# Lake Michigan Tributaries Watershed Management Plan

*"A Guide for the Protection and Improvement of Water Quality"*

CLEANER WATER
BETTER BEACHES
SOUTHWEST MICHIGAN

November 2018

# Lake Michigan Tributaries Watershed Management Plan

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# 1 Introduction

The Lake Michigan Tributaries Watershed (LMTW) includes 14 subwatersheds in Berrien County between the Michigan/Indiana state line border and Stevensville that drain to Lake Michigan. Wetlands, ponds, lakes, streams and other surface water bodies on this land and the groundwater are also part of the watershed. Water is a critical resource for recreation, irrigation, and increasing the value of adjacent real estate. These uses depend on good water quality, but they can also be a threat to it.

A watershed is all of the land that drains into a common body of water. Watersheds surpass political boundaries and connect communities with a common resource.

The LMTW is a priority for protection and improvement due to high levels of E. coli. Southwest Berrien County is located on the eastern shore of Lake Michigan and is a popular recreation and vacation destination and home to one of Michigan's most visited state parks, Warren Dunes. Tourism is critical to the local economy and tourists have been turned away from beaches due to high levels of E. coli. The LMTW Management Plan is intended to guide individuals, businesses, organizations and governmental units working cooperatively to ensure the water and natural resources necessary for future growth and prosperity are improved and protected. It can be used to educate watershed residents on how they can improve and protect water quality, encourage and direct natural resource protection and preservation, and develop land use planning and zoning that will protect water quality in the future. Implementation of the plan will require stakeholders to work across political boundaries.

Watershed management involves identifying and prioritizing problems, promoting involvement by stakeholders, developing solutions and measuring success through monitoring and data collection.

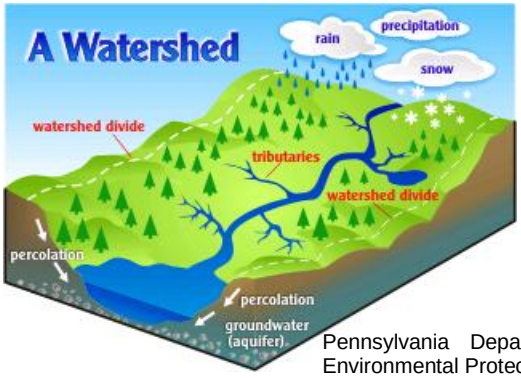
Chapters 2 and 3 of the management plan provide an overview of the watershed. Chapter 4 outlines the role governmental units play in protecting water quality. Chapter 5 describes the natural features of the watershed. The process used to develop the plan is reviewed in Chapter 6. Chapter 7 summarizes water quality throughout the watershed and Chapter 8 prioritizes the areas, pollutants and sources impacting it. Chapter 9 offers goals for the watershed and Chapter 10 provides strategies for achieving them. Lastly, Chapter 11 suggests a strategy for evaluating the progress toward the goals of the plan.

The State of Michigan protects all water bodies for designated uses such as water supply, fisheries and for partial and total body contact for recreation. This management plan was created as part of the LMTW planning project, which was funded with a SAW grant from the Michigan Department of Environmental Quality and local match funding from The Pokagon Fund. The overall health of a watershed can be difficult to determine. Characterizations and recommendations in this plan are based on the best available data.

# 2 Watershed Description

## 2.1 Geography

The term watershed describes an area of land that drains down slope to the lowest point. It includes all of the land in which any drop of water falling within it will leave in the same stream or river. Watersheds can be large or small and can traverse county, state or national boundaries. Every stream, tributary or river has an associated watershed; and small watersheds join to become larger watersheds. The Lake Michigan Tributaries drain directly into Lake Michigan, emphasizing the absolute impact these tributaries have on the water quality where they meet with Lake Michigan.

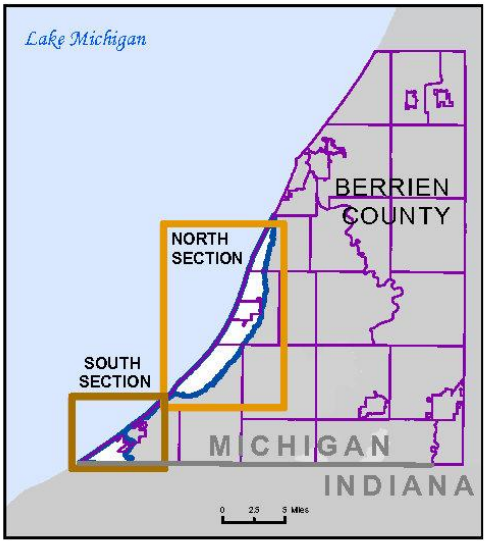


Pennsylvania Department of Environmental Protection

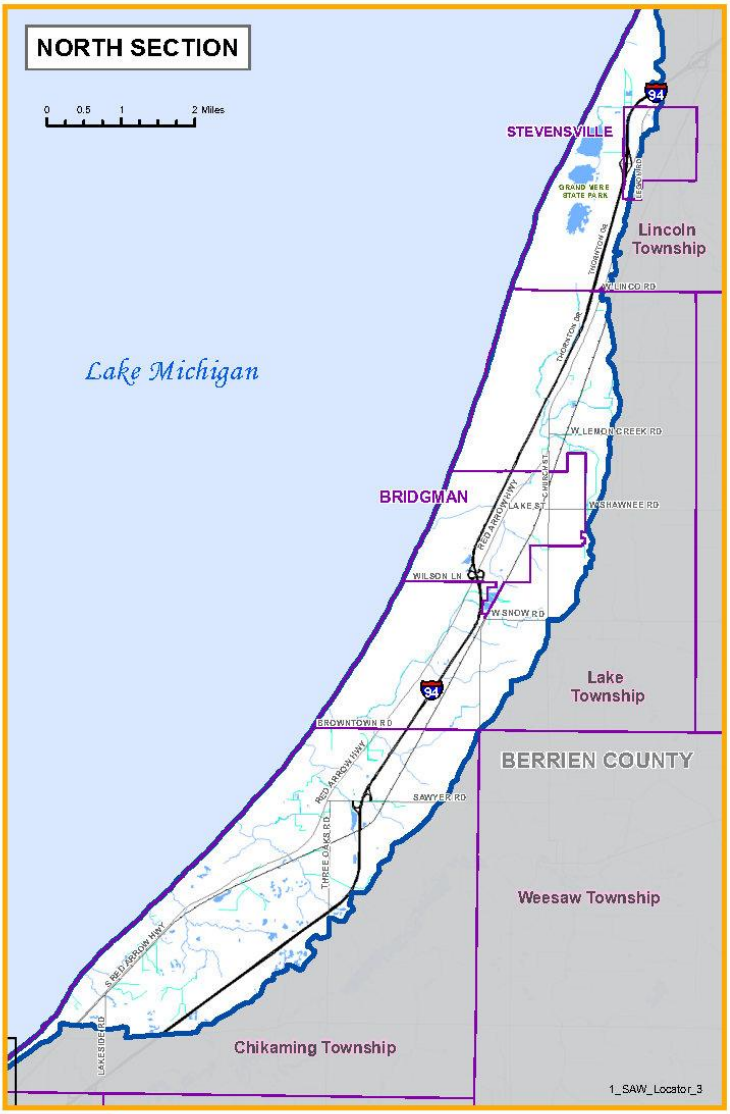
The Lake Michigan Tributaries flow westward in southwestern Lower Michigan from an area just east of the shoreline before emptying into Lake Michigan in an area of Berrien County running from the Michigan/Indiana state line border north to Stevensville. The LMTW encompasses approximately 20,909 acres (32.66 square miles) in Berrien County. The North section includes the subwatersheds of Birchwood Creek, Chikaming Creek, Deer Creek, John Markley Drain, Lakeside Creek, Painterville Drain, Swift Creek, Valley Drain, and Weko Beach (Tanner Creek), as well as the Grand Mere, Timber Lane and Warren Dunes coastal watersheds. The South section includes the New Buffalo Drain subwatershed and the Southern (White Ditch) and Timber Lane coastal watersheds. The total length of these tributaries is approximately 159 miles. The LMTW also includes four lakes in and around Grand Mere State Park, which total approximately 171 acres.

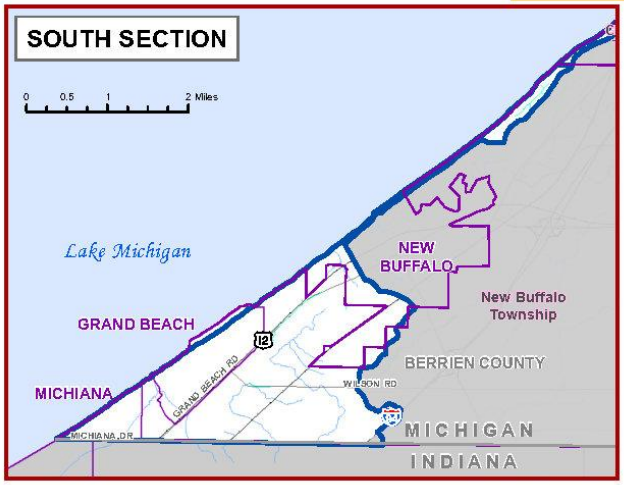
**Figure 1. Lake Michigan Tributaries Watershed Locator, Regional**

**Figure 2. Lake Michigan Tributaries Locator, County Level**




LAKE MICHIGAN TRIBUTARIES



Watersheds are typically identified by Hydrologic Unit Codes (HUCs). HUCs were developed by the United States Geologic Society to provide official boundaries for watersheds. HUCs identify a geographic area, which includes part or all of a surface drainage basin. The United States is divided into successively smaller hydrologic units. The units are classified into six levels starting with large areas such as the Great Lakes Region (2-digit) down to small areas like the Lake Michigan Tributaries subwatershed (12-digit). HUC 12 is a more local subwatershed level that captures tributary systems. The North and South sections each have their own HUC 12 – 04040001- 0102 and 04040001- 0101.

The North and South subwatershed sections have slopes, soils and other conditions, which direct runoff to one of their tributaries. The above Figures identify the location of the LMTW. The Table below lists the names of the tributaries and their acreage.

**Figure 3. Lake Michigan Tributaries Watershed, Subwatershed, North Section**

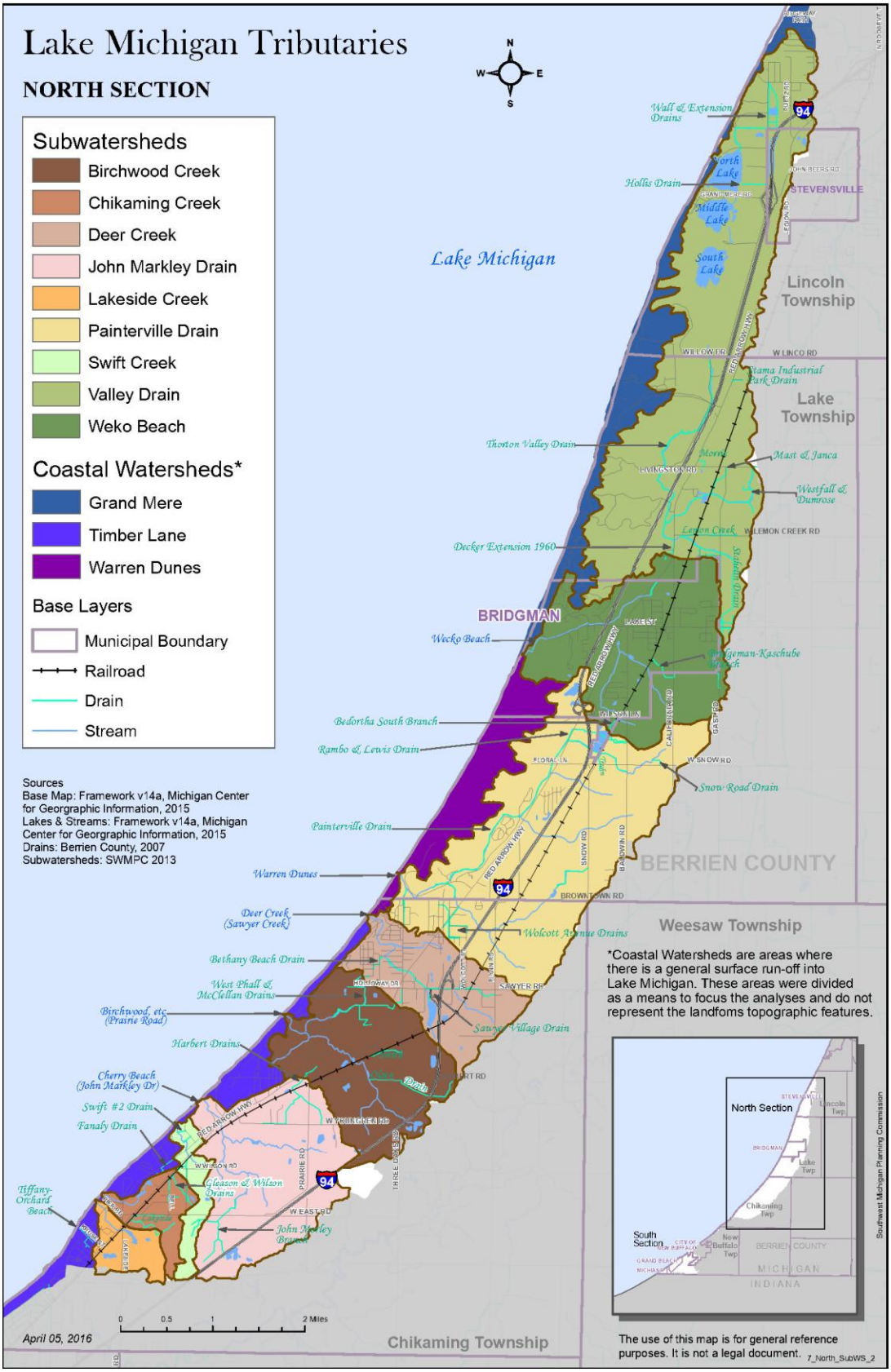


**Figure 4. Lake Michigan Tributaries Watershed, Subwatershed, South Section**

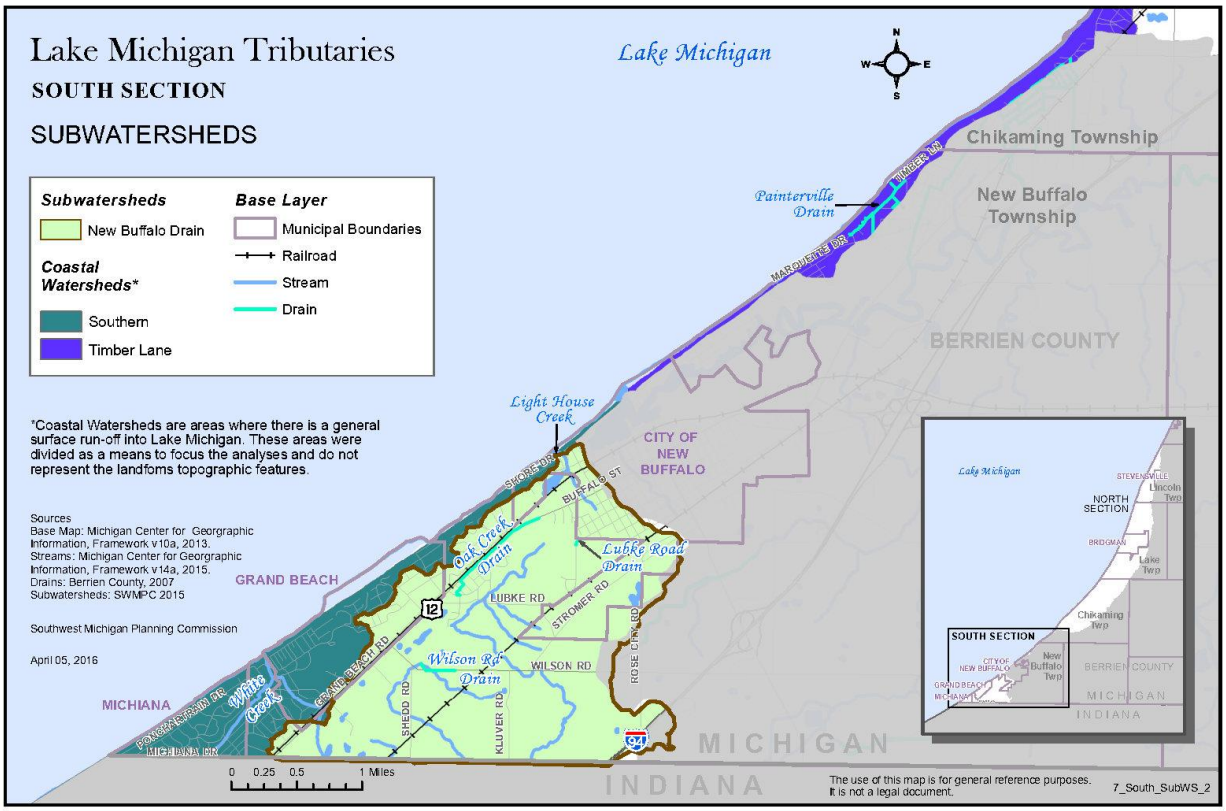



**Table 1. Lake Michigan Tributaries**

| Name | Total Area (Acres) |
|---|---|
| Birchwood Creek | 1,575 |
| Chikaming Creek | 327 |
| Deer Creek | 1,028 |
| Grand Mere | 1,001 |
| John Markley Drain | 1,671 |
| Lakeside Creek | 268 |
| New Buffalo Drain | 2,755 |
| Painterville Drain | 3,311 |
| Southern (White Ditch) | 808 |
| Swift Creek | 254 |
| Timber Lane | 951 |
| Valley Drain | 4,275 |
| Warren Dunes | 750 |
| Weko Beach (Tanner Creek) | 1,934 |
| **Totals** | 20,909 |

## 2.2 Climate

The proximity of the Lake Michigan Tributaries to Lake Michigan and prevailing westerly winds moderate the climate and produce lake-effect precipitation during the fall and winter months. The climate is also influenced by the Maritime Tropical air mass, which tends to be a relatively warm and humid air mass. The average growing season in the area (consecutive days with low temperatures greater than or equal to 32 degrees) was 143 days between 1981-2010 (May 14 – Oct. 5). Total annual precipitation is approximately 37.08 inches including approximately 82 inches of snowfall, according to the National Climatic Data Center. At an average temperature of 72°F, July is the hottest month of the year. In January, the average temperature is 24°F (climatedata.org).

Climate change has had an impact on Southwest Lower Michigan, and will continue to do so, with dire effects likely if the causes are to continue unabated. Air temperatures have been much warmer than average and annual precipitation is increasing in the Great Lakes Region. 2017 was the wettest year on record with severe downpours increasing 45%. Moving forward the area is faced with more winter precipitation as rain, with rain and snow melt happening at the same time leading to earlier peak stream flow. There will be more variable river flow with more high flow days in winter and spring and low flow days in the summer. Summer will also see increased warming with less precipitation, causing lakes and rivers to warm. Warm water species, such as carp, bluegill, and catfish, with thrive, along with harmful algae blooms and more runoff. Cool water species, namely sport fish, will be threatened.

Ecoregions are delineated by their climates, soils, vegetation, land slope and land use. The LMTW lies within the Southern Michigan, Northern Indiana Drift Plains (SMNITP) ecoregion. The region is characterized by many lakes and marshes as well as an assortment of landforms, soil types, soil textures, and land uses. Broad till plains with thick and complex deposits of drift, paleobeach ridges, relict dunes, morainal hills, kames, drumlins, meltwater channels, and kettles occur. Oak-hickory forests, northern swamp forests, and beech forests are typical. The coastal dunes area addressed in this watershed management plan is of particular importance. It is these natural areas that are a priority for protection. The LMTW tributaries specifically are a priority for improvement due to elevated E. coli levels causing impairments in this watershed.

## 2.3 Geology, Hydrology and Soils

<u>Geology and Hydrology</u>

Virtually all of Michigan's topography and hydrology has been influenced by glacial action. Repeated advances of continental ice sheets eroded the pre-existing rock and soils and then redeposited these materials as sediments as the ice advanced, melted and retreated during several cycles. These glacial materials were deposited as sands, gravels, silts and clays, as well as various mixtures, and vary in thickness within the watershed area from approximately 130 feet to over 400 feet. Michigan is home to the largest dune system in the world, associated with a freshwater lake. The sand dunes along the eastern shore of Lake Michigan were created by the prevailing westerly winds

blowing the sand deposited along the beaches into the dune formations. Ice movement and its meltwater influenced the patterns and distributions of various landforms, such as moraines and stream valleys. The meltwater created large rivers, which deposited glacial materials throughout the region. These glacial deposits and their associated landforms provide a foundation for the hydrology, soil types and land cover that exist today.

Soils

The National Cooperative Soil Survey publishes soil surveys for each county within the U.S. These soil surveys contain predictions of soil behavior for selected land uses, and also highlight limitations and hazards inherent in the soil, general improvements needed to overcome the limitations, and the impact of selected land uses on the environment. The soil surveys are designed for many different users. Planners, community officials, engineers, developers, builders, etc., use the surveys to help plan land use, select sites for construction, and identify special practices needed to ensure proper performance.

Although wetland regulations do not apply to all hydric soil areas, they are poorly suited for development, especially for septic fields. Indeed, the soil throughout the LMTW is poor for septic, especially hydric soil areas. Septic systems installed in areas with unsuitable soils are prone to failure, which can lead to nutrient and bacteria pollution of groundwater and surface water.

Hydrologic soil groups can help determine which portions of the watershed are more important for groundwater recharge; groundwater inputs are important for maintaining stream temperatures and flow throughout the system.

Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Where A's generally have the smallest runoff potential and Ds the greatest.

Details of this classification can be found in ‘Urban Hydrology for Small Watersheds’ published by the Engineering Division of the Natural Resource Conservation Service, United States Department of Agriculture, Technical Release–55.

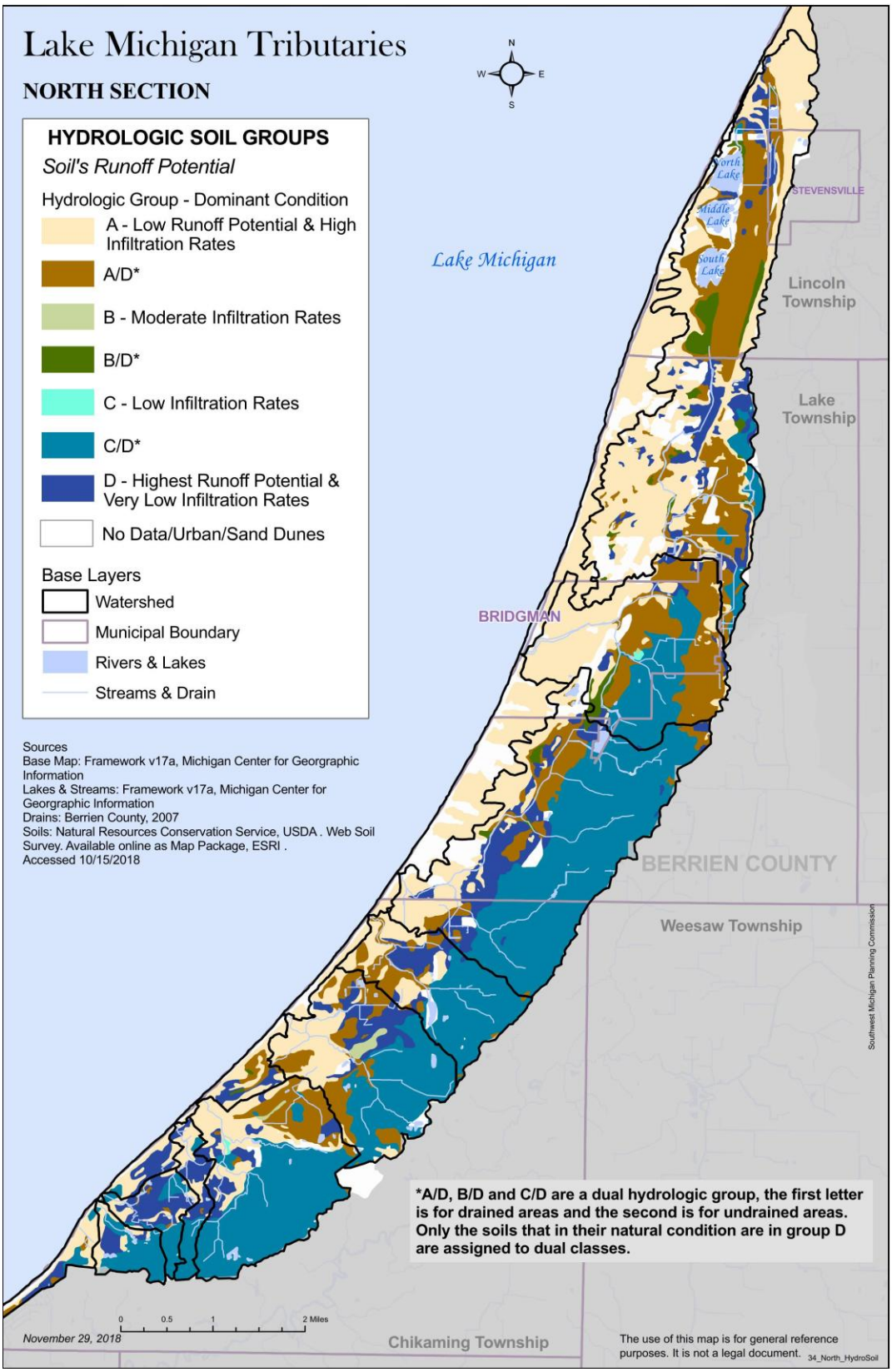
Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

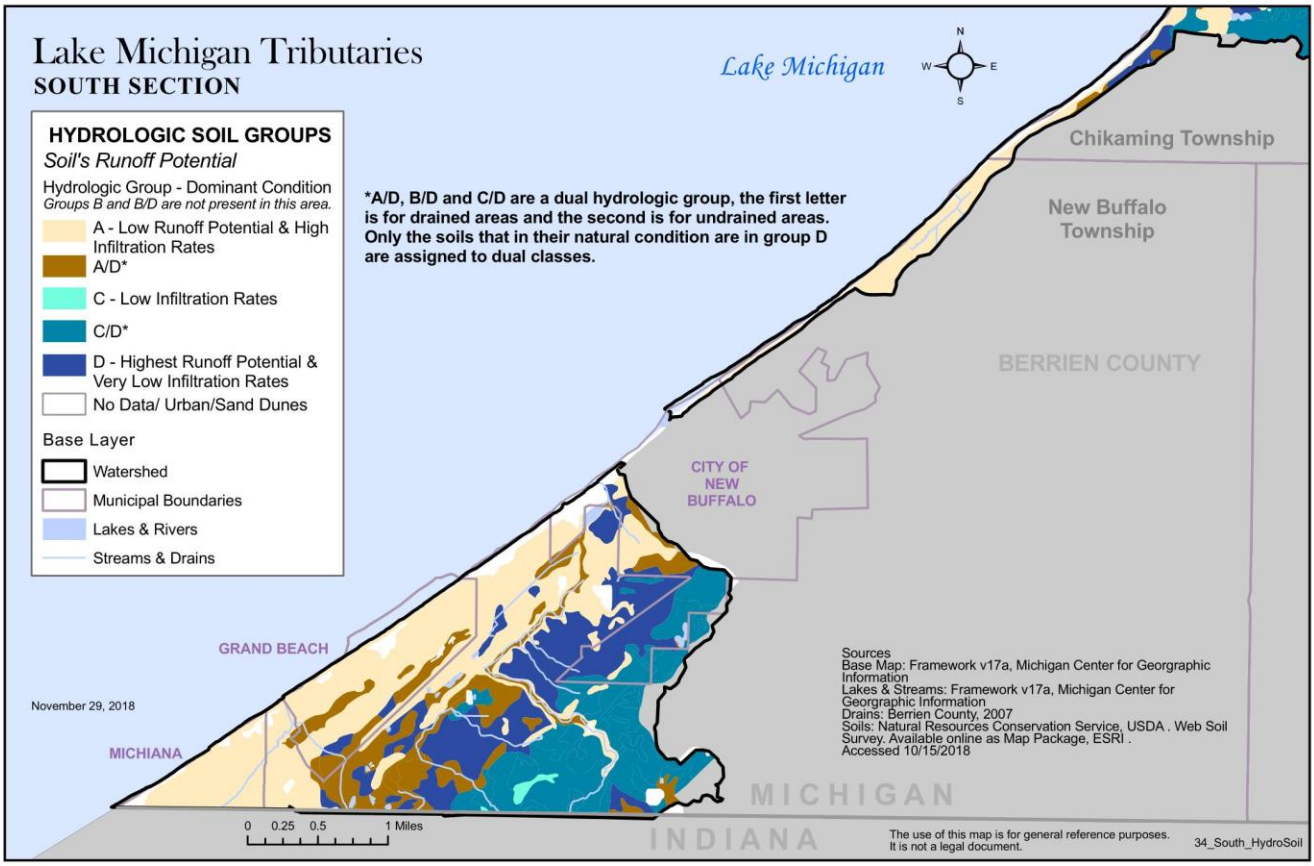
Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have Very Low Infiltration Rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

**Figure 5. Hydric Soils, North Section**



## Figure 6, Hydric Soils, South Section



## 2.4 Land Cover

Prior to European settlement in the early-to-mid-1800's, much of the LMTW was forest (Beech/Sugar Maple and White Oak/Hickory), wetlands and coastal dunes (see Figures below). Today, natural land cover in the LMTW has become fragmented, primarily by residential development and to a lesser degree commercial development and agricultural practices. However, despite the increasing pressure from these competing land uses, significant portions of natural land cover remain.

