface or groundwater withdrawal is likely to cause an ARI in an inland lake or pond; allow the water user to register LQWs that pass the screening tool; and require a site specific review (SSR) by the DEQ for any proposed LQWs that cannot be passed by the screening tool.

The current stream network GIS data layer used by the on-line WWAT does not include inland lakes and ponds in Michigan that are not part of the stream network. In-line inland lakes and ponds (those with both an inlet and an outlet) may be displayed as stream segments (essentially the lake's or pond's central thread line). Isolated lakes or ponds (those with no inlet or outlet) and some headwater lakes or ponds (those with only an outlet) are not shown in this GIS data layer. Furthermore, the equations used by the WWAT's groundwater model are not capable of estimating indirect LQW depletions from inland lakes and ponds.

At the current time, we do not have enough data about inland lake and pond characteristics to include or develop a screening assessment of indirect withdrawals and therefore no statutory change to prevent ARIs from indirect withdrawals is recommended at this time. On a case-by-case basis, the DEQ is able to assess impacts of withdrawals from lakes and ponds using a SSR, but the large number (over 11,000) of inland lakes over 5 acres in Michigan and the large number of registration requests received annually makes SSRs impracticable to perform for all but a subset of the proposed indirect withdrawals. Further study is needed to develop a feasible screening tool for assessing whether a groundwater or surface water LQW is likely to cause an ARI in an inland lake or pond. We need to have some means of prioritizing which lakes and ponds are most likely to be at risk of an ARI.

The ARI risk assessment decision tree is one way of prioritizing inland lakes and ponds as being a high, moderate or low risk for an ARI. The screening tool could be designed to authorize (assuming that the proposed LQW does not cause an ARI to a river or stream) proposed LQWs in inland lakes and ponds that are a low risk for an ARI. SSRs could be required for proposed LQWs that are in proximity to inland lakes and ponds that are at a moderate or high level of risk for an ARI.

Resources needed: An on-line screening tool for the Water Use Program should be capable of assessing the impacts of proposed groundwater and surface water LQWs on streams, inland lakes and ponds. This will require major modifications to the current WWAT or potentially development of new models used by the Tool to accommodate inland lakes and ponds. The modified WWAT will need to be housed on the State of Michigan's network. Modifying the WWAT to include inland lakes and ponds as well as streams will require a collaborative effort by the DEQ, DNR, USGS, MSU and other interested parties. It may even require a formal stakeholder council. A project of this magnitude will likely take at least 5 years to complete and will likely cost hundreds of thousands of dollars. The DEQ will be required to provide funding to the DTMB for their work in modifying the WWAT.

Relationship to other recommendations: The development and testing of a screening tool capable of assessing inland lakes and ponds as well as rivers and

streams will need to follow the implementation of a sufficient body of data collection in Recommendations IL 1.1, 1.2 and 3.1 such that the Department can work with stakeholders and future advisory councils to determine a threshold for size and data sources needed to model a screening tool. Much of the data collection for inland lakes can be independent of (but could be concurrent with) the data collection for Recommendations EM 1.1-1.6, EM 2.1, 2.3 and 2.4.

IL 2.2c Develop a SSR procedure for the DEQ to determine whether a proposed surface or groundwater LQW is likely to cause an ARI in an inland lake or pond. The procedure should be publicly available on the DEQ's website.

The SSR needs to determine whether the lake or pond is hydraulically connected to the aquifer used by the groundwater LQW. Two- and three-dimensional analytical and numerical models are available to assess the impacts of groundwater and surface water LQWs on inland lakes and ponds. Factors that need to be included in the model include the historical range in lake or pond levels, lake or pond bathymetry, lake or pond volume, lake or pond area, lake or pond bed conductance (the ability for water to move through the lake or pond bed sediments between the surface water and groundwater), evapotranspiration, precipitation, surface water flow into and out of the lake or pond and groundwater flow rates. Also, as with modeling LQW effects on stream flow, data on the 3-dimensional stratigraphy of the glacial deposits are often inadequate to understand how well confining layers isolate deeper aquifers used by many groundwater LQWs.

DEQ staff has only performed one SSR on a request for a direct lake withdrawal to date; a summary of that SSR is attached. A detailed presentation on this SSR is available in Appendix C.

Resources needed: Development of the SSR procedure should be concurrent with the modification of the WWAT per IL 2.2b. While the DEQ currently has modeling software that can be used to predict the impacts of proposed surface and/or groundwater withdrawals to inland lakes and ponds, data availability is a primary limiting factor for developing the SSR process for inland lakes and ponds. A similar 5 year or longer timeframe may be required to have a fully developed SSR process, and will require a sufficient body of data collection in Recommendations IL 1.1, 1.2 and 3.1 such that the Department can work with stakeholders and future advisory councils to determine a threshold for size and data sources needed to develop the SSR process. If an efficient screening process can be developed for proposed withdrawals in or near inland lakes and ponds, then a relatively small percentage of these proposed withdrawals should require SSRs. The DEQ Water Use Program already needs additional FTEs in order to significantly reduce or eliminate the SSR backlog. No additional FTEs are anticipated to be necessary to handle SSRs for inland lakes and ponds over and above the additional FTEs necessary to handle the existing SSR backlog.

The SSR guidance, like other DEQ guidance documents, will be subject to DEQ Policy and Procedure Number 09-013, "Department Policy And Procedure, Division Policy And Procedure, And Administrative Procedures Act Guideline Development, Revision, Rescission, And Use", http://www.michigan.gov/documents/deq/deq-dept-policies-09-013_377468_7.pdf?20141029155535. This policy and procedure provides direction to DEQ staff on how to develop guidance documents in compliance with the

Administrative Procedures Act (APA). This policy and procedure also provides DEQ staff with direction on determining when external stakeholder review of draft guidance documents is appropriate and, if so, how to conduct external stakeholder reviews.

Relationship to Other Recommendations: IL 2.2c is related to TU 4.1 and 4.2, which recommend that the DEQ document how it conducts stream index flow reviews; EM 1.3, which recommends that the DEQ develop protocols and standards for the collection and use of stream flow data; and EM 2.2, which recommends that the State of Michigan publish its protocols and standards for the collection and use of groundwater data. TU 4.1, 4.2, EM 2.2, and (to a lesser extent) EM 1.3 involve documenting existing processes while IL 2.2c involves creating & documenting a whole new process. Implementation of IL 2.2c should follow implementation of IL 2.2b, or at least be concurrent with the later stages of the implementation of IL 2.2b. The implementation of IL 2.2c can be independent of, but possibly concurrent with, the implementation of TU 4.1, 4.2 and EM 1.3.

Attachment

Summary of Inland Lake SSR Process

Part 327 prohibits adverse resource impacts from direct withdrawals from lakes or ponds with a surface area of 5 acres or greater. The withdrawal impacts the lake or pond if it impairs its function (for example inability to support fish, destroys spawning grounds, increases temperature, promotes algae or other vegetation growth or use for example, impacts fishing or boating activities or lowers water levels so a dock may not be useable).

In an example of one SSR performed in response to a request for direct withdrawal from an inland lake (Fulks Lake in Branch County), DEQ staff used the following process to determine potential impact:

1) Consider Issues
   a) Are There Fish in the Lake?
   b) How Deep is the Lake?
   c) Wetland Area?
   d) Endangered or Threatened Species?
   e) Part 303 Permit Required?
   f) Geology-Hydrogeology
   g) Will Withdrawal Lower the Lake Water Level?
   h) Will a Water Level Drop Impact the Lake?
   i) Should the Withdrawal Be Authorized?

2) Interview people with knowledge of the lake
   a) Property owner
   b) County Drain Commissioner

3) Look for records on lake
   a) Well IDs so that logs of existing wells can be located
   b) DNR survey reports, wetland, and inland lake maps
   c) National Wetlands Inventory map
   d) Survey reports on nearby lakes
   e) DEQ wetlands inventory map viewer including any bathymetric data

4) Determine whether threatened and endangered species are present in the area
   a) US Fish and Wildlife Service
   b) Michigan Natural Features Inventory

5) Conduct a site visit
   a) Evaluate wetland presence and extent and any stream connections

6) Estimate correlated clay intervals from the well logs and contoure to evaluate the clay continuity and look for outliers (possible bad data calls/points)
   a) Use Wellogic records or any other available information for geologic data
   b) Run Darcy's equation to estimate water level change

7) Consult with DEQ and DNR staff to estimate impact to species due to estimated water depletion from withdrawal

8) Issue approval or denial
   a) Include recommendations on additional permits needed (e.g., Part 301 or 303)

3. Inland Lake Level Data

Charges IL-B, IL-C, IL-F

Issue
A decrease in an inland lake or pond's water level could be due to a large quantity water withdrawal (LQW), either directly or indirectly (e.g., a nearby groundwater withdrawal); or it could be due to drought conditions or other factors or some combination of multiple factors. Identifying the cause(s) of lake level declines is a complex process. Knowing the natural range of variability in a given lake level over time is an essential part of this analysis. Unfortunately very little historical lake level data are available for inland lakes and ponds in Michigan.

Recommendation

IL 3.1 A collaborative effort should be made to utilize public and private funds to install staff gauges in inland lakes and ponds in Michigan. Recognizing that some private groups may want to have staff gauges installed in lakes of interest to them, the staff gauges should be installed first in those inland lakes that are at high and medium risk for ARIs. We recommend using the decision tree in Appendix C as an initial predictive tool for identifying the relative ARI risk for inland lakes and ponds. The staff gauges should be tied into upland elevation benchmarks. The staff gauge elevations should be annually resurveyed due to the potential for damage from ice and other factors.

Background
Michigan has approximately 65,000 lakes. To date, the Inland Lake ARI workgroup received survey responses from lake associations concerning 111 inland lakes. Fifty-eight of those lakes have legal lake levels established. So far we have only received historical lake level data for 12 lakes from those organizations and from MSU. The quality of the lake level measurements varies considerably, with many measurements being made relative to seasonal dock structures rather than properly maintained staff gauges. Only 9 of the lake level data sets received to date from the survey can be displayed in graphs of lake levels over time. The USGS has historical data on lake levels from 47 gauge sites, some stretching back to 1971. Those data may be useful for looking at trends over time in the lake types the agency has reviewed.

This data gap can be addressed several ways. Aerial surveys using light detection and ranging (LiDAR) can provide very precise lake elevation data but are too expensive to conduct over broad areas or to obtain repeat coverage. A single point in time LiDAR measurement of Michigan's inland lake levels would cost about $1,500,000 and be of limited value.

Staff gauges are affordable (usually <$100) and they allow lake levels to be recorded over time with an acceptable level of accuracy (+/- 0.01 foot for staff gauges with 0.02 foot gradations). They can be attached to permanent structures (e.g., dams) or on posts driven into the lake bottom. The staff gauge's elevation needs to be tied into an upland elevation benchmark, and because of the potential for staff gauges to be shifted or damaged by ice and other factors, they should be annually resurveyed.

The Michigan Clean Water Corps (MiCorps) was created by Executive Order to assist the DEQ in collecting and sharing water quality data for use in water resources management and protection programs. MiCorps builds upon existing volunteer monitoring programs established

by the DEQ, including the Cooperative Lakes Monitoring Program. Training offered by the DEQ to groups interested in lake monitoring could be supplemented to include training on collecting lake level data to supplement DEQ and DNR data collection efforts.

It is not feasible to install staff gauges in all 65,000 inland lakes in Michigan. The decision tree document in Appendix C is proposed as a way to classify inland lakes in terms of their likely risk for ARI from LQW. This classification was developed based on DNR records collected from approximately 2,700 inland lakes that have been bathymetrically mapped across Michigan. The classification begins with the 65,000 lakes across Michigan and sets aside the approximately 330 lakes with lake level control structures, many of which have legally set water levels. Since levels and potential impacts to those lakes are subject to legal requirements set by Court Order, they are outside the WWAT program. The classification then classifies the remaining lakes by size (size, depth and area tend to be correlated).

As seen on the classification, most inland lakes are smaller than five acres in size and would therefore not be regulated under Part 327 of NREPA. Remaining lakes were divided into lakes between five and ten acres, and those larger than ten acres. This was done for two reasons: first, because small lakes are more likely to be at risk of an ARI due to their small volume and shallowness, and second, because so little bathymetry or other study has been done for these small lakes, it is difficult to classify them in the same manner as the larger lakes throughout the rest of the classification.

For lakes greater than ten acres, the classification continues by dividing lakes on streams from those isolated from streams or at the headwaters of streams. This is done to acknowledge that while the WWAT does not account for the storage and volume of an on-stream lake, it does recognize the stream segment that includes the lake and therefore at least partially considers that lake by considering the flow that serves the attached stream. Lakes at stream headwaters and those not on stream systems are not be considered by the WWAT at all. Once all the above lakes are removed from the classification, approximately 3,900 inland lakes are left.

Of those 3,900 lakes, their position in the landscape and depth relative to estimated water table depth led to their classification as groundwater or surface water dominated lakes. While a lake may not be entirely groundwater or surface water fed, the relative contribution of groundwater versus surface water to a lake can affect its sensitivity to large quantity withdrawals. As a provisional approach, the determination of groundwater versus surface water domination for lake categories was based on an assessment of groundwater movement, surficial geology and surface topography run through a Darcy model. This model is also used in stream assessments to predict stream temperature due to groundwater influence. Lakes occurring in areas with higher groundwater movement (50th percentile or higher) were assigned a classification of groundwater dominated influence. These lakes were divided by size categories: 10-100 acres, 100-1000 acres, and over 1000 acres. They were also divided by mean depth categories: less than 15 feet, 15-35 feet, and over 35 feet. The resultant lake classes were assessed by risk for an adverse resource impact due to large quantity withdrawals. DNR staff have modeled how lake morphology is related to impact on loss of littoral zone of lakes and determined that size and mean depth have the strongest direct correlation to potential loss of littoral zone due to large quantity withdrawals, and therefore risk assessments were assigned accordingly.

Inland lakes that are classified as high and medium ARI risks may then be prioritized for receiving staff gauges. Some private groups may want to install staff gauges on inland lakes that are lower priorities and their wishes should be accommodated to the extent that funding

and labor are available. Inland lakes that have volunteers willing to collect lake level data should also be a factor in prioritizing which lakes receive staff gauges. At publicly accessible lakes, online data submission ("crowdsourcing") by the public may help augment the observational data.

Resources needed: Lake water level data collection should be initiated as soon as possible because it takes years of observations to build an understanding of the hydrological variability of a particular lake. The DEQ and USGS have a long history of monitoring of water levels and have procedures in place for ensuring that data is of sufficient quality to be used for regulatory decisions. Funding shortages in recent years drastically reduced the number of lakes where water levels are monitored. Historic gauge records, including hard-copy versions of lake level data at the USGS, should be evaluated to determine if historic data are available for lakes that are deemed high and medium risk for ARIs. Researching historical lake level data at the USGS could be done by paid or unpaid student interns, contractors, university researchers, and federal or state agency staff. Re-establishing gauges at these locations should be the highest priority and could likely begin in 2015.

Water level monitoring entails installation of staff gages on secure mounting. Enameled metal gages are best and 3-foot segments cost under $50. They can be affixed to steel sign posts, fence posts, or pipes driven well into the sediments, or mounted securely on seawalls or other permanent structures (it is best not to mount them on seasonal docks). The total cost of materials for a gage could be kept under $150.

At least 0.25 FTE of either DEQ or USGS staff (or alternatively, working through MiCorps—see below) should be dedicated to a targeted effort of installing staff gauges at lakes identified as medium to high risk and many of these are likely on private property. Effort also needs to be dedicated to procedure development for volunteers (see below) and data management. The DEQ should work with stakeholders and any future advisory council on determining a threshold for number and variety of lake data collection needed for program use and development of trends and models, in order to identify total need for staff and/or volunteer time and resources needed.

Relationship to other recommendations: This recommendation needs to be implemented before IL 2.2b and IL 2.2c.

TOPICS TO BE ADDRESSED BY FUTURE COUNCILS

A number of items were undertaken by the Council, and some topic areas could not be addressed in the two year timeframe. Certain topics were more complicated and time-consuming than others, and Council members volunteered their time to complete tasks. Several workgroups, but not all, submitted a list of items that could be considered by future advisory councils of the Water Use Program. The list below reflects items that the Technical Underpinnings, Water Users Groups and Inland Lakes ARI workgroups were unable to fully address. It is not comprehensive in terms of all aspects of the Water Use Program.

Technical Underpinnings of Withdrawal Decision Making

The following topics were identified by the Technical Underpinnings workgroup as important topics, but the workgroup did not have time to address or make recommendations on these topics. The fact that the workgroup did not make recommendations on these subjects should not be interpreted as a consequence of these not being critical issues to address. The workgroup recommends a future Water Use Advisory Council address these issues.

1. Consider revising the withdrawal allocation between neighboring WMAs. The workgroup discussed this issue at length, but did not reach consensus on how to best address it. The status quo may result in under prediction of withdrawal allocations to some watersheds and potentially omitting others from consideration and record keeping.

    a. The "½ Max rule" (depletions are only entered into the accounting if they are at least half the maximum depletion of all the neighboring Watershed Management Areas).

2. What happens if the stream index flow is reduced (in a SSR, because of changes made to the process, or because of changes in stream classification) to the point where large quantity withdrawals (LQWs) previously authorized by the WWAT or an earlier SSR now deplete the Watershed Management Area's index flow beyond the point where an ARI is likely to occur?

3. Develop a framework for return flow accounting and downstream accounting for withdrawals. These are two sides of the same issue. As identified in the preceding "water council", currently the WWAT and WWAP do not track the cumulative return flow or depletions of index flows from large quantity water withdrawals, downstream across subsequent connected Watershed Management Areas. Potentially, a maximum allocation 20% of index flow could occur in one Watershed Management Area, and this would not be reflected in the accounting of available flow in the next most downstream area. Not correcting this could contribute to allowing an ARI to occur, and registering water users that may be found to cause ARIs in the future, after they make investments.

    a. Criteria for crediting return flows.
    b. Accounting system to track return flows within the WWAP.
    c. Accounting system that will appropriately translate withdrawals and return flows to downstream Watershed Management Areas.

d. How existing registered users could be incorporated into proposed accounting system.

4. How existing registered users could be incorporated into proposed accounting system. How are “use” and “capacity” used in the SSR process?

5. Should large quantity, short term withdrawals (e.g. hydraulic fracturing, construction dewatering) be considered in the process? The WWAT is currently being used to screen and predict the impact of short term hydraulic fracturing withdrawals.
   a. What volumes, over what time period, should be considered?
   b. What environmental concerns need to be addressed, and how including these withdrawals in the process will be beneficial?
   c. How these withdrawals would be handled in the accounting system.
   d. Policy options for “predicting” ARI’s from large quantity, but short-term water withdrawals.

Water Users Groups

The Water Users Groups workgroup spent considerable time discussing the following charges, but time was too short to address the complexities and uncertainties related to the issue sufficiently to support a recommendation.

