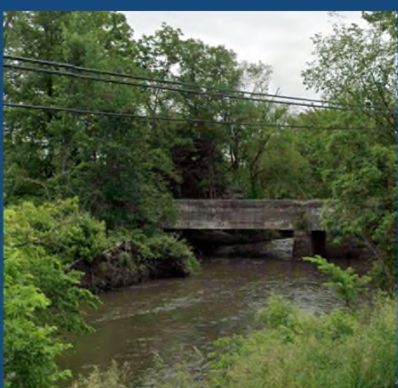
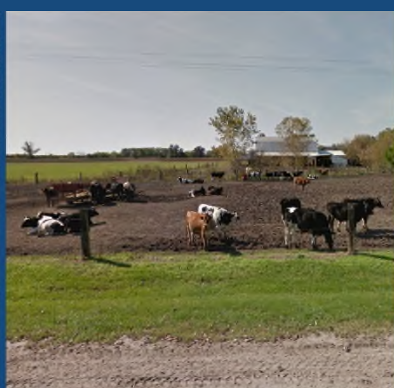
Ottawa-Stony North Watershed Management Plan

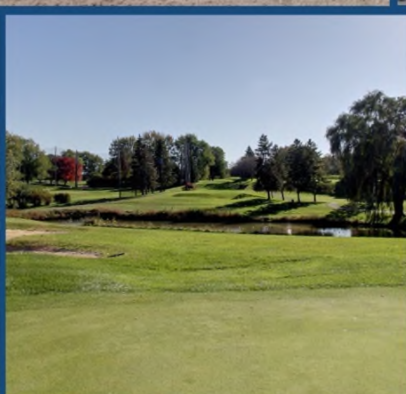
Prepared by:
LimnoTech, Monroe Conservation District, and Washtenaw County Conservation District

DRAFT

September 2024





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Prepared by:
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Top cover photos (left to right): Stony Creek near Telegraph Road, cattle near Kelly Drain, subdivision in the Paint Creek subwatershed, and MAEAP verified farm in the Sugar Creek subwatershed.

Bottom cover photos (left to right): greenhouse operation in the Little Swan Creek subwatershed, golf course in the Paint Creek subwatershed, Crosswinds Marsh nature preserve, and Sandy Creek at Bluebush Road.

Acknowledgements

This document was prepared and written for the Monroe Conservation District (MCD) and Washtenaw County Conservation District (WCCD) by Derek Schlea of LimnoTech, with primary assistance from Nicholas Machinski (WCCD), Brittany Santure (formerly MCD), and Jackson Cenusa (MCD).

Many other individuals and groups have contributed to the information, analysis, and insight contained within this watershed management plan (WMP). Other LimnoTech staff playing key roles included Dani Cohn (geospatial analysis) and Chris Behnke (field support). Hannah Witt (formerly MCD) supported the project by participating in water quality sampling and streamwalk activities.

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Abbreviations

ACPF	Agricultural Conservation Planning Framework
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CSA	Critical Source Area
DO	Dissolved Oxygen
DPO4-P	Dissolved Orthophosphate
E. coli	*Escherichia coli*
EGLE	Michigan Department of Environment, Great Lakes, and Energy
FWMC	Flow-Weighted Mean Concentration
GLRI	Great Lakes Restoration Initiative
GLWMS	Great Lakes Watershed Management System
GLWQA	Great Lakes Water Quality Agreement
HAB	Harmful Algal Bloom
LLWFA	Landscape Level Wetland Functional Assessment
MCARD	Michigan Commission of Agriculture and Rural Development
MCD	Monroe Conservation District
MDARD	Michigan Department of Agriculture and Rural Development
MDEQ	Michigan Department of Environmental Quality
MST	Microbial Source Tracking
NRCS	Natural Resources Conservation Service
NPS	Nonpoint Source
NWI	National Wetlands Inventory
OSDS	On Site Disposal Systems
OSN	Ottawa-Stony North
PBC	Partial Body Contact
QAPP	Quality Assurance Project Plan
SRLP	Septic Replacement Loan Program
TBC	Total Body Contact
TMDL	Total Maximum Daily Load
TDS	Total Dissolved Solids
TP	Total Phosphorus
TSS	Total Suspended Solids
UAL	Unit Area Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WASCOB	Water and Sediment Control Basin
WCCD	Washtenaw County Conservation District
WLEB	Western Lake Erie Basin
WMP	Watershed Management Plan
WQ	Water Quality

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

1.1 Purpose & objectives

Recent sampling of streams in the Ottawa-Stony North (OSN) Watershed in Southeast Michigan indicates water quality concerns and impairments for *Escherichia coli (E. coli)*, sediment, total dissolved solids (TDS), dissolved oxygen (DO), habitat alteration, and flow regime modification (Figure 1, Figure 2). The OSN Watershed is part of the Western Lake Erie Basin (WLEB), the landscape that drains to Lake Erie's westernmost and shallowest basin, which experiences annual algal blooms fueled by phosphorus loading.

The purposes of this OSN watershed management plan (WMP) are to identify the stressors causing the water quality impairments, to prioritize areas for restoration and protection, and to recommend management actions that aim to improve water quality in watercourses within the watershed and reduce nonpoint source phosphorus loading to Lake Erie. This plan follows the format of a U.S. Environmental Protection Agency (USEPA) nine key element plan, which includes the following requirements: (1) identifying sources and causes of pollution, (2) estimating pollutant loading, (3) describing management measures, (4) estimating technical and financial assistance, (5) informational and educational components, (6) project schedule, (7) measurable milestones, (8) benchmarks to measure progress, and (9) a monitoring component.

Ultimately, the goal that this WMP seeks to accomplish is restoration of the currently unsupported designated and desired uses of waterbodies in the watershed, alleviating all known water quality impairments. Achieving this goal will take time and will require engagement with key stakeholders and the implementation of management actions described in this WMP. The management recommendations described in the WMP aim to reduce phosphorus and sediment loads and *E. coli* contamination from agricultural and residential sources by addressing cropland and livestock operation runoff, loading from failing or poorly functioning OSDS, and residential stormwater runoff, which collectively contribute to the water quality impairments. Management objectives to help meet the WMP goals include improving outreach, education, and information sharing activities; increasing landowner participation in existing conservation programs; expanding the technical and financial assistance available residents and producers; increasing the adoption of residential property management, livestock management, row crop operational, and land conservation practices; and establishing methods to track progress.

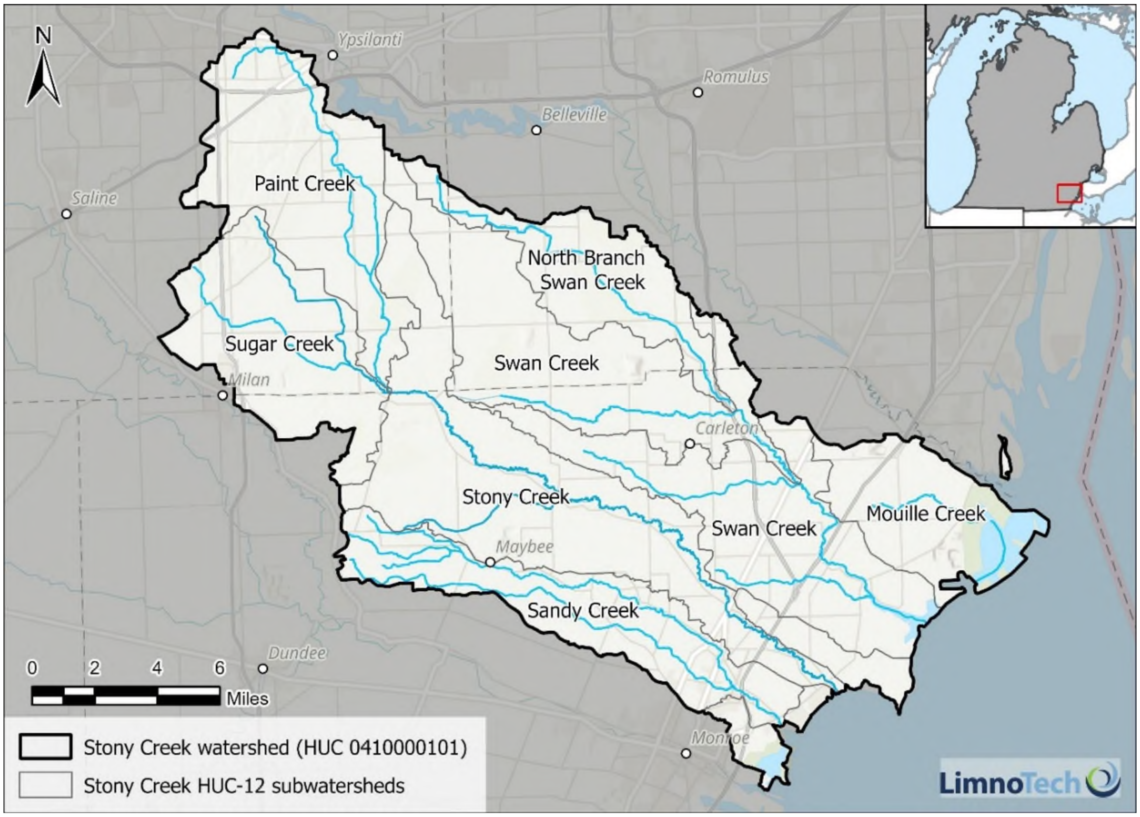

Figure 1. Map of the OSN Watershed depicting HUC-12 subwatersheds.

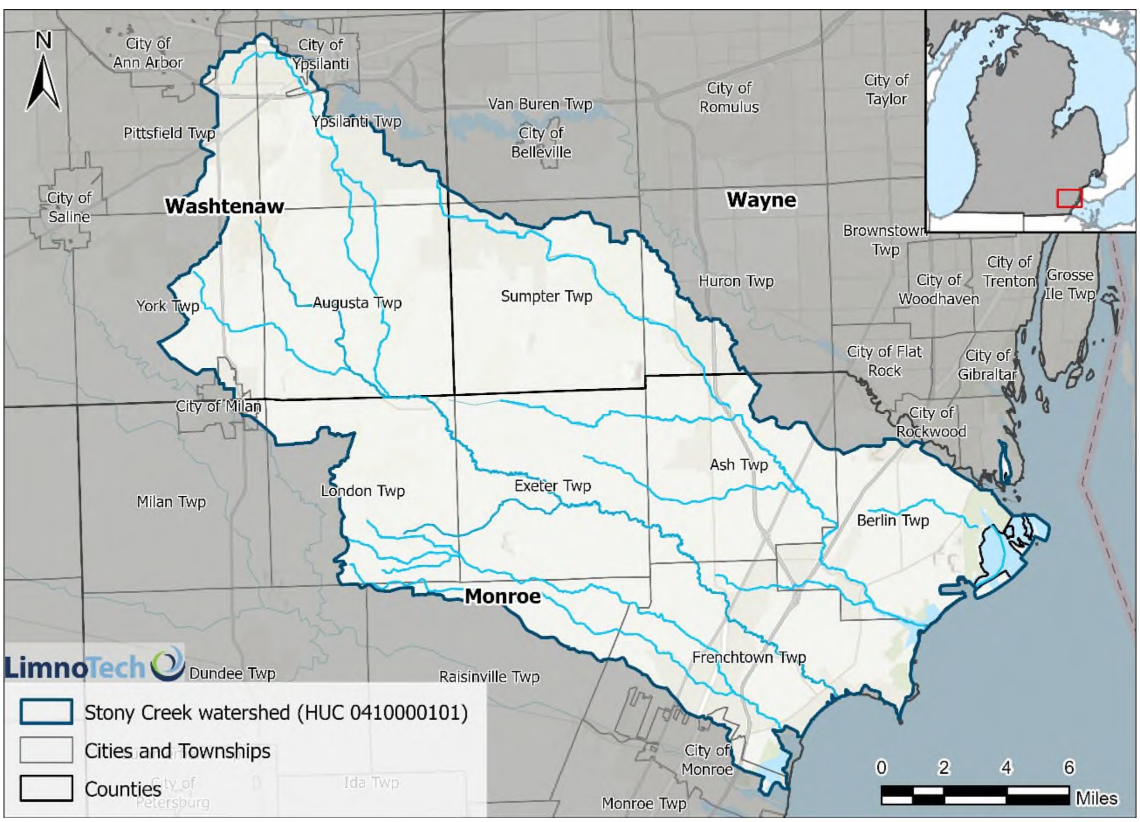

Figure 2. Map of the OSN watershed depicting various jurisdictions.

2 WATERSHED DESCRIPTION

2.1 Project background

The OSN Watershed (HUC 0410000101) lies within Monroe, Washtenaw, and Wayne counties in Southeast Michigan. Several creeks make up the watershed, flowing from northwest to southeast, and it is situated between the Huron and Raisin rivers, draining into Lake Erie just north of the City of Monroe.

The State of Michigan Integrated Report, developed by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), lists impaired water bodies under Clean Water Act Section 303(d) that do not meet designated uses (Goodwin and Smith 2020, Goodwin and Smith 2022, Goodwin et al. 2024). Several subwatersheds within the watershed have been added to Michigan's 303(d) list of impaired waterbodies. The unsupported uses and causes of impairments for all impaired waterbodies in the OSN Watershed are listed in Table 1 and shown in Figure 3. In response to the 303(d) impairments for Paint Creek, Total Maximum Daily Loads (TMDLs) were developed by EGLE (formerly Michigan Department of Environmental Quality, MDEQ) for Dissolved Oxygen (DO), Biota, and *E. coli* (Brunsen 2005, Wuycheck 2005, Alexander and Sayles 2005). The State also developed a statewide *E. coli* TMDL in 2019 to eliminate the need for individual watershed-based TMDLs (Rippke 2019). The 2020 addendum to the statewide *E. coli* TMDL listed the portions of Swan, Stony, and Sandy creeks impaired for *E. coli*, thereby resulting in removal of these waterbodies from the 303(d) list by reason of being included in an approved TMDL (EGLE 2020).

Table 1. Unsupported designated uses and causes of impairments in the OSN Watershed.

AUID(s)	Subwatershed	Unsupported Uses	Causes of Impairment
041000010105-01	Paint Creek	Other Indigenous Aquatic Life and Wildlife	Sedimentation/Siltation
041000010105-02	Paint Creek	Partial Body Contact Recreation & Total Body Contact Recreation	*E. coli*
041000010105-02	Paint Creek	Cold Water Fishery	DO & Sedimentation/Siltation
041000010102-01, 041000010103-01, 041000010104-01, 041000010104-02	Swan Creek	Partial Body Contact Recreation & Total Body Contact Recreation	*E. coli*
041000010103-01	Swan Creek	Other Indigenous Aquatic Life and Wildlife	Mercury in Water Column
041000010104-01	Swan Creek	Other Indigenous Aquatic Life and Wildlife	Flow Regime Modification & Habitat Alterations
041000010104-02	Swan Creek	Other Indigenous Aquatic Life and Wildlife	Flow Regime Modification & Other Anthropogenic Substrate Alterations
041000010107-01	Stony Creek	Other Indigenous Aquatic Life and Wildlife	Flow Regime Modification, Mercury in Water Column, Other Anthropogenic Substrate Alterations, & TDS
041000010107-02	Stony Creek	Partial Body Contact Recreation & Total Body Contact Recreation	*E. coli*
041000010107-02	Stony Creek	Other Indigenous Aquatic Life and Wildlife	Mercury in Water Column & TDS
041000010108-02, 041000010108-04	Sandy Creek	Partial Body Contact Recreation & Total Body Contact Recreation	*E. coli*
041000010108-02	Sandy Creek	Warm Water Fishery	Flow Regime Modification & Other Anthropogenic Substrate Alterations
041000010108-04	Sandy Creek	Other Indigenous Aquatic Life and Wildlife	Flow Regime Modification & Habitat Alterations

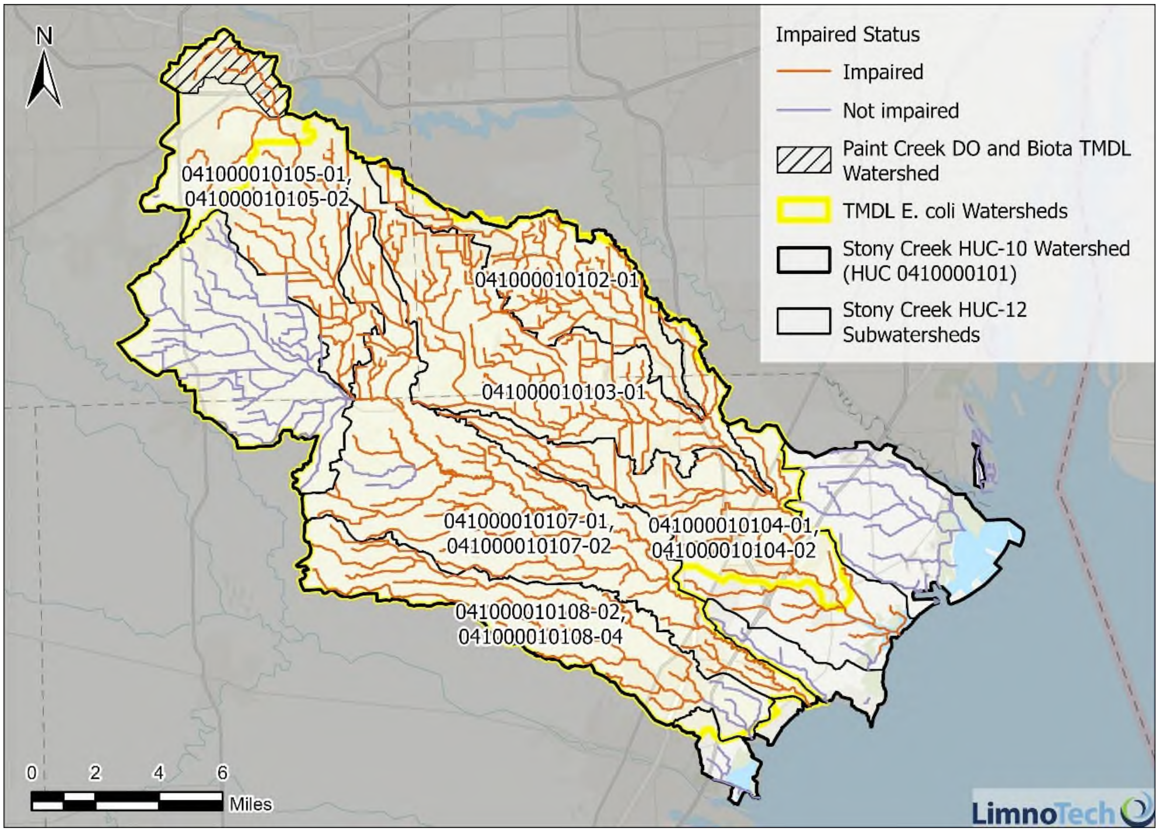

Figure 3. Impaired stream segments and TMDL coverage areas within the OSN Watershed.

2.2 Watershed characteristics

2.2.1 Land Use, Soils, and Slopes

The OSN Watershed spans 750 square kilometers and contains a mix of different land uses, with cultivated cropland representing the majority at about 44% (Table 2, Figure 4). The cultivated cropland is mostly used for growing corn, soybeans, and, to a lesser extent, winter wheat. Some agricultural lands are used for vegetable production, nurseries, and greenhouses. Although there are no concentrated animal feeding operations (CAFOs) within the watershed, several medium and hobby-size horse and cattle farms are present. Developed land use including commercial, industrial, and residential areas can be found throughout the watershed including the outskirts of Ypsilanti and Ann Arbor to the north, Monroe metro area to the south, and smaller communities in the center (Milan, Maybee, Carleton, and others). Major commercial and industrial footprints in the watershed include a nuclear power plant, gravel and limestone quarries, golf courses, a landfill, a federal prison, storage and distribution facilities, and several manufacturing facilities. Land classified as deciduous forest and woody wetlands, interspersed with rural residences, makes up a meaningful portion of Augusta, London, and Sumpter townships in the center of the watershed (Table 2).

Table 2. OSN watershed land cover breakdown (derived from National Land Cover Dataset).

Land Cover	Area (Acres)	Percent
Cultivated Cropland	81,041	44%
Pasture/Hay	13,090	7%
Developed	40,926	22%
Forest	31,565	17%
Wetlands/Water	18,488	10%
TOTAL	**185,110**	

Most of the watershed and cultivated cropland sits atop group C/D and group D soils which have slow/very slow infiltration rates. Because of this, many fields have had artificial subsurface drainage (i.e., tile drainage) installed to make the land arable. The central region of the watershed where the deciduous forest and woody wetlands are located is largely dominated by group A and group A/D soils. Group B, C, and B/D soils are also present in the watershed, but to lesser extends than the other hydrologic soil groups (Figure 5).

The watershed is extremely flat and sits in the Huron/Erie Lake Plain ecoregion, occupying an area once inundated by the ancient "Lake Maumee" (i.e., an ancestor of Lake Erie). Only a fraction of the northwest most corner of the watershed has more meaningful changes in elevation and topography (Figure 6, Figure 7). This area with greater relief is in the Eastern Corn Belt Plains ecoregion and is separated from the flatter majority of the watershed by Stony Creek Road, which runs along a sandy ridge that marked the ancient lakeshore. Despite being part of the corn belt ecoregion, very little agriculture is present in this rolling/hilly portion of the watershed, and it is instead used for residential, commercial, and recreational purposes, including the aptly named Rolling Hills County Park.

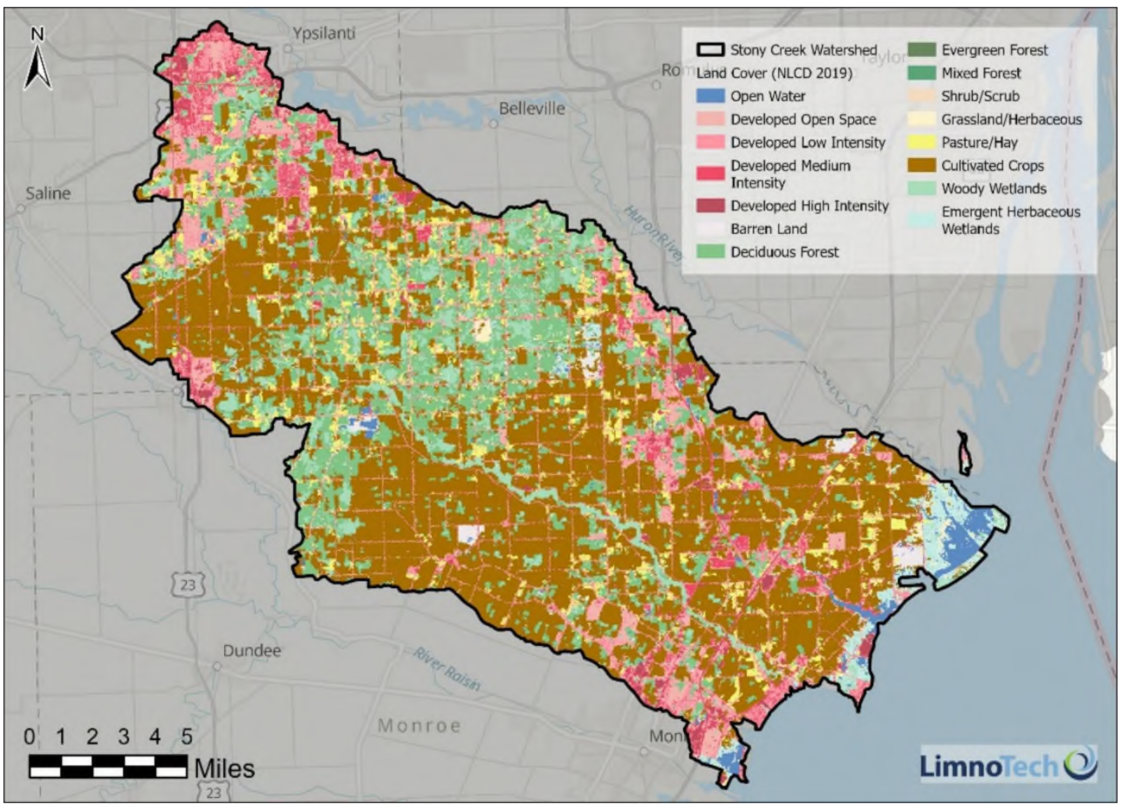

Figure 4. OSN Watershed land cover breakdown.

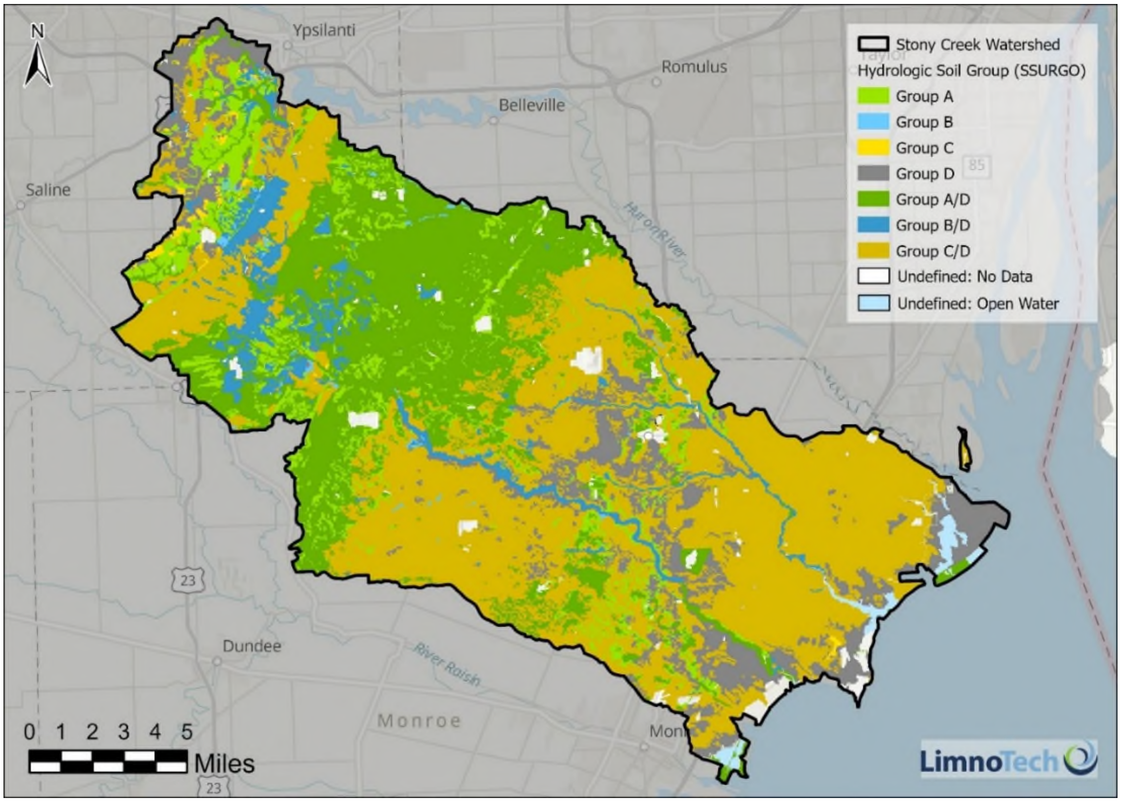

Figure 5. Hydrologic soil groups in the OSN Watershed.

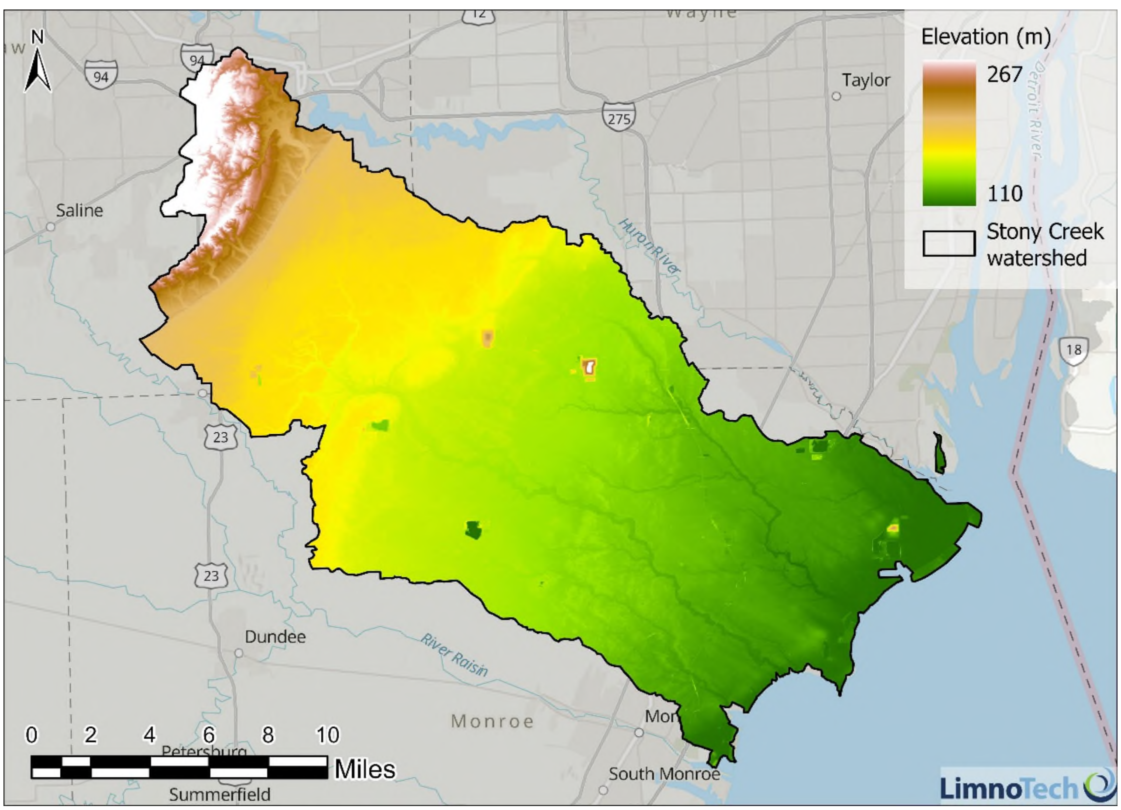

Figure 6. Elevation map for the OSN Watershed.

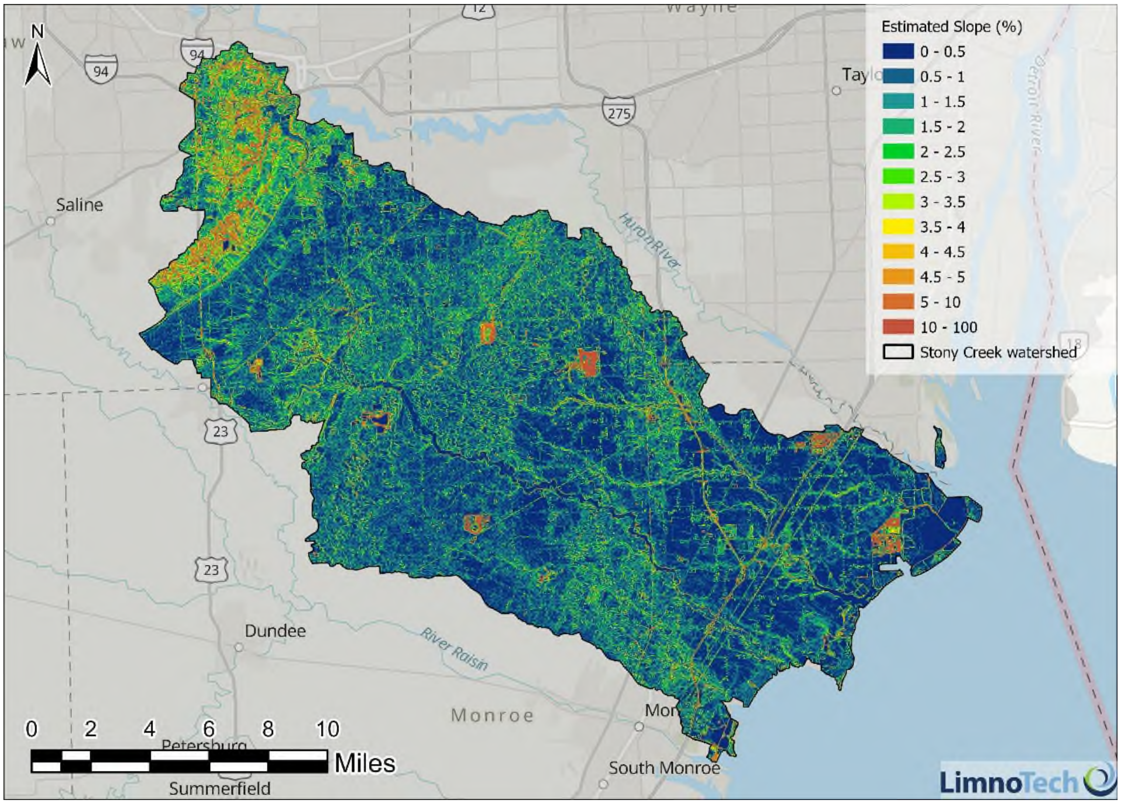

Figure 7. Land slopes within the OSN Watershed.

2.2.2 Landscape Level Wetland Functional Assessment

Wetlands are a critical component to hydrology and nutrient transport within a watershed. In recent years, the United States Fish and Wildlife Services (USFWS), Michigan EGLE, and the USEPA supported the update of the National Wetlands Inventory (NWI). EGLE incorporated this enhanced NWI into a Landscape Level Wetland Functional Assessment (LLWFA). A LLWFA uses aerial photography, hydrologic data, topographic data, and other valuable information such as the enhanced NWI to identify areas where wetland restoration is possible, wetland functions, and loss of wetland function due to land use change and ultimately help inform watershed management plans.

A LLWFA was performed on the OSN watershed. Within the watershed, there were 105,500 acres of wetland pre-European settlement and 22,800 acres in 2015 which equates to a loss of 78% of wetland area (Figure 8). Freshwater forested/shrub wetlands represent the largest NWI category of wetlands remaining in the watershed. The Crosswinds Marsh located in the center of the watershed is classified as a freshwater emergent wetland and represents one of the largest wetland mitigation projects in the country. Figure 9 shows both current and historic wetland locations that are rated as “high” or “moderate” for nutrient transformation according to the LLWFA analysis. Management actions (described later in this plan) should focus on preservation of the current wetlands rated as high/moderate for nutrient transformation and restoration of historic wetland areas with the same rating, especially where they overlap with depressional areas of the landscape (Figure B-11, Figure B-12). In addition to the loss of overall wetland area relative to pre-European settlement, the remaining wetlands are also predicted to have lost functional capacity for several categories (Table 3).

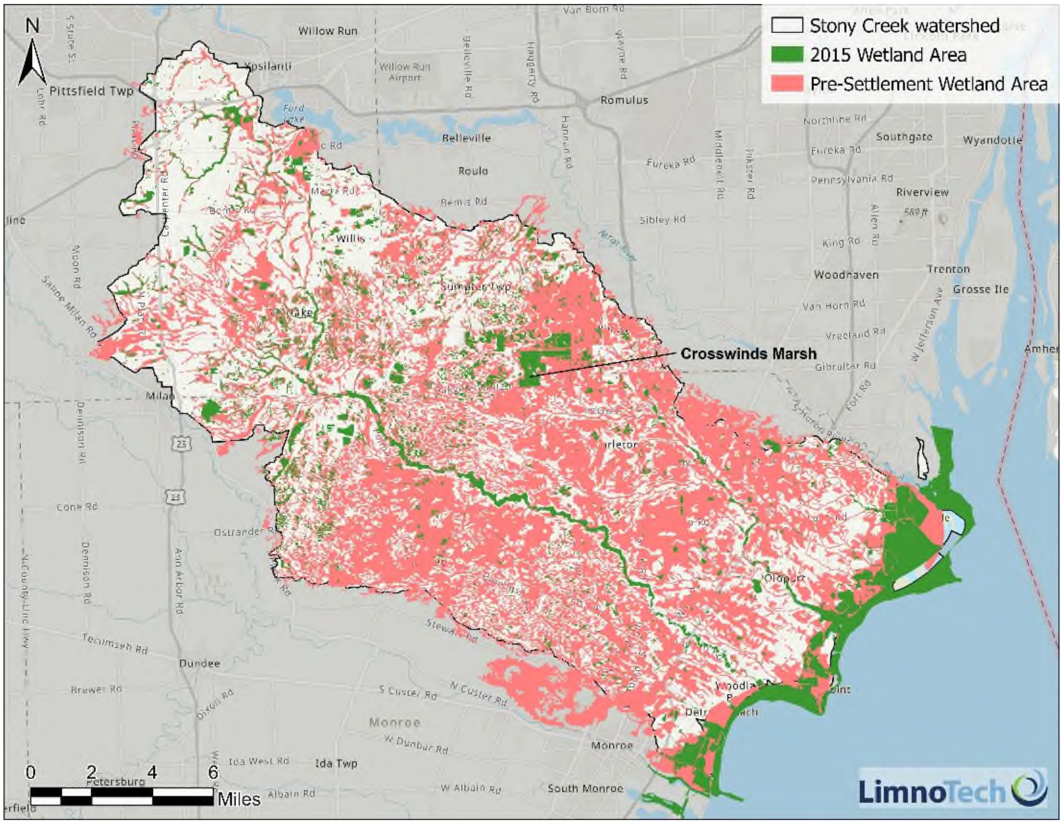

Figure 8. OSN Watershed LLWFA map showing current and pre-settlement wetland areas.

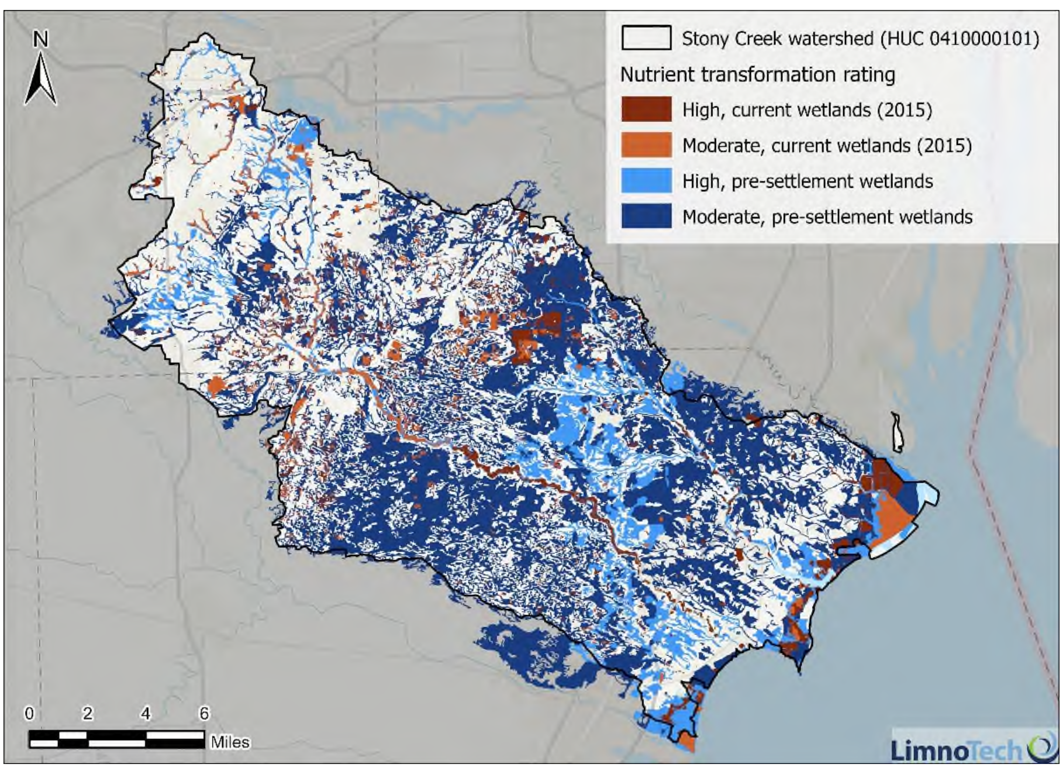

Figure 9. Map showing priority locations for nutrient transformation wetlands (existing and historic).

Table 3. OSN Watershed LLWFA results for 15 wetland functional categories

Function	Pre-European Settlement Conditions (acres)	2015 Conditions (acres)	Predicted Functional Capacity Loss (%)
Flood Water Storage	102,000	10,058	90.1%
Streamflow Maintenance	92,625	13,767	85.1%
Nutrient Transformation	105,119	13,934	86.7%
Sediment and Other Particulate Retention	45,131	8,298	81.6%
Shoreline Stabilization	93,704	10,839	88.4%
Fish Habitat	99,005	15,403	84.4%
Stream Shading	21,088	1,828	91.3%
Waterfowl and Waterbird Habitat	21,168	6,503	69.3%
Shorebird Habitat	104,777	13,005	87.6%
Interior Forest Bird Habitat	88,785	9,380	89.4%
Amphibian Habitat	63,449	9,703	84.7%
Ground Water Influence	3,347	183	94.5%
Carbon Sequestration	16,524	3,340	79.8%
Conservation of Rare & Imperiled Wetlands & Species	n/a	15,075	n/a
Pathogen Retention	100,136	4,283	95.7%

2.3 Water Quality Impairments

2.3.1 Great Lakes Water Quality Agreement

The Great Lakes Water Quality Agreement (GLWQA) was signed by the United States and Canada in 1972 to commit to the shared responsibility to restore and protect the Great Lakes and updated in 2012 to consider current threats to lake quality. Annex 3 of the GLWQA addresses chemicals of mutual concern including mercury. In June 2021, the Great Lakes Binational Strategy for Mercy Risk Management was published (ECCC and USEPA 2021). Annex 4 of the GLWQA addresses actions to control nutrients, namely phosphorus. Following a commitment from the 2012 GLWQA, the two countries established binational phosphorus load reduction targets for Lake Erie including a 40% reduction of total phosphorus (TP) load into Lake Erie's western and central basins which equates to a 3,316 metric ton (MT) per year reduction by the U.S. relative to a 2008 baseline water year (USEPA 2018).

2.3.2 Section 303(d) List and TMDLs

Nine waterbodies (041000010102-01, 041000010103-01, 041000010104-01, 041000010104-02, 041000010105-02, 041000010107-01, 041000010107-02, 041000010108-02, & 041000010108-04) are listed as impaired on Michigan's 303(d) list for not meeting the designated uses. These waterbodies are polluted by *E. coli*, mercury, TDS, flow regime modifications, habitat alterations, DO, and/or sedimentation (Table 1). TMDLs were developed for DO, Biota, and *E. coli* for a 4.6-mile segment of Upper Paint Creek upstream of Textile Road (Brunsen 2005, Wuycheck 2005, Alexander and Sayles 2005). The State also developed a statewide *E. coli* TMDL in 2019, which has been occasionally updated to expand the number of waterbodies covered in it, including in 2020 when an addendum to the statewide TMDL added portions of Swan Creek, Stony Creek, and Sandy Creek that had high *E. coli* measurements (Rippke 2019, EGLE 2020).

2.4 Water Quality Standards

The Michigan Administrative Code R 323.1041 – 323.1117 in Michigan's Part 4 Rules, Water Quality Standards (Part 31, Water Resources Protection, of Act 451 of 1994) established water quality standards and designated uses within the state. Section R 323.1100 Rule 100 of the Michigan Administrative Code states that all surface waters of the state are, at minimum, to be designated and protected for the following uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption.

2.4.1 *E. coli*

Under Michigan Administrative Code R 323.1062 Rule 62, the *E. coli* standards are established. The applicable subrules state that:

> "(1) All surface waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli* (*E. coli*) per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the surface waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.
>
> (2) All surface waters of the state protected for partial body contact recreation shall not contain more than a maximum of 1,000 *E. coli* per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples, taken during the same sampling event, at representative locations within a defined sampling area."

The statewide *E. coli* TMDL and Upper Paint Creek *E. coli* TMDL both use concentration-based TMDLs with targets consistent with these values stated in R 323.1062, rather than load-based TMDLs, as USEPA allows pathogen TMDLs to be expressed in terms of daily maximum allowable organism counts or resulting concentrations (Rippke 2019, Alexander and Sayles 2005).

2.4.2 Dissolved Oxygen

Michigan Administrative Code R 323.1064 Rule 64 details dissolved oxygen standards for the Great Lakes and all connecting waters and inland streams:

> "(1) A minimum of 7 milligrams per liter of dissolved oxygen in all Great Lakes and connecting waterways shall be maintained, and, except for inland lakes as prescribed in R 323.1065, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained at all times in all inland waters designated by these rules to be protected for coldwater fish. In all other waters, except for inland lakes as prescribed by R 323.1065, a minimum of 5 milligrams per liter of dissolved oxygen shall be maintained. These standards do not apply for a limited warmwater fishery use subcategory or limited

coldwater fishery use subcategory established pursuant to R 323.1100(11) or during those periods when the standards specified in subrule (2) of this rule apply.

(2) Surface waters of the state which do not meet the standards set forth in subrule (1) of this rule shall be upgraded to meet those standards. The department may issue permits pursuant to R 323.2145 which establish schedules to achieve the standards set forth in subrule (1) of this rule for point source discharges to surface waters which do not meet the standards set forth in subrule (1) of this rule and which commenced discharge before December 2, 1986. For point source discharges which commenced before December 2, 1986, the dischargers may demonstrate to the department that the dissolved oxygen standards specified in subrule (1) of this rule are not attainable through further feasible and prudent reductions in their discharges or that the diurnal variation between the daily average and daily minimum dissolved oxygen concentrations in those waters exceeds 1 milligram per liter, further reductions in oxygen-consuming substances from such discharges will not be required, except as necessary to meet the interim standards specified in this subrule, until comprehensive plans to upgrade these waters to the standards specified in subrule (1) of this rule have been approved by the department and orders, permits, or other actions necessary to implement the approved plans have been issued by the department. In the interim, all of the following standards apply:

(a) For surface waters of the state designated for use for coldwater fish, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 6 milligrams per liter at the design flow during the warm weather season in accordance with R 323.1090(2) and (3). At the design flows during other seasonal periods, as provided in R 323.1090(3), a minimum of 7 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(b) For surface waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(3), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(c) For surface waters of the state designated for use for warmwater fish and other aquatic life, but also designated as principal migratory routes for anadromous salmonids, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below 5 milligrams per liter as a minimum during periods of migration."

2.4.3 Paint Creek DO and Biota TMDLs

A TMDL was developed for DO for a 4.6-mile segment of Upper Paint Creek upstream of Textile Road after continuous DO monitoring in September 2003 revealed one of three stations studied was not attaining the daily minimum DO WQS of 7 mg/L for a coldwater system (Brunsen 2005). The other two stations, downstream of Textile Road, were meeting or exceeding the WQS and therefore the TMDL only applied to the uppermost portions of Paint Creek. The oxygen deficit resulting in DO concentrations below the WQS was attributed primarily to wet weather events, with total suspended solids (TSS) loading during stormwater runoff events leading to excessive sediment oxygen demand (SOD) in a 44-acre detention basin/wetland constructed directly in-line of Upper Paint Creek (Brunsen 2005). A second TMDL was developed for biota for a 0.5-mile segment of Paint Creek extending just downstream of the detention basin where fish kills had been observed in the past, linked to the low DO concentrations (Wuycheck 2005). The TMDLs both specified a common maximum TSS loading that could be assimilated by the waterbody while achieving the minimum DO concentration criteria through natural reaeration processes. Table 4 lists the sum of individual wasteload allocations for several industrial and municipal separate storm sewer system (MS4) permits, load allocations for nonpoint sources, and a margin of safety of 10% established in the Upper Paint Creek DO TMDL (Brunsen 2005, Wuycheck 2005).

Table 4. Annual TSS load source allocations and numeric targets established in the Paint Creek DO TMDL.

TSS Source	Current Load (lbs/yr)	TMDL Allocation (lbs/yr)	Required Reduction (lbs/yr)	Percent Reduction
Wasteload allocation – point sources: industrial stormwater and MS4 permits	97,769	42,850	54,919	56%
Load allocation – nonpoint sources: loading from non-MS4 areas	21,259	10,713	10,546	50%
Margin of safety (10% of target load)		5,951		
Total	119,028	59,514	65,465	55%

Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) uses a narrative standard instead of a numeric standard for TSS which states: “surface waters of the state shall not have any of the following physical properties in unnatural quantities which are or may become injurious to any designated use: (a) Turbidity. (b) Color. (c) Oil films. (d) Floating solids. (e) Foams. (f) Settleable solids. (g) Suspended solids. (h) Deposits.” While a numeric TSS value was not provided, EGLE guidance on water quality parameters suggests: “Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty.” A wet weather concentration target of 80 mg/L TSS has also been reported. A biota TMDL for an urban watershed on the west side of Michigan, Plaster Creek, which has similar characteristics to Upper Paint Creek, set a TSS concentration target of 30 mg/L as a mean annual value (Wuycheck 2002). Lacking specific guidance or TSS concentration targets, and given the range of potentially acceptable values, this OSN watershed plan recommends a TSS concentration target of 30 mg/L, measured as a mean annual value from sampling that consists of both dry and wet weather flow conditions, which follows the precedence established for Plaster Creek in Kent County, Michigan.

2.4.4 Total Phosphorus

The total phosphorus standard established under Michigan Administrative Code R 323.1060 states:

> “(1) Consistent with Great Lakes protection, phosphorus which is or may readily become available as a plant nutrient shall be controlled from point source discharges to achieve 1 milligram per liter of total phosphorus as a maximum monthly average effluent concentration unless other limits, either higher or lower, are deemed necessary and appropriate by the department.
>
> (2) In addition to the protection provided under subrule (1) of this rule, nutrients shall be limited to the extent necessary to prevent stimulation of growths of aquatic rooted, attached, suspended, and floating plants, fungi or bacteria which are or may become injurious to the designated uses of the surface waters of the state.”

In addition to the Water Quality Standards described in Michigan Administrative Code, as part of Annex 4 of the GLWQA, the U.S. committed to a 40% reduction of TP load into Lake Erie’s central and western basins (relative to water year 2008 as a baseline), including the River Raisin as a priority tributary (USEPA 2018). The load reduction was also expressed as a flow-weighted mean concentration (FWMC) target for TP of 0.09 mg/L for the River Raisin (USEPA 2018, State of Michigan 2018).

2.4.5 Mercury

Mercury standards are outlined Michigan Administrative Code R 323.1057 Rule 57 (Table 5). Mercury impairments in the OSN watershed are addressed as part of the Michigan statewide mercury total maximum daily load (TMDL) and are therefore not discussed further in this plan (LimnoTech 2018).

Table 5. Mercury water quality standards

Value	Standard (µg/L)
Aquatic maximum value for protection of aquatic life in ambient water	1.4
Final chronic value for protection of aquatic life in ambient water	0.77
Water quality value for protection of wildlife	0.0013
Human Noncancer value for protection of human health	0.0018

3 WATERSHED ASSESSMENTS

3.1 Sources of pollutants

Water quality threats can occur from both point and nonpoint sources (NPS). Point sources dischargers require a national pollutant discharge elimination system (NPDES) permit from ELGE. Any facility that discharges directly to surface water is required to obtain an NPDES permit which contains specific water quality criteria for that facility based upon the facility as well as the waters they are discharging to. Typically point sources requiring NPDES permits are categorized as municipal or industrial facilities, but the State also regulates concentrated animal feeding operations (CAFOs) under the NPDES permitting program. The largest municipal wastewater treatment plant (WWTP) discharging within the OSN watershed is the Carleton WWTP. Though several other developed areas of the watershed are on municipal sewer systems, wastewater from these areas is routed to neighboring watersheds including the Saline River (Milan), Huron River (Ypsilanti area), and River Raisin (Monroe metro area). There are no permitted CAFOs in the OSN watershed, but several small, medium, and large size livestock operations are present, ranging from hobby farms to the largest dairy operation in Monroe County.

Due to the complexity of tracing NPS pollutants, there is less regulation in place to document and limit these sources. Sources of NPS pollution may include runoff from both agricultural and urban areas, septic systems, animal excrement, and atmospheric sources. Elevated phosphorus loading from agricultural landscapes due soil erosion and application of commercial fertilizer and livestock manure can threaten water quality and is linked to Western Basin HABs and annual Central Basin hypoxia in Lake Erie. Other sources of phosphorus in the watershed may include urban runoff, septic systems, runoff from natural landscapes (forests and grasslands), and in-stream bed and bank erosion.

Sources of bacteria leading to the *E. coli* impairments in many streams in the watershed may include both dry and wet weather sources. Bacteria sources during dry weather potentially include illicit sanitary connections, failing or poorly operating septic systems, livestock or wildlife with stream access, or resuspension of bacteria from streambed sediments. Wet weather driven sources of bacteria include runoff from agricultural areas with a livestock manure source (recently applied manure, feedlots, pastures), urban runoff (transporting pet or urban wildlife waste), or combined sewer overflows (CSOs) although none are present in this watershed.

3.2 STEPL Assessment

Phosphorus and sediment loads within each watershed were estimated using the Spreadsheet Tool for Estimating Pollutant Loads (STEPL). This model uses land use, soil type, septic, and agricultural animal data to quantify pollutant loads within the watershed. Land use, soil type, and agricultural animal data were obtained from Model My Watershed. For the goal of this plan, STEPL was used to estimate loads from each 12-digit hydrologic unit code (HUC-12) subwatershed within the OSN Watershed. Unit area loading rates (UALs) for each HUC-12 are shown in Figure 10 and Figure 11. These UALs (or yields) represent the loads normalized by the drainage area of each HUC-12 to give an indication of the relative loading from each subwatershed without bias toward those with the largest drainage areas. Overall, the area-normalized TP and sediment loads suggest there is not much variability across the subwatersheds, with all HUC-12 subwatersheds ranging between 0.42 to 0.63 lbs-TP/acre/year and 0.4-0.8 tons sediment/acre/year. These yields, along with the total subwatershed load, and the associated percent of the total watershed load are listed in Table 6.

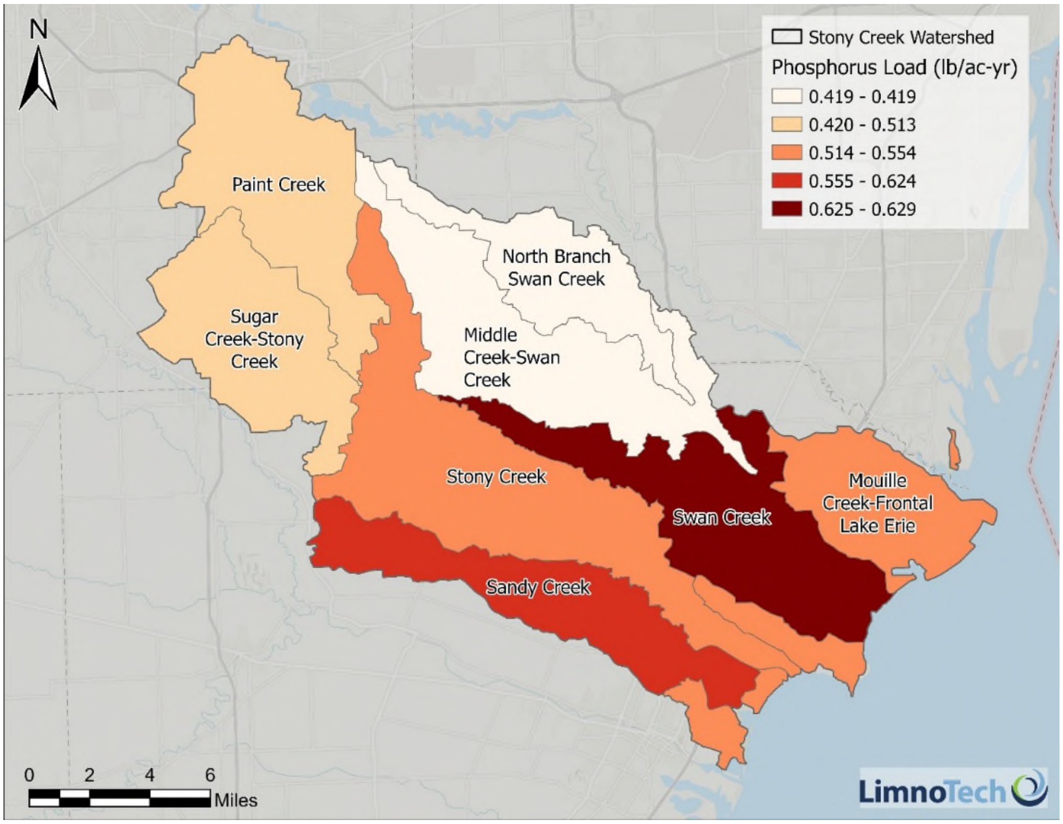

Figure 10. Unit area TP loading rates by HUC-12 subwatershed estimated from STEPL

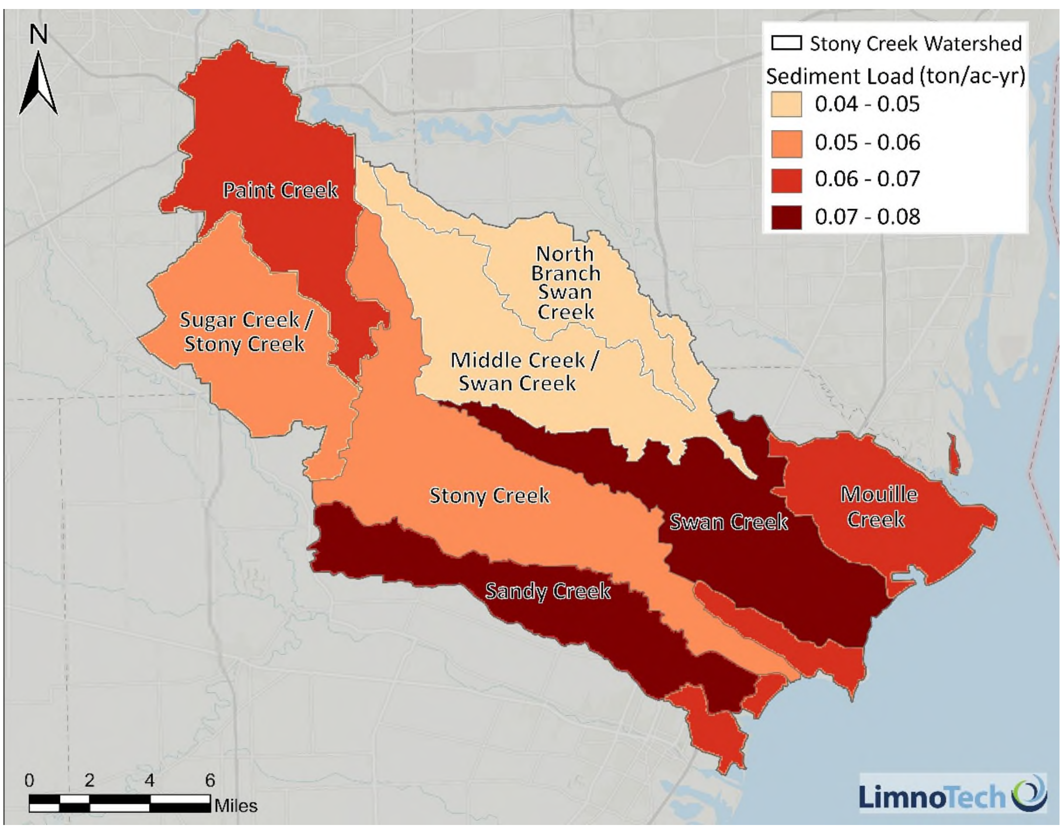

Figure 11. Unit area sediment loading rates by HUC-12 subwatershed estimated from STEPL

Table 6. STEPL estimated HUC-12 subwatershed TP and sediment loads

HUC-12 subwatershed (name, last 4 digits)	Phosphorus			Sediment		
	Load (lb/yr)	UAL (lb/ac/yr)	Percent	Load (ton/yr)	UAL (ton/ac/yr)	Percent
Mouille Creek (-0101)	11,326	0.59	12%	1,242	0.06	11%
N. Branch Swan Creek (-0102)	5,609	0.41	6%	610	0.04	6%
Middle Swan Creek (-0103)	10,844	0.41	11%	1,188	0.05	11%
Swan Creek (-0104)	15,783	0.64	17%	1,928	0.08	17%
Paint Creek (-0105)	12,135	0.51	13%	1,531	0.06	14%
Sugar Creek (-0106)	9,599	0.47	10%	1,174	0.06	11%
Stony Creek (-0107)	18,246	0.53	19%	1,979	0.06	18%
Sandy Creek (-0108)	11,742	0.62	12%	1,384	0.07	13%

3.3 On-Site Disposal Systems

On-site disposal systems (OSDS), or septic systems, are common in rural communities which are not connected to a municipal sanitary sewer system and are prevalent throughout much of the OSN Watershed. In OSDS wastewater from toilets, showers, laundry machines, and other fixtures, is transported to a septic tank for settling of solids and then discharged to a drain field for further treatment in the soil media. If there are leaks in the system or sufficient treatment is not reached, pollutant-rich water can be expelled by the system and contaminate both the groundwater and surface water. Certain systems may even have connections from the septic tank directly to a ditch, subsurface tile drain, or surface waterbody without utilizing a drain field. Such systems would be considered illicit discharges of sanitary waste.

All residences and other buildings utilizing water that are not connected to a municipal sewer system are assumed to utilize an OSDS. A map of the unsewered housing density across the watershed is presented in Figure 12. Data were obtained from the 2010 Census. The average unsewered housing density in the watershed is 202 houses per square mile. The highest density of houses on OSDS is on the northern and northwestern edges of the watershed in the suburban areas of Pittsfield, Ypsilanti, and Sumpter townships. Areas in the south-central portion of the watershed, other than the Maybee community, while also on OSDS, are at a relatively lower density due to dominance of cropland in this portion of the watershed. Several municipal sewer systems are present in the watershed servicing the Ypsilanti, Belleville, Milan, Maybee, Carleton, and Monroe areas. These areas appear unshaded in Figure 12.

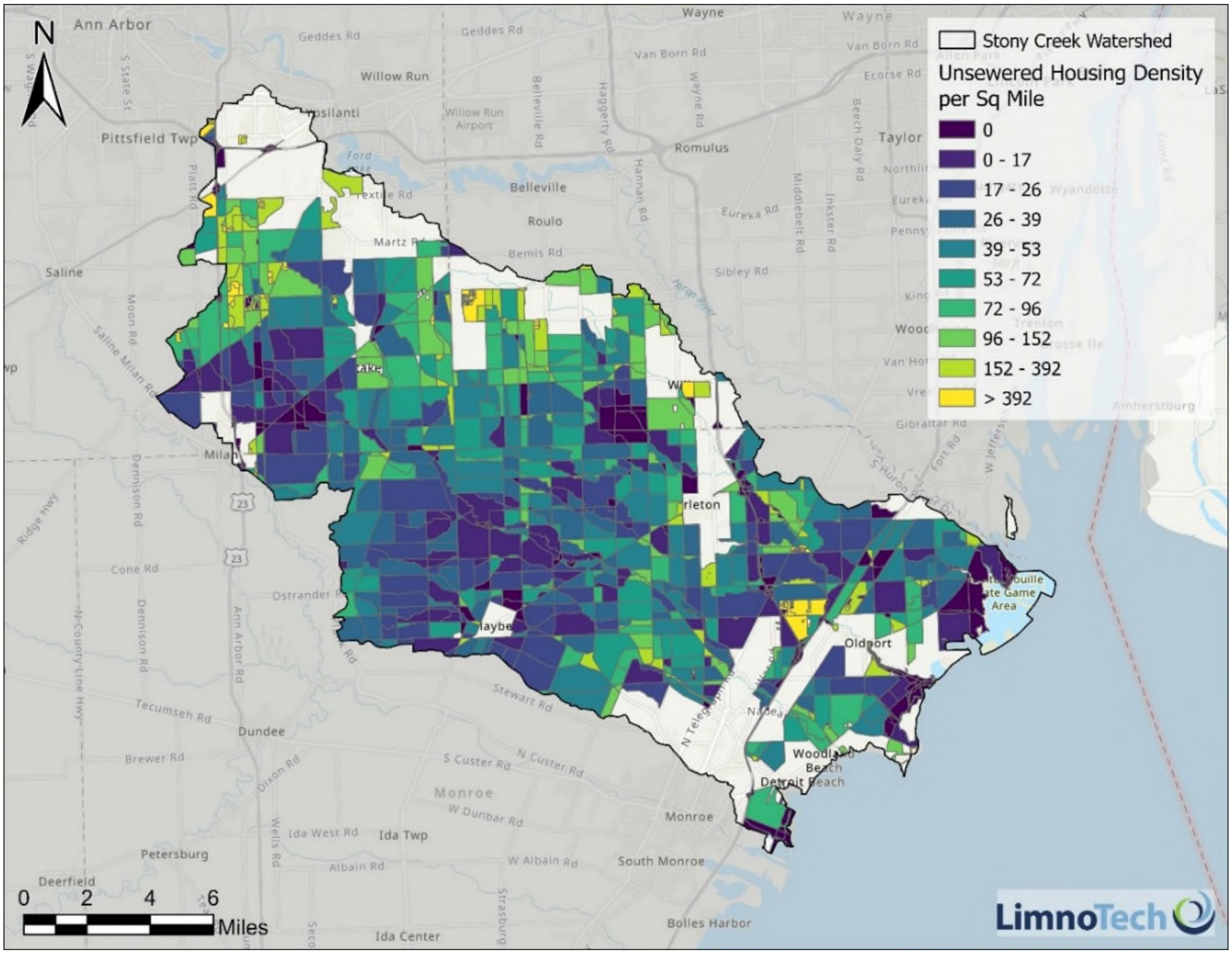

Figure 12. Unsewered housing density OSN Watershed.

3.4 Water Quality Monitoring

3.4.1 Monitoring Program Overview

Between August 2022 and July 2023, water quality monitoring was conducted at ten locations distributed throughout the watershed. These locations were chosen based on a combination of factors, including overlap with *E. coli* sampling previously conducted by the state for a subset of the stations, diverse spatial representation of the watershed, and proximity to the confluence of main tributaries. The sampling locations are listed in Table 7 and shown in Figure 13. Water quality samples were collected and submitted to laboratories for analysis for five sampling occasions: two dry weather and three wet weather events. Wet weather sampling was in response to precipitation events of at least 0.5 inches within a 24-hour period, and dry weather sampling was conducted following a 72-hour period when less than 0.1 inches of rainfall was reported at nearby airports. The second, fourth, and fifth sampling events were considered wet weather (9/22/2022, 6/26/2023, and 7/27/2023) and the first and third events were considered dry weather (8/12/2022 and 10/4/2022). Parameters analyzed included total phosphorus (TP), dissolved orthophosphate (DPO4-P), *E. coli* and microbial source tracking (MST). Additional details on the water quality monitoring procedures are described in the quality assurance project plan (QAPP; LimnoTech 2022).

Table 7. Water quality monitoring locations sampled during 2022-2023

Site IDS	Site Name	Drainage Area (sq. mi.)
OSN-1	Sandy Creek at Doty Road	6.8
OSN-2	Sandy Creek at Monroe Street	13.5
OSN-3	Little Sandy at Monroe Street	10.6
OSN-4	Sugar Creek at Whitaker Road	24.0
OSN-5	North Branch Swan Creek at Grafton Road	20.9
OSN-6	Swan Creek at Grafton Road	35.0
OSN-7	Little Swan Creek at Telegraph Road	12.5
OSN-8	Paint Creek at Talladay Road	33.2
OSN-9	Stony Creek at Sumpter Road	93.0
OSN-10	Stony Creek at Mentel Road	120.5

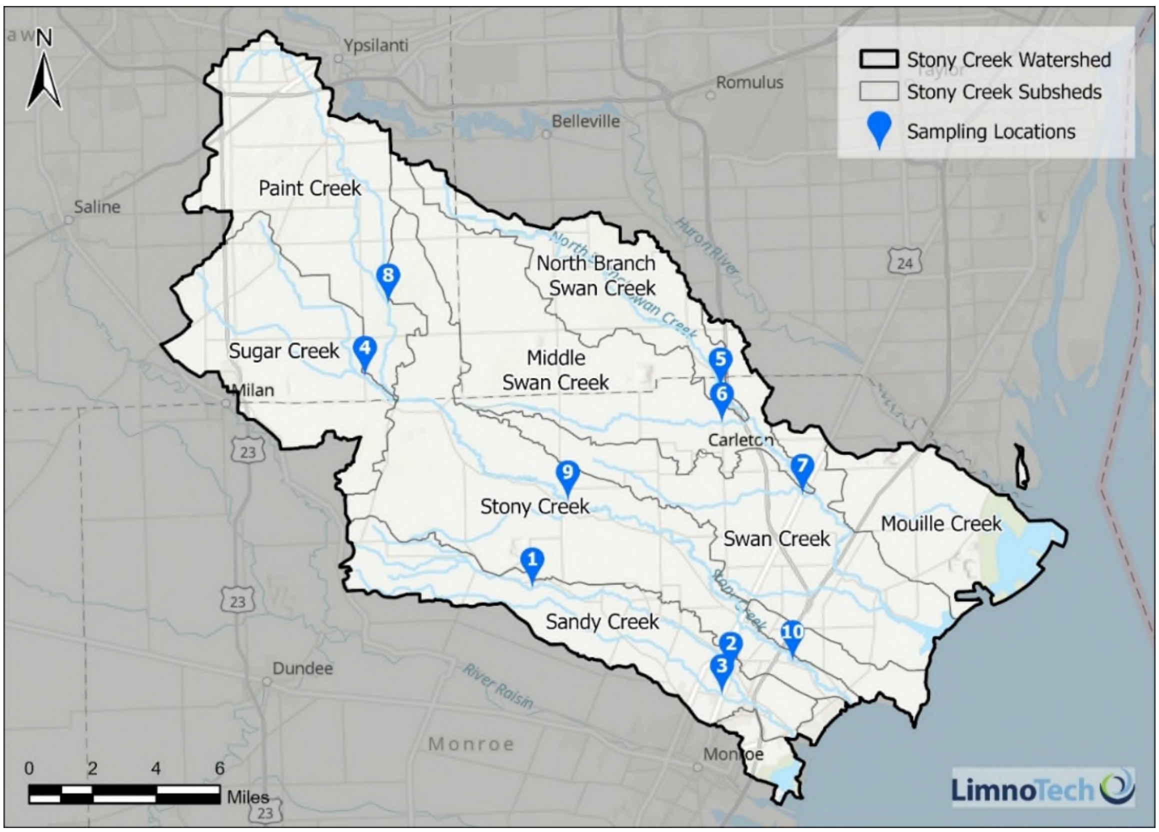

Figure 13. Water quality monitoring locations sampled during 2022-2023.

Although streamflow monitoring was not conducted as part of this study and there are no active USGS gages in the OSN watershed, an assessment of streamflow from three nearby USGS gages was completed to couple with the water quality monitoring results. In addition to distinguishing wet versus dry weather events, having streamflow is useful to inform whether changes in phosphorus or E. coli concentrations are observed during elevated streamflow. The USGS gages selected were Mallets Creek in Ann Arbor (10.9 sq mi drainage area), Poet & Frank Drain in Trenton (19.3 sq mi drainage area), and Muddy Creek in Erie (6.0 sq mi drainage area), which border the OSN watershed to the northwest, east, and south, respectively. The Mallets Creek and Poet & Frank Drain watersheds are much more developed and impervious compared to Muddy Creek's agricultural watershed, and therefore show streamflow responses to more rain events compared to Muddy Creek (see individual streamflow plots in Appendix C).

A hybrid daily streamflow time series was developed by simply averaging the per-unit-area streamflow (cubic feet per second, per square mile) for each of these three gages for each day during the August 2022-July 2023 period corresponding to the water quality monitoring timeframe (Figure 14). As shown in Figure 14, the dry weather monitoring events in August and October 2022 corresponded to the approximately lowest daily streamflow during the entire one-year period. The June and July 2023 wet weather monitoring events corresponded to the highest five percent of flows during the period, while the September 2023 wet weather monitoring event was at approximately a median flow, likely due to the very dry antecedent conditions preceding the rainfall event.

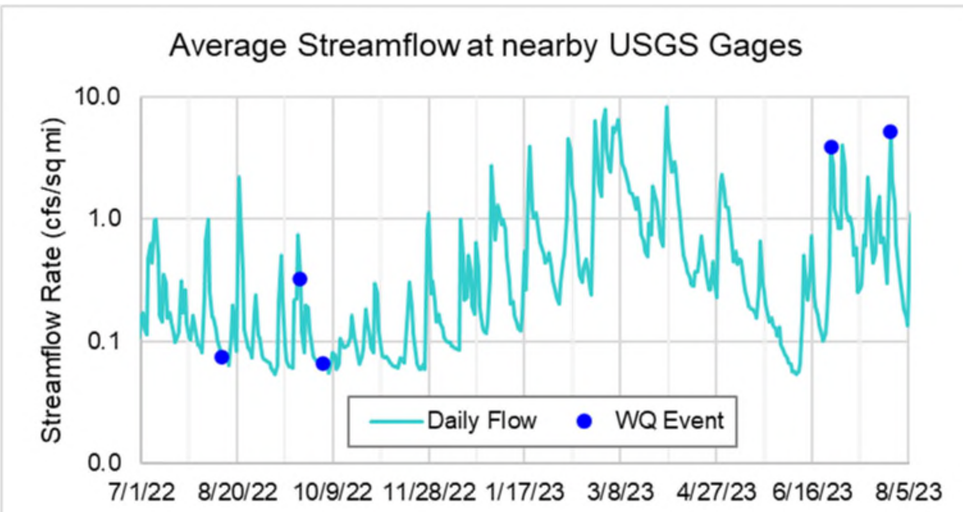

Figure 14. Daily average streamflow rate computed from three USGS gages near the OSN Watershed perimeter.

3.4.2 Phosphorus Results

Most TP concentration measurements during the five sampling events were in the 0.05-0.30 mg/L range (Figure 15). The Swan Creek at Grafton Road site (OSN-6) stood out as having consistently high TP concentrations. This site is just downstream of the Carleton wastewater treatment plant (WWTP) outfall (i.e., within a few hundred feet). Given the relatively low streamflow observed in the August-October 2022 period due to drought conditions, it is assumed that the Carleton WWTP effluent heavily influenced the TP results for this OSN-6 location. The site with the next highest TP concentrations was Little Swan Creek at Telegraph Road (OSN-7), which ranked in the top third of sites for all five sampling events. Of the remaining eight sampling locations, there was not much spread in the range of TP concentrations measured, but the Little Sandy Creek at Monroe Street (OSN-3) site was third highest in terms of overall average concentration, while the Sandy Creek at Monroe Street (OSN-2) and Stony Creek at Mentel Road (OSN-10) sites generally had the lowest concentrations.

Figure 15 also shows that in relation to the FWMC target of 0.09 mg/L established for the River Raisin (see Section 2.4.3), during most of the wet weather events and most locations this threshold was exceeded, although by varying amounts. When considering all stations and all events, TP concentrations were on average 36% higher during the wet weather sampling events compared to the dry weather events. When the TP concentration results were paired with the daily streamflow estimates described above, a FWMC could be estimated for each location. Like the arithmetic mean, the Swan Creek at Grafton (OSN-6) and Little Swan Creek at Telegraph (OSN-7) sites had the highest FMWC, while the two Sandy Creek sites (OSN-1 and OSN-2) and two Stony Creek sites (OSN-9 and OSN-10) had the lowest FWMC. Full numeric results for TP concentrations are provided in Appendix A.

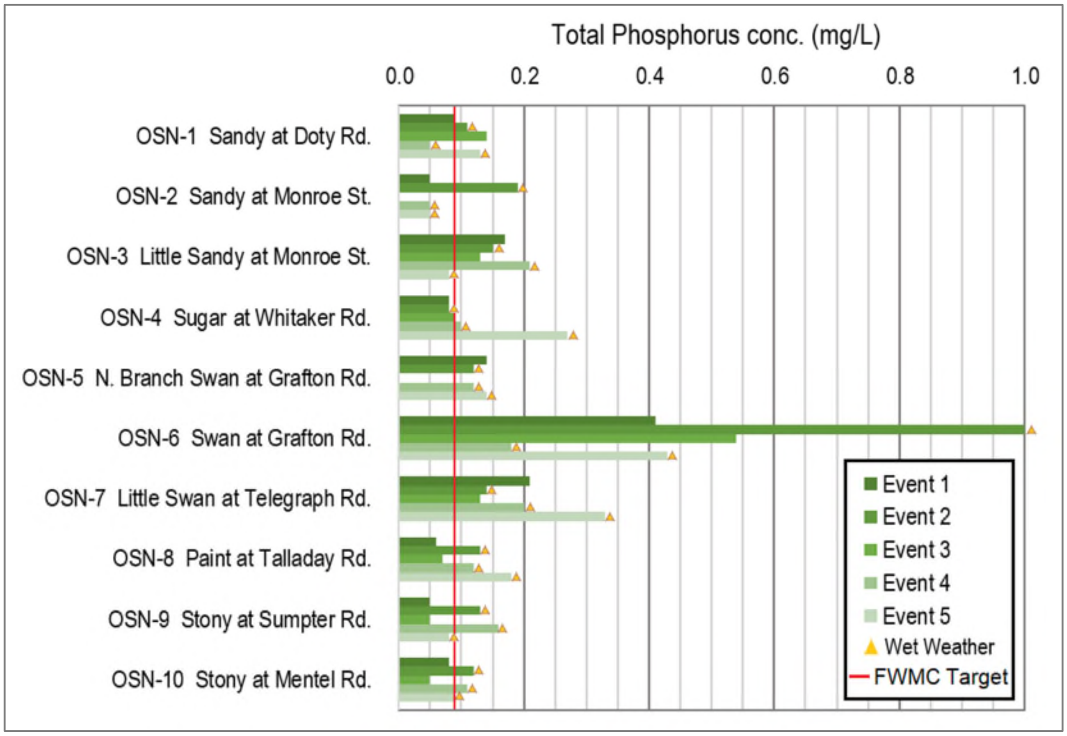

Figure 15. Total phosphorus 2022-2023 sampling results

The DPO4-P concentration measurements were below the detection limit of 0.05 mg/L for most sites and most sampling events, with 71% of all samples being reported as not-detected (Table 8). The Swan Creek at Grafton Road (OSN-6) was the only site to have DPO4-P above the detection limit for all five events. As noted above for TP concentrations, it is also assumed that the Carleton WWTP effluent heavily influenced the DPO4-P results for this OSN-6 location. Also as was observed for the TP results, the site with the next highest DPO4-P concentrations was Little Swan Creek at Telegraph Road (OSN-7), which was above the detection limit for three of five events. Of the remaining eight sampling locations, DPO4-P results were near or below detection limits for nearly all sampling events.

Table 8. Dissolved orthophosphate (dPO4-P) 2022-2023 sampling results

Site ID	Site Name	DPO4-P (mg/L)				
		Event 1	Event 2	Event 3	Event 4	Event 5
OSN-1	Sandy Creek at Doty Rd.	<0.05	<0.05	<0.05	<0.05	0.13
OSN-2	Sandy Creek at Monroe St.	<0.05	0.07	*dry*	<0.05	<0.05
OSN-3	Little Sandy at Monroe St.	<0.05	<0.05	<0.05	<0.05	<0.05
OSN-4	Sugar Creek at Whitaker Rd.	<0.05	<0.05	<0.05	<0.05	<0.05
OSN-5	N. Branch Swan Creek at Grafton	<0.05	<0.05	*dry*	<0.05	0.06
OSN-6	Swan Creek at Grafton Rd.	0.30	0.86	0.48	0.08	0.10
OSN-7	Little Swan Creek at Telegraph	<0.05	<0.05	0.05	0.09	0.12
OSN-8	Paint Creek at Talladay Rd.	<0.05	<0.05	<0.05	<0.05	<0.05
OSN-9	Stony Creek at Sumpter Rd.	<0.05	<0.05	0.11	<0.05	<0.05
OSN-10	Stony Creek at Mentel Rd.	<0.05	<0.05	0.06	<0.05	0.06

3.4.3 Bacteria Results

Prior to the water quality sampling conducted during this study, LimnoTech, under contract to the Michigan Department of Environmental Quality (MDEQ), collected *E. coli* samples in the OSN Watershed at nine locations over five events as part of MDEQ's routine *E. coli* monitoring program (MDEQ 2018). The sampling, which was conducted in the summer of 2017, revealed that *E. coli* concentrations were above the total body contact (TBC) water quality criteria for all locations and all five events except for Swan Creek at Dixie Highway (Figure 16). This sampling location is very near Lake Erie and may have been influenced by dilution impacts from the lake, and therefore it was not sampled during 2022-2023. *E. coli* concentrations were consistently highest at Sandy Creek at Monroe Street (i.e., the same site as OSN-2) followed by Little Swan Creek at Telegraph Road (OSN-7), North Branch Swan Creek at Grafton Road (OSN-5), and Swan Creek at Grafton Road (OSN-6). Other than the Sandy Creek site, these highest sites for E. coli tended to be in the more northern, populated areas of the watershed. For most locations sampled, *E. coli* concentrations were much higher during the two wet weather events (denoted by yellow triangles) compared to the three dry weather events sampled (Figure 16).

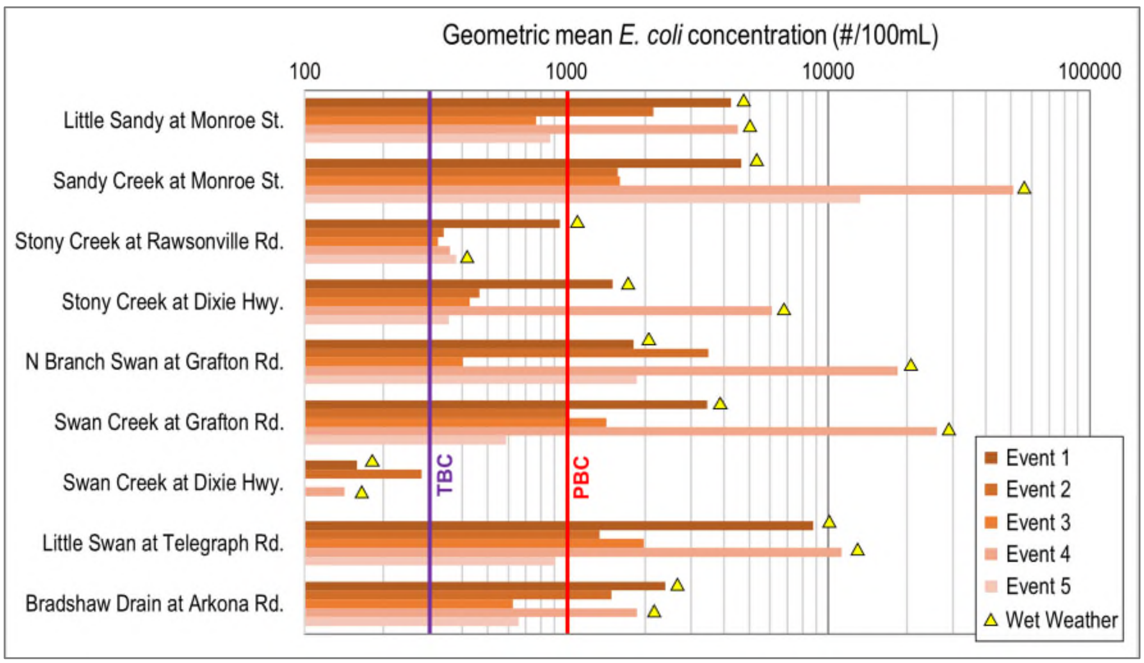

Figure 16. *E. coli* 2017 sampling results

Of the nine sites sampled for *E. coli* in 2017, five sites were sampled at the exact same location in 2022-2023 and two sites were sampled in the same vicinity but at a different bridge crossing. The sampling performed in 2022-2023 confirmed several observations made from the 2017 sampling: consistent exceedances of the TBC threshold and occasional exceedances of the PBC threshold throughout the watershed, relatively higher *E. coli* concentrations in the northern portion, and higher *E. coli* during wet weather events (Figure 17). Full numeric results for *E. coli* concentrations are provided in Appendix A.

Like 2017, nearly all single day geometric mean *E. coli* concentrations were above the TBC criteria of 300 #/100 mL (88% of samples), and many were also above the PBC criteria of 1000 #/100 mL (50% of samples). The only site that was below the TBC threshold for three of five events was Little Swan Creek at Telegraph Road (OSN-7), which interestingly was one of the highest sites for *E. coli* in 2017. The sites tending to have the highest *E. coli* concentrations were in the northern, more populated portions of the watershed that are not serviced by municipal sewer systems. These sites included two of the locations that were also among the highest in 2017, North Branch Swan Creek at Grafton Road (OSN-5) and Swan Creek at Grafton Road (OSN-6), and two sites that were not sampled in 2017; Sugar Creek at Whitaker Road (OSN-4), and Paint Creek at Talladay Road (OSN-8). The site with the lowest overall geometric mean concentration was Little Swan Creek at Telegraph Road (OSN-7), but this was largely influenced by low concentrations during the three 2022 sampling events. This site had much higher concentrations during the two 2023 sampling events, which were both wet weather events with much higher flows than in 2022 (Figure 14). The next two lowest sites were those on the Stony Creek mainstem (OSN-9 and OSN-10). These two sites have the largest drainage areas compared to the other sites, which may have been a factor in the lower *E. coli* concentrations due to diluting effects of landscapes contributing lower bacteria loads and/or in-stream attenuation impacts.

Lastly, as depicted in Figure 17 and consistent with the 2017 sampling results, *E. coli* concentrations were much higher during the two significant wet weather sampling events during June and July 2023. Although concentrations above PBC and TBC thresholds occurred during both dry and wet weather sampling for *E. coli* during the 2017 sampling program and the 2022-2023 sampling conducted under this grant, the highest concentrations were generally associated with wet weather sampling events at most locations for both monitoring programs. This suggests that both dry and wet weather driven sources of bacteria loading exist throughout the watershed, with wet weather sources being relatively more pronounced. Implementation of management actions should seek to address both dry and wet weather causes of bacteria impairments.

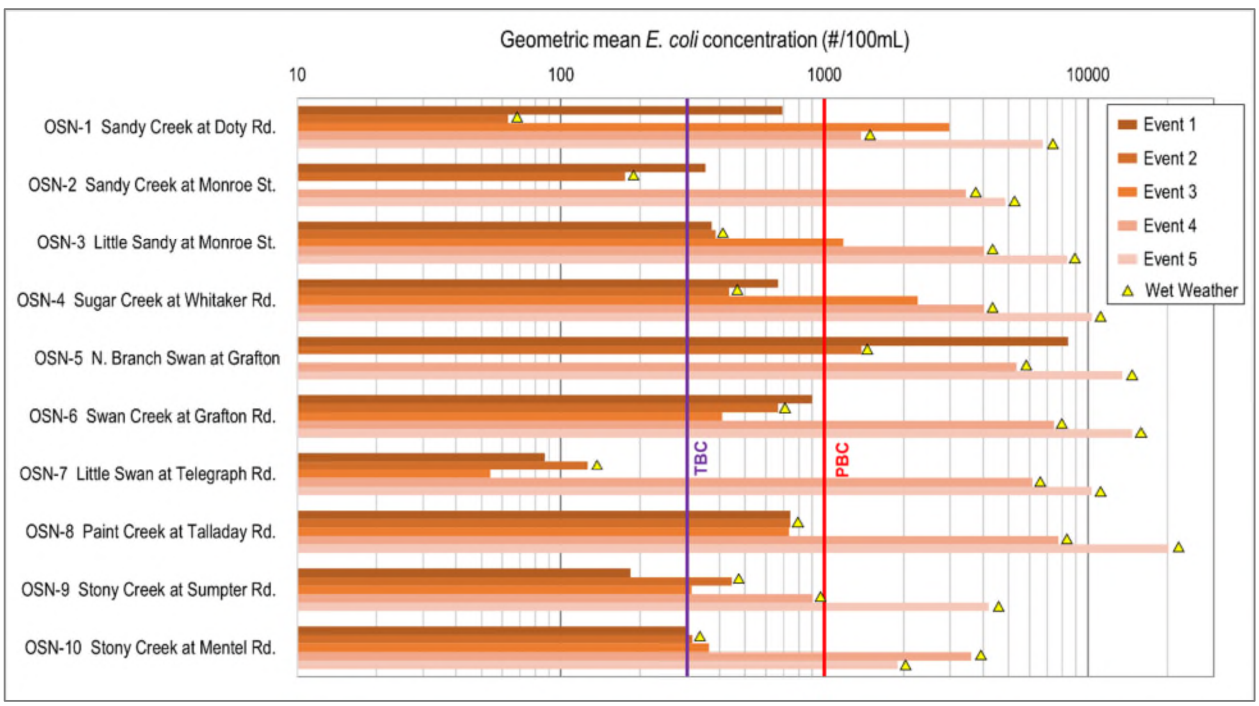

Figure 17. *E. coli* 2022-2023 sampling results.

3.4.4 Microbial Source Tracking Results

Microbial source tracking (MST) results are shown in Table 9, overlayed on the event geometric mean *E. coli* concentrations for the first four events. A total of 25 samples were submitted for MST analysis spanning the first four events. This was more than the anticipated 20 samples indicated in the QAPP and allowed for between two and three samples to be analyzed per station. Samples from the fifth event were not submitted because it was uncertain at the time whether sufficient rain event would occur to allow for a final wet weather sampling event, and the fourth event *E. coli* concentrations were sufficiently high at all locations to indicate elevated bacteria levels. Overall, very few MST samples analyzed were above the detection limits for human or bovine markers; 19 of 25 samples analyzed were non-detects. Despite relatively high *E. coli* concentrations during the fourth event (i.e., the daily geometric mean for 9 of 10 sites was above the TBC threshold), only two of ten samples submitted for MST analysis were above the detection limits. Notably, human markers were detected at the Swan Creek at Grafton Road site (OSN-6) for all three of the MST samples submitted for this location. As mentioned above, this site is just downstream of the Carleton WWTP effluent discharge location, and therefore the quantitative MST results are consistent with expectations that this site would have presence of human markers. The Paint Creek sampling location (OSN-8) also had a positive detection for human markers. Bovine markers were above detection limits at OSN-5 for Event 2 and at OSN-10 for Event 4. OSN-5 has a few relatively smaller livestock operations immediately upstream of the sampling location, and OSN-10, representing the largest drainage area of all sampling locations, has several relatively larger livestock operations upstream of it. Full MST numeric results are provided in Appendix A.

Table 9. Microbial source tracking (MST) 2022-2023 sampling results for four events and ten sites.

Site ID	Site Name	Event 1		Event 2		Event 3		Event 4	
OSN-1	Sandy Creek at Doty Rd.	***Non-Detect***	692	-	63	***Non-Detect***	2986	***Non-Detect***	1377
OSN-2	Sandy Creek at Monroe St.	***Non-Detect***	353	-	175	-	*dry*	***Non-Detect***	3444
OSN-3	Little Sandy at Monroe St.	-	374	-	386	***Non-Detect***	1180	***Non-Detect***	4027
OSN-4	Sugar Creek at Whitaker Rd.	***Non-Detect***	667	-	436	***Non-Detect***	2259	***Non-Detect***	4036
OSN-5	N. Branch Swan Creek at Grafton	***Non-Detect***	8410	***positive BOVINE***	1382	-	*dry*	***Non-Detect***	5364
OSN-6	Swan Creek at Grafton Rd.	***positive HUMAN***	898	***positive HUMAN***	668	-	410	***positive HUMAN***	7432
OSN-7	Little Swan Creek at Telegraph	-	87	***Non-Detect***	126	-	54	***Non-Detect***	6149
OSN-8	Paint Creek at Talladay Rd.	***positive HUMAN***	744	***Non-Detect***	743	-	733	***Non-Detect***	7709
OSN-9	Stony Creek at Sumpter Rd.	-	184	***Non-Detect***	446	-	313	***Non-Detect***	904
OSN-10	Stony Creek at Mentel Rd.	-	301	-	315	***Non-Detect***	365	***positive BOVINE***	3612

* MST results are shown beside *E. coli* concentrations (#/100 mL) for context on the magnitude of bacteria.

** "-" denotes sample was not analyzed for MST (25 of 38 samples from first 4 events were analyzed for MST)

(light pink) *E. coli* exceeded TBC (300) but not PBC (1000) threshold

(dark pink) *E. coli* exceeded both TBC (300) and PBC (1000) thresholds

3.5 Agricultural Inventory

The agricultural inventory component of this project included conducting windshield surveys of select fields across the agricultural landscape, utilizing the Agricultural Conservation Planning Framework (ACPF), completing desktop assessments of livestock operations and riparian filter strips, and conducting streamwalks of several miles of creeks identified for potentially elevated pollutant loading. Each component and results are described in the following sections.

3.5.1 Windshield Surveys

One part of the agricultural inventory process developed by EGLE's NPS Program involves conducting windshield surveys, which entails driving a predetermined route through a portion of a watershed or other geographic area of interest and recording spatially explicit observations related to cropland management practices. A total of four (4) windshield surveys, two fall tillage surveys and two spring residue surveys, were conducted by MCD and WCCD from Fall 2021 to Spring 2023 to record observations including crop rotation, tillage practice, use of cover crops, and presence of crop residue. Due to the relatively large spatial scale of the cropland area in the OSN Watershed, the entirety of cropland was not surveyed, but instead a representative area covering over 40,000 acres, agreed upon with EGLE staff prior to beginning the work, was used. Additional details on the windshield surveys are described in the QAPP.

A summary of the windshield survey data is presented in Table 10. No tillage done was recorded for the most acres in both the Fall 2021 and 2022 tillage surveys, although there was a sizeable drop in no-till acres between the 2021 to 2022 surveys by nearly 50%. The decrease in no-till acres coincided with increases in acres recorded as being chisel plowed or using mulch till. The fall of 2021 into winter 2022 was relatively wet, whereas the following fall-winter was relatively dry, so the higher no tillage done in the earlier survey may have been more correlated to moisture conditions than preferred practices. Cover crops were utilized on 3,621 acres and 3,056 acres during the 2021-22 and 2022-23 nongrowing seasons, respectively. This represents between 7 to 9% of the cropland area surveyed. The spring residue category with the highest total acres for both the 2022 and 2023 surveys was "0%", followed by a mix of the other categories (<30%, >30%, planted, not planted, NA, and skipped). Consistent with the decrease in no-till between the two years, there was an increase in the 0% spring residue category between the two years by over 4,000 acres. Maps showing the tillage practice, spring residue category, cover crop usage, and crops grown for each windshield survey are provided in Appendix B.

Table 10. Windshield survey summary (all values are in units of acres)

Tillage Practice			Spring Residue			Cover Crop		
Category	2021	2022	Category	2022	2023	Category	2021	2022
Chisel Plowed	1,435	7,323	> 30%	6,643	5,355	Yes	3,621	3,056
Mulch Till	2,296	5,497	< 30%	4,582	3,513	No or not summarized	37,638	38,204
Planted	2,946	6,333	0%	9,604	13,774			
NA	2,636	2,787	Planted	3,138	4,086			
None (No-Till)	28,024	14,555	Not Planted	4,552	978			
Skipped	3,292	3,967	NA	4,609	7,516			
Not summarized	8.5	516	Skipped	7,683	6,038			

3.5.2 Agricultural Conservation Planning Framework

The ACPF is a tool that relies on various geospatial information that can be used to aid in identification of agricultural land parcels that have potentially greater impacts on water quality, for prioritizing sites for potential actions, and to suggest best management practices (BMPs) that might be best suited for implementation on these parcels. ACPF is a key component in Michigan's efforts to reduce NPS phosphorus loading from the WLEB by focusing agricultural conservations measures in the right places (State of Michigan 2021). Prior to the start of the project as part of a grant from the Erb Family Foundation, the Environmental Working Group digitized the agricultural cropland and created maps outlining all individual crop fields within three HUC-12 subwatersheds: Sandy Creek (HUC 041000010108), Stony Creek (HUC 041000010107), and Swan Creek (HUC 041000010104). Aerial photographs were overlaid with subwatershed outlines to digitize boundaries for every individual field. In addition to field digitization, EGLE staff utilized the ACPF to hydro-enforce a high-resolution digital elevation model (DEM) of the subwatersheds to accurately model likely pathways of overland flows over the landscape. The resulting flow paths from this hydro-enforcing work are shown in Figure 18 for the Sandy Creek subwatershed. Additional maps of the overland runoff/flow paths are provided in Appendix B.

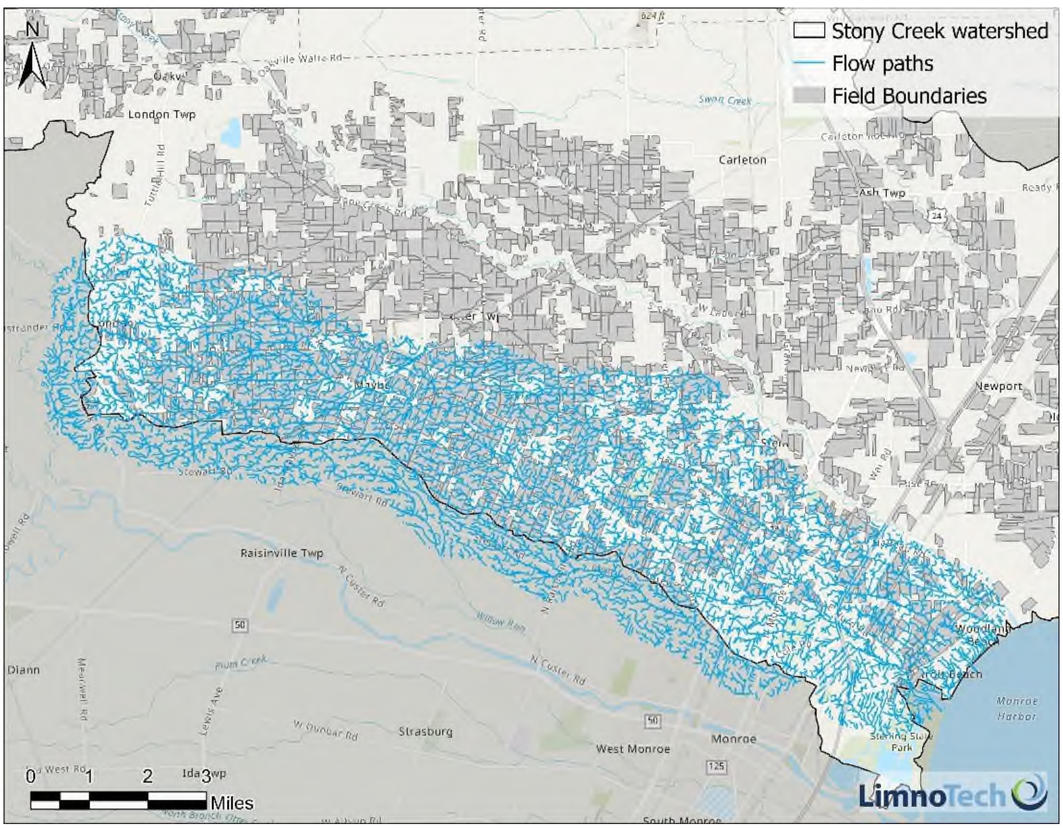

Figure 18. Likely pathways of overland runoff derived from ACPF for the Sandy Creek subwatershed.

The ACPF tool was also used to produce information regarding field slope (overall average and portion of the field falling in different slope ranges), distance from field boundaries to perennial stream segments, and an assessment of runoff risk, which factors in the slope, and proximity to the stream segment to indicate a risk score from "low" to "very high". A map of the 75^{th} percentile slope category for each field is shown in Figure 19. As suggested, the cropland in these subwatersheds is relatively flat, with most fields having 75^{th} percentile slopes of four percent or lower. A map of the runoff risk categories is shown in Figure 20. ACPF is primarily used to suggest suitable locations for structural BMPs such as grassed waterways, contour strips, nutrient removal wetlands, and water and sediment control basins (WASCOBs). As described later, these pieces of information obtained from the ACPF model aided in the identification of priority areas and sources of pollutants.

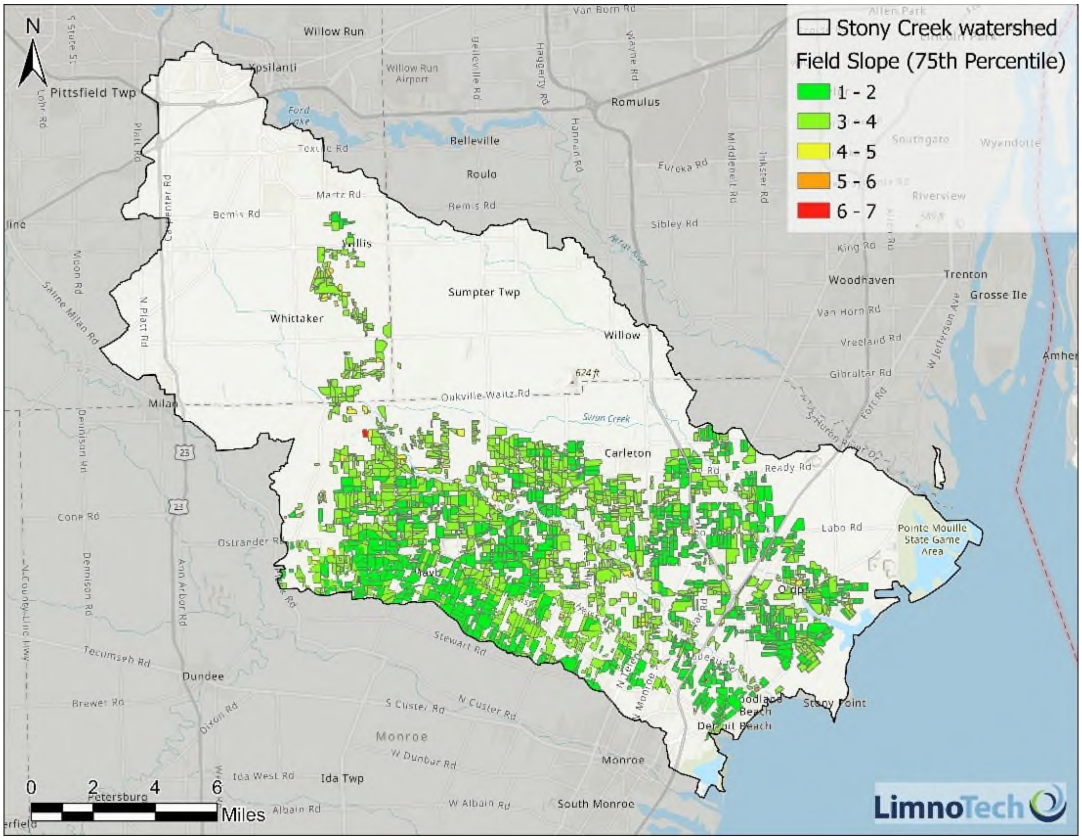

Figure 19. 75th percentile slopes derived from ACPF.

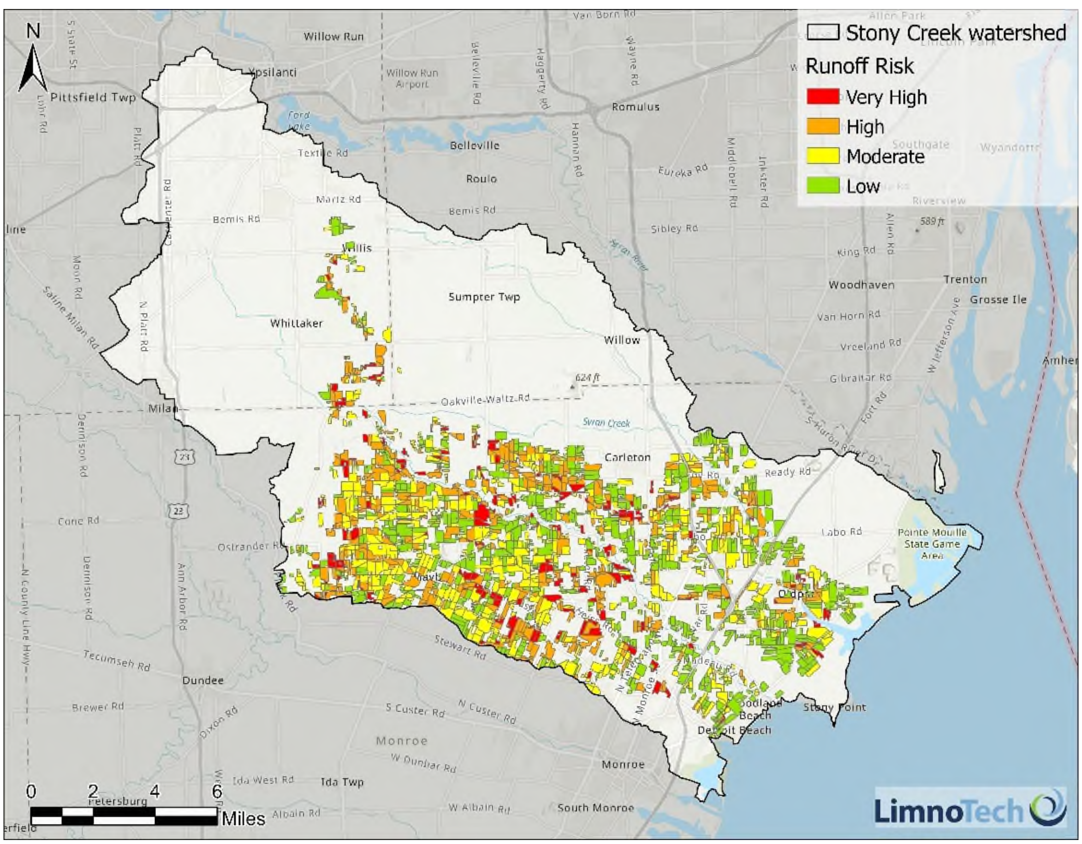

Figure 20. Runoff risk categories derived from ACPF.

3.5.3 Livestock Operations

Although there were no permitted CAFOs in the watershed as of the date of this plan, many operations of various sizes raising various types of livestock are present. MCD and WCCD used satellite imagery and first-hand knowledge from working in the area to identify these locations with livestock, and a geospatial dataset was produced from the analysis. Each livestock operation was classified by primary animal type and approximate size of the operation if such information was known or easily identifiable. This analysis identified 591 livestock locations within the watershed (Figure 21). From these 591 locations, 12 priority operations were determined based on either the largest in size or proximity to surface waterways. Two additional geospatial analyses were performed using the livestock locations. The first involved creating a one-mile radius (buffer) around the priority operations and determining which fields (of those used the windshield surveys and ACPF analyses) overlapped with this buffer. This field proximity to the priority operations was used as a proxy to determine likelihood that manure would be applied to a given field (i.e., the closer a field is to a relatively large operation, the more likely it is to receive manure application, and vice versa). The second geospatial analysis involved determining which of the entire 591 locations were within 50 feet of an overland runoff flow path identified with the ACPF tool. This analysis was used to identify operations that might be subject to relatively higher runoff and delivery of phosphorus from animal housing areas.

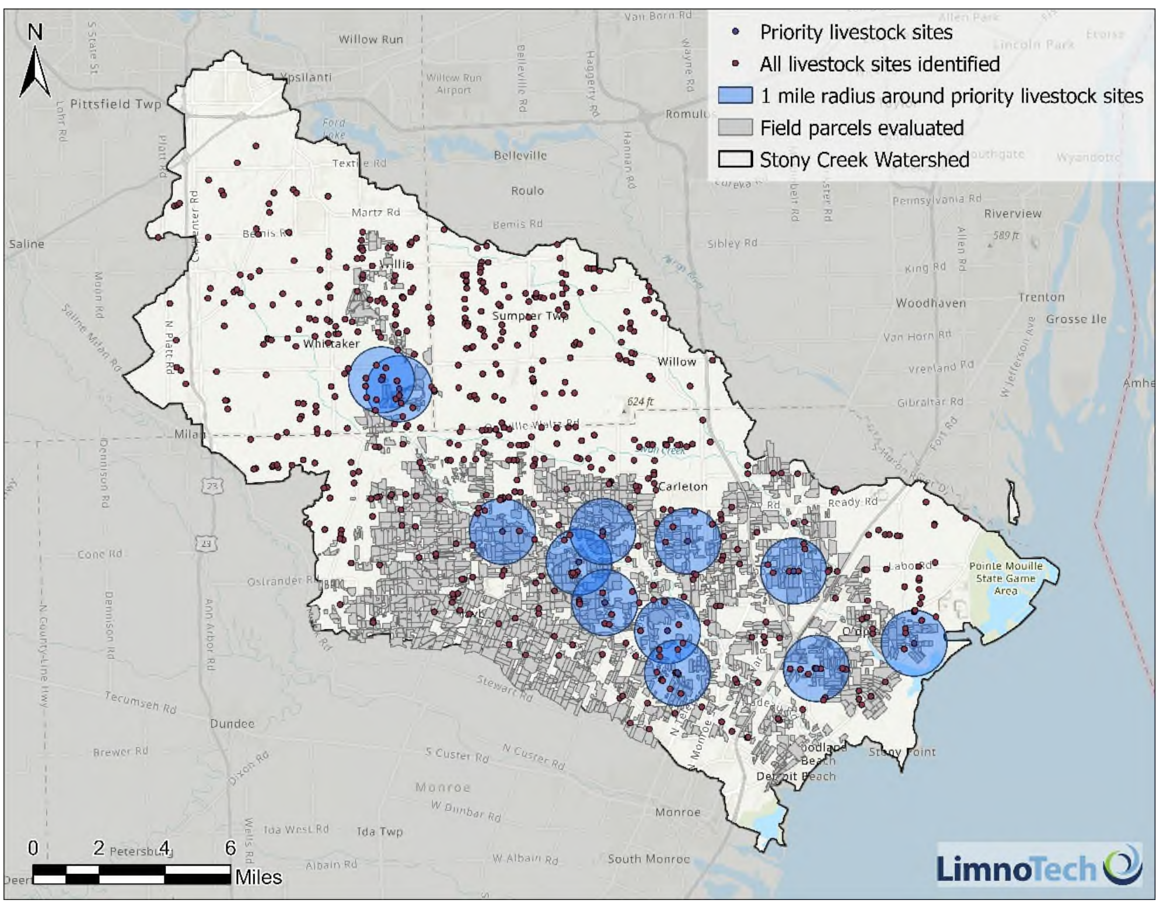

Figure 21. Livestock sites identified with emphasis on 12 priority operations

3.5.4 Riparian Filter Strips

The presence of vegetated filter strips in the area between crop fields and surface waterbodies (i.e., the riparian zone) functions to slow and distribute overland flow, resulting in both removal of particulate pollutants via settling and filtration and dissolved pollutants via infiltration. When riparian filter strips are inadequate or absent, overland flow leaving cropland is discharged directly into surface waterbodies without opportunity for pollutant removal. A desktop analysis was performed to identify whether fields within a 50-foot distance of surface waterbodies had an adequate riparian filter strip presence, defined as a 30-foot width between the edge of the field and the top of the bank. The first step was performed using geospatial analysis to set a 50-foot buffer on streamlines (e.g., streams, creeks, and drainage ditches) and intersect this with the fields used in the windshield surveys and ACPF analysis. A total of 1180 fields (56%) met this criterion. Of those fields, the project team used geospatial measuring tools and manual inspection of recent satellite imagery to determine whether a 30-foot riparian filter strip was present, and the vegetation was determined as grass or similar. Trees, shrubs, or similar woody vegetation with potentially sparse understory vegetated density were not considered adequate because they do not meet NRCS conservation practice standard #393 (filter strip) requirements. Figure 22 and Figure 23 below show several examples of fields in the watershed with either adequate or inadequate riparian filter strips. Of the fields bordering streamlines, only about one of every ten had an adequate buffer. Nine hundred and fifty-one fields (or 46% of all evaluated fields) were classified as both within 50-foot of a surface waterbody and not having an adequate 30-foot riparian filter (Figure 24).

Figure 22. Satellite images from several locations in the OSN Watershed with notes indicating whether the riparian filter strip width and type was determined as adequate ("YES") or inadequate ("NO").

Figure 23. Google Street View images from several locations in the OSN watershed with notes indicating whether the riparian filter strip width and type was determined as adequate ("YES") or inadequate ("NO").

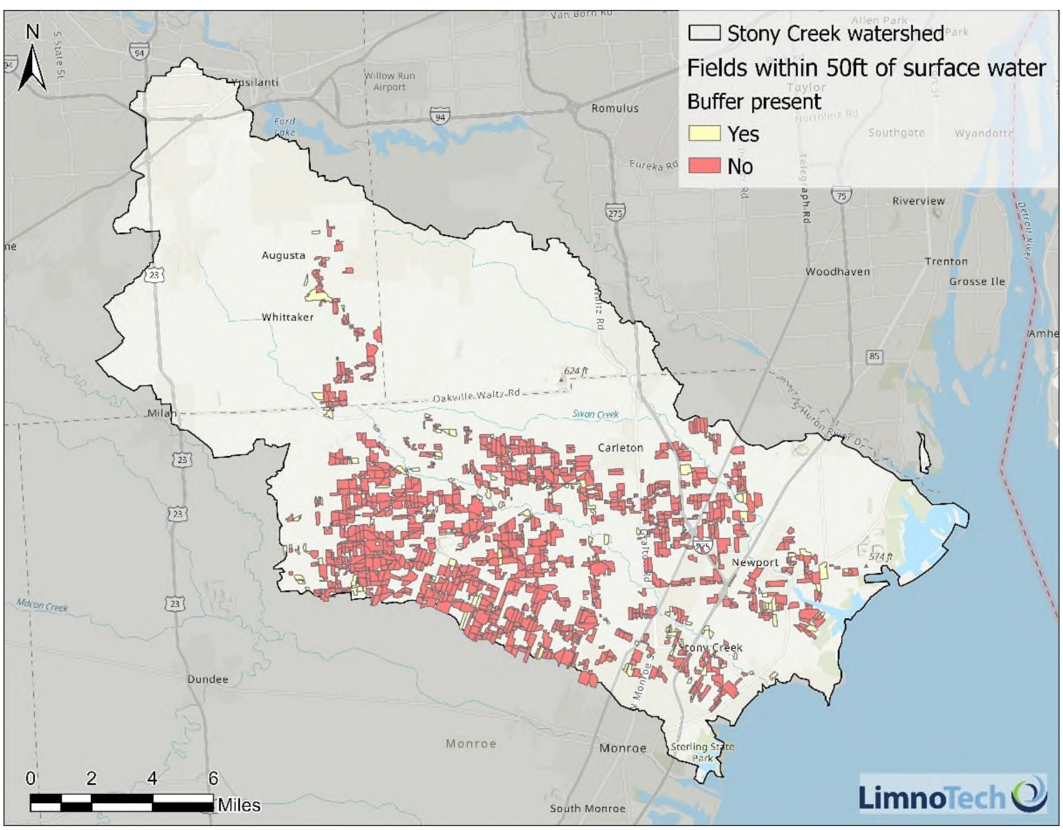

Figure 24. Map depicting results of riparian filter strip analysis.

3.5.5 Streamwalk

A streamwalk assessment was conducted to identify pollutant sources contributing to elevated phosphorus and *E. coli* concentrations and guide recommendations for implementation of BMPs to improve water quality in certain priority reaches. Stream reaches were prioritized based on potential for relatively higher loading using data and information collected from the water quality monitoring, ACPF, windshield surveys, and livestock operation identification activities. The streamwalk study consisted of walking along each waterway, documenting current conditions, and identifying vulnerable areas potentially causing pollutant loading. Observations during the streamwalk may include, for example, erosion due to road runoff, gully erosion, riparian buffers, streambank erosion, stream crossings, livestock access, agricultural runoff, and tile outlets. Additional details on the streamwalk assessment survey are described in the QAPP.

A portion of Paint Creek and a portion of Little Sandy Creek were identified for completing the streamwalks, both of which were conducted in April 2023. The most common observations recorded during the Paint Creek streamwalk were tile outlets and streambank erosion (Figure 25). Streambank erosion was frequently observed in the segment of Paint Creek south of Bemis Road, upstream of an apparent beaver dam. Although tile outlets were observed throughout the entire segment of Paint Creek studies, none appeared to be causing significant erosion at, or around, the outlet. The most common observations recorded during the Little Sandy Creek streamwalk were tile outlets, gully erosion, and stream crossings (Figure 26). The Little Sandy Creek streamwalk also had a sod dam and pumping diversion structure observed. Relative to the Paint Creek segment walked, the Little Sandy Creek segment had far fewer streambank erosion observations. Neither livestock access nor pasture or feedlot-sourced manure runoff observations were recorded for either creek. No obvious sources of bacteria loading were identified during the streamwalk assessment. The streamwalk assessment overall suggests that the most likely contributions to TP loading in the vicinity of the creeks investigated include discharge from tile drains, localized gully erosion and erosion at stream crossings, and streambank erosion.

Sediment and TP loading estimates were made for gully erosion, stream crossing erosion, and streambank erosion sites based on field measurements taken during the assessment (i.e., substrate type and erosion width, depth, length) and using the STEPL module for estimating sediment loading (Table 11, Table D-2). These loading estimates were then used to prioritize sites for implementation activities to eliminate these sediment and TP loading sources (e.g., via streambank stabilization, gully stabilization, grassed waterways). Four streambank erosion sites, all in Paint Creek (observations 11, 13, 16, and 25), and three gully erosions sites, all in Little Sandy Creek (observations 80, 81, and 82), were ranked as the highest priority sites. These seven sites were estimated to contribute 65% of the sediment and TP load of all sites identified during the streamwalk. An additional nine sites were ranked as medium priority sites, contributing an additional 25% of the sediment and TP load of all streamwalk sites (Table D-2). The remaining low priority sites were ranked as such due to relatively lower contributions to sediment and TP loading.

Table 11. Sediment and TP load estimates summarized by stream segment walked and source type.

Segment	Source Type	Number	Sediment Load (tons/year)	TP Load (lbs/year)
Paint Creek	Streambank Erosion	13	45.1	173.2
	Stream Crossing	2	1.5	5.8
Little Sandy Creek	Streambank Erosion	4	3.2	12.2
	Stream Crossing	6	0.8	3.2
	Gully Erosion	9	33.1	126.0

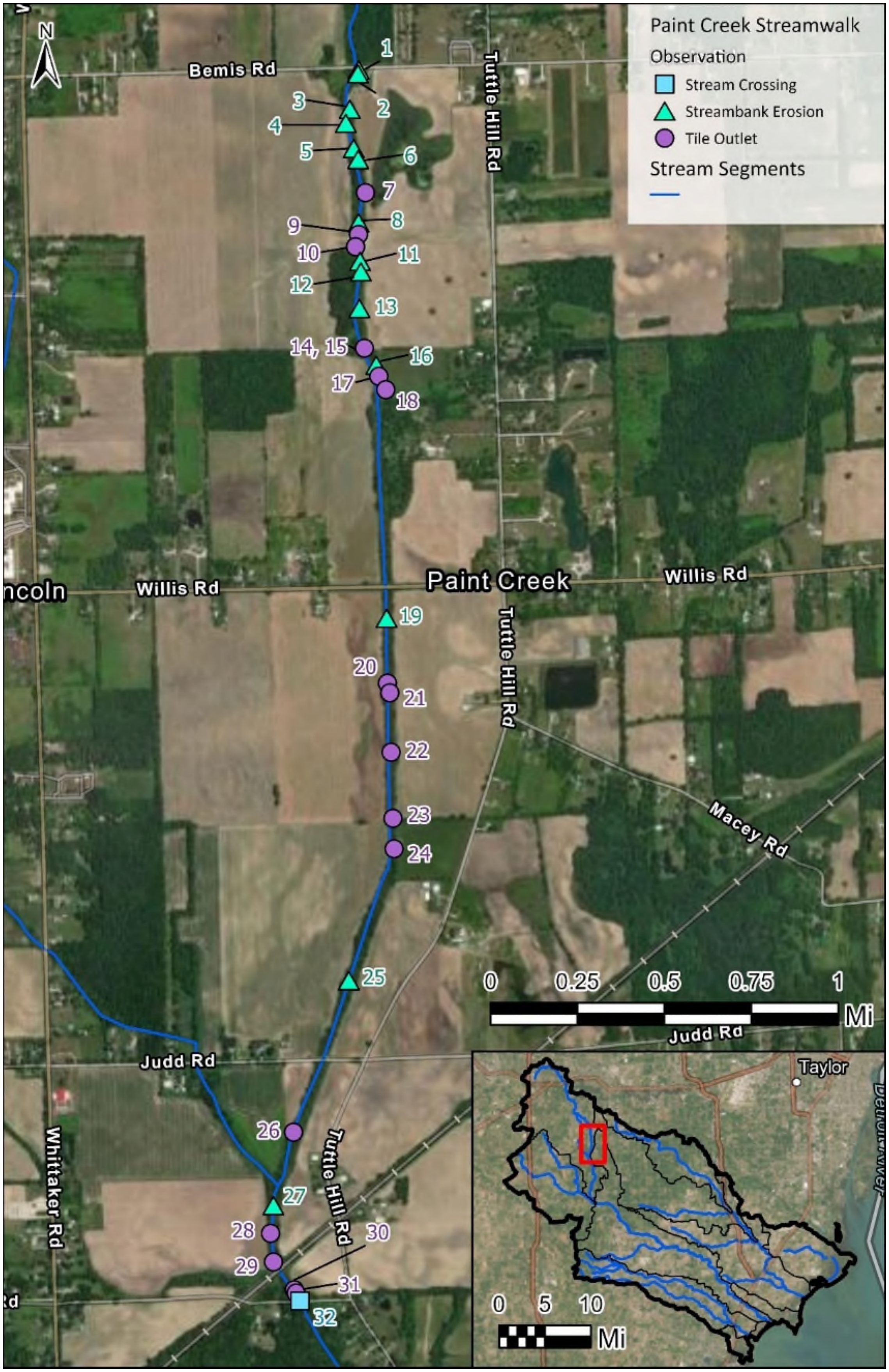

Figure 25. Paint Creek streamwalk observations recorded April 2023.

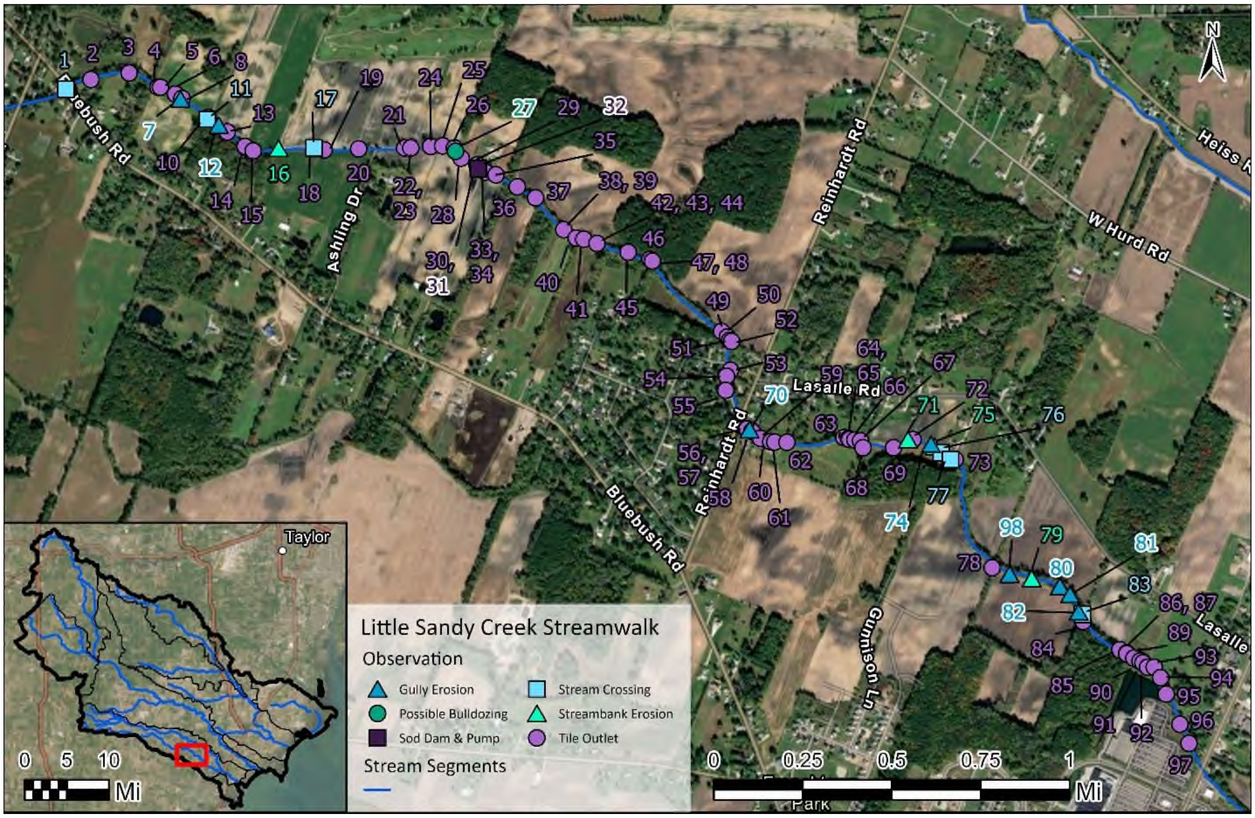

Figure 26. Little Sandy Creek streamwalk observations recorded April 2023.

3.6 Critical areas and sources

Critical source areas (CSA) are those that have a high likelihood of contributing NPS pollutants to surface waters during runoff events, based on the field conditions present and proximity to surface water bodies. Sites were highlighted as a CSA based on several factors, including the tillage practice, percentage of crop residue, lack of adequate riparian filters, potential for elevated manure application, proximity to surface water bodies, and runoff risk suggested by ACPF.

Observations recorded during the four windshield surveys provided valuable insights into which fields might be prioritized based on the management practices utilized. More intensive fall tillage practices reduce the amount of crop residue on field surfaces during the winter and early spring. This reduction in crop residue increases the potential for soil erosion and the delivery of sediment and nutrients to surface waters during storm and snowmelt events. Moldboard plowing is the most intensive tillage practice followed by chisel plowing. Depending on the crop that was planted on a field previously, little to no residue could be left after these tillage practices are implemented, especially if the vegetation of the observed previous crop is not very hearty (e.g., soybeans). Less intensive practices such as mulch till, strip till, no-till, or planting a winter wheat crop, or other over-winter cover crop, result in more crop residue left on the soil surface or a living cover, thereby reducing the amount of sediment and nutrients reaching surface waters. Depending on the crop that was planted, even sites where less intensive tillage practices were used, there could still be little to no residue left. Fields that were observed to have zero or less than 30 percent residue during spring residue surveys, that are in proximity of a surface water body, and that have no buffer between fields and surface water bodies were given a higher priority for future BMP implementation efforts due to the increased likelihood that runoff events could transfer sediment and nutrients unabated to surface waters.

Using the logic described above for the windshield survey observations, and incorporating the runoff risk assessment conducted in ACPF, the riparian filter strip assessment, and the identification of priority livestock facilities, we followed examples provided by EGLE staff and demonstrated in the Bean Creek WMP to construct a field prioritization scheme (Blonde and Cleland 2019, Cleary 2021). This field prioritization approach was also implemented in a recent study for five priority subwatersheds in Southeast Michigan (Schlea and Zimnicki 2024). The results of the field prioritization assessment executed using the various components of the agricultural inventory work are shown in Figure 27. Darker shades of red indicate fields given the highest priority while the lightest shades indicate fields that had the lowest prioritization score. For example, a very high score (i.e., near 100) would result from a field having chisel plowing, low spring residue, no use of cover crops, potential for manure application, high runoff risk from ACPF, and in close proximity to a surface drainage waterbody without an adequate riparian filter strip. In contrast, a field using no-till and cover crops, having high spring residue, not in the vicinity of a priority livestock operation, with low runoff risk from ACPF, and with either an adequate riparian filter strip or a far distance from a surface waterbody, would result in among the lowest scores (i.e., near 0). The fields with the highest scores as shown in Figure 27 will be prioritized for the agricultural-related management recommendations and actions described in the next section.

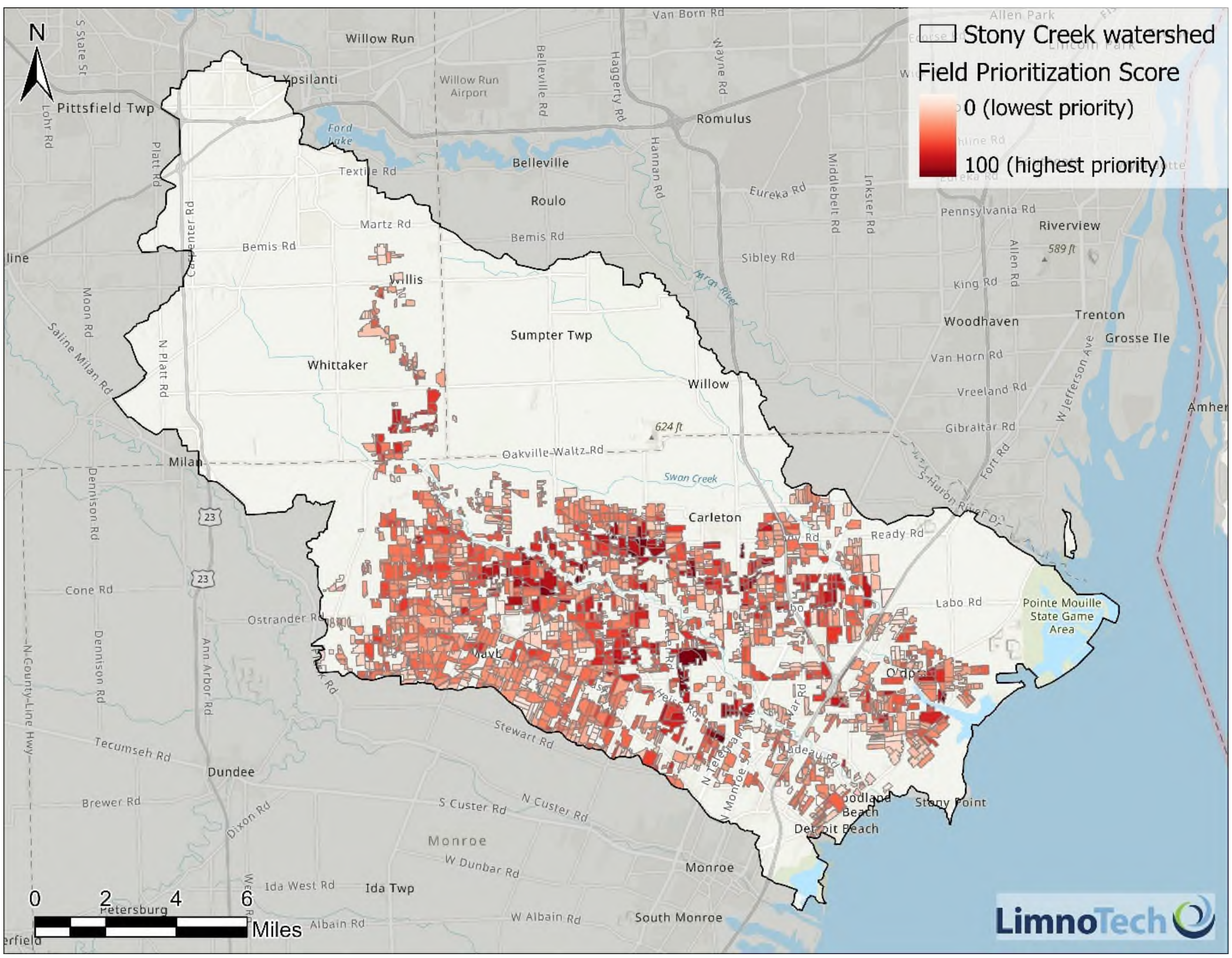

Figure 27. Field prioritization results for the parcels included in ACPF analysis and windshield surveys.

3.7 Social Surveys and Focus Groups

3.7.1 Survey Methods

Social surveys were conducted to determine current levels of awareness, attitudes, behaviors, and understanding of issues related to water quality by both area farmers and municipalities. The survey was conducted by mail and followed the protocols outlined in "The Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management" handbook (Genskow and Prokopy 2011). Topics included:

- The level of concern regarding water quality
- Individual practices that negatively impact water quality
- Barriers to behavior change

The results of these surveys were used to help inform the path forward for implementing BMPs as well as education and outreach campaigns. Survey responses were also used to establish a baseline of current knowledge amongst area farmers and municipalities regarding best farming practices, stormwater management, and septic system maintenance. This baseline can serve as a benchmark to evaluate progress against via additional future survey(s) after outreach and education campaigns have been conducted.

3.7.2 Agricultural Owner/Operator Survey Results

The landowner survey asked a range of questions arranged by different topic areas, the first of which was general awareness regarding water quality in the watershed. Landowners tended to say that the water quality in their area was "Okay". They leaned towards agreeing that they have a personal responsibility to help protect water quality and that they would be willing to change management practices to improve water quality. However, many tended to say that they would not be willing to pay more to improve water quality. This was true across the range of landowner ages and size of operations. Landowners tend to think that trash/debris in the water and algae in the water are the biggest water impairments, but they believe it is a moderate problem. Landowners farming between 500-1,500 acres tend to believe that sedimentation is only a "slight problem", but smaller farmers believed it to be more a "severe problem". Sedimentation had the largest percentage of respondents saying it was a "moderate problem". The percentage of respondents indicating they don't know how severe the impairments are ranged from 20-38%.

The next topic asked questions regarding the source of water pollution. Overall, landowners tended to say that all the listed sources were "slight problems". "Discharge from sewage treatment plants" tended to be named the most problematic source. "Soil erosion from farms" scored in the middle. "Manure from farm animals" was cited as one of the least problematic sources. Landowners tended to say that "excessive aquatic plants or algae" was the biggest issue in their area, and it was viewed as a "moderate problem". "Contaminated drinking water" was only viewed as a "slight problem" by those that participated.

Questions regarding adoption of practices that improve water quality, including barriers to implementation, were another major topic area in the landowner survey. Over 62% of respondents were familiar with regularly getting their septic system serviced. "Cost" was viewed as the most limiting factor in implementing this practice. Regarding agricultural BMPs, landowners tended to say that they maintain crop residue to reduce soil erosion, they use cover crops for erosion protection and soil improvement, and that filter strips are used on their property and were relevant (note that the size of a filter strip was not specified in the survey question). Over 57% of respondents tended to say that they are currently using soil tests on their property, while 10% of respondents indicated knowing how to use it but were not currently using it. Over 65% of respondents said that they would be willing to try soil testing or already do. The most limiting factors in implementing soil testing were “cost” and “desire to keep things the way they are”. Forty-five percent of respondents said that they currently use no-till practices with over 23% knowing how to use it but not using it. Over 22% were somewhat familiar with no-till but were not currently using it. Over 59% tended to say that they would be willing to try no-till or already do. The most limiting factors in implementing no-till were “cost”, “desire to keep things the way they are”, and “lack of equipment”.

The final set of questions sought to understand landowner’s thoughts about the future or their operations, potential for change, and trust and handling of water quality related issues by local institutions and governments. Landowners were inclined to say that their “personal out-of-pocket expense” was the most limiting factor in making changes to their management practices. Regarding the future of their operation, respondents tended to say that a family member would definitely not, or probably not, take over the farm once they retire. Farmers also said that their operation would be the same in five years. Landowners leaned to saying that they did not have a job outside of their farm. Landowners tended to say that they get their information on soil and water conservation issues from newsletters/brochures/factsheets as well as conversations with others. When it comes to where they get their information on soil and water conservation issues, landowners tended to trust their Soil and Water Conservation District (SWCD) the most, while local government was the least trusted. Landowners tended to think that local government should not handle inspection and maintenance of septic systems.

3.7.3 Municipal Survey Results

The municipal survey also asked a range of questions arranged by different topic areas, however with less of a focus on agricultural practice questions as compared to the agricultural landowner/operator survey. The respondents had an average age of 61, 68% were male, and all had completed high school with 86% having attended at least some college. Most were elected officials (59%) serving at the township level (91%).

When rating the water quality of their area, municipal leaders tended to rate their water quality as “good” for scenic beauty. It was rated “Okay” for “picnicking & family activities,” “fish habitat,” “boating,” and “eating fish” and rated “poor” for swimming. In responding to a question on severity of different pollutants, municipal leaders tended to describe the impairments as “moderate problems”, ranked in the following order of highest to lowest average: phosphorus, bacteria and viruses, toxic materials, and sedimentation. Municipal leaders tended to agree that “The quality of life in my community depends on good water quality in local streams, rivers and lakes.”

Municipal leaders tended to agree with the following statements:

- “I would support changes to our master plan and zoning ordinance to improve water quality.”
- “The economic stability of my community depends upon good water quality.”
- “Residents are personally responsible to help protect water quality.”

Municipal leaders tended to disagree with the following statements:

- “Protecting water quality is the state’s responsibility, not our local unit of government.”
- “It is okay to reduce water quality to promote economic development.”
- “What residents do on their land does not make much difference in overall water quality.”

When given a list of problems, “excessive use of lawn fertilizers and/or pesticides” received the most “severe problem” responses, though its overall average response suggested a moderate problem. The following options were also rated as a moderate problem (on average): discharge from sewage treatment plants; urban stormwater runoff; drainage/filling of wetlands; soil erosion from farm fields; droppings from geese, ducks and other waterfowl; removal of riparian vegetation; and soil erosion from shoreline or streambanks. Excessive aquatic plants or algae, reduced beauty of lakes or streams, reduced opportunities for water recreation, and contaminated fish were all rated as “moderate problems” when describing consequences of poor water quality for the communities the municipal leaders represent.

When asked about what planning or zoning practices that improve water quality ***they support individually***, municipal leaders tended to be more familiar with: minimum open space requirements for new developments; septic system restrictions; and stormwater regulations. They tended to be less familiar with keyhole regulations and rain garden requirements. Responses were similar when asked about what planning or zoning practices that improve water quality that they believe ***their community supports***, municipal leaders tended to say: minimum setbacks along lakes and streams; incorporate water quality protection statements in our master plan; and permit coordination with state and local agencies. They tended to be less familiar with rain garden requirements, keyhole regulations, and lake and stream vegetation buffer requirements. Regarding mechanisms for making a change on personal property, municipal leaders tended to say the following were most impactful: legal restrictions; no communities we know are implementing the practice; lack of need for additional regulations in our community; and approval by residents of my community. When asked specifically about regulations regarding septic systems, municipal leaders responded:

- There should NOT be ordinances requiring inspections at set times (e.g., every 5 years) (50% No).
- There should be an inspection of septic systems prior to the selling of a residence (83.3% Yes).
- A local government agency should handle inspection and maintenance of septic systems (47.8% Yes).
- Local governments should NOT offer financial assistance to replace failed septic systems (47.8%).
- They do NOT believe there is support for septic system regulations/ordinances in their area (45.5% NO).

The last category of topics surveyed respondents regarding sources of information. Municipal leaders said they seek information about water quality issues from: newsletters (80%), internet (70%), workshops-demonstrations-meetings (70%), conversations with others (60%), and newspapers-magazines (30%). When asked about groups of people that serve as a source of information about water quality, municipal leaders tended to say planning consultants (rated “moderately”, though “very much” received 52.4% of the vote), followed by municipal attorneys and EGLE (both rated “moderately” on average). The following tended to be least sought out: county planning department, planning officials like me in other communities, and USEPA.

3.7.4 S.S. LaPointe Drain WMP Public Opinion Survey

The S.S. LaPointe Drain WMP included use of two public opinion surveys to inform various aspects of the plan including: messages and delivery mechanisms for education and outreach activities, technical and financial assistance needs, barriers to implementation, and most appropriate BMPs (River Raisin Institute 2017). While both agricultural and non-farming landowner surveys were conducted, here we focus on the results from the non-farming landowner survey because the OSN project included its own survey of primarily agricultural landowners. There were overall positive attitudes toward water quality and willingness to make changes to improve. Among the greatest barriers to making changes for improving water quality were a general lack of knowledge about residential BMPs including relevance to individual properties (e.g., proper septic system maintenance, following fertilizer application guidelines, and use of rain gardens and streambank protection), the perceived effectiveness of the BMPs, and cost constraints. The survey found that printed information sources were still among the highest valued, especially with older respondents, so newspaper articles, newsletters, and facts sheets were recommended as a primary delivery mechanism for education outreach.

3.7.5 Focus Groups

The project team held in-person meetings with individuals from different focus areas to discuss the OSN WMP project, water quality issues, high priority geographic areas or project implementation ideas, and any other relevant concerns. Three focus group meetings were convened during Summer 2023: one with county drain offices, one with county health departments, and one with land-owning farmers that reside and operate in the OSN watershed. Notes from the focus group meetings are provided in Appendix F.

Though diverse in the main topics of discussion, a common theme across all three focus groups was that availability of funding is a key barrier toward scaling activities that would improve water quality. For the two county government groups, lack of funding to hire more staff or conduct more inspections were communicated as a main reason why current or future regulations aimed at improving water quality, though well-intended, would be difficult or impossible to properly enforce and therefore might not make much of a difference. There was a perception that the current levels of funding for these county offices was already insufficient, such that adding more responsibilities without an increase in funding would not be successful.

The farmer focus group also expressed that the availability of sufficient and sustained funding programs for agricultural conservation measures is lacking, and while many farmers are willing to engage with conservation professionals if funds are available, they ultimately need strong evidence to be convinced that BMP adoption will positively impact their bottom line while also leading to improved water quality. It was suggested that completing an economic case study was a high priority and that such a study should use several actual farm operations in or near the OSN watershed to demonstrate tradeoffs between potential losses in income (e.g., via lower crop yields or taking certain marginal cropland out of production) and gains in income via conservation funding. The farmer focus group also brought up concerns about flooding of their farmland, which was a topic that had been repeated during several steering committee meetings. They also provided valuable information regarding preferred methods of information delivery, such as newsletters, which validated some of the findings from the social surveys.

3.8 Flow Regime and Flooding

Several of the unsupported uses in the OSN watershed are caused by flow regime modifications or sedimentation/siltation, which is linked to flashy streamflow, including portions of Stony Creek, Swan Creek, Sandy Creek, and Paint Creek. Anthropogenic causes of the hydrologic alterations include high levels of imperviousness/development in the upper portions of Paint Creek and Swan Creek, artificial subsurface and surface drainage meant to quickly move water off the agricultural and residential landscape, and channel modifications (e.g., straightening/channelization).

Observations of recent flooding damage to both agricultural and residential properties adjacent to waterways were also brought up during multiple events over the course of this project, including several steering committee meetings, the drain commissioner focus group meeting in June 2023, the farmer focus group meeting in September 2023, and the public meeting in March 2024. Flashy flows from the highly impervious areas of Ypsilanti and Pittsfield townships, other developed areas, after significant rain events and lack of conveyance or capacity in channel to move water downstream were suspected causes. The presence of log jams in streams not maintained as county drains (e.g. the Stony Creek mainstem) and the lack of gradient between property and Lake Erie resulting in backwater or very slow-moving water were other factors mentioned by landowners. Extreme weather is also a contributing factor, as evidenced by a severe storm on August 24, 2023 that led to a federal disaster declaration for Monroe and Wayne counties, which experienced flood damage including portions of the OSN watershed (City of Monroe 2024). Precipitation totals from this event ranged from 4.2-6.8 inches at locations within the watershed (NOAA NWS 2023).

While this project included some assessments related to the flow regime, such as evaluation of water quality sampling events relative to nearby USGS streamflow gages and the streamwalk identifying areas prone to erosive stream flows, a more in-depth hydrologic and hydraulic (H&H) study of the OSN watershed would be needed to identify the most problematic areas and potential solutions to mitigating flood related issues. While later sections of this plan recommend certain actions that will improve water quality by addressing the flow regime related issues (e.g., implementation of detention and retention type green infrastructure in highly developed areas, mitigating areas of severe streambank erosion), a holistic investigation of how water moves through the drainage network of the OSN watershed could better identify priority areas and projects that can both alleviate downstream flooding while also leading to better water quality. Lacking such an H&H modeling study or investigation, performing actions such as those proposed during the focus group meetings and public meeting (i.e., log jam removals, woody debris removal, or other stream cleanouts) may alleviate flooding in one area but exacerbate flooding issues further downstream, as peak flows could be simply passed to the next pinch point in the drainage system.

4 MANAGEMENT GOALS AND OBJECTIVES

4.1 Management plan requirements

The *Handbook for Developing Watershed Plans to Restore and Protect our Waters* outlines nine key elements designed to ensure planned watershed improvements are sufficient to restore waters for regulations as well as designated and desired uses: (1) Identify causes and sources of pollution; (2) Estimate pollutant loading into the watershed and the expected load reductions; (3) Describe management measures that will achieve load reductions and targeted critical areas; (4) Estimate the authorities and the technical and financial assistance needed to implement the plan; (5) Develop an information and education component; (6) Develop a project schedule; (7) Describe the interim, measurable milestones; (8) Identify benchmarks to measure progress; and (9) Develop a monitoring component.

The OSN watershed management plan elements described in the following sections include:

- Management measures that target CSAs to achieve needed load reductions.
- The levels of technical and financial assistance needed to implement the plan.
- Information and outreach activities to encourage implementation of management measures.
- A schedule for implementing management measures.

4.2 Management goals

Management goals for this plan are to restore the currently impaired designated uses of the tributaries within the OSN watershed planning area, including: to restore their safety for human TBC and PBC by reducing potential for exposure to elevated bacteria levels, to reduce sediment loads in the upstream Paint Creek tributary, and to reduce phosphorus loading to Lake Erie. Another goal includes ensuring the unimpaired designated uses throughout the OSN watershed are protected from becoming impaired. Achieving these goals will require engagement with key stakeholders and the implementation of new BMPs at critical locations. The management recommendations described below to achieve these goals aim to reduce phosphorus loads and *E. coli* contamination from agricultural and residential sources by addressing cropland and livestock operation runoff, loading from failing or poorly functioning OSDS, and residential stormwater runoff, which collectively contribute to both the phosphorus and bacteria loads experienced by Lake Erie and tributaries within the watershed.

4.3 Management objectives

Management objectives to help meet the watershed management plan goals include: (1) develop an implementable watershed management plan that prioritizes BMPs specific to pollutant sources and causes; (2) improve outreach, education, and information sharing activities with residential property owners, agricultural property owners, and agricultural producers to promote awareness and encourage BMP adoption; (3) increase participation in existing state (MAEAP) and federal (FSA and NRCS) conservation programs; (4) expand the technical and financial assistance available to residents and producers, including increasing Conservation District and MAEAP technical staffing; (5) increase the adoption of residential property management, livestock management, row crop operational, and land conservation BMPs at a level necessary to achieve desired water quality outcomes; and (6) establish methods including water quality monitoring and agricultural inventorying to track progress toward meeting goals and objectives.

5 MANAGEMENT ACTIONS

5.1 Overview

This section describes the management actions necessary to achieve the desired water quality outcomes for the OSN tributaries. It includes discussion of the pollutants, sources, and causes that the different types of management actions address, as well as estimates of the quantity of BMPs, costs, priority areas, and phosphorus load reductions expected. Table 12 summarizes the management actions and pollutant sources reduced, organized into seven source categories. Additional details are provided in the following sections, which describe the sources, causes, and management actions for the two primary pollutants addressed in this plan: *E. coli* and phosphorus. For greater details on management actions, the USDA NRCS Field Office Technical Guide is suggested for agricultural BMPs (USDA NRCS 2024), MCARD (2024) for livestock operations, and EGLE (2023) for details regarding operation and maintenance of septic systems.

Table 12. Summary of management actions to reduce phosphorus and bacteria pollution sources.

Source Category	Management Actions	Benefits
Row Crop Agriculture	Nutrient management planning, 4Rs, cover crops, no-till or reduced tillage, grassed waterways, WASCOBs, filter strips, drainage water management, retirement of cropland on marginal land, constructed wetlands	• Reduces soil erosion • Increases soil organic matter • Increases soil porosity and promotes matrix flow • Improves infiltration and reduces compaction • Improves nutrient use and water efficiency for crops • Minimizes loss of nutrients from cropland • Intercepts pollutants in runoff • Reduces flood risks
Livestock Operations	Livestock exclusion fencing, stream crossings, manure storage structures, manure management planning	• Minimizes loss of phosphorus from feedlots • Reduces delivery of pollutants to streams and ditches from pastures
Humans / On-Site Disposal Systems	Education and outreach, inspections, maintenance, replacements	• Reduces risk of contaminating drainage with bacteria • Reduces risk of discharging excess nutrients
Pets	Education and outreach	• Reduces risk of contaminating stormwater runoff with bacteria
Streambank Erosion	Streambank stabilization, floodplain reconnection, riparian setbacks or buffers, two-stage ditches.	• Minimizes losses of sediment-bound pollutants • Reduces peak streamflow rates • Improves in-stream habitat for aquatic species • Reduces flood risk to downstream properties
Residential Property	Education and outreach, rain barrels, rain gardens	• Leads to more conservation practices that reduce runoff, nutrient, and bacteria loads • Encourages improved management
Construction Site Stormwater Runoff	Low impact development, bioretention, retention ponds, vegetated swales, check dams, infiltration basins	• Reduces soil losses from recently disturbed construction sites • Maintains post-development peak runoff rates and average runoff volumes that are similar to pre-development levels

5.2 Sources, causes, and management actions for phosphorus and *E. coli*

5.2.1 Row Crop Agriculture

Due to its dominance in the landscape draining to Western Lake Erie, runoff from cropland areas is reported to be the largest source of phosphorus loading to the lake, though that load is distributed across hundreds of thousands of properties. While cropland is a primary source of phosphorus loading in the OSN watershed, it is not likely to be a primary source of *E. coli* (except when linked to manure applications, which is covered in the next section). The causes linked to cropland as a phosphorus source may include: improper application of phosphorus fertilizers including both manure and inorganic fertilizers; soils with high phosphorus levels, erosion of disturbed or poorly covered soils containing particulate phosphorus, particularly on fields with high slopes and concentrated flow paths (including ephemeral gully erosion); short-circuiting of phosphorus laden runoff into subsurface drainage pipes (i.e., tile drainage) via preferential flow paths in the soil or surface inlets; and concentrated or distributed overland flow paths leaving the fields and entering the surface waterbodies with little or no opportunity for filtering and infiltration in the riparian zone.

Management actions to address cropland sources of phosphorus include:

- Outreach, education, and information sharing activities with farmers
- Comprehensive nutrient management planning
- Adoption of 4R nutrient management principles
- Cover crops
- No-till or reduced tillage
- Nutrient removal wetlands
- Grassed waterways, including stabilization of ephemeral gullies
- Water and sediment control basins (WASCOBs)
- Riparian filter strips
- Drainage water management
- Retirement of cropland on marginal land

Priority fields for implementing these agricultural BMPs were identified as part of the critical source area evaluation described in Section 3.6 and are shown in Figure 27. Fields with the highest prioritization scores should be considered for implementation of multiple in-field management practices including both nutrient management and activities that decrease the risk of soil erosion by increasing surface residue and cover. Fields that should be considered for installation of structural BMPs suggested by the ACPF are shown in Figure 28 for grassed waterways. Figure 29 demonstrates several locations where gully erosion was evident from aerial imagery, which may also be good candidates for grassed waterways. The Little Sandy Creek streamwalk also identified several areas where gully erosion is problematic (Section 3.5.5, Table D-2). Figure 24, earlier, shows fields identified for possible installation of riparian filter strips adjacent to surface waterbodies where a desktop analysis suggested they were absent. Although the results of ACPF did not return any suggestions for locations of WASCOBs or nutrient removal wetlands, locations of grassed waterways and concentrated flow paths (Figure 18) may be a surrogate for locations where WASCOBs may be suitable and as shown in Figure 8, much of the watershed was historically wetlands, so low-lying areas that can intercept large quantities of flow and nutrient runoff from priority fields would be suitable for wetland restorations.

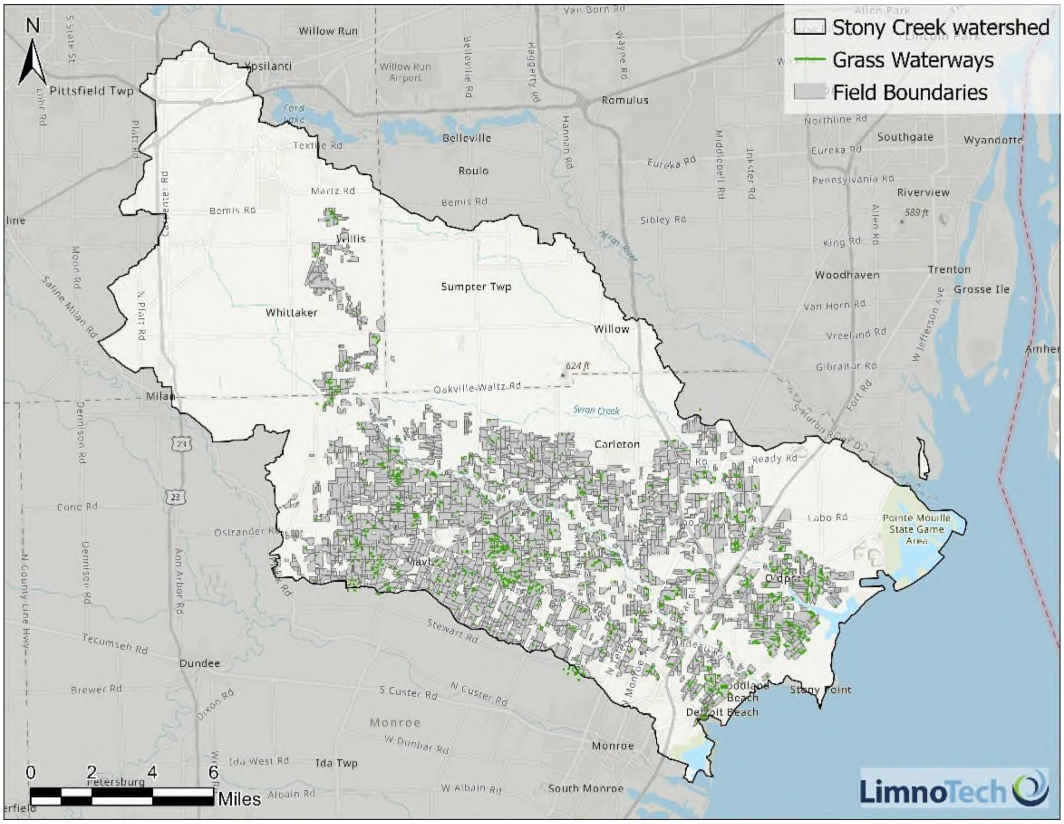

Figure 28. Locations suitable for grassed waterways derived from ACPF


Figure 29. Satellite images from several locations in the OSN Watershed for potential grassed waterway installation or other structural practices to mitigate concentrated overland flow paths.

5.2.2 Livestock Operations

Waste from livestock can be a major source of excess phosphorus and *E. coli* when mismanaged. Although there are no permitted CAFOs in the watershed, several medium-to-large cattle and horse operations are present. Excrement from these animals can be a cause of elevated TP and *E. coli* concentrations in surface waterbodies when livestock have direct access to streams, are in pastures immediately adjacent to streams, when stormwater runoff from improperly stored manure drains to waterbodies, or when manure applied to crop fields is done improperly. Livestock operations are scattered throughout the watershed, but a subset was identified as higher priority based on relatively large size or proximity to surface waterways (Figure 21). Example imagery of livestock operations of various sizes near surface waterways are shown in Figure 30.

Implementing BMPs in and around livestock facilities, grazing fields, and storage areas such as tanks or ponds can reduce the adverse impacts of livestock to the environment. Comprehensive nutrient or manure management plans for addressing livestock resource concerns often include roof runoff structures, waste storage facilities, waste transfer infrastructure, waste separation facilities, and animal mortality facilities (Michigan NRCS 2017). Other management actions to address livestock sources of TP and *E. coli* include: outreach, education, and information sharing activities with owners of livestock operations; exclusion fencing to restrict direct stream access; improved stream crossing structures to restrict occasional access; riparian filter strips to increase distance between pastures and waterbodies; and proper manure application methods.

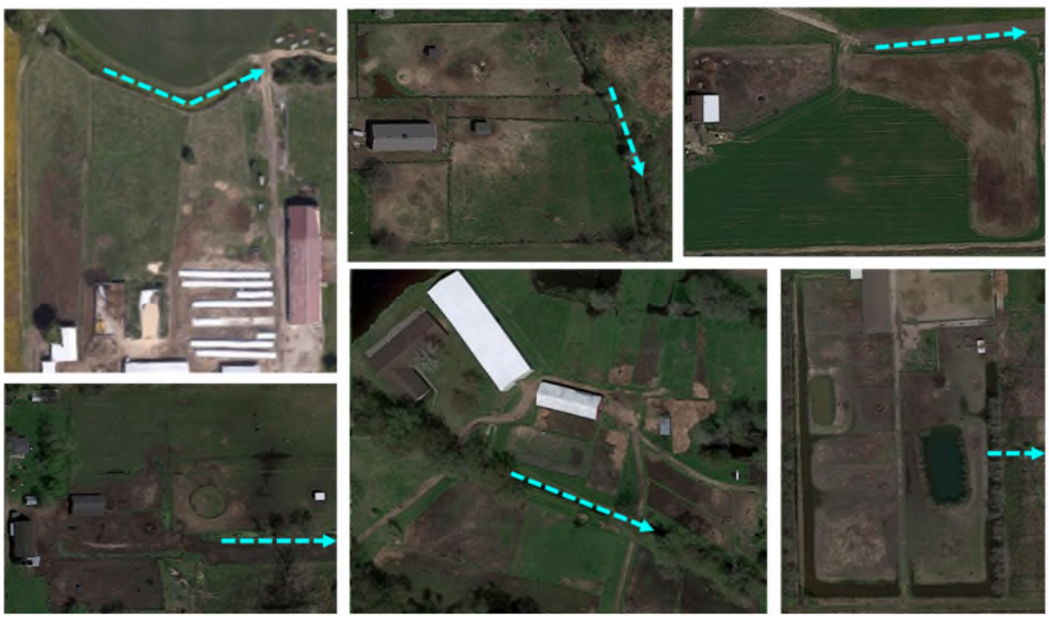

Figure 30. Satellite images from several livestock operations in the OSN Watershed bordering surface waterways or with apparent flooding issues (indicated by blue arrows).

5.2.3 Human Sources / On-Site Disposal Systems

Humans are likely a primary source of *E. coli* pollution and phosphorus loading in the watershed, caused by two suspected pathways: poorly functioning or failing OSDS, or lack of a proper OSDS. As described in Section 3.3, many of the residences and some businesses in the watershed utilize OSDS for sanitary waste disposal. An example of one of the densest residential areas of the watershed believed to rely entirely on OSDS for waste disposal is shown in Figure 31. If not properly maintained, septic systems on residential, commercial, or municipal properties can harm the environment by contaminating groundwater or by releasing bacteria, viruses, nutrients, and toxic chemicals to surface waters. Recommendations from EGLE on proper usage of these OSDS include inspections and pumping every three to five years, complete any necessary repairs, limit what contents go into the system, protect the septic field from heavy objects resting over pipes, and to test nearby wells. Outreach efforts to inform landowners of the necessary management steps for avoiding OSDS leakage or backup is one way to prevent issues and increase the likelihood of proper action in response to

OSDS failure. Proper operation and routine maintenance of OSDS can reduce the risk of system failure. Maintenance measures recommended by Monroe County (2023) and EGLE (2023) include:

- On a 1-to-2-year basis, the septic tank should be pumped by a licensed septic tank pumper.
- Do not pour materials down the drain that can clog the system such as fats, grease, or solids. The same goes for toilets; avoid items such as coffee grounds, floss, wipes, cat litter, etc.
- Reduce water consumption and implement low flow fixtures.
- Direct surface drainage away from the septic system.
- Avoiding planting trees above or nearby to reduce risk of damage to the tank and pipes by the roots.
- Immediate repair leaks on household water fixtures.
- Spread out water intense activities such as laundry and dishwashing to prevent overloading the system.
- Do not drive over, construct over, or pave over any portion of the septic system. Contact the Monroe County Health Department before constructing any new structures.
- Do not add garbage grinders, sump pumps, foot drains, or water softeners directed to the septic tank.
- Test well drinking water for contaminants.

Direct management measures and actions that will address contamination from failing OSDS include:

- Field inventory work targeted toward sources of *E. coli;*
- Review isolation distances;
- Increase the inspection rates for OSDS;
- Conduct Illicit Discharge Elimination Program; and
- Outreach to educate residents.

Figure 31. Satellite image from a location in the OSN Watershed with one of the highest densities of residences utilizing OSDS.

5.2.4 Pet sources of *E. coli*

Pets, primarily dogs, are a potential source of *E. coli* pollution in the watershed due to the potential for stormwater runoff in the residential areas to enter subsurface pipes and be directly discharged to waterbodies during wet weather. Although the population of dogs was not estimated, when not picked up and disposed of properly, dog waste containing *E. coli* may contribute to local hotspots areas where residences are relatively dense, including the outskirts of Ypsilanti and Ann Arbor, Monroe metro area, Milan, Maybee, and Carleton. Stormwater runoff from these communities enter pipes through surface inlets and is piped directly to waterways. Management actions to reduce *E. coli* contributions from pets include outreach, education, and information sharing with residents to promote proper dog waste management.

5.2.5 Residential, Commercial, and Institutional Sources of Phosphorus

Runoff from developed areas (e.g., residential, commercial, and institutional properties) of the watershed is another source of phosphorus loading. Phosphorus in stormwater runoff from developed areas originates from multiple sources including pet waste, grass clippings and leaf litter, accumulated sediment on roads and other impervious surfaces, wildlife excrement, and lawn and turf fertilizers. The Ypsilanti, Ann Arbor, and Monroe metro communities have the highest density of impervious surfaces in the watershed, which results in relatively higher stormwater runoff during rain events compared to other areas of the watershed with limited imperviousness. This stormwater runoff carries phosphorus from the sources listed as it enters pipes through surface inlets and is conveyed directly to waterways. Causes of these pollution sources that can be addressed through management activities include lack of proper disposal of pet waste and organic materials, and application of fertilizers containing phosphorus that is not in compliance with State of Michigan fertilizer legislation adopted in 2012 (MDEQ 2013).

Management actions to address phosphorus originating from developed areas include:

- Outreach, education, and information sharing activities with private citizens and public officials, including knowledge of Michigan Fertilizer Law (1994 PA 451, Part 85 Fertilizers) restricting the use of phosphorus fertilizers.
- Installing signage at parks and near stormwater infrastructure.
- Soil testing to determine lawn and turf fertilizer needs.
- Rain gardens or other green infrastructure to intercept and infiltrate stormwater runoff.

5.2.6 Streambank Erosion

Streambank erosion is a source of particulate phosphorus loading in the watershed. Just as soil erosion from crop fields carries phosphorus bound to the sediment particles, erosion of streambanks also contributes loading of sediment-bound phosphorus. Several causes can collectively contribute to this phosphorus loading source, including: farming or developments than encroach on the riparian space (i.e., floodplain) needed by the stream networks to dissipate high flows; relatively flashy peak flows which can be linked to several causes (e.g., increased development or imperviousness in headwaters, expansion of tile drainage, and climate change induced extreme precipitation events); trampling of streambanks by livestock or disturbance by machinery; and lack of vegetative cover to protect the streambanks. Several critical areas of streambank erosion were identified during the Paint Creek and Little Sandy Creek streamwalks conducted as part of this project (Figure 25, Figure 26) and during a recent streamwalk of North Branch Swan Creek, including those depicted in Figure 32. Management actions to directly address this source include streambank stabilization work, stream meander restorations, floodplain reconnections, two-stage ditches, and riparian setbacks or buffers. Other actions that more indirectly address streambank erosion include implementation of green infrastructure projects or stormwater detention basin retrofits in developed watersheds such as Upper Paint Creek to reduce flashy event flows that lead to the in-stream erosion (Stantec Consulting Services, Inc. 2020).

Figure 32. Example photos of locations in the OSN Watershed depicting streambank erosion identified during streamwalks.

5.2.7 Stormwater Runoff from Construction Sites

Stormwater runoff from construction sites, both during and after construction is completed, is a potential source of phosphorus loading in the watershed. Construction activities often expose large areas of soil that was previously protected by some ground cover, resulting in elevated risk of soil erosion during storm events which carries particulate phosphorus into waterways. Examples of several areas of the watershed with exposed soils during construction of residences are shown in Figure 33. Additionally, to establish lawns or other vegetation on the disturbed soil, construction activities may include spreading of relatively high rates of phosphorus-containing fertilizer. These pathways can result in construction sites being hotspots of phosphorus loading. As construction sites are always changing, it is difficult to pinpoint locations of the watershed at greater risk, but these sites generally tend to be adjacent to the developed areas where urban sprawl is most active (i.e., outskirts of Monroe and Ypsilanti) and less present in the more rural communities.

Management actions to reduce phosphorus loading from construction sites include following state regulations for both active sites and for post-construction, such as:

- Use of silt fences, sedimentation ponds, and other structural measures.
- Covering exposed soil that will sit for a certain number of days.
- Staging construction activities to ensure soils are not exposed to rain events during wet months.
- Installing permanent BMPs to capture runoff from a certain sized storm event (retention ponds, bioretention basins, vegetated swales, check dams, etc.)
- Establishing a vegetated grass (or other) cover as soon as possible to stabilize the site.
- Controlling post-construction sediment and runoff rates and volumes to levels consistent with the new Development Management Measure (i.e., reduce the average annual total suspended solids loadings by 80 percent and maintain post-development peak runoff rate and average volume at levels that are similar to pre-development levels).

Figure 33. Historic aerial images from several locations in the OSN Watershed depicting residential construction sites with exposed soils.

5.3 Priority Management Actions

Widespread implementation of management actions will be necessary to meet the established water quality goals: over 50% TSS load reduction to meet the Upper Paint Creek DO TMDL and a 40% TP load reduction from the entire OSN drainage area to meet the Lake Erie target. Recognizing that implementation efforts may be time or resource limited, the actions described in the above sections were prioritized based on an assessment of landowner willingness and ability to implement, potential for meaningful/near-term reduction of pollutant sources, or actions that can serve as catalytic or enabling activities (i.e., actions that have the potential to foster accelerated and scalable adoption of BMPs that may otherwise not happen). The information gathered during steering committee meetings, focus group meetings, and from the social surveys was key to informing this assessment of priority actions. In addition to prioritizing which actions are highest priority, another critical component involved prioritizing which areas of the OSN watershed are highest priority for the different pollutant sources. These geographic prioritization analyses described in Section 3 included the OSDS assessment, streamwalks, evaluation of livestock operations, and agricultural inventory process to arrive at the critical source areas for agricultural fields. Based on these various assessments, the following list details the highest priority activities recommended for the first implementation phase:

1. Conducting a hydrologic and hydraulic (H&H) modeling study of the entire OSN watershed, emphasizing analysis of areas most prone to flooding according to information gathered during public outreach and focus group meetings.
2. Completing economic case studies for certain willing farm producers to investigate and demonstrate agricultural BMP adoption techniques that can be both beneficial to the farm's bottom line while also positively impacting the water environment.
3. Establishing a network of demonstration farms in the OSN watershed or immediate vicinity (i.e., within five miles of the watershed boundary) and conduct field days to bring producers to these demo sites where agricultural conservation techniques are being practiced.
4. Implement agricultural BMPs on priority fields or areas within these demonstration farms, such as wetland restoration, floodplain reconnection, retirement of frequently flooded or marginal cropland, nutrient/manure management planning/implementation, and/or drainage water management.
5. Use various actions at a priority livestock operation with willing owner, such as manure storage, manure management planning, and use of vegetated filters/borders between livestock housing and feedlot areas and surface water runoff pathways.
6. Conduct an education and outreach campaign raising awareness of septic system operation and maintenance, targeting the dense, priority areas (mainly in Washtenaw and Wayne counties) while also broadcasting to the entire OSN watershed.
7. Implement green infrastructure practices in the Upper Paint Creek subwatershed, following the list of priority projects identified by Stantec Consulting Services, Inc. (2020).

Additional high priority actions recommended include:

- Comprehensive nutrient management planning
- Riparian filter strips on high priority fields (Figure 24)
- Outreach to high priority livestock operations and use of demonstration farm to showcase BMPs (Figure 21)
- Preservation of existing wetlands in locations rated as high/medium (Figure 9, Figure B-12)
- Restoration of historic wetlands in locations rated as high/medium (Figure 9, Figure B-12)
- Streambank stabilization and gully stabilization for high priority locations in Paint Creek and Little Swan Creek (Figure 25, Figure 26, Table D-2)

- Commercial property scale green infrastructure (Stantec Consulting Services, Inc. 2020)
- Replacement of any failing OSDS identified or installation of new OSDS where none exist.

The following actions, though eventually necessary to achieve water quality goals, are considered important, medium priority actions:

- Cover crops
- No tillage and conservation tillage
- Drainage water management
- Grassed waterways
- Cropland retirement of marginal areas
- Riparian filter strips on lower or medium priority fields
- Implementation of appropriate livestock BMPs for lower priority operations and hobby farms
- Residential rain gardens and rain barrels
- Inspection of septic systems

5.4 Financial and Technical Assistance

5.4.1 Sources of technical and financial assistance

A variety of partners are available to provide technical and financial assistance to address water quality concerns in the OSN watershed. Although participation levels may vary by location and project type, each agency or group identified has an existing or potential role to play. County-level groups include the Washtenaw, Monroe, and Wayne County Conservation Districts, County Drain Commissions, and the County Health Departments. Many local governments that control local ordinances also play a role, including several townships (Pittsfield, Ypsilanti, York, Sumpter, Augusta, Exeter, London, Ash, Frenchtown, and Berlin) and municipalities (Ypsilanti, Milan, Monroe, Maybee, Carleton, and Newport). These groups are most familiar with the local landscape and issues important to residents of the watershed. At the state level, EGLE's NPS Program is key for facilitating implementation of projects and its staff provide technical expertise, information regarding grant funding opportunities, and facilitate coordination with other state and federal agencies. Program staff provides local assistance through technical expertise, grant funding, and coordination with state / federal agencies. Other technical assistance options include working with service providers, MSU Extension Service, the Great Lakes Commission, and non-government organizations active in the WLEB like The Nature Conservancy and Ducks Unlimited.

Several state and federal funding sources provide opportunities for project implementation. Financial assistance to support implementation efforts that are administered by EGLE via state or federal funding sources include: Section 319(h) grants, Section 205(J) grants, Clean Michigan Initiative (CMI) grants, Water Pollution Control Revolving Fund (WPCRF), GLRI grants, and other programs. New in 2024, EGLE and Michigan Saves launched the Septic Replacement Loan Program (SRLP) to provide low-interest loans for up to $50,000 for Michigan homeowners that need to replace failing septic systems. Another relevant source of funding originating from American Rescue Plan Act and allocated by the state legislature is being managed by Ducks Unlimited for wetland restoration projects in the Lake Erie watershed. The U.S. Department of Agriculture (USDA) through the Natural Resources Conservation Service (NRCS) offers voluntary programs to eligible landowners and agricultural producers, which provides financial and technical assistance that address natural resource concerns. Included are the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), and the Conservation Innovation Grant (CIG) program.

5.4.2 Cost estimate

This section describes a cost estimate associated with implementation activities proposed in the WMP. While it is acknowledged that scaling BMP implementation will not only require the cost to build and maintain new BMPs, but also increases in professional staffing for those involved in the implementation activities. These professional duties include education and outreach work, providing technical support to farmers and other private landowners, performing monitoring and tracking of progress, and engineering and design for relatively larger structural projects. The financial resources needed to accomplish these various activities can be quite variable, and therefore a graduated level of costs estimates was used, following the precedence of other WMPs developed for Michigan watersheds (Table 13).

In addition to the graduated scales for professional costs, cost estimates associated with 16 different types of individual BMPs were completed (Table 14). A 40% TP load reduction goal relative to 2008 conditions was established for this watershed by USEPA (2018) and the State of Michigan (2018). The magnitude of BMP implementation needed to achieve an approximately 40% TP load reduction for the entire drainage areas to Lake Erie was assessed in a spreadsheet model described below. While most of the TP load reduction needed was assumed to come from cropland, BMP assignments and subsequent TP load reductions were also assumed for pasture, septic systems, and urban stormwater runoff sources. Unit cost estimates were multiplied by the number of units at full implementation to achieve desired WQ outcomes, and then an annual average cost was computed for each individual BMP by assuming a lifespan of 20 years for structural BMPs or assuming unit costs apply annually for the non-structural BMPs (Table 14). Costs associated with information and educational activities are described in Section 6.1.

Table 13. Graduated scales to estimate technical and financial assistance needs (from Blonde and Cleland 2019).

Tiers used to estimate technical assistance effort for proposed implementation activities			
Assistance Tier	Description	Actions Included	Sources
Tier 1	No special assistance needed; can be handled by conservation district staff	Distribute information, meetings, presentations	County conservation districts, local partners
Tier 2	Some technical assistance needed	Local outside experts needed: meetings, workshops, field days, technical assistance	MDARD, EGLE, MSU Extension, local agricultural service providers, etc.
Tier 3	Moderate technical assistance needed	Low level consulting, planning and data collection, develop project recommendations	Consultants, engineers, planners
Tier 4	Significant technical assistance needed	High level consulting, project implementation, construction	Specialty consultants, developers, engineers, planners
Graduated scale used to estimate approximate costs of proposed implementation activities			
Cost Level	Description	Actions Included	Estimated Annual Costs
Level 1	Staff time, mileage	Meetings, presentations	\$1,000-\$5,000
Level 2	Includes all above costs plus printing postage, advertising, speaker fees, etc.	Mailings, workshops, field days	\$4,000-\$8,000
Level 3	Includes all above costs plus consultant fees (planning & design).	Field inventory, special data collection, site-specific planning & design	\$8,000-\$10,000
Level 4	Includes all above costs plus engineering design, permitting, and construction.	Construction & Implementation of projects	\$10,000-\$100,000 (or more)

Table 14. Annual cost estimates for management actions described in Section 5.2.

Category	Management Action	Unit Cost [1]	Units	Annual Cost
Row Crop Management	Cover Crops	$70/acre	20,200 acres	$1,414,000
	No-till	$25/acre	32,315 acres	$807,875
	Conservation tillage	$10/acre	32,315 acres	$323,150
	Comprehensive nutrient management	$55/acre	60,590 acres	$4,544,250
	Cropland retirement of marginal area	$125/acre	400 acres	$50,000
Structural BMPs	Drainage water management	$11/acre	1,620 acres	$890
	Grassed waterway	$5/linear foot	58,650 feet	$14,660
	Riparian filter strip	$300/acre	1,010 acres	$15,150
	Nutrient removal wetlands	$15,000/acre	80 acres	$60,000
Livestock	Livestock exclusion fencing	$5/linear foot	5280 linear feet	$1,320
	Livestock stream crossing structures	$10/sq ft	3000 sq ft	$1,500
	Manure storage structures	$20/sq ft	5000 sq ft	$5,000
	Manure management planning	$35/acre	500 acres	$17,500
Other	Residential rain barrels	$10/barrel	200 barrels	$100
	Residential rain gardens	$0.95/sq ft	10 acres	$20,690
	OSDS inspections	$300/inspection	20 per year	$6,000

[1] Unit cost data sources included USDA NRCS (2024), Schlea and Zimnicki (2024), and Blonde and Cleland (2019).

5.5 TP and Sediment Load Reduction Estimates

An assessment of baseline TP and sediment loading, load reductions expected with full implementation of BMPs, and an estimate of the total costs was completed. As described in Section 3.2, baseline TP and sediment loads for eight HUC-12 subwatersheds were estimated using the STEPL model. Source categories represented included cropland, pastures, urban, forest, wetland, septic systems, and streambank and gully erosion. The project team discussed arriving at realistic yet aggressive levels of adoption of the various BMPs in terms of the percent of the cropland area for implementing or the number of new projects per year. The diverse set of agricultural BMPs was represented in STEPL using the "combined BMP" option, which computes aggregated nutrient and sediment reduction efficiencies based on efficiencies of individual BMPs and the relative proportions of implementation. BMPs were assumed to be implemented on all HUC-12 watersheds, including those for which an ACPF analysis has not yet been completed. This was necessary to achieve the overall 40% TP load reduction from the entire OSN drainage area. Load reductions from streambank and gully stabilization projects were assumed as 100% reduction (i.e., complete stabilization). Results from the assessment of TP and sediment load reductions are shown in Table 15 for each HUC-12 subwatershed area evaluated. Appendix D contains additional details on this assessment, including load reductions associated with individual BMPs for which reductions could be quantified.

Table 15. Pre- and post-implementation annual TP load estimates

HUC-12 Subwatershed	Pre-Implementation TP Load (lbs/year)	Post-Implementation TP Load (lbs/year)	Reduction
041000010101 Mouille Creek-Lake Erie	11,326	6,545	42%
041000010102 North Branch Swan Creek	5,609	4,213	25%
041000010103 Middle Creek-Swan Creek	10,844	7,200	34%
041000010104 Swan Creek	15,755	8,057	49%
041000010105 Paint Creek	12,135	9,411	22%
041000010106 Sugar Creek-Stony Creek	9,599	5,198	46%
041000010107 Stony Creek	18,246	8,407	54%
041000010108 Sandy Creek	11,742	6,169	47%
TOTAL	**95,256**	**55,199**	**42%**

Table 16. Pre- and post-implementation annual sediment load estimates

HUC-12 Subwatershed	Pre-Implementation Sediment Load (tons/year)	Post-Implementation Sediment Load (tons/year)	Reduction
041000010101 Mouille Creek-Lake Erie	1,242	719	42%
041000010102 North Branch Swan Creek	610	432	29%
041000010103 Middle Creek-Swan Creek	1,188	716	40%
041000010104 Swan Creek	1,928	1,009	48%
041000010105 Paint Creek	1,531	1,172	23%
041000010106 Sugar Creek-Stony Creek	1,174	562	52%
041000010107 Stony Creek	1,979	874	56%
041000010108 Sandy Creek	1,384	745	46%
TOTAL	**11,036**	**6,228**	**44%**

6 PUBLIC ENGAGEMENT

6.1 Description of information/education component

Community participation will be critical to the success of this plan as the implementation actions are voluntary. To encourage and best inform community participation in the implementation of the plan, educating the members of the watershed will be essential. The goals of the information and education component of this plan include:

- Increasing public awareness on the water quality challenges faced in the OSN watershed, focusing on bacteria (statewide *E. coli* TMDL and Upper Paint Creek *E. coli* TMDL), phosphorus (Annex 4 of the GLWQA), and sedimentation for the Upper Paint Creek DO TMDL.
- Increasing public understanding of the factors that contribute to the water quality challenges faced in the OSN watershed, focusing on bacteria and phosphorus.
- Increasing homeowners' understanding of the negative environmental impacts of poorly functioning and failing septic systems and educate them on routine inspections and maintenance.
- Provide an opportunity for community input into the plan.

The approach for developing the information and education strategy tables below involved identifying stakeholders most closely linked to the primary pollutant sources and causes, having several discussions with local government groups, relying on experiences and lessons learned from the MCD and WCCD staff who assisted in authoring this plan, and referring to strategies developed recently for other rural watersheds in Southeast Michigan (River Raisin Institute 2017, Blonde and Cleland 2019). Also critical to informing the many components of the information and education tables were the two social surveys conducted as part of this project and information learned from the non-farming landowner survey conducted in the neighboring S.S. LaPointe Drain watershed area (see Section 3.6 for discussion on the results from these surveys). Table 17 through Table 20 provide detailed information on the overall strategy for the public information, education, and participation component of this plan. Tables are organized by management action topic areas and describe the pollutant and causes addressed, educational goal, organizations responsible, target audience, message, delivery method, timeline and milestones, evaluation criteria, and anticipated costs.

Table 17. Information and education strategy for row crop agriculture.

Information and Education strategy: **Best Agricultural Practices**			
Educational Goal:		Increase awareness of water quality issues and adoption of both field management and structural BMPs.	
Cost:	$15,000/year	**Critical Areas:**	Priority Fields (Figure 27)
Pollutant:	Phosphorus	**Cause:**	Soil erosion, fertilizer and manure application, excess runoff.
Organization(s) Conducting:		MCD, WCCD, Farmer Led Group, Farm Bureau	
Target Audience:		Agricultural producers and landowners.	
Message: • Phosphorus losses from cropland contribute to degraded water quality. • Use of appropriate BMPs to reduce losses of sediment and phosphorus from cropland can be economically advantageous while also improving water quality. • Technical and financial assistance is available to help with BMP implementation.			
Delivery Method: • Conduct one-on-one meetings with producers operating on identified priority fields. • Provide articles, fact sheets, or infographics for distribution via local newspapers, newsletters, web articles, or direct mailings. • Host field events at demonstration farms in the watershed or nearby.			
Timeline & Milestones: • Short-term: Develop mailing list of producers operating within OSN watershed with annual direct mailing. • Short-term: Compile existing materials or develop new materials to communicate key messages. • Mid-Term: Host field events at demonstration farms. • Long-term: Continue annual I&E events, increase the number of operations participating in MAEAP verification process and use of technical and financial resources for BMPs.			
Evaluation Criteria: • Attendance at in-person events. • Number of new inquiries to MCD or WCCD. • Conducting surveys to learn if the I&E strategy is impacting the intended audience. • Increased use of no-till/minimal tillage and residue management practices. • Increase use of filter strips, grassed waterways, WASCOBs, DWM, and wetlands.			

Table 18. Information and education strategy for livestock operations.

Information and Education strategy: **Best Livestock Operation Practices**			
Educational Goal:		Increase awareness of water quality issues and adoption of new BMPs by livestock operations.	
Cost:	$5,000/year	**Critical Areas:**	Priority Livestock Operations (Figure 21)
Pollutant:	Phosphorus, *E. coli*	**Cause:**	Stream access, short setbacks from waterways, runoff from manure storage.
Organization(s) Conducting:		MCD, WCCD, Farmer Led Group, Farm Bureau	
Target Audience:		Livestock producers and hobby farmers.	

Message:

- Phosphorus and bacteria from livestock manure contribute to degraded water quality.
- Clean water is important to maintain livestock health, improve public perception of modern agriculture, and preserve the resource for future generations.
- Technical and financial assistance is available to relieve any perceived burden of changing practices.

Delivery Method:

- Conduct one-on-one meetings with owners/managers of priority operations.
- Provide articles, fact sheets, or infographics for distribution via newsletters, web articles, or direct mailings.
- Host field events at demonstration farms in the watershed or nearby.

Timeline & Milestones:

- Short-term: Develop mailing list of producers operating within OSN watershed with annual direct mailing.
- Short-term: Compile existing materials or develop new materials to communicate key messages.
- Mid-Term: Host field events at demonstration farms.
- Long-term: Continue annual I&E events, increase the number of operations participating in MAEAP verification process and use of technical and financial resources for BMPs.

Evaluation Criteria:

- Attendance at in-person events.
- Number of new inquiries to MCD or WCCD.
- Conducting surveys to learn if the I&E strategy is impacting the intended audience.
- Implementation of proposed livestock management BMPs.

Table 19. Information and education strategy for promoting homeowner awareness regarding septic systems.

Information and Education strategy: **Septic System Management**			
Educational Goal:		Increase awareness of water quality issues linked to septic systems and importance of routine maintenance.	
Cost:	$15,000/year	**Critical Areas:**	Dense non-sewered areas (Figure 12)
Pollutant:	Phosphorus, *E. coli*	**Cause:**	Improper or malfunctioning septic systems
Organization(s) Conducting:		Health Departments, Local Municipalities, EGLE	
Target Audience:		Homeowners in non-sewered areas	

Message:

- Improper or malfunctioning septic systems contribute to water quality issues in local tributaries and lakes, including both pathogens and excess nutrient loading.
- Homeowners are responsible for understanding their septic system and properly operating and maintaining it, including routine inspections and tank pumping.
- Properly maintaining your system now can prevent the need for larger financial investments to repair or install a new system in the future.
- Technical assistance is available.

Delivery Method:

- Provide articles, fact sheets, or infographics for distribution via local newspapers, newsletters, web articles, social media, or direct mailings.
- Presentations or booths during routine community events.

Timeline & Milestones:

- Short-term: Develop mailing list of residence in critical areas with annual direct mailing.
- Short-term: Compile existing materials or develop new materials to communicate key messages.
- Mid-Term: Give presentations or establish booths at community events.
- Long-term: Increase routine maintenance on septic systems.

Evaluation Criteria:

- Attendance at in-person events.
- Number of new inquiries to health department.
- Number of presentations given, and articles published.
- Number participants reached via presentations and meetings.

Table 20. Information and education strategy for promoting residential awareness regarding pollution sources.

Information and Education strategy: **Residential Landscape Management**			
Educational Goal:		Increase awareness of impacts to water quality from excessive runoff, lawn fertilizers, pet wastes, yard wastes.	
Cost:	$10,000/year	**Critical Areas:**	Dense housing areas (Figure 4), Upper Paint Creek watershed
Pollutant:	Phosphorus, *E. coli,* Sediment	**Cause:**	Stormwater runoff carrying pet and wildlife excrement, lawn fertilizers, sediment, and other sources.
Organization(s) Conducting:		MCD, WCCD, WCD, Townships, Municipalities	
Target Audience:		Homeowners in dense housing areas (Ypsilanti, Monroe)	

Message:

- Stormwater runoff from residential properties can contribute to issues in local tributaries and Lake Erie, including both pathogens and excess sediment and nutrient loading. Two TMDLs are in place for Paint Creek (DO and *E. coli*), a statewide *E. coli* TMDL, and a 40% phosphorus load reduction goal for Lake Erie.
- A law passed in Michigan in 2012 restricts lawn fertilizers containing phosphorus to very limited circumstances – following soil testing or when establishing a new lawn.
- Small actions such as picking up pet waste, managing grass clippings and leaf litter, and adding structural BMPs to your landscaping such as rain barrels, rain gardens, or vegetated buffer strips can result in measurable water quality improvements.

Delivery Method:

- Provide direct evidence through monitoring results.
- Provide articles, fact sheets, or infographics for distribution via local newspapers, newsletters, web articles, social media, or direct mailings.
- Presentations or booths during routine community events.

Timeline & Milestones:

- Short-term: Develop mailing list of residence in critical areas with annual direct mailing.
- Short-term: Compile existing materials or develop new materials to communicate key messages.
- Mid-Term: Give presentations or establish booths at community events.
- Long-term: Increase adoption of residential BMPs.

Evaluation Criteria:

- Attendance at in-person events, meetings, and virtual presentations.
- Number of new inquiries to local municipalities or conservation districts.
- Number of presentations given, and articles published.

6.2 Plan partners

Many groups involved in data gathering, plan development, review, or providing valuable feedback for this plan will also be critical partners as the effort moves into implementation phases. These key plan partners span a diverse range of institutions and may include the following:

- Conservation districts
    - Monroe Conservation District
    - Washtenaw County Conservation District
    - Wayne Conservation District
- University
    - Michigan State University (MSU)
    - MSU Extension
    - MSU Institute for Water Research (IWR)
    - University of Michigan
    - University of Michigan Water Center (UMWC)
- Industry or Commodity Associations
    - Michigan Farm Bureau
    - Monroe County Farm Bureau
    - Washtenaw County Farm Bureau
    - Michigan Corn Growers Association
    - Michigan Soybean Association
- Federal agencies
    - USEPA
    - USDA Natural Resources Conservation Service
    - USDA Farm Service Agency
- State quality of life agencies and programs
    - EGLE
    - MDARD
    - MAEAP
    - MDNR
- County government groups
    - Health Departments
    - Monroe County Drain Commission
    - Washtenaw County Water Resource Commissioner
- Local municipalities
    - Several Cities and Villages
    - Numerous Townships
- Other local groups or environmental organizations
    - Western Lake Erie Basin Farmer Led Water Conservation Initiative
    - Local Farm Venues
    - The Nature Conservancy
    - Ducks Unlimited
    - Pheasants Forever

7 IMPLEMENTATION

7.1 Timeline

Implementation of the activities described in this WMP will occur over a ten-year period, divided into three phases: Phase 1 (2025-2027), Phase 2 (2028-2030), and Phase 3 (2031-2034). The first phase will focus on executing the outreach, education, and information sharing activities described in Section 6.1 to expand awareness of both the water quality issues and technical and financial resources available to homeowners, agricultural producers, agricultural landowners, and government leaders. The first phase also includes certain implementation activities prioritized for the critical areas identified during development of this WMP. The second and third phases will focus on expanding implementation activities across all categories to reach the overall adoption levels needed to result in desired water quality outcomes. Table 21 below summarizes the activities planned for each implementation phase, organized by category.

Table 21. Watershed management plan activities arranged by category for each of the three phases.

Timeline	Category	Activities
Phase 1 2025-2027	Livestock Operations	• Execute information and education strategy activities. • Manure management plan for high priority operations. • Livestock exclusion (if necessary) for high priority operations.
Phase 2 2028-2030		• Manure management plan for additional high priority operations. • Manure storage structures for high priority operations.
Phase 3 2031-2034		• Manure management plans and other actions deemed necessary for additional livestock operations and hobby farms.
Phase 1 2025-2027	Row Crop Operations	• Execute information and education strategy activities. • Riparian filter strips for high priority fields. • Increase acreages of non-structural BMPs and adoption of structural BMPs according to phase 1 milestones.
Phase 2 2028-2030		• Increase acreages of non-structural BMPs and adoption of structural BMPs according to phase 2 milestones.
Phase 3 2031-2034		• Increase acreages of non-structural BMPs and adoption of structural BMPs according to phase 3 milestones.
Phase 1 2025-2027	Streambank Erosion and Wetland Restoration	• Execute information and education strategy activities. • Restore 20 acres of high priority, nutrient removal wetlands. • Implement 4 high priority streambank stabilization projects.
Phases 2-3 2028-2034		• Restore 60 acres of high priority, nutrient removal wetlands. • Implement 6 streambank stabilization projects.
Phase 1 2025-2027	On-Site Disposal Systems	• Execute information and education strategy activities. • Prioritized inspections of residences in critical source areas. • Mitigation of failing or illicit septic systems (if identified).
Phases 2-3 2028-2034		• Prioritized inspections of residences in critical source areas. • Mitigation of failing or illicit septic systems (if identified).
Phase 1 2025-2027	Residential Landscapes	• Execute information and education strategy activities. • Increase adoption of BMPs according to phase 1 milestones.
Phases 2-3 2028-2034		• Increase adoption of BMPs according to phase 2 and 3 milestones.
All Phases 2025-2034	Construction Sites	• Routine inspection of construction site stormwater runoff controls and enforcement of violations.
All Phases 2025-2034	Monitoring	• Routine monitoring by MCD, WCCD, and EGLE.

7.2 Milestones and outcome monitoring

Evaluating progress made on the goals and objectives defined in this WMP will be done by establishing interim milestones for the various management actions in the implementation strategy, conducting water quality monitoring, and monitoring adoption of new BMPs as described in the sections below. The MCD and WCCD will use these strategies to determine if progress in the OSN watershed is on track with the timeline defined in the plan. If it is determined that implementation milestones are not being met or water quality improvements are not being realized, the team may decide revisions to the WMP or Upper Paint Creek TMDLs are necessary. This determination will be conducted on approximately an annual basis. Prior to pursuing revisions to the WMP, however, the team will assess potential reasons for a lack of progress, following the guidance established in the *Handbook for Developing Watershed Plans to Restore and Protect our Waters*, which includes asking a series of questions that can inform whether a plan revision is needed and what factors specifically need updated (USEPA 2008).

7.2.1 Interim milestones

Interim milestones for each management action described in the sections above are listed in Table 22 below, organized into the three phases over which implementation activities will occur. For non-structural management-type BMPs, the milestones represent cumulative area of the watershed experiencing that BMP in any given year. For structural BMPs, the milestones represent the cumulative total new area, length, or number of the BMP relative to the pre-implementation levels. Likewise, annual events conducted such as the education and outreach activities or OSDS inspections are represented by the cumulative number achieved over the course of the three-phase implementation period.

Table 22. Interim milestones for the various management actions described in this WMP.

Category	Management Action	Phase 1 Milestone 2025-2027	Phase 2 Milestone 2028-2030	Phase 3 Milestone 2031-2034
Row Crop Management BMPs	No-till or conservation tillage	32,300 acres	42,000 acres	51,700 acres
	Cover crops	3,000 acres	4,000 acres	5,100 acres
	Nutrient management planning	15,100 acres	30,300 acres	45,400 acres
	Cropland retirement for marginal land	100 acres	250 acres	400 acres
Row Crop Structural BMPs	Drainage water management	200 acres	800 acres	1,620 acres
	Riparian filter strip	200 acres	500 acres	1,010 acres
	Nutrient removal wetlands	20 acres	40 acres	80 acres
	Grassed waterway	10,000 feet	25,000 feet	58,650 feet
Livestock	Livestock exclusion fencing, stream crossings, or riparian buffers	3 operations	6 operations	10 operations
	Manure storage structures or feedlot runoff reduction measures	3 operations	6 operations	10 operations
	Manure management plans	5 operations	10 operations	15 operations
Streambank Erosion	Streambank stabilization, floodplain reconnection, or similar stream restoration activities	4 projects	7 projects	10 projects
Residential	Education and outreach activities	6 events	12 events	20 events
	Residential rain barrels	50 barrels	100 barrels	200 barrels
	Residential rain gardens	2 acres	5 acres	10 acres
	OSDS inspections	20 inspections	40 inspections	60 inspections
	Mitigation of failing/illicit systems	-	3 systems	6 systems
Construction Sites	Routine inspection of construction site stormwater runoff controls	*Ongoing*	*Ongoing*	*Ongoing*
	Enforcement of violations	*As needed*	*As needed*	*As needed*

7.2.2 Water quality monitoring

The ultimate outcome sought in developing this WMP and resulting from implementation phases is improvement in water quality in the OSN tributaries and Lake Erie. The MCD and WCCD in partnership with the City of Monroe laboratory successfully executed a tributary water quality monitoring program for this project. An important action identified in this WMP to occur during all three phases is continuation of a monitoring program to both confirm past monitoring results of potential elevated source areas and to serve as a measure of progress resulting from implementation activities. Table 23 describes the locations, parameters, analyses, frequency of sampling, and responsible parties for completing this monitoring. Water quality improvement progress will be made by comparing *E. coli,* TP, TSS, and DO concentration measurements against Water Quality Standards described earlier in this document. *E. coli* concentration measurements will be evaluated against the PBC criteria of 130 cfu/100 mL for the 30-day geomean and 300 cfu/100 mL for the single day geomean, and the TBC criteria of 1000 cfu/100 mL for the single day geomean. TP concentration measurements will be evaluated against the FWMC target of 0.09 mg/L established for the River Raisin as part of the Annex 4 process (USEPA 2018, State of Michigan 2018). DO concentration measurements for the impaired section of Paint Creek will be evaluated against the daily minimum concentration of 7 mg/L described in Michigan Administrative Code R 323.1064 Rule 64. This OSN watershed plan recommends a TSS concentration target of 30 mg/L, measured as a mean annual value from sampling that consists of both dry and wet weather flow conditions, which follows the precedence established for Plaster Creek in Kent County, Michigan (Wuycheck 2002).

In addition to the routine, annual water quality monitoring at the ten key sites, certain special monitoring programs conducted by EGLE should be considered for sites in the OSN watershed to evaluate improvements in other water quality related variables. This may include using the EGLE Water Resources Division (WRD) annual process of soliciting Targeted Monitoring Requests for surface water quality monitoring. EGLE has conducted sampling in the OSN watershed at 5-year intervals (2012, 2017, and 2022) to evaluate biological, chemical, and physical habitat conditions such as macroinvertebrate and habitat evaluations. The City of Monroe also conducts weekly *E. coli* sampling at two beaches, one of which (Sterling State Park) is in the OSN watershed boundaries and may be influenced by runoff from Sandy Creek or Stony Creek. This sampling should continue and may help indicate local problems or if long-term improvements are made in terms of reducing beach closures or advisories resulting from implementation actions in the OSN watershed.

Table 23. Water quality monitoring plan details.

Location(s)	Parameters	Type of Analysis	Protocol	Frequency	Responsible Party
OSN-1 through OSN-10	Total Phosphorus	4500-P E	See QAPP (LimnoTech 2022)	5 times/year (May-Sep)	MCD, WCCD, City of Monroe
	E. coli	9223B / Colilert 18			
Stony Creek at Telegraph (10T), other targeted sites	*Biology*	*Benthic macroinvertebrates*	P51	5-year interval	EGLE WRD
Sterling State Park (Sandy Creek confluence)	*E. coli*	9223B / Colilert 18	City of Monroe lab SOPs	Weekly (June-Sep)	City of Monroe
Upper Paint Creek at Textile Road and upstream	TSS, DO, *E. coli*	2540D (TSS), DO sonde, NPEC-LO (*E. coli*)	EGLE state lab protocols	Weekly (June-Sep)	EGLE WRD

7.2.3 BMP adoption monitoring

Monitoring or tracking of agricultural BMP adoption will be another measure of progress toward the milestones established in this WMP. The State of Michigan in its 2023 update to the domestic action plan for reducing phosphorus loading to Lake Erie has committed to improved tracking of conservation practices through a MAEAP database and an enhanced Great Lakes Watershed Management System (GLWMS) that will incorporate information collected during the agricultural inventory process and possibly remote sensing of agricultural conservation measures (State of Michigan 2024). In addition to information compiled by the MCD and WCCD during future implementation funding cycles specific to the OSN watershed, these two resources will be used to monitor progress of agricultural BMP adoption.

7.3 Public Participation

Public participation in this WMP development process included involving representatives from various local governments, public works staff, and citizens in the agricultural community. A steering committee was formed during the initial stages of the project, and regular meetings were held allowing for both virtual and in-person participation. Representatives from over 15 groups were invited to participate in the steering committee; townships, villages, cities, health departments, and drain commissions. The use of two surveys was another form of seeking public input during the WMP development. One survey sought to gather information from agricultural producers and landowners, and another survey solicited feedback from municipal leaders. Additionally, several special meetings were held where individuals from different focus areas met with the project team to discuss water quality issues, any high priority areas for them, and any concerns they had. Three of these focus groups were convened: one with the county health departments, one with county drain offices, and one with area farmers. Finally, information was shared about the WMP with the broader public via a news release and articles in annual conservation district reports.

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APPENDIX A: WATER QUALITY RESULTS

Table A-1: Full *E. coli* sampling results for the 2022-2023 monitoring program (all values have units of #/100 mL)

Site No.	OSN-1	OSN-2	OSN-3	OSN-4	OSN-5	OSN-6	OSN-7	OSN-8	OSN-9	OSN-10
Site Name	Sandy at Doty	Sandy at Monroe	Little Sandy at Monroe	Sugar at Whitaker	N. Branch Swan at Grafton	Swan at Grafton	Little Swan at Telegraph	Paint at Talladay	Stony at Sumpter	Stony at Mentel
Event 1 - August 11-12, 2022 (dry)										
Center	857	341	414	663	6131	860	72	1017	204	341
Left	631	504	259	645	11199	1067	145	657	193	228
Right	613	257	488	695	8664	788	63	616	158	350
Geomean	**692**	**353**	**374**	**667**	**8410**	**898**	**87**	**744**	**184**	**301**
Event 2 - September 22, 2022 (wet)										
Center	97	145	328	393	1314	683	175	669	554	318
Left	63	336	388	465	1439	663	183	935	368	275
Right	41	110	452	452	1396	657	63	657	435	359
Geomean	**63**	**175**	**386**	**436**	**1382**	**668**	**126**	**743**	**446**	**315**
Event 3 - October 4-5, 2022 (dry)										
Center	3654	*dry*	1314	1607	*dry*	478	52	631	327	384
Left	5794	*dry*	1455	2755	*dry*	341	74	771	350	368
Right	1257	*dry*	860	2603	*dry*	422	41	809	269	345
Geomean	**2986**	**-**	**1180**	**2259**	**-**	**410**	**54**	**733**	**313**	**365**
Event 4 - June 26, 2023 (wet)										
Center	988	2723	4611	5172	4106	9208	5475	8664	1092	2489
Left	2755	3448	3255	3282	6488	7270	4611	6867	857	4106
Right	960	4352	4352	3873	5794	6131	9208	7701	789	4611
Geomean	**1377**	**3444**	**4027**	**4036**	**5364**	**7432**	**6149**	**7709**	**904**	**3612**
Event 5 - July 27, 2023 (wet)										
Center	5475	5794	8664	9804	14136	12997	8664	17329	4106	1835
Left	6867	6488	8164	12997	15531	17329	12033	19863	2924	1918
Right	8164	3076	8164	8664	11199	14136	10462	24196	6131	1918
Geomean	**6746**	**4872**	**8327**	**10335**	**13497**	**14711**	**10294**	**20270**	**4191**	**1890**
Overall, five-event geometric mean										
	OSN-1	**OSN-2**	**OSN-3**	**OSN-4**	**OSN-5**	**OSN-6**	**OSN-7**	**OSN-8**	**OSN-9**	**OSN-10**
Geomean	**1039**	**1009**	**1417**	**1939**	**5386**	**1931**	**519**	**2293**	**628**	**750**

Table A-2: Full total phosphorus (TP) and dissolved ortho-phosphorus (DPO4-P) sampling results for the 2022-2023 monitoring program (all values have units of mg-P/L)

Site No.	OSN-1	OSN-2	OSN-3	OSN-4	OSN-5	OSN-6	OSN-7	OSN-8	OSN-9	OSN-10
Site Name	Sandy at Doty	Sandy at Monroe	Little Sandy at Monroe	Sugar at Whitaker	N. Branch Swan at Grafton	Swan at Grafton	Little Swan at Telegraph	Paint at Talladay	Stony at Sumpter	Stony at Mentel
Event 1 - August 11-12, 2022 (dry)										
TP	0.09	0.05	0.17	0.08	0.14	0.41	0.21	0.06	0.05	0.08
DPO4-P	<0.05	<0.05	<0.05	<0.05	<0.05	0.30	<0.05	<0.05	<0.05	<0.05
Event 2 - September 22, 2022 (wet)										
TP	0.11	0.19	0.15	0.08	0.12	1.00	0.14	0.13	0.13	0.12
DPO4-P	<0.05	0.07	<0.05	<0.05	<0.05	0.86	<0.05	<0.05	<0.05	<0.05
Event 3 - October 4-5, 2022 (dry)										
TP	0.14	dry	0.13	0.09	dry	0.54	0.13	0.07	<0.05	<0.05
DPO4-P	<0.05	dry	<0.05	<0.05	dry	0.48	0.05	<0.05	0.11	0.06
Event 4 - June 26, 2023 (wet)										
TP	<0.05	<0.05	0.21	0.10	0.12	0.18	0.20	0.12	0.16	0.11
DPO4-P	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.09	<0.05	<0.05	<0.05
Event 5 - July 27, 2023 (wet)										
TP	0.13	0.05	0.08	0.27	0.14	0.43	0.33	0.18	0.08	0.09
DPO4-P	0.13	<0.05	<0.05	<0.05	0.06	0.10	0.12	<0.05	<0.05	0.06
Overall, five-event arithmetic mean										
	OSN-1	**OSN-2**	**OSN-3**	**OSN-4**	**OSN-5**	**OSN-6**	**OSN-7**	**OSN-8**	**OSN-9**	**OSN-10**
TP average	**0.10**	**0.09**	**0.15**	**0.12**	**0.13**	**0.51**	**0.20**	**0.11**	**0.09**	**0.09**
Overall, five-event flow-weighted mean concentration (FWMC), estimated using streamflow from nearby USGS gages										
	OSN-1	**OSN-2**	**OSN-3**	**OSN-4**	**OSN-5**	**OSN-6**	**OSN-7**	**OSN-8**	**OSN-9**	**OSN-10**
TP FWMC	**0.10**	**0.05**	**0.14**	**0.19**	**0.13**	**0.35**	**0.27**	**0.15**	**0.11**	**0.10**

Table A-3: Bacteroides (B. theta) human specific marker sampling results for the 2022-2023 monitoring program

MSU ID	Sample ID	Filtered Volume (mL)[a]	DNA Extraction Date	DNA Concentration in Extract [c] (ng/µl)	ddPCR Processed Date[d]	*Bacteroides* (B.theta) human specific marker Arithmetic Average Gene Copies / 100ml
LM 23-1	OSN-1 8/12/22	100 [b]	7/14/23	13.4	7/17/23	ND [e]
LM 23-2	OSN-2 8/11/22	100 [b]	7/14/23	11.4	7/17/23	ND [e]
LM 23-3	OSN-4 8/12/22	100 [b]	7/14/23	9.5	7/17/23	ND [e]
LM 23-4	OSN-5 8/11/22	100 [b]	7/14/23	25.6	7/17/23	ND [e]
LM 23-5	OSN-6 8/11/22	100 [b]	7/14/23	23.3	7/17/23	4.72×10^2
LM 23-6	OSN-8 8/12/22	100 [b]	7/14/23	11.6	7/17/23	1.19×10^3
LM 23-7	OSN-5 9/22/22	100 [b]	7/14/23	28.3	7/17/23	ND [e]
LM 23-8	OSN-6 9/22/22	100 [b]	7/14/23	9.1	7/17/23	7.47×10^2
LM 23-9	OSN-7 9/22/22	100 [b]	7/14/23	18.3	7/17/23	ND [e]
LM 23-10	OSN-8 9/22/22	100 [b]	7/14/23	13.7	7/17/23	ND [e]
LM 23-11	OSN-9 9/22/22	100 [b]	7/14/23	19.9	7/17/23	ND [e]
LM 23-12	OSN-1 10/5/22	100 [b]	7/14/23	9.6	7/17/23	ND [e]
LM 23-13	OSN-3 10/5/22	100 [b]	7/14/23	10.8	7/17/23	ND [e]
LM 23-14	OSN-4 10/4/22	100 [b]	7/14/23	5.1	7/17/23	ND [e]
LM 23-15	OSN-10 10/4/22	100 [b]	7/14/23	6.2	7/17/23	ND [e]
LM 23-16	OSN-1 6/26/23	100 [b]	7/14/23	14.0	7/17/23	ND [e]
LM 23-17	OSN-2 6/26/23	100 [b]	7/14/23	6.2	7/17/23	ND [e]
LM 23-18	OSN-3 6/26/23	100 [b]	7/14/23	14.2	7/17/23	ND [e]
LM 23-19	OSN-4 6/26/23	100 [b]	7/14/23	14.5	7/17/23	ND [e]
LM 23-20	OSN-5 6/26/23	100 [b]	7/14/23	10.5	7/17/23	ND [e]
LM 23-21	OSN-6 6/26/23	100 [b]	7/14/23	20.5	7/17/23	6.53×10^2
LM 23-22	OSN-7 6/26/23	100 [b]	7/14/23	32.5	7/17/23	ND [e]
LM 23-23	OSN-8 6/26/23	100 [b]	7/14/23	39.7	7/17/23	ND [e]
LM 23-24	OSN-9 6/26/23	100 [b]	7/14/23	31.5	7/17/23	ND [e]
LM 23-25	OSN-10 6/26/23	100 [b]	7/14/23	20.5	7/17/23	ND [e]

[a] Total sample volume used for DNA extraction
[b] Volume filtered for analysis
[c] Bead Beating DNA Extraction Method
[d] After DNA extraction, DNA is frozen at -20°C to -80°C until processed by ddPCR
[e] ND: Non-detect; Sample concentration was below the Lower limit of detection (LDL) of 354 GC/ 100ml for 100ml sample filtrations, below 177 GC/ 100ml for 200ml sample filtrations, or below 118 GC/ 100ml for 300ml sample filtrations.

Table A-4: Bacteroides bovine specific marker sampling results for the 2022-2023 monitoring program

MSU ID	Sample ID	Filtered Volume (mL)[a]	DNA Extraction Date	DNA Concentration in Extract [c] (ng/µl)	ddPCR Processed Date[d]	Bovine (CowM2) specific marker Arithmetic Average Gene Copies / 100ml
LM 23-1	OSN-1 8/12/22	100 [b]	7/14/23	13.4	7/17/23	ND [e]
LM 23-2	OSN-2 8/11/22	100 [b]	7/14/23	11.4	7/17/23	ND [e]
LM 23-3	OSN-4 8/12/22	100 [b]	7/14/23	9.5	7/17/23	ND [e]
LM 23-4	OSN-5 8/11/22	100 [b]	7/14/23	25.6	7/17/23	ND [e]
LM 23-5	OSN-6 8/11/22	100 [b]	7/14/23	23.3	7/17/23	ND [e]
LM 23-6	OSN-8 8/12/22	100 [b]	7/14/23	11.6	7/17/23	ND [e]
LM 23-7	OSN-5 9/22/22	100 [b]	7/14/23	28.3	7/17/23	3.85×10^2
LM 23-8	OSN-6 9/22/22	100 [b]	7/14/23	9.1	7/17/23	ND [e]
LM 23-9	OSN-7 9/22/22	100 [b]	7/14/23	18.3	7/17/23	ND [e]
LM 23-10	OSN-8 9/22/22	100 [b]	7/14/23	13.7	7/17/23	ND [e]
LM 23-11	OSN-9 9/22/22	100 [b]	7/14/23	19.9	7/17/23	ND [e]
LM 23-12	OSN-1 10/5/22	100 [b]	7/14/23	9.6	7/17/23	ND [e]
LM 23-13	OSN-3 10/5/22	100 [b]	7/14/23	10.8	7/17/23	ND [e]
LM 23-14	OSN-4 10/4/22	100 [b]	7/14/23	5.1	7/17/23	ND [e]
LM 23-15	OSN-10 10/4/22	100 [b]	7/14/23	6.2	7/17/23	ND [e]
LM 23-16	OSN-1 6/26/23	100 [b]	7/14/23	14.0	7/17/23	ND [e]
LM 23-17	OSN-2 6/26/23	100 [b]	7/14/23	6.2	7/17/23	ND [e]
LM 23-18	OSN-3 6/26/23	100 [b]	7/14/23	14.2	7/17/23	ND [e]
LM 23-19	OSN-4 6/26/23	100 [b]	7/14/23	14.5	7/17/23	ND [e]
LM 23-20	OSN-5 6/26/23	100 [b]	7/14/23	10.5	7/17/23	ND [e]
LM 23-21	OSN-6 6/26/23	100 [b]	7/14/23	20.5	7/17/23	ND [e]
LM 23-22	OSN-7 6/26/23	100 [b]	7/14/23	32.5	7/17/23	ND [e]
LM 23-23	OSN-8 6/26/23	100 [b]	7/14/23	39.7	7/17/23	ND [e]
LM 23-24	OSN-9 6/26/23	100 [b]	7/14/23	31.5	7/17/23	ND [e]
LM 23-25	OSN-10 6/26/23	100 [b]	7/14/23	20.5	7/17/23	3.85×10^2

[a] Total sample volume used for DNA extraction

[b] Volume filtered for analysis

[c] Bead Beating DNA Extraction Method

[d] After DNA extraction, DNA is frozen at -20°C to -80°C until processed by ddPCR

[e] ND: Non-detect; Sample concentration was below the Lower limit of detection (LDL) of 354 GC/ 100ml for 100ml sample filtrations, below 177 GC/ 100ml for 200ml sample filtrations, or below 118 GC/ 100ml for 300ml sample filtrations.

APPENDIX B: SUPPLEMENTAL MAPS

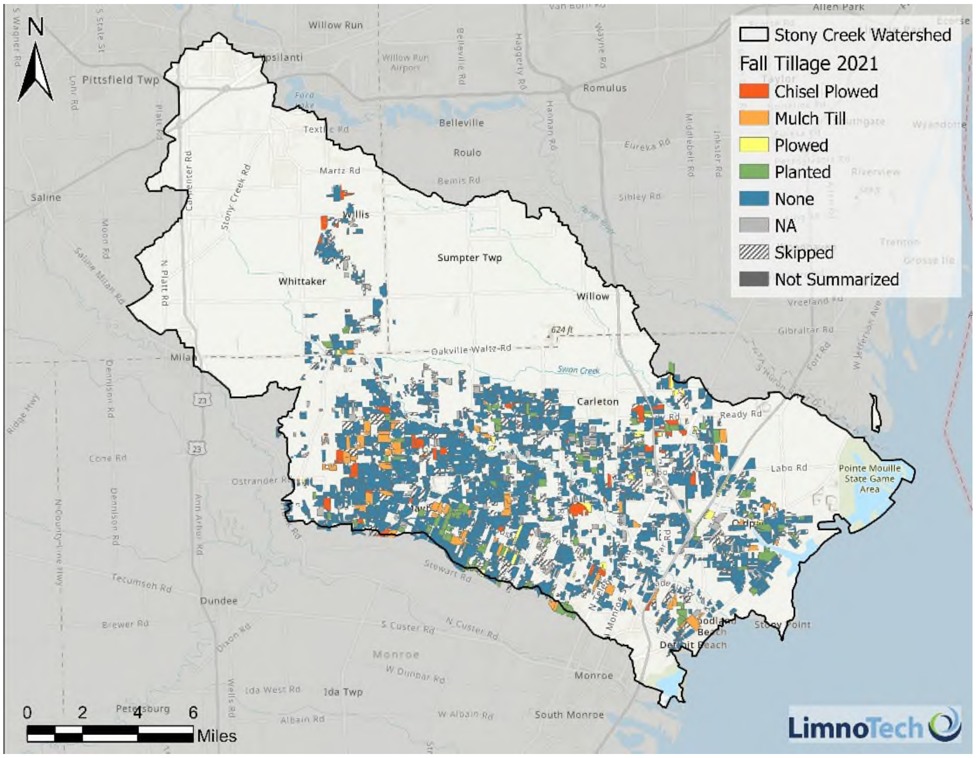


Figure B-1: Agricultural inventory windshield survey results for Fall Tillage 2021-22.

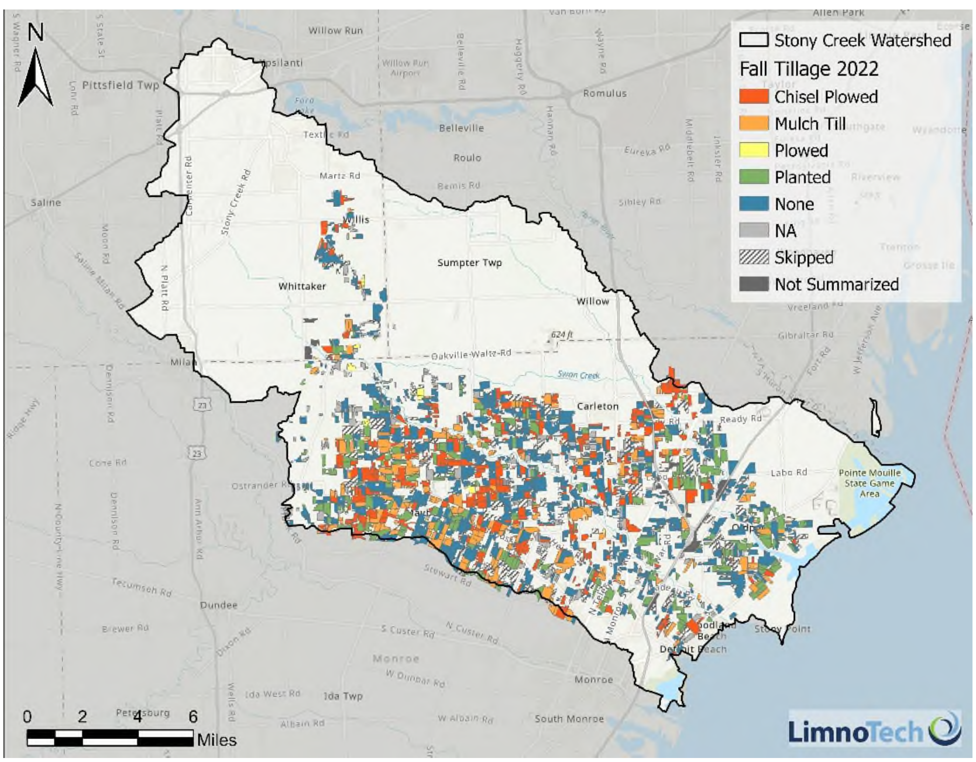


Figure B-2: Agricultural inventory windshield survey results for Fall Tillage 2022-23.

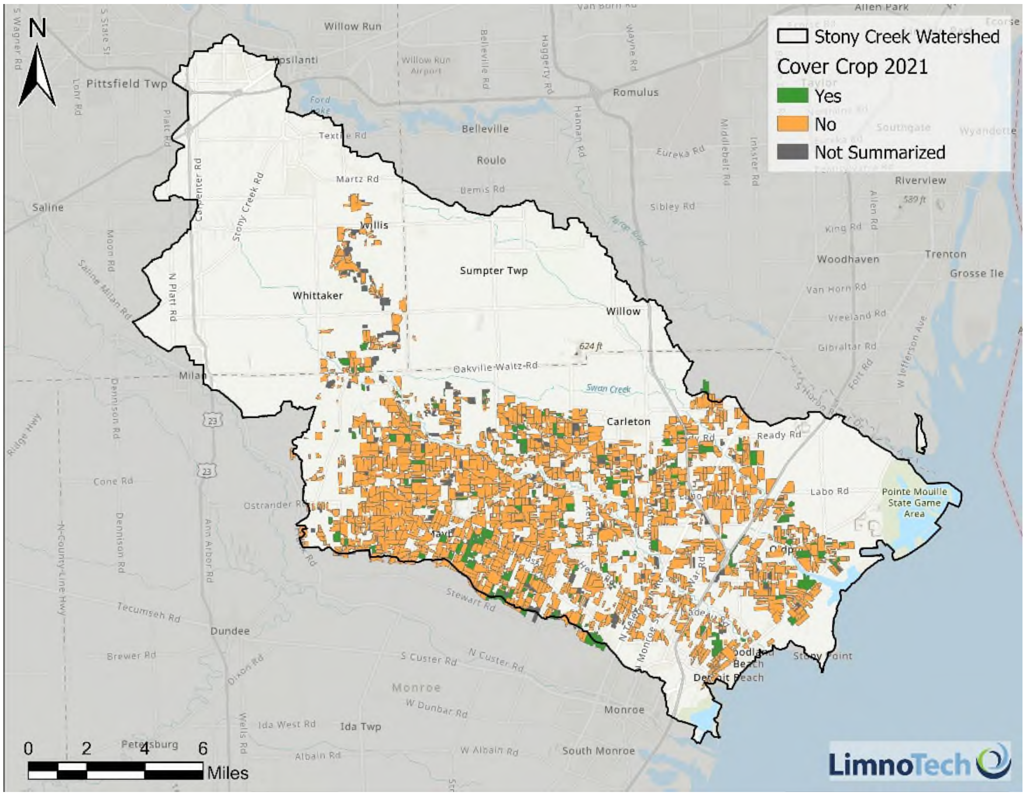


Figure B-3: Agricultural inventory windshield survey results for Cover Crop 2021-22.

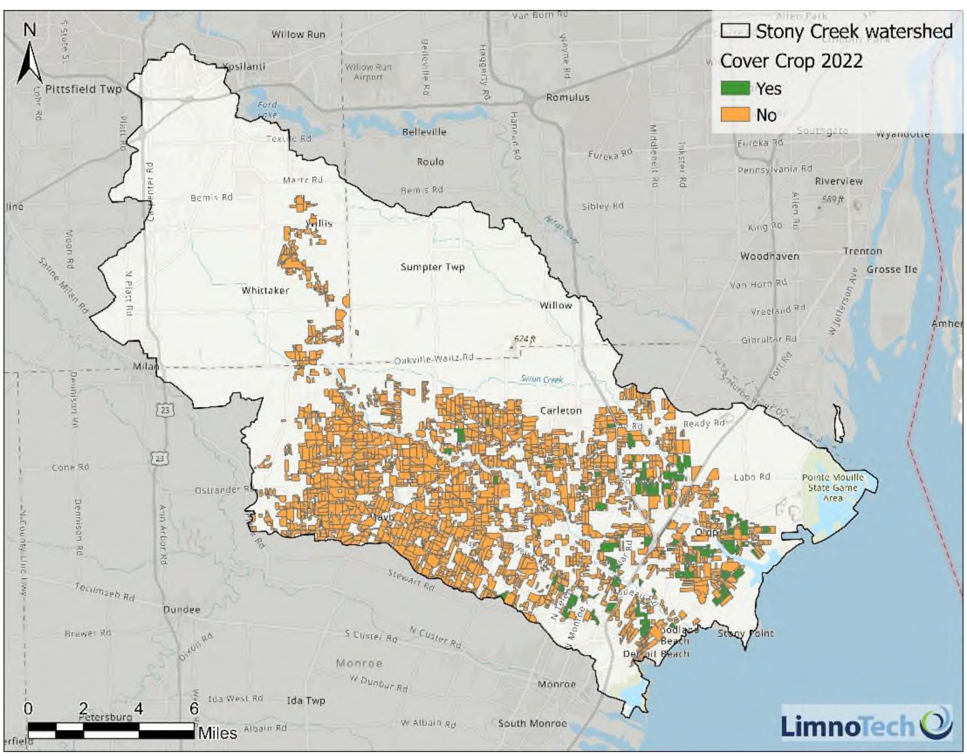


Figure B-4: Agricultural inventory windshield survey results for Cover Crop 2022-23.

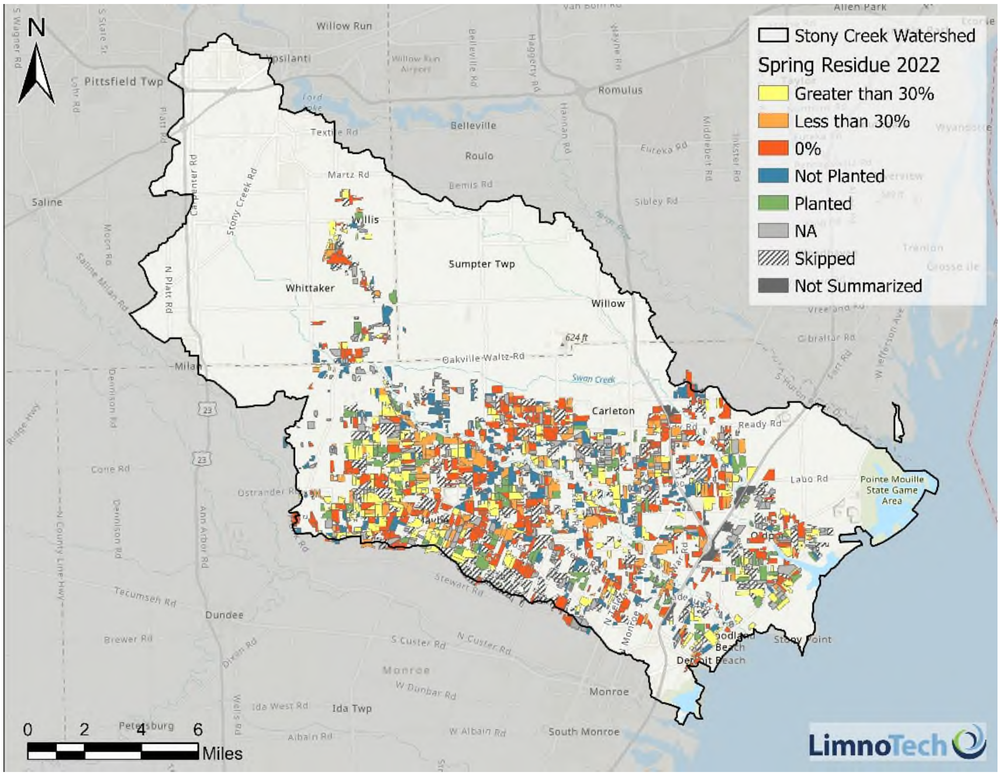


Figure B-5: Agricultural inventory windshield survey results for Spring Residue 2022.

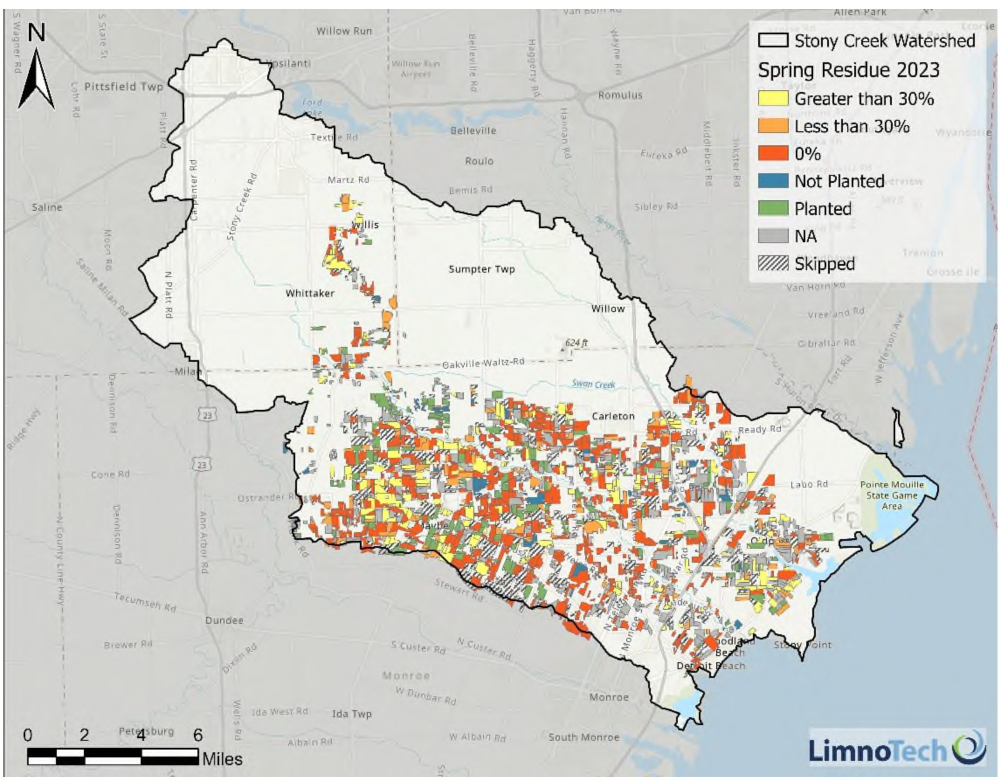


Figure B-6: Agricultural inventory windshield survey results for Spring Residue 2023.

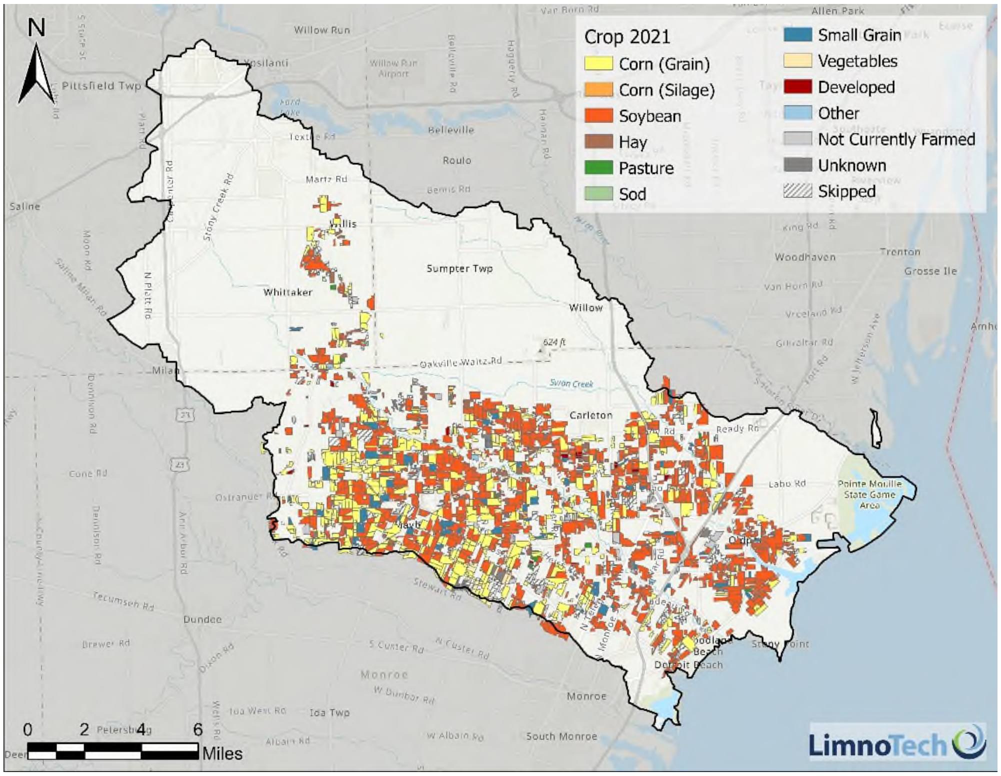


Figure B-7: Agricultural inventory windshield survey results for Crop Grown 2021.

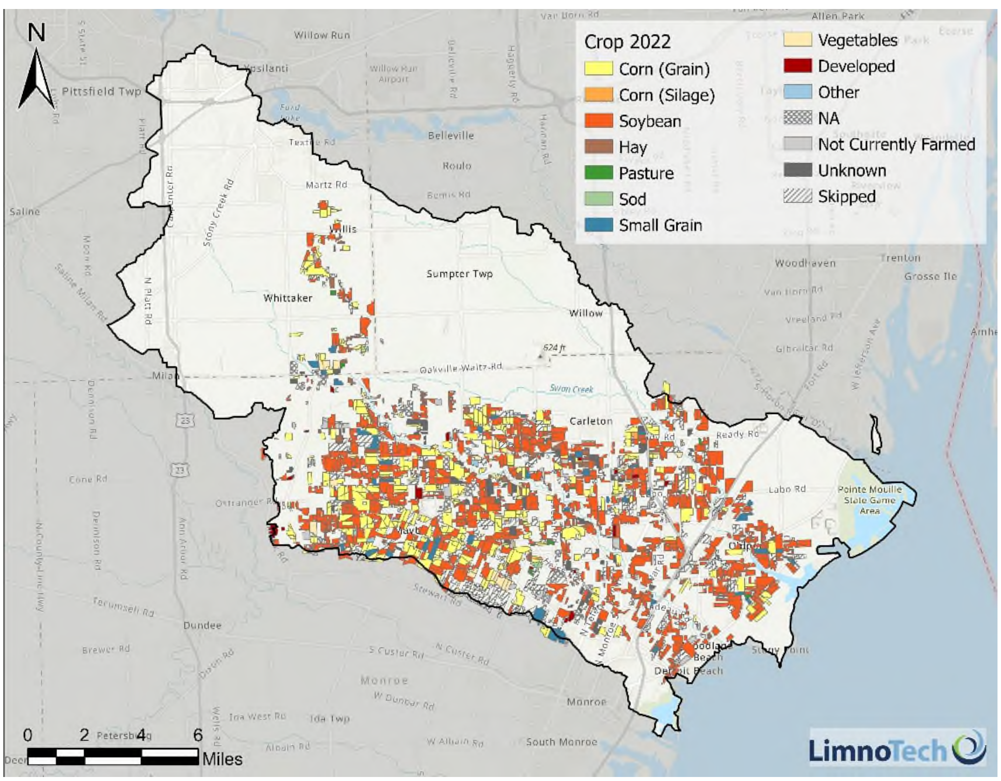


Figure B-8: Agricultural inventory windshield survey results for Crop Grown 2022.

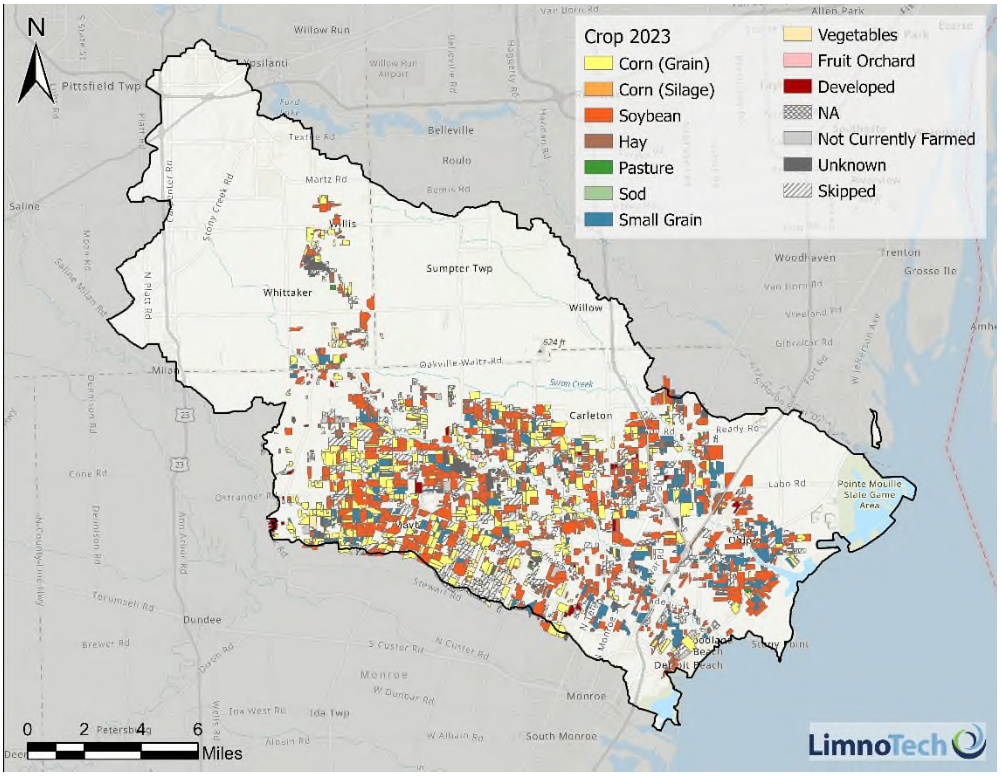


Figure B-9: Agricultural inventory windshield survey results for Crop Grown 2023.

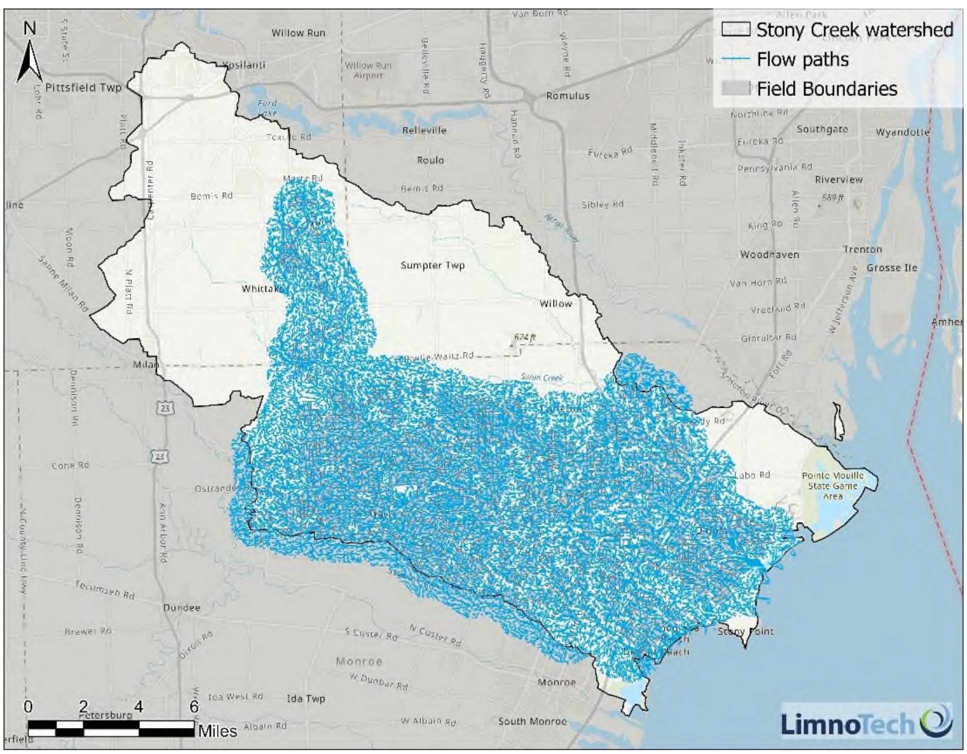


Figure B-10: Flow paths derived from ACPF.

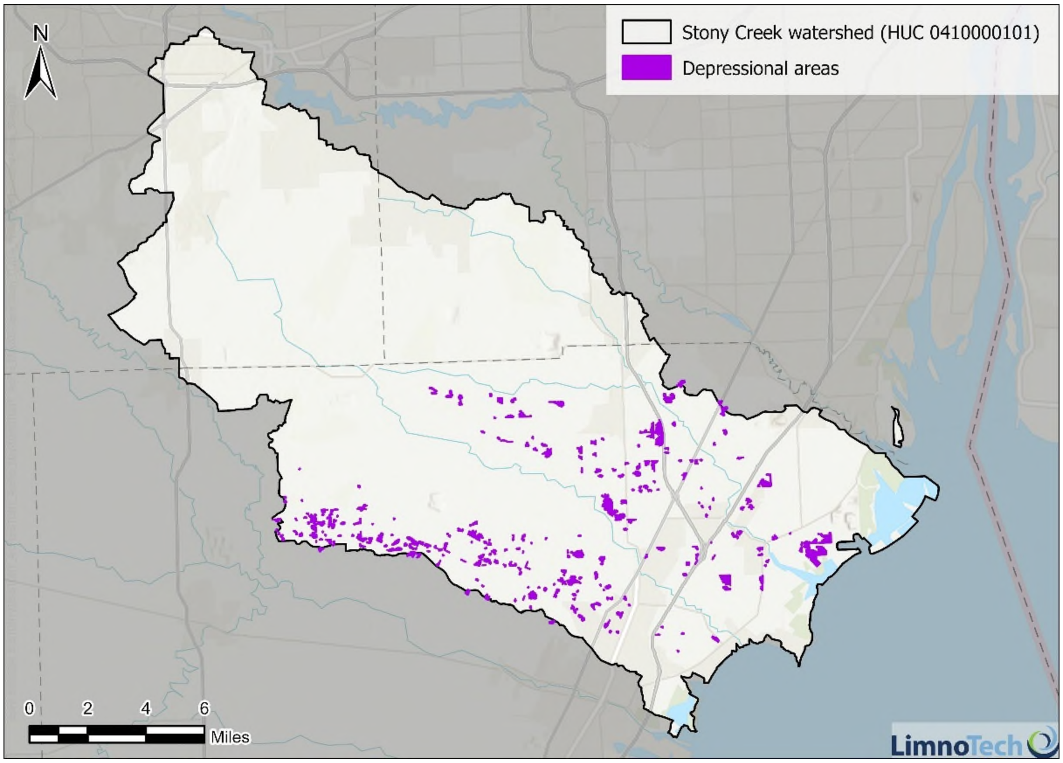


Figure B-11: Depressional areas derived from ACPF.

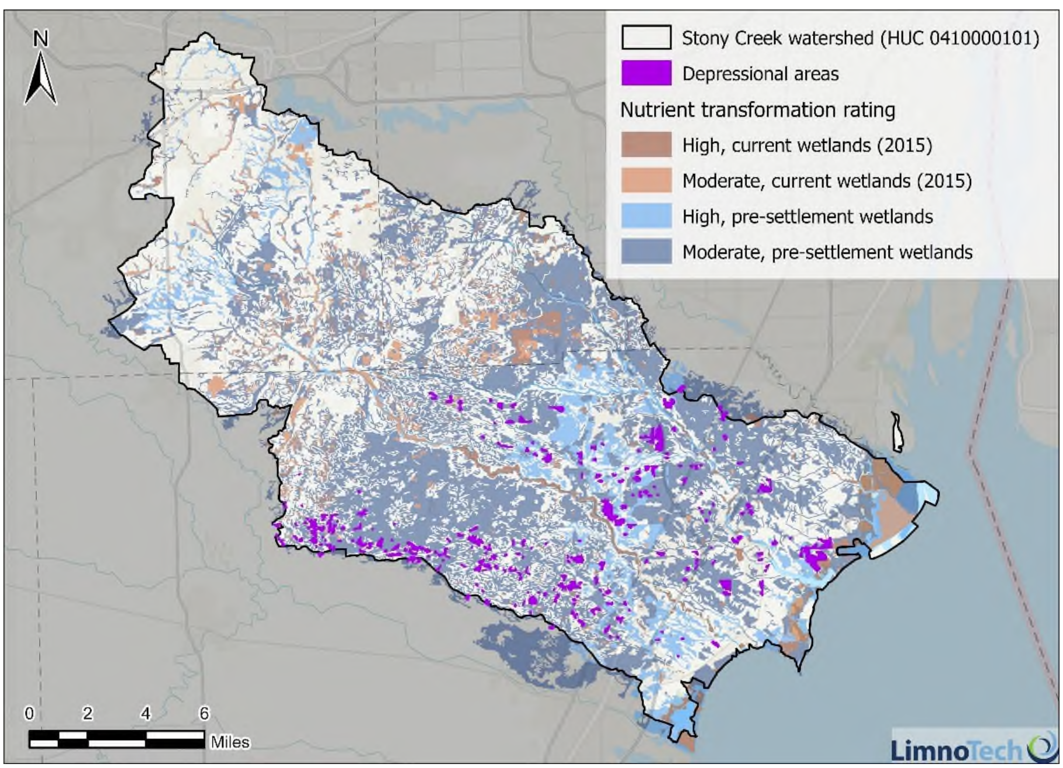


Figure B-12: Depiction of depressional areas on LLWFA results for moderate and high rated nutrient transformation wetlands, both current and pre-settlement.

APPENDIX C: USGS STREAMFLOW

Figure C-1: Screenshot of USGS streamflow gages near the OSN watershed (approximate watershed area).

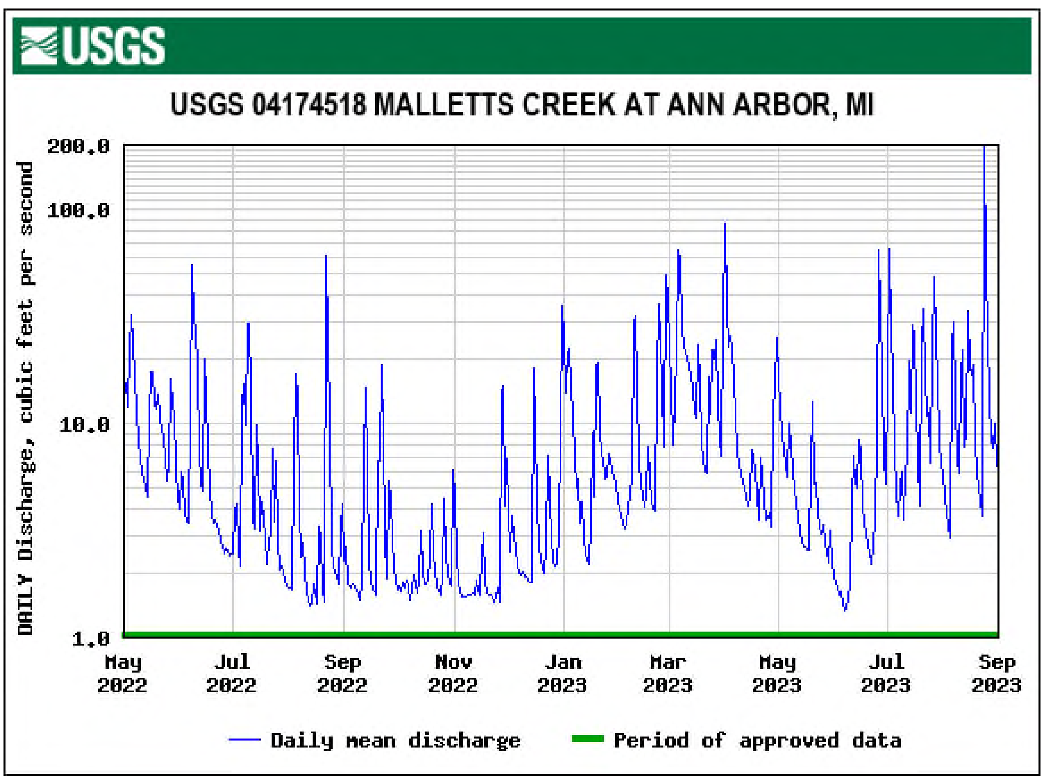


Figure C-2: Daily average streamflow for the Mallets Creek at Ann Arbor USGS gage.

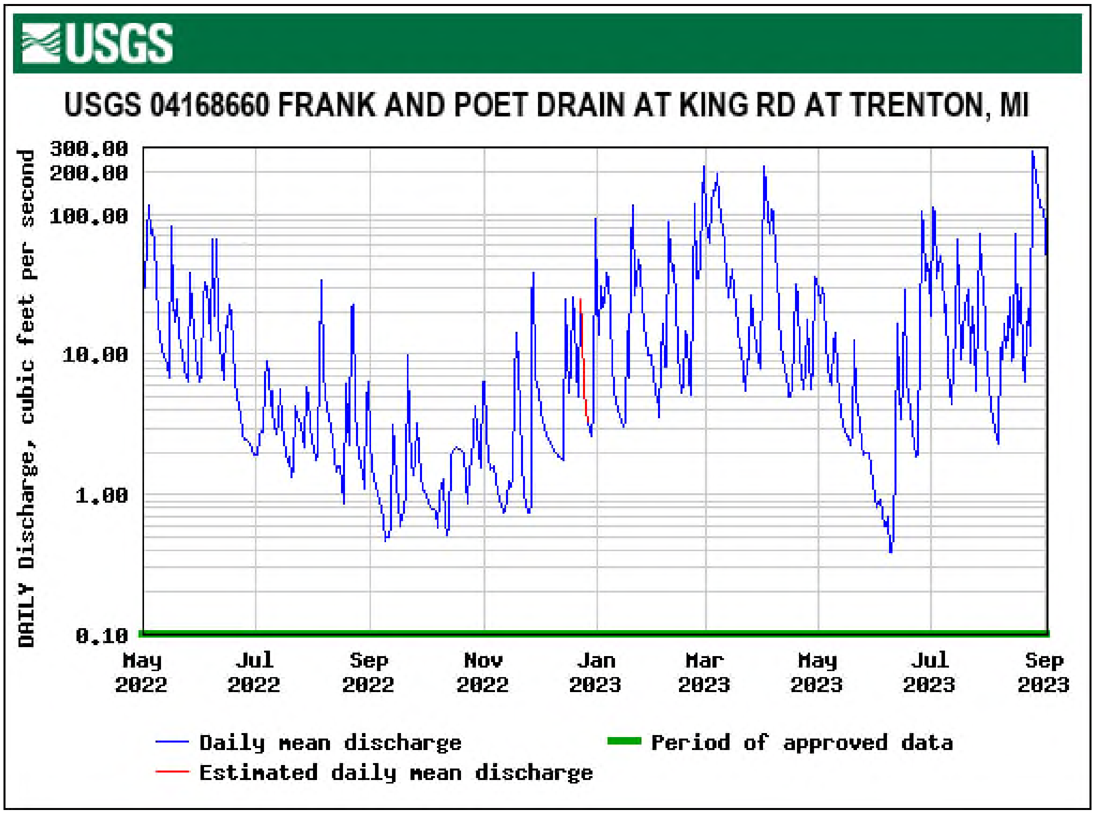


Figure C-3: Daily average streamflow for the Frank & Poet Drain at Trenton, MI USGS gage.

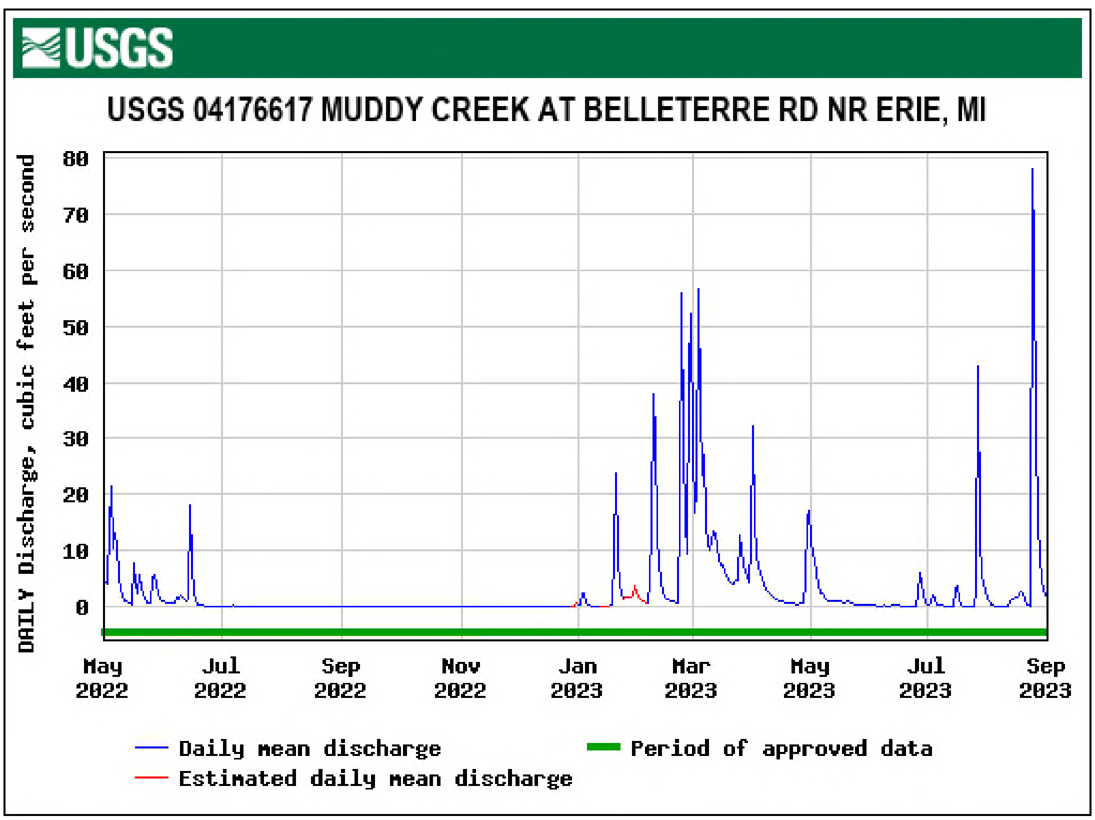


Figure C-4: Daily average streamflow for the Muddy Creek at Erie, MI USGS gage.

APPENDIX D: STEPL MODELING

Table D-1: Detailed breakdown of STEPL estimated TP and sediment load reductions by management action.

Management Actions	TP Load Reduction (lbs/year)	Sediment Load Reduction (tons/year)
No-till and conservation tillage	15,100	3,120
Cover crops	480	130
Comprehensive nutrient management	9,270	0
Drainage water management	190	0
Riparian filter strip	5,970	1,350
Nutrient removal wetlands	380	200
Cropland retirement	110	20
Grassed waterways	80	20
Streambank erosion stabilization	185	48.2
Gully and stream crossing erosion stabilization	136	35.4
Total	**31,901**	**4,924**

Table D-2. Gully, stream crossing, and streambank erosion observations from Little Sandy Creek and Paint Creek streamwalk for which sediment and TP loads could be quantified.

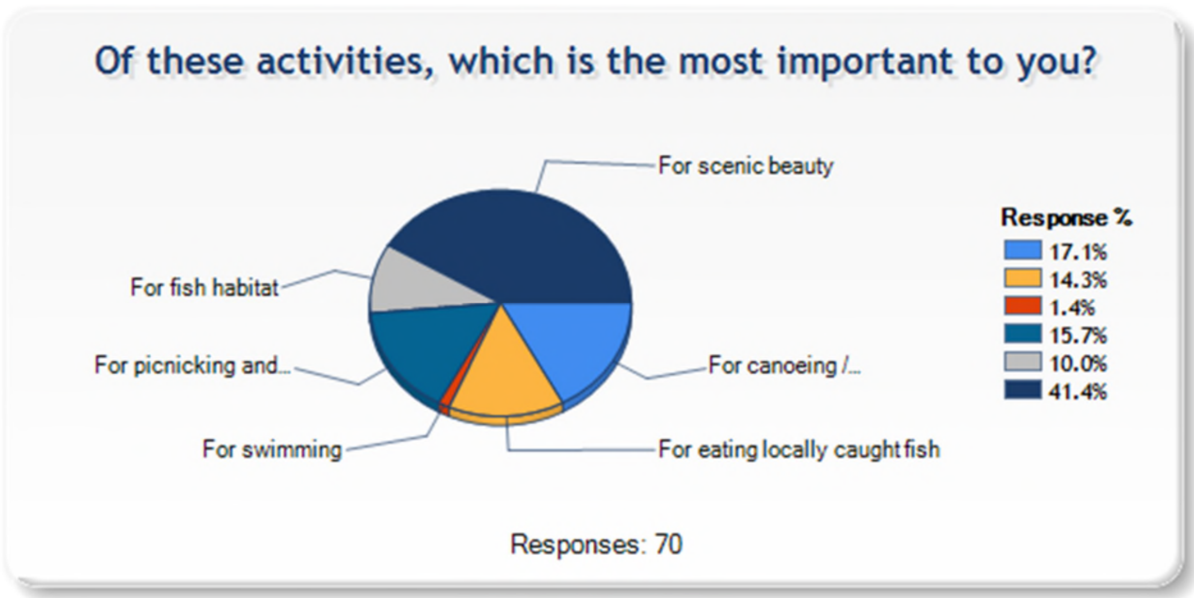
Identifier (Stream + Point)	Erosion Type	Soil Texture	Years to Form	Top Width (feet)	Bottom Width (feet)	Depth (feet)	Length (feet)	Sediment Load (tons/year)	TP Load (lbs/year)	Priority
Little Sandy - 80	Gully	Silt	2	5	1.5	3	46.4	11.9	45.6	High
Little Sandy - 82		Silt	2	3.5	6.3	1.5	51.3	9.9	38.0	High
Little Sandy - 81		Silt	2	4.5	4	2	21.4	4.8	18.3	High
Little Sandy - 98		Silt	5	1	13	0.5	90	3.3	12.7	Medium
Little Sandy - 9		Clay	2	1	5.6	1.3	27	2.0	7.8	Medium
Little Sandy - 7		Clay	5	1	3	2.5	14	0.5	1.9	Low
Little Sandy - 70		Silt	5	0.9	3.2	1.7	12.6	0.5	1.8	Low
Little Sandy - 12		Clay	10	1.2	3.1	1.8	10.8	0.1	0.6	Low
Little Sandy - 74		Organic	3	2	3	1	8	0.1	0.3	Low
Paint - 1 (left)	Stream Crossing	Sandy clay	5	7	0.2	5	6	1.0	3.7	Low
Paint - 1 (right)		Sandy clay	5	9	0.2	1.8	5	0.4	1.4	Low
Paint - 32		Sandy clay	5	5	2	2	2.8	0.2	0.7	Low
Little Sandy - 77		Organic	5	8.5	9.5	2.4	15	0.7	2.7	Low
Little Sandy - 1		Organic	5	4.5	5	0.5	9	0.0	0.2	Low
Little Sandy - 76		Organic	5	1.8	3	0.5	12.3	0.0	0.1	Low
Little Sandy - 11		Organic	5	2.6	3	0.5	5.6	0.0	0.1	Low
Little Sandy - 83		Organic	2	0.8	0.5	1	4.2	0.0	0.1	Low

Identifier (Stream + Point)	Erosion Type	Soil Texture	Severity	Height (feet)	Length (feet)	Sediment Load (tons/year)	TP Load (lbs/year)	Priority
Little Sandy - 79	Streambank	Silt Loam	Very Severe	5	13	1.4	5.3	Medium
Little Sandy - 71	Streambank	Silt Loam	Very Severe	3.8	13	1.0	4.0	Low
Little Sandy - 16	Streambank	Clay	Moderate	4.8	22.6	0.5	1.9	Low
Little Sandy - 75	Streambank	Silt Loam	Severe	1.3	11	0.2	0.9	Low
Paint - 25	Streambank	Silt Loam	Very Severe	6	98	12.5	48.0	High
Paint - 16	Streambank	Silt Loam	Very Severe	4	67	5.7	21.9	High
Paint - 13	Streambank	Silt Loam	Very Severe	4	58	4.9	18.9	High
Paint - 11	Streambank	Silt Loam	Severe	3.6	72	4.4	16.9	High
Paint - 3	Streambank	Silt Loam	Very Severe	4	39	3.3	12.7	Medium
Paint - 8	Streambank	Clay	Very Severe	4	42.4	3.0	11.4	Medium
Paint - 27	Streambank	Clay	Very Severe	6.5	24	2.7	10.5	Medium
Paint - 2	Streambank	Clay	Very Severe	4.4	34.9	2.7	10.3	Medium
Paint - 6	Streambank	Clay	Very Severe	3	42.9	2.3	8.6	Medium
Paint - 5	Streambank	Clay	Very Severe	2.5	34.1	1.5	5.7	Medium
Paint - 12	Streambank	Clay	Severe	4.5	15	0.9	3.6	Low
Paint - 19	Streambank	Silt Loam	Very Severe	3.5	11	0.8	3.1	Low
Paint - 4	Streambank	Clay	Severe	4.5	5.8	0.4	1.4	Low

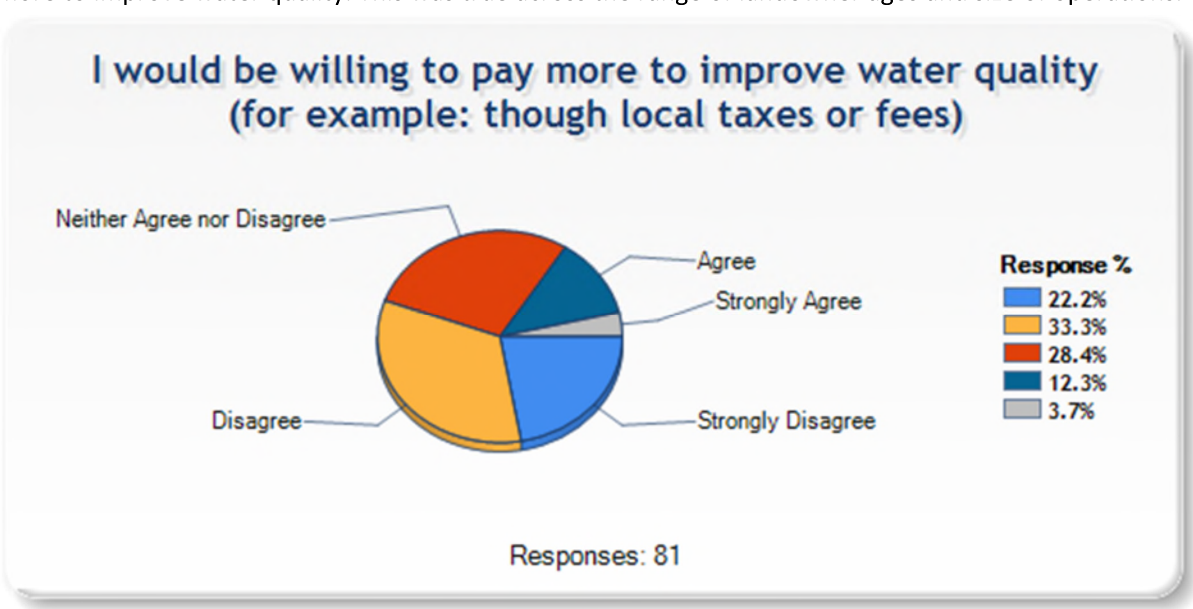
APPENDIX E: SOCIAL SURVEY RESULTS

Agricultural Owner/Operator Survey Results

The landowner survey asked a range of questions arranged by different topic areas, the first of which was general awareness regarding water quality in the watershed. Landowners were asked about water quality relating to boating, fishing, swimming, aquatic habitat, family activities, and scenic beauty. With each of these topics, landowners tended to say that the water quality in their area was "Okay" and considered "Scenic Beauty as being the most important quality.

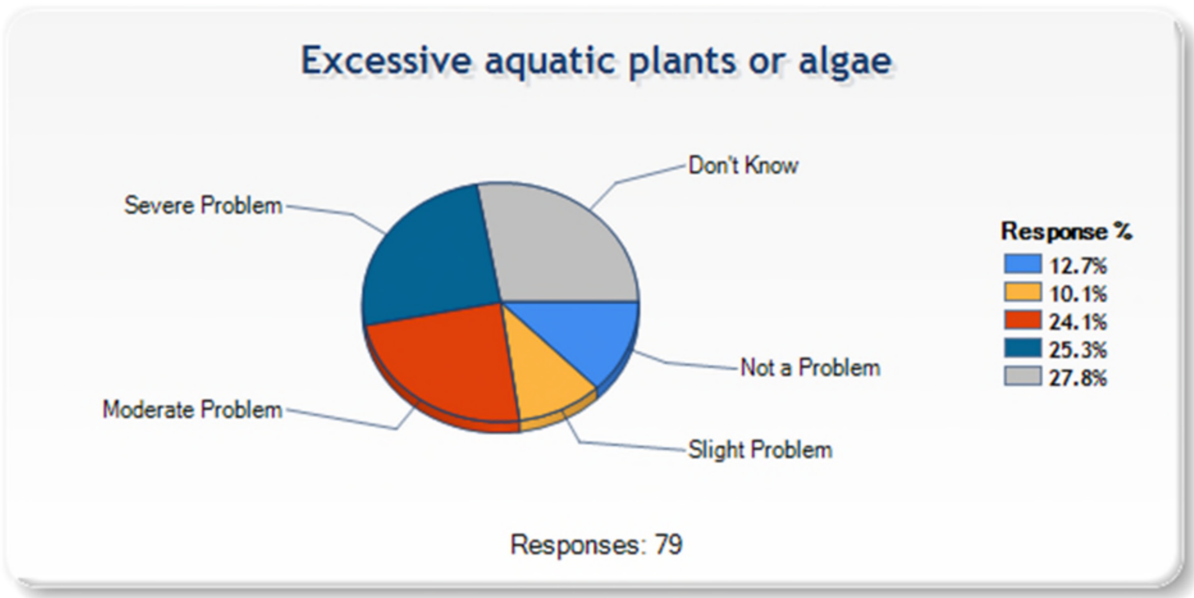


When asked about their opinions on water quality, landowners tended to agree that they had a personal responsibility to help protect water quality and that they would be willing change their farm management practices to improve water quality. However, many tended to say that they would not be willing to pay more to improve water quality. This was true across the range of landowner ages and size of operations.



Landowners tend to think that trash/debris in the water and algae in the water are the biggest water impairments facing the watershed. When it came to the topic of sedimentation, landowners farming between 500-1500 acres tend to believe that sedimentation is only a “slight problem”, while smaller farmers believed it to be more a “severe problem”. The percentage of respondents indicating they don’t know how severe impairments are within the watershed range from 20-38%.

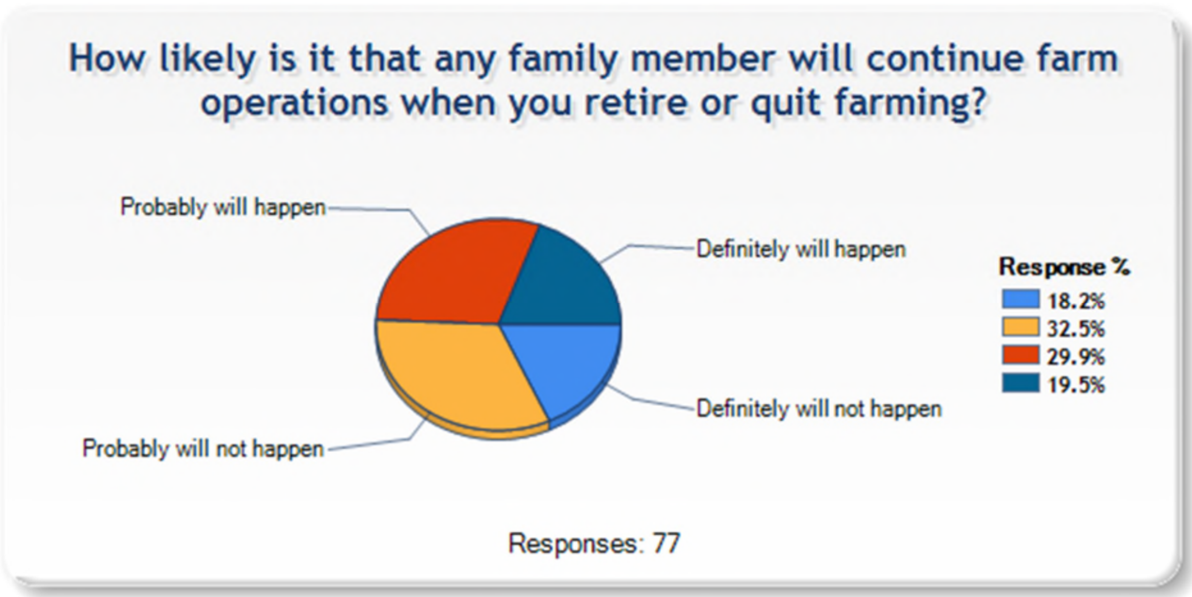
The next section asked questions regarding the source of water pollution. Overall, landowners tended to say that all the listed sources were “slight problems”. However, “Discharge from sewage treatment plants” tended to be named the most problematic source. Interestingly, “Manure from farm animals” was cited as one of the least problematic sources. When it came to the consequences of poor water quality, landowners tended to say that “excessive aquatic plants or algae” was the biggest issue in their area, and it was viewed as a “moderate problem”. Meanwhile, “Contaminated drinking water” was only viewed as a “slight problem” and in the watershed by those that participated.



Questions regarding adoption of practices that improve water quality, including barriers to implementation, were another major topic area in the landowner survey. Over 62% of respondents were familiar with regularly getting their septic system serviced. However, “cost” was viewed as the most limiting factor in implementing this practice. Regarding agricultural BMPs, landowners tended to say that they follow university recommendations for fertilization rates, maintain crop residue to reduce soil erosion, they use cover crops for erosion protection and soil improvement, and that filter strips are used on their property and were relevant (note that the size of a filter strip was not specified in the survey question).

Over 57% of respondents tended to say that they are currently using soil tests on their property, while 10% of respondents indicated knowing how to use it but were not currently using it. The most limiting factors in implementing soil testing were “cost” and “desire to keep things the way they are”. Meanwhile, 45% of respondents said that they currently use no-till practices with over 23% knowing how to use it but not using it. Over 22% were somewhat familiar with no-till but were not currently using it. Once again, the most limiting factors in implementing no-till were “cost”, “desire to keep things the way they are”, and “lack of equipment”.

The final set of questions sought to understand landowner's thoughts about the future or their operations, potential for change, and trust and handling of water quality related issues by local institutions and governments. Landowners were inclined to say that their "personal out-of-pocket expense" was the most limiting factor in making changes to their management practices. Landowners leaned to saying that they did not have a job outside of their farm and that their farm would be the same in five years' time. Regarding the future of their operation, about half of respondents tended to say that a family member would "definitely not" or "probably not" take over the farm once they retire.

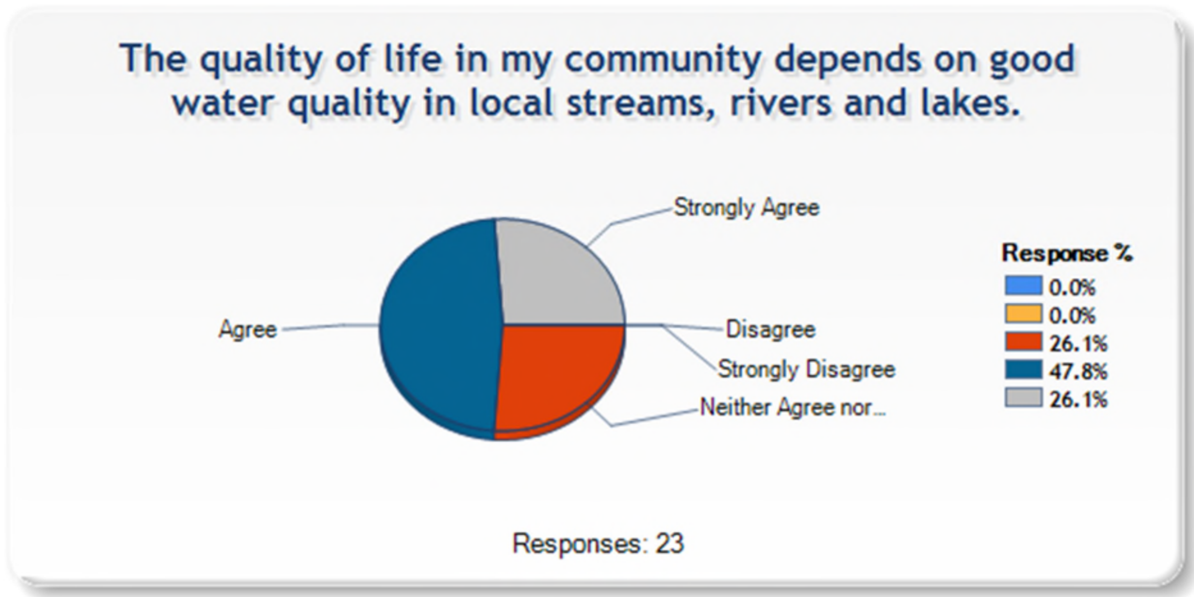


When it comes to where they get their information on soil and water conservation issues, landowners tended to trust their Soil and Water Conservation District (SWCD) the most, while local government was the least trusted. Landowners tended to say that they get their information on soil and water conservation issues from newsletters/brochures/factsheets as well a conversation with other landowners.

Municipal Survey Results

The municipal survey also asked a range of questions arranged by different topic areas, however with less of a focus on agricultural practice questions as compared to the agricultural landowner/operator survey. The respondents had an average age of 61, 68% were male, and all had completed high school with 86% having attended at least some college. Most were elected officials (59%) serving at the township level (91%).

When rating the water quality of their area, municipal leaders tended to rate their water quality as “good” for scenic beauty. It was rated “Okay” for “picnicking & family activities,” “fish habitat,” “boating,” and “eating fish” and rated “poor” for swimming. In responding to a question on severity of different pollutants, municipal leaders tended to describe the impairments as “moderate problems”, ranked in the following order of highest to lowest average: phosphorus, bacteria and viruses, toxic materials, and sedimentation. Municipal leaders tended to agree that “The quality of life in my community depends on good water quality in local streams, rivers and lakes.”



Municipal leaders tended to agree with the following statements:

- “I would support changes to our master plan and zoning ordinance to improve water quality.”
- “The economic stability of my community depends upon good water quality.”
- “Residents are personally responsible to help protect water quality.”

Municipal leaders tended to disagree with the following statements:

- “Protecting water quality is the state’s responsibility, not our local unit of government.”
- “It is okay to reduce water quality to promote economic development.”
- “What residents do on their land does not make much difference in overall water quality.”

When given a list of problems, “excessive use of lawn fertilizers and/or pesticides” received the most “severe problem” responses, though its overall average response suggested a moderate problem. The following options were also rated as a moderate problem (on average): discharge from sewage treatment plants; urban stormwater runoff; drainage/filling of wetlands; soil erosion from farm fields; droppings from geese, ducks and other waterfowl; removal of riparian vegetation; and soil erosion from shoreline or streambanks. Excessive aquatic plants or algae, reduced beauty of lakes or streams, reduced opportunities for water recreation, and contaminated fish were all rated as "moderate problems" when describing consequences of poor water quality for the communities the municipal leaders represent.

When asked about what planning or zoning practices that improve water quality ***they support individually***, municipal leaders tended to be more familiar with: minimum open space requirements for new developments; septic system restrictions; and stormwater regulations. They tended to be less familiar with keyhole regulations and rain garden requirements. Responses were similar when asked about what planning or zoning practices that improve water quality that they believe ***their community supports***, municipal leaders tended to say: minimum setbacks along lakes and streams; incorporate water quality protection statements in our master plan; and permit coordination with state and local agencies. They tended to be less familiar with rain garden requirements, keyhole regulations, and lake and stream vegetation buffer requirements. Regarding mechanisms for making a change on personal property, municipal leaders tended to say the following were the biggest factors to consider: legal restrictions; no communities we know are implementing the practice; lack of need for additional regulations in our community; and approval by residents of my community.

When asked specifically about regulations regarding septic systems, municipal leaders responded:

- There should NOT be ordinances requiring inspections at set times (e.g., every 5 years) (50% No).
- There should be an inspection of septic systems prior to the selling of a residence (83.3% Yes).
- A local government agency should handle inspection and maintenance of septic systems (47.8% Yes).
- Local governments should NOT offer financial assistance to replace failed septic systems (47.8%).
- They do NOT believe there is support for septic system regulations/ordinances in their area (45.5% NO).

The last category of topics surveyed respondents regarding sources of information. Municipal leaders said they seek information about water quality issues from: newsletters (80%), internet (70%), workshops-demonstrations-meetings (70%), conversations with others (60%), and newspapers-magazines (30%). When asked about different groups of people that serve as a source of information about water quality, municipal leaders tended to say planning consultants (rated "moderately", though "very much" received 52.4% of the vote), followed by municipal attorneys and Michigan Department of Environmental Quality (EGLE) (both rated "moderately" on average). The following tended to be the least sought out: county planning department, planning officials like me in other communities, and U.S. Environmental Protection Agency.

APPENDIX F: FOCUS GROUP NOTES

Farmer Focus Group – Meeting Notes

- Area farmers were called and asked if they would like to participate in a focus group.
    - Four (4) farmers attended a meeting on September 19, 2023, at an OSN watershed farm.
- Summary of topics discussed, and opinions shared by the attendees:
    - Flooding – ditches/creeks not being cleaned or being blocked up
        - Farmers want them cleaned out so water will flow
        - They believe it will lead to less flooding on their lands and therefore less sediment being carried away and improving water quality
    - Nutrient Management Planning
        - Deviate from plan depending on circumstances such as weather
    - Soil Testing to Reduce Agriculture Nutrient Delivery (STRAND) program
        - Very popular with farmers. Effective.
        - Discontent with NRCS and how they roll-out programs
            - Too slow. Doesn't cover everything (cost).
            - What if Conservation Districts or another group covered the difference?
    - Soil Sampling
        - Lack of staff at co-op seen as an issue because soil sampling isn't always completed
    - Yield vs. Bottom Line
        - The participants in the group focus on their bottom line rather than crop yield.
        - They see that they can make profit even with a yield loss in some cases.
        - Recognize that there are many (peer farmers) who still focus on yield, however.
            - Expressed the need for an economic case study to get producers away from the yield mindset.
            - MSU has been unreliable in recent years and the group does not believe that they could be relied upon for an economic study.
    - Program Promotion
        - Should be a priority
            - If a tech called and explained that they had funds available, the farmer would be open to listening.
        - Email is a poplar way of communication for the attendees, but this contradicts technician experience and Landowner Survey results
        - Would farmers engage in a newsletter?
            - Yes, for example, those that subscribe to it read Farm Bureau's newsletter.
        - Other ways to promote
            - USDA (FSA counter)
            - Michigan Farm News
            - Facebook

County Drain Commissioner Focus Group – Meeting Notes

- County Drain Commissioner Offices were asked to participate in a focus group
    - Three (3) representatives, one each from the Monroe County, Wayne County, and Washtenaw County drain commissioner offices, attended a meeting on June 13, 2023.
    - A follow-up email was sent a few weeks after the meeting asking about needs and wants, but no responses were received from the participants.
- Summary of topics discussed, and opinions shared by the attendees:
    - Pollution Source Assessment
    - Regulations/Permitting
        - Disturbing the soil needs a permit.
        - No permit issued for drain tiles. Technically they can, but there is no enforcement.
    - Sedimentation Control
        - Washtenaw – tight control where development is occurring.
            - Minimal or not monitoring in rural areas.
        - Wayne – if there is an issue, an engineer will make note of it.
    - How often are drains cleaned?
        - Some are continuously cleaned.
        - Others are more difficult to do.
        - Not enough maintenance funds to service all of them or to create regional detention.
        - Can maintain to original design but any more needs permits via EGLE.
    - List of approved maintenance activities:
        - Could create a pool of funds for pre-approved activities (MDOD) that the township would pass a resolution.
        - Petitions can come from landowners.
        - If another pool of money was available under the drain code.
        - Could enter into an agreement with another private landowner/ MOU.
    - Drain Design
        - Current designs do not meet the requirements for some rain events we are seeing.
        - Do not meet projected rainfall event amounts/frequency.
    - What policies are your offices considering to regulate sedimentation (amending drain code)?
        - Suggest presenting more information at a district meeting
        - Need more funds for maintenance
    - Why do some places implement two-stage ditches, and some do not?
        - Funding? Space?
        - Would imagine it would cut down on the risk of flooding.
        - Most issues have been in the pipe networks and not in the open flow channels.
    - Are you exploring any projects in the Ottawa-Stony North watershed?
        - Upper Paint Creek – green corridor project
        - Rain Gardens
            - Have had a notable impact in Washtenaw County.
    - If money were no object, what would you do?
        - Regional detention projects (Washtenaw)
        - As you develop and redevelop, the rules will regulate how to manage
            - Can you put in regional detentions rather than individual?
            - Where is the land coming from for regional detentions?
            - Washtenaw owns 5 existing basins. Can retrofit them or expand them.
        - Stormwater capital improvement plan (Washtenaw)
            - Have a plan for future structure, so when the funding becomes available, they can jump on it.

County Health Department Focus Group – Meeting Notes

- County Health Departments were asked to participate in a focus group
    - Four (4) representatives (one from Monroe County, one from Wayne County, and two from Washtenaw County) attended a meeting on July 31, 2023.
- Summary of topics discussed, and opinions shared by the attendees:
    - Water Quality Monitoring Results were presented by the project team.
    - Septic Code and Water Quality Policies
        - Washtenaw County
            - Has a "Time of Sale" ordinance.
            - Some systems look good still after 40 years.
        - Wayne County
            - Majority of county is sewered
            - A lot of elevated beds
            - Has a time of sale ordinance
            - Old systems are their leading cause for failures
        - Monroe County
            - Does not have a time of sale ordinance
            - Staff cutting over the years
    - Bill in Michigan legislature to make inspections mandatory
        - Would remove time-of-sale / point-of-sale inspections
        - Would require more staff, which counties can't afford
            - May lead to inspections not happening at all even at the time of sale
        - Can't be enforced. Difficult to implement.
    - Technology
        - Software is behind (paper records).
        - Washtenaw County – first online payment in 2023.
    - Pumping and dumping from septic haulers?
        - Washtenaw County – had a case a decade ago, but it is very rare.
    - Funding Priorities?
        - Data of well and septic.
        - Information about those running septic system pipes to ditches.
    - Education?
        - Laundry detergent.
        - What people should not be dumping or using.

APPENDIX G: PHOTOS

Figure G-1: Array of photos depicting water sampling activities.

Figure G-2: Array of photos taken during the Paint Creek streamwalk depicting streambank erosion (top), woody debris (center), and stream crossing erosion (bottom).

Figure G-3: Array of photos taken during the Little Sandy Creek streamwalk depicting gully erosion (top) and streambank erosion sites (middle and bottom).