Enhancing Adoption of On-Farm Conservation Measures to Improve Water Quality

Lessons Learned from Saginaw Bay and Western Lake Erie Watersheds

Prepared for:

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Under contract to:
The Nature Conservancy

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Executive Summary

The overall goal of enhancing the adoption of permanent on-farm conservation measures and improving the water quality of Michigan's Western Lake Erie Basin has proven to be challenging. Progress has been made in the Saginaw Bay watershed with pilot-scale versions of successful on-farm conservation approaches, which are beginning to be adapted to Michigan's Western Lake Erie Basin to achieve permanent agricultural conservation and improved water quality. Likewise, Saginaw Bay programs have adapted Western Lake Erie Basin approaches, including the recent expansion of watershed monitoring facilitated by the Saginaw Bay Monitoring Consortium's efforts, coordinated by The Nature Conservancy (TNC). LimnoTech supported TNC in preparing and executing a series of three workshops to promote the exchange of effective agricultural conservation approaches among advisors and stakeholders in the Saginaw Bay watershed and the Western Lake Erie watershed to reduce nonpoint source nutrient loads and eutrophication. Findings and recommendations from the Saginaw Bay and Western Lake Erie Basin knowledge exchange effort can broadly be subdivided into three categories:

(1) program structure, operations, and staffing;

(2) incentivizing agricultural conservation; and

(3) tracking of Best Management Practice (BMP) implementation and impacts.

The findings and recommendations arising in each of these categories are summarized here. Note that actions are already underway on many fronts to address some of the recommendations.

Program structure, operations, and staffing

The agricultural conservation sector in Michigan broadly suffers from inadequate staffing, inexperienced and underpaid staff, and high turnover. This impacts the ability of programs to build effective long-term relationships with producers and partners, and results in limited institutional memory and relatively low engagement over time, especially where new programs or changes to existing programs need to be communicated. Many programs are also characterized by fragmentation and ineffective coordination among related groups.

Recommendations:

- Develop more complete career paths for conservation organizations at all levels (e.g., conservation districts, State of Michigan Quality of Life agencies, watershed councils or non-governmental organizations [NGOs]) with competitive compensation within programs that would allow staff to progress from technician positions to watershed-scale program management, regional responsibilities, and even statewide roles while staying in the same geographic location. Keeping continuity between staff and their locations can stabilize their networks, build trusted relationships, and produce more permanent results over time as they train junior staff and introduce them to regional producers and partners.

- Develop more formalized communication pathways, agreements, or other structured collaborative relationships among agency-led agricultural conservation programs and NGOs to provide better outreach on technical and financial assistance opportunities, improve coordination of activities, reduce redundancy in programs, and leverage trusted partner relationships with producers and other agricultural stakeholders. Many NGOs, including TNC, play an integrator role – linking stream health and biodiversity to agricultural stressors across jurisdictions. These groups can also develop policy, play advocacy roles, access subject matter experts and communicators outside of agencies, serve as effective conveners, and augment program funds with philanthropic support.

- Encourage better integration between federal, state, and local programs. This may include leveraging the Michigan Agriculture Environmental Assurance Program (MAEAP) as an established program known throughout the State to streamline participation between multiple programs, simplify producers' paperwork and data submissions, and incentivize participation in programs with similar goals or for which only a few additional practices are needed to expand certification to multiple programs.

- Expand support for the development and maintenance of producer conservation networks including administrative management to allow them to share conservation information, program opportunities, experiences in implementation, and guidance through adoption on the farm.

- Offer opportunities to producer conservation networks to be more engaged and integral in planning field day events and expanding demonstration farm networks to bring conservation professionals, the farm community, and other stakeholders together.

Incentivizing agricultural conservation

There is broad agreement that the incentives that are associated with many agricultural conservation programs under the Farm Bill and other legislation are inadequate to justify the investment of time, money, and energy required by producers to participate. While investments by producers to reduce erosion and nutrient losses from their farms may seem like common sense, the reality is that current agricultural markets do not provide sufficient or timely financial returns on many BMP investments, making their implementation a drain on farms' business viability. Long-term efforts that support the creation of reliable markets that provide premiums for products created using positive environmental practices or other market-based incentives (e.g., carbon credits) could support expanded and sustained adoption of BMPs.

Recommendations:

- Build on recent studies of the BMP investments needed to meet nutrient reduction targets in the Western Lake Erie Basin (AGL and OEC 2023) by completing similar analyses for the Saginaw Bay watershed to better quantify the technical and financial challenges that exist to meeting nutrient load reduction targets for the bay. The study could further investigate various strategies for directing funding toward enabling long-term BMP implementation.

- Perform comprehensive studies to determine competitive pricing for initial adoption of conservation practices (i.e., capital expenses/implementation costs) and for persistent adoption of conservation practices (i.e., rewarding producers for long-term contributions made to the public good beyond their farm).

- Identify stable funding sources and allocate adequate resources to meet the needs of producers to accelerate sustained BMP adoption. Remove disincentives and barriers like complex application procedures, short-duration contracts that do not allow sufficient flexibility to adjust for weather conditions or diverse crop rotations, conservation program restrictions on equipment purchases or capital improvements, and challenges associated with landowner/tenant relationships and agreements.

Tracking of BMP implementation and impacts

Being able to track existing BMP implementation at sufficiently high spatial (field scale) and temporal (seasonal to annual) resolution to understand what is happening on the landscape is a critical component of effectively executing agricultural conservation programs. Similarly, higher resolution water quality data are also needed to link field-scale conservation practices with improvements in streams and rivers. Concerns about protecting the anonymity of Farm Bill program participants have led to anonymizing of survey data and other information to the county scale in most cases, which is too coarse to be useful for many purposes. New technologies may be able to provide more spatially relevant information while still protecting individual producer privacy and make the most of limited resources to provide a balance of the need for long-term monitoring with the implementation of practices to improve water quality. New monitoring approaches and policies are needed.

Recommendations:

- Develop and implement scientifically sound monitoring strategies that increase resolution and better integrate ground-based, water-based, and remote sensing data to allow conservation professionals to make informed decisions about where to direct producer outreach, what practices are most effective, and how the agricultural landscape is shifting based on private, public, technical, and market-based drivers. This information could be used to perform an annual BMP adoption analysis at the watershed scale, drive the application of emerging artificial intelligence/machine learning tools, confirm that funded conservation commitments are being implemented, and guide new agricultural conservation and ecosystem service market-based programs.

- Incentivize voluntary data-sharing by rewarding conservation-oriented producers with meaningful credentials and certifications that will be valued by their customers, colleagues, and other interested parties.

- Establish and maintain long-term water quality monitoring programs to measure whether improvements in in-stream nutrient loading are being made.

The path forward will require improved programs, better tracking, and more compelling incentives. The pace at which these recommendations are implemented will substantially determine the rate of water quality improvement in the waters and tributaries of Lake Erie and Saginaw Bay.

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1 INTRODUCTION

The Saginaw River and Maumee River basins are two of four agricultural priority watersheds highlighted in the Great Lakes Restoration Initiative (GLRI) action plans (GLRI 2024). A significant cause of water quality challenges is excessive phosphorus in runoff in these watersheds that leads to harmful algal blooms (HABs) in the shallow embayments to which these river systems discharge: Saginaw Bay and Western Lake Erie. The other smaller drainage areas that discharge directly to Saginaw Bay and Western Lake Erie are also acknowledged as priority tributaries contributing to nearshore water quality issues (USEPA 2018, USDA NRCS 2023). Accelerating adoption of agricultural conservation practices in these areas is critical so that nutrient load reductions can be realized within established timeframes.

1.1 Project Vision and Approach

For the past 12 years, The Nature Conservancy (TNC) Michigan chapter has focused its agricultural conservation efforts on the Saginaw Bay watershed. Over that time certain tactics for accelerating awareness and adoption of conservation measures have succeeded and others have failed. As TNC-Michigan expands its strategic area of focus to other parts of the State critical for both water quality and agricultural production, it partnered with the Fred and Barbara Erb Family Foundation (2021-2024) on an effort to export learnings between the Saginaw Bay and Western Lake Erie priority watersheds, with the end goal of crowdsourcing proven and shovel-ready strategies that could be deployed in either area.

The project approach included conducting a series of three workshops that brought together agricultural interests from both watersheds in 2022 and 2023 to exchange knowledge and discuss ways that conservation practices could be more widely adopted and nutrient loading could be reduced to acceptable levels. An essential aspect of accelerating agricultural conservation practice adoption is for Michigan's conservation community to break down geographic silos and instead work together across watershed boundaries to share lessons learned, innovative ideas, and successful strategies. The workshops served to initiate communication and knowledge exchange across the priority watershed boundaries for conservation practitioners to share experiences on successes and failures regarding agricultural conservation implementation efforts. Although the workshops and white paper focus on Michigan watersheds, lessons and information from Ohio and Indiana, among other states and provinces, have also been included. The agricultural programs of TNC are global in scope.

This white paper is an outgrowth of the three workshops conducted as part of the project. It examines the various challenges associated with increasing agricultural conservation practice adoption, discusses potential approaches for supporting and tracking progress, and explores alternatives to promote knowledge exchange regarding various aspects of conservation programming among advisors and stakeholders in Michigan's Saginaw Bay and Western Lake Erie watersheds. Prior to covering these topics, the paper first gives a brief overview of the two watersheds followed by a review of recent watershed research and technological developments relevant to agricultural nutrient management in the region.

1.2 A Tale of Two Watersheds

Although Saginaw Bay and Western Lake Erie watersheds are both named as agricultural priority watersheds under the GLRI for excessive phosphorus runoff leading to eutrophication issues, they have certain notable differences (Table 1). Though the Western Lake Erie Basin (WLEB) is about 30% larger than the Saginaw Bay (SB) watershed, it has more than double the amount of land area in farms, and a percentage distribution of 75% farmland in the WLEB compared to 47% for the Saginaw. Of the total area of the Maumee River watershed, which is the largest WLEB tributary, 7% lies in Michigan, with the rest in Indiana (20%) and Ohio (73%). The WLEB has a larger portion of its cropland in corn, soybeans, or small grains at 83% compared to 61% for the SB watershed. It has a similar population density of cattle, but almost nine times the hog and pig density and more than five times the chicken density when compared to the SB watershed. The SB watershed, though also dominated by cropland, is more diverse in land use than the WLEB, with greater land area in forest or forested wetlands in the northern part of the watershed and a more diverse crop mix (sugar beets, dry beans, potatoes).