**Figure 7. Pre-settlement Vegetation Cover, North Section**

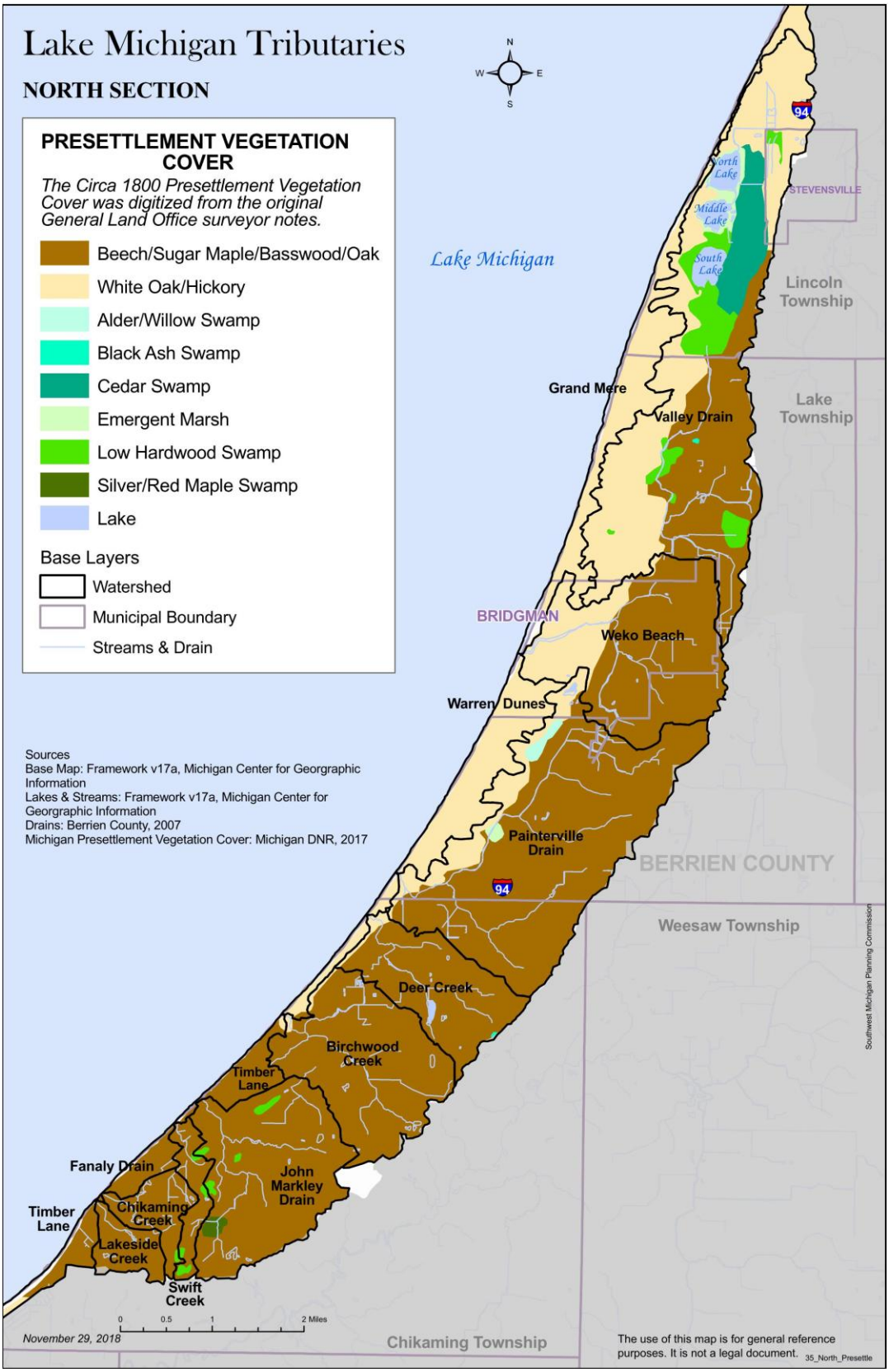
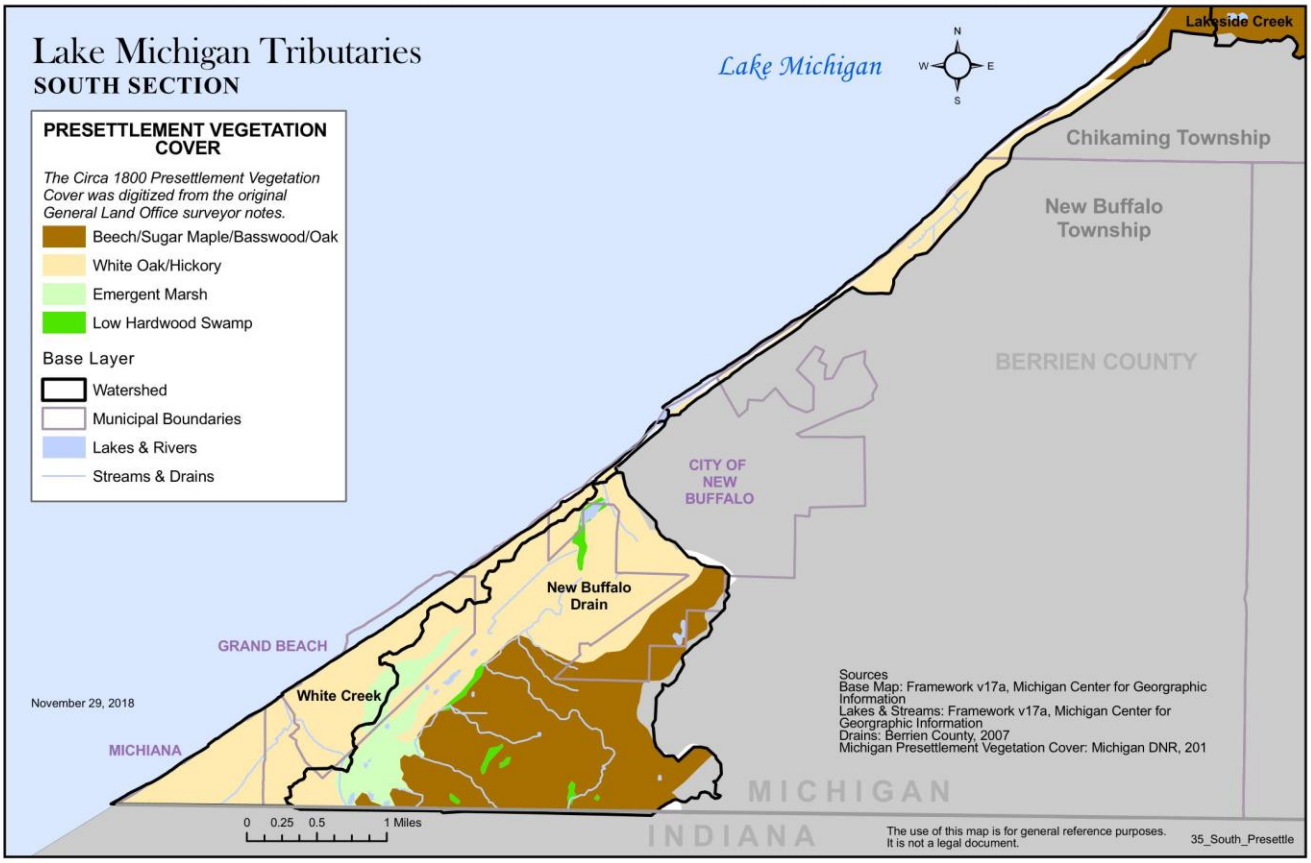


**Figure 8. Pre-settlement Vegetation Cover, South Section**




As seen in the following Tables and Figures, the watershed contains mostly natural land cover, with the greatest percentage being forested. These Tables further detail land cover by subwatershed. The relatively high percentage of natural land cover in the LMTW is threatened by increasing development pressure. An estimated 46% of wetlands have been lost in the LMTW in the last 200 years. Addressing septage issues, preservation and restoration of natural land cover, as well as proper management of future development will be critical to protecting and improving water quality in the LMTW.

Addressing septage, preservation and restoration of natural land cover, as well as proper management of future development will be critical to protecting and improving water quality in the LMTW.

**Table 2. Lake Michigan Tributaries Watershed Land Cover (2010)**

| Land Cover Category | % of Watershed | Area (acres) |
|---|---|---|
| Medium Intensity Developed | 4.05% | 847.1 |
| High Intensity Developed | 0.81% | 169.7 |
| **Total High and Medium Intensity Developed** | **4.86%** | **1016.8** |
| | | |
| **Total Low Intensity Developed** | **10.58%** | **2212.8** |
| | | |
| **Total Cultivated Crops** | **11.16%** | **2332.5** |
| | | |
| **Total Pasture/Hay/Grassland** | **6.86%** | **1433.1** |
| | | |
| **Total Developed Open Space** | **10.19%** | **2130.1** |
| | | |
| Deciduous Forest | 34.12% | 7134.6 |
| Mixed Forest | 3.02% | 631.4 |
| Evergreen Forest | 2.01% | 419.2 |
| Scrub/Shrub | 1.73% | 361.6 |
| **Total Forest** | **40.88%** | **8546.8** |
| | | |
| Palustrine Forested Wetland | 6.84% | 1430.2 |
| Palustrine Scrub/Shrub Wetland | 1.71% | 358.3 |
| Palustrine Emergent Wetland | 1.40% | 292.9 |
| **Total Wetland** | **9.96%** | **2081.4** |
| | | |
| **Total Water** | **1.15%** | **242.6** |
| | | |
| Bare Land | 4.32% | 904.2 |
| Unconsolidated Shore | 0.04% | 8.7 |
| **Total Sand** | **4.36%** | **911.4** |
| | | |
| **Total** | **100.00%** | **20,909.00** |

**Figure 9. Land Cover in the Lake Michigan Tributaries Watershed (percent)**

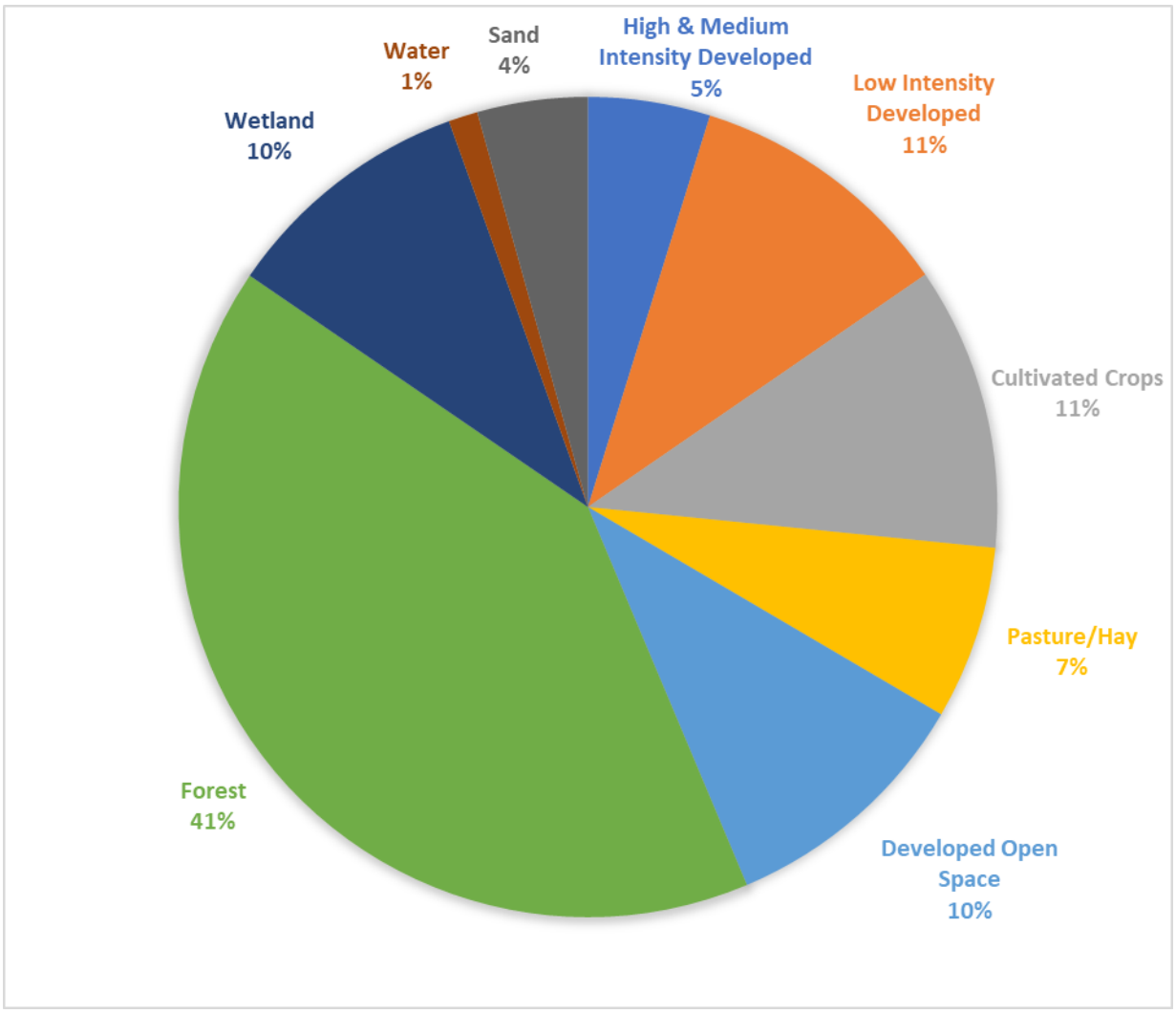


**Figure 10. Lake Michigan Tributaries Watershed Land Cover, North Section (2010)**

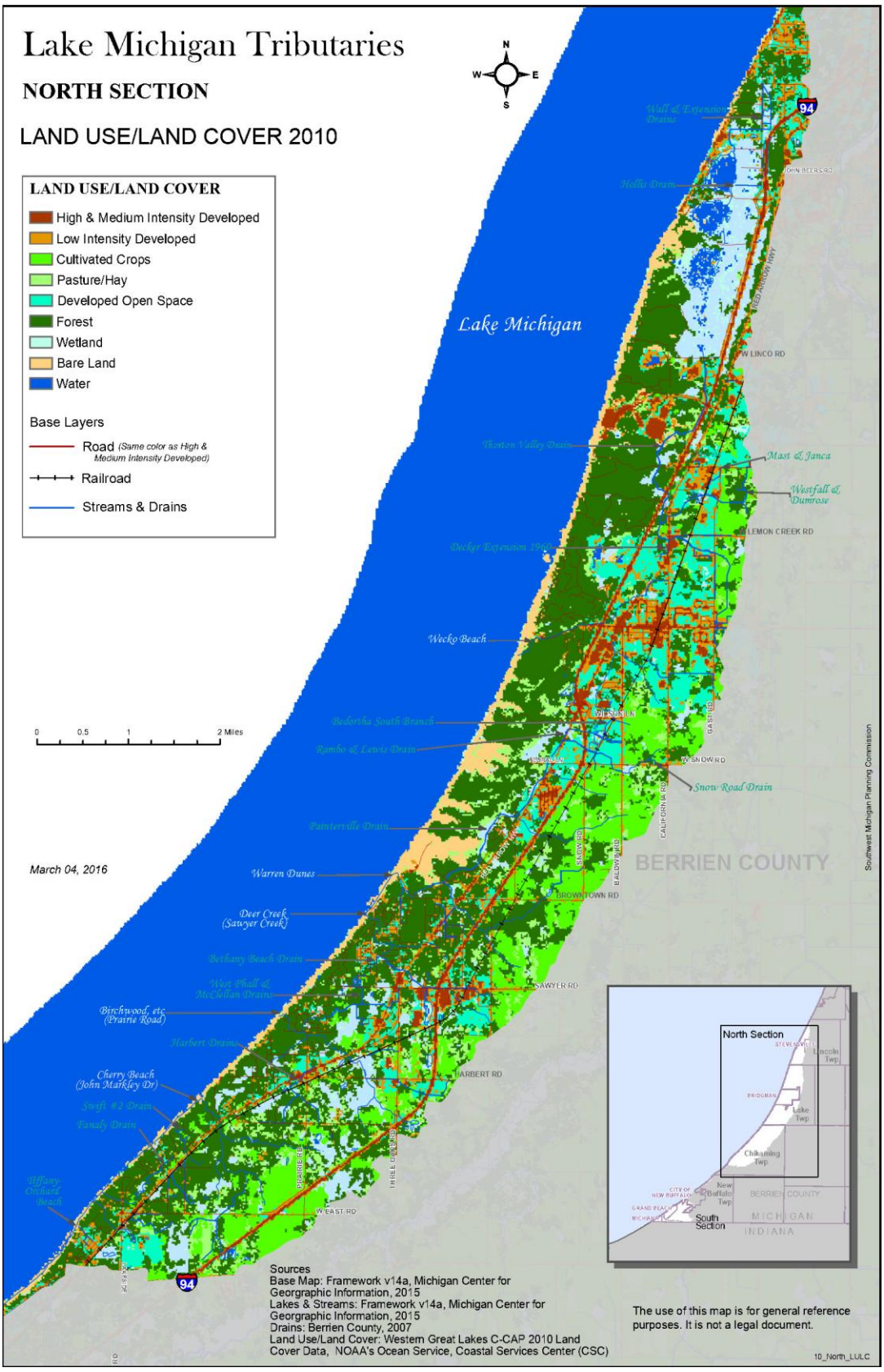


**Figure 11. Lake Michigan Tributaries Watershed Land Cover, South Section (2010)**

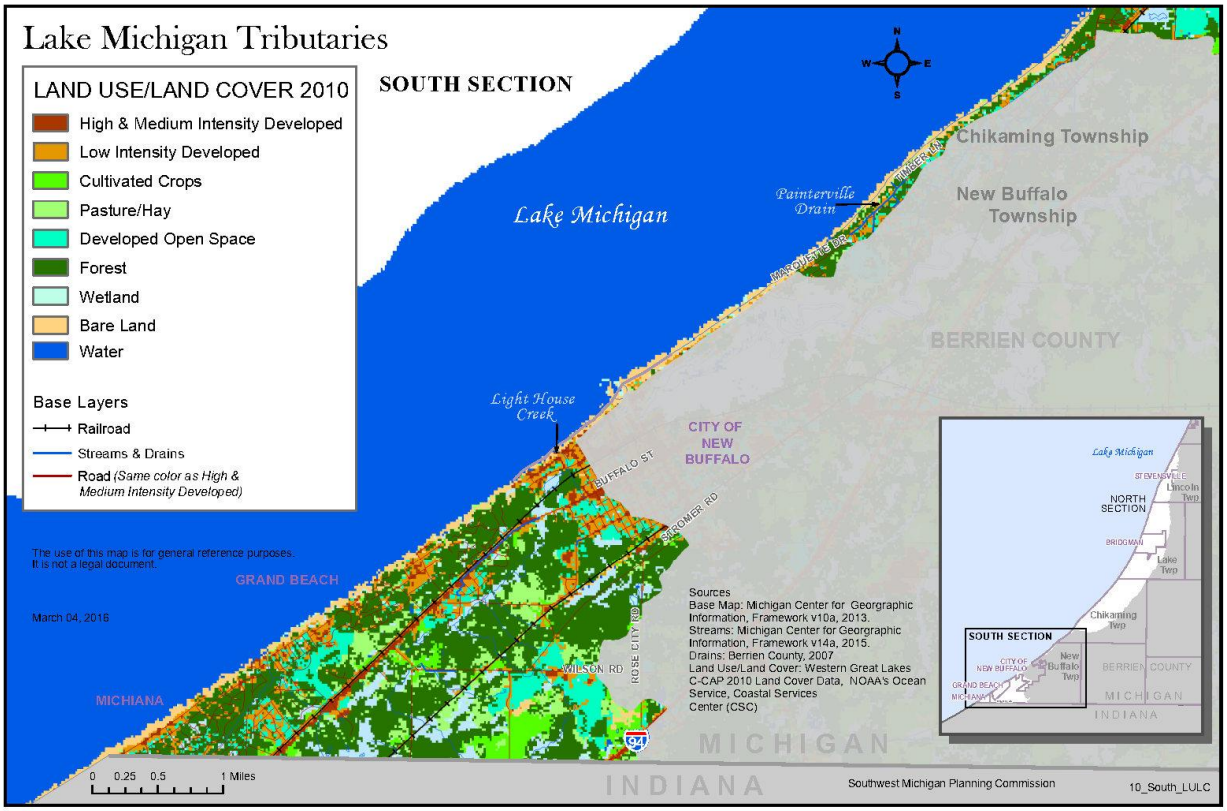


**Table 3. Generalized Land Cover by Subwatershed – High & Medium Intensity Developed and Low Intensity Developed (2010)**

| | High & Medium Intensity Developed | | Low Intensity Developed | |
|---|---|---|---|---|
| | **Acres** | **% of WS** | **Acres** | **% of WS** |
| Birchwood Creek | 65.16 | 0.31% | 161.68 | 0.77% |
| Chikaming Creek | 7.12 | 0.03% | 37.58 | 0.18% |
| Deer Creek | 88.07 | 0.42% | 144.11 | 0.69% |
| Grand Mere | 69.83 | 0.33% | 97.85 | 0.47% |
| John Markley Drain | 42.25 | 0.20% | 86.96 | 0.42% |
| Lakeside Creek | 4.00 | 0.02% | 24.02 | 0.11% |
| New Buffalo Drain | 111.20 | 0.53% | 285.55 | 1.36% |
| Painterville Drain | 120.32 | 0.58% | 272.43 | 1.30% |
| Southern (White Ditch) | 35.81 | 0.17% | 152.34 | 0.73% |
| Swift Creek | 2.22 | 0.01% | 13.34 | 0.06% |
| Timber Lane | 4.67 | 0.02% | 95.85 | 0.46% |
| Valley Drain | 239.30 | 1.14% | 498.16 | 2.38% |
| Warren Dunes | 0.67 | 0.00% | 7.12 | 0.03% |
| Weko Beach (Tanner Creek) | 217.95 | 1.04% | 339.15 | 1.62% |
| **Total** | **1008.56** | **4.82%** | **2216.16** | **10.59%** |

**Table 4. Generalized Land Cover by Subwatershed – Cultivated Crops, Pasture/Hay, Developed Open Space (2010)**

| | Cultivated Crops | | Pasture/Hay | | Developed Open Space | |
|---|---|---|---|---|---|---|
| | **Acres** | **% of WS** | **Acres** | **% of WS** | **Acres** | **% of WS** |
| Birchwood Creek | 203.05 | 0.97% | 115.87 | 0.55% | 130.32 | 0.62% |
| Chikaming Creek | 20.91 | 0.10% | 15.57 | 0.07% | 10.90 | 0.05% |
| Deer Creek | 105.41 | 0.50% | 69.16 | 0.33% | 136.99 | 0.65% |
| Grand Mere | 5.34 | 0.03% | 23.80 | 0.11% | 37.36 | 0.18% |
| John Markley Drain | 491.27 | 2.35% | 215.05 | 1.03% | 26.46 | 0.13% |
| Lakeside Creek | 18.68 | 0.09% | 14.01 | 0.07% | 81.62 | 0.39% |
| New Buffalo Drain | 178.14 | 0.85% | 294.00 | 1.41% | 254.64 | 1.22% |
| Painterville Drain | 914.48 | 4.37% | 329.14 | 1.57% | 253.08 | 1.21% |
| Southern (White Ditch) | 7.78 | 0.04% | 38.25 | 0.18% | 111.20 | 0.53% |
| Swift Creek | 23.13 | 0.11% | 27.80 | 0.13% | 1.56 | 0.01% |
| Timber Lane | 4.45 | 0.02% | 27.58 | 0.13% | 48.26 | 0.23% |
| Valley Drain | 229.29 | 1.10% | 128.77 | 0.62% | 526.85 | 2.52% |
| Warren Dunes | 1.33 | 0.01% | 76.50 | 0.37% | - | 0.00% |
| Weko Beach (Tanner Creek) | 134.55 | 0.64% | 56.49 | 0.27% | 517.29 | 2.47% |
| **Total** | **2337.81** | **11.17%** | **1431.99** | **6.84%** | **2136.54** | **10.21%** |

**Table 5. Generalized Land Cover by Subwatershed – Forest, Water, Sand (2010)**

| | Forest | | Wetland | | Water | | Sand | |
|---|---|---|---|---|---|---|---|---|
| | **Acres** | **% of WS** | **Acres** | **% of WS** | **Acres** | **% of WS** | **Acres** | **% of WS** |
| Birchwood Creek | 648.50 | 3.10% | 254.42 | 1.22% | 1.78 | 0.01% | 3.11 | 0.01% |
| Chikaming Creek | 193.93 | 0.93% | 40.70 | 0.19% | | 0.00% | 1.33 | 0.01% |
| Deer Creek | 424.99 | 2.03% | 54.93 | 0.26% | 3.11 | 0.01% | 2.00 | 0.01% |
| Grand Mere | 543.75 | 2.60% | 13.34 | 0.06% | 7.56 | 0.04% | 206.60 | 0.99% |
| John Markley Drain | 635.16 | 3.04% | 167.02 | 0.80% | 6.00 | 0.03% | 1.78 | 0.01% |
| Lakeside Creek | 101.86 | 0.49% | 21.35 | 0.10% | 0.44 | 0.00% | 1.11 | 0.01% |
| New Buffalo Drain | 1307.68 | 6.25% | 292.45 | 1.40% | 8.01 | 0.04% | 20.91 | 0.10% |
| Painterville Drain | 1187.81 | 5.68% | 162.13 | 0.77% | 2.00 | 0.01% | 70.28 | 0.34% |
| Southern (White Ditch) | 358.94 | 1.72% | 28.02 | 0.13% | 1.33 | 0.01% | 75.39 | 0.36% |
| Swift Creek | 147.22 | 0.70% | 39.36 | 0.19% | 0.00 | 0.00% | 0.00 | 0.00% |
| Timber Lane | 512.84 | 2.45% | 44.48 | 0.21% | 12.68 | 0.06% | 201.71 | 0.96% |
| Valley Drain | 1496.04 | 7.15% | 901.14 | 4.31% | 198.15 | 0.95% | 52.26 | 0.25% |
| Warren Dunes | 383.85 | 1.83% | 9.12 | 0.04% | 1.78 | 0.01% | 270.88 | 1.29% |
| Weko Beach (Tanner Creek) | 610.69 | 2.92% | 52.71 | 0.25% | 0.22 | 0.00% | 4.45 | 0.02% |
| **Total** | **8553.27** | **40.88%** | **2081.16** | **9.95%** | **243.08** | **1.16%** | **911.82** | **4.36%** |

As demonstrated in the following Figures, the LMTW has a significantly smaller portion of cropland relative to other watersheds of southwest lower Michigan. This minimizes the number of factors that impact water quality, allowing for easier determination of impairment sources.