- Identify alternative voluntary measures, including but not limited to water conservation and drought management and information sources for such measures, and provide advice on methods to identify voluntary measures that may be helpful in allocating scarce resources and eliminating or preventing adverse resource impacts (some overlap with water conservation group). Propose roles and responsibilities of users to make allocation decisions.
- Recommend tools and procedures for incorporating local water use agreements and long term plans into the DEQ’s decision making process.

In addition, the workgroup discussed briefly the following charge. We concluded, similarly to the Water Conservation workgroup, that insufficient data exists to accurately evaluate water use trends. Also, estimating water demand is a more fruitful and informative undertaking, but it would require a lengthy research effort.

- Recommend approaches and considerations for evaluating local water use trends and projecting future water use demands.

Preventing Adverse Resource Impacts in Inland Lakes and Ponds

The following specific tasks were part of the Preventing Adverse Resource Impacts in Inland Lakes and Ponds Workgroup’s charge, but the workgroup did not have sufficient time to fully address these charges. The historical lake and pond water level data, bathymetry and other data are also insufficient to allow these charges to be fully addressed at this time. Some of the work group’s recommendations partially address these charges, including recommendations for additional data collection to address these data gaps. The workgroup strongly recommends that

any successor external stakeholder group(s) to the Water Use Advisory Council fully address these charges:

1. Propose criteria and identify information that should be used in the short term to evaluate whether direct withdrawals from inland lakes would result in an ARI as defined by the Part 327 narrative standard.
2. Propose an approach for a scientifically robust evaluation of whether direct withdrawals from inland lakes would result in an ARI, including actions, tools, data gaps and resources needed to implement the proposed approach.
3. Define the types of lakes and ponds for which current tools and decision frameworks are not adequate; if appropriate, recommend priorities by types of lakes and ponds for which tools, data, and other actions are needed.

WORKGROUP PRODUCTS SUMMARY

In several instances, as workgroups developed recommendations, additional products were produced. Specific products are listed below and available in Appendix C.

- Summary of conservation programs of other jurisdictions (Water Conservation)
- Water education and information programs (Water Conservation)
- Information sources (Water Conservation)
- Water Users sample kick-off meeting agendas (Water Users)
- Community Dispute Resolution Centers (Water Users)
- Inland Lakes and ponds decision tree (Inland Lakes ARI)
- Inland Lakes and ponds case study (Inland Lakes ARI)

APPENDICES

A. 2014 Membership List
B. Workgroup Charges
C. Workgroup Products
D. Recommendations Matrix
E. Dissenting Opinions
F. Links to Meeting Summaries
G. List of Council Meeting Speakers

APPENDIX A | 2014 Membership List

Name	Organization	Representing
Gary Dawson*	Consumers Energy	Utilities
Pat Staskiewicz*	Michigan Section American Water Works Association	Municipal water supplies
Molly Robinson (alternate)		
Matt Evans	Michigan United Conservation Clubs	Conservation organization
Dave Hamilton	The Nature Conservancy	Conservation organization
Rich Bowman (alternate)		
Gildo Tori	Ducks Unlimited	Conservation organization
James Clift	Michigan Environmental Council	Environmental organization
Grennetta Thomassey (alternate)	Tip of the Mitt Watershed Council	
Frank D. Ettawageshik	United Tribes of Michigan	Tribes
Charlie Scott	Michigan Golf Course Owners Association	Non-agricultural irrigators
Jon Scott (alternate)		
Wm. Scott Brown	Michigan Lake and Stream Associations	Riparian organization
Andy Such	Michigan Manufacturers Association	Business and manufacturing
Thomas Frazier	Michigan Townships Association	Local government
Judy Allen (alternate)		
Michael Newman	Michigan Aggregates Association	Aggregates industry
Shada Biabani (alternate)		
Wayne H. Wood* (co-chair)	Michigan Farm Bureau	Agricultural organization
Laura Campbell (alternate)		
Jim Byrum	Michigan Agri-Business Association	Agricultural organization
Mike Menkel (alternate)		
George M. Carr	Michigan Ground Water Association	Water Well Drillers
Bryan Burroughs* (co-chair)	Michigan Trout Unlimited	Angler organization
Robert Whitesides	Kalamazoo River Watershed Council	Watershed council
Steve Hamilton (alternate)		
Ben Russell	Southwest Michigan Water Resources Council	Regional Water Use Stakeholders
Steven M. Rice	Michigan Wetlands Association	Wetland protection
Patricia Norris	Michigan State University	Academic
David Lusch*	Michigan State University	Academic
Brian Eggers* (co-chair)	AKT Peerless	Michigan Chamber of Commerce
Howard Reeves	United States Geological Survey	Ex-officio; technical support
John Yellich	Western Michigan University	Ex-officio; Michigan Geological Survey
Alan E. Kehew (alternate)		
Jon Bartholic	Michigan State University	Ex-officio; Academic
Frank Ruswick (alternate)		
Jon Allan*	Office of the Great Lakes	Ex-officio
Jamie Clover Adams	Michigan Dept of Agriculture and Rural Development	Ex-officio
Abby Eaton (alternate)		

Tammy Newcomb	Michigan Dept of Natural Resources	Ex-officio
Sharon Hanshue (alternate)		
Peter Manning	Dept of the Attorney General	Ex-officio
Margaret Bettenhausen (alternate)		
Dan Wyant	Michigan Dept of Environmental Quality	
Dina Klemans*		Designee for Director Wyant

*Served on Leadership Committee

APPENDIX B | Workgroup Charges

TECHNICAL UNDERPINNINGS OF WITHDRAWAL DECISION MAKING WORKGROUP

CHARGE

Background

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act requires the development and implementation of an internet-based assessment tool [a.k.a. the Water Withdrawal Assessment Tool (WWAT)] to determine the significance of proposed large quantity surface water and groundwater withdrawals relative to impacts on resident fish populations (i.e. Zone A, B, C or D) and whether a proposed withdrawal is likely to cause an adverse resource impact based on the type

of river system affected by the withdrawal. An adverse resource impact for rivers and streams is defined according to the maximum allowable reductions in stream flow that results in specified reductions in the density of thriving fish populations or the abundance of characteristic fish populations by stream/river type, or decreasing the index flow by more than 25%. The statute requires the tool to contain a flow- based safety factor, account for cumulative withdrawals and to distinguish the impact of a proposed withdrawal based upon the size of the drainage area of the affected river/stream. Implementing these statutory requirements necessitates having groundwater withdrawal, hydrologic stream flow and fish population response models, and a water availability and depletion accounting system.

Part 327 requires the DEQ to add verified data from annual water use reporting, water use conservation plans and other data sources about the state's water resources to the assessment tool's database. Technical modifications to the tool related to considerations of temperature, hydrology and stream/river flow must be based on a methodology adopted by the Natural Resources Commission (now the DNR Director). The DEQ may not rely on the assessment tool's determination when making a decision on a site specific review.

Goals

- Ensure defensible scientific assessments and analyses are used to develop and support technical frameworks for decision making in the Water Use Program.
- Establish clear, objective criteria and transparent processes for modifying baseline information used in the decision making process.

Specific Tasks

TU-A Develop a plan for addressing each task and meeting workgroup goals in consideration of other workgroups' work, sequencing of task and delivery of all final recommendations and products from the Council to the Quality of Life agencies by December 15, 2014. The plan should also identify information needed from and potential areas of overlap with other workgroups, and information and support needed from the QOL agencies.

TU-B Evaluate additional criteria and tracking mechanisms related to water depletion accounting, including but not limited to crediting for return flows, use versus capacity, identifying and including "invisible" depletions (e.g. unregistered withdrawals), and accounting for water depleted in upstream segments through connected downstream

Watershed Management Areas; provide recommendations related to water depletion accounting.

TU-C Recommend improvements and updates to the function and data support systems for the water withdrawal assessment tool; considering for example, map scale and accuracy, withdrawal allocation between watersheds.

TU-D Recommend criteria and procedures, or changes to existing criteria and procedures for determining when and how index flows, and stream temperature classifications may be adjusted.

TU-E Provide advice on defining adverse resource impacts on inland lakes, ponds and wetlands, including but not limited to appropriate metrics, and withdrawal assessment and decision making process.

TU-F Identify, evaluate and provide advice on additional or alternative models to support water use decision making.

TU-G Recommend additional, existing data sources and/or criteria for considering additional, existing data sources to improve modeling results; such as geologic information, watershed-based groundwater recharge rates, hydraulic conductivity, information on currently "invisible" withdrawals, etc.

TU-H Provide recommendations and information not specifically covered in these bullets but, in the view of the workgroup, are critical to meet the specified goals of the workgroup.

Timeline and Deliverables

- Present workgroup plan, including timing of presentations to the Council and proposed dates for delivery of written report(s) and recommendations to the DEQ – first Council meeting following establishment of workgroup
- Oral report on activities, progress and barriers to fulfilling the charge - each Council meeting
- Draft recommendations and guidance for the Council's consideration - TBD
- Present background and draft recommendations at full Council meetings - TBD
- Prepare reports for consideration by the full Council, including a brief summary of pertinent background information, recommendations around which there is workgroup consensus, recommendations around which there was discussion but no consensus, and other areas that should be explored or require additional work – TBD
- Revise and finalize reports based on feedback from the Council, such that the findings and recommendations reflect the views of the Council rather than the workgroup - TBD/Complete by December 15, 2014.

Members

George Carr – Co chair
Dave Hamilton – Co chair
Bryan Burroughs
Mike Wenkel
James Clift
Abby Eaton
Brian Eggers
Dave Lusch
Howard Reeves
Troy Zorn
John Yellich
Jill VanDyke
Jim Milne
Brant Fisher

ENVIRONMENTAL MONITORING WORKGROUP

CHARGE

Background

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act requires the development and implementation of an assessment tool that is dependent on the availability of defensible scientific information on groundwater and aquifer characteristics, stream/river flow and temperatures, and characteristic fish populations. The DEQ is required to add verified data about the state's water resources to the assessment tool's database and to make technical modifications to the tool related to considerations of temperature, hydrology and stream/river flow based on an approved methodology. When a site specific review or a permit is required, the DEQ must rely on site specific data and information.

Adverse Resource Impact (ARI) is defined in Part 327 for rivers, streams, lakes and ponds. Water resources and biological data are needed to fine tune and verify predictions that large quantity withdrawals will or will not cause adverse resource impacts, and to determine whether an ARI has occurred.

Part 327 requires the DEQ to develop a quality assured protocol for the collection of stream/river flow measurements by persons other than the DEQ staff, and that the data collected pursuant to the protocol may be used in the implementation of the program.

Goals

- Ensure defensible scientific data, information, assessments and analyses are available for informing decision making in the Water Use Program.
- Identify and reconcile potential discrepancies between decisions and data management protocols, and real world impacts of water withdrawals.

Specific Tasks

EM-A Develop a plan for addressing each task and meeting workgroup goals in consideration of other workgroups' work, sequencing of task and delivery of all final recommendations and products from the Council to the Quality of Life (QOL) agencies by December 15, 2014. The plan should also identify information needed from and potential areas of overlap with other workgroups, and information and support needed from the QOL agencies.

EM-B Identify and evaluate available data and information related to surface water flow and groundwater characteristics; recommend additional data needs and monitoring strategies to refine and support the water withdrawal assessment tool, site specific reviews and permit application decisions.

EM-C Identify and evaluate available data for assessing aquatic resource health; recommend data needs and monitoring strategies to assess aquatic resources health; for example, to evaluate possible ARIs on rivers, lakes, ponds, and wetlands.

EM-D Recommend monitoring strategies to assess the accuracy of the water withdrawal assessment tool and site specific reviews (collectively) in predicting "real world" aquatic resource responses (i.e. stream flows and biological responses).

EM-E Recommend data types and data collection protocols for monitoring and measurements that may be conducted by persons other than Quality of Life Agency staff. Citizen science initiatives and volunteer monitoring programs may offer useful models and opportunities for collaboration.

EM-F Provide recommendations and information not specifically covered in these bullets but, in the view of the workgroup, are critical to meet the specified goals of the workgroup.

Timeline and Deliverables

- Present workgroup plan, including timing of presentations to the Council and proposed dates for delivery of written report(s) and recommendations to the DEQ – first Council meeting following establishment of workgroup
- Oral report on activities, progress and barriers to fulfilling the charge - each Council meeting
- Draft recommendations and guidance for the Council's consideration - TBD
- Present background and draft recommendations at full Council meetings - TBD
- Prepare reports for consideration by the full Council, including a brief summary of pertinent background information, recommendations around which there is workgroup consensus, recommendations around which there was discussion but no consensus, and other areas that should be explored or require additional work – TBD
- Revise and finalize reports based on feedback from the Council, such that the findings and recommendations reflect the views of the Council rather than the workgroup - TBD/Complete by December 15, 2014.

Members

Bryan Burroughs – Co chair
Laura Campbell (Wayne Wood) – Co chair
John Yellich
Al Kehew
Scott Brown
Bryan Burroughs
Abby Eaton
Jill VanDyke
Todd Wills

WATER USERS GROUPS WORKGROUP

CHARGE

Background

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act allows for the formation of three types of local water users groups in different circumstances:

- *Water Resources Assessment and Education Committees* may be formed by local entities on notification by the DEQ that a zone B or zone C withdrawal has been authorized by the WWAT, a permit issued under Part 327 or a permit issued under the Safe Drinking Water Act. The purpose of these committees is to assess trends in water use in the vicinity of the withdrawal, education water users, and provide recommendations related to long-term water resources planning, use of conservation measures, drought management activities and other topics related to water use identified by the committee. Part 327 says the DEQ shall assist in the formation of the committees and may provide technical information regarding water use and capacity within the vicinity aggregated at the stream reach level.
- *Water Users Committees* may be formed by water use registrants, permit holders and local governments to evaluate the status of current water resources, water use, and trends in water use within the watershed and to assist in long-term water resources planning. The statute requires the DEQ to notify all registrants, permit holders and local units of government officials within a watershed when it authorizes a zone B withdrawal in a cold-transitional river system or a zone C withdrawal and of the authority to establish WUCs. The statute authorizes the DEQ to provide technical information regarding water use and capacity within the vicinity aggregated at the stream reach level.
- *Ad hoc subcommittees* may be created by a local government official who is participating on a WUC to obtain information and advice from residents in that local governmental unit on water resources, water use, and trends in water use within the local unit of government.

Part 327 also requires the DEQ to convene a meeting of registrants and permit holders within a watershed when it has determined that adverse resource impacts are occurring or are likely to occur due to one or more large quantity withdrawals and there is no WUC. The purpose of the meeting is to attempt to facilitate an agreement on voluntary measures to prevent adverse resource impacts.

Goals

- Develop tools, methods and resources to assist local water user groups in getting started, assessing water use trends, educating water users and the community in general, planning for the shared use of potentially limited water resources, and resolving water use conflicts when additional withdrawals cannot be authorized.
- Identify alternative voluntary measures that may prevent or eliminate adverse resources impacts and that are likely to be acceptable to a broad array of water users.

Specific Tasks

WU-A Develop a plan for addressing each task and meeting workgroup goals in consideration of other workgroups' work, sequencing of task and delivery of all final recommendations and products from the Council to the Quality of Life agencies by December 15, 2014. The plan should also identify information needed from and potential areas of overlap with other workgroups, and information and support needed from the QOL agencies.

WU-B Recommend draft guidance and available tools related to establishing and effectively operating the various types of water users groups, including when and how to establish an effective group; who (i.e. stakeholder groups, water users, local governments, tribes, etc.) should be included; how to engage those who are not currently registered water users; topics for discussion; tools for productive, collaborative discussion and decision making; methods for resolving conflict; etc.

WU-C Recommend approaches and considerations for evaluating local water use trends and projecting future water use demands.

WU-D Identify alternative voluntary measures, including but not limited to water conservation and drought management and information sources for such measures, and provide advice on methods to identify voluntary measures that may be helpful in allocating scarce resources and eliminating or preventing adverse resource impacts (some overlap with water conservation group).Propose roles and responsibilities of users to make allocation decisions.

WU-E Recommend tools and procedures for incorporating local water use agreements and long term plans into the DEQ's decision making process.

WU-F Provide recommendations and information not specifically covered in the bullets but, in the view of the workgroup, are critical to ensure the success of water user groups.

Timeline and Deliverables

- Present workgroup plan, including timing of presentations to the Council and proposed dates for delivery of written reports and recommendations to the DEQ – first Council meeting following establishment of workgroup.
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- Revise and finalize reports based on feedback from the Council, such that the findings and recommendations reflect the views of the Council rather than the workgroup - TBD/Complete by December 15, 2014.

Members

Pat Norris – Co chair
Ben Russell – Co chair
Jim Johnson
Andy LeBaron
Mike Newman (Shada Biabani)
Andy Such
Charlie Scott (Jon Scott)
Abby Eaton
Tammy Newcomb

WATER CONSERVATION AND USE EFFICIENCY WORKGROUP

CHARGE

Background

The Great Lakes Compact and Agreement require each party to develop water conservation goals and objectives, and to implement water conservation and efficiency programs. Annual assessment and adjustment of the programs is also required in consideration of new demands or patterns of water use, cumulative impact and effects, new technologies, and climate.

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act requires the DEQ to review and accept appropriate water conservation measures for representative water use sectors, and to prepare generic water conservation measures by March 2009. This has been completed. Conservation measures for agricultural purposes are must be updated annually. This annual process is done as part of the review and update of generally accepted agricultural and management practices under the Michigan Right to Farm Act.

Goals

- Promote an understanding of water use trends and projected water use demands in Michigan in order to inform recommendations and future direction of the Water Use Program, specifically but not limited to water conservation, use efficiency, outreach and education, and water users groups.
- Identify water conservation and use efficiency practices to preserve the quantity and quality of Michigan's and Great Lakes water resources.

Specific Tasks

WC-A Develop a plan for addressing each task and meeting workgroup goals in consideration of other workgroups' work, sequencing of task and delivery of all final recommendations and products from the Council to the Quality of Life agencies by December 15, 2014. The plan should also identify information needed from and potential areas of overlap with other workgroups, and information and support needed from the QOL agencies.

WC-B Evaluate water use trends and predicted future demands in Michigan, including consumptive and nonconsumptive uses, regional differences, use by sector, etc. and make recommendations for future water conservation and efficiency activities based on projected use demands. Recommendations may include outreach and education activities, research and development of conservation practices in emerging areas of large quantity water use, etc.

WC-C Review water conservation practices in other states and countries, particularly in the Great Lakes region; propose updates to the water conservation practices (generic, sector specific industry standards – water supply, agriculture, turf grass irrigation, other nonagricultural irrigation, aggregate industry, chemical industry, etc.

WC-D Identify and evaluate existing metrics for water conservation and use efficiency and recommend metrics for Michigan's program. In particular, review the "The Water Efficiency and Conservation State Scorecard: An Assessment of Laws and Policies," by the alliance for Water Efficiency and the Environmental Law Institute and provide recommendations to the QOL agencies regarding whether the metrics are relevant to

Michigan's program and alternatives for raising Michigan's grade if so. The report is here:
(The link provided was broken and has been removed.)