Both watersheds are mostly comprised of rural towns and villages, but the WLEB has a greater human population, with relatively larger cities like Detroit, Toledo, Fort Wayne, Ann Arbor and surrounding suburban communities, while the SB watershed has smaller cities (Flint, Saginaw, Midland, and Bay City). The farming communities in both watersheds are comprised of people with similar European ancestry -- German (largest), English, Irish – but the SB watershed has more residents with Polish ancestry than the WLEB. There are Amish farming communities in both watersheds, especially in the Michigan “thumb” area of SB and in the western headwaters region of the WLEB Maumee River watershed around Ohio, Michigan, and Indiana.

The WLEB and SB watersheds are generally similar in physiographic characteristics, as both are primarily situated in the Huron/Erie Lake Plains ecoregion, which is characterized by the flattest landscape in Michigan formed by ancient glacial lakes. Relatively smaller portions of each watershed have greater relief where glacial moraines were deposited, including the Eastern Corn Belt Plains ecoregion of the western WLEB and the Northern Lakes and Forests ecoregion of the northern SB watershed. The agricultural parts of the watersheds generally have poorly draining clay-rich soils, which has resulted in another common characteristic of both areas -- the introduction of artificial drainage to move water off the landscape from former marshes and swamps and lower the regional water table via both surface ditches and subsurface tile drainage pipes.

Table 1. 2022 Census of Agriculture for the Saginaw Bay and Western Lake Erie watersheds (USDA 2024).

Category	Saginaw Bay (HUC-040801 & 040802)	Western Lake Erie (HUC-041000)	Saginaw Bay	Western Lake Erie
Total area	5,836,800 acres	7,616,000 acres	-	-
Land in farms	2,754,970 acres	5,676,105 acres	47% of total	75% of total
Corn	692,129 acres	1,691,468 acres	25% farmland	30% farmland
Soybeans	759,552 acres	2,700,234 acres	28% farmland	48% farmland
Small Grains	228,302 acres	335,882 acres	8% farmland	6% farmland
Cattle & Calves inventory	36 per mi^2	29 per mi^2	329,018	343,276
Hogs & Pigs inventory	13 per mi^2	114 per mi^2	115,433	1,357,147
Chickens inventory	125 per mi^2	647 per mi^2	1,139,696*	7,701,585

**Sum of permitted inventory for two regulated CAFOs in the watershed.*

1.3 Water Quality Impairments and Phosphorus Loading Targets

The 112 square miles of Lake Erie falling within Michigan's jurisdiction and 223 square miles of the Saginaw Bay nearshore area are both currently on Michigan's comprehensive list of Federal Clean Water Act Section 303(d) impaired water bodies for not supporting the other indigenous aquatic life and wildlife designated use due to nutrient-related eutrophication (Goodwin et al. 2024). Lake Erie was first added to Michigan's list of impairments in 2016 (MDEQ 2016), while the inner Saginaw Bay shoreline was added in 2022 (Goodwin and Smith 2022). Ohio and Indiana have taken different approaches. The 2018 integrated report added another designated use impairment for Lake Erie: not supportive of public water supply due to microcystin toxins from cyanobacteria. There are several other impairments listed for these water bodies and various tributaries within the watersheds, too numerous to comprehensively list in this white paper, but include not supportive of fish consumption due to PCBs and DDT in fish tissue and total body contact recreation due to *E. coli*.

Phosphorus is commonly accepted as the limiting nutrient for the growth of both WLE and SB algal communities, hence the GLRI Action Plan prioritizes both watersheds for phosphorus reductions. Both the WLEB and Saginaw River have phosphorus loading targets established, though the Saginaw River target has not been updated since the 1978 amendment to the Great Lakes Water Quality Agreement (GLWQA) (Stow et al. 2014). Under the GLWQA, a 440 metric ton per year total phosphorus (TP) loading target was established for the Saginaw River, and an inner bay target TP concentration of 15 ug/L was also set for Saginaw Bay. Due to the 2022 listing of the Saginaw Bay shoreline impairment, however, a total maximum daily load (TMDL) study may be conducted and would likely result in updating the area's loading targets. For Lake Erie, a 40% TP load reduction relative to 2008 conditions was established for reducing WLE HABs (spring loads) and Central Basin hypoxia (annual loads) (Annex 4 Objectives and Targets Task Team 2015, USEPA 2018). This 40% TP load reduction target represented an update to previous load targets established under earlier versions of the GLWQA. Relevant to the State of Michigan, the River Raisin, Maumee River, and Detroit River were all named as priority tributaries, though the 40% load reduction target applied to the entirety of TP loads linked to the State (i.e., all WLEB drainage areas). While the River Raisin and Maumee River are among the most well-monitored tributaries in the nation due to the work of the National Center for Water Quality Research (NCWQR) at Heidelberg University and therefore have a robust history of TP load measurements, the Saginaw River lacks such a monitoring program and therefore estimates of TP loads are far less certain for it.

2 REVIEW OF RECENT WATERSHED RESEARCH AND TECHNOLOGY DEVELOPMENTS

Among the key actions needed to improve water quality outcomes of agricultural conservation are research and technology innovation and deployment to optimize farming system and conservation program operations. As insight and innovation grow, there is also a need to transfer technology to farmers (or producers, as used below). In some cases, this leads to minor adjustments in programs and practices that require minimal investments of time and financial resources. In other cases, structural or equipment changes may require years to develop and substantial funding commitments, including financing and grants. The role of communicating new developments is played by a diverse set of individuals including researchers, extension agents, crop advisors, conservation technicians, commodity experts, and innovators from within the producer community itself. Here we summarize recent research and technology developments that can inform nutrient management in Saginaw Bay and Lake Erie and accelerate the uptake and impact of modified farming practices and programs. In Section 3 we discuss how progress can be tracked more effectively, and in Section 4 we discuss changes to programs that can improve the delivery of insights and enhancement of on-farm practices to yield sustained improvements in water quality.

2.1 Recent Synthesis Reports

Three recent reports synthesized the state of knowledge about agricultural nutrient management and impacts for the Western Lake Erie watershed:

1. *Alliance for the Great Lakes and Ohio Environmental Council: The Cost to Meet Water Quality Goals in the Western Basin of Lake Erie* (AGL and OEC, 2023)
2. *International Joint Commission: Synthesis of Recommendations and Assessment of Action to Reduce Great Lakes Nutrient Impacts* (IJC, 2022)
3. *International Joint Commission: Toward the Implementation of a Manure Management Framework* (IJC, 2023)

The AGL and OEC (2023) study concluded that annual spending for agricultural conservation in Ohio and Michigan would need to increase by a minimum of 70% and over 600%, respectively, to meet phosphorus load reduction goals. A related Canadian study by Brouwer et al. (2023) of a major watershed draining to eastern Lake Erie also showed a substantial funding gap for best management practice (BMP) implementation. The IJC 2022 report found that substantial progress has been made in advancing research priorities identified in binational reports, but nonpoint nutrient reductions are not on track with commitments in most Lake Erie jurisdictions. The report further found that substantial progress has been made since 2012 in developing the monitoring, modeling, and data management infrastructure necessary to support future adaptive management, but that increased spring runoff, ongoing installation of tile drains in agricultural land, and less incorporation of applied fertilizer and manure into agricultural soil due to reduced tillage have led to increased loading of dissolved phosphorus to Lake Erie over the prior 20 years, despite advantages in reducing sediment and particulate phosphorus losses. Finally, the IJC 2023 manure framework study found that state and provincial programs and guidelines in Ohio and Ontario have been modified in the last decade, under Federal oversight, to promote more intensive manure management to control nutrient loss to waterways, but that additional work remains to be done, especially where livestock operations are expanding.

No comparable synthesis has been completed in the last few years for the Saginaw Bay watershed, but earlier work looked at the impact of multiple stressors on the bay (Stow 2014) and reviewed the status of agricultural conservation (Fales et al. 2016) and restoration in the Saginaw Bay Area of Concern (Selzer et al. 2014). Fales et al. (2016) summarized three case studies from 7 of the 17 Saginaw Bay subwatersheds and concluded that securing conservation funding from outside U.S. Farm Bill programs can be an effective way to augment those programs and avoid associated restrictions on prioritizing funding in areas that are the biggest sources of excess nutrient loading. These case studies built on the analysis of Sowa et al. (2016), which sought to determine how much conservation was needed to restore healthy fish communities in Saginaw Bay tributaries, similar to the AGL and OEC (2023) analysis described above for Lake Erie restoration. Sowa et al. (2016) concluded that more than 50% of agricultural land in the study area, which consisted of 4 of the 17 Saginaw Bay subwatersheds, would need to have conservation practices applied consistently to meet ecological goals.

An earlier report by the Great Lakes Commission (GLC 2020) examined the effectiveness of agricultural programs in all four GLRI priority watersheds and concluded that the top three barriers to greater adoption of nutrient BMPs, as identified by producers, were (1) restrictions on land management associated with conservation programs, (2) too much paperwork for application and reporting, and (3) payments that were too small to justify the investments needed to implement the BMPs and comply with program requirements. Recommendations that came out of the study included increased federal interagency coordination and program tracking, more investment in outreach and capacity building staff, more funding for the purchase of conservation-oriented farming equipment, and better alignment of reporting requirements with crop cycles.

Prior to these efforts, TNC led Conservation Effects Assessment Projects (CEAPs) of agricultural streams in Wisconsin and lower Michigan (Sowa et al. 2011), including the Saginaw Bay watershed, and later in the WLE watershed (Keitzer et al. 2016). The 2011 study found that the Soil and Water Assessment Tool (SWAT) could be applied over large areas to effectively simulate impacts of agricultural BMP scenarios on stream water quality and, by correlation with water quality limitations, fish communities. The WLEB study found that impacts of agricultural nutrients and erosion of soil limited fish community health in more than 10,000 km of streams and rivers, representing more than 50 percent of the watershed. Additional mitigation measures needed on WLEB farms to substantially reduce impacted river length were estimated to cost $149 million annually above the 2012 annual spending level of $277 million.