**Figure 12. Lake Michigan Tributaries Watershed Cropland, North**

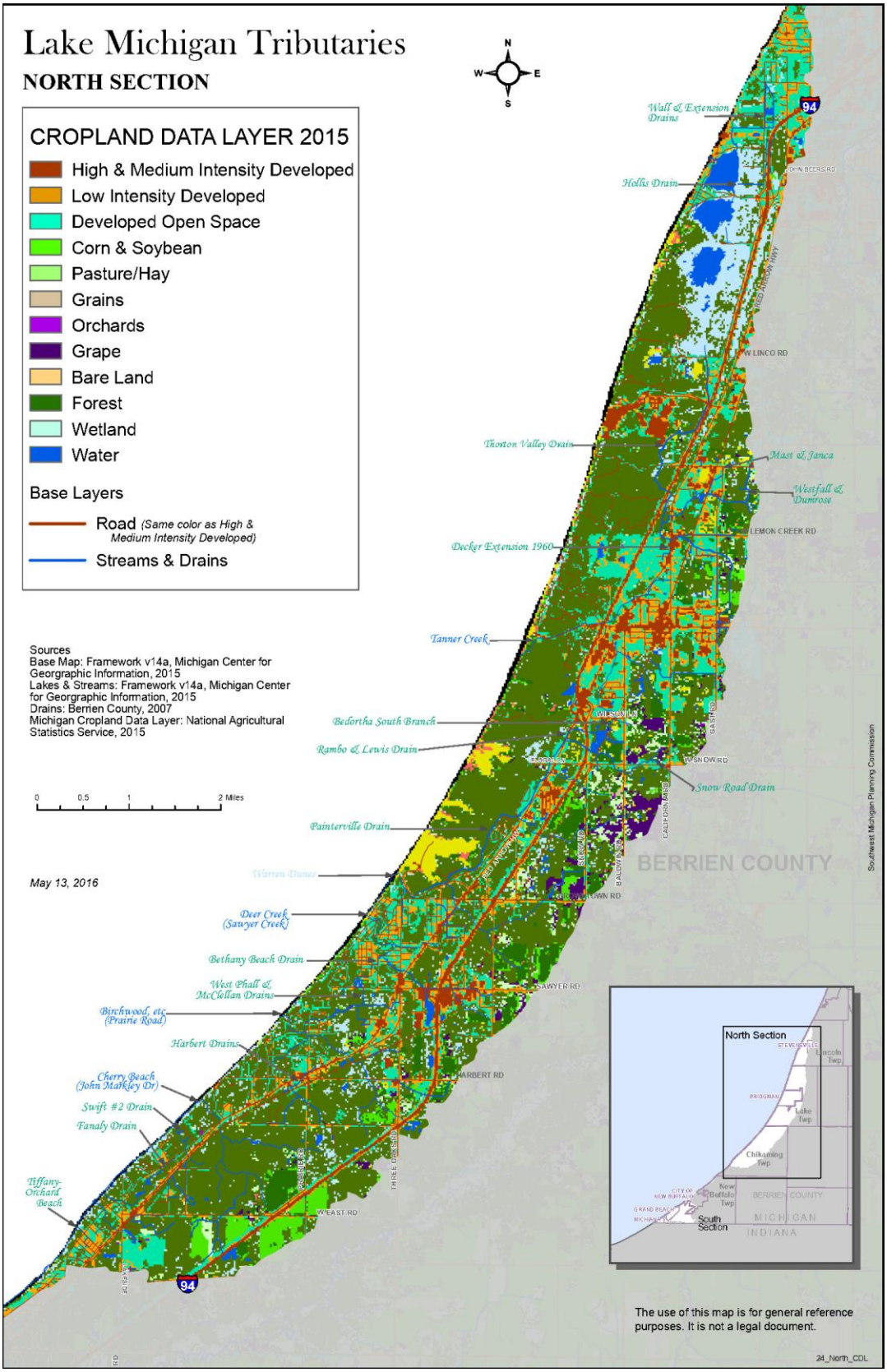
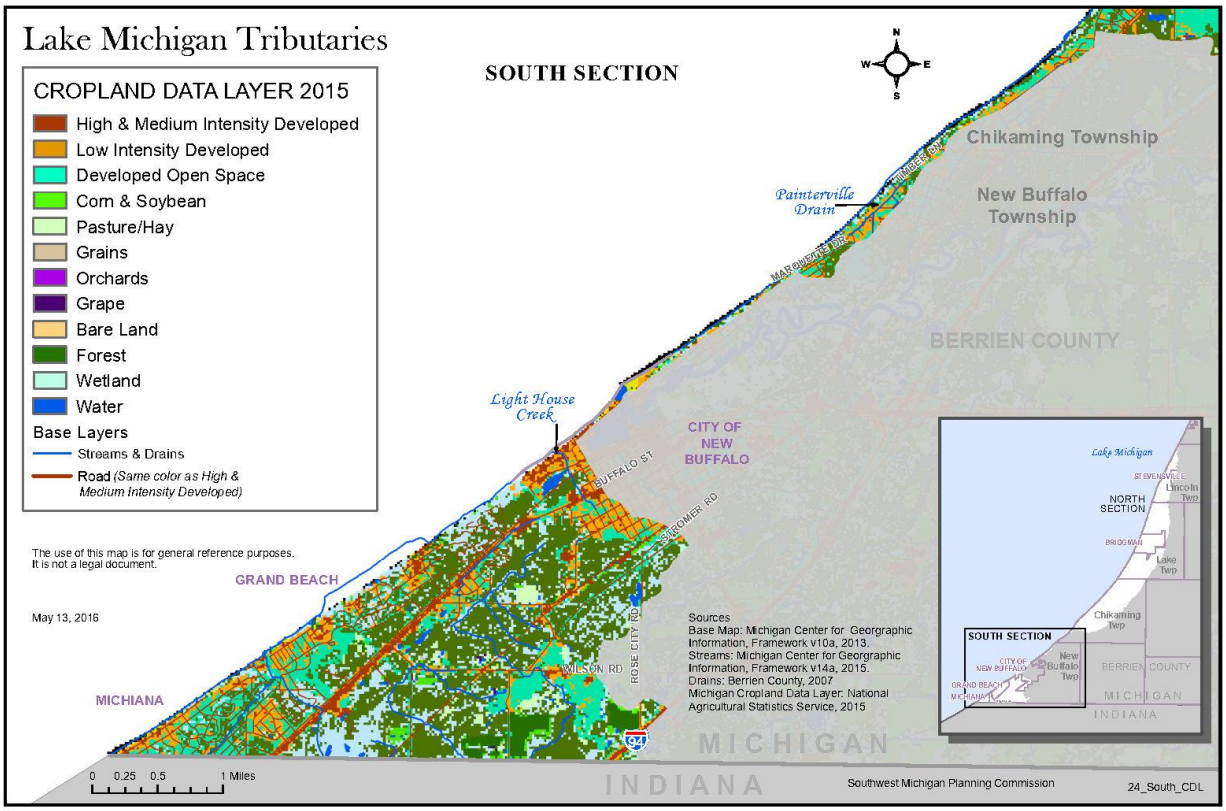


**Figure 13. Lake Michigan Tributaries Watershed Cropland, South**



# 3 Community Profile

## 3.1 Governmental Units

In the LMTW, there are 10 governmental units including four (4) townships, three (3) villages, two (2) cities, and one (1) county (Berrien). See the following Figures for maps of governmental units in the PPRW.

The following Table 6 lists all of the municipalities located in the LMTW along with the number of acres of that municipality in the LMTW and the percent of the watershed the is in each of those municipalities. The North section is the largest at 83%; Chikaming Township has the largest percentage with 32%, followed by Lake Township with 31%. The South section comprises just 17% of the watershed, and New Buffalo Township has the largest percentage of that area – 11%.

**Figure 14. Governmental Units in Lake Michigan Tributaries Watershed, North Section**

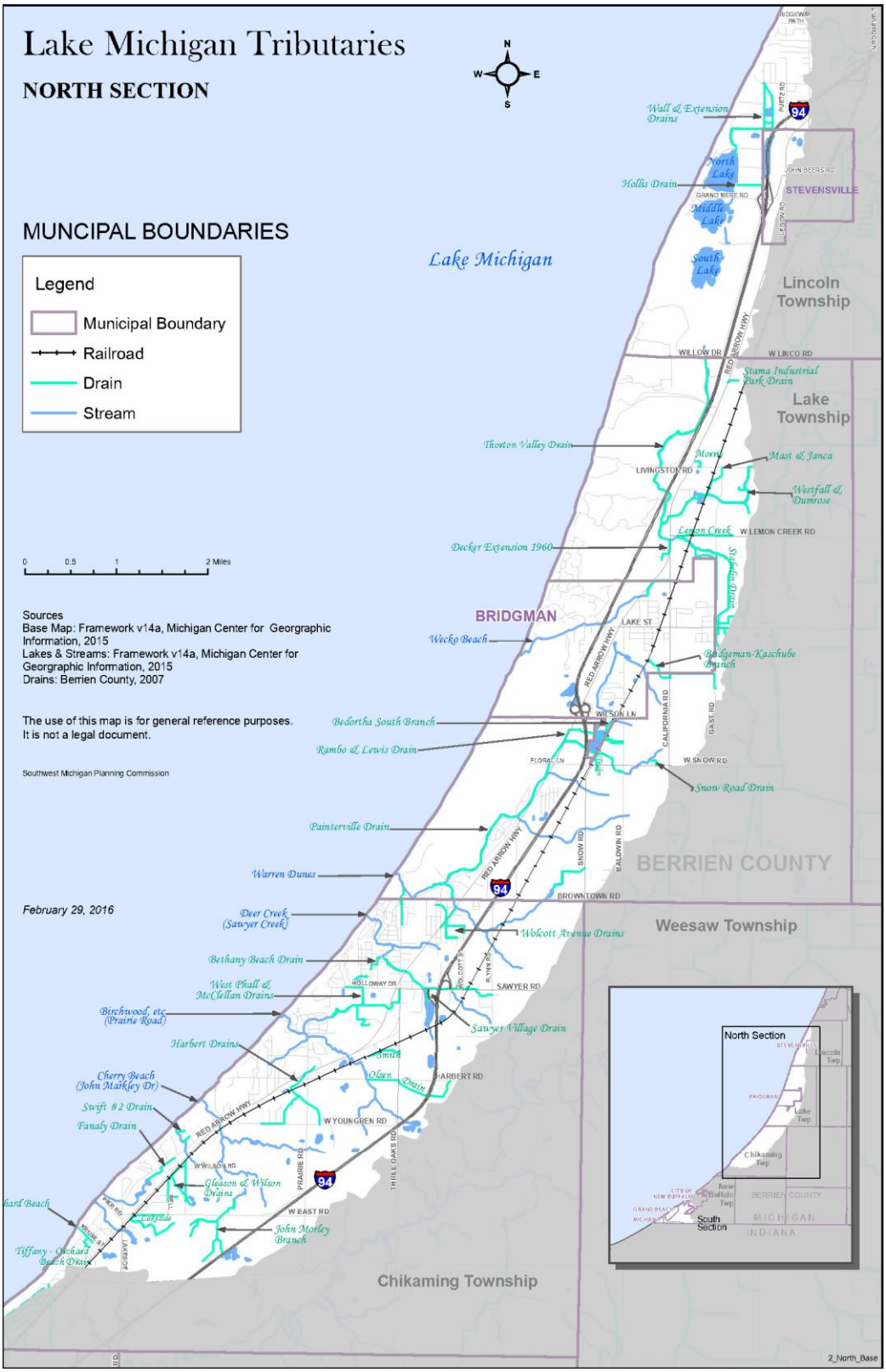


**Figure 15. Governmental Units in Lake Michigan Tributaries Watershed, South Section**

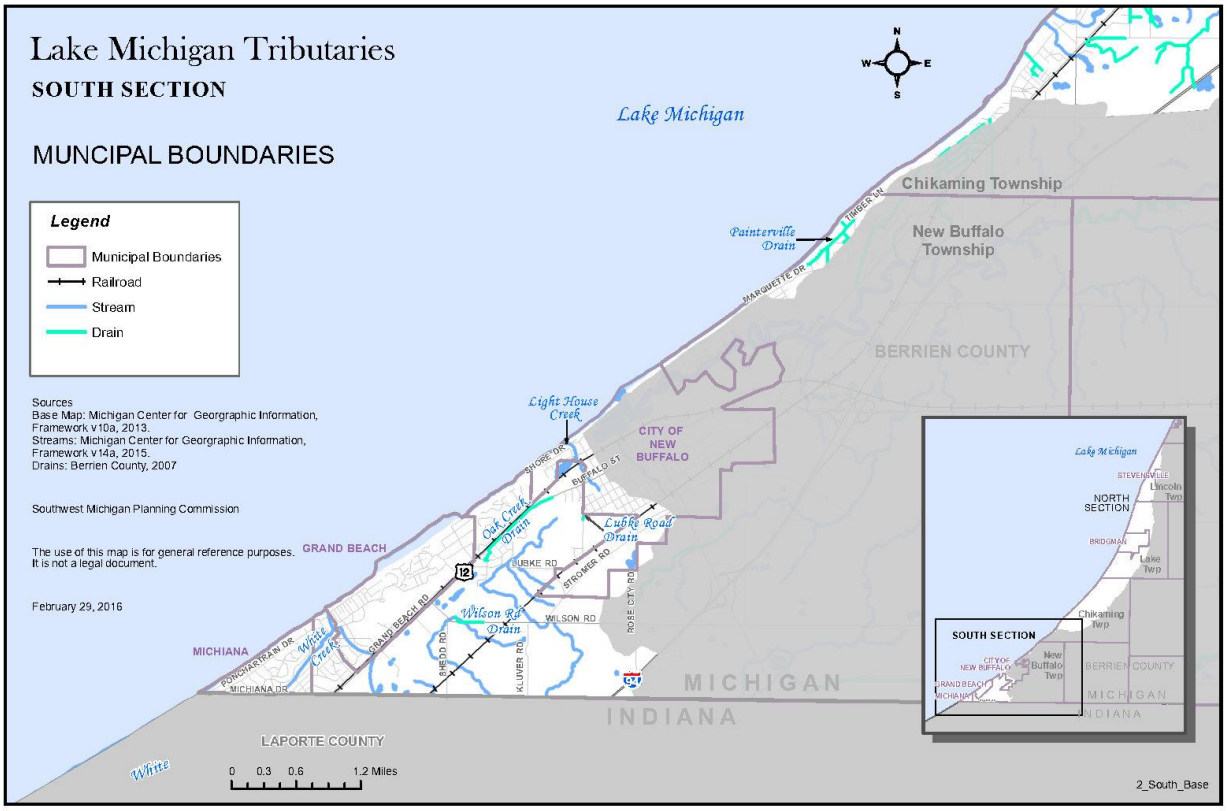



**Table 6. Watershed Area, Percentage of Watershed, by Governmental Unit**

| Governmental Unit | Watershed Area (Acres) | % of Watershed |
|---|---|---|
| **North Section** | | |
| Lincoln Twp | 2,182 | 11% |
| Stevensville, Village of | 198 | 1% |
| Lake Twp | 6,080 | 30% |
| Bridgeman, City of | 1,871 | 9% |
| Chikaming Twp | 6,670 | 32% |
| **Total** | **17,001** | **83%** |
| | | |
| | | |
| **South Section** | | |
| New Buffalo Twp | 2,285 | 11% |
| New Buffalo, City of | 510 | 2% |
| Grand Beach, Village of | 526 | 3% |
| Michiana, Village of | 232 | 1% |
| **Total** | **3,553** | **17%** |

The following Tables show the miles of streams and drains by municipality. Chikaming Township has the greatest total length with 30.11 miles, as well as the greatest total stream miles (15.5). Lake Charter Township has the greatest drain miles (14.61).

**Table 7. Total Miles of Streams and Drains, by Municipality**

| Municipality | Total Miles | Total Stream Miles | Total Drain Miles |
|---|---|---|---|
| Chikaming Township | 30.11 | 15.5 | 14.61 |
| Lake Charter Township | 27.47 | 12.32 | 15.15 |
| New Buffalo Township | 10.27 | 7.94 | 2.33 |
| Bridgman, City of | 10.97 | 4.06 | 6.91 |
| Lincoln Charter Township | 3.39 | 1.25 | 2.14 |
| Stevensville, Village of | 0.88 | 0.88 | n/a |
| New Buffalo, City of | 0.61 | 0.61 | n/a |
| Grand Beach, Village of | 0.51 | 0.51 | n/a |
| Michiana, Village of | 0.50 | 0.50 | n/a |
| **Total** | **84.71** | **43.57** | **41.14** |

**Table 8. Drains, Lake Charter Township, by Length (Miles)**

| Drain Name | Drain Length (Miles) |
|---|---|
| Thornton Valley | 3.75 |
| Painterville | 2.23 |
| Stahelin Outlet | 1.43 |
| Painterville | 0.69 |
| Lemon Creek | 0.64 |
| Westphal & Dumrose Extension | 0.53 |
| Muench | 0.51 |
| Decker | 0.47 |
| Mast & Janca | 0.47 |
| Clymer | 0.44 |
| Rambo & Lewis | 0.44 |
| Westphal & Dumrose | 0.44 |
| Bedortha Easement | 0.42 |
| Stahelin Linke Branch | 0.34 |
| Decker Extension 1960 | 0.29 |
| Dohrer Gast Road Branch 1989 | 0.28 |
| Bedortha Southwest Branch | 0.27 |
| Woodridge Estates | 0.21 |
| Truhn | 0.20 |
| Stahelin Extension | 0.17 |

| Drain Name | Drain Length (Miles) |
|---|---|
| Bridgman - Kaschube Branch Extension 1989 | 0.16 |
| Stama Industrial Park | 0.15 |
| Westphal & Huston | 0.14 |
| Snow Road | 0.14 |
| Morris | 0.13 |
| Tower Hill | 0.12 |
| Stahelin Shawnee Branch | 0.05 |
| Ricoby Pond | 0.02 |
| **Total** | **15.15** |

**Table 9. Drains, Chikaming Township, by Length (Miles)**

| Drain Name | Drain Length (Miles) |
|---|---|
| Olson | 1.09 |
| Lakeside | 1.07 |
| Gleason & Wilson | 1.05 |
| West Phall & McClellan | 1.00 |
| Harbert | 0.94 |
| Sawyer Village Extension | 0.89 |
| Wolcott Avenue South | 0.87 |
| John Morley | 0.66 |
| West Phall & McClellan East Branch | 0.64 |
| Wolcott Avenue | 0.54 |
| John Morley Branch | 0.44 |
| Sawyer Village | 0.42 |
| Fanaly | 0.42 |
| Gleason & Wilson (old) | 0.41 |
| West Phall & McClellan South Branch | 0.40 |
| Harbert Branch Extension | 0.38 |
| Smith | 0.36 |
| Tower Hill | 0.35 |
| John Morley Lateral | 0.32 |
| West Phall & McClellan Branch | 0.27 |
| Harbert Extension | 0.25 |
| Bethany Beach | 0.25 |
| Tiffany - Orchard Beach | 0.21 |
| John Morley Lateral | 0.21 |
| Lakeside Branch No. 1 | 0.21 |
| Sawyer Village South Branch | 0.14 |
| Sawyer Village Relocation | 0.12 |
| Swift #1 | 0.10 |
| Highland Shores | 0.10 |
| Swift #2 | 0.09 |
| Tiffany | 0.08 |
| Tiffany - Orchard Beach Kruse Branch | 0.08 |

| Drain Name | Drain Length (Miles) |
|---|---|
| Edinger | 0.08 |
| Lakeside East Road Branch | 0.05 |
| Streed Extension | 0.05 |
| Sawyer Village Super 8 Branch | 0.05 |
| Tiffany - Orchard Beach South Branch | 0.02 |
| Lakeside Branch No. 2 | 0.01 |
| **Total** | **14.61** |

**Table 10. Drains, City of Bridgman, by Length (Miles)**

| Drain Name | Drain Length (Miles) |
|---|---|
| Tanner Creek | 1.30 |
| Bedortha North Branch | 1.20 |
| Bridgman | 1.05 |
| Bridgman - Kaschube Branch Extension 1989 | 0.53 |
| Stahelin Gast Road Branch | 0.51 |
| Williams & Essig | 0.44 |
| Stahelin | 0.39 |
| Bridgman - Kaschube Branch | 0.38 |
| Rambo & Lewis | 0.34 |
| Williams & Essig South Branch | 0.29 |
| Bridgman - Church St. Ext | 0.25 |
| Bedortha Southwest Branch | 0.25 |
| **Total** | **6.91** |

**Table 11. Drains, New Buffalo Township, by Length (Miles)**

| Drain Name | Drain Length (Miles) |
|---|---|
| Lubke Road | 0.07 |
| Wilson Road | 0.29 |
| Oak Hill Springs | 0.96 |
| Timber Lane | 1.00 |
| **Total** | **2.33** |

**Table 12. Drains, Lincoln Charter Township, by Length (Miles)**

| Drain Name | Drain Length (Miles) |
|---|---|
| Hollis | 0.28 |
| Wall & Extention - older | 0.61 |
| Wall & Extension - 2000 | 0.63 |
| Wall & Extension | 0.63 |
| **Total** | **2.14** |

## 3.2 Demographics

The LMTW is an important resource for its human population, and it is important to understand the characteristics of the population in the watershed. By having a better understanding of the people, water quality related management and outreach efforts can be tailored to be more effective for the intended audience(s).

All of the demographic information presented here is from the US Census. According to the 2010 US Census data, there were 9,100 people living in the LMTW. The average population density in the watershed was 280 people per square mile. In 2010, the watershed contained 4,012 households with 3,132 (78%) of these being owner occupied. The average household contained 2.24 persons. According to 2010 Census data, of the 5,388 households in the North section of the LMWT 1,987 (36.9%) were designated “For Seasonal/Recreational/Occasional Use,” and in the South section, of the 2,020 households, 1,033 (51%) has the same designation. This signifies the area being a draw for tourism and second-home owners, which underlies the particular impact of E. coli-related beach closings. The following Figures illustrate that the most densely populated areas of the watershed are located in the cities of Bridgman and New Buffalo. The Tables below list the race breakdown of the population living in the watershed. In the North section 94.8% were white only, 1.4% were black or African American and 2.4% were Hispanic or Latino. In the South section 95.6% were white only, .9% were black or African American and 3% were Hispanic or Latino.

**Figure 16. Population Density, North Section (2010)**

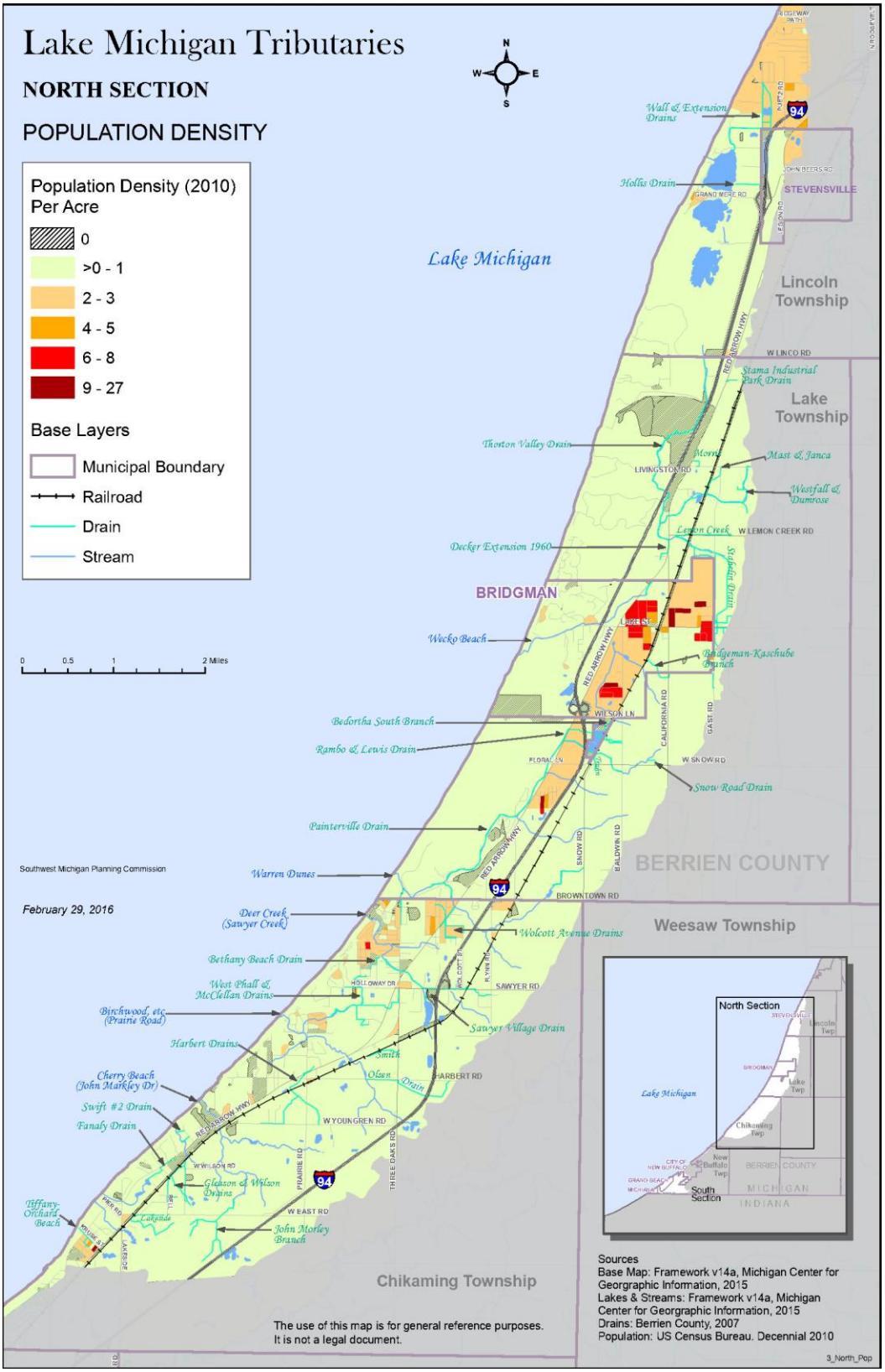


**Figure 17. Population Density, South Section (2010)**

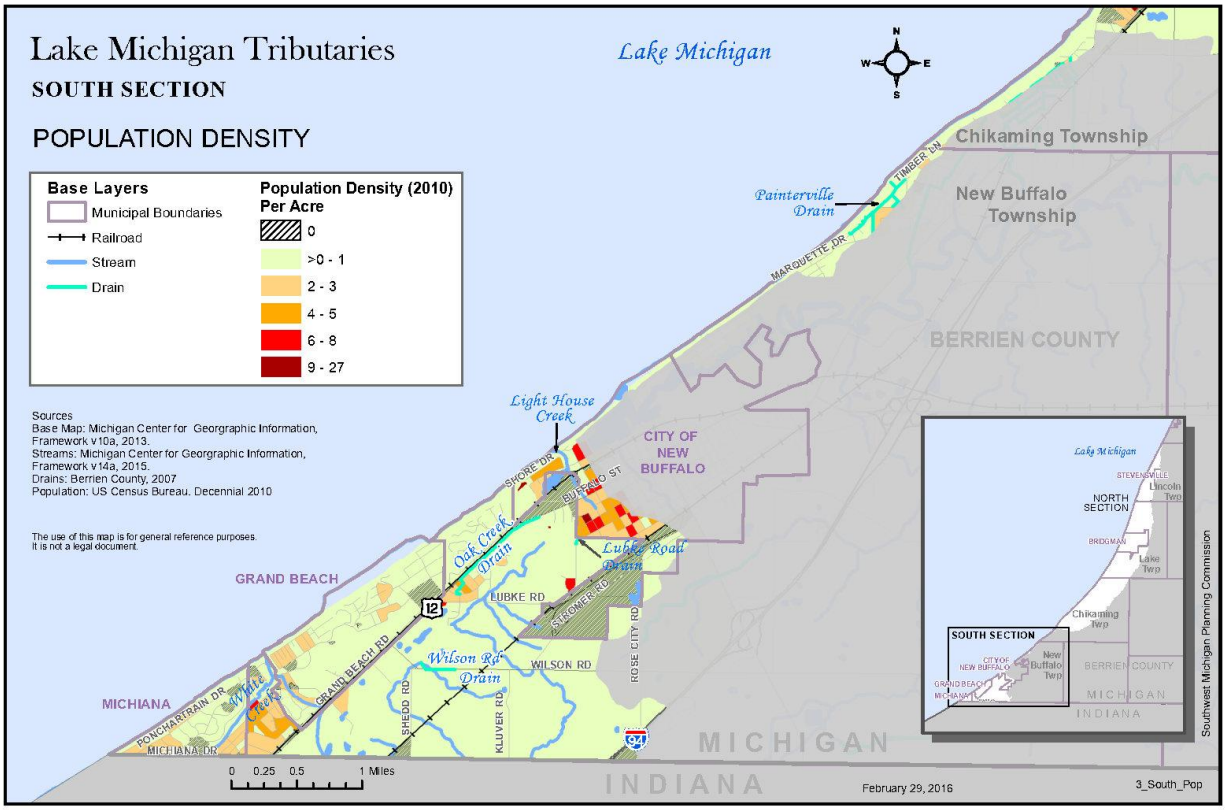



**Table 13. Race, North Section (2010)**

| Race | Number | Percentage |
|---|---|---|
| White | 6,692 | 94.8% |
| Black | 98 | 1.4% |
| American Indian | 27 | 0.4% |
| Asian | 109 | 1.5% |
| Pacific Islander | 1 | 0.0% |
| Some Other Race | 39 | 0.6% |
| Two or More Races | 94 | 1.3% |
| Hispanic | 172 | 2.4% |

**Table 14. Race, South Section (2010)**

| Race | Number | Percentage |
|---|---|---|
| White | 1,949 | 95.6% |
| Black | 19 | 0.9% |
| American Indian | 8 | 0.4% |
| Asian | 8 | 0.4% |
| Pacific Islander | 3 | 0.1% |
| Some Other Race | 26 | 1.3% |
| Two or More Races | 25 | 1.2% |
| Hispanic | 62 | 3.0% |

The following Figures show median annual household in the LMTW. The highest median annual household income of $75,001-$84,563 is found along the lakeshore in Lake Township/Bridgman in the North section

**Figure 18. Median Household Income, North Section**

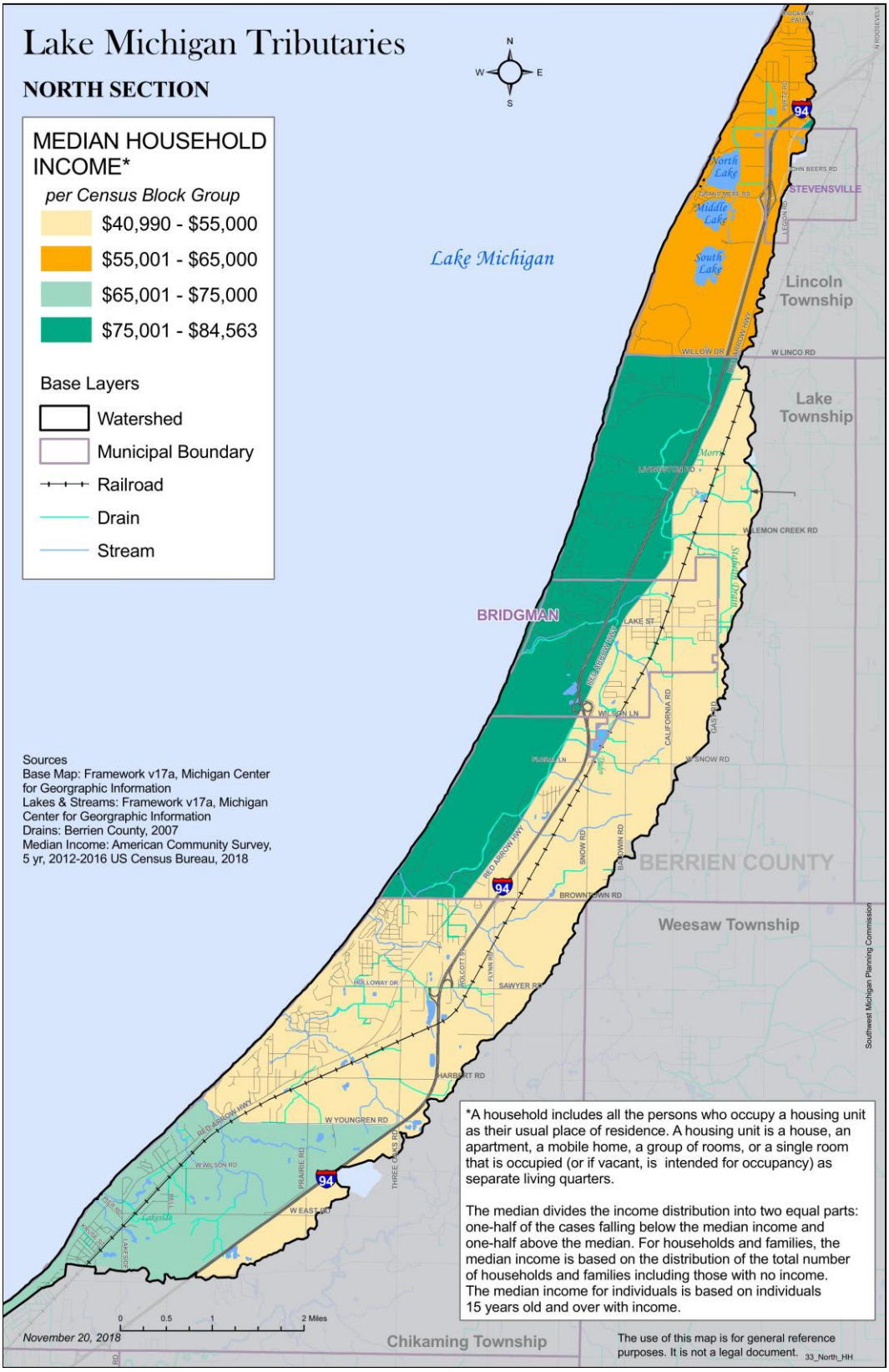
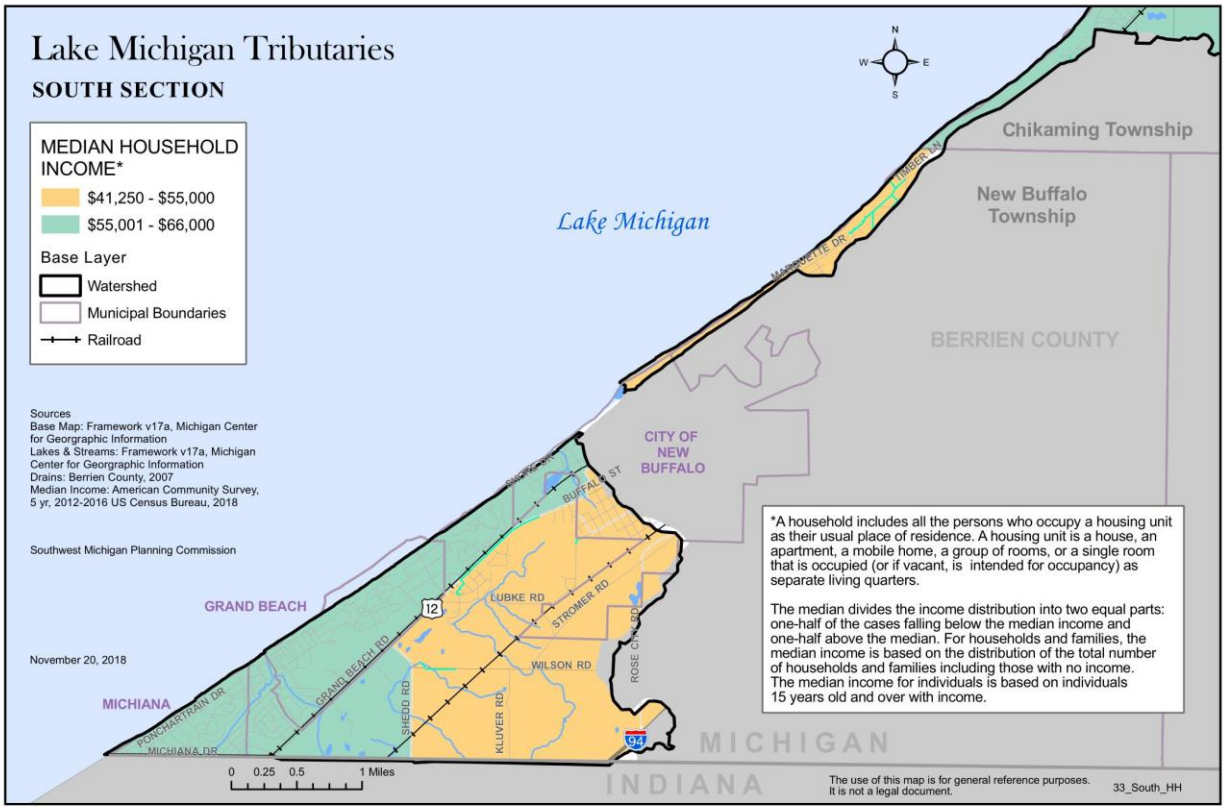


**Figure 19. Median Household Income, South Section**




## 3.3 Future Growth and Development

The LMTW has abundant natural and water resources that attract businesses and residents, as well as a significant number of tourists. Over the next few decades, the LMTW is expected to see increased demand for residential development; however, much of the available land is difficult to develop due to wetlands, soils and drainage. Furthermore, current septic and sanitary sewer conditions will require attention in order to withstand additional stresses. With a large percentage of housing being non-primary, it will be essential to educate these homeowners, many of whom reside primarily in urban areas, about the intricacies of living with septic and older sanitary sewer systems, of which they may not be accustomed. Similarly, business owners and operators will need to be made better aware of the implications of their operations on sanitary sewer systems.

For the long-term prosperity and health of these communities, the water quality and natural resources need to be recognized for their important role in the current and future economic development of the region. It will be imperative to have thoughtful and sensitive planning of these and other developments to ensure that the water quality and natural resources and the services they provide are protected and that water quality that is currently compromised is improved. For more information on economic development and natural resources visit www.swmpc.org/growgreen.asp.

# 4 Resource Management

Federal, state, county and local governmental units and their agencies have exclusive, or share, responsibility for the management and protection of water, land and other natural resources. Local entities are obligated to comply with federal and state environmental statutes, county level ordinances and local ordinances. In the case of surface water protection, the federal and state laws generally provide a national or statewide strategy for water quality protection. Because of their broad-scale nature there are often gaps in protection efforts. This presents opportunities for county and local governmental units to enact ordinances or standards that will support a more comprehensive water quality protection strategy.

For more information on opportunities for local government to protect water and other natural resources consult the "Filling the Gaps" documents at www.swmpc.org/gaps.asp.

## 4.1 Land Use and Water Quality

The way land is managed, patterns of land use in relation to natural resources, and especially the way water is managed on a site to support the land use, has a large impact on the quality of water and the ecology of lakes, rivers, streams and shorelands. The authority to regulate land use rests primarily with local governments, largely through master plans and zoning ordinances. In addition, counties have the authority to enact ordinances that could affect the management of land. As a result, city, village, and township governments have a significant role to play in protecting water resources. This role presents itself where federal and state statutes and county ordinances leave off. For example, Michigan is currently the only state in the U.S. that does not regulate septic systems on a statewide basis. Eleven counties in the state maintain some oversight of septics after installation, but Berrien is not one of them.

The authority to regulate land use rests primarily with local governments. This gives cities, villages and townships a significant role in protecting water resources.

It is essential to plan for land uses with respect to existing natural features, soils and drainage patterns to lessen the impacts to water quality. Certain uses and activities should be located in areas where their impacts to water will be minimized. From a watershed perspective, land use will not only affect the immediate area, but also downstream areas and water bodies, as is clearly demonstrated by the E. coli-related beach closings' links to upstream issues.

Once the placement of different future land uses (high density residential, low density residential, commercial, industrial, etc.) are located with respect to soils, natural features, water bodies and drainage patterns, there should be great attention to how the land is developed. Land development can have a significant impact on water quality. The impacts to water quality that commonly result directly from development activity and increased drainage to support land development can be minimized through the use of smart growth and low impact development techniques. For more information on low impact development techniques visit www.swmpc.org/lid.asp.

Roads and Water Quality

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important. For example, the salting and sanding of roads during the winter can be a major pollution concern. The following Figures show where there are road-stream crossings in the LMTW, of which there are 174 in the North section and 24 in the South section. (The road/stream crossings are locations of culverts and bridges. The layer was created by automation, finding the intersection of drains and creeks with the road data. Therefore, the crossings sites are a possible location and have not been verified.)

Roads are a land use that can have substantial impacts on water quality. Controlling roadway-related pollution during project planning, construction and ongoing maintenance is important.

Poorly designed and maintained road crossings across creeks and streams can lead to damaging erosion and may block fish movement. MDOT and County Road Commissions are responsible for the construction and maintenance of most roads in the LMTW. However, the management of local roads is often shared with townships, cities and villages. In addition, many cities and villages have their own road systems, which they maintain. The Southeast Michigan Council of Governments (SEMCOG) published a guidance document designed to promote good planning practices and endorse consideration and integration of environmental issues into transportation projects. This guidance document is available on-line at www.swmpc.org/downloads/enviro_transpo_guidance.pdf.

**Figure 20. Road-Stream Crossings – North Section**

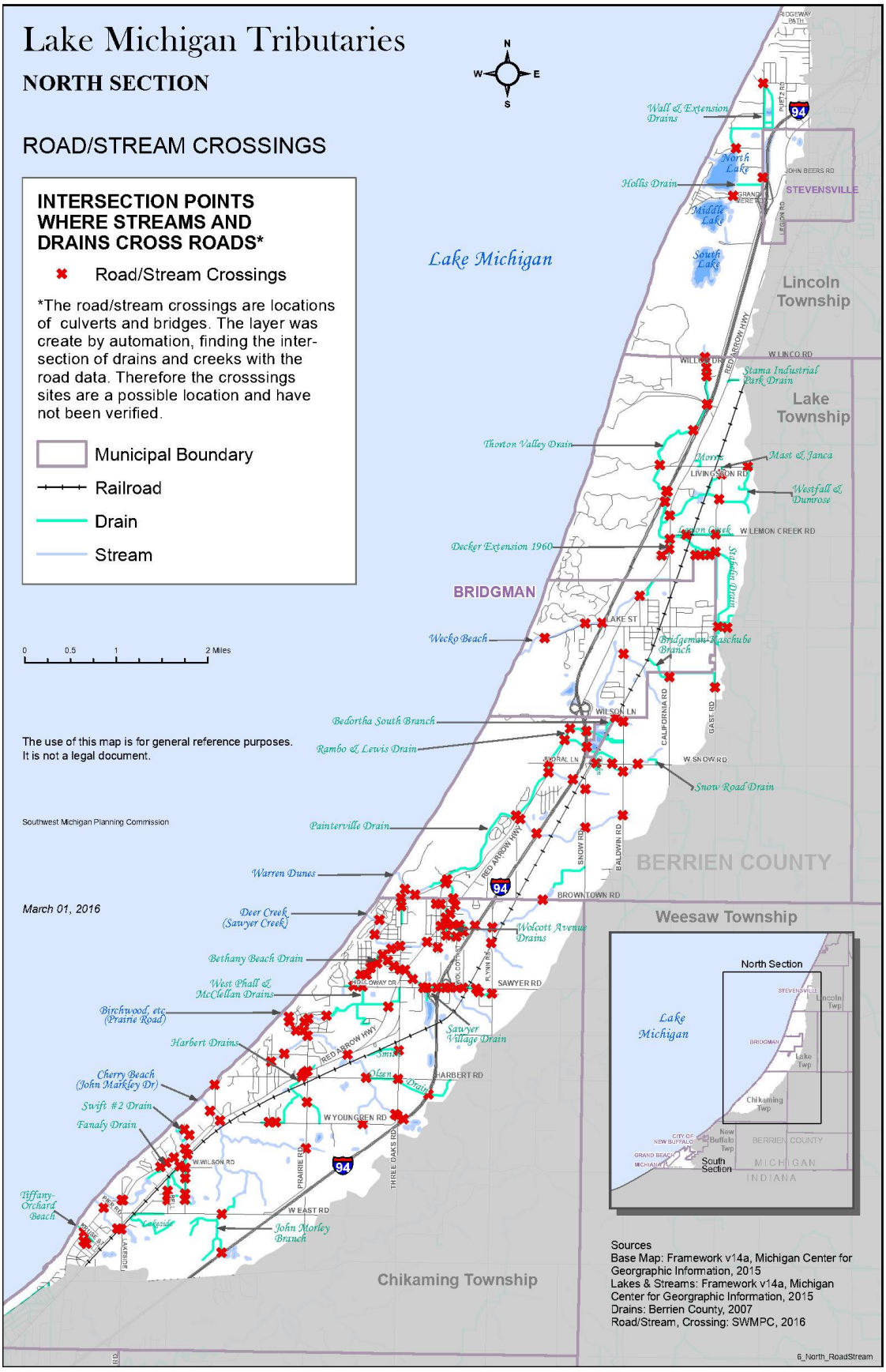
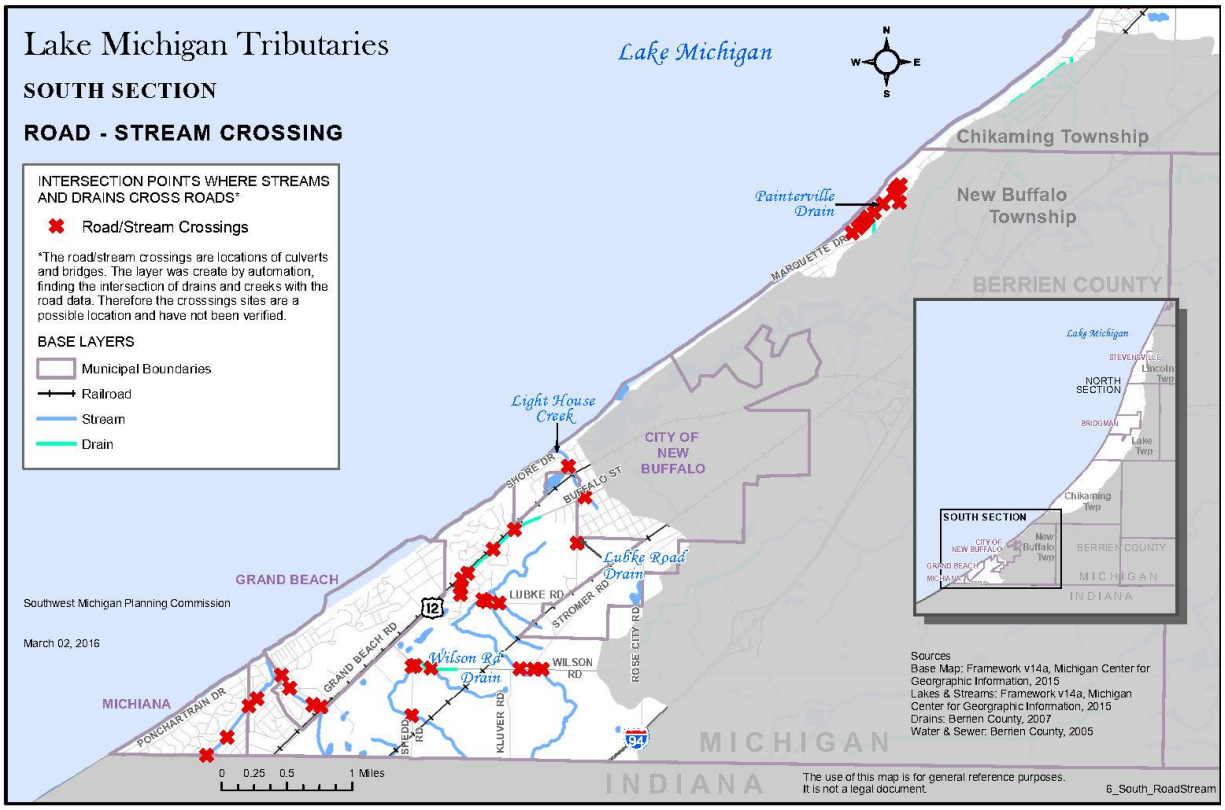


**Figure 21. Road-Stream Crossings, South Section**




## Water and Sewer Lines

The Galien River Sanitary District (GRSD) Sewer Authority is an intergovernmental agency responsible for wastewater treatment in the LMTW area, serving the City of New Buffalo, New Buffalo Township, Chikaming Township, the city of Bridgman, and Lake Charter Township.

A three-year study funded by a MDEQ SAW grant to assess the state of the sewer systems in the GRSD found that failing sewer pipes and lift stations, and leakage and corrosion in the evident in the aging system. With a significant 95 miles of sewer line, the 77% of lift stations at risk for failure, and indeed, some having already failed, compounds the likelihood of the sewer system compromising the quality of streams and groundwater. Wherever those leaking sewer lines come in contact with streams or groundwater there is contamination, which is often, considering the overall miles of sewer lines and number of lift stations.

The study also noted that an ongoing significant problem throughout the GRSD system has been the infiltration of stormwater into the sewer system during rain events, putting a strain on a system developed to deal with only wastewater. The solutions under development addresses two major courses of action that could help alleviate problems: raise the capacity of the system; and stem the infiltration of stormwater with the wastewater. However, what remains unclear is to what degree the issue of the exfiltration that results is being recognized and addressed.

The following Figures show water and sewer service in the North and South sections of the LMTW. The Table below shows the feet and miles of sewer line and water line in the North and South section of the LMTW.

**Figure 22. Water and Sewer Service, North Section**

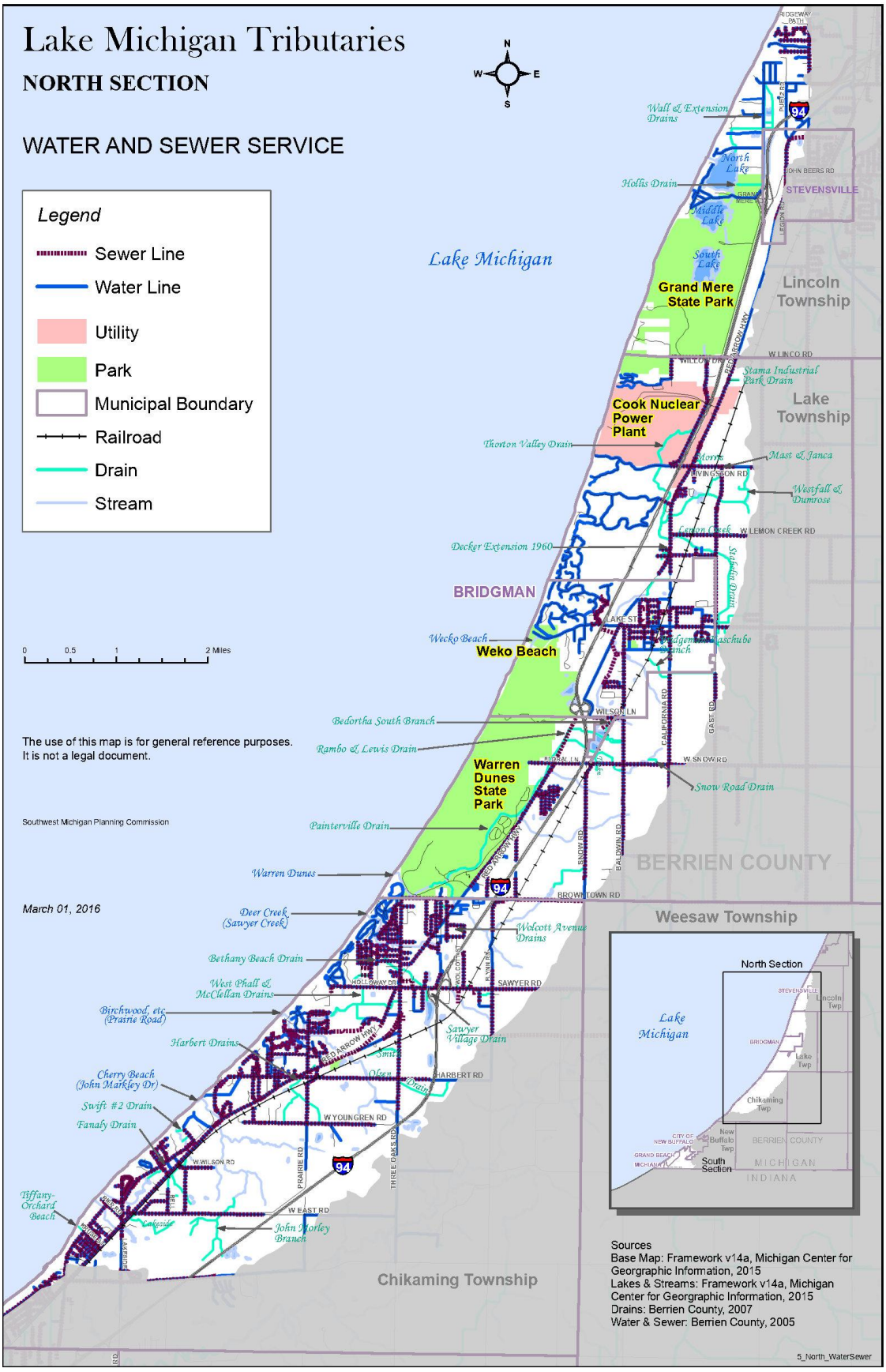


**Figure 23. Water and Sewer Service, South Section**

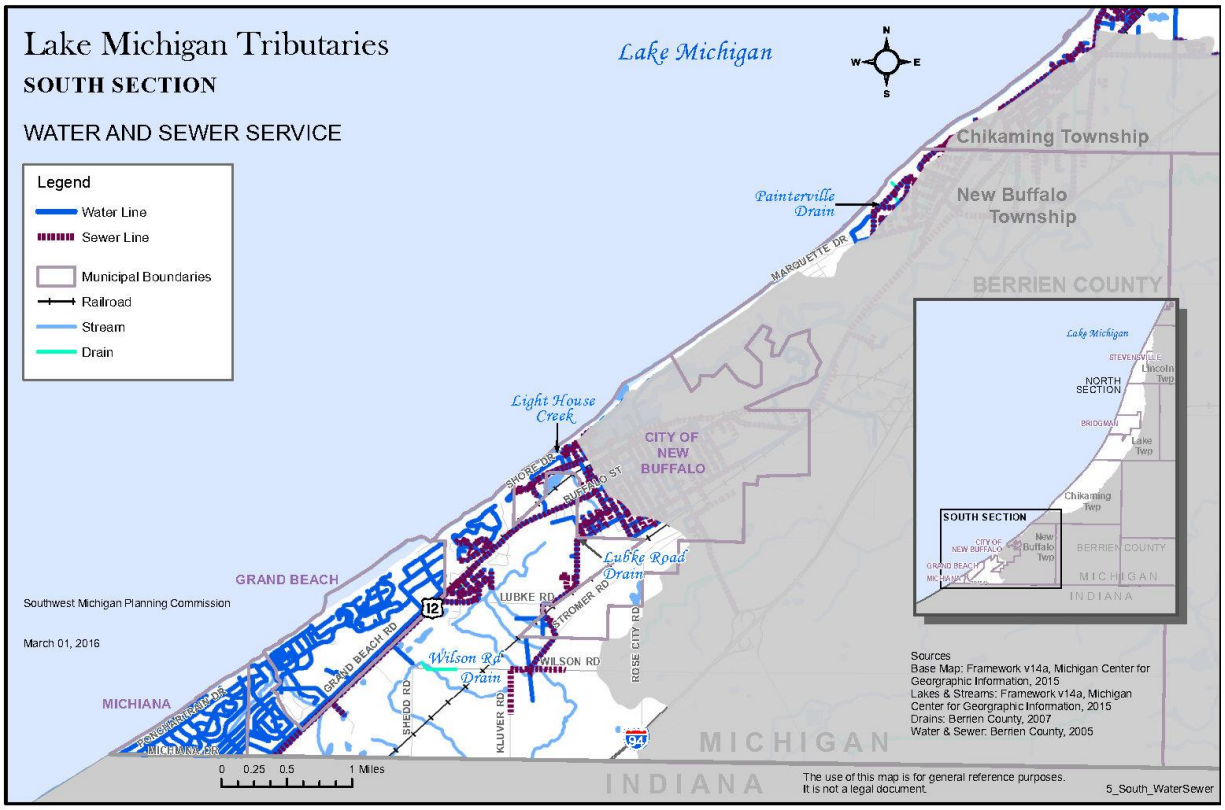



**Table 15. Sewer and Water Lines, North and South Sections, Feet and Miles**

| | Sewer line (feet) | Water line (feet) | Sewer line (miles) | Water line (miles) |
|---|---|---|---|---|
| North Section | 435,407 | 640,472 | 82 | 121 |
| South Section | 65,877 | 199,357 | 12 | 38 |
| **Total** | **501,284** | **839,828** | **95** | **159** |

## 4.2 Regulatory Authority and Water Resources

Water Bodies (rivers, drains, streams, lakes)

The Michigan Department of Environmental Quality (MDEQ) regulates water bodies in the watershed based on the Natural Resources and Environmental Protection Act, PA 451, part 301 Inland Lakes and Streams. This program oversees activities including dredging, filling, constructing or placement of a structure on bottomlands, constructing reconfiguring, or expanding a marina, interfering with the natural flow of water or connecting a ditch or canal to an inland lake or stream. It also requires a permit from the Water Resources Division of the DEQ for certain construction activities on inland lakes and streams. Cities, villages and townships should enact ordinances that further protect the water quality of lakes and streams. Model ordinances to protect water quality can be found at www.swmpc.org/ordinances.asp.

MDEQ also regulates any discharges to lakes or streams such as those from industrial operations or municipal wastewater treatment plants through the National Pollutant

Discharge Elimination System (NPDES) program. Further, the MDEQ administers the Phase II stormwater program, which requires owners or operators of municipal separate storm sewer systems (MS4s) in urbanized areas to implement programs and practices to control polluted stormwater runoff. Berrien County Road Commission, Berrien County Drain Commissioner and Administration, Grand Beach Village, Michiana Village, Stevensville Village, Bridgman City and Lincoln Township participate in the Phase II stormwater program. More information on this program is available at www.swmpc.org/lsjr.asp.

The County Drain Commissioner is responsible for the administration of the Drain Code of 1956, as amended. The duties of the Drain Commissioner include the construction and maintenance of drains, determining drainage districts, apportioning costs of drains among property owners, and receiving bids and awarding contracts for drain construction. The Drain Commissioner also approves drainage in new developments and subdivisions and maintains lake levels. The soil erosion and sedimentation program is housed in the Drain Commissioner's office. The County Enforcement Agent for the soil erosion program has the responsibility of ensuring earth change activities that are one or more acres in area and/or within 500 feet of a watercourse or lake do not contribute soil to water bodies.

Wetlands

Michigan is one of two states that has the authority to administer section 404 of the Clean Water Act dealing with wetland protection. The Michigan Department of Environmental Quality regulates wetlands; however, MDEQ does not regulate all wetlands. Wetlands are regulated by MDEQ if they meet any of the following criteria:

- Connected to one of the Great Lakes.
- Located within 1,000 feet of one of the Great Lakes.
- Connected to an inland lake, pond, river, or stream.
- Located within 500 feet of an inland lake, pond, river or stream.
- Not connected to one of the Great Lakes or an inland lake, pond, stream, or river, but are more than 5 acres in size.
- Not connected to one of the Great Lakes, or an inland lake, pond, stream, or river, and less than 5 acres in size, but the DEQ has determined that these wetlands are essential to the preservation of the state's natural resources and has notified the property owner.

Local governmental units can enact building setbacks and a no disturb zone around wetlands to help protect water quality.

Since there are gaps in state protection of wetlands, a local unit of government (city, township, village, county) has the authority to create wetland regulations. A local wetland ordinance must be at least as restrictive as state regulations and the MDEQ must be notified if there is a local wetland ordinance in effect. Approximately 50 communities in Michigan have adopted local wetland ordinances. Although, none of these are in the LMTW, Chikaming Township requires building setbacks and a no-disturb zone around wetlands, which can be just as effective as a wetland ordinance.

Floodplains

The Michigan Department of Environmental Quality requires that a permit be obtained prior to any alteration or occupation of the 100-year floodplain of a river, stream or drain to ensure that development is reasonably safe from flooding and does not increase

flood damage potential. Local ordinances restricting development in floodplains can be more restrictive than MDEQ regulations.

All communities in the LMTW participate in Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) (see Table 9). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. The program is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods. The overall intent of NFIP is to reduce future flood damage through community floodplain management ordinances and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

Groundwater

Locally, the health department plays a role in groundwater protection with the regulation of the installation and design of septic systems. Local units of government have the authority to require the maintenance of septic systems through a septic system maintenance district ordinance. Another local groundwater protection option is a point of sale inspection ordinance for septic systems. With this ordinance, when property is sold there is a requirement to inspect the septic system. In the LMTW there are no septic-related ordinances.

At the state level, the Department of Environmental Quality and the Department of Agriculture and Rural Development monitor groundwater use. All large quantity withdrawals, defined as having the capacity to withdraw more than 100,000 gallons of water per day average over any 30-day period, equivalent to 70 gallons per minute pumping, must be registered and water use must be reported annually. The Comprehensive State Groundwater Protection Program is a statewide program that looks at groundwater uses, including drinking water, and its role in sustaining the health of surface water bodies (rivers, streams, wetlands, marshes). The Wellhead Protection Program is intended to protect the drinking water supply. The program minimizes the potential for contamination by identifying and protecting the area that contributes water to municipal water supply wells and avoids costly groundwater clean-ups. Currently, no government units in the LMTW have a Wellhead Protection Program in place.

## 4.3 Local Water Quality Protection Policies

Local governments regulate land use mostly through master plans and zoning ordinances. The Table below presents a list of governmental units in the LMTW that possess master plans and zoning ordinances as well as participation in the FEMA NFIP. Community participation in the NFIP is voluntary and based on an agreement between local governmental units and the Federal Government that states if a governmental unit will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas, the Federal Government will make flood insurance available within the community as a financial protection against flood losses.

It is crucial that master plans and zoning ordinances be living documents and are updated regularly. It is also essential that these documents relate water quality and natural resource protection to the safety and welfare of the residents, tourists and community and address the connection between land use and water quality. Further,

the plans should discuss the negative impacts of increased impervious surfaces and the need for stormwater management and low impact development techniques to protect water quality. Lastly, the plans should include language on natural resources (lakes, wetlands, streams, riparian buffers, woodlands, open space etc.) and their value to the community and their role in protecting water quality. The following provides provision guidelines for zoning ordinances:

**1. Waterbody Protection**

- require adequate building setbacks along rivers/drains and wetlands
- require naturally vegetated buffers along streams, rivers, lakes and wetlands
- floodplain protection regulations

**2. Site Plan Review Process**

- show the location of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns on site plans
- show and label all stormwater best management practices on the site plan (rain gardens, swales, etc)
- site plan review criteria – require the preservation of natural features, such as lakes, ponds, streams, floodplains, floodways, wetlands, woodlands, steep slopes, and natural drainage patterns to the fullest extent possible and minimize site disturbance as much as possible
- require drain commissioner review of stormwater management during the site plan review process
- require the use of native plants in all landscaping plans and vegetative stormwater Best Management Practices (BMPs) (to help reduce storm water velocities, filter runoff and provide additional opportunities for wildlife habitat)
- require the use of Low Impact Development techniques whenever feasible (see Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers at www.swmpc.org/downloads/lidmanual.pdf

**3. Open Space Preservation**

- use bonus densities or other incentives to encourage open space developments
- require all Planned Unit Developments (PUDs) to provide 25-50% open space
- require open space areas to be contiguous and restrict uses of open space area to low impact uses

**4. Parking Lots and Roads – Reducing Impervious Surfaces**

- allow for more flexibility in parking standards and encourage shared parking
- require a portion of large paved parking lots to be planted with trees/vegetation
- require treatment of stormwater parking lot runoff in landscaped areas
- require 30% of the parking area to have compact car spaces (9 x18 ft or less)
- require space for bicycle parking in parking lots
- allow driveways and overflow parking to be pervious or porous pavement
- use maximum spaces instead of minimums for parking space numbers
- require landscaped areas in cul-de-sacs and allow hammerheads
- allow swales instead of curb and gutter (if curbs are used require perforated or invisible curbs, which allow for water to flow into swales

**5. Stormwater BMPs** (refer to "Low Impact Development for Michigan: A Design Guide for Implementers and Reviewers" at www.swmpc.org/downloads/lidmanual.pdf or see model stormwater ordinance at www.swmpc.org/ordinances.asp )

- allow the location of bioretention areas (rain gardens, filter strips, swales) in required setback areas and common areas

- encourage the use of BMPs that improve a site's infiltration and have BMPs labeled and shown on site plans
- require use of native plants for landscaping plans and for runoff/stormwater controls (prohibit invasive and exotics species)
- require use of BMPs and encourage use of above ground BMPs instead of below ground stormwater conveyance systems
- prohibit direct discharge of stormwater into wetlands, streams, or other surface waters without pre-treatment
- require periodic monitoring of BMPs to ensure they are working properly and require that all stormwater BMPs be maintained

**Table 16. Zoning, Master Plans and NFIP Participation by Governmental Unit**

| Governmental Unit | Zoning? | Master Plan Date* | FEMA NFIP Participation |
|---|---|---|---|
| Bridgman City | Yes | 2015 | Yes |
| Chikaming Township | Yes | 2014 (update in process) | Yes |
| Grand Beach Village | Yes | 2009 | Yes |
| Lake Charter Township | Yes | 2007 | Yes |
| Lincoln Charter Township | Yes | 2013 | Yes |
| Michiana Village | Yes | 2005 (draft) | Yes |
| New Buffalo City | Yes | 2003 | Yes |
| New Buffalo Township | Yes | 2009 | Yes |
| Stevensville Village | Yes | 2018 | Yes |

*Master Plans can be found at https://www.swmpc.org/planlibrary.asp

Chikaming Township has implemented specific protection regulations for the Lake Michigan Tributaries. Ordinances that mandate building setbacks along water bodies and wetlands, could provide protection of water quality. These setbacks would also provide room for a stream to meander and change its course over time. A building setback of at least 100-150 feet is ideal (this width may need to be increased if the floodplain is wider or if it is a coldwater stream).

### 4.4 Private Land Management

Beyond, federal, state and local laws protecting water quality, the greatest opportunity to protect and preserve water quality and natural resources rests with the landowner in how they manage their lands. Most of the land in the watershed is in private ownership. For the LMTW, communication with land owners about the importance of proper septic care and maintenance is a key component of successful implementation on this Plan. Many organizations are willing to provide technical assistance to landowners on how to better manage their lands to protect natural resources and water quality. These organizations include: MSU County Extension Offices, Chikaming Open Lands, Conservation Districts, Natural Resources Conservation Service, Southwest Michigan Land Conservancy, The Nature Conservancy, Department of Natural Resources and United States Fish and Wildlife Service (Partners for Wildlife Program).

# 5 Natural Features

The natural features of the LMTW provide ecosystem services that benefit humans, such as recharging groundwater, cleansing air and filtering water. These natural features also provide recreational opportunities including swimming, hiking, fishing, hunting and boating.

## 5.1 Recreation and Conservation

The Figures below show the recreation and protection areas in the LMTW. These lands include those owned by Michigan Department of Natural Resources, Southwest Michigan Land Conservancy (SWMLC), Chikaming Open Lands (COL) and cities, villages and townships. These organizations work to create, preserve, and maintain natural areas for the enjoyment and life-enrichment of area residents and tourists.

Warren Dunes and Grand Mere State Parks have by far the largest acreage of the conservation and recreation lands in the LMTW (1430, 1104 respectively). Chikaming Open Lands has a combined total of 276 acres for preserves and conservation easements.

The Table below shows recreational activities participation in the LMTW and Berrien County. Swimming and fishing are the top activities; this is seriously threatened by the impacts of water-quality issues in the LMTW.

**Figure 24. Parks, Recreational Area, and Conservation Lands, North Section**

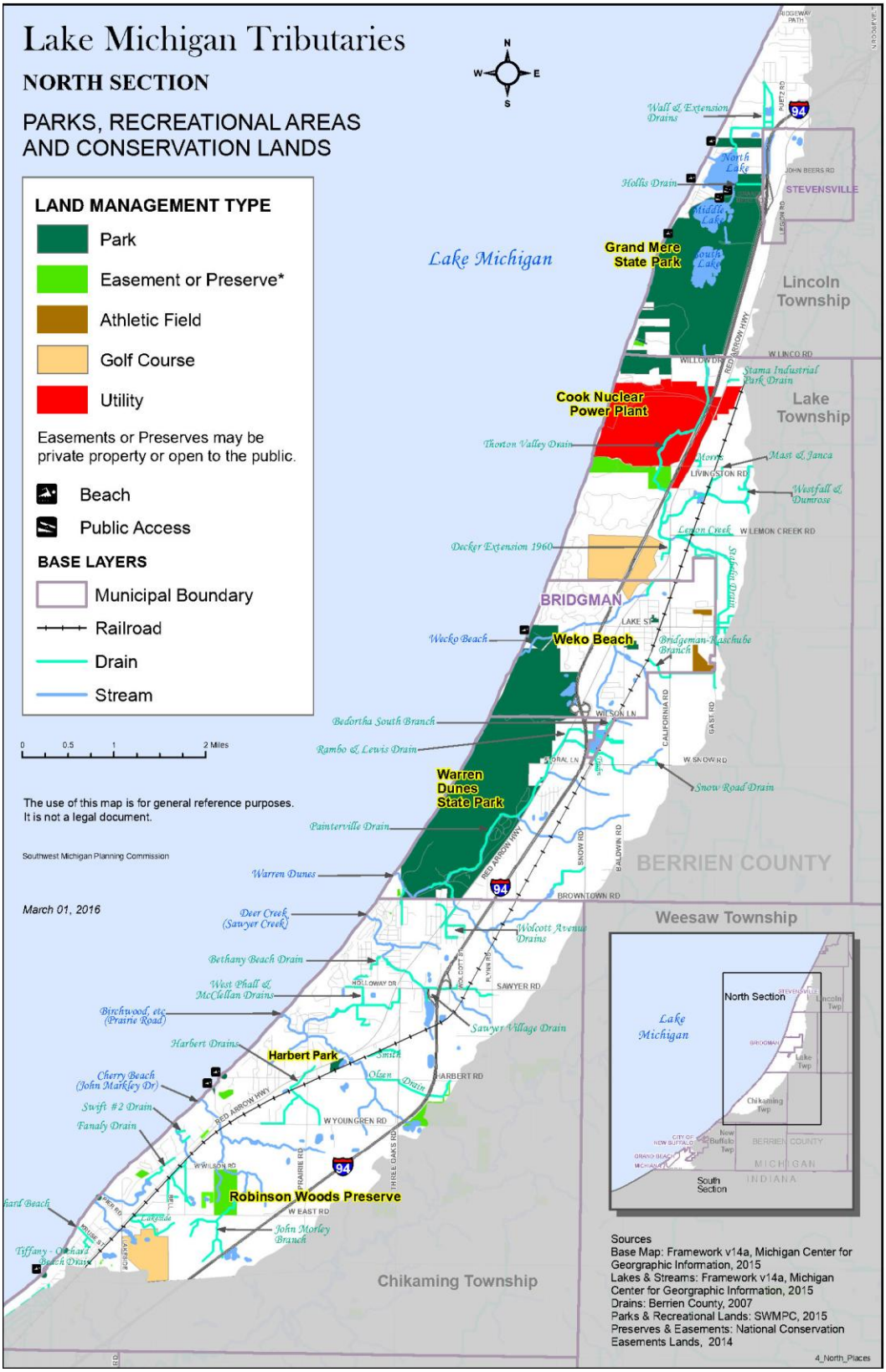


**Figure 25. Parks, Recreational Area, and Conservation Lands, South Section**

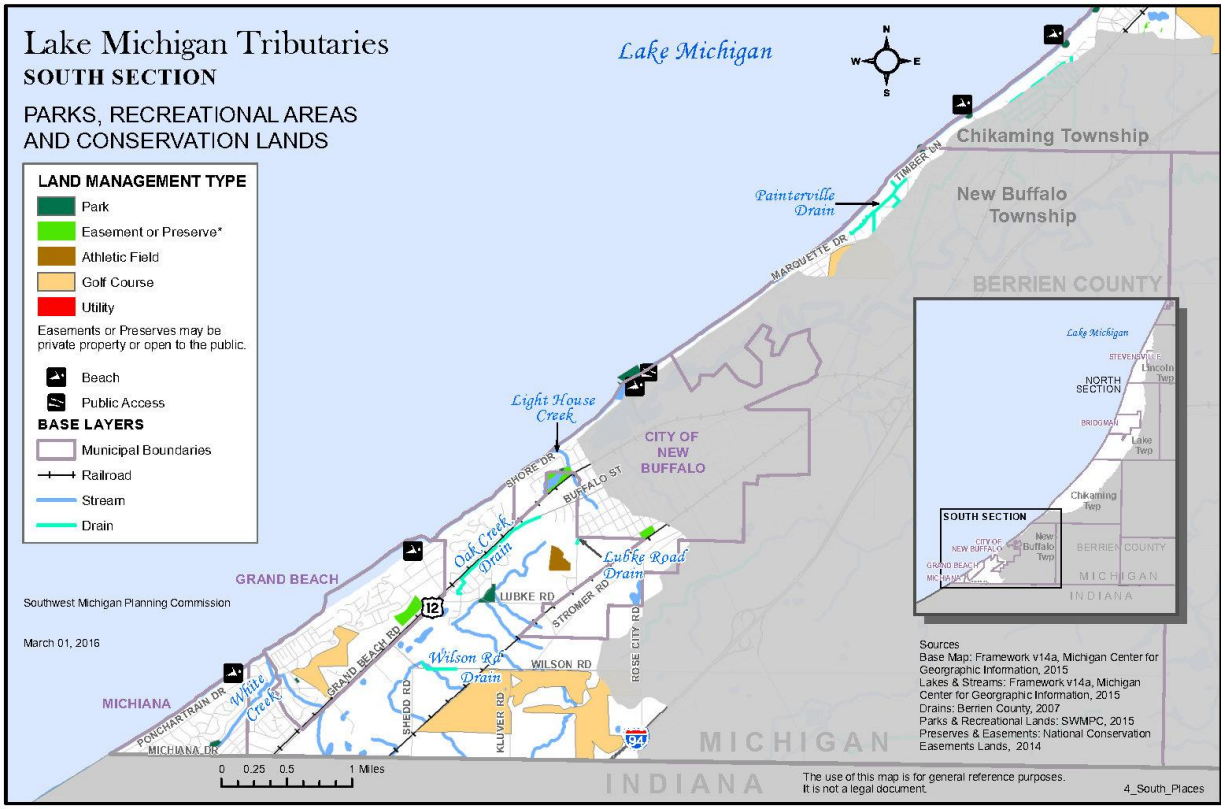


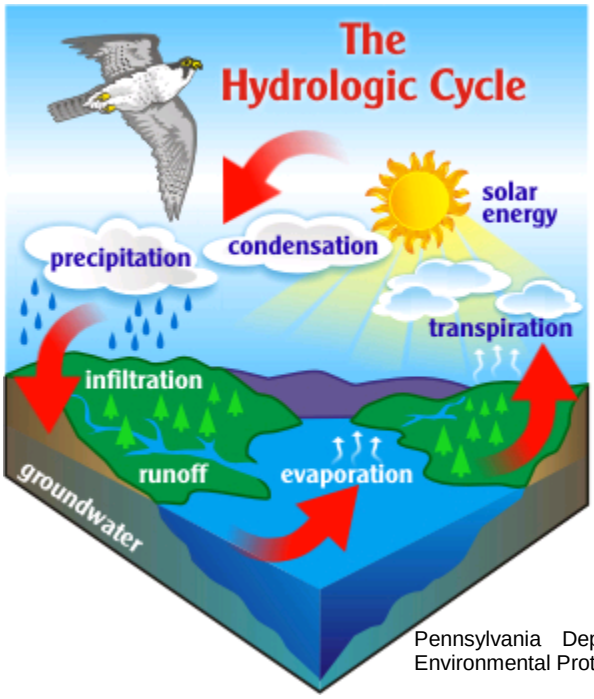

**Table 17. Recreation participation LMT/Berrien County**

| Participated in in last 12 months – 2015 | LMT South | LMT North | Berrien County |
|---|---|---|---|
| **Backpacking** | 73 | 162 | 3,172 |
| **Bicycling (road)** | 194 | 634 | 11,920 |
| **Boating (power)** | 180 | 560 | 7,855 |
| **Canoeing/kayaking** | 134 | 424 | 7,548 |
| **Fishing (fresh water)** | 276 | 1,181 | 19,193 |
| **Hiking** | 210 | 559 | 11,206 |
| **Swimming** | 318 | 1,068 | 19,088 |

Source: Esri ArcGIS Community Analyst

## 5.2 Generalized Hydrologic Cycle

The earth's water is one large, continuous feature that exists within a complex and dynamic cycle and is commonly categorized as distinct features such as surface water, groundwater and wetlands. Although the cycle has no beginning or end, it is convenient to describe the generalized cycle with a starting point of surface water. Water evaporates from oceans, lakes and other surface waters to the atmosphere and is carried over land surfaces, where it condenses and is precipitated onto the land surfaces as rain, snow, etc. Some water will drain across the land as runoff into a water body. The land cover will affect how this water moves across the land. If the surface soil is permeable, some water will infiltrate to the subsurface under the influence of gravity and will saturate the soil and/or rock. This zone of saturation is recognized as groundwater. Due to gravity, groundwater generally moves from areas of higher elevations to lower elevations to locations where it discharges to wetlands and/or surface water (lakes, streams, rivers). Wetlands may be viewed as a transition of groundwater to surface water, and vice versa.




Pennsylvania Department of Environmental Protection

A properly functioning hydrologic cycle is greatly dependent upon the land cover and natural features in the watershed. Natural vegetation, such as forested land cover, usually has high infiltration capacity and low runoff rates.

Groundwater has been compromised in the LMTW due to elevated E. coli levels from leaking septage causing impairments in this watershed.

Impervious areas (buildings, parking lots and roads) and networks of ditches, pipes and storm sewers, which augment natural stream channels, can also have a significant impact on runoff and groundwater resources.

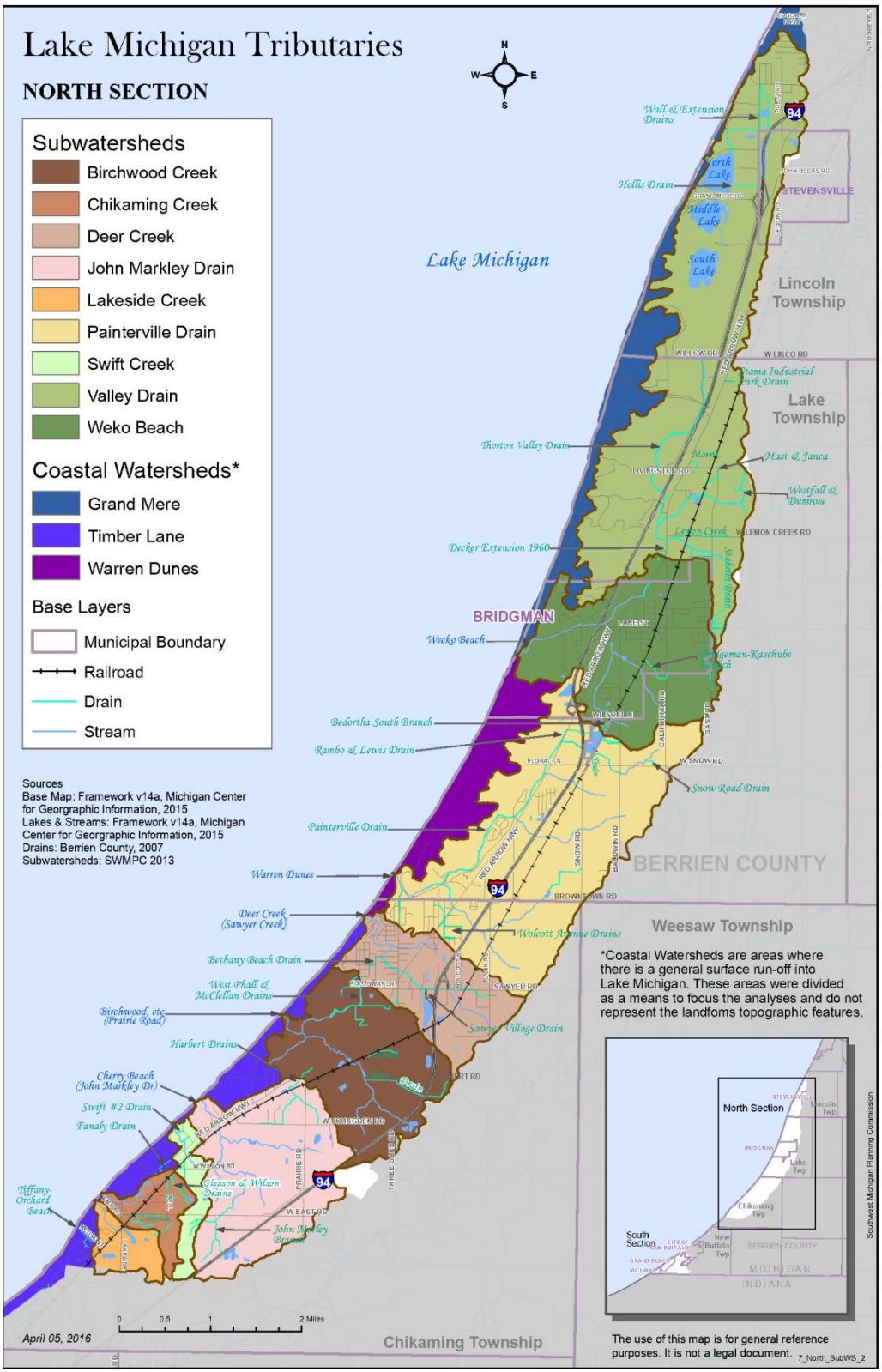
The impacts resulting from land use change also negatively impact the fragmented natural areas left in the watershed. Following is a discussion of the different natural communities found in the LMTW and the major threats to their existence and quality. The interdependent natural systems and communities discussed in this chapter include streams, lakes, wetlands, groundwater, floodplains, forests, coastal dunes, oak savanna and prairie remnants and rare species.

## 5.3 Streams

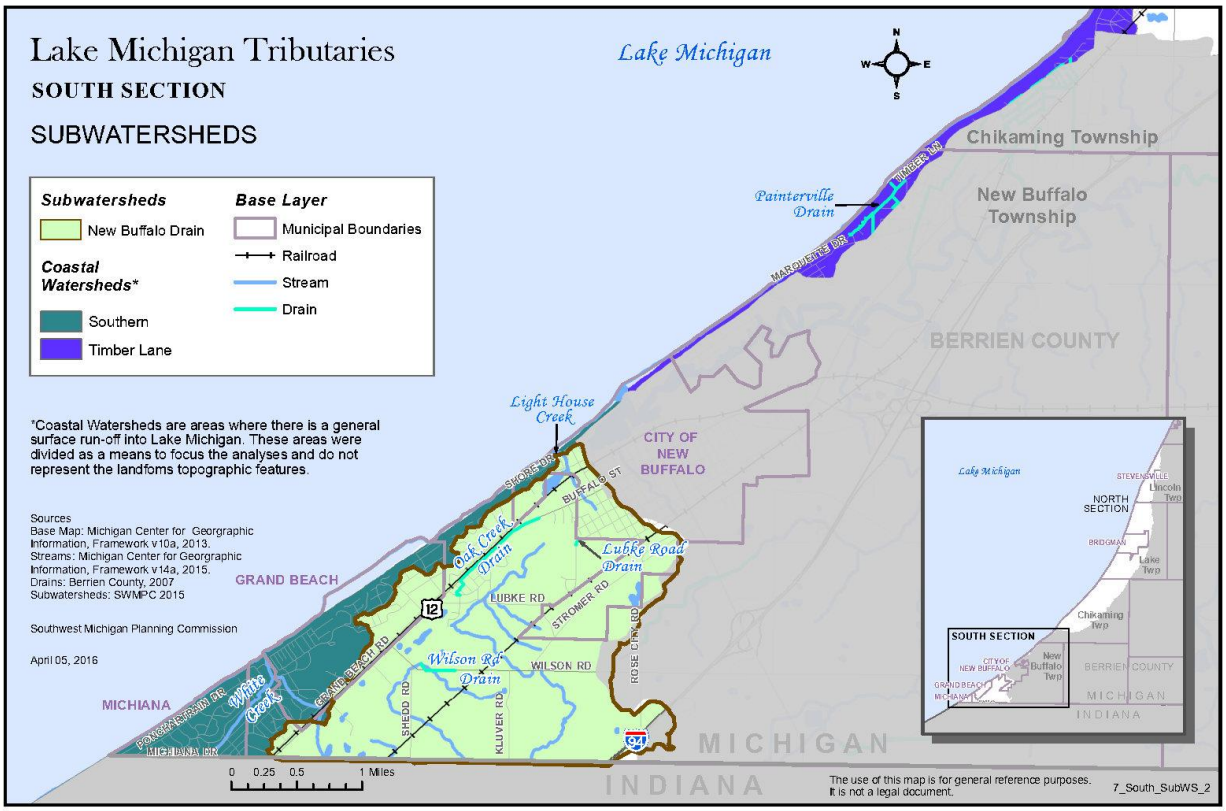
The Lake Michigan Tributaries subwatersheds drain directly to Lake Michigan and are a priority for improvement due to high levels of E. coli. These streams are either already compromised or threatened due to failing septic and sanitary sewer systems allowing human waste to infiltrate the streams. As these streams empty directly into Lake Michigan, E. coli-related beach closings are the result. Historical beach closure rates reflect insufficient testing and the need to introduce more widespread and frequent testing practices. The following Figures show the streams LMTW.

The Table below lists the subwatersheds/streams in the Lake Michigan Tributaries Watershed.

**Figure 26. Lake Michigan Tributaries Watershed, North Section**



## Figure 27. Lake Michigan Tributaries Watershed, South Section




## Table 18. Subwatersheds in the Lake Michigan Tributaries Watershed

| Name | Total Area (Acres) |
|---|---|
| Birchwood Creek | 1,575.08 |
| Chikaming Creek | 327.42 |
| Deer Creek | 1,028.46 |
| Grand Mere | 1,000.76 |
| John Markley Drain | 1,671.03 |
| Lakeside Creek | 268.16 |
| New Buffalo Drain | 2,754.73 |
| Painterville Drain | 3,310.56 |
| Southern (White Ditch) | 808.12 |
| Swift Creek | 254.36 |
| Timber Lane | 951.49 |
| Valley Drain | 4,274.55 |
| Warren Dunes | 749.95 |
| Weko Beach (Tanner Creek) | 1,934.44 |
| **Totals** | **20,909.11** |

Threats

As discussed at the beginning of this chapter, E coli is a major threat to the streams in the Lake Michigan Tributaries Watershed. This management plan is intended to address the major threats to surface water.

## 5.4 Lakes

There are four inland lakes totaling 171 acres that lie behind the dunes in the undeveloped natural area in and around Grand Mere State Park. These waters offer fishing, boating and hunting opportunities. Middle and South Lakes are within the State Park; a boat launch provides access to Middle Lake. Lake Ann has seven acres on state land and two acres on the Fairmount Minerals Property. North Lake Park, located at the northern end of the State Park features a shelter, picnic area and fishing.

The lakes are significant waterfowl and songbirds migrating areas and provide a unique ecological area that encompasses the full range of open water aquatic to closed forest terrestrial communities. Within the inland lakes area, the fragrant water lily, yellow waterlily, pickerel weed and various pond weeds can be found. South Lake contains wild rice, pitcher plant and humped bladderwort. All the lakes in Grand Mere State Park provide excellent habitat for reptiles and amphibians. North & Middle Lakes support populations of bluegill, pumpkinseed, yellow perch, black crappie, largemouth bass and northern pike.

The glaciers that scooped out the Great Lakes 10,000 years ago also carved out a number of smaller depressions along the western edge of the state, which evolved into interdunal lakes, ponds, and wetlands. At one time, this area contained a chain of five such lakes that were protected ecologically by a line of windblown sand dunes between them and Lake Michigan. Now there are only three, a result of aquatic succession. Beginning at North Lake, you can see how each lake is progressively disappearing, with open water first turning into marsh and then woodland swamps and closed bog forests, the fate of the former two lakes that lie south of the park. The following Figure shows the lakes in the area of Grand Mere State Park; the Table below lists the lakes and their approximate acreage.

**Figure 28. Lakes in the Lake Michigan Tributaries Watershed**


**Table 19. Lakes in the LMT Watershed**

| Name | Area (Acres) |
|---|---|
| North Lake | 68 |
| Middle Lake | 62 |
| South Lake | 32 |
| Lake Ann | 9 |

Threats

Threats to lake environments within the watershed are primarily related to shoreline development and land uses. Residential development around lakes (in this case only North Lake) with no connection to municipal wastewater treatment facilities can increase nutrient levels and bacteria counts in the lake. With residential development, coarse woody material abundance and shoreline habitat diversity strongly declines while nutrient loading increases. Aquatic plant assemblages are also influenced by residential development, and interestingly, reproductive success of black bass nests declines almost two-fold with increasing residential development. (Kregg Smith, MDNR Fisheries Division, 2007)

Human activities negatively affect inland lake ecosystems through alterations in water quality and physical habitat. For example, increased nutrient loadings from lawn fertilizers can increase algae and aquatic vegetation to nuisance levels and decrease concentrations of dissolved oxygen when excess algae and vegetation decompose. In addition, the quantity and quality of physical habitat available to fishes in the area between high and low water marks is altered by removal of coarse woody debris, by an increase or decrease (via chemical or mechanical removal) of aquatic plants, and by homogenization of the shoreline through erosion control efforts (e.g., rip-rap and sheet piling). Such changes in water quality and habitat features have been shown to

negatively impact fish growth, limit natural reproduction of certain fish species, and reduce fish species richness while shifting assemblage structure towards more tolerant species. (Kregg Smith, MDNR Fisheries Division, 2007)

## 5.5 Wetlands

Wetlands provide critical ecosystem services such as cleansing water, storing water and providing wildlife habitat. The wetland resource base in the LMTW has undergone significant disruption in the 200 years since Michigan was settled, losing approximately 46% of its total wetland area. Wetland are crucial for a number of reasons: flood water storage to reduce flooding, streamflow maintenance for stable flows, nutrient transformation for less aquatic vegetation, shoreline stabilization for less erosion, groundwater recharge for drinking water, fish and wildlife habitat for fishing and hunting, and of particular concern for this Plan, E. coli reduction for cleaner water.

In the MDEQ Landscape Level Watershed Functional Assessment tool (LLWFA) current wetland's data, there are wetlands that follow the coastline of Lake Michigan. The area is 1,556 acres, its linear, ranging from 200 ft - 1,000 ft wide and 22 miles long. This is an extremely dynamic environment, dependent upon many factors including the depth of Lake Michigan and wind conditions. In comparison to a 2012 aerial photograph, the area includes the beach and surf zone. The National Wetland Inventory description for this wetland is a lacustrine system which includes wetlands and deep-water habitats. Extending from the shoreward boundary to 2 meters (6.6 feet) below the annual low water or to the maximum extent of nonpersistent emergents, if these grow at depths greater than 2 meters. The system has an unconsolidated bottom, in this case, sand and/or rocks with a water regime of intermittently flooded. The surface water is present throughout the year except in years of extreme drought. The area has high rankings in the functional class of fish habitat and conservation of rare and imperiled wetlands.

The following Figures show the existing wetlands in the LMTW and potential restoration areas. The Table below shows wetland acreage and restoration wetlands in the subwatersheds of the LMTW.

**Figure 29. Wetlands in the Lake Michigan Tributaries Watershed, North Section**

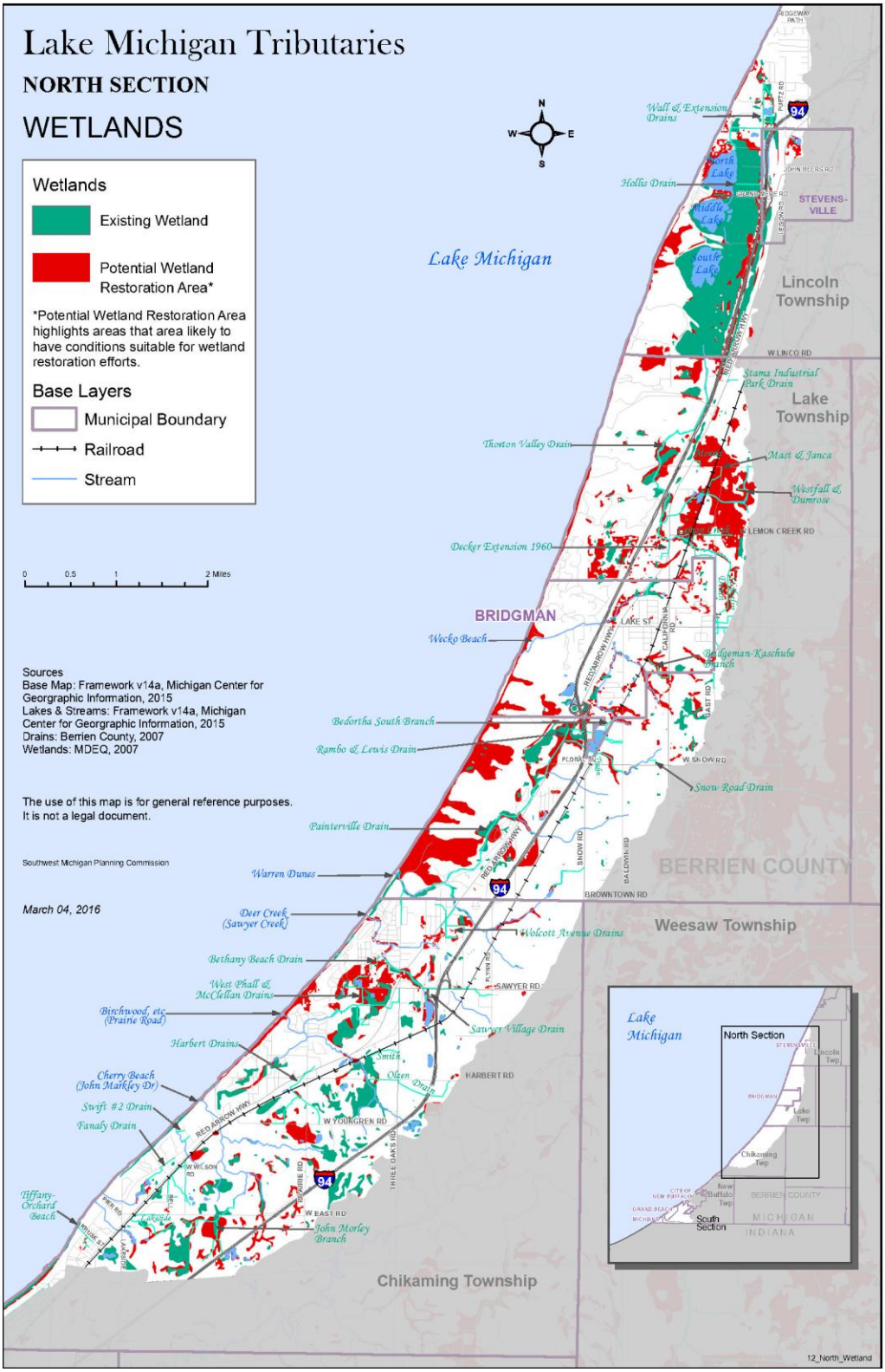


**Figure 30. Wetlands in the Lake Michigan Tributaries Watershed, South Section**

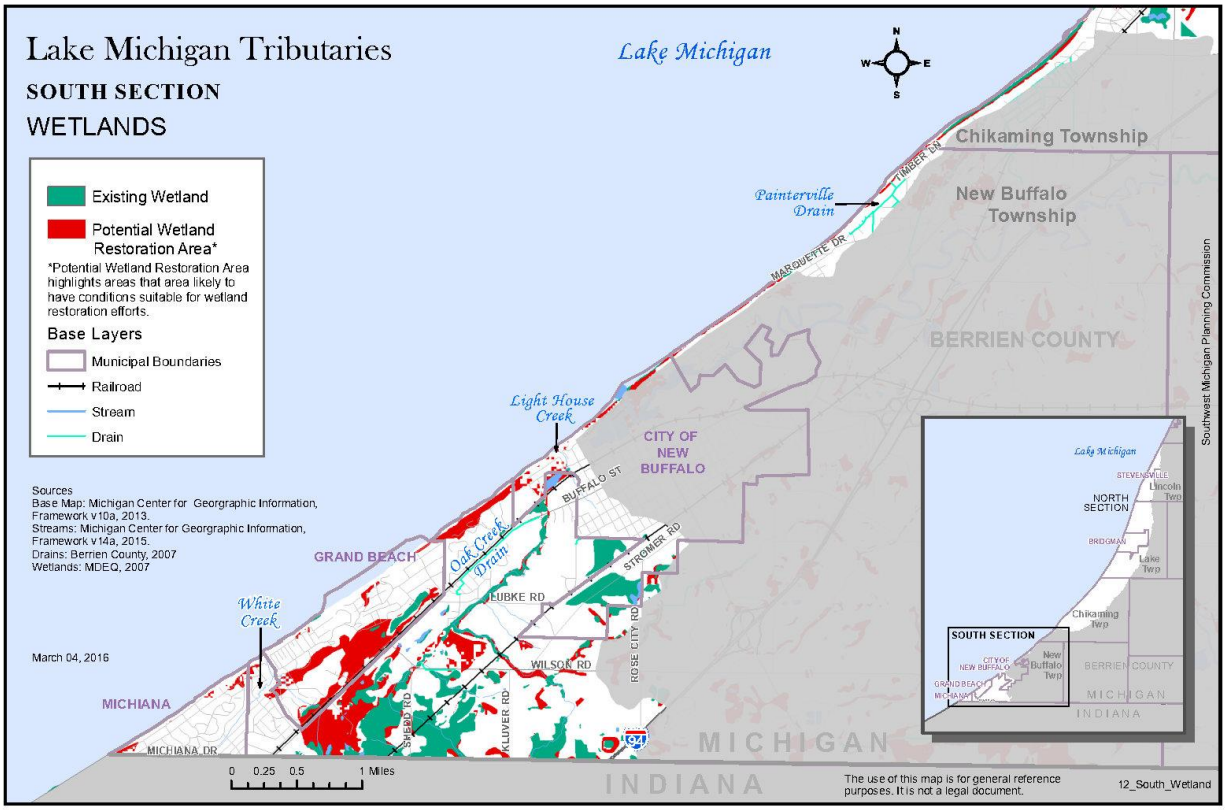



**Table 20. Wetland Acreage and Restoration Wetlands**

| Name | Watershed total acres | Wetland (acres) | Restoration wetland (acres) *Wetland acres lost* | Total wetland acres (existing and lost) | Percent wetlands lost |
|---|---|---|---|---|---|
| **Birchwood Creek** | 1,575 | 208 | 97 | 305 | 32% |
| **Chikaming Creek** | 327 | 41 | 13 | 54 | 24% |
| **Deer Creek** | 1,028 | 37 | 148 | 185 | 80% |
| **Grand Mere** | 1,001 | 7 | 42 | 49 | 86% |
| **John Markley Drain** | 1,671 | 191 | 136 | 327 | 42% |
| **Lakeside Creek** | 268 | 25 | 12 | 36 | 32% |

| Name | Watershed total acres | Wetland (acres) | Restoration wetland (acres) *Wetland acres lost* | Total wetland acres (existing and lost) | Percent wetlands lost |
|---|---|---|---|---|---|
| **New Buffalo Drain** | 2,755 | 456 | 267 | 723 | 37% |
| **Painterville Drain** | 3,311 | 169 | 194 | 363 | 54% |
| **Southern (White Ditch)** | 808 | 19 | 113 | 132 | 85% |
| **Swift Creek** | 254 | 57 | 13 | 70 | 19% |
| **Timber Lane** | 951 | 91 | 79 | 170 | 46% |
| **Valley Drain** | 4,275 | 1,036 | 684 | 1,719 | 40% |
| **Warren Dunes** | 750 | 14 | 15 | 29 | 53% |
| **Weko Beach (Tanner Creek)** | 1,934 | 62 | 251 | 314 | 80% |
| **Totals** | 20,909.11 | 2411.76 | 2,064.19 | 4,475.95 | 46% |

Threats

Historically the LMTW contained 4,476 acres of vegetated wetland or 21.4% of the total watershed area

Current threats to wetlands include filling or draining to accommodate industrial, residential, or recreational land uses. Altered hydrology is a significant threat to most wetland types, whether it is due to a change in groundwater contributions to a fen or diversion of the water that feeds a swamp or marsh due to new road construction. Exotic species invasion, altered fire regime, and polluted runoff with sediment, nutrients and chemicals also threaten wetlands.

## 5.6 Floodplains

A river, stream, lake, or drain may on occasion overflow their banks and inundate adjacent land areas. The land that is inundated by water is defined as a floodplain. In Michigan, and nationally, the term floodplain has come to mean the land area that will be inundated by the overflow of water resulting from a 100-year flood (a flood which has a 1% chance of occurring any given year). Often, floodplains are forested with silver maple (Acer saccharinum) and red ash (Fraxinus pennsylvanica) being the major over-story dominant trees. These dynamic forested systems represent an interface between terrestrial and aquatic ecosystems and are extremely valuable for storing floodwaters,

allowing areas for sediment to settle and providing wildlife habitat. The following Figures show the elevation and flood prone areas of the North and South sections of the LMTW.

**Figure 31. Elevation and Flood Prone Areas, North Section**

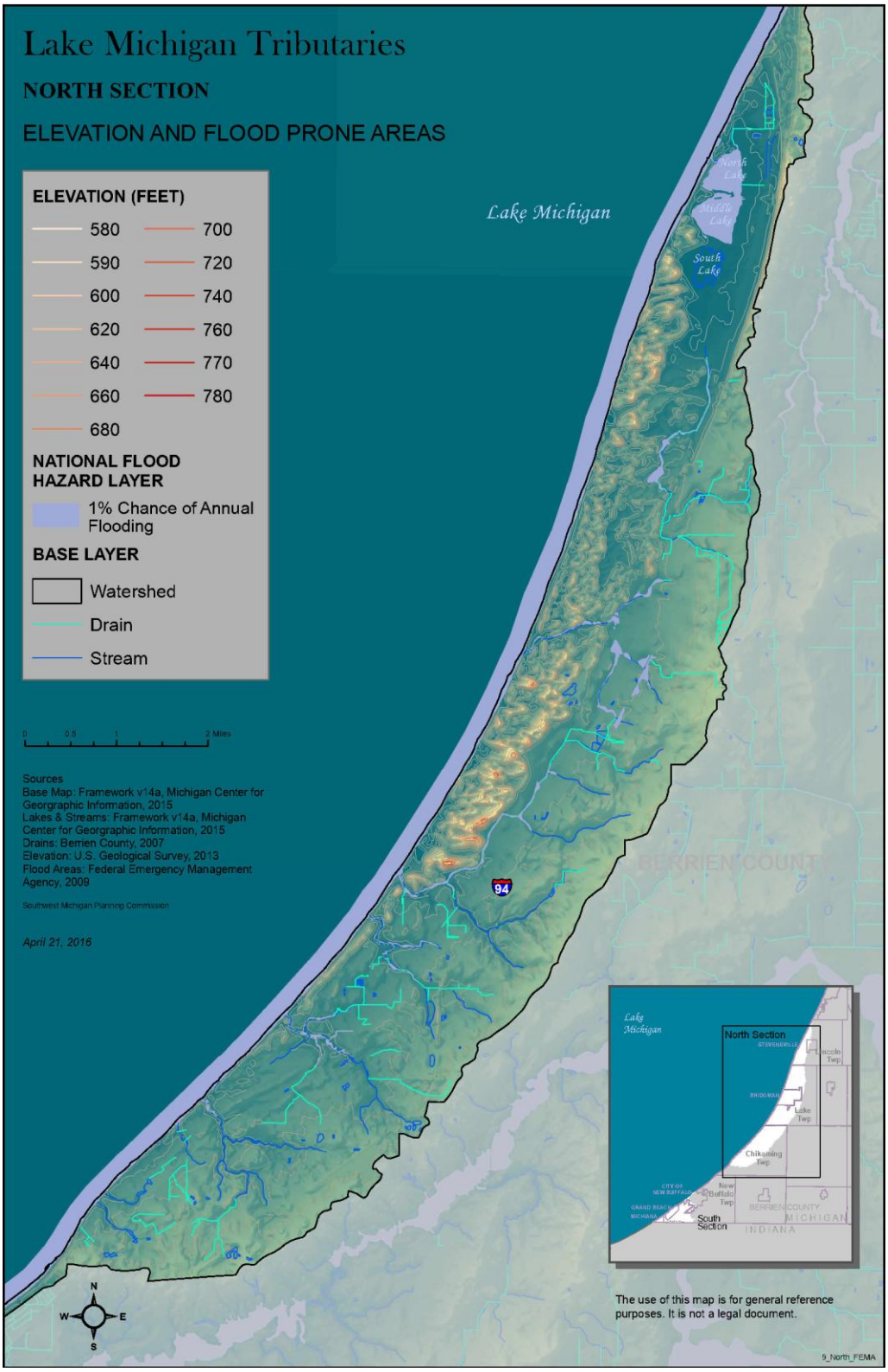
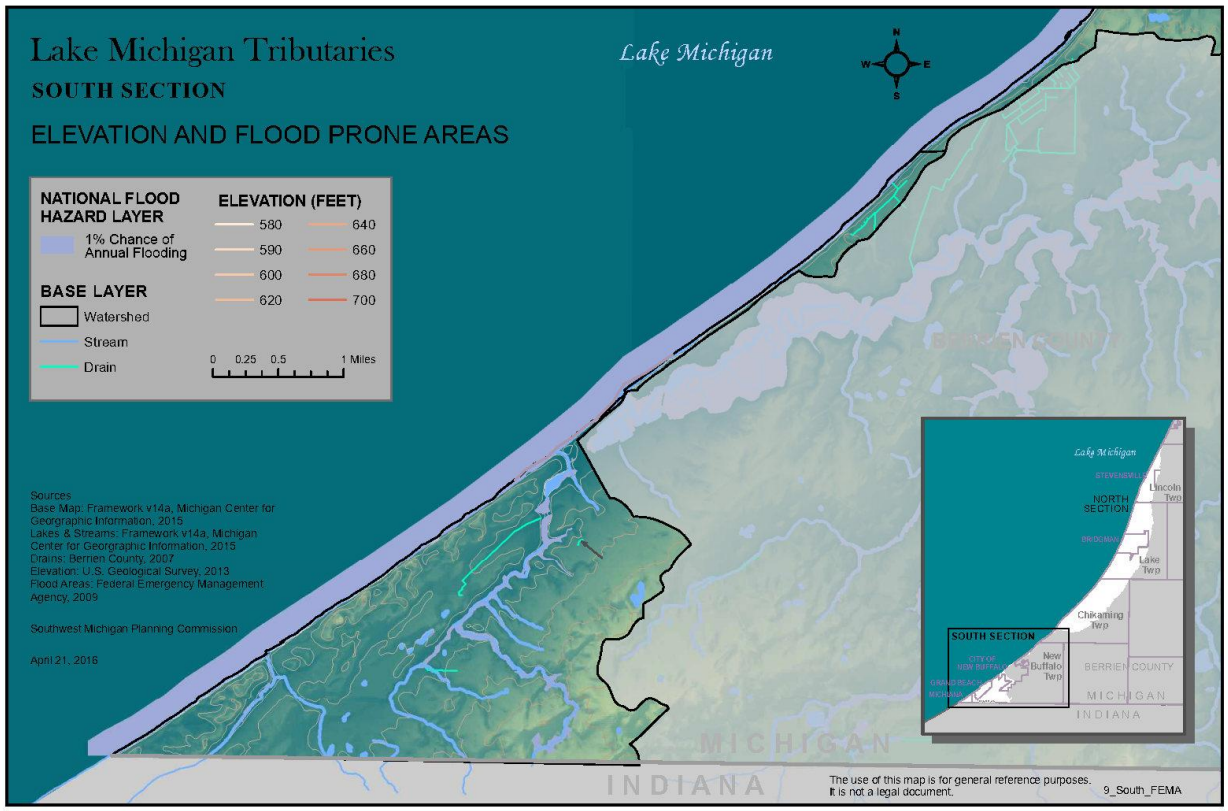


**Figure 32. Elevation and Flood Prone Areas, South Section**




Threats

Current threats to floodplains include conversion to industrial, residential, or recreational uses, wetland or floodplain fill or drainage, exotic species invasion, chemical pollution, sedimentation, and nutrient loading from agriculture and other land uses. Almost all rivers and their floodplains are subject to multiple hydrologic alterations, such as changes in land use, human-made levees, impoundments, channelization, and dams. The Nature Conservancy stated in the 2006 prioritization floodplain forest report, “even at the best floodplain forest sites, there is a serious threat from invasive species, because the forests here have extensive boundaries along agricultural lands offering numerous routes for invasion. Additional buffering of these core floodplain forest areas with more native upland forest would benefit them.”

## 5.7 Groundwater

Groundwater is the water that saturates the tiny spaces between soil and rock. Most groundwater is found in aquifers, which are underground layers of porous rock that are saturated from above or from structures sloping toward it. For water to reach the aquifer, it must be able to infiltrate through the soil.

Groundwater and surface water are fundamentally interconnected. In fact, it is often difficult to separate the two because they "feed" each other. Aquifers feed streams and provide a stream's baseflow. Those streams with a high baseflow are often coldwater streams. Often groundwater can be responsible for maintaining the hydrologic balance of streams, springs, lakes and wetlands.

Most of the LMTW is underlain with Ellsworth Shale bedrock, along with Antrim Shale Bedrock Overall, groundwater in southwest Michigan is very vulnerable to groundwater pollution.

Threats

Increased groundwater withdrawal to meet the demands of a growing population is a threat. Despite a general abundance of groundwater in the LMTW, there is growing concern about the availability of good quality groundwater for municipal, industrial, and domestic use, and for adequate baseflow to our lakes, streams and wetlands. Increased withdrawal can cause groundwater overdraft, which occurs when water removal rates exceed recharge rates. This depletes water supplies and may even cause land subsidence (the gradual settling or sudden sinking of the land surface from changes that take place underground).

In addition to groundwater withdrawals, increases in impervious surface and soil compaction limit infiltration and reduce groundwater recharge. These land use changes along with improvements in drainage efficiency (adding drain tiles, storm drains and ditches) further reduce groundwater recharge. The reduction in infiltration alters the hydrology of surface water causing increased flooding and streambank erosion.

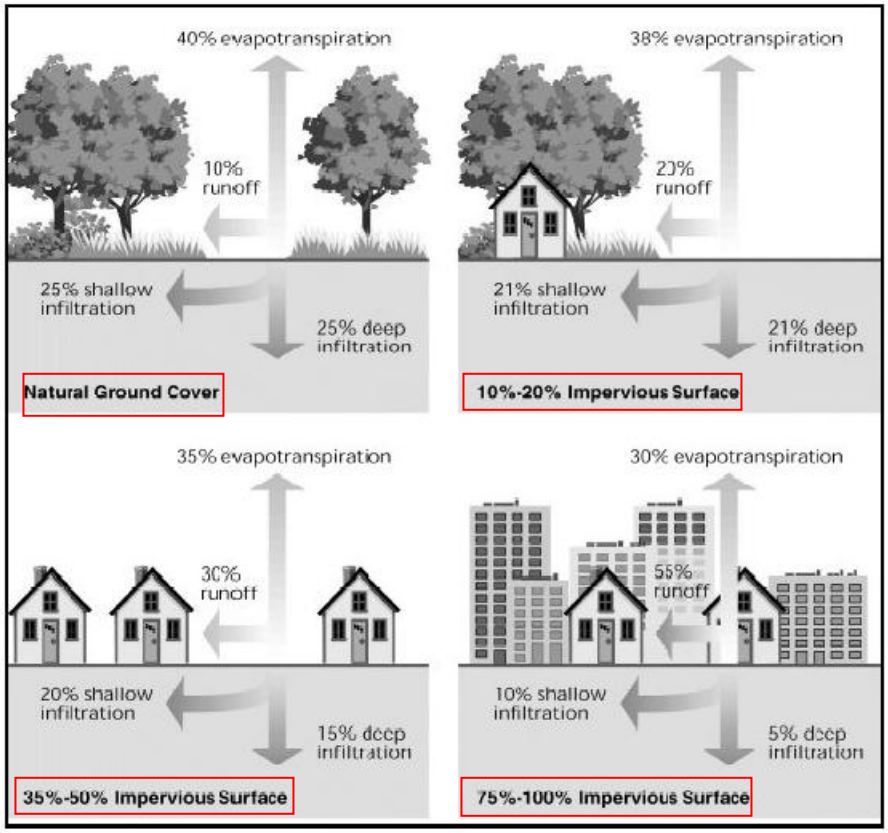



**Figure 33. Effects of Impervious Cover**

Groundwater contamination can often be linked to land use. What goes on the ground can seep through the soil and turn up in drinking water, lakes, rivers, streams and wetlands. Activities in that pose significant threats to groundwater quality in the LMTW include industrial and municipal waste disposal, road salting, and septic systems.

The following Table lists common groundwater contaminant sources.

**Table 21. Common Groundwater Contaminant Sources**

| Source | Contaminant | Source | Contaminant |
|---|---|---|---|
| Salting practices & storage | Chlorides | Industrial uses | Hazardous materials |
| Snow dumping | Chlorides | Households | Hazardous materials |
| Agricultural fertilizers | Nitrates | Gas stations | Hydrocarbons, Solvents |
| Home fertilizer | Nitrates | Auto repair shops | Hydrocarbons, Solvents |
| Septic systems | Nitrates, pathogens | Recycling facilities | Hydrocarbons, Solvents |
| Urban landscapes | Hydrocarbons, pesticides, pathogens | Auto salvage yards/junk yards | Hydrocarbons, Solvents |
| Home fertilizer | Nitrates | Underground storage tanks | Hydrocarbons |

## 5.8 Forests

Forest lands protect rivers and streams and provide habitat for many species. Forest tress and the underlying organic humus layer intercept and help to infiltrate rainfall runoff contributing to the stability of the hydrologic cycle. According to the Figures below there are significant intact forested areas, particularly closer to the coast. Woodlands of southern Michigan that are dominated by beech and sugar maple also contain red oak, basswood, white ash, tulip tree, black cherry, black walnut and bitternut hickory. Upland forests on drier soils are generally an oak and hickory composition with black, red, white, and bur oaks, shagbark and pignut hickories, black cherry, black walnut and red maple. This region also contains a Mesic Southern Forest, Michigan State Natural Resources Inventory code S3, a rare occurrence on sand dunes. Typical dry-mesic southern forests are dominated by black and white oak, with northern pin oak on the driest hilltops and ridges. Northern red oak is common in valleys, on north slopes, and on wetland edges. Dry-mesic southern forests occur on dunes, outwash, and ice-contact features, with soil textures ranging from sandy loam to sand.

**Figure 34. Land Cover in the Lake Michigan Tributaries Watershed, North Section**

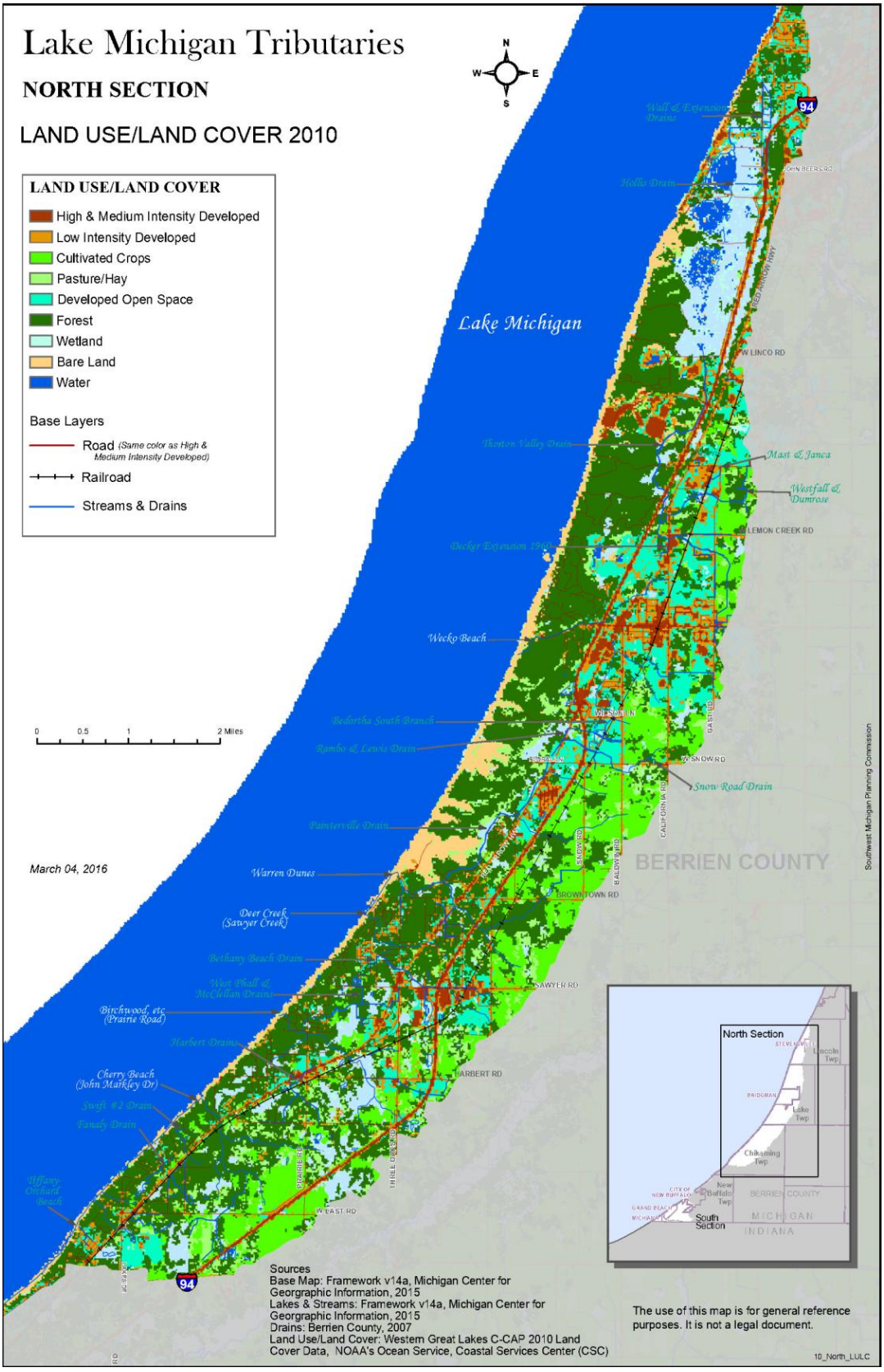
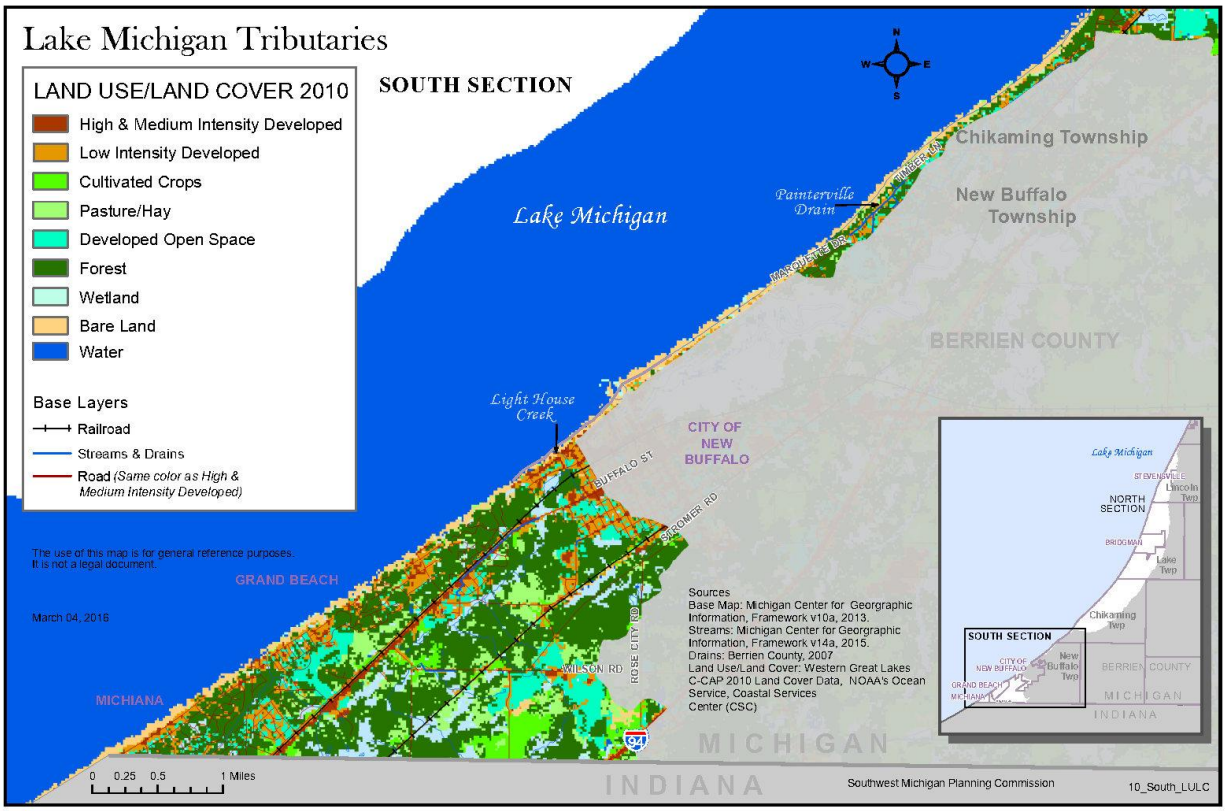


**Figure 35. Land Cover in the Lake Michigan Tributaries Watershed, South Section**




Threats

The largest threats to natural forest communities in the LMTW are continued fragmentation and invasive species (e.g., garlic mustard). Fragmentation often results in nest predation and nest parasitism (mainly by cowbirds), which accounts for population declines of forest birds, especially neotropical migrants. Fragmentation also increases the ability of invasive species to penetrate forested areas. Invasive species can disrupt the forest's role in managing water and the hydrologic cycle. For more information on forests visit www.swmpc.org/downloads/mesic_southern_forest.pdf.

## 5.9 Coastal Dunes

A combination of water erosion and wind deposition resulted in the formation of Great Lakes coastal dunes. The sand source for the coastal dunes was glacial sediment that was eroded by streams and by waves eroding bluffs along the Great Lakes shoreline. These sediments were then moved along the Great Lakes shoreline by nearshore currents, and then deposited along the shoreline by wave action. Strong winds then carried the sands inland, creating dunes.

Coastal dune sand is generally free of silt and clay, has a common range of grain sizes, and is generally more rounded than other types of sand deposits. Coastal dunes usually reach a height of over 100 feet above the surrounding terrain and form prominent knolls, peaks, mounds, and ridges. When not stabilized by vegetation, they are extremely unstable and migrate in the direction of the prevailing winds. The dunes front directly on the lake in places, while at others there is a significant beach between the dunes and the water. A dynamic landscape, parts of the dunes are stabilized, while other parts are actively eroding or being buried by additions of sand.

Unusual plant habitats are to be found in the sand dunes along the eastern shoreline of Lake Michigan, where a combination of coarse soils, diverse terrain, reduced summertime evaporation and daytime temperature, an extended growing season, and a moderation of severe winter cold because of the nearby water has permitted an extraordinarily rich mixture of plants to coexist. Within Berrien County particularly, small areas of dune landscape contain a greater number of plants than is found in any other comparably sized area of the state.

The high-relief dunes in Grand Mere are a unique natural phenomenon not found anywhere else in the world; Warren Dunes has a dune formation that rises 260 feet above the lake.

The following Figures show designated and critical dune areas of the LMTW.

**Figure 36. Designated Critical Sand Dune Area, North Section**

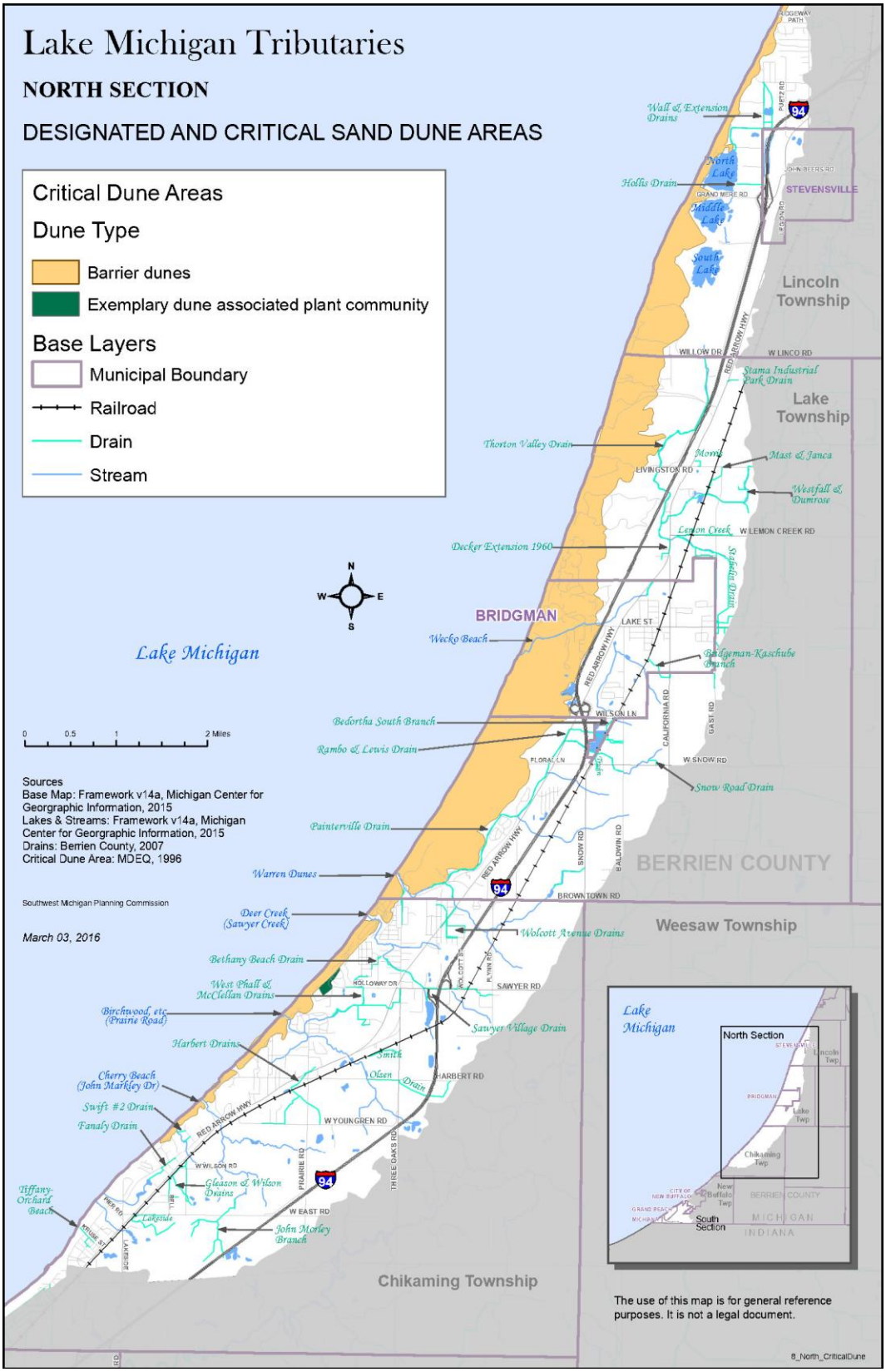
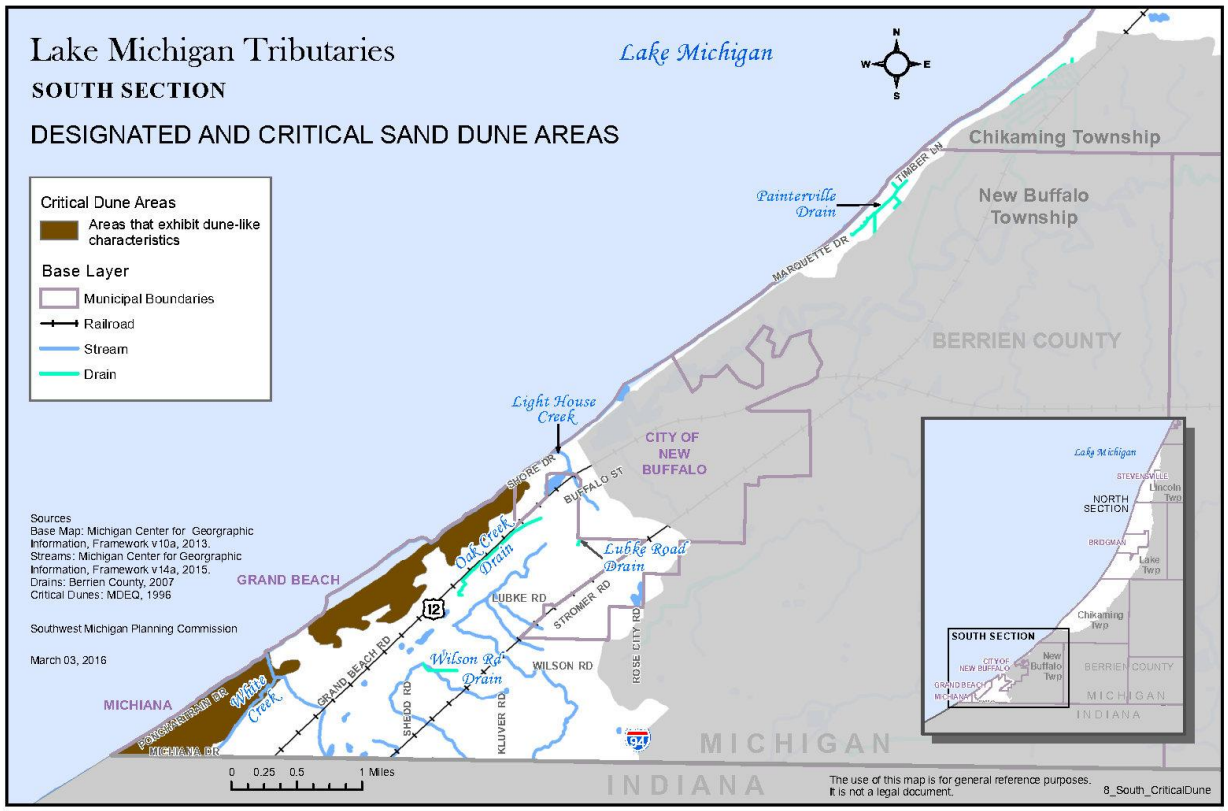


**Figure 37. Designated Critical Sand Dune Area, South Section**




Threats

Major threats to open dunes include off-road vehicles, recreational overuse, residential development, sand mining, and invasive plants and animals. While blowouts are a natural occurrence, their frequency is greatly exacerbated by human activities that erode vegetation cover. Off-road vehicles and recreational overuse can destroy plants that stabilize dunes, leading to large blowouts during heavy storms and significantly reducing vegetation cover from both massive wind erosion and burial of existing flora and fauna. Eliminating illegal off-road vehicle activity is a primary means of protecting the ecological integrity of open dunes and associated shoreline communities. Residential development destroys dune habitat, results in introductions of invasive plants, and prevents natural dune movement, which many dune plants require. In addition, roaming pets disrupt ground-nesting birds, some of which are globally rare. Sand mining directly destroys dunes. Invasive plants can eliminate native dune plants through competition for resources and by stabilizing dunes, which results in the loss of plants that rely on shifting sand and facilitates conversion to closed-canopy forest.

## 5.10 Savanna and Prairie Remnants

The LMTW has oak savanna and prairie remnants. Southwest Michigan is part of the tallgrass prairie region, which is dominated by grasses such as big bluestem and Indian grass. The tallgrass prairie vegetation sometimes reaches a height of 10 feet or more. Oak savannas, characterized by a grassy prairie-type ground cover underneath an open tree canopy, are common in areas that border the prairies. Prairies and oak savannas are fire-dependent systems.

Oak savanna and prairies support many species such as the Eastern box turtle and the Great Plains spittlebug. These systems in the LMTW also support plants that are rare in Michigan and indicative of high-quality savannas, including Rattlesnakemaster, prairie coreopsis, sand grass, and black haw. The savannas with their native plants play an integral part of the hydrologic cycle by providing areas where water can easily infiltrate the soil. For more information on oak savannas visit www.swmpc.org/downloads/oak_barrens.pdf.

Threats

The largest threat to savanna areas is the conversion to developed uses. Developing these natural areas can disrupt the natural water infiltration capacity of these areas. In addition, invasive alien plants have become extensively established in oak savanna and prairie remnants. These aggressive species are encouraged by the conversion of open lands to homes. Development creates large amounts of disturbed open ground and roadways that are new invasion routes for invasive species. Increased human recreational and other activities connected to development also tend to spread invasive plants' seeds further into natural areas. Suppression of natural fire regimes in developed areas further encourages the dominance of invasive over native plants, which are often adapted to recurring fire. Invasive plant species can actually result in reduced groundwater recharge, which disrupts the hydrologic cycle.

## 5.11 Rare Features

Berrien County is known for its diverse habitats and rare species, especially along the coastline.

Threats

The major threat to rare species and features is habitat loss and fragmentation. As natural habitats become more fragmented and disrupted, invasive species can be accidentally or deliberately introduced into high quality habitat areas. Invasive species can displace or eliminate native species, particularly rare species that have specific habitat requirements. Invasive species can substantially alter the structure and functioning of high-quality natural communities including an alteration of the amount of water that is infiltrated. Further, new construction can affect groundwater infiltration rates and consequently reduce the amount of water discharging from a spring. An altered hydrologic cycle can change the conditions necessary for the continued health of rare species populations and some natural communities such as prairie fens.

# 6 Plan Development Process

This LMTW Management Plan was developed utilizing the best available data along with input from stakeholders. The planning process included

- soliciting public input
- meetings with municipal officials
- the use of scent tracking dogs to determine priority areas
- reviewing previous studies and reports
- conducting research on topics of concern such as wetland functions, floodplain forests, and hydrology

## 6.1 Public Input

Initial public participation and project awareness were utilized to initiate the necessary involvement of residents and businesses to ensure project success. Project partners hosted two successful, very well attended workshops – a well water testing night and a wetlands workshop. SWMPC also gave a presentation to Western Michigan University's Public Health students about the project.

A stakeholder meeting was held to discuss the E. coli contamination issue and to review the results from 2016. All municipalities were present along with the Drain Commission, Health Dept and GRSD. Following this meeting, the stakeholders asked SWMPC and the Pokagon Fund to send out a press release.

SWMPC created maps for each municipality and held follow up meetings with all of the municipalities and the GRSD to go over sampling strategy and to do some in the field investigations. New Buffalo Township, Grand Beach Village and Bridgman all went out in the field with SWMPC to investigate problem areas. SWMPC developed a follow up strategy based on the feedback and investigations. The maps can be found in the Appendix: Localized E. coli Maps.

Project partner include: Chikaming Open Lands, The Conservation Fund, Great Lakes Scientific Berrien County Health Department, Great Lakes Scientific Lab, and Southwest Michigan Planning Commission.

The media assisted in alerting watershed stakeholders and residents about the LMTW Management Plan including articles in local newspapers and a story on NPR detailing the efforts of the scent tracking dogs.

## 6.2 Watershed Research – Scent Tracking Dogs/E. coli Sampling

Canine scent detection, or sewage-sniffing dogs, by Environmental Canine Services LLC (ECS) has been nationally recognized for the past ten years as an effective tool for assisting with detection of illicit sewage discharges into stormwater systems and surface waters. In 2012 The Conservation Fund hired ECS to look for illicit connections and

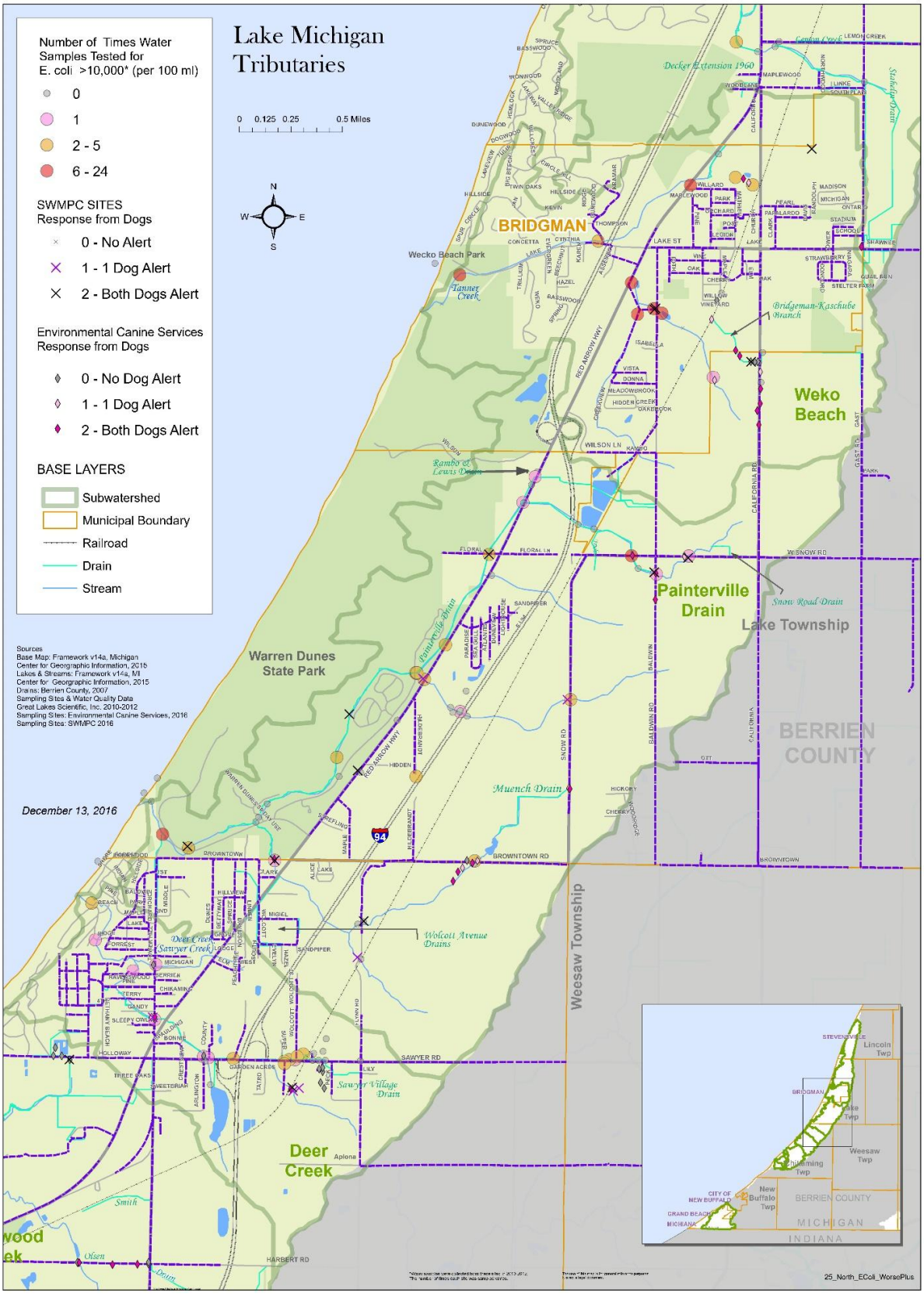
direct pipes to the White, Pier Street north and south, John Markley, Birchwood, Swift Road, and Deer Creeks to determine if there was human septage. The dogs are trained to alert if there is human septage and the places where alerts occurred is described as part of the creek description.

A new rapid and cost-effective method for screening water samples anywhere in the country for the presence of sewage contamination was added by ECS in 2014. The method, called “Ship and Sniff”, consists of collecting water samples from areas of concern and shipping them to ECS, using strict quality control protocol, for the canines to scent test. The canines only alert to the presence of human sewage, not to animal fecal contamination. The screening results, along with laboratory testing of samples and other methods, can help provide valuable information for further monitoring efforts or planning for source tracking investigations.

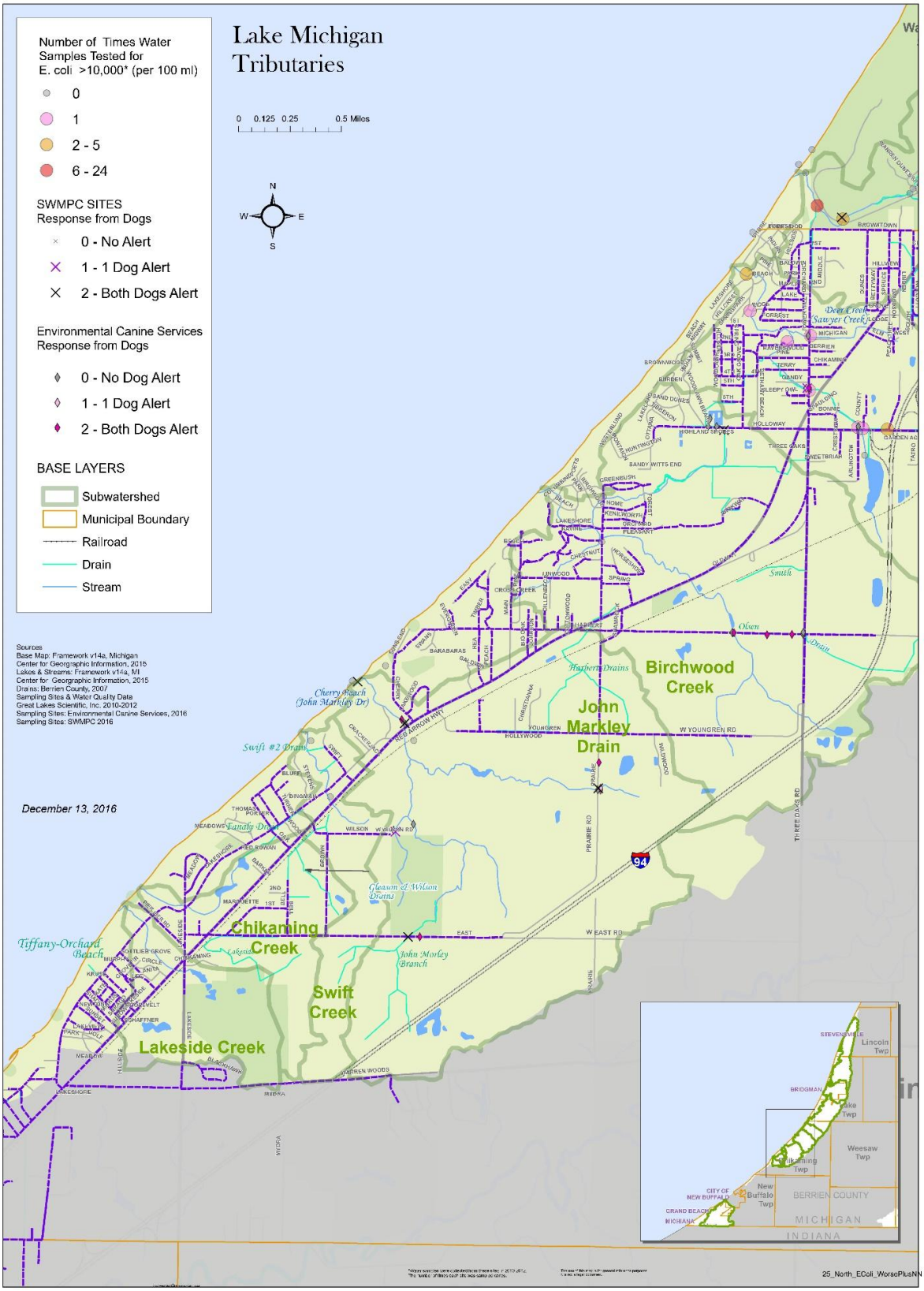
In summer of 2016, project partners continued investigating the sources of E. coli and other water quality issues along 14 streams in the LMTW. The sampling window was between Memorial Day and Labor Day because of the high number of seasonal/second homes in the watershed. Water samples, taken from each stream at the outlet to Lake Michigan and at points further upstream, were sent to ECS to be sniffed by dogs that can detect human wastewater. ECS then brought dogs to the area for follow-up investigations. The dogs identified several problem areas including failing septic systems and pipes that are funneling sewage from homes to creeks and storm drains. However, most of the problems are believed to be a result of failing public sanitary sewer infrastructure which is widespread in the watershed area (see 4.2 Regulatory Authority and Water Resources). These sanitary sewer lines and lift stations may be leaking sewage into streams, which then flow to Lake Michigan and cause beach closures. Since 2010, several beaches along Lake Michigan, from Stevensville to the Indiana state line, have had closings due to the potential risk of serious illness caused by high levels of bacteria, including: Warren Dunes State Park Beach (19 days); Weko Beach (7 days); Cherry Beach (8 days); Union Pier (Townline Road) (9 days); Harbert Beach (2 days) (not monitored since 2013); Grand Beach/Michiana beaches (11 days). Increasing the frequency and breadth of beach-water testing programs could help to further pinpoint priority areas.

SWMPC conducted additional stream sampling in 2017 and 2018 to follow up on problem areas and to try to determine the sources of the human waste. In these two years, the ECS ship and sniff was utilized along with taking E.coli samples. This was done to try to determine the magnitude of the E.coli problem. Unfortunately, in 2017 there was not much rain and many of the tributaries had no flowing water during most of the sampling period so not much sampling was possible as flowing water is needed. In 2018, there were more rain events and more sampling was possible. Efforts in 2018 focused on trying to detect sources in Deer Creek (Sawyer Drain), Painterville and White Ditch because these waterbodies continually had contamination. The data from 2017 and 2018 has not been mapped yet. However, all the results are housed at SWMPC’s office. The following Figures detail the locations for testing and the results in the LMWT.

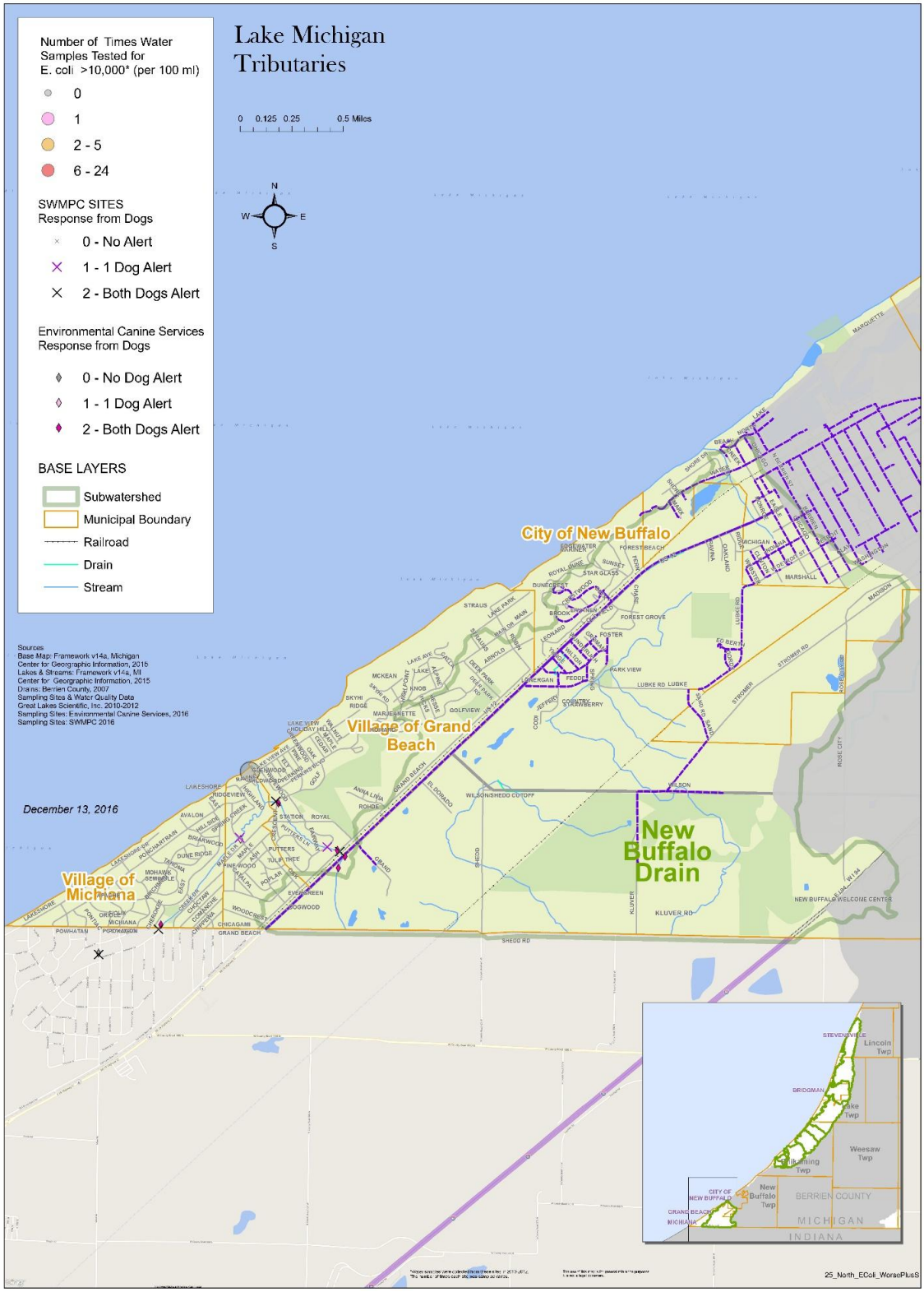
**Figure 38. Dog sampling, E. coli Testing, North**



## Figure 39. Dog sampling, E. coli Testing, Mid-North



## Figure 40. Dog sampling, E. coli Testing, South



# 7 Water Quality Summary

## 7.1 Designated Uses

According to the Michigan Department of Environmental Quality (MDEQ), the primary criterion for water quality is whether the water body meets designated uses. Designated uses are recognized uses of water established by state and federal water quality programs. All surface waters of the state of Michigan are designated for and shall be protected for the uses listed in Table 12. (Citation: R323.1100 of Part 4, Part 31 of PA 451, 1994, revised 4/2/99). A watershed management plan provides direction for protecting and restoring designated uses.

**Table 12. Definitions of Designated Uses**

| Designated Use | General Definition |
|---|---|
| Agriculture | Water supply for cropland irrigation and livestock watering |
| Industrial Water Supply | Water utilized in industrial processes |
| Public Water Supply | Public drinking water source |
| Navigation | Waters capable of being used for shipping, travel, or other transport by private, military, or commercial vessels |
| Warmwater Fishery | Supports reproduction of warmwater fish |
| Coldwater Fishery | Supports reproduction of coldwater fish |
| Other Indigenous Aquatic Life and Wildlife | Supports reproduction of indigenous animals, plants, and insects |
| Partial Body Contact | Water quality standards are maintained for water skiing, canoeing, and wading |
| Total Body Contact | Water quality standards are maintained for swimming |

The designated uses of Public Water Supply, Navigation, Coldwater Fishery are not applicable to the streams/subwatersheds of the LMTW. For the designated uses of Agriculture, Industrial Water Supply, Warmwater Fishery and Other Indigenous Aquatic Life and Wildlife there is no data to support that these are not being met. However, Partial and Total Body Contact designated uses are impaired or threatened due to elevated E. coli levels in the LMWT.

## 7.2 General Water Quality Statement

This project addresses the last streams in Berrien County that do not have watershed management plans completed and empty directly into Lake Michigan. Southwest Berrien County is located on the eastern shore of Lake Michigan and is a popular recreation and vacation destination and home to one of Michigan's most visited state parks, Warren Dunes. Tourism is critical to our economy and tourists have been turned

away from the beaches due to high levels of E. coli. In order to stop these beach closings and improve water quality, this project attempts to identify E. coli sources through water testing, environmental canine scent tracking and development of this comprehensive NPS watershed management plan that will be used to guide implementation efforts.

### 7.3 Individual Water Body Assessment

Within a watershed, water quality can vary greatly from one water body to the next. An assessment of individual water bodies was completed for the LMTW. The following Table provides a summary of the assessment. The assessment includes: 1) which designated uses are threatened or impaired, and 2) the known or suspected pollutant. Further descriptions are provided for some of the creeks/drains that have had issues or continue to have issues with elevated E. coli levels.

**Table 13. Water Bodies Summary – Designated Uses**

| Water Body | Impaired Uses | Threatened Uses | Pollutants (known (k) or suspected (s)) |
|---|---|---|---|
| Birchwood Creek | None | Partial & Total Body Contact | E. coli (s) |
| Chikaming Creek | None | Partial & Total Body Contact | E. coli (s) |
| Deer Creek | Partial & Total Body Contact | None | E. coli (k) |
| Grand Mere | None | None | None |
| John Markley Drain | None | Partial & Total Body Contact | E. coli (s) |
| Lakeside Creek | None | Partial & Total Body Contact | E. coli (s) |
| New Buffalo Drain | None | Partial & Total Body Contact | E. coli (s) |
| Painterville Drain | Partial & Total Body Contact | None | E. coli (k) |
| Southern (White Ditch) | Partial & Total Body Contact | None | E. coli (k) |
| Swift Creek | None | Partial & Total Body Contact | E. coli (s) |
| Timber Lane | None | Partial & Total Body Contact | E. coli (s) |
| Valley Drain | None | Partial & Total Body Contact | E. coli (s) |
| Warren Dunes | None | Partial & Total Body Contact | E. coli (s) |
| Weko Beach (Tanner Creek) | None | Partial & Total Body Contact | E. coli (s) |

**Sawyer Creek/Deer Creek** in Chikaming Township has been the site of much testing, canine scent tracking and even drain camera work in the past. There are two large homeowners associations, the unincorporated town of Sawyer, two truck stops and a large industrial building in this watershed. Several years ago, canine scent tracking alerts and drain camera work resulted in an illicit drain connection being identified. The

restaurant owner fixed the illicit connection immediately but there continues to be high E. coli in Sawyer Creek. Shorewood Association, a homeowner association, has paid for testing of their beach and it consistently exceeds levels for the water quality standard for partial and total body contact. Deer Creek was first placed on the Section 303(d) list in 1998. A TMDL which addresses approximately seven miles of stream was developed in 2002. For this EPA approved concentration based TMDL, the Water Quality Standard of 130 per 100 ml as a 30-day geometric mean is the target level from May 1 to October 31.

**Painterville Drain** is the stream that impacts the most people as it flows out through Warren Dunes State Park in Lake and Chikaming Townships. Warren Dunes State Park beach closes several times a year due to elevated E.coli levels. Warren Dunes is the 2nd most visited State Park in Michigan with mostly out of state visitors. Painterville Drain has several tributaries and many of them have exhibited high E. coli levels and dog alerts. Painterville Drain is also listed in the Statewide TMDL for E. coli. See more information on the Statewide TMDL below the stream descriptions.

**White Creek (Drain)** has a small portion of its watershed in Michigan (33%) and the majority of land area is in Indiana; however, it flows largely through the Villages of Michiana and Grand Beach (in New Buffalo Township) which does not have a sewer system. The area around Michiana/Grand Beach is densely developed with many second homes. This creek is listed in Michigan's Statewide TMDL for E. coli. See more information on the Statewide TMDL below the stream descriptions.

**Lighthouse Creek** is a small creek entering Lake Michigan at a private beach just south of the Galien River in the City of New Buffalo. Lighthouse Creek flows through an area of New Buffalo Township that was once coastal marshes but now is filled and developed with houses. There is extensive hydrological modification and the City has consistently had E. coli problems from failing septic systems and illicit connections. There has been extensive work identifying illicit drains. The Berrien County Drain Commission along with the City of New Buffalo completed a major creek restoration project near the outlet to Lake Michigan during the grant project period that has improved this stream greatly. When sampled at the outlet, no detection of human waste was found during the project period.

**South Pier Street Creek** is a small creek that enters Lake Michigan at the end of Pier Street in Chikaming Township. Between the North and South Creeks at the end of Pier Street is a small public beach. This is a highly developed area with extensive vacation and second-home development. There was a canine alert at South Pier Street Creek during the 2012 canine scent tracking. In follow up sampling during this project, no detection of human waste was found.

**North Pier Street Creek** is a small creek that enters Lake Michigan at the end of Pier Street in Chikaming Township. Between the North and South Creeks at the end of Pier Street is a small public beach. This is a highly developed area with extensive vacation

and second home development. Canine scent tracking done in 2012 and in 2016 did not result in any positive results.

**Swift Creek** flows to a private beach accessed only by homeowners along Swift Road in Chikaming Township. In the past, the homeowners had done some limited water testing and the E. coli results had been high. There is a large estate lot residential development near Lake Michigan. There are large areas of wetland and forest that could be preserved in this watershed. There was no dog alert in 2012 or 2016 indicating a problem.

**John Markley Creek** flows into Lake Michigan just south of Cherry Beach in Chikaming Township. This beach is the most visited of the Chikaming Township public beaches. There is extensive residential development in this watershed; however, there are still large privately owned parcels of wetland that could be preserved. Robinson Woods, an 80-acre natural area is owned by Chikaming Open Lands in this watershed. Right before this project commenced, a large culvert at Red Arrow Highway was replaced and also sections of sanitary sewer lines. Since then the issues with human waste have seemed to decline near Lake Michigan, but human waste is being detected in several upstream areas.

**Birchwood Creek** in Chikaming Township is composed of several tributaries that flow through homeowner associations and blueberry fields. There are three homeowners associations in this watershed and dense residential development. During the project human waste was found in the upstream areas, but not at the Lake Michigan outlet.

**Tanner Creek (Weko Beach)** is located in the City of Bridgman and Lake Township and empties into Lake Michigan at Weko Beach, a very popular city-owned beach. This creek flows through the City of Bridgman where there is extensive residential, commercial and industrial development. Past and current sampling and scent tracking has shown that there are problems throughout this watershed on its different tributaries.

**Grand Mere Creek** is an arbitrary name for a small creek that is located in Lincoln Township and flows through Grand Mere State Park before entering Lake Michigan. The majority of the watershed is in Grand Mere State Park. Water testing has been completed on the North, South and Middle lakes, but not the stream outlet to Lake Michigan because it is surrounded by private residences and with high lake levels inaccessible. Dog scent tracking did not result in any problem areas being discovered, so after 2016 no further testing was conducted.

<u>Statewide TMDL</u>

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and in-

stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources.

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant a water body can receive and still meet applicable water quality standards.

**Painterville and White Ditches** are water bodies included in the Statewide E. Coli TMDL and both were listed in 2016 as not meeting water quality standards. The impaired designated uses addressed by this TMDL are TBC and PBC recreation. The designated use rule (Rule 100 [R 323.1100] of the Part 4 Rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended) states that this water body be protected for TBC recreation from May 1 through October 31 and PBC recreation year-round. The target levels for these designated uses are the ambient E. coli WQS established in Rule 62 as follows:

> R 323.1062 Microorganisms.
> Rule 62. (1) All waters of the state protected for total body contact recreation shall notcontain more than 130 E. coli per 100 milliliters (mL), as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during five or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of three or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 E. coli per 100 mL. Compliance shall be based on the geometric mean of three 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 mL. 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.
> A watershed management plan provides direction for protecting and restoring designated uses. The goal of the LMT watershed management plan is to ensure that all subwatersheds are kept off the State of Michigan's 303(d) list of impaired water bodies.

Sanitary wastewater discharges have an additional target:
Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 mL, based on the geometric mean of all of five or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 mL, based on the geometric mean of all of three or more samples taken during any period of discharge not to exceed seven days. Other indicators of adequate disinfection may be utilized where approved by the Department.

For this TMDL, the WQS of 130 E. coli per 100 mL as a 30-day geometric mean and 300 E. coli per 100 mL as a daily maximum to protect the TBC use are the target levels

for the TMDL reaches from May 1 through October 31, and 1,000 E. coli per 100 mL as a daily maximum year-round to protect the PBC use.

Sanitary wastewater discharges are required to meet 200 fecal coliform per 100 mL as a monthly average and 400 fecal coliform per 100 mL as a maximum. Michigan's WQS for E. coli are based upon criteria in the USEPA's 1986 criteria document (USEPA, 1986). Specifically, the USEPA criterion of 126 E. coli per 100 mL is the basis for Michigan's TBC WQS of 130 E. coli per 100 mL. This criterion is intended to provide a level of protection of producing no more than 8 illnesses per 1,000 swimmers and approximates the degree of protection provided by the 200 fecal coliform per 100 mL bacteria standard recommended by the USEPA prior to the adoption of the 1986 criteria. E. coli is a subset of fecal coliform. Accordingly, the sanitary discharges are expected to be in compliance with the ambient PBC and TBC E. coli WQS if their National Pollutant Discharge Elimination System (NPDES) permit limits for fecal coliform are met.

Assessment Units Impaired by E. coli - Statewide E. coli TMDL

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 | Column 7 | Column 8 | Column 9 | Column 10 | Column 11 | Column 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Assessment Unit | Type | n | Geometric Mean (E. coli) | % Reduction | # of 30-Day Geometric Means | % 30-day TBC Exceedance | % Daily TBC Exceedance | % Daily PBC Exceedance | Interstate Waters | Code | Cycle First Listed |
| Subwatershed | 040400010101 | Painterville Drain-Frontal Lake Michigan | | | | | | | | | |
| 040400010101-05 | river | 3 | 1,244,542 | 100.0% | 0 | | 100% | 100% | | Raw Sewage | 2016 |
| 040400010101-09 | river | 6 | 575 | 47.8% | 2 | 100% | 67% | 17% | | | 2014 |
| Subwatershed | 040400010102 | White Ditch-Frontal Lake Michigan | | | | | | | | | |
| 040400010102-01 | river | 12 | 1,301 | 76.9% | 4 | 100% | 100% | 58% | From Indiana | | 2016 |

# 8 Prioritization - Areas, Pollutants, Sources

Even though the LMTW has several impaired water bodies that are not meeting water quality standards for partial and total body contact, much of the watershed still has significant natural areas intact. Therefore, both improvement and protection priority areas have been identified.

## 8.1 Improvement Prioritization

The highest priority improvement areas are those that are on the State of Michigan's 303(D) list of water bodies that are not attaining the designated uses of Total and Partial Body Contact and have established TMDLs to meet and maintain Water Quality Standards. These include White Creek, Deer (Sawyer) Creek, and Painterville Creek, which all have elevated E. coli levels that place them on the 303(d) list due to compromised septic and public sanitary systems. The second priority watersheds are the subwatershds with non-TMDL water bodies, but are suspected to have E. coli problems – Tanner Creek (Weko Beach), Birchwood Creek, John Markley (Cherry Beach), Swift Drain, Fanaly Drain, Chikaming Creek, Birchwood Creek and Lighthouse Creek.

For improvement areas, the priority pollutant is E. coli and the priority sources are failing or lacking septic systems, illicit discharges (especially connections between stormwater and sanitary systems) and failing sanitary sewer infrastructure (lift stations and sewer lines). Improvement of the water quality in these areas will be essential to ensure that they are removed from the impaired list and that they do not contribute to the high E. coli levels impacting the ability of the area beaches to remain open for recreational uses.

**Figure 41 Priority Improvement Subwatersheds, North Section**

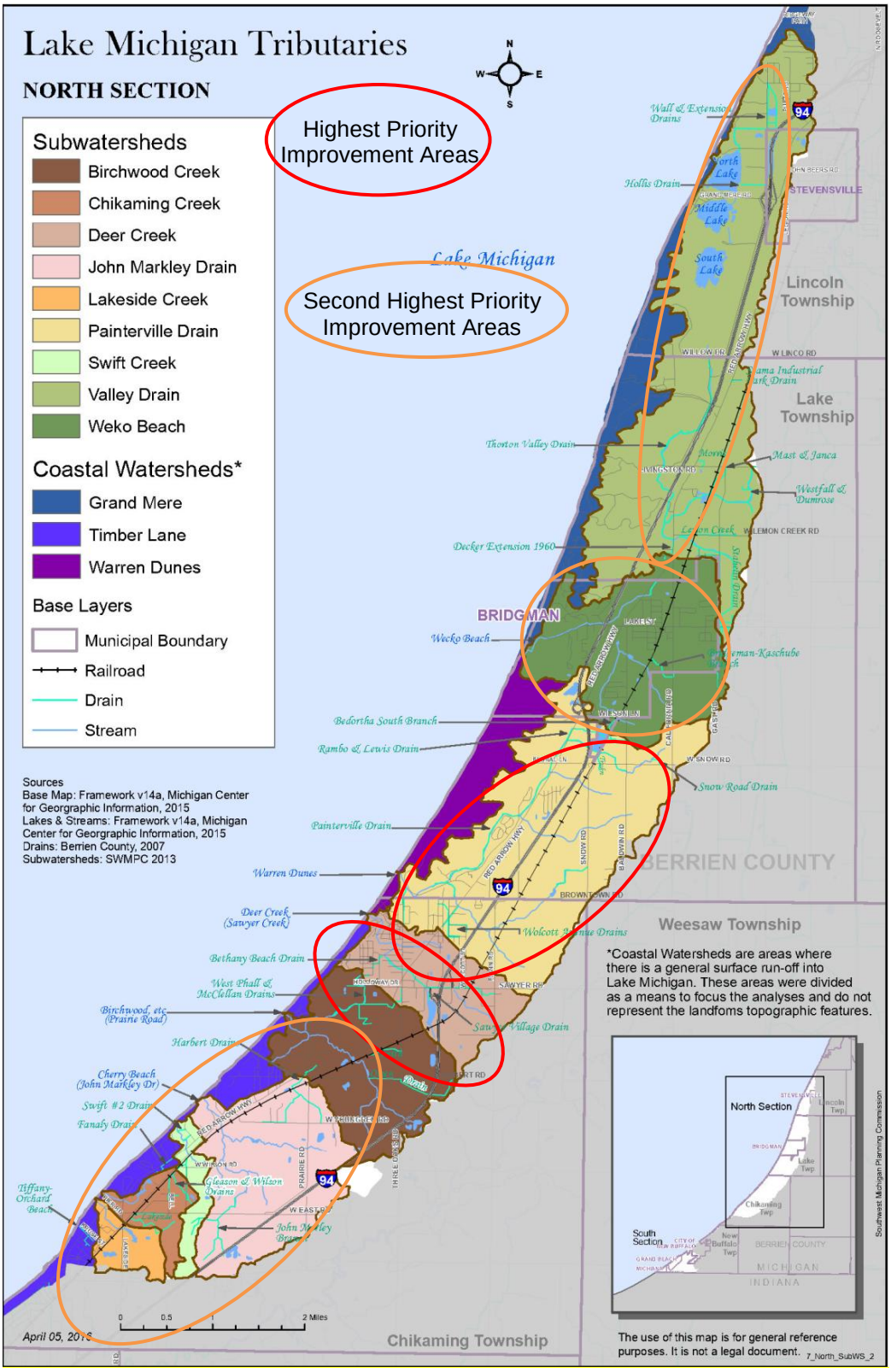