WC-E Recommend public outreach and education approaches related to water conservation and efficient use.
WC-F Evaluate public comments on Michigan's Water Conservation and Efficiency Program under the Great Lakes Compact and make recommendations to the Council on how to address them, including changes to the Program.
WC-G Consider and provide related recommendations regarding incorporation of a periodic assessment and adjustment process to update Michigan's accepted water conservation measures.
WC-H Identify information sources used for these tasks that might be useful on a regional scale to assist water users groups.
WC-I Provide recommendations and information not specifically covered in these bullets but, in the view of the workgroup, are critical to meet the specified goals of the workgroup.

Timeline and Deliverables

- Present workgroup plan, including timing of presentations to the Council and proposed dates for delivery of written report(s) and recommendations to the DEQ – first Council meeting following establishment of workgroup.
- Oral report on activities, progress and barriers to fulfilling the charge - each Council meeting
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- Revise and finalize reports based on feedback from the Council, such that the findings and recommendations reflect the views of the Council rather than the workgroup - TBD/Complete by December 15, 2014.

Members

Margaret Bettenhausen, Michigan Department of Attorney General
Gary Dawson, Consumers Energy
Abby Eaton, Michigan Department of Agriculture and Rural Development
Frank Ettawageshik, United Tribes of Michigan
Matt Evans, Michigan United Conservation Clubs
Tom Frazier, Michigan Townships Association
Dave Guastella, (Guest), Tucker, Young, Jackson, Tull, Inc.
Penny Holt, Michigan Department of Environmental Quality
Steve Rice, Michigan Wetlands Association
Molly Robinson, Michigan Section American Water Works Association
Frank Ruswick, Michigan State University (Co-Chair)
Pat Staskiewicz, Michigan Section American Water Works Association
Robert Whitesides (Co-Chair), Kalamazoo Watershed Council

PREVENTING ADVERSE RESOURCE IMPACTS IN INLAND LAKES AND PONDS WORKGROUP

CHARGE

Background

Part 327, Great Lakes Preservation, of the Natural Resources and Environmental Protection Act (NREPA) prohibits a person from making a new or increased large quantity withdrawal (LQW) from waters of the state that causes an adverse resource impact (ARI), requires a property owner who intends to make such a LQW to register the withdrawal prior to beginning the withdrawal, and requires the Department of Environmental Quality (DEQ) to determine whether an ARI is likely to occur or has occurred. Tools, decision frameworks and criteria for implementing these requirements are well established for withdrawals affecting rivers and streams. This is not the case for withdrawals affecting other waters of the state, i.e. inland lakes, ponds, wetlands, which leaves water users and the DEQ without a consistent, transparent approach and criteria for decision making about withdrawals that affect other waters.

ARIs for inland lakes and ponds are specifically referenced and defined in Part 327 providing a good starting point for discussion around protection of waters other than rivers and streams. Part 327 defines an ARI for lakes and ponds as:

Decreasing the level of a lake or pond with a surface area of 5 acres or more through a direct withdrawal from the lake or pond in a manner that would impair or destroy the lake or pond or the uses made of the lake or pond, including the ability of the lake or pond to support characteristic fish populations, or such that the ability of the lake or pond to support characteristic fish populations is functionally impaired. As used in the subparagraph, lake or pond does not include a retention pond or other artificially created surface water body.

Notable in this definition is the limitation that the decrease in lake or pond level must be caused by a "direct withdrawal," which is undefined in the statute. The common interpretation of "direct withdrawal" in this context is a withdrawal from the lake or pond, rather than a withdrawal from groundwater that affects the lake or pond, although withdrawals from groundwater in the vicinity of a lake or pond could result in the same ARIs. While one focus of the workgroup is on developing strong, defensible criteria for the definition of ARIs to lakes and ponds, it should be kept in mind that those criteria could apply to the effects of both direct and indirect withdrawals. The Compact includes all Great Lakes basin waters, and Section 32702(2) specifically references the legislature's authority, under sections 51 and 52 of article IV of the state constitution of 1963 to regulate withdrawal and uses of waters of the state, including both surface water and groundwater. Part of the scope of this workgroup is to consider the appropriateness and desirability of a statutory amendment to extend these protective ARI criteria for lakes and ponds to the impacts of groundwater withdrawals.

The legislative findings of Part 327 (Section 32702 (1)(f) and (i) in particular) provide some insights as to the water uses that must be protected. In addition, one may look to the Part 4 Rules, Water Quality Standards, promulgated pursuant to Part 31, Water Resources Protection, of the NREPA, (specifically Rule 100, designated uses) for additional uses for which surface waters of the state are protected.

The development of tools, criteria and decision making frameworks to protect inland lakes from ARIs is clearly complicated and multi-faceted; additional information, data and resources may be needed to arrive at approaches for inland lakes and ponds that are comparable in rigor to those for rivers and streams. Nevertheless, proposals for large quantity withdrawals from inland lakes and ponds, and complaints (at least 16 in the past 2 years) alleging water level declines in inland lakes and ponds due to large quantity withdrawals are occurring.

Goals

- Prevent ARIs in inland lakes and ponds.
- Identify meaningful and defensible criteria for defining ARIs in inland lakes and ponds in the short term and over the long term.

- Identify scientifically defensible approaches for preventing ARIs in inland lakes and ponds in the short term and over the long term.

Specific Tasks

IL-A Develop a plan for addressing each task and meeting workgroup goals in consideration of other workgroups' work, sequencing of task and delivery of all final recommendations and products from the Council to the Quality of Life (QOL) agencies by December 15, 2014. The plan should also identify information needed from and potential areas of overlap with other workgroups, and information and support needed from the QOL agencies.

IL-B Propose criteria and identify information that should be used in the short term to evaluate whether direct withdrawals from inland lakes would result in an ARI as defined by the Part 327 narrative standard.

IL-C Propose an approach for a scientifically robust evaluation of whether direct withdrawals from inland lakes would result in an ARI, including actions, tools, data gaps and resources needed to implement the proposed approach.

IL-D Define the scope of lakes and ponds for which current tools and decision frameworks are not adequate; if appropriate, recommend priorities by type of lakes and ponds for which tools, data, and other actions are needed.

IL-E Recommend short term and long term approaches (if different) for tracking withdrawals and cumulative impacts of withdrawals as a means of preventing ARIs, including actions, tools, data gaps and resources needed to implement the proposed approaches.

IL-F Propose priorities, sequencing, time frames and alternatives for filling identified gaps in data, resources and tools.

IL-G Consider the impacts and feasibility of evaluating indirect withdrawals on inland lakes and the necessity and desirability of statutory amendments to address them.

IL-H Provide recommendations and information not specifically covered in these bullets but, in the view of the workgroup, are critical to meet the specified goals of the workgroup.

Timeline and Deliverables

- Present workgroup plan, including timing of presentations to the Council and proposed dates for delivery of written report(s) and recommendations to the DEQ – first Council meeting following establishment of workgroup
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Members

Jon Allan
Scott Brown
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Jim Milne (Dina Klemans)
Sharon Hanshue (Tammy Newcomb)
Mike Walterhouse (Dina Klemans)
Steve Hamilton

APPENDIX C | Workgroup Products

- Summary of conservation programs of other jurisdictions (Water Conservation)
- Water education and information programs (Water Conservation)
- Water conservation information sources (Water Conservation)
- Water Users sample kick-off meeting agendas (Water Users)
- Community Dispute Resolution Centers (Water Users)
- Inland Lakes and ponds decision tree (Inland Lakes ARI)
- Inland Lakes and ponds case study (Inland Lakes ARI)

Conservation Programs of Other Jurisdictions[1]

GREAT LAKES STATES

Minnesota

Minnesota Department of Natural Resources/Water
A permit[2] is required to withdraw surface or groundwater for any domestic use serving more than 25 people and for any other use that exceeds 10,000 gpd or 1,000,000 gallons per year (gpy). Permits may require water level monitoring and annual reporting. All active water use permits must be equipped with an approved measuring device with accuracy to 10%. During droughts and when conditions warrant, the DNR may completely suspend surface water appropriation permits.

Wisconsin

Wisconsin Department of Natural Resources/Water Resources
A permit is required for withdrawal of surface or groundwater above 100,000 gpd. There is a $500 application fee and annual pumping reports are required. In 2011, Wisconsin established a statewide voluntary conservation program with some mandatory elements for new and increased large quantity withdrawals and diversions located within the Great Lakes Basin. Conservation requirements vary based on 3 impacts based on increasing use.

Illinois

Illinois Department of Natural Resources/Water Resources
Illinois has selective surface water permitting, while groundwater withdrawals above 100,000 gpd are required to be registered. Water conservation activities are voluntary. Illinois is partnering with the USEPA in the WaterSense program. Program staff participate on an advisory Great Lakes project called "Piloting a Paradigm for Adaptive Management of Great Lakes Watershed Based on Virtual Water".

Indiana

Indiana Department of Natural Resources/Water Division
Registration and reporting is required for surface and groundwater withdrawals exceeding 100,000 gpd.
Water conservation activities are all voluntary.

Ohio

Ohio Department of Natural Resources/Division of Soil and Water Resources
Registration is required for any withdrawal above 100,000 gpd. Information gathered by registrations establishes a chronology which is used in resolving water use conflicts. Additional "ground water stress areas" can be designated and registration required in these areas for withdrawals less than 100,000 gpd. Permitting and reporting is required for withdrawals exceeding 2,000,000 gpd over a 30 day period. If a permit is required, the facility's current consumptive use must incorporate maximum feasible conservation practices, considering available technology and the nature and economics of alternatives. Beyond this, conservation measures are voluntary.

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[1] Information developed through material available on the web. Amount of information available from and ease of use for this source varies with resulting implication for summary information presented.
[2] All permit requirements described herein include some exceptions.

Pennsylvania
Pennsylvania Department of Environmental Protection/Water
Registration and periodic reporting is required for any withdrawal or use over 10,000 gpd and 100,000 gpd depending on the source of the withdrawal. Activities using less than 10,000 gpd may choose to register voluntarily to help develop a more complete picture of water use. Public water supply agencies may be required to establish drought contingency plans, install meters, establish leakage/loss repair program, provide conservation education, and other conservation measures. Withdrawals from the Delaware River Basin require “maximum feasible efficiency” in water use.

New York
New York State Department of Environmental Conservation/Lands and Waters
Permits and annual reporting required for all non-agricultural water withdrawals at or above 100,000 gpd. Water withdrawals for agricultural purposes are required to register, report usage, or apply for permits based on factors specific to the farm. All applications require a “Water Conservation program” form be completed and included with the submittal documenting “environmentally sound and economically feasible” measures. These include measures to minimize inefficiencies and water losses, and may include metering, system auditing, leak detection, recycling and reuse, and drought contingency plans.

NEW ENGLAND STATES

Connecticut
A permit is required for a "diversion" (withdrawal). No apparent volume threshold. Permit application requires a description of previous conservation measures instituted by the applicant and a conservation plan to be implemented by the applicant. The plan must meet certain criteria including: 1) the identification of and cost effectiveness of distribution system rehabilitation to correct sources of lost water, 2) measure which encourage proper maintenance and water conservation, 3) a public information program to promote water conservation, including industrial and commercial recycling and reuse, and 4) contingency measures for limiting water use during seasonal or drought shortages. The conservation plan must include an implementation schedule and detailed program for measuring conservation measures.

Maine
Permit required for a "significant" groundwater well (75,000 - 144,000 gpd depending on distance from surface water). Conservation and efficiency is "mandatory", but further description of this term could not be readily found. A farm is to have an irrigation management plan under certain circumstances that is to ensure that "the amount of water used for crop irrigation will be kept to a minimum".

Massachusetts
Permit required for groundwater withdrawals above 100,000 gpd. Conservation and efficiency required. Each permittee files an annual report including conservation measures instituted in the reporting period, savings due to conservation measures and metered usage.

New Hampshire
Permit required for a withdrawal above 20,000 gpd. Applications must include a water conservation plan governed by rules applicable to different use sectors including agricultural users who must irrigate in accordance with irrigation best management practices developed by the New Hampshire Department of Agriculture. Each use sector also must meet water loss

requirements such as a water audit and leak detection program and response plan. Metering is required for new permitted withdrawals.

New Jersey
Permit required for a withdrawal above 100,000 gpd. A permittee must adopt and implement, to the "satisfaction" of the regulatory agency, a water conservation and drought management plan. Each permit contains a requirement for reporting on conservation measure implementation. The regulatory agency may require a permittee to improve or repair equipment to eliminate water loss.

Rhode Island
A permit is required for certain withdrawals, but the criteria are not readily available. Available information on water use management largely focused on public water supply sector. These systems are subject to a mandatory leakage detection program and loss threshold (10%). There appear to be generalized provisions for efficient water use.

Vermont
A permit is required for a groundwater withdrawal of more than 57,600 gpd. That the proposed withdrawal is "planned in a fashion that provides for efficient use of water" is a criteria for issuance. The permit may also be conditioned on "any other consideration that the secretary (of the issuing agency) determines necessary for the conservation of water...." The permit application must include "conservation measures to be implemented to reduce water consumption."

WESTERN STATES

The water conservation programs of Washington, Oregon, California, Colorado, and Arizona were reviewed. While they have different approaches to addressing water use, like most western states, they implement the Appropriation Doctrine which has the following two fundamental principles:
1) Establishes a “first in time, first in right” approach to allotting use water. Those applying for and receiving water rights first have priority over later requests, “senior” vs. “junior” water users, regardless of whether they are riparian or not. 2) Use of the water in a beneficial application is the basis and measure of the right. Beneficial uses originally included agricultural, industrial, and household. Ecological purposes have been added to that list in some areas but not all. Different sectors, such as agricultural and urban, have different planning and reporting requirements. Instream lease and transfers are options to varying degrees in a number of the states.

Washington
Washington State Department of Ecology/Water Resources
Property owners whose use of surface water or non-exempt groundwater before enactment of the surface water (1917) or groundwater codes (1945), and who continue that use must have filed a water right claim. “Water right claims” is a claim by the property owner stating they beneficially used the water prior to enactment of the water code, and that they have continued to use that water without a break of five or more consecutive years. Water rights may be legally lost if the right is not used for five or more consecutive years. There are more than 168,000 water right claims in Washington State. Water use is regulated through a state permit and certification system. There are exceptions to permitting requirements, however these exempted uses are monitored and may become subject to restrictions. Metering is required in all new

surface and ground water withdrawals, and existing water rights that met the following conditions:

- Surface water diversions greater than one cubic feet of water per second, or
- Diversions and withdrawals from surface and ground water sources that support fish stocks classified as critical or depressed.

California
Department of Water Resources
A 2009 Act required Agricultural Water Management Plans and Urban Water Management Plans which were required to be updated approximately every 5 years. As the severe drought continues, in 2014 the California Water Action Plan was released and lists a number of priorities with conservation at the top. At this time, conservation measures are voluntary. Both the 2009 Act and the 2014 Plan call for a 20% per capita urban reduction in water use by 2020.

Colorado
Department of natural resources/Division of Water Resources
Water Conservation Act of 2004 requires "covered entities-retail water providers selling ≥ 2,000 acre-feet of water annually" to have a water efficiency plan filed with the state.
Colorado also participates in The Conservation Reserve Enhancement Program (CREP) which is a federal-state cooperative conservation program that addresses targeted agricultural-related environmental concerns. CREP participants voluntarily enroll in 14- to 15-year Conservation Reserve Program contracts with USDA's Farm Service Agency. Participants receive financial incentives to remove cropland and marginal pastureland from agricultural production, converting enrolled land to native grasses, trees and other applicable vegetation to improve soil retention and water, air and wildlife habitat quality.

Oregon
Oregon Water Resources Department
Oregon's water laws give priority to holders of the oldest water rights. "Junior" users will be restricted from use during periods of water shortage. In 1987, the Allocation of Conserved Water Program was passed to allow users who conserve water to use a portion of the conserved water in a variety of ways: use on other lands, to lease or sell the water, or dedicate water to instream use. This voluntary program encourages more efficient use of water by providing more flexibility in the use of conserved water.

Arizona
Arizona Department of Water Resources
Areas with heavy reliance on groundwater are designated as Active Management Areas (AMAs). The five AMAs (Prescott, Phoenix, Pinal, Tucson, and Santa Cruz) are subject to regulation established is the Groundwater Code. Conservation requirements are mandatory within the 5 AMAs. Agricultural users in AMAs are subject to a non-expansion provision that limits irrigated farmland to those lands legally irrigated between 1975 and 1980. Industry, commercial, and institutional users have conservation requirements specific to the activity.

CANADIAN GREAT LAKES PROVINCES

Ontario
A permit is required for the withdrawal of more than 50,000 liters per day (13,200 gpd). Permit applicants are "encouraged" to take all reasonable and practical measures to conserve water and be up-to-date with sector-specific best management practices. An application must include

a description of water conservation practices undertaken or that will be undertaken as well as a goal for reducing "use, loss and/or waste of water (e.g., percentage or liters per day or per unit of production)...."

Quebec
A permit is required for a withdrawal of more than 75,000 liters per day (19,800 gpd). Conservation requirements unclear.[3]

Water education and information programs

The websites below, and their corresponding organizations, provide information on water conservation programs, projects, conferences, etc… This list is not intended to be all inclusive, but act merely as a starting point to assist in a search for information.

http://www.epa.gov/watersense/
WaterSense, is a partnership program by the U.S. Environmental Protection Agency, which seeks to protect the future of our nation's water supply by offering people a simple way to use less water with water-efficient products, new homes, and services.

http://www.projectwet.org/
Project WET's mission is to reach children, parents, teachers and community members of the world with water education that promotes awareness of water and empowers community action to solve complex water issues. The Michigan Project WET program is administered by Grand Valley State University's Annis Water Resources Institute. Their website is http://www.gvsu.edu/wri/education/michigan-project-wet-educator-information-45.htm

http://www.awwa.org/
Established in 1881, the American Water Works Association is the largest nonprofit, scientific and educational association dedicated to managing and treating water. The AWWA Resource Community is intended to keep the water industry *in the know* about tools, issues and developments related to water conservation.

https://www.nrcs.usda.gov/wps/portal/nrcs/mi/programs/
Natural Resources Conservation Service (Michigan) programs help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Public benefits include enhanced natural resources that help sustain agricultural productivity and environmental quality while supporting continued economic development, recreation, and scenic beauty.

http://www.savemiwater.org/
Michigan Citizens for Water Conservation website is dedicated to helping Michigan's citizens protect one of our most valuable natural resources: our communities' water supplies. Michigan Citizens for Water Conservation was organized in 2000 exclusively for educational, scientific, and advocacy purposes. Their goal is to conserve, preserve, and protect Michigan's natural water resources and the public trust in those natural resources for the benefit of the public.

(The link provided was broken and has been removed.)

[3] Much of the web information was in French.

This website provides information about Cranbrook Institute of Science watershed education programs and events, resources for Great Lakes education, and ideas on how you can protect and conserve the Great Lakes.

https://www.watershedcouncil.org/
Tip of the Mitt Watershed Council is dedicated to protecting our lakes, streams, wetlands, and groundwater through advocacy, education, water quality monitoring, research and restoration.

http://www.hrwc.org/
The Huron River Watershed Council (HRWC) is an environmental organization dedicated to river protection. The Huron River Watershed Council is coalition of Huron Valley residents, businesses, and local governments. Serving those constituencies, HRWC directs multiple programs addressing pollution prevention and abatement, wetland and floodplain protection, citizen education, and natural resource and land-use planning.

http://www.miwaterstewardship.org/
Michigan Water Stewardship Program provides easy-to-find resources on a wide range of environmental issues and provides online water conservation classes.

http://www.miswcs.org/
Soil and Water Conservation Society is a professional society organized for educational, scientific and charitable purposes to foster the science and art of soil, water, and related resource management to achieve sustainability.

http://www.landtrustalliance.org/
The Land Trust Alliance is a national conservation organization that works in three ways to save the places people love. The Land Trust Alliance sponsors conferences and provides links to information on water and land conservation.

http://macd.org/
The Michigan Association of Conservation Districts is a non-profit organization that represents the interests of Michigan Conservation Districts and works to strengthen Districts through leadership, information and representation at the state level. More information on your local districts their programs, projects, and activities can be found at https://www.macd.org/find-your-district

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Great Lake Compact Council
Re-affirmation of Conservation and Efficiency Goals and Objectives
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SAMPLE AGENDA

Water Users Group
Kick-off Agenda (Scenario 1)

Month, Day, Year

Invited:
Attending:
Facilitator:
Note taker:
Meeting objective:

I. Introductions (everyone attending)

II. Meeting format and ground rules

III. Background information
   a. Purpose of meeting -- DEQ unable to approve registration/permit and applicant requested assistance
   b. Review of Water Withdrawal statute and program and basic water law
   c. Review of watershed characteristics
      i. geography
      ii. hydrology
      iii. types of withdrawals (generally)

IV. Detailed explanation of reason for convening users and how common law water rights work

V. Choice to be made by registered and permitted users - reduce cumulative withdrawals or anticipate litigation – presentation of example scenarios

VII. Role of DEQ, MDARD in the process -- technical assistance

VIII. Establish plans for future meetings of water users
   a. Who
   b. Where
   c. When
   d. Facilitator

SAMPLE

SAMPLE AGENDA

Water Users Group
Kick-off Agenda (Scenario 2)

Month, Day, Year

Invited:
Attending:
Facilitator:
Note taker:
Meeting objective:

I. Introductions (everyone attending)

II. Meeting format and ground rules

III. Background information
   a. Purpose of meeting -- DEQ required by law to convene the group because of concerns about water availability in the watershed
   b. Review of Water Withdrawal statute and program and basic water law
   c. Review of watershed characteristics
      i. geography
      ii. hydrology
      iii. types of withdrawals (generally)
   d. Problem that resulted in convening registered and permitted users

IV. Detailed explanation of how problem was realized (finding non-compliant user, intermittent/perennial issue, observation of low streamflow, etc.)

V. Statutory language about the role of registered and permitted users in resolving issue
   a. Timeframe – statute says agreement in 30 days
   b. Resources
   c. Desired outcome

VI. Role of registered and permitted users - deciding how to reduce cumulative withdrawals

VII. Role of DEQ in the process -- technical assistance

VIII. Establish plans for future meetings of water users
   a. Who
   b. Where
   c. When
   d. Facilitator

SAMPLE

Community Dispute Resolution Centers

BERRIEN, Branch, Cass, St. Joseph, Van Buren
Citizens Mediation Service, Inc.
811 Ship Street, Suite 205
St. Joseph, MI 49085
Phone: 269-982-7898
Fax: 269-982-7899
E-mail: matt_balfe@citizensmediation.org
Website: www.citizensmediation.org
Contact: Matthew Balfe

CHARLEVOIX, Emmet
Citizen Dispute Resolution Service, Inc.
Northern Community Mediation
415 State Street
Petoskey, MI 49770
Phone: 231-487-1771
Fax: 231-487-1770
E-mail: jane@northernmediation.org
Website:
Contact: Jane Millar

CHIPPEWA, Luce, Mackinac
Eastern UP Dispute Resolution Center, Inc.
P.O. Box 505
Sault Ste Marie, MI 49783
Phone: 906-253-9841
Fax: 888-664-6402
E-mail: cdrc@eupmediate.org
Website: https://www.eupmediate.org/
Contact: Cynthia Merkel

DELTA, Baraga, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Menominee, Ontonagon, Schoolcraft
Resolution Services Program
UPCAP Services, Inc.
P.O. Box 606
Escanaba, MI 49829
Phone: 906-789-9580
Fax: 906-786-5853
E-mail: gocc@upcap.org
Website: www.upcap.org
Contact: Cheryl Goc

GENESEE, Arenac, Bay, Clare, Gladwin, Midland, Ogemaw, Roscommon, Saginaw
Community Resolution Center
315 East Court Street, Suite 200
Flint, MI 48502
Phone: 810-249-2619
Fax: 810-239-9545
E-mail: Jane.Odell@comcast.net
Website: www.mediation-crc.org
Contact: Jane O'Dell

GRAND TRAVERSE, Antrim, Benzie, Leelanau, Missaukee, Wexford
Conflict Resolution Services, Inc.
852 S. Garfield Avenue, Suite B
Traverse City, MI 49685-1035
Phone: 231-941-5835
Fax: 231-941-4530
E-mail: CRSmediates@gmail.com
Website:
Contact: Rebecca Garland

INGHAM, Clinton, Eaton, Gratiot, Isabella, Shiawassee
Resolution Services Center of Central Michigan
516 S. Creyts Road, Suite A
Lansing, MI 48917
Phone: 517-485-2274
Fax: 517-485-1183
E-mail: gtrice@rsccm.org
Website: www.rsccm.org
Contact: Gretta McHaney-Trice

JACKSON, Hillsdale, Lenawee, Monroe
Southeastern Dispute Resolution Services
United Way of Jackson County
P.O. Box 1345
536 N. Jackson Street
Jackson, MI 49204
Phone: 517-990-0279
Fax: 517-784-2340
E-mail: mstanley@uwjackson.org
Website:
Contact: Marc Stanley

KALAMAZOO, Barry, Calhoun
Dispute Resolution Services
Gryphon Place
3245 South 8th Street
Kalamazoo, MI 49008
Phone: 269-552-3434
Fax: 269-381-0935
E-mail: drsmediate@hotmail.com
Website: www.gryphon.org
Contact: Maricela Alcala

KENT, Ionia, Lake, Mecosta, Montcalm, Newaygo, Osceola
Dispute Resolution Center of West Michigan
Community Reconciliation Center
678 Front Avenue, NW
Suite 250
Grand Rapids, MI 49504-5368
Phone: 616-774-0121
Fax: 616-774-0323
E-mail: cgilman@drcwm.org
Website: www.drcwm.org
Contact: Christine Gilman

MACOMB, Huron, Lapeer, Sanilac, St. Clair, Tuscola
The Resolution Center
176 South Main Street, Suite 2
Mt. Clemens, MI 48043
Phone: 586-469-4714
Fax: 586-469-0078
E-mail: cpappas@theresolutioncenter.com
Website: www.theresolutioncenter.com
Contact: Craig R. Pappas

MARQUETTE, Alger
Marquette-Alger Resolution Service
715 W. Washington Street, Suite A
Marquette, MI 49855
Phone: 906-226-8600
Fax: 906-226-5399
E-mail: marsmediation@yahoo.com
Website: www.marsmediation.org
Contact: Jennifer Frazier

MUSKEGON, Manistee, Mason, Oceana
Mediation & Restorative Services
27 East Clay Avenue
Muskegon, MI 49442
Phone: 231-727-6001
Fax: 231-727-6011
E-mail: kkscarbrough@mediatewestmichigan.com
Website: www.mediatewestmichigan.com
Contact: Kate Kesteloot Scarbrough

OAKLAND
Oakland Mediation Center, Inc.
550 Hulet Drive, Suite 102
Bloomfield Hills, MI 48302
Phone: 248-338-4280
Fax: 248-338-0480
E-mail: bhanes@mediation-omc.org
Website: www.mediation-omc.org
Contact: Bonnie Hanes

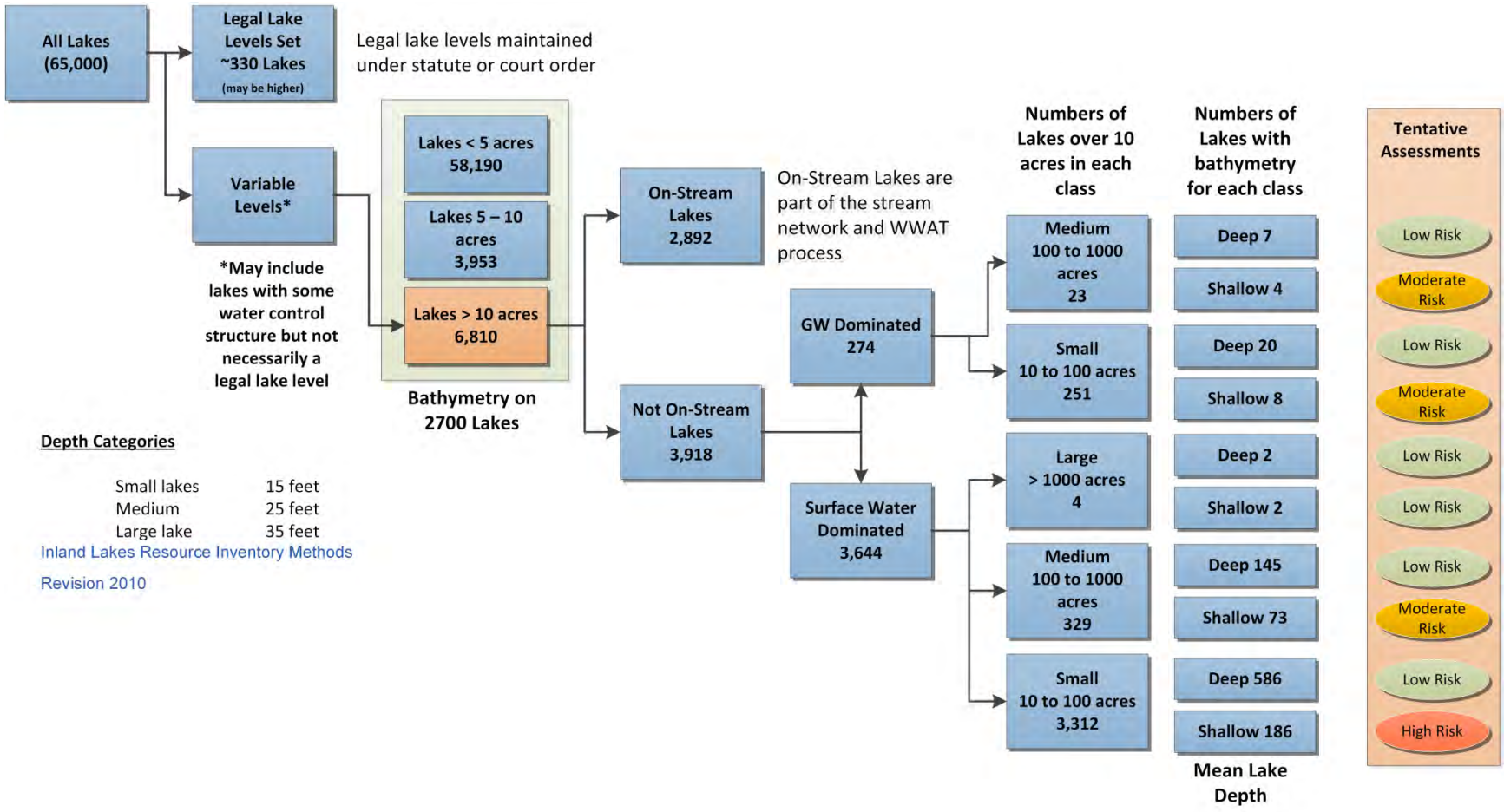
OTSEGO, Alcona, Alpena, Cheboygan, Crawford, Iosco, Kalkaska, Montmorency, Oscoda, Presque Isle
Community Mediation Services
Otsego County
United Way Building
116 5th Street
Gaylord, MI 49735
Phone: 989-732-1576; 989-705-1227
Fax: 989-705-1337
E-mail: annette@mimediation.com
Website: www.mimediation.com
Contact: Annette Wells

OTTAWA, Allegan
Mediation Services
Center for Dispute Resolution
Courthouse Square
68 West 8th Street, Suite 220
Holland, MI 49423
Phone: 616-399-1600
Fax: 616-399-1090
E-mail: EGiddings@MediationServices.Works
Website: www.MediationServices.Works
Contact: Elizabeth Giddings

WASHTENAW, Livingston
Dispute Resolution Centers of Michigan, Inc.
The Dispute Resolution Center
4101 Washtenaw Avenue
Suite 1105
Ann Arbor, MI 48108
Phone: 734-794-2125
Fax: 734-794-2126
E-mail: dulinb@ewashtenaw.org
Website: www.thedisputeresolutioncenter.org
Contact: Belinda Dulin

WAYNE
Wayne Mediation Center
Garrison Place
19855 W. Outer Drive
Suite 206 -- East Building
Dearborn, MI 48124
Phone: 313-561-3500
Fax: 313-561-3600
E-mail: bdempsey@mediation-wayne.org
Website: www.mediation-wayne.org
Contact: Bernard Dempsey

Inland Lake and Pond ARI Decision Tree Diagram



Depth Categories

Small lakes	15 feet
Medium	25 feet
Large lake	35 feet

Inland Lakes Resource Inventory Methods

Revision 2010

Inland Lake Case Study
(WWAT) Site Specific Review

Inland Lake Work Group
April 3, 2014

Jill Van Dyke DEQ
Mario Fusco DEQ

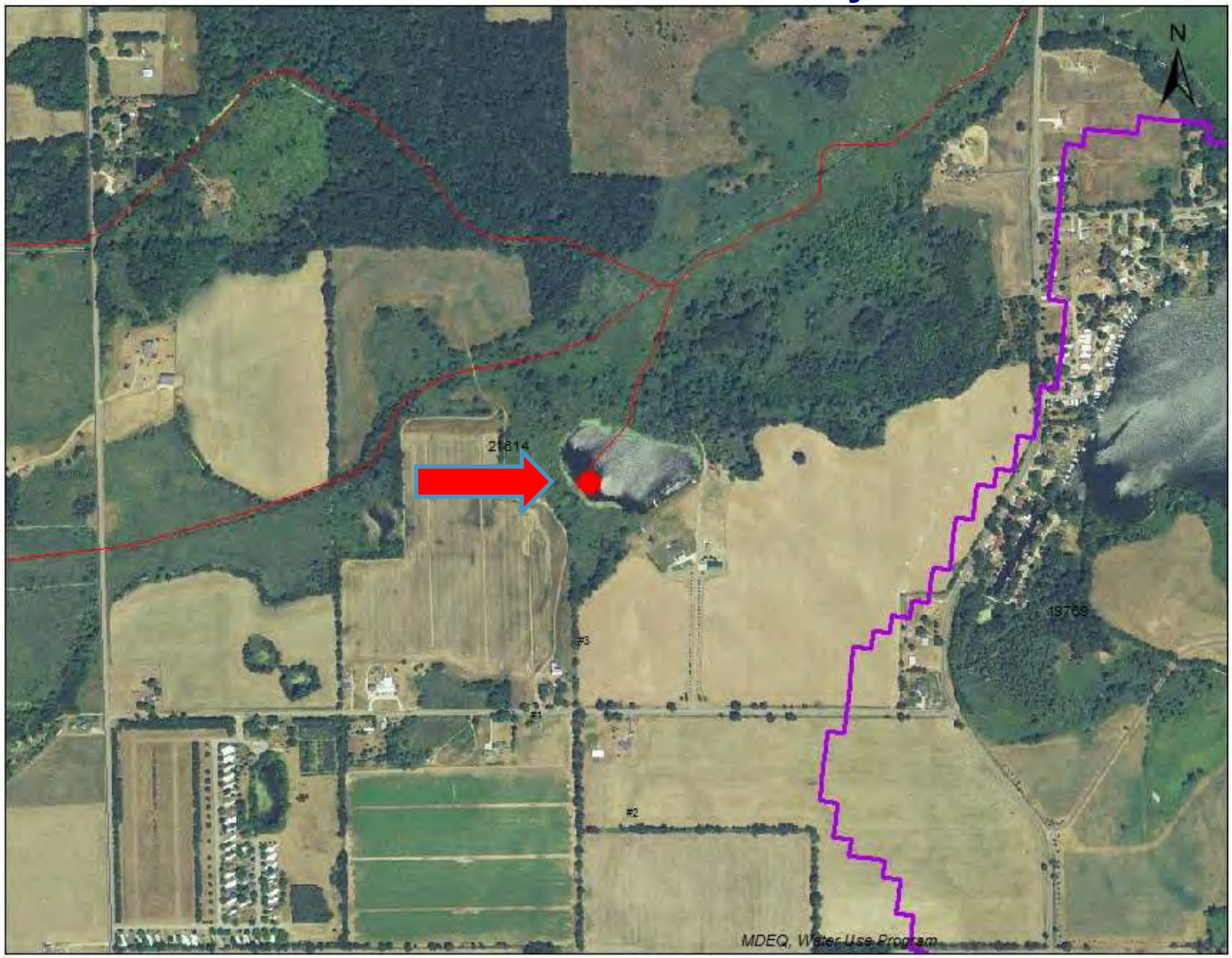
Part 327 Assessment of Impact to Lakes

- Surface Area 5 Acres or Greater
- Direct Withdrawal from Lake or Pond
- Withdrawal Impairs Function
  - Inability to Support Fish Populations
  - Impairs or Destroys Spawning Grounds
  - Increases Temperature
  - Promotes Growth of Algae or Vegetation
- Withdrawal Impairs Uses
  - Impacts Fishing Activites
  - Impacts Boating Use
  - Impacts Usability of Docks

Inland Lake Case Study
Fulks Lake Branch County

- Issues Considered
- Available Information
- Site Visit
- Results of SSR
- Additional Needs

Fulks Lake – Branch County



Issues Considered

- Are There Fish in Fulks Lake?
- How Deep is the Lake?
- Wetland Area?
- Endangered or Threatened Species?
- Part 303 Permit Required?
- Geology-Hydrogeology
- Will Withdrawal Lower the Lake Water Level?
- Will a Water Level Drop Impact the Lake?
- Should the Withdrawal Be Authorized?

Property Owner Interviewed

- Lake Never Freezes Over
- Spring Fed – "Bubbling" in Winter at Times
- County Drain Work Changed Lake Outlet 10 Years Ago
- Water Depth Along Shore 2 to 4 ft
- Fishing
- Boating

DNR 1939 Fulks Lake Survey Report

DEPARTMENT OF CONSERVATION

LAKE REPORT NO. 45 FISHERIES DISTRICT NO. 9

1. Name Fulks Lake Other names

2. Location Branch (County) Coldwater (Township) 6S (Town) 6W (Range) 1 (Section)

3. Check: Is lake public? Private? Semi-private? X. If the latter, explain conditions under which the public is permitted to fish:

By permission of landowner.

4. How reached by road: 1 mile east; 2½ miles north of Coldwater on gravel road; 20 rods west on farm lane to lake.

5. Character of surrounding country rolling, partly cultivated; marsh

6. Area of lake, in acres 20 Source of information G.G. Cole

7. Maximum depth 20 ft. Indicate approximate proportion of water area:

Over 40 feet ____ From 6 to 20 feet 75% Under 6 feet 25%

8. Character and source of water supply springs

9. Outlet Channel to Coldwater (Name) (Check): Continuous X Seasonal ___ Intermittent ___

10. Kind of beaches and quality of swimming None

11. Kind of shores mud & marl

12. Approximate number of:

	Private	Commercial
Cottages	none	none
Bathing beaches	"	"
Camp sites	"	"
Boats	1	"

13. Kind and extent of fishing:

Kind of fish	Open water	Through the ice
bluegills	medium	medium
l.m. bass	"	"
perch	"	"
sailor bass	"	"
pike	"	"
bullheads	"	"
sunfish	"	"
yellow bass	"	"

14. Species recommended for stocking bluegills, l.m. bass (Game fish or forage)

By whom recommended G. G. Cole—J. Scully

15. Date of report 9/2/39 Submitted by J. Scully, G.G. Cole

(Use reverse side or separate sheet for extended answers or remarks)

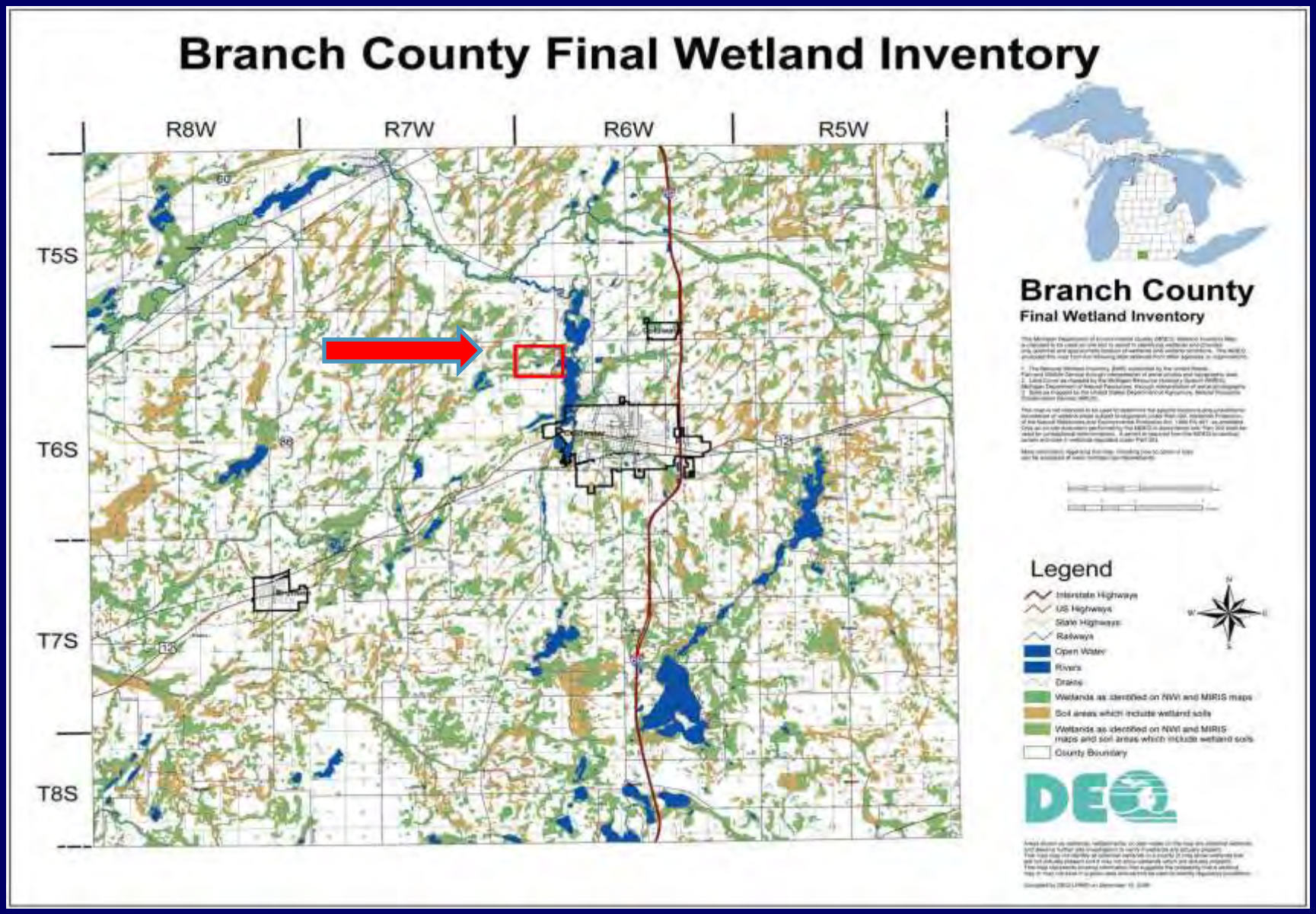
Fish 2M 6-38.

W. Fulks—farm lane to lake

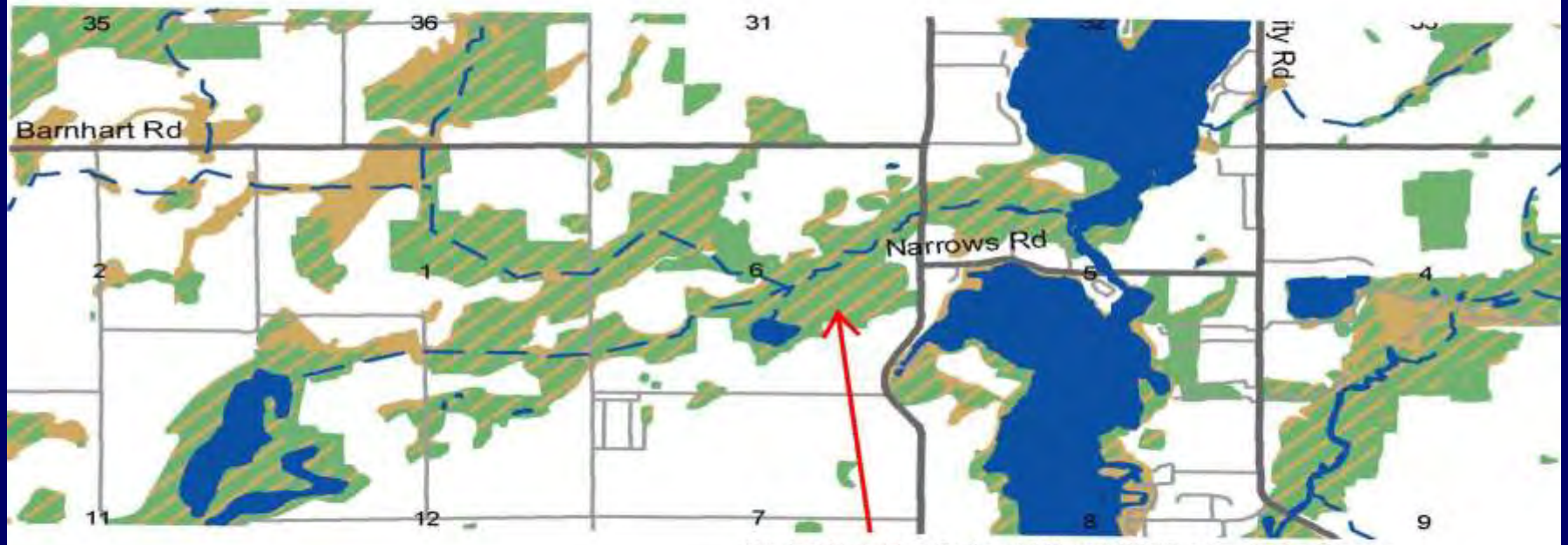
DNR 1939 Fulks Lake Survey Report

- List of Fish Populations
- Depth of Lake 20 ft
- Size – 20 Acres (6.5 Acres Currently)
- Spring Fed
- Rolling Hills, Partly Cultivated, Marshy
- Mud and Marl Shores
- 75% of Lake 6 to 20 ft Deep

Branch County NWI Map



Fulks Lake – Wetland Soils



Wetlands as identified on NWI and MIRIS maps and soil areas which include wetland soils

DNR Inland Lake Maps

DNR - Inland Lake Maps by County - Windows Internet Explorer

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- Commissions, Boards and Committees
- Doing Business
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  - Kids, Parents, Teachers
  - Fishing Licenses, Seasons, Regulations
  - Managing Michigan's Fisheries
  - Doing Business: Permits, Applications & Reporting
  - Calendar
- Forestry
- Grants
- Hunting & Trapping

DNR > FISHING > FISHING IN MICHIGAN

Inland Lake Maps by County

Michigan boasts more than 11,000 inland lakes. Now you can access 2,700 inland lake maps online. Click on a county for a list of inland lakes in that county.

The Michigan DNR makes every effort to provide useful and accurate information. It does not warrant the information to be completely representative of current conditions. Counties displayed in [illegible] do not have maps available.

DNR Branch County Lakes

DNR - Branch County - Windows Internet Explorer

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Michigan Department of Natural Resources

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  - Kids, Parents, Teachers
  - Fishing Licenses, Seasons, Regulations
  - Managing Michigan's Fisheries
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  - Calendar
- Forestry
- Grants
- Hunting & Trapping

Branch County

Archer Lake
Bartholomew Lake
Cary Lake
Cemetary Lake
Clayton Lake
Coldwater Lake
Craig Lake
Gilead Lake
Goodrich Lake
Haven Lake
Kenyon Lake
Lake George
Lavine Lake
Long Lake
Loon Lake
Marble Lake
Matteson Lake
Messenger's Lake
Morrison Lake
Mud Lake
North Lake
Randall Lake
Rose Lake(s) (Lake Of The Woods)
Silver Lake
Union Lake

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Related Content

- Alger County
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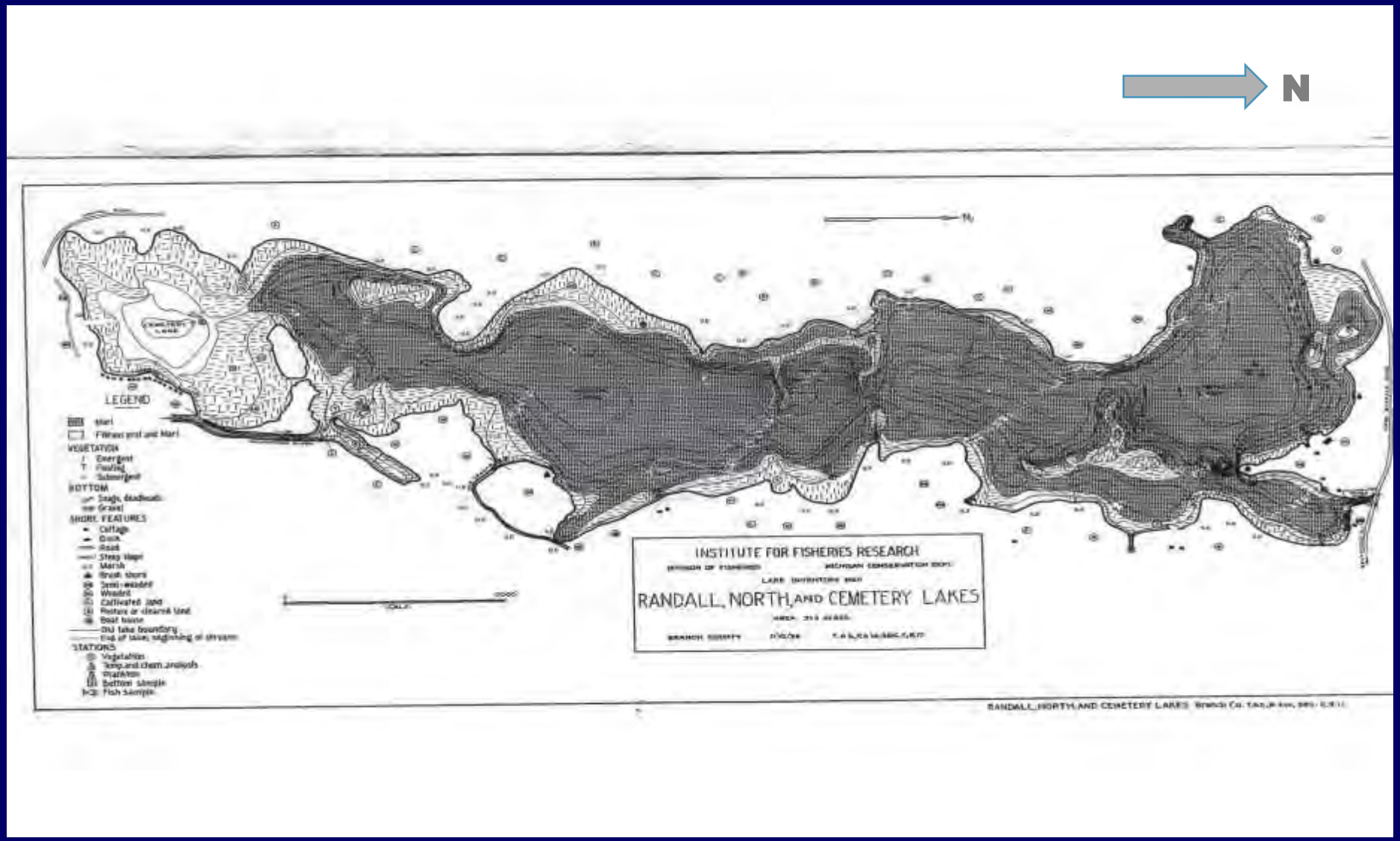
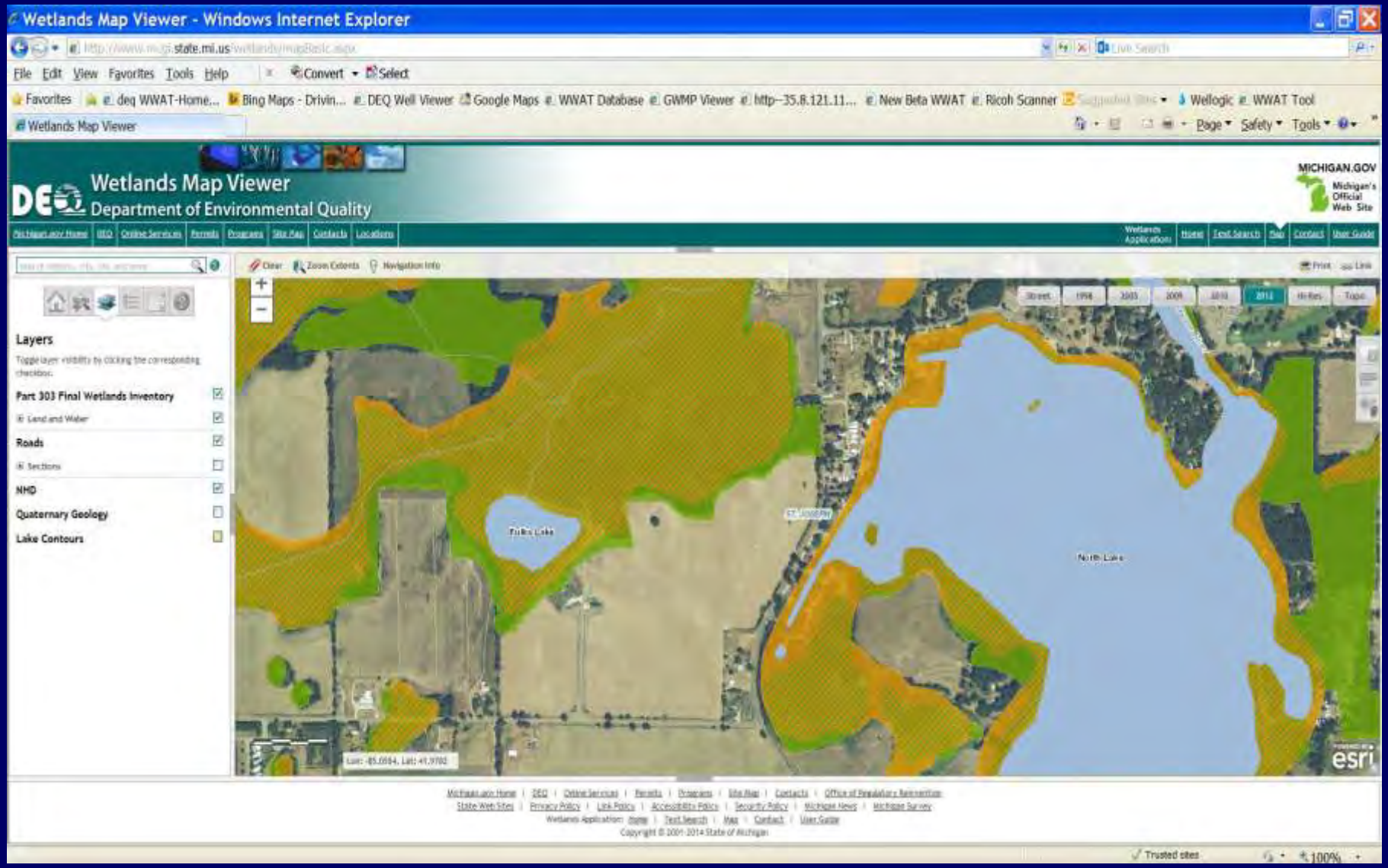
- Cheboygan County
- Chippewa County
- Clare County
- Clinton County
- Crawford County
- Delta County
- Dickinson County
- Emmet County
- Genesee County
- Gladwin County
- Gogebic County
- Grand Traverse County
- Gratiot County
- Hillsdale County
- Houghton County
- Ingham County
- Ionia County
- Iosco County

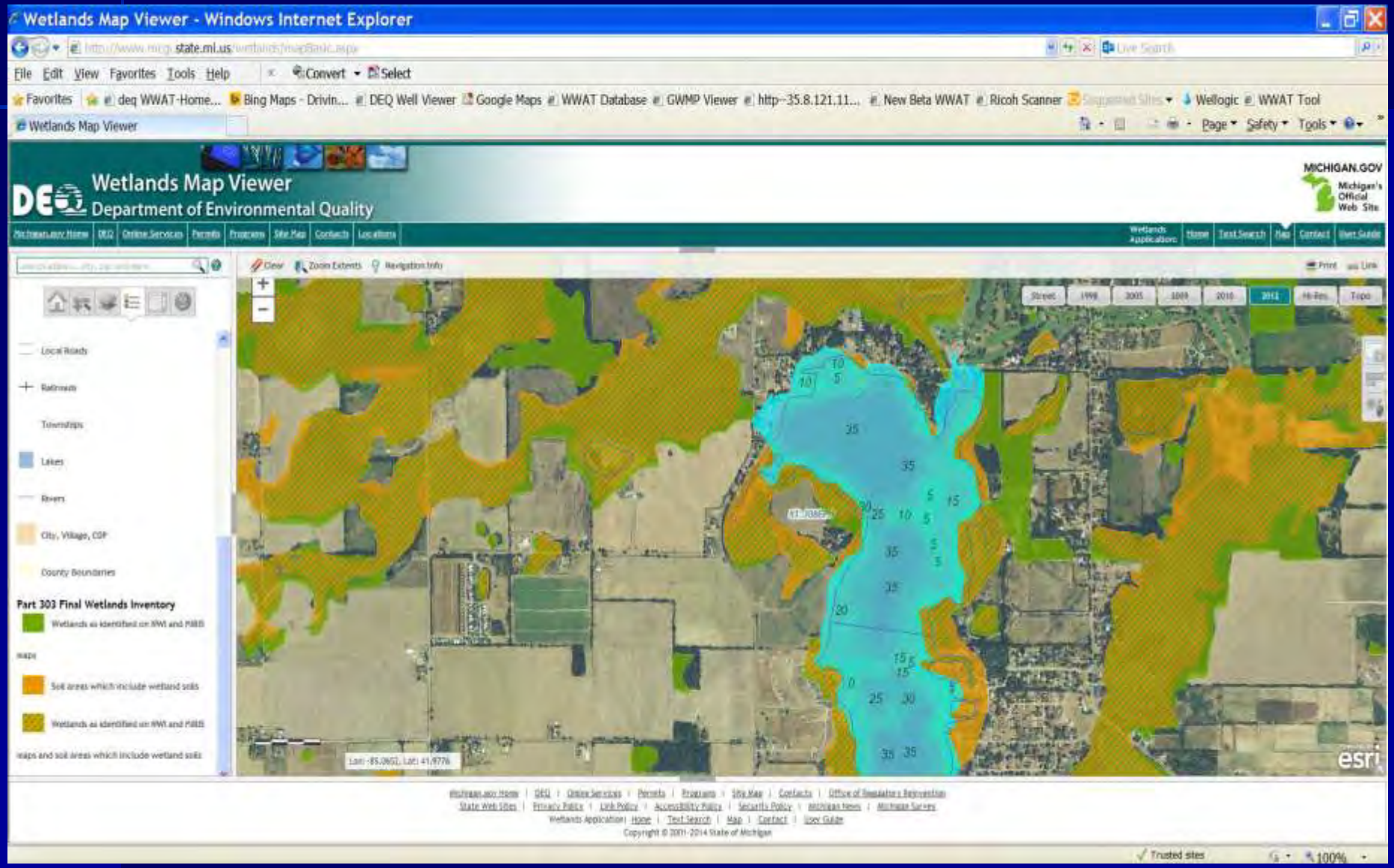
1938 North-Randall Lake Inventory Map



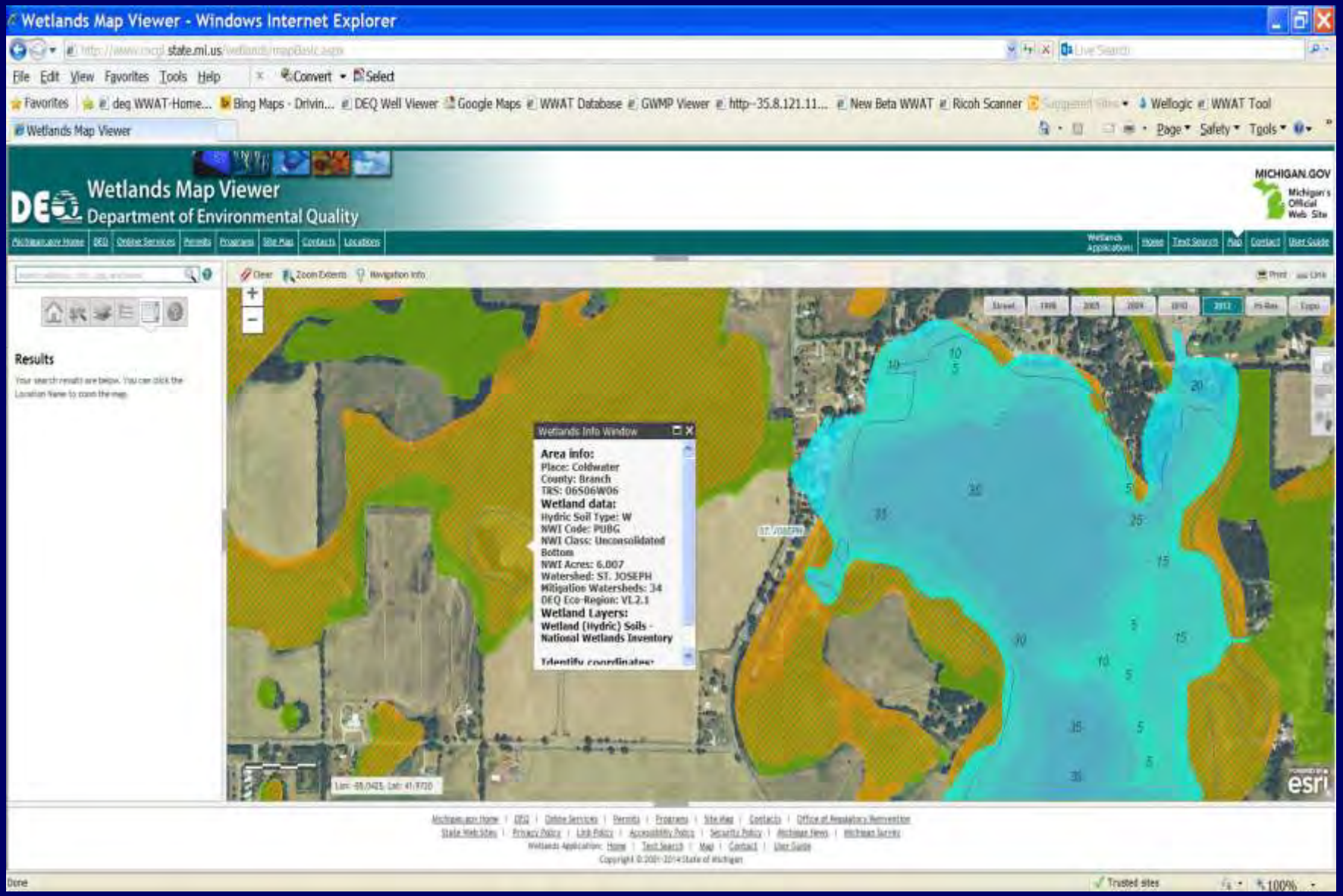
DEQ Wetlands Interactive Map Viewer



Wetlands and Bathymetry Layers



Interactive Layers - Information



US Fish and Wildlife Service
Michigan Endangered Species

USFWS: Endangered Species in Michigan - Windows Internet Explorer

U.S. Fish & Wildlife Service

Endangered Species

Midwest Region

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- Species Lists
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Endangered Species Daily Facts

Migration is not limited to birds and butterflies. In March, male gray whales and newly pregnant females start a northern migration

Michigan

Federally-listed Threatened, Endangered, Proposed, and Candidate Species

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For more information about threatened and endangered species in Michigan, contact the U.S. Fish & Wildlife Service office at 2651 Coolidge Road, East Lansing, Michigan 48823 (517/351-6274)

Bald Eagle

Bald eagles are no longer protected under the federal Endangered Species Act and Section 7 consultation with the U.S. Fish and Wildlife Service is no longer necessary. However, the bald eagle remains protected under the Bald and Golden Eagle Protection Act.

- Information about Bald Eagles
- Information about Eagle Permits and the Bald and Golden Eagle Protection Act

Gray Wolf

The Gray Wolf population that includes Michigan was removed from the list of threatened and endangered species and is no longer protected under the Endangered Species Act.

SPECIES	STATUS	COUNTIES	HABITAT
MAMMALS			
Canada lynx (*Lynx canadensis*)	Threatened	**Current distribution:** A Canada lynx was recently documented in the Upper Peninsula. The counties listed here have the highest potential for Lynx presence: Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon, Schoolcraft.	Northern forests
Indiana bat	Endangered	Allegan, Barry, Bay, Benzie,	Summer habitat includes

Federal Endangered or Threatened Species

- Indiana Bat
- Copperbelly Water Snake
- Mitchell's Satyr Butterfly

Michigan DNR List of Endangered Species

DNR - County Element Lists - Windows Internet Explorer

http://www.michigan.gov/dnr/0,4570,7-153-10370_12145---,00.html

endangered species branch county michigan

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Favorites | deq WWAT-Home... | Bing Maps - Drivin... | DEQ Well Viewer | Google Maps | WWAT Database | GWMP Viewer | http--35.8.121.11... | New Beta WWAT | Ricoh Scanner | Wellogic | WWAT Tool

DNR - County Element Lists

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Michigan Department of Natural Resources

- About the DNR
- Camping & Recreation
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- Doing Business
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- Public Lands Managed by the DNR

DNR > WILDLIFE & HABITAT > ENDANGERED & NONGAME WILDLIFE > PROTECTION OF THREATENED SPECIES

County Element Lists

The County Element Lists include all elements (species and natural communities) for which locations have been recorded in Michigan Natural Features Inventory's (MNFI) Biological and Conservation Datasystem for each county. Information from the database cannot provide a definitive statement on the presence, absence, or condition of the natural features in any given locality. The County Elements Lists should be used as a reference of which natural features currently or historically were recorded in the county and should be considered when developing land use plans.

These lists are produced by Michigan Natural Features Inventory (MNFI). MNFI is a cooperative program of Michigan State University Extension and the Michigan Department of Natural Resources. By clicking on the link below, you will be re-directed to the MNFI website to view the lists.

Michigan County Element Lists

Related Content

- Michigan's Official List of Endangered and Threatened Species Effective April 9, 2008
- Michigan's Special Animals
- Michigan's Special Plants

Trusted sites 100%

DNR-Branch County Endangered Species

County Element Data - Windows Internet Explorer

Michigan Natural Features Inventory

MICHIGAN STATE UNIVERSITY EXTENSION

County Element Data

Choose a new county

Branch County

Current as of 11/26/2013

Scientific Name	Common Name	Federal Status	State Status	Global Rank	State Rank
Acris crepitans blanchardi	Blanchard's cricket frog		T	G5T5	S2S3
Alasmidonta viridis	Slipershell		T	G4G5	S2S3
Ammodramus henslowii	Henslow's sparrow		E	G4	S2S3
Ammodramus savannarum	Grasshopper sparrow		SC	G5	S3S4
Amorpha canescens	Leadplant		SC	G5	S3
Aristolochia serpentaria	Virginia snakeroot		T	G4	S2
Baptisia lactea	White or prairie false indigo		SC	G4Q	S3
Clemmys guttata	Spotted turtle		T	G5	S2
Coregonus artedi	Lake herring or Cisco		T	G5	S3
Cypripedium candidum	White lady slipper		T	G4	S2
Erimyzon claviformis	Creek chubsucker		E	GNR	S1S2
Fundulus diaphanus	Starhead topminnow		SC	G4	S2
Hedyotis nigricans	Hedyotis		X	G5	SX
Hybanthus concolor	Green violet		SC	G5	S3
Hydrastis canadensis	Goldenseal		T	G4	S2
Lepisosteus oculatus	Spotted gar		SC	G5	S2S3
Lipans ilinfoka	Purple bowyblade		SC	G5	S3
Moxostoma carinatum	River redhorse		T	G4	S1
Myotis sodalis	Indiana bat	LE	E	G2	S1
Neonympha mitchelli mitchelli	Mitchell's satyr	LE	E	G1G2T1T2	S1
Nerodia erythrogaster neglecta	Copperbelly water snake	LT	E	G5T3	S1
Notropis anogenus	Pugnose shiner		E	G3	S3
Notropis chalybaeus	Ironcolor shiner		X	G4	S1

Site Visit

- Conducted By District Staff
- Onsite in June
- Evaluate Potential Wetland – Permit
- Connection of Lake to Stream

Site Visit Results

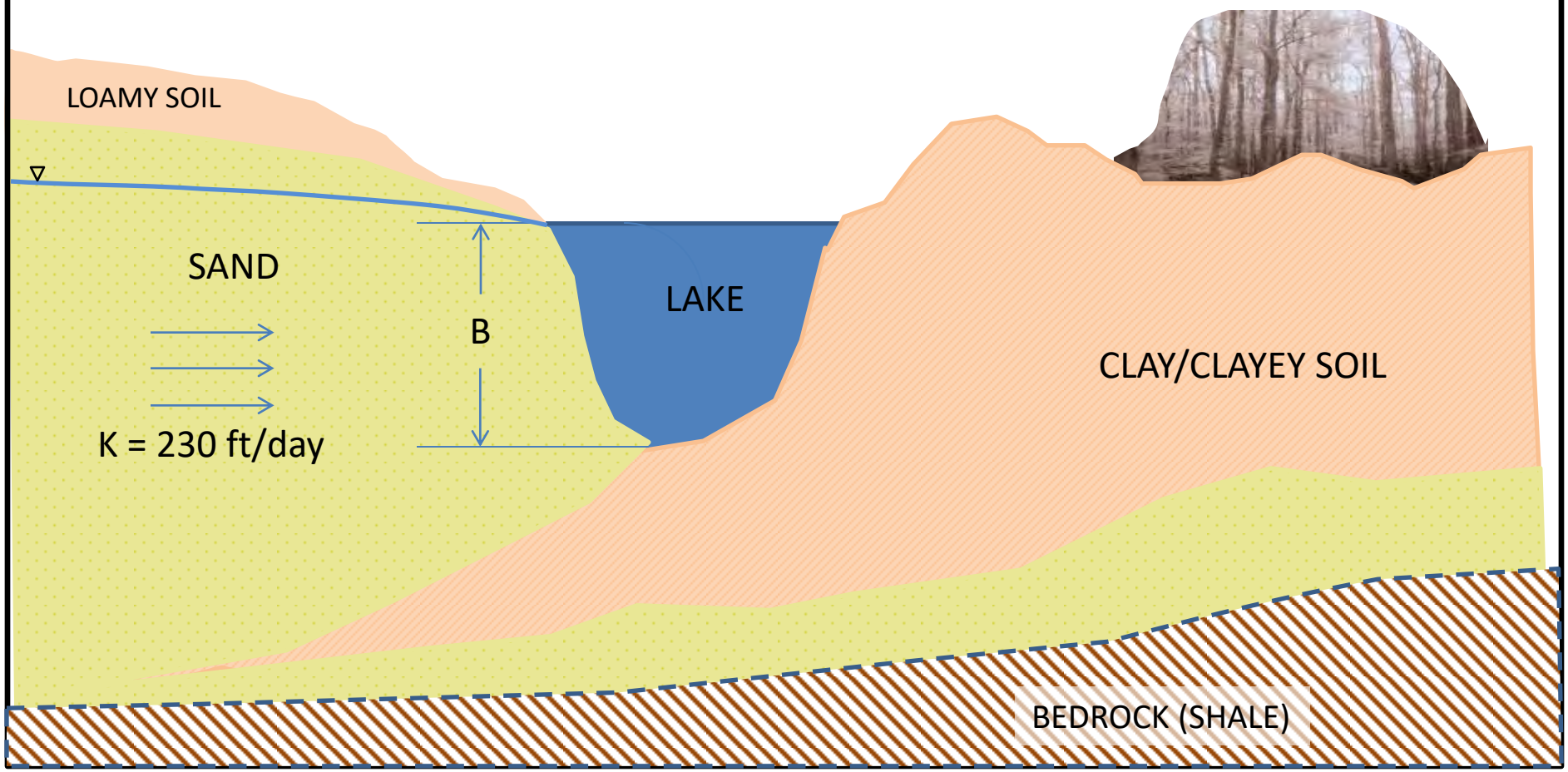
- Fill Associated with a Seawall
- Forested, Deciduous Wetland
- Dense Underbrush, Poison Sumac, Alkaline Species
- Skunk Cabbage, Reed Canary Grass, MI Holly, Sedges
- Seasonally Saturated, Water Ponding in Areas
- Trees Show Evidence of Innundation
- Possible Bat Habitat
- No Outlet to Stream Observed

Geology-Hydrogeology

- Clay Rich Beneath Stream and Wetland
- Sands Increase Toward South and West
- Residential Wells Surrounding
- Shale at 65- 75 ft Toward East
- Shale at 55 ft Toward South
- Groundwater Flow Toward Northeast
- Water from the Lake Flows into Wetland Periodically

Fulks Lake Area Well Locations

CONCEPTUAL MODEL



DARCY'S EQUATION

$$Q = -KAdh/dl$$

K = 230 ft/day

$$\frac{dh}{dl} = Hydraulic\ Gradient = -0.011$$

A = AREA = Aquifer/Sat Zone thickness X Aquifer width

In our example :

Aquifer/sat zone thickness = 20 ft
Aquifer width = 950 ft

FULKS LAKE DEPLETION CALCULATION:

LAKE AREA (acres)	6.5	ACRES
LAKE AREA (ft^2)	283140	ft^2
PI	3.1416	
EQUIVALENT RADIUS	300	ft

LAKE VOLUME

SHELF LENGTH (FT)	DEPTH	UPPER AREA	LOWER AREA	AVERAGE AREA	VOLUME1
8	3	282744	267865.3824	275304.6912	825914.0736
100	17	267865.3824	125664	196764.6912	3344999.75
				TOTAL VOLUME (ft^3)	4170914

PROPOSED WELL

		OPERATION DAYS	HOURS PER DAY
PUMP CAPACITY(gpm)	500	3	12
PUMP CAPACITY(gpd)	720000		

GROUNDWATER INFLOW

GRONDWATER INFLOW (DARCY'S LAW)	
Hydraulic Conductivity, k (ft/day)	230
Aquifer/Sat Zone thickness, B (ft)	20
Aquifer width, W (ft)	950
Groundwater Slope (ft/ft)	0.011

GW INFLOW (ft3/day)	GW INFLOW (gpd)	GW INFLOW (gpm)	VOLUME (ft^3)
48070	359588.5483	249.7142537	72105

VOLUME CALCULATION

PUMP VOLUME (ft^3)	GW INFLOW (ft^3)	DELTA VOLUME (ft^3)
144375.048	72105	72270

DEPTH DEPLETION

WATER DEPTH	AVERAGE AREA	VOLUME (ft^3)	CUMULATIVE VOLUME	NET VOLUME (w/ GW INFLOW)
0.2	282241.7908	56448.35816	56448.35816	15821.64184
0.256	281599.1232	15769.5509	72217.90906	52.09094135
0.6	280597.3856	96525.50065	168743.4097	-96473.40971
3.69	263215.4789	813335.8299	982079.2396	-909809.2396

Estimated Water Level Change

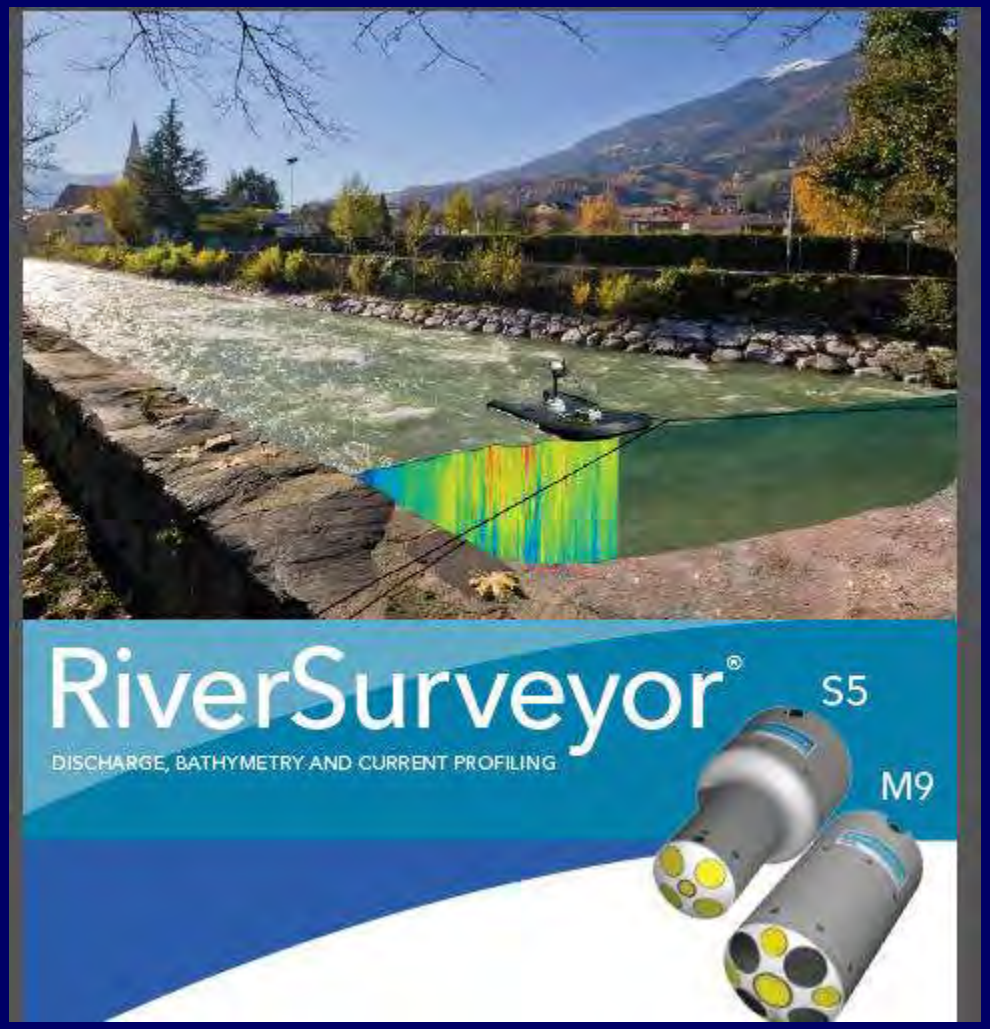
- 500 gpm, 3 Days/Week, 12 Hours/Day
- Pumping June, July, August
- Estimated Sand Conductivity 230 ft/Day
- Water Level Drop of 0.25 ft After 3 Days
- DNR Concluded That This Level of Change Not Likely to Cause Impact to Fish

Site-Specific Review Result

- Withdrawal Isolated from Stream by 20 ft Surface Clay
- No Impact from Water Level Change
- Possible Wetland Permit Required
- Voluntary Lake Level Monitoring
- SSR No ARI Determination Part 327

Additional Needs

- Bathymetry for Fulks Lake
- Monitoring Points During Withdrawal
- Means of Considering Wetland Impact
- Means of Considering Water Quality
- Geology Information, Well Log Data, Cores



http://www.sontek.com/productsdetail.php?RiverSurveyor-S5-M9-14

Summary

- Direct Withdrawal from a 6.5 Acre Lake
- Part 327 Applies but is Limited
- Part 303 Wetland Permit May be Required
- Withdrawal Request was Authorized Based on Part 327 Criteria
- Additional Criteria Needed to Assess Withdrawal Impacts on Lake and Wetland

QUESTIONS?

Appendix D | Recommendations Matrix

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
TU-C	**TU 1.1**	As quickly as possible, the Program should partner with Michigan NHD Steward to edit the NHDH, attributing all segments as intermittent that are symbolized as intermittent on the most current version of the 1:24,000 topographic maps.				
TU-C	**TU 1.2**	As soon as an edited version of the NHDH is available, the DEQ should eliminate all intermittent segments and adopt this revised file as the hydrography used by the Program in both the WWAT and during site specific reviews.				
TU-C	**TU 1.3**	Recognizing that such an effort could be lengthy, the Council recommends that the DEQ use a phased approach by giving first priority to those regions of the State where the majority of the current water withdrawal registrations have occurred.				
TU-C, TU-G, TU-H	**TU 2.1**	Modify the WWAT's coding to use the top-of-bedrock depth from the WWAT's glacial thickness map GIS data layer at the proposed well location instead of using an average top-of-bedrock depth for the Watershed Management Area.	DTMB-CSS		One year	DTMB-CSS can provide estimate
TU-C, TU-G, TU-H	**TU 2.2**	Make the WWAT registration number a required field in Wellogic (and on paper well logs) for high-capacity wells.	If not implemented, will require additional DEQ staff support to systematically match well logs **OR** contract out.	MGWA, MI Environmental Health Association, MFB, MABA, MSUE, MSU IWR, MDARD	One year	
TU-C, TU-G, TU-H	**TU 2.3**	Permanently discontinue use of the "Bedrock Auto Pass" feature. The WWAT should be reconfigured in the areas that originally used the "Bedrock Auto Pass" feature. The WWAT should use bedrock aquifer characteristics to calculate streamflow depletion when bedrock is selected. As an interim measure, until the bedrock aquifer calculation is implemented, the DEQ should use glacial aquifer characteristics in the WWAT when bedrock is requested. If that triggers a SSR, the DEQ should use bedrock aquifer characteristics to calculate streamflow depletion.	DTMB-CSS			
TU-H	**TU 3.1**	The process for checking the compliance of "as built" well construction details with WWAT and/or SSR registrations of groundwater LQWs should be automated. Discrepancies between these should be flagged for follow up by staff.	Ongoing follow-up by DEQ staff. Automated process anticipated to reduce staff labor overall.			
TU-H	**TU 3.2**	The DEQ should work with stakeholders to increase the understanding of Part 327 requirements for owners of newly constructed large capacity wells, and increase compliance with the requirement to report differences between registered and "as built" well characteristics.		Engage stakeholder group: property owners, well drillers, health departments		
TU-D, TU-H	**TU 4.1**	The DEQ should write up the procedures and criteria used to modify index flows. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.	Existing DEQ staff	Review through Council		
TU-D, TU-H	**TU 4.2**	The DNR should write up the procedures and criteria used to modify stream classification. The procedures and criteria should be reviewed by the Council, or similar stakeholder group, before adoption by the Department.	Moderate - significant DNR staff time.	Review through Council		

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
TU-D, TU-H	**TU 4.3**	The DEQ/DNR should use Table TU-1 as a guide to determine what level of approval is needed to make modifications within the Water Withdrawal Assessment Process.	No action needed at this time			
TU-C, TU-F, TU-H	**TU 5.1**	Continue to use the index flow estimation model for the initial values in the WWAT that are then modified by SSRs.	No action needed at this time			
TU-C, TU-F, TU-H	**TU 5.2**	Continue to use the current analytical solution (Hunt, 1999) in the WWAT to compute streamflow depletion.	No action needed at this time			
TU-G, TU-H	**TU 6.1**	Work with stakeholders to develop criteria describing site specific data analyses to estimate potential streamflow depletion by a new well. The criteria should specify desired quality assurance and quality control processes for the program.	Moderate DEQ staff time	Engage stakeholders, plus a technical workgroup		
TU-G, TU-H	**TU 7.1**	Work with stakeholders to develop criteria describing the required features of groundwater-flow models to be used in the water-withdrawal assessment process focusing on streamflow depletion.		Engage stakeholders, plus a technical workgroup		
EM-B	**EM 1.1**	To ensure prevention of adverse resource impacts, and to reduce potential for water user conflicts, the DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of stream flow data in high water withdrawal areas or areas of potential conflict.	Additional monitoring staff **AND/OR** contract out.	Engage stakeholder group		New funding required
EM-B	**EM 1.2**	We recommend the DEQ invest resources to reasonably ensure continuous progress towards filling streamflow measurement data gaps.	Additional monitoring staff **AND/OR** contract out.			
EM-B, EM-E	**EM 1.3**	Protocols and standards for the collection and use of stream flow data for use in this program should be developed by the DEQ, approved by the WUAC and approved through the appropriate statutory process, and clearly published on its website.	Moderate - significant existing DEQ staff time **AND/OR** implement via Council.	Council		
EM-B	**EM 1.4**	When the DEQ receives or acquires data of the quality and standards that would prompt the Department to change a Tool parameter for a Watershed Management Area, the DEQ should not wait until a registration request triggers an SSR in that Watershed Management Area. The DEQ should incorporate that new data and make any appropriate changes at least bi-annually.	Minimal, ongoing existing DEQ staff time			
EM-E	**EM 1.5**	The DEQ should develop a program for streamflow data collection by non-agency persons. This program should provide data collection procedures and guidance, explanation of how the data can be used, provide for training opportunities, and provide for the collection, storage and accessibility of the data collected.	Moderate - significant existing DEQ staff time for program development. Ongoing support to manage program. Workload lessened by using existing framework from MITU and working with MiCorps.			New funding required to support trainings and equipment
EM-D	**EM 1.6**	The DEQ and DNR should invest in the strategic acquisition of research and/or monitoring to assess the real-world impacts of large-quantity water withdrawals.	Universities, consultants or other contractors	Engage stakeholders		
EM-B, TU-C, TU-H	**EM 1.7**	We recommend that an overall statistical update of all index flows is not yet necessary. The need to perform this statistical update should be reviewed by the DEQ at least every 5 years.	Minimal existing DEQ staff time for review every 5 years		Statistical update review every 5 years	

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
EM-B	**EM 2.1**	We recommend a database be created to gather and collate data on glacial geology, static water levels and aquifer characteristics collected by state and federal agencies as well as by universities and private industry. It should utilize a common set of accepted geologic and hydrogeologic terms and fields. Organizations or agencies collecting this data should have the ability to submit information to be entered into the database, and the data submitted shall conform to State program requirements. This database should be publicly viewable.	2-6 months DEQ staff time. Scanning and digitizing could be done via students/MGS.		About one year, 3 months to build database and populate with data	
EM-B, EM-E	**EM 2.2**	The State should publish its protocols and standards for the collection and use of groundwater data and glacial geology on its public websites.		Engage Council		
EM-B	**EM 2.3**	The DEQ should prioritize and invest resources to ensure prompt, adequate and strategic acquisition of groundwater data in areas receiving or anticipated to receive high levels of water withdrawal registrations.	Contract out		3 to 6 years for geologic mapping of one county	New funding required. $161,343 for two 7.5 minute quadrangles in Cass County. Entire county ~$1,613,430. Could be done on quadrangle or watershed basis to prioritize.
EM-B	**EM 2.4**	The DEQ should use high quality data it receives, acquires, or collates from the data submitted to the groundwater database and integrate those data into the SSRs, develop numerical models to better understand the hydrogeology of certain areas, and develop better tools to predict streamflow depletion in those areas. Collection of these data and using updated models can ultimately inform and upgrade the screening tool once sufficient data is collected for the associated Watershed Management Areas.				
EM-B	**EM 2.5**	The DEQ should continue to collaborate with Michigan Geological Survey and water well drillers on new tools and training programs being developed to improve geologic data entered into Wellogic records, and should make necessary changes to Wellogic forms to facilitate the entry of more accurate geologic data into Wellogic.	MGS, MGWA in collaboration with DEQ	Well drillers	Draft program could be in place by mid-2015	
WU-F	**WU 1.1**	The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding into the formal list of registered and permitted users those noncompliant large quantity users who were making large quantity withdrawals prior to 2006. This process should not include a debiting of the water accounting system for the pre-2006 withdrawals.	DEQ staff time	Engage stakeholders		
WU-F	**WU 1.2**	The DEQ should establish a process, in advance of any efforts to comprehensively identify large quantity water users, for adding noncompliant large quantity users who have initiated withdrawal since February 28, 2006, without going through the required screening process into the formal list of registered and permitted users. Designing this process will require careful consideration of whether a distinction should be made between those withdrawals initiated prior to October 1, 2008, and those initiated after that date with respect to any decision to require the formal application and screening process to be undertaken by these users.	DEQ staff time. Will increase as more noncompliant users are incorporated into system	Engage stakeholders		
WU-F	**WU 1.3**	The DEQ and MDARD should partner to develop and maintain a system for cross-checking annual water use reports against lists of registered and permitted users to monitor compliance with water use reporting requirements.	Ongoing DEQ staff time to update database. Annual compliance monitoring.			

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
WU-B	**WU 2.1**	The DEQ should invest resources to produce and maintain an online set of resources (as described in Table WU-2) resource to provide technical, organizational and financial information to water users groups to support the formation and functioning of Water Resources Assessment and Education Committees (WRAECs) and Water Users Committees (WUCs).	Existing DEQ staff **OR** contract out via students or consultants			
WU-B	**WU 2.2**	The DEQ should invest resources to produce a brochure that explains the role of WUCs in Michigan's Water Use Program. The brochure would describe the conditions under which the input from a WUC might be needed, benefits to water users of being part of a WUC, and benefits of creating a WUC before a Zone D request is made or an ARI is observed.	Existing DEQ staff **OR** contract out		Review every two years	Contractor cost ~$1500. Annual cost of printing 4000 - 5000 copies: $600 - $750 ($0.15/copy) or $800 - $1000 ($0.20/copy).
WU-B	**WU 2.3**	The DEQ should enclose a copy of the brochure in letters sent to all registered and permitted users and associated local governments when a Zone C (or Zone B for a cold transitional stream) withdrawal is approved after a site specific review and in letters that are mailed to all registered and permitted users and associated local governments when a negative SSR occurs.	Minimal ongoing DEQ staff time. Could increase demand for DEQ assistance.			
WU-B	**WU 2.4**	We recommend that the DEQ undertake the initial convening of a WUC in two scenarios: a) if a recipient of a negative SSR requests help with contacting and convening large quantity water users within the catchment of concern, and b) if an ARI is suspected.	Additional DEQ staff needed for ongoing assistance			
WU-B	**WU 2.5**	The DEQ should develop a protocol to be used for the initial convening of WUCs. The protocol should include the specific tasks the DEQ will undertake at the first WUC meeting.	DEQ staff time			
WU-B	**WU 3.1**	At the request of a WUC (registered and permitted water users in a watershed), the DEQ and MDARD should be prepared to share with the WUC the following information: • Contact information for all registered and permitted water users in the watershed • The cumulative withdrawals in the watershed • The legally available amount of streamflow depletion for the watershed.	DEQ and MDARD staff to create database. Ongoing support needed.			
WU-B	**WU 4.1**	Financial commitment should be made to support the facilitation of water user group negotiations.	Possibly could create new position at QOL agency or external organization (e.g., university, NPO).			Private facilitators could cost ~$500/hr. CDRP more cost effective. Possibly could provide support to CDRP or develop fund to support WUC facilitation.
WU-B	**WU 4.2**	Financial resources should be committed to fund a position which would provide technical assistance to the WUCs and DEQ, serve as liaison between the WUC and DEQ, and assist with the analysis (including analysis of the expected impacts of alternative scenarios that the WUC might consider).	Possibly could create new position at a university, following PERM example			$200,000 salary/benefits

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
WC-B	**WC 1.1**	**Michigan should improve its water use-related data management program. This includes improving the quality of current water use reporting, the capacity to track water usage, the result of conservation measures, and the development of water demand analysis for individual water use sectors. In particular, each water use sector should design the appropriate data sets in order to track water use, progress on water efficiency and conservation, and develop demand analysis. Development of these data sets must balance the need to be generally applicable to a sector or sub-sector and the ability to be tracked over time with the complexities of the circumstances faced by each particular user. The state-specific outcomes described in Recommendation WC 5.1 can inform the development of these data sets. Ideally, these data sets could be recommended for Great Lakes Basin-wide use.**	No current dedicated funding for water use reporting staff. This needs to be addressed.		Agriculture portion of database needs updating at this time.	$50-60,000 per sector update.
WC-B	**WC 1.2**	Based on the water use trends, more focus needs to be placed on conservation and efficiency in the Irrigation Sector. MDARD has developed comprehensive guidance in the form of Generally Accepted Agricultural and Management Practices (GAAMPs), which includes guidance in preparing a water conservation and efficiency plan. MDARD and Michigan State University (MSU) Cooperative Extension should continue to provide and expand training and outreach to the Irrigation Sector to increase the use of these GAAMPs.	Additional FTE in Extension			
WC-B	**WC 1.3**	The DEQ should incentivize water conservation and efficiency in the public sector by rewarding the implementation of water conservation and efficiency measures when applying for State funding for water infrastructure projects. This could be accomplished by providing significant points to project plans from water systems that already have a water conservation and efficiency plan, thereby increasing the likelihood that the project will be funded.	DEQ staff time to develop process. Once developed, minimal ongoing DEQ staff time.			
WC-B	**WC 1.4**	Michigan should also enhance programs to address the supply side of the water equation. For example, the DEQ should continue and expand programs to support development of green infrastructure and review rules and regulations associated with the beneficial reuse of wastewater/process water/storm water to promote more development in this area.	DEQ staff to review regulations			
WC-C	**WC 2.1**	The DEQ should undertake a process to update the current generic and sector-specific conservation measures. This process should include direct involvement by multi-interest stakeholder groups and broader public involvement.	DEQ and MDARD staff time to arrange meetings and engage stakeholders	Stakeholder group		
WC-C	**WC 2.2**	**Michigan should revise its water conservation program to: 1) further inform and encourage water conservation, and 2) assess and document the nature and extent of water conservation practiced by large water users. This program should consist of the following components:**	See 2.2a-2.2d			
WC-C	**WC 2.2a**	Michigan should convene a multi-interest workgroup to identify existing and new opportunities to incentivize water conservation. This effort should target all water users and encourage conservation generally, the adoption of specific practices, and contribution to improved data collection.	DEQ and MDARD staff time to arrange meetings and engage stakeholders	Stakeholder group		

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
WC-C	**WC 2.2b**	Among the specific practices encouraged should be a water auditing program. For public supplies, the water audit should be in conformance with the American Water Works Association (AWWA), M36 Water Audits and Loss Control Programs. Water users should be encouraged to develop a water conservation program based on the results of the audit. While each water user is able to determine the nature and extent of its conservation program, incentives should specifically encourage a component on metrics for evaluating the performance of the program and reporting of results to the DEQ or MDARD. Providing information to employees or water customers on the water user's conservation programs and policies should also be encouraged.	DEQ and MDARD staff time to promote water conservation and provide tools			
WC-C	**WC 2.2c**	To facilitate the above set of activities, the DEQ and MDARD should develop, or arrange for the development of, templates for water audits and conservation plans. These instruments should be considered by the multi-interest group.	DEQ and MDARD staff time to develop templates	Stakeholder group		
WC-C	**WC 2.2d**	The multi-interest workgroup should also be charged with developing a process for evaluating the results of the incentive-based system. This process should include metrics and data collection and evaluation methodologies. Ideally, metrics should be based on outcomes (e.g., volume of water conserved) rather than outputs (e.g., number of conservation practices adopted).	DEQ and MDARD staff time to arrange meetings and engage stakeholders			
WC-C	**WC 2.3**	Michigan should improve the administration of its current water conservation requirements. Specifically, the DEQ and MDARD should evaluate the efficacy of current requirements that farms submit conservation plans (if reporting usage to MDARD) and new registrants in Zone C self-certify compliance with generic or sector-specific conservation measures. The efficacy of these requirements should be considered with reference to the current lack of agency follow-up, the potential for and outcomes of actual enforcement of those requirements, and the opportunities provided by the incentive-based program described above.	DEQ and MDARD staff time to evaluate work and review practices			
WC-D	**WC 3.1**	The Alliance for Water Efficiency Scorecard provides some valuable information on different tools available for addressing water efficiency and conservation in the municipal sector. However, it is not a good metric to evaluate Michigan's Water Use Program overall or the municipal sector of Michigan's Water Use Program in particular. The workgroup does not recommend its use as a metric.	No action needed at this time			
WC-D	**WC 3.2**	**Michigan should develop Water Use Program metrics based on state-specific Water Conservation Program Goals and Objectives, which are recommended for development in Recommendation WC 5.1.**	DEQ and MDARD staff time to develop metrics			
WC-D	**WC 3.3**	Beyond metrics based on state-specific goals and objectives, Michigan should encourage the development of regional metrics tied to the Regional Goals and Objectives developed by the Great Lakes Compact Commission.	DEQ and MDARD staff time to lobby partners			
WC-E	**WC 4.1**	Michigan should coordinate a statewide campaign and marketing effort to encourage water conservation action, or wise water use, across water use sectors and among individuals.	Additional FTEs in DEQ **AND/OR** MDARD			$750,000 for website development, operating and maintenance, additional FTE(s)
WC-E	**WC 4.2**	Michigan should invest in hiring a marketing firm to conduct the necessary research to develop a common theme (similar to "Pure Michigan") and consistent message appropriate to target audiences upon which sectors can build actionable messages appropriate to their client base/members.	Third-party marketing firm		Multiple years	$1.6 million/year

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
WC-E	**WC 4.3**	Michigan should tap into and partner with successful local sector and non-profit campaigns for examples of creative and effective messaging regarding responsible water use.	Ongoing staff time for partnership building			
WC-F	**WC 5.1**	Response to Comment: Michigan should adopt state-specific goals and objectives for its Water Conservation and Efficiency Program.	DEQ and MDARD staff time to arrange meetings and engage stakeholders	Stakeholder group		
WC-F	**WC 5.2**	Response to Comment: Michigan should be doing more to manage water resources on the basis of long-term sustainability, including consideration of climate change.	Ongoing DEQ and MDARD staff time to promote sustainable practices			
WC-F	**WC 5.3**	Response to Comment: Michigan should include current users in programs encouraging adoption of water conservation measures.	DEQ and MDARD staff time to develop/deliver message			
WC-G	**WC 6.1**	This report contains a variety of recommendations for updating Michigan's water conservation program. When the program has been updated, a periodic evaluation of the program must take place to ensure its effectiveness and plan for improvement.	DEQ and MDARD staff time to conduct periodic evaluations	Involve stakeholders		
WC-G	**WC 6.2**	A full program assessment and update should take place every five years, using data compiled from measurable objectives that have been established for each of the program components. This data should be gathered on an annual basis where applicable.	DEQ and MDARD staff time to conduct review every 5 years. Gather data annually.	Involve stakeholders		
WC-I	**WC 7.1**	Pursuant to the terms of the Tribal State Water Accord, Michigan should consult twice yearly with the Tribal Governments in the state to share respective progress on individual and joint efforts to manage Michigan's water resources in furtherance of shared interests in protecting and preserving the Great Lakes basin waters. The discussion should specifically address the coordination of Michigan's accounting-based water management program and tribal water management programs.	DEQ and MDARD staff time to attend bi-annual meetings and follow-up with Tribal governments			
IL-B, IL-C	**IL 1.1**	The DEQ should review, and work with DNR, on the development of protocols and procedures for collecting bathymetric data so that data collected under these standards can be used to develop inland lake and pond maps that include information about lake and pond depth and volume. The Departments should publish and make available to the public these protocols and standards so that non-agency persons can participate in bathymetric data collection for inland lakes and ponds.	Additional staff required for systematic mapping of at-risk lakes **OR** implement through citizens. Will require ongoing quality control by DEQ, DNR or MiCorps.		At least 1 year to develop protocols	
IL-B, IL-C	**IL 1.2**	The DEQ should develop training modules through such means as its existing MiCorps program and crowd hydrology projects to encourage citizen participation in lake and pond water level data collection, and ensure that data collection is conducted according to protocols agreed upon by DNR and DEQ for both documenting changes in water levels over time as well as to create bathymetric maps from which mean depth and hypsographic curves can be derived.	Staff time to install gages **OR** MiCorps or university lab. DNR could survey elevations. MiCorps to develop new monitoring program. University lab for bathymetric mappin/quality control.		Lake data collection could begin in 2016	Supplemental funding for MiCorps (~$25,000) for monitoring program, maybe more in first year. Bathymetric mapping by university students, ~$20,000/year.

Charge	Number	Recommendation	Implementing Organizations	Stakeholder Involvement	Implementation Time Frame	Funding
IL-B, IL-E, IL-G	**IL 2.1**	The ARI definition for inland lakes and ponds in MCL 324.32701 (1) (a) (vii) does not need to be amended at this time. Inland lakes and ponds may need protection to prevent ARIs from indirect (groundwater) withdrawals, as well as direct withdrawals. However, our knowledge of interactions between groundwater and surface water of inland lakes and ponds is insufficient to develop a statewide assessment procedure to efficiently and reliably screen lakes for the potential for an ARI caused by a given withdrawal proposal. Data and further research are needed to support an agency determination of an ARI for lakes and ponds potentially affected by LQWs. Once a screening procedure is established and validated, statutory changes may be made to Part 327 to protect inland lakes and ponds from both direct and indirect withdrawals. An ARI determination should include the recognized and legally protected uses of lakes and ponds.	No action needed at this time			
IL-B, IL-E, IL-G	**IL 2.2**	The State of Michigan's Quality of Life agencies (DEQ, DNR, and MDARD), in collaboration with the United States Geological Survey (USGS), should work with the successor to the current Water Use Advisory Council to:	DEQ, DNR, MDARD in collaboration with USGS and Council for 2.2a-2.2c			
IL-B, IL-E, IL-G	**IL 2.2a**	Prioritize additional data collection and research to better characterize and classify inland lakes and ponds in Michigan with respect to their vulnerability to ARIs caused by groundwater and surface water LQWs.			1 - 2 years	
IL-B, IL-E, IL-G	**IL 2.2b**	Develop an on-line screening tool capable of assessing whether a proposed surface or groundwater withdrawal is likely to cause an ARI in an inland lake or pond; allow the water user to register LQWs that pass the screening tool; and require a SSR by the DEQ for any proposed LQWs that cannot be passed by the screening tool.		May need stakeholder council	At least 5 years	Hundreds of thousands of dollars. Will need to provide funding to DTMB.
IL-B, IL-E, IL-G	**IL 2.2c**	Develop a SSR procedure for the DEQ to determine whether a proposed surface or groundwater LQW is likely to cause an ARI in an inland lake or pond. The procedure should be publicly available on the DEQ's website.	Heavily dependent on data availability. No additional FTEs needed over and above additional FTEs to handle existing SSR backlog.	Engage stakeholders and council	At least 5 years	
IL-B, IL-C, IL-F	**IL 3.1**	A collaborative effort should be made to utilize public and private funds to install staff gauges in inland lakes and ponds in Michigan. Recognizing that some private groups may want to have staff gauges installed in lakes of interest to them, the staff gauges should be installed first in those inland lakes that are at high and medium risk for ARIs. We recommend using the decision tree in Appendix C as an initial predictive tool for identifying the relative ARI risk for inland lakes and ponds. The staff gauges should be tied into upland elevation benchmarks. The staff gauge elevations should be annually resurveyed due to the potential for damage from ice and other factors.	0.25 FTEs of DEQ **OR** USGS staff time for installing gages **UNLESS** implemented via MiCorps. Historical lake level data research by students, contractors, researchers or gov't staff.	Engage stakeholders and council	Could begin in 2015	

APPENDIX E | Dissenting Opinions

Water Use Advisory Council

Tier II Dissenting Opinion - Michigan Ground Water Association – (MGWA)

Michigan groundwater law consists of the application of Common Law, Riparian Law, and the Reasonable Use Doctrine. The existing Michigan Water Withdrawal Assessment Tool (WWAT) and the associated "Batch Tool" are currently used in both the screening process and the site specific review (SSR) process to allocate groundwater. There is a lack of sufficient data for any of these measures to predict stream flow depletion effects or Adverse Resource Impacts (ARIs). The system also lacks viable analytical methods and models utilized in the SSR process to determine streamflow depletion effects at the local and regional levels. There are no written protocols to define what data, data collection methods, or analyses are necessary for resolution of an SSR. Changes to the WWAT, SSR process and Batch Tool were all developed and implemented without notice or participation by the groundwater industry or impacted property owners.

Access to, and management of, the significant groundwater resources in Michigan are essential to the economy and meeting the water demands within the state. The water well drilling industry is an essential part of meeting those needs. Registered water well drillers need to be participants in defining and upholding necessary regulations to ensure safe, sustainable use of the groundwater resources. Misuse and manipulation of the data drillers report through Well Logic is a major contributing factor to the current system's failures.

The Michigan Ground Water Association Board of directors unanimously identified the following specific problem areas with the current MI-WWAT and SSR process:

1. Both the original USGS map and the proposed 24,000-1 replacement are based on early 1980's photo interpreted data containing significant errors. Areas mapped in more accurate methodology indicate error rates as high as 30% to 80% in some headwater drainage areas. Modern imaging systems offer a cheap and accurate method to update and correct the stream resource map that forms the core of the MI-WWAT process. Standard protocols employing available technology should be adopted to update the resource map to accurate current conditions.

2. The use of historic well logs in developing the MI-WWAT was, and continues to be, a flawed methodology for mapping and authorizing high capacity water withdrawals. Work with the Michigan Geologic Survey strongly indicates 50% or more of the well logs used in development and operation of the WWAT and SSR are unusable or improperly interpreted. Statistical analyses alone are not enough to identify, correlate, and interpret the remaining well logs that may be more accurate but have never been field validated.

3. The use of uniform state-wide geologic assumptions of ground water movement are inherently flawed and have led to significant errors in the WWAT and SSR when compared to

actual documented subsurface hydrogeology. This is a significant defect in the WWAT and SSR. Left uncorrected it will continue to result in increasing and compounding errors in water withdrawal assessments.

4. The WWAT, its operation and amendments have ignored basic Michigan Administrative Law. It has operated without public input or professional peer review outside the original drafters, the MDEQ and IRW-MSU. The program lacks even a threshold level of external professional review or industry standards of accuracy. Since inception, the WWAT has had no enumerated or demonstrated level of accuracy in predicting ground water/stream impact. Records to date have not documented any stream impact from the use of a high capacity well let alone an adverse impact.

5. The Site Specific Review (SSR) process continues to be conducted and amended without notice, public input, outside peer review or accountability. Without established written standards or protocols the program effectively operates at the discretion of MDEQ staff. The "stream truncation" process continues to be implemented at the sole discretion of the MDEQ staff when the acknowledged statutory requirement places the function clearly within the Natural Resources Commission through the MDNR Director by Executive Order.

6. Taken as a whole to date, the WWAT/SSR program has been structured and operated by the MDEQ as if groundwater is a "Public Trust" state resource while the statutes specifically provide for the recognition of Michigan's "Reasonable Use" doctrine and associated personal property rights.

The MGWA supports maintaining the internet computer based high capacity water withdrawal registration program now properly housed within the MDEQ. We recommend the Michigan Legislature first codify or benchmark all historic, WWAT approved, and SSR approved withdrawals as not causing an ARI in their appropriate watersheds. The Legislature should immediately begin hearings to move from the current WWAT/SSR program to one that is based on sound groundwater industry-standard science and an accurately defined resource.

Michigan's high capacity water withdrawal regulatory process needs to be brought up to the customary procedures and standards of other MDEQ programs. With the operational import of the MI-WWAT into the MDEQ the Department has a unique opportunity to bring due process and accountability into a clearly troubled program.

MGWA and its members are committed to work with our customers, MDEQ, and stakeholders to develop a groundwater program for Michigan that is based on real science and an accurate definition of water resources through an open and public process. All property owners deserve notice and due process when their water rights are impacted by the WWAT/SSR process. These changes are the minimum required to protect Michigan's most valuable resource while providing safe sustainable use.

10/29/14

Water Use Advisory Council

Dissenting Opinion - Michigan Environmental Council

Since 2009, Michigan has used the Michigan Water Withdrawal Assessment Tool (WWAT) to screen for large quantity water withdrawals that are most likely to harm aquatic health. A more detailed site-specific review (SSR) process uses the best available information and science to evaluate those groundwater withdrawals and ensure those allowed will not cause an adverse resource impact. This process relies on computer models to predict both the individual and cumulative impacts of water withdrawals. The models are not perfect, but they form the best tools currently available to the state to manage these important resources.

A number of the recommendations in this report call for more specific written protocols to define data collection methods and analysis techniques that are necessary to conduct site-specific reviews and to improve system accuracy in predicting impacts. According to the authorizing statute, the department may incorporate new data that is gathered using approved methods or make technical modifications to the assessment tool related to considerations of temperature, hydrology, and stream flow based upon a scientific methodology that has been adopted by order of the Director of the Department of Natural Resources.

The Michigan program has won national awards for its innovative application of sound science to resource management, and developing a very efficient process administratively. Sound management of our significant groundwater resources is essential to our economy and meeting current and future water demands within the state. Trends demonstrate that Michigan's water resources are coming under increased demand. The program uses data from a variety of sources including stream gauges maintained by the United States Geological Survey (USGS), the Wellogic database of over 400,000 well drilling records and miscellaneous measurements made by local units of governments and other water users.

Droughts in California and elsewhere may place additional pressure on Michigan to increase agricultural production, therefore putting increasing demand on water resources for irrigation purposes. The good news is that Michigan has abundant water resources. However, there are localized areas of the state which overuse of water can impact fish populations harming recreational opportunities and the associated tourism industry. The program is designed to avoid and manage these conflicts.

The Michigan Environmental Council supports the recommendations included in this report as steps necessary to improve our program and incorporate new data and scientific techniques for analyzing that data as it becomes available.

We strongly support the recommendation that the work of this stakeholder group, or one similar in nature be formed to continue to work with the department to provide oversight for this

program and ensure that it serves the needs of water users in Michigan and protects our world class water resources.

The Michigan Environmental Council made a recommendation that the MDEQ pursue additional general fund support for program operation and computer upgrades that was not adopted by the council as a whole. The needs of this program are two-fold. First, it needs sufficient staff to interact with the public to explain the program and help facilitate voluntary agreement in those areas of the state which may experience limitation on the availability of water. Secondly, it must monitor the best available science and computer models to be ready to incorporate those into its decision making process when it will lead to better service for Michigan residents and businesses. To perform both of these functions properly the program needs additional financial support.

APPENDIX F | Links to Meeting Summaries

February 15, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
April 4, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
May 23, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
June 26, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
August 22, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
October 14, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
December 9, 2013	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
January 12, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
February 18, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
March 18, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
April 15, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
May 20, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
June 17, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
July 15, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
August 19, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
September 16, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html
October 21, 2014	https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html

November 3, 2014 https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html

November 18, 2014 https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html

December 16, 2014 https://www.michigan.gov/egle/0,9429,7-135-3313_3684_64633---,00.html

APPENDIX G | List of Council Meeting Speakers

February 15, 2013	Overview of Michigan's Water Use Program – Jim Milne, DEQ
April 4, 2013	Water Withdrawal Assessment Tool – Howard Reeves, USGS Site Specific Review Process—Jill VanDyke, DEQ
May 23, 2013	Water Depletion and Availability Tracking—Andy LeBaron, DEQ
August 22, 2013	Compact Council Update- Grant Trigger, Racer Trust
October 14, 2013	Southwest Michigan Water Resources Council Update—Marcy Colclough, Southwest Michigan Planning Commission An Introduction to a Southwest Michigan Groundwater Study– Todd Feenstra, Tritium, Inc.
December 9, 2013	Hydraulic Fracturing, Water Use, and Proposed Rule Changes—Adam Wygant, DEQ
January 12, 2014	Michigan's geology: What do we know and what do we need to know to manage our groundwater resources? – Al Kehew, Western Michigan University
February 18, 2014	Envisioning a Great Lakes Water System Accounting Program—Paul Seelbach, USGS
March 18, 2014	Southwest Michigan Groundwater Study– Todd Feenstra, Tritium, Inc.
June 17, 2014	Southwest Michigan Water Resources Council Final Report—Marcy Colclough, Southwest Michigan Planning Commission DEQ draft field procedure for identifying perennial streams—Mike Walterhouse, DEQ
July 15, 2014	Field Trip Speakers: Andy Partlo, Co-owner of Old Au Sable Fly Shop Chad Brown, Owner of Homewaters Realty

August 19, 2014	Statewide Water Planning - an example from Indiana —Jack Wittman, INTERA Inc. Field Trip Speakers: Ben Russell – PMCA Farms Brian AcMoody – AcMoody Farms Bruce Mackellar – MSU Extension Derek Peterson – DeKalb Seed Corn Larry Walton – Walton Farms Lowayne Yoder – Meadow Brook Farms Lyndon Kelley – MSU Extension Michael Collins – Abbott Industries Randy Bartholomew – Greenmark Equipment Ray Baker – Black Gold Farms Ralph Haefner – USGS Sara Trattles – Greenstone FCS Todd Feenstra – Tritium Inc. Tom Bodtke – Cornerstone Ag Enterprises
October 21, 2014	Review of updated WWAT interface – Andy LeBaron, DEQ