2.2 Recent Modeling and Field Studies

There have been several recent water quality modeling studies completed in the WLEB that can inform the management of agricultural nonpoint nutrient loading. Similar studies have been undertaken in the Saginaw Bay watershed but are approaching 10-years old or more (Giri et al. 2012, Giri and Nejadhashemi 2014, Karpovich et al. 2016). A project funded by the Fred and Barbara Erb Family Foundation convened a team of Michigan universities, federal and state government groups, TNC, and LimnoTech to develop an Optimization Decision Model (ODM) for strategically allocating resources and conservation practices to benefit multiple ecological and socioeconomic endpoints and applied the ODM to guiding investments of restoration funds through actual conservation programs. Discussions are underway among investigators about beginning a new modeling effort for the watershed and bay. Modeling studies in the WLEB have identified potential priority areas for nonpoint source management (Dagnew et al. 2019). They also examined climate change forecasts for the region, concluding that there was “no clear agreement on the direction of change in future nutrient loadings or discharge” in one case (Kujawa et al., 2020), but that “climate impacts on watershed processes are likely to lead to reductions in future loading” in another (Scavia et al. 2021 and 2024).

Recent numerical modeling work in the WLEB has concentrated on improving understanding of how to optimize BMP placement and combinations to achieve the 40% phosphorus load reduction target for Lake Erie. Yuan and Whisenant (2023) combined the Agricultural Conservation Planning Framework (ACPF) with the Soil and Water Assessment Tool (SWAT) to evaluate the potential effectiveness of various BMPs in reducing phosphorous losses. They showed that a combination of grassed waterways, contour buffer strips, water and sediment control basins, nutrient removal wetlands, and farm ponds could reduce total phosphorus losses by up to 49% in the watershed studied. Martin et al. (2021) performed a related study using an ensemble of multiple models to evaluate management options to reduce Lake Erie loading and blooms. A stakeholder group provided guidance throughout the modeling project and advised on the development of realistic scenarios. Combinations of subsurface placement of phosphorus-containing fertilizers, cover crops, riparian buffers, and wetlands were determined to be among the most effective management options. In all scenarios evaluated, however, the loading reduction goal was not met as frequently as desired based on the average of model predictions, indicating that greater (and possibly unrealistic) adoption rates of practices than those tested may be needed to reach the targets.

Several field-based studies have refined the understanding of the presence and mobility of legacy phosphorus stored in watershed soils, streambanks, and sediments, which can improve results of future modeling efforts. Williamson et al. (2024) showed that geomorphology and land use play important roles in streambed sediment mobility and phosphorus storage. Guo et al. (2020) demonstrated that tributary loading can respond rapidly (within the same season) to reductions in the application of new phosphorus in fertilizer to WLEB fields. Tedeschi et al. (2024) showed by analyzing 11 years of data that increasing the amount of tile drainage in the study area (Canadian tributaries) can increase dissolved phosphorus loading, especially during the spring thawing season. Osterholz et al. (2023 and 2024) demonstrated that older phosphorus is more likely to contribute to tile drain loss than newer fertilizer and manure applications, which appear to be more susceptible to losses via surface runoff at the sites studied.

2.3 Human Dimensions Research

Additional studies of the human factors that influence agricultural BMP adoption and perception have been conducted over the last several years that provide insights into ways that nutrient control programs can be better implemented. Most of this recent work has been in the WLEB, with relatively little in the Saginaw Bay watershed. In a 2019 commentary, Wilson et al. reviewed BMP effectiveness and behavioral data to determine how best to achieve the 40% load reduction target. They determined that a majority of the farming population is willing to consider many of the recommended practices, but that inadequate cost-benefit information, site-specific decision support tools, and technical assistance are limiting adoption of conservation practices. They concluded that a combination of voluntary and mandatory approaches may be needed. Walpole et al. (2023) found that the 4R Nutrient Stewardship Certification Program, which certifies crop advising companies and agronomy retailers or Nutrient Service Providers to promote best practices in nutrient management, has had a positive impact on 4R behaviors that is independent of other potential explanations for observed changes in practices. Shaffer-Morrison and Wilson (2024) examined local water quality perception in the Lake Erie Basin and concluded that greater trust in agricultural organizations and local government was consistently associated with better perceived water quality, whether or not water quality was improved. In the absence of specific metrics of water quality, beliefs about water quality may be formed based on who is trusted the most; this also correlates with political affiliation. Kast et al. (2021) linked what they termed "conservation identities" of producers with a numerical watershed model. Their results indicated that by developing nutrient management strategies that optimized BMP placement based on a combination of physical field characteristics and human-operator characteristics, limited resources could be spent most efficiently to provide maximal environmental benefits.

2.4 Expansion of Water Quality Monitoring

Ohio's Western Lake Erie Basin

Tributary water quality monitoring in Ohio's WLEB expanded significantly during the 2013-2018 period with the addition of over 15 new stations with sufficient sample collection to estimate seasonal and annual loading, adding to the approximately six existing stations with longer-term datasets. Funding for the monitoring efforts is derived from a variety of sources, including federal, state, regional, city, and corporate. The NCWQR at Heidelberg University and the U.S. Geological Survey (USGS) are the two primary institutions that conduct the monitoring. Water quality data produced from these monitoring initiatives are available in various forms, including data downloads from NCWQR and USGS websites, annual Water Monitoring Summary documents presented on the Ohio Lake Erie Commission website, a biannual Nutrient Mass Balance Study produced by the Ohio EPA, and numerous peer-reviewed publications that rely on the data.

Field-scale water quality monitoring and associated research was also expanded in Ohio's WLEB over the last decade in response to the agricultural runoff-fueled HABs in Lake Erie. Similar to the tributary monitoring, the edge-of-field monitoring has been funded by numerous sources. The monitoring has largely been conducted by researchers with the USDA Agricultural Research Service (ARS) and the USGS (Williams et al. 2016; Fermanich et al. 2023). A subset of the Ohio edge-of-field monitoring sites makes up the Blanchard River Demonstration Farms network (discussed later in this white paper; https://blancharddemofarms.org/).

Michigan's Western Lake Erie Basin

Michigan has been expanding its tributary water quality monitoring capabilities in the WLEB over the last several years in response to increased attention to Lake Erie HABs and loading targets. The River Raisin near Monroe is monitored by the NCWQR for water quality and USGS for streamflow and is Michigan's most robust water quality monitoring station, with sediment and nutrient load estimates dating back to 1982. In October 2018, an additional three stations were brought online for water quality monitoring: Bean Creek, East Branch St. Joseph River, and West Branch St. Joseph River. These three locations essentially monitor the loading from the State of Michigan that contributes to the Maumee River watershed. An additional four locations representing much smaller drainage areas were brought online in November 2020 (Lime Creek, Nile Ditch, South Branch River Raisin, and Muddy Creek) and a fifth HUC-12-scale location was initiated in May 2024 (Headwaters Saline River). The Michigan Department of Agriculture and Rural Development (MDARD) recently announced that additional hydrology and water quality monitoring will be conducted within those five priority

HUC-12 subwatersheds over the next five years to better understand nutrient losses and transport in the WLEB. The initiative was also supported by funding from the Fred and Barbara Erb Family Foundation and involves the Alliance for the Great Lakes (AGL), Michigan State University (MSU) Institute of Water Research (IWR), and LimnoTech as partners.

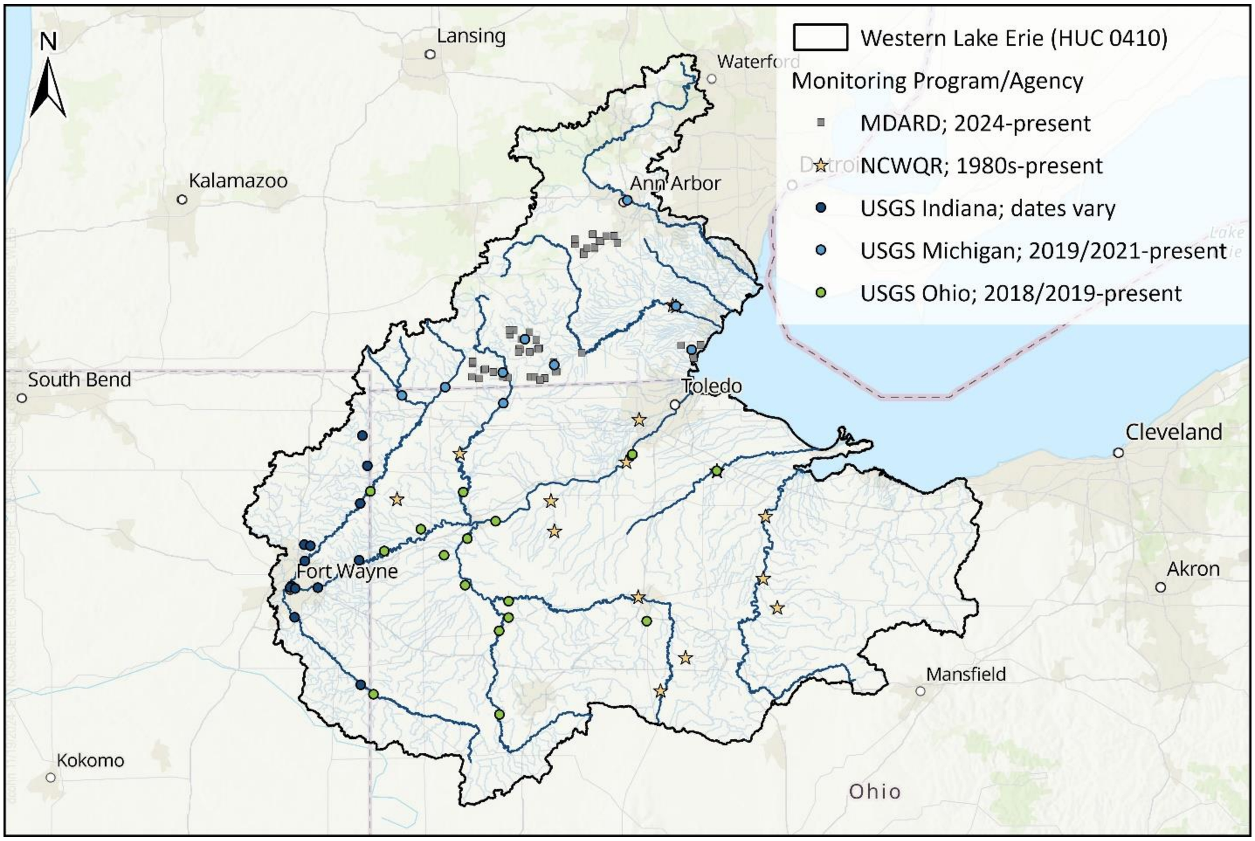

Figure 1. Water quality monitoring stations in the Michigan, Indiana, and Ohio WLEB watersheds.

Michigan's Saginaw Bay Watershed

Relative to the WLEB watersheds, the Saginaw Bay watersheds have historically had less water quality monitoring , though efforts to expand monitoring have increased in recent years. Saginaw Valley State University's Saginaw Bay Environmental Science Institute has conducted various research, such as special monitoring of dissolved oxygen and bacteria in the Kawkawlin River, but unlike the WLEB the SB tributaries have insufficient nutrient datasets to understand trends over time (i.e., long-term data) and space (i.e., a network of stations distributed throughout the watershed). Recently, however, the Saginaw Bay Monitoring Consortium (SBMC) was established in an effort to fill these data gaps and inform future management actions. Like efforts in the WLEB, the SBMC is a collaboration between various institutions, organizations, and the Saginaw Chippewa Indian Tribe that is leveraging funding from multiple sources. Under the SBMC, the USGS expanded its streamflow monitoring locations during the 2022-2023 period by adding 11 gages to complement the existing 7 gages in the watershed. Numerous water quality parameters, including phosphorus and nitrogen, are monitored at these USGS stream gages. Additionally, the National Oceanic and Atmospheric Administration (NOAA) expanded its monitoring of 10 Saginaw Bay sampling points to complement the expanded watershed monitoring and data from an existing seasonal buoy that it maintains.

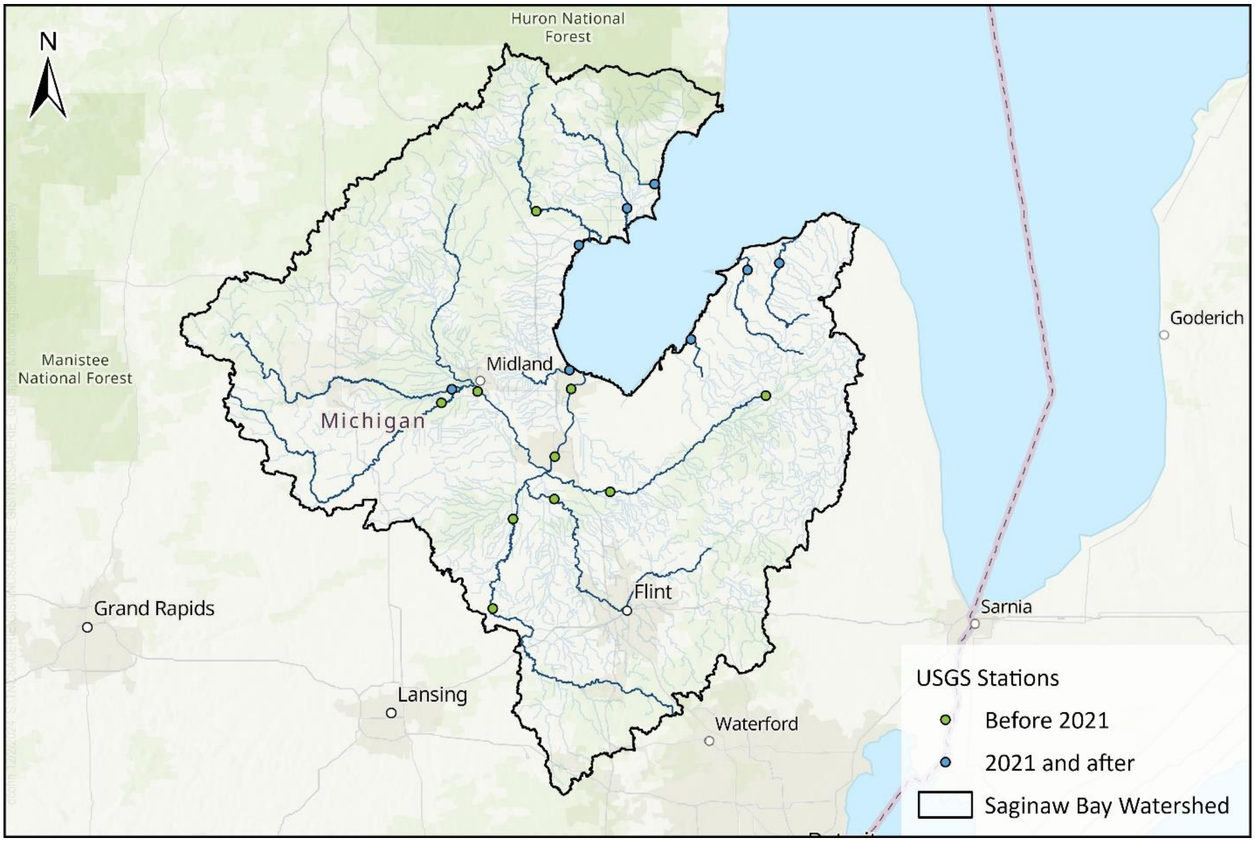

Figure 2. Water quality monitoring stations in the Saginaw Bay watershed.

2.5 Agricultural Conservation Programs

Many federal, state, and local programs seek to support the adoption of agricultural conservation measures in both the WLEB and SB watersheds. The programs vary in longevity, funding availability, geographic coverage, and many other factors. Some of these programs have been established for decades and are sustained with funding allocated by the U.S. Congress through the Farm Bill, while others are relatively short-term offerings for specific purposes.

Table 2. Select agricultural conservation programs in WLEB and SB watersheds.

Federal	Active or Inactive	Notes
Conservation Reserve Program (CRP)	Active	Participants receive financial support to establish long-term, resource-conserving covers on erodible or environmentally sensitive land
Conservation Reserve Enhancement Program (CREP)	Active	An offshoot of the CRP; pays producers for long-term conservation contracts, removing environmentally sensitive land from agricultural production and implementing conservation practices
Conservation Stewardship Program (CSP)	Active	Supports development and implementation of conservation plans to expand and improve previously implemented BMPs that yield cleaner water, healthier soil, and better wildlife habitat, all while improving agricultural operations
Environmental Quality Incentives Program (EQIP)	Active	Provides technical and financial assistance to agricultural producers and forest landowners to address natural resource concerns

Regional Conservation Partnership Program (RCPP)	Active	Partners with state agencies, and nonprofits to provide financial and technical assistance to producers to install conservation activities in a state or region
Conservation Innovation Grant (CIG) program	Active	Supports the development of new tools, approaches, practices, and technologies to further natural resource conservation on private lands
Great Lakes Restoration Initiative (GLRI)	Active	Funds restoration and protection of Great Lakes ecosystems, including reducing impacts from agriculture
American Rescue Plan Act (ARPA)	Inactive	Created to support recovery from the COVID pandemic; included agricultural investments
Infrastructure Investment and Jobs Act (IIJA), a.k.a. Bipartisan Infrastructure Law (BIL)	Active	Designed, in part, to improve water quality and help protect communities from climate change impacts
Inflation Reduction Act (IRA)	Active	Provides funding through EQIP and CSP to address unmet demand for these programs; includes climate-smart activities
State		
Michigan Agriculture Environmental Assurance Program (MAEAP)	Active (Michigan)	Voluntary program to support producers via education, farm-specific risk assessment, and on-farm verification
Soil Testing to Reduce Agriculture Nutrient Delivery (STRAND)	Inactive (Michigan)	Allowed cost share on new practices and equipment, nutrient management planning, soil testing, and nutrient mapping and yield analysis
EGLE Nonpoint Source Program implementation grants	Active (Michigan)	Supports projects that will prevent, reduce, or eliminate polluted runoff and other nonpoint sources of pollution (statewide)
Clean Michigan Initiative grant program	Active (Michigan)	Invests in pollution control, water quality measures, and the redevelopment of contaminated sites
Lake Erie and Saginaw Bay Wetland Conservation Program	Active	Used ARPA funds to acquire, engineer, restore, create, or enhance wetlands in the Lake Erie and Saginaw Bay watersheds
H2Ohio Program	Active (Ohio)	Supports the creation of wetlands, reduction in phosphorus runoff, and upgrading of septic systems
Other Programs		
Sustainable Option Wheat Program	Inactive	Pilot program where TNC and Star of the West paid nature-based bonuses to wheat growers in the Saginaw Valley who implemented sustainability practices
The Fertilizer Institute 4R Nutrient Stewardship Certification Program	Active (in OH and Ontario, but not MI)	Encourages agricultural retailers and independent crop consultants to adopt proven best practices through application of the 4Rs

The H2Ohio program represents one of the largest state-sponsored, water quality focused conservation initiatives in the country, encompassing both natural resources and agricultural lands. Funding is a critical element to increased adoption of practices such as the development of voluntary nutrient management plans (VNMP) covering over one million acres in Ohio's WLEB counties.

MAEAP has been a staple of Michigan's agricultural conservation efforts for over two decades, with its vision beginning in the late 1990s and the first livestock farm verification occurring in 2002. MAEAP is a voluntary program where producers can complete a confidential verification process to meet the mission of "ensuring that producers are engaging in cost effective pollution prevention practices and working to comply with state and federal environmental regulations." The latest annual legislative program report (fiscal year 2023) suggests that 12% of Michigan's nearly 8 million acres of cropland were verified or reverified at some point during the last five fiscal years. MAEAP is in the process of being modified to improve its effectiveness and impact, but final details about proposed modifications have not yet been resolved. Aspects being considered include enhancements to data tracking, increasing staff compensation to reduce turnover, adjustment of jurisdictional boundaries around watersheds rather than county lines, adapting program components to better identify and address climate resiliency and regenerative agriculture principles, and changes to the program management structure.

TNC led a Sustainable Option Wheat Program in the SB watershed to pilot a pay-for-performance approach to encourage adoption of multiple conservation measures for wheat-growing operations. The three-year program leveraged partnerships with consumer-packaged goods (CPG) companies, MDARD, and a local grain processing company (Star of the West Milling Company). Similarly, TNC was part of a team that implemented a USDA grant program in the Saginaw Bay watershed starting in 2021 known as the Accessing Subsidized Strip-Till Equipment Trial Program (ASSET). The ASSET program developed and delivered a competitive incentive package to Saginaw Valley sugar beet producers that included financial and enhanced technical assistance, peer learning networks, and assistance acquiring specialized equipment. The program sought to catalyze the purchase of 10 new sets of strip tillage equipment in the watershed on 10 different sugar beet farms.

3 PROPOSED FRAMEWORKS FOR MAKING AND TRACKING PROGRESS

Here we describe frameworks for how conservation practices and associated water quality improvements can be supported and tracked more effectively, with special emphasis on successful structures and lessons learned in the Saginaw Bay watershed that can be adapted for the Western Lake Erie watershed, and vice versa.

3.1 Framework for Supporting Progress

The State of Michigan draft five-year update of the Domestic Action Plan (DAP) for Lake Erie centers around five strategies to support progress on nonpoint source phosphorus load reductions. The strategies are aimed at supporting progress toward the State's phosphorus-reduction goal and include:

- implementing and tracking conservation practices,
- measuring water quality results,
- conducting research and improving modeling,
- expanding outreach and education, and
- maintaining and expanding collaboration (State of Michigan 2024 *in prep*).

Among changes underway with state-run programs, MAEAP is currently undergoing restructuring in response to critiques like those raised during the three in-person workshops conducted as part of this Saginaw-Erie project. Aimed at enhancing the capability of MAEAP staff to perform verification work, and improving retention of critical technicians, the MAEAP restructuring will include goalsetting for staff, and incorporating climate resiliency and regenerative agriculture principles into the program. With support from the University of Michigan, an advisory group and science panel were also created to provide input to state agencies on agricultural conservation in the Lake Erie watershed, as envisioned in *Michigan's Adaptive Management Plan* (AMP) *to Reduce Phosphorus Loading into Lake Erie*, released in 2021. The state has no similar plans to the DAP and the AMP for Saginaw Bay.

3.2 Framework for Tracking Progress

Tracking temporal changes in adoption rates of conservation practices across different geographies and different funding programs, and subsequently reporting out to producers and stakeholders can be accomplished through various means, such as online conservation dashboards. These types of systems can have multiple benefits, such as facilitating communication with producers about the impacts of their efforts, highlighting the variety of conservation practices being adopted to public stakeholders, and demonstrating progress toward meeting water quality goals. Examples of tracking progress tied to monitoring-based load estimates include the federally supported Blue Accounting platform, Ohio Lake Erie Commission's annual water monitoring summary fact sheets for WLEB tributaries, and Ohio EPA's biannual nutrient mass balance study.

The Michigan State University Institute of Water Research (MSU IWR) is refining a system to track progress on Michigan's phosphorus-reduction goal for the WLEB. The Great Lakes Watershed Management System (GLWMS) has been around for over a decade, and recently has received state funding to be further enhanced, specifically for tracking progress. GLWMS is an online tool with sediment and nutrient calculators capable of assessing the environmental benefits of various conservation practices from a field-to-watershed scale for priority basins around the Great Lakes. Updates are underway that will allow Michigan's Quality of Life agencies to quantify and track progress toward phosphorus load reduction goals in the WLEB. Working with the State and stakeholders, researchers and programmers are developing a dashboard that will allow centralized reporting of key indicators and critical metrics, as data become available. In addition, existing models will be expanded to include watersheds not currently covered, and IWR will expand the types of BMPs available in the GLWMS. Currently, the dashboard is limited by data availability, but research is underway to improve linkages between field-scale practices and monitored water quality improvements, as well approaches to use satellite-derived data to track some BMPs such as planting of cover crops (Wang et al., 2023), establishment of filter strips along waterways (Novoa et al., 2018), and changes in tillage practices (Zhang et al., 2024).

Figure 3. Screenshot of the nutrient reduction dashboard prototype that will be incorporated into GLWMS.

Dating back to 2017, the State initiated work on a database to track BMPs implemented by verified farms as well as those working toward verification in MAEAP and other projects funded by MDARD. The MAEAP database has been in various stages of development since its inception, including introduction of spatial mapping to help prioritize acres and tracking of verified acres in priority WLEB watersheds (State of Michigan 2018, State of Michigan 2021).

Other states, such as Iowa, have updated their reporting systems to include a series of dashboards, allowing increased timeliness, frequency, and transparency of updates. The Iowa platform includes six primary dashboard categories of interest, several of which are relevant to the topic of this white paper: (1) Funding and

Resources, (2) The Human Dimension, (3) Wastewater and Industrial Permitting, (4) Land Use and In-Field Practices, (5) Edge of Field and Erosion Control Practices, and (6) Water Quality and Nutrient Export (Figure 4).

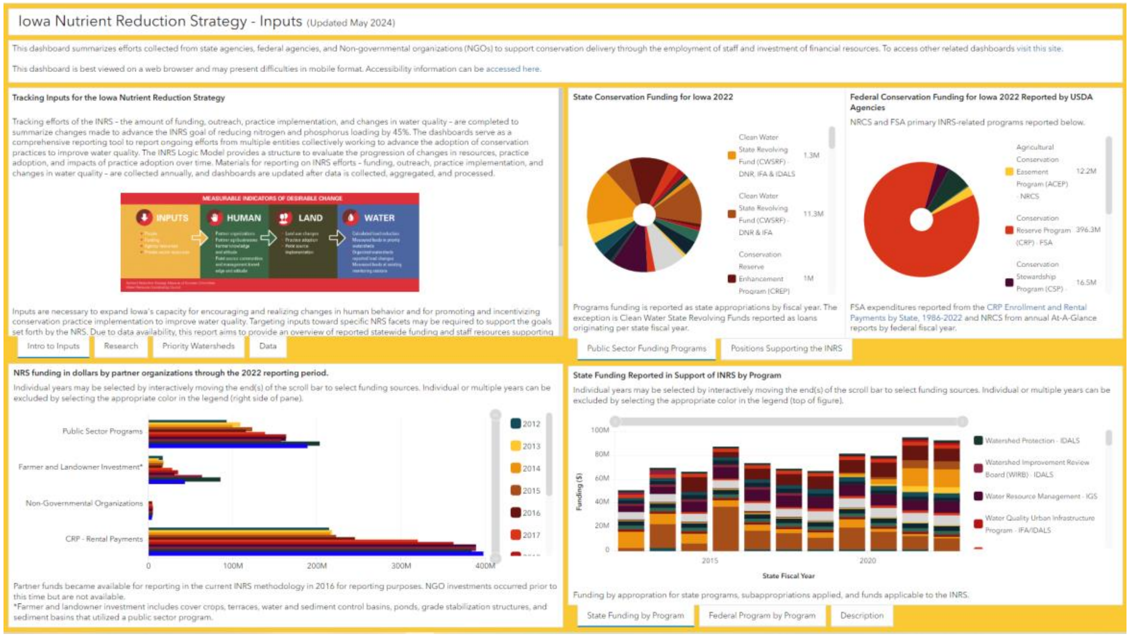

Figure 4. Screenshot of Iowa's Nutrient Reduction Strategy dashboard.

The Indiana State Department of Agriculture (ISDA) developed an interactive map-based web application (Figure 5) that highlights Indiana's efforts to enhance water quality and enables users to learn more about conservation programming in each of Indiana's ten major river and lake basins. Users can see the spatial distribution of conservation efforts and programming and can access information about soil health and local watershed groups. Indiana also hosts a Sediment and Nutrient Load Reductions application that allows users to view and download data on conservation practices, and sediment and nutrient load reduction information that is aggregated at the HUC-12 watershed scale.

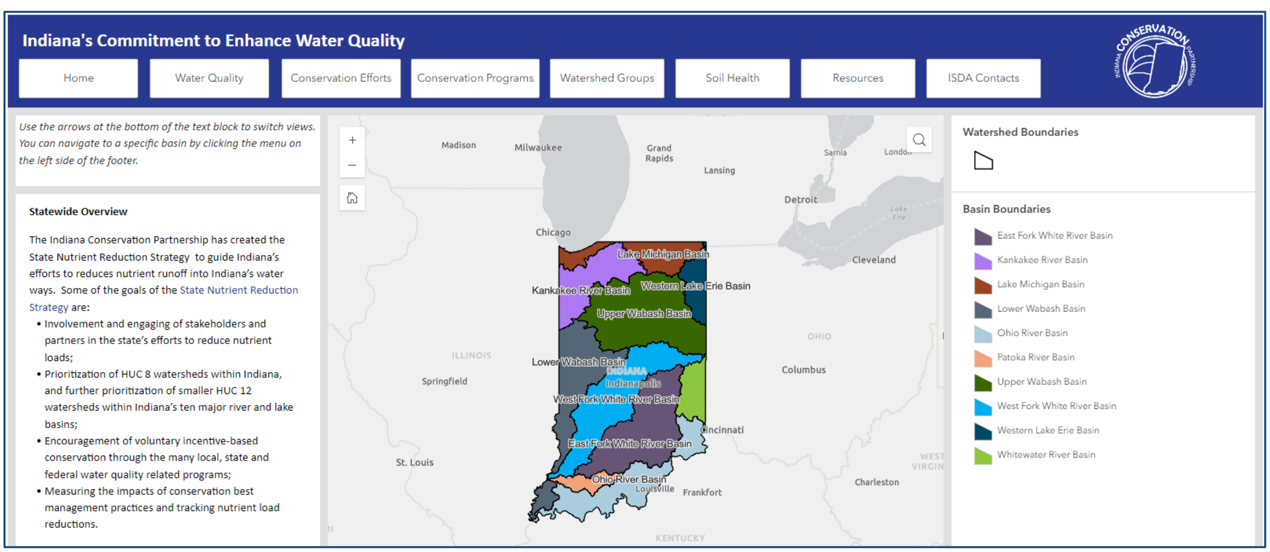

Figure 5. Screenshot of Indiana's map-based web application for agricultural conservation program tracking.

4 IMPROVING COMMUNICATION AND PROGRAM UPTAKE

As with most human endeavors, improving the effectiveness of communication among interested parties is the key to unlocking success in on-farm conservation and downstream water quality improvement in Michigan. Those in positions to sell ideas for improving farming practices must understand producers' motivations, communication styles, seasonal availability, comfort zones, and values. Messaging should be tailored to cropping systems, landscape characteristics, and other factors for it to be effectively received by producers. Likewise, the conservation "salesforce" needs to listen to ideas and insights that producers and agricultural landowners communicate back. Below we summarize messages and themes about what works and what does not when it comes to communication and response to farm-related conservation programs. The key takeaways and summaries from three in-person workshops also cover this topic (Appendix A).

4.1 Barriers to Implementation of Conservation Practices

Conservation practice adoption rates are relatively stable in Michigan and other Great Lakes states, even though BMPs are promoted heavily by conservation districts, government programs, and NGOs (Beetstra et al., 2022). What is not working when it comes to asking producers to adopt new practices or recruiting new producers to existing programs? What is working? What are the best pathways towards improving conservation uptake? We have identified four types of barriers to increasing the adoption of BMPs: programmatic, technological, economic, and cultural.

Programmatic barriers are the logistical challenges presented to conservation staff when trying to enroll more producers in conservation programs. How does a conservation specialist go about getting producers to come in the door, to voluntarily listen to information or ask for information? How can conservation specialists engage with more than just willing and easy to reach individuals? During the third workshop, participants strongly felt that developing and retaining high-quality technicians who can build trust with producers was a priority for outreach to new producers. In addition to quality, there must also be a sufficient *quantity* of these trustworthy technicians. One complaint is that there are simply not enough people: not enough conservation technicians or specialists, not enough trained and capable co-op or agricultural applicators, for example. One potential cause may be that these types of career paths in agricultural conservation are not perceived as a profitable or sustainable option compared to alternatives in the agricultural or environmental industry such as product or equipment sales jobs. Another cause of high turnover can be dissatisfaction among technicians if they feel as though they are being sent out to pitch practices that do not actually succeed in generating the environmental benefits that are intended because of the short duration of contracts. Another common programmatic barrier to uptake of BMP incentive programs can be complexity and timing issues with the application process. During the third project workshop many participants felt that rolling application periods and simple applications were important programmatic solutions, as complicated applications or rejections of applications deter producers from applying or reapplying for conservation funding.

The second type of barrier to conservation practice uptake is technological in nature. Certain BMPs, such as precision nutrient management, may require technologies that producers or even agricultural service providers are not able to implement due to lack of training or proper equipment. There can also be considerable variation in the success of BMPs from field to field when the technologies used to design or implement BMPs do not consider site-specific factors. These differences can result from factors such as variations in soil types or in previous management practices. Looking ahead, it may become increasingly important to adapt BMPs to increase on-farm resilience to climate variability. This adaptation will be crucial to address not only as a technological challenge but also to ensure that these practices can accommodate changing weather patterns.

The third category discussed here is economic barriers to the voluntary adoption of conservation practices. From the financial point of view, available payments are insufficient in amount or duration, or are perceived to be insufficient, to incentivize change in a successful farming operation or to offset the potential risks or downsides of change. Producers generally do not have the luxury of passing the “buck” back to the consumer because they are limited by market prices and tight profit margins. Each year, Purdue University releases a Crop Cost & Return Guide. For 2024, this guide shows that all productivity-size-rotation combinations evaluated resulted in a net operating loss once annual overhead costs (machinery, land, labor) were factored in. Even if the per unit BMP financial incentive were more attractive to producers such that it would incentivize change, the overall magnitude of spending on agricultural conservation incentives may be the greatest economic barrier to scalable adoption. As noted previously in Section 2, the AGL reported in 2023 that Michigan and Ohio would need to increase spending on conservation by $40-65 million and $170-250 million annually, respectively, over current investments. Related to the programmatic barrier discussing conservation professionals, increased conservation staff turnover due to salary limitations undermines the ability to build consistent, long-term, and trusting relationships with producers.

Finally, cultural barriers may stand in the way of conservation uptake. Farming communities are typically close-knit, with producers knowing many of their peers operating in the same area. This may result in a social stigma attached to adopting certain farming practices or participating in certain government programs. For example, just a few failed attempts to implement a new practice by otherwise successful producers may result in negative experiences being shared broadly, leaving others reluctant to try that practice. Producers also take pride in their ability to care for their land, with aesthetics often serving as a measure for such care. If a BMP leaves a field looking unkempt or creates delays or challenges with necessary agricultural operations like planting, weed and pest management, harvest, or efficient drainage, that may sway a producer to look at other practices. Additionally, trust in institutions has eroded in American society at large. In a recent study, rural populations specifically were 20% more likely to say they had little to no trust in the federal government than their urban counterparts (Hitlin and Shutava, 2022). The 2024 Edelman Trust Barometer reports that respondents rated their peers as equally reliable as scientists to tell them the truth about new innovations and technologies. These barriers to trust may serve to inhibit the uptake of BMPs recommended by federal programs and research scientists. Barriers to conservation practice adoption, along with potential solutions to overcome the barriers, are summarized in Table 3 below.

Table 3. Common Barriers to BMP Implementation and Methods for Addressing

Barrier Type	Problems	How to Address
Programmatic	Marketing and logistical challenges for conservation staff	Raising incentives and matching them better with producer needs (e.g., equipment costs, like STRAND program) helps programs sell themselves
	Complexity of the application process	Creation of online forms and tutorials that can simplify the process and reduce staff workloads, and ensure program staff are trained to maximize both customer service and streamlining applications
Technological	Variation in the success of any given BMP from field to field	Develop geospatial analysis at the field scale of BMP suitability to inform staff and applicants
	Differences in soil types or previous management	Create and maintain high-resolution and up-to-date BMP databases
	Adapting practices to climate variability	Build in situ and remote sensing data into automated BMP management systems to increase resilience
Economic	Insufficiency of conservation payments (real or perceived)	Explore innovative ways to enhance conservation funding through credit programs (carbon, nutrient, water), adjusting contract length, and premium commodity pricing for sustainably grown products
	Producers limited by market prices and tight margins	Adjust subsidy programs to make them more responsive to market forces (e.g., fertilizer costs, political instability abroad)
	Agency staff turnover due to low salaries	Rework agency salary structures and career paths to incentivize stable staffing and the development of long-term advisor/producer relationships
Cultural	Social stigma attached to adopting certain farming practices	Create media campaigns that shift attitudes about field aesthetics and tie practices to a multi-generational stewardship ethic (e.g., work with faith communities)
	Erosion of trust in institutions	Strengthen partnerships among trusted institutions and facilitate conversations that mix groups with different interests; seek endorsement of trusted individuals for programs and practices

4.2 Communication Strategies for Sharing Information

There are several approaches for sharing information with the farming community. Field day events are a common method for conservation specialists to engage with area producers and other stakeholders. These may be annually recurring events at common locations or special, one-time events associated with conferences or other initiatives. For example, the Erb Family Foundation recently supported a regenerative agriculture field tour that took participants to several WLEB farms. The MSU Extension held field day events around the state in 2024, including two events at the Saginaw Valley Research and Extension Center showcasing wheat (June) and bean and beets (August).

Demonstration farms are a popular and well-received strategy that may host multiple field day-type events per year as well as share information by other means. The Blanchard River Demonstration Farms Network, a partnership between USDA-NRCS and the Ohio Farm Bureau Federation, showcases conservation practices meant to improve water quality in the Maumee River basin. Three farms in Northwest Ohio demonstrate eight to ten conservation practices each and allow researchers to study their impact while simultaneously serving as an information hub for producers and landowners. In Michigan, the Lenawee County Center for Excellence works with local family farms that serve as demonstration sites during annual field day activities. Elsewhere in the Great Lakes Region, several of these research-oriented farm networks have been established, including one of the oldest in the Wisconsin Discovery Farms, a spin-off Discovery Farms Minnesota, and the Fox Demo Farms.

Other examples of producer-focused sharing out can be seen in the Farmer-Led Watershed Conservation Group and the Saginaw Watershed Farmer Network. Within these networks, producers can interface with other producers to get assistance in adopting BMPs. Thinking creatively can also bring non-producers to the action. In March of 2020, the Great Lakes Commission launched 'Conservation Kick', a program designed to create a water quality marketplace for the Great Lakes Basin. This program takes lessons the GLC has learned by designing and leading water quality trading efforts in both the Fox River Basin (Wisconsin) and the WLEB and seeks to expand water quality trading across the Great Lakes Basin.

University-affiliated agricultural extension offices or research farms are yet another means for directly engaging producers during in-person events or fostering information sharing and communication by other means. In the Saginaw area, MSU Extension operates the Saginaw Valley Research and Extension Center (SVREC) near Frankenmuth. It opened in April 2009, replacing the previous Saginaw Valley Bean and Beet Research Farm, and grows dry beans, sugar beets and rotational crops like wheat, corn, and soybeans on roughly 250 acres. The education center can host meetings, gatherings, and educational programming with space for over 300 people. SVREC specifically seeks to provide growers with accurate, economically relevant knowledge that keeps them competitive in dry bean and sugar beet production.

4.3 Recent Programmatic Changes

There have been several substantial changes in recent years in staff, positions, and organization at MDARD. These have included the hiring of a new director in March 2023, creation of a Western Lake Erie Strategist position in 2022, and hiring a Chief Science Officer in 2024. The MAEAP and its staff have been targets of executive branch and legislative reworking in Michigan in 2024. The Governor's 2025 budget proposed moving the MAEAP technicians from the Soil Conservation Districts to MDARD and shifting their geographic coverage from counties to watersheds, while the State's House of Representatives supported leaving the program unchanged and the Senate proposed moving the technicians to MSU Extension. In the signed budget, MAEAP technicians ultimately stayed with Conservation Districts and the Michigan Legislature approved funding to study the challenges and needs of Conservation Districts to help them succeed. The state is also looking for ways to enhance and expand MAEAP practices and enrollment with information gathered from the Michigan

Climate Smart Farm Project and the MI Healthy Climate Plan as well as include regenerative agriculture principles, working with MSU's Center for Regenerative Agriculture.

4.4 Knowledge Exchange Themes and Ideas

As part of the three-workshop series that initiated this project, several recurring themes were identified, and often carried over from one event to the next. Workshop #1 included three facilitated breakout groups covering knowledge exchange on: (1) conservation practitioner programming, (2) conservation practitioner outreach to new producers, and (3) farmer-led watershed groups. Conclusions of the discussions highlighted the importance of building relationships, establishing and maintaining credibility, continuity in programs and staff, fairness in design and eligibility of programs, effectiveness of conservation practices, and affordability of implementation for producers. Workshop #2 involved presentations covering a variety of project-related topics covered by TNC, AGL, Michigan Farm Bureau, LimnoTech, and Monroe Conservation District. Several of the conclusions from Workshop #1 were repeated during Workshop #2, and new themes emerged such as the importance of sustained conservation funding, a lingering notion that producers are singled out for nutrient pollution issues, the lack of adequate systems to track BMP adoption and water quality impacts, and the need to better account for challenges presented by owned vs. rented agricultural land for production. Workshop #3 included live polling of attendees to capture opinions regarding priorities for programming, outreach to new farmers, and farmer-led knowledge exchange, and to explore a series of "Million Dollar Ideas" that participants had proposed following the second workshop. The tone of Workshop #3 was positive and optimistic (Figure 6). Participants were energized by the prospects of new funding, new ideas, new technologies, and new leadership in Michigan's approaches to agricultural conservation. Full summaries for each of the three workshops are available in Appendix A.

Figure 6. Workshop #3 at Devries Nature Conservancy in Owosso, May 31, 2023.

Several themes, unresolved questions, or tensions emerged from Workshop #3, some of which were carried over from prior workshops. Among these were the following:

- Good technicians were recognized as a key component in building trusting relationships between producers and program managers. Insufficient staffing and compensation lead to high turnover rates, which has handicapped program effectiveness in the past.
- Participants were interested in the development of demonstration farm networks in the Michigan portions of the WLEB and Saginaw Bay watersheds as a method to facilitate technology transfer, foster improved communication, and build a sense of community and engagement among producers, researchers, and conservation program leads and staff.
- The results of prior investments in programs and research under GLRI and other initiatives do not always make their way back to advisors and producers. More effective technology transfer and plans for communication of lessons learned should be developed and implemented, working with existing networks and outlets that reach these audiences.
- Better coordination across states and organizations is needed, including basin-wide agencies (e.g., Great Lakes Commission, International Joint Commission advisory boards and working groups), academic institutions (land grant schools and others), and NGOs to maximize impact and minimize duplication.
- Expanded monitoring and data access for water quality, BMP implementation, and BMP effectiveness was recognized as a broad need, including real-time or at least in-season information and easy access through smart phone applications.
- Innovative approaches like remote sensing for monitoring BMP and cropping system practices were supported as ways to improve the temporal and spatial resolution of information to support program decisions and avoid data anonymity issues.

Seven ideas were presented and discussed, as described in Table 4. Appendix B contains greater detail for each of the "Million Dollar Ideas".

Table 4. Summaries of Million Dollar Ideas.

Idea Name	Summary
1. Pay-for-Performance+	Expand on the prior pilot framework of linking producer incentives to measured environmental outcomes by establishing a minimum payment threshold, requiring in-field measurement "spot checks", reinforcing voluntary enrollment and de-emphasizing "targeting", and providing streamlined contracting procedures
2. STRAND+	Build on the success of the prior STRAND program by establishing an improved results modeling and monitoring protocol, and establishing better baseline and post-implementation documentation of impacts
3. Two-Stage Ditches	Support expanding the width of drains to allow for water to be contained in channels rather than flooding fields, capturing phosphorus and sediment; leverage impact with easements on filter strips, which could be hayed or planted with trees; ditches maintained in coordination with local drain commission

Idea Name	Summary
4. MiWater Challenge	Fund watershed and municipal BMPs and restoration for water quality improvements through a taxpayer-supported water fund, analogous to H2Ohio, which will connect water users with those who implement sustainable agricultural practices
5. Profit for Soil Health	Conduct an economic analysis and then develop a linked cost-share program that ties improved soil health to profitability, providing bridging funds to protect producers from the economic costs of implementation until the profitability impacts are clearly realized and sustained
6. Risk-Managed Conservation	Provide cost-share for a suite of in-field practices that improve water quality and prevent erosion, along with protection for any related decrease in yield (not just weather-related but related to new practices)
7. Cover Crop Transitions	Provide cost-share at a reduced per-acre rate but over a longer transition period than traditional programs (6 to 9 years, versus 3 years) to allow for soil health and yield benefits to become clearer to producers, resulting in permanent cover crop adoption without cost-share

5 SUMMARY AND RECOMMENDATIONS

The overall goal of enhancing the adoption of permanent on-farm conservation measures and improving the water quality of Michigan's Western Lake Erie Basin has proven to be challenging. Progress has been made in the Saginaw Bay watershed with pilot-scale versions of successful on-farm conservation approaches, which are beginning to be adapted to Michigan's Western Lake Erie Basin to achieve permanent agricultural conservation and improved water quality. Likewise, Saginaw Bay programs have adapted Western Lake Erie Basin approaches, including the recent expansion of watershed monitoring facilitated by the Saginaw Bay Monitoring Consortium's efforts, coordinated by TNC. LimnoTech supported TNC in preparing and executing a series of three workshops to promote the exchange of effective agricultural conservation approaches among advisors and stakeholders in the Saginaw Bay watershed and the Western Lake Erie watershed to reduce nonpoint source nutrient loads and eutrophication. Findings and recommendations from the Saginaw Bay and Western Lake Erie Basin knowledge exchange effort can broadly be subdivided into three categories:

(1) program structure, operations, and staffing;

(2) incentivizing agricultural conservation; and

(3) tracking of BMP implementation and impacts.

The findings and recommendations arising in each of these categories are summarized here. Note that actions are already underway on many fronts to address some of the recommendations.

5.1 Program structure, operations, and staffing

The agricultural conservation sector in Michigan broadly suffers from inadequate staffing, inexperienced and underpaid staff, and high turnover. This impacts the ability of programs to build effective long-term relationships with producers and partners, and results in limited institutional memory and relatively low engagement over time, especially where new programs or changes to existing programs need to be communicated. Many programs are also characterized by fragmentation and ineffective coordination among related groups.

Recommendations:

- Develop more complete career paths for conservation organizations at all levels (e.g., conservation districts, State of Michigan Quality of Life agencies, watershed councils or non-governmental organizations) with competitive compensation within programs that would allow staff to progress from technician positions to watershed-scale program management, regional responsibilities, and even statewide roles while staying in the same geographic location. Keeping continuity between staff and their locations can stabilize their networks, build trusted relationships, and produce more permanent results over time as they train junior staff and introduce them to regional producers and partners.

- Develop more formalized communication pathways, agreements, or other structured collaborative relationships among agency-led agricultural conservation programs and NGOs to provide better outreach on technical and financial assistance opportunities, improve coordination of activities, reduce redundancy in programs, and leverage trusted partner relationships with producers and other agricultural stakeholders. Many NGOs, including TNC, play an integrator role – linking stream health and biodiversity to agricultural stressors across jurisdictions. These groups can also develop policy, play advocacy roles, access subject matter experts and communicators outside of agencies, serve as effective conveners, and augment program funds with philanthropic support.

- Encourage better integration between federal, state, and local programs. This may include leveraging MAEAP as an established program known throughout the State to streamline participation between multiple programs, simplify producers' paperwork and data submissions, and incentivize participation in programs with similar goals or for which only a few additional practices are needed to expand certification to multiple programs.

- Expand support for the development and maintenance of producer conservation networks including administrative management to allow them to share conservation information, program opportunities, experiences in implementation, and guidance through adoption on the farm.

- Offer opportunities to producer conservation networks to be more engaged and integral in planning field day events and expanding demonstration farm networks to bring conservation professionals, the farm community, and other stakeholders together.

5.2 Incentivizing agricultural conservation

There is broad agreement that the incentives that are associated with many agricultural conservation programs under the Farm Bill and other legislation are inadequate to justify the investment of time, money, and energy required by producers to participate. While investments by producers to reduce erosion and nutrient losses from their farms may seem like common sense, the reality is that current agricultural markets do not provide sufficient or timely financial returns on many BMP investments, making their implementation a drain on farms' business viability. Long-term efforts that support the creation of reliable markets that provide premiums for products created using positive environmental practices or other market-based incentives (e.g., carbon credits) could support expanded and sustained adoption of BMPs.

Recommendations:

- Build on recent studies of the BMP investments needed to meet nutrient reduction targets in the Western Lake Erie Basin (AGL and OEC 2023) by completing similar analyses for the Saginaw Bay watershed to better quantify the technical and financial challenges that exist to meeting nutrient load reduction targets for the bay. The study could further investigate various strategies for directing funding toward enabling long-term BMP implementation.

- Perform comprehensive studies to determine competitive pricing for initial adoption of conservation practices (i.e., capital expenses/implementation costs) and for persistent adoption of conservation practices (i.e., rewarding producers for long-term contributions made to the public good beyond their farm).

- Identify stable funding sources and allocate adequate resources to meet the needs of producers to accelerate sustained BMP adoption. Remove disincentives and barriers like complex application procedures, short-duration contracts that do not allow sufficient flexibility to adjust for weather conditions or diverse crop rotations, conservation program restrictions on equipment purchases or capital improvements, and challenges associated with landowner/tenant relationships and agreements.

5.3 Tracking of BMP implementation and impacts

Being able to track existing BMP implementation at sufficiently high spatial (field scale) and temporal (seasonal to annual) resolution to understand what is happening on the landscape is a critical component of effectively executing agricultural conservation programs. Similarly, higher resolution water quality data are also needed to link field-scale conservation practices with improvements in streams and rivers. Concerns about protecting the anonymity of Farm Bill program participants have led to anonymizing of survey data and other information to the county scale in most cases, which is too coarse to be useful for many purposes. New technologies may be able to provide more spatially relevant information while still protecting individual producer privacy and make the most of limited resources to provide a balance of the need for long-term monitoring with the implementation of practices to improve water quality. New monitoring approaches and policies are needed.

Recommendations:

- Develop and implement scientifically sound monitoring strategies that increase resolution and better integrate ground-based, water-based, and remote sensing data to allow conservation professionals to make informed decisions about where to direct producer outreach, what practices are most effective, and how the agricultural landscape is shifting based on private, public, technical, and market-based drivers. This information could be used to perform an annual BMP adoption analysis at the watershed scale, drive the application of emerging artificial intelligence/machine learning tools, confirm that funded conservation commitments are being implemented, and guide new agricultural conservation and ecosystem service market-based programs.

- Incentivize voluntary data-sharing by rewarding conservation-oriented producers with meaningful credentials and certifications that will be valued by their customers, colleagues, and other interested parties.

- Establish and maintain long-term water quality monitoring programs to measure whether improvements in in-stream nutrient loading are being made.

5.4 Conclusion

There is broad agreement among the farming community and the conservation community that the current approach to improving the environmental sustainability of agriculture in the SB watershed and the WLEB is not meeting nutrient reduction targets. The path forward will require improved programs, better tracking, and more compelling incentives. Little progress is likely to be made without solid and lasting partnerships that eschew adversarial approaches and embrace and articulate common goals, objectives, agendas, and desired changes to taxpayers, consumers, investors, and people in positions of influence, recognizing that those people change over time. The pace at which these recommendations are implemented will substantially determine the rate of water quality improvement in the waters and tributaries of Lake Erie and Saginaw Bay.

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APPENDIX A
Workshop Summary Memos

[memos to be attached in final PDF version]

APPENDIX B
Million Dollar Ideas

Project #1: Pay-for-Performance+ (PfP+)

Lead Organization: The Nature Conservancy

Type of Project: Incentives

Affected Audience: Farmers, Conservation Agencies

The Problem: Traditional farmer incentive programs typically provide flat rates per acre, regardless of environmental outcome. Pay-for-Performance on the other hand, optimizes environmental results by linking payment amounts to measured conservation benefit. However, in early iterations of this program, participation was limited due to confusing agreement terms, and perceived inequities amongst farmers.

The Solution: PfP+ will expand on the existing framework of linking farmer incentives to measured environmental outcomes and add the following improvements:

- Establish a minimum payment threshold equivalent to at least the cost of implementation
- Require some in-field measurement “spot checks” as a quality control measure to vet estimated results.
- Reinforce messaging that PfP does not preclude participation in other carbon-type programs.
- Reinforce voluntary enrollment and de-emphasize “targeting”.
- Borrow some of STRAND’s administrative contracting procedures to improve farmer satisfaction with program.

Conservation Impact: Conservation Impact will be commensurate to funding availability. However, based on prior PfP trials, estimated conservation impact will be over 4 times greater than traditional cost-share frameworks.

Project #2: STRAND+

Lead Organization: Conservation Districts, MDARD

Type of Project: Incentives

Affected Audience: Farmers, Agribusiness

The Problem: Traditional farmer incentive programs typically require extensive time commitments and burdensome paperwork to enroll. STRAND 1.0 established a proven framework for expediting the enrollment process to accelerate nutrient reduction on the land and improve farmer satisfaction. However, certain program deficiencies in STRAND 1.0 were identified for improvement. Once implemented, the STRAND model can serve as an even better model for delivering local conservation.

The Solution: STRAND+ will expand on the existing framework of rapid enrollment and ease of participation by implementing the following:

- Establish/require an improved results modeling/monitoring protocol
- Establish/require better before-and-after documentation

Conservation Impact: Conservation Impact will be limited to funding availability. However, it is projected that STRAND+ will result in one of the most effective conservation programs for deploying rapid results on the landscape, while remaining a popular choice amongst farmers.

Project #3: Two-Stage Ditch Installation

Lead Organization: County Drain Commissioners

Type of Project: Science/Evaluation/Technology; Incentives

Affected Audience: Farmers

The Problem: County drains and local streams are too narrow. Wetlands have disappeared over the decades as they've been drained for farming. Expanding the width of drains allows for the water to be contained in channels rather than flooding fields. This practice has also shown to capture phosphorus and particulate matter more efficiently.

The Solution: Expanding the width of drains allows for the water to be contained in channels rather than flooding fields. This practice has also shown to capture phosphorus and particulate matter more efficiently. Easements on filter strips along the drains/ditches would be proposed and kept by the conservation district or watershed councils. These filter strips could be hayed, maintained as a regular filter strip, or be planted with trees. They would be maintained in conjunction with the producer and/or local drain commission.

Conservation Impact: Improved capture of surface runoff and better capture of nutrients within the waterway. Better drainage of the waterway during storm events and a reduction of flooding in farm fields.

Project #4: MiWater Challenge

Lead Organization: State-led (EGLE)

Type of Project: Incentives; Policy

Affected Audience: Residents of and visitors to the coasts, cities, and rural watersheds experiencing water quality challenges

The Problem: Excess sediment and nutrients from primarily agricultural sources that contribute to HABs and other water quality issues in Saginaw Bay and WLE. Funding for BMPs and restoration is inadequate and not sustained

The Solution: Funding watershed and municipal BMPs and restoration for water quality improvement through a water fund, analogous to H2Ohio.

Conservation Impact: Helping to connect water users to those on whom we rely on to implement sustainable practices through a sustained funding stream. Those who are being harmed will begin to pay for practices implemented by those who are contributing to the problem.

Project #5: Profit from Soil Health

Lead Organization: Michigan Farm Bureau

Type of Project: Incentives; Science/Evaluation/Technology; Education/Outreach

Affected Audience: Farmers, particularly those not in existing programs and no interest in participating.

The Problem: Conservation Practice programs either do not offer a long-enough pay period or don't reflect the cost/return on investment (ROI) for farmers. Middle adopters need a simple, flexible program that they can see makes business sense.

The Solution:

1) Complete an economic study for Michigan regions/commodities on conservation practices: how much they cost to implement, what is the ROI and how much time does it take to see the soil health/yield/profitability benefit, and what practices never even break even in cost and how much gap exists between implementation cost and ROI.

2) Tailor a cost share program to the economic study-- pay for practices for the length of time it takes to get to break-even, or periodic payments for the life of a practice that never breaks even. Use mapping/modeling available to provide either a higher payment or bonus for enrolling acres where the practice resolves a high risk for water quality, but provide sufficient payments to make it worth any farmer's time, for the social benefit of word-of-mouth popularity of the program.

Conservation Impact: This program depends on the education/outreach impact of helping farmers understand the business implications of implementing various conservation practices. It then fills the financial gap to protect farmers from the economic cost of implementation, until the soil health, yield, input reduction, erosion, profitability impact can be seen and the farmer no longer needs the financial support. It gives the flexibility of allowing farms to enroll the number of acres and number of practices they are comfortable with, and rolls over enrollment if a practice can't be implemented due to weather or supply chain shortages. It builds the culture of thinking of soil health as something that should be part of a business plan, not just a conservation plan, and tailors payments to the actual financial impact farms must incur to put them in place. Implemented practices can be tracked and aggregated at watershed, county, or other levels and modeled through existing tools like RUSLE2, SWAT, etc. to provide environmental impact and strategic water quality monitoring can track progress to identify changes.

Project #6: Risk-Managed Conservation

Lead Organization: Michigan Farm Bureau

Type of Project: Incentives

Affected Audience: Farmers in all the of the counties that program is available

The Problem: When changing a something on the farm, especially an in-field practice, there is a risk, and this can come in the form of a hit to the farmer's yield.

The Solution: Cost-share for a suit of in-field practices that improve water quality and prevent erosion. There would be higher cost-share rates for adopting more than one practice. AND there would be some sort of yield hit insurance - if it's a relatively normal year and your yield takes a hit below your five-year average (or whatever number makes sense) the program would pay out a certain amount of $$

Conservation Impact: Hopefully increasing adoption of conservation among middle adopters. There might be other factors affecting water quality that could be addressed with regional practices).

Project #7: Cover Crop Transitions

Lead Organization: Michigan Agriculture Advancement

Type of Project: Incentives; Science/Evaluation/Technology; Education/Outreach

Affected Audience: Conventional farmers and/or first time CC adopters.

The Problem: Introducing a new management practice to any farm increases financial risk and uncertainty. There's often an extensive trial and error period a farmer must go through before they've perfected implementation of the new practice in their operation and can begin seeing results in improved soil health. Unfortunately, traditional (i.e., Farm Bill) incentive programs typically only offer three years of cost-share, which is barely enough time to get a farm through one full crop rotation, let alone regenerate soil health. New research from U of M indicates that the full spectrum of cover crop benefits is not fully realized if current soil health levels in a field are low. To receive maximum ROI benefit from a cover crop (e.g., carbon sequestration, nutrient mineralization), a certain level natural processes/function must be present in the soil. If not, cover crop performance will be suboptimal. Therefore, in a quick 3-year cover crop incentive program, conventional farmers with poor soil quality won't have the opportunity to experience full cover crop benefit, thus resulting in a likely dis-adoption of the practice once incentive ends.

The Solution: To help a farmer fully unlock the benefits of cover crops and increase the likelihood of their long-term adoption, the "Cover Crop Transitions" program proposes a reallocation of traditional incentive contracts to A.) reduce the per-acre payment rate for cover crops, but B.) double or triple the period a farmer will be eligible to receive those payments. Further, this program will "stair step" cover crop implementation requirements over time so that A.) a farmer can ease into cover crops intensity to gain needed experience and knowledge of cover crop O & M, while at the same time B.) slowly building soil health over time so that by the end of the program (the most diverse cover crop implementation requirements) a farmer's fields are more likely to produce greater environmental benefits.

The suggested timetable for cover crop progression over this 6-year period would be:

- Years 1-2: one winter-terminated cover crop species
- Years 3-4: one overwintering cover crop species
- Years 5-6: a multi-species blend (of two or more functional groups).

Note, this 6-year enrollment term is suggested for a corn/soy rotation but could be as long as 9 years for 3- or 4-way crop rotations.

Conservation Impact: 7,407 acres of permanent cover crops (an important distinction is that this program will result in permanent adoption vs. the temporary adoption seen in other programs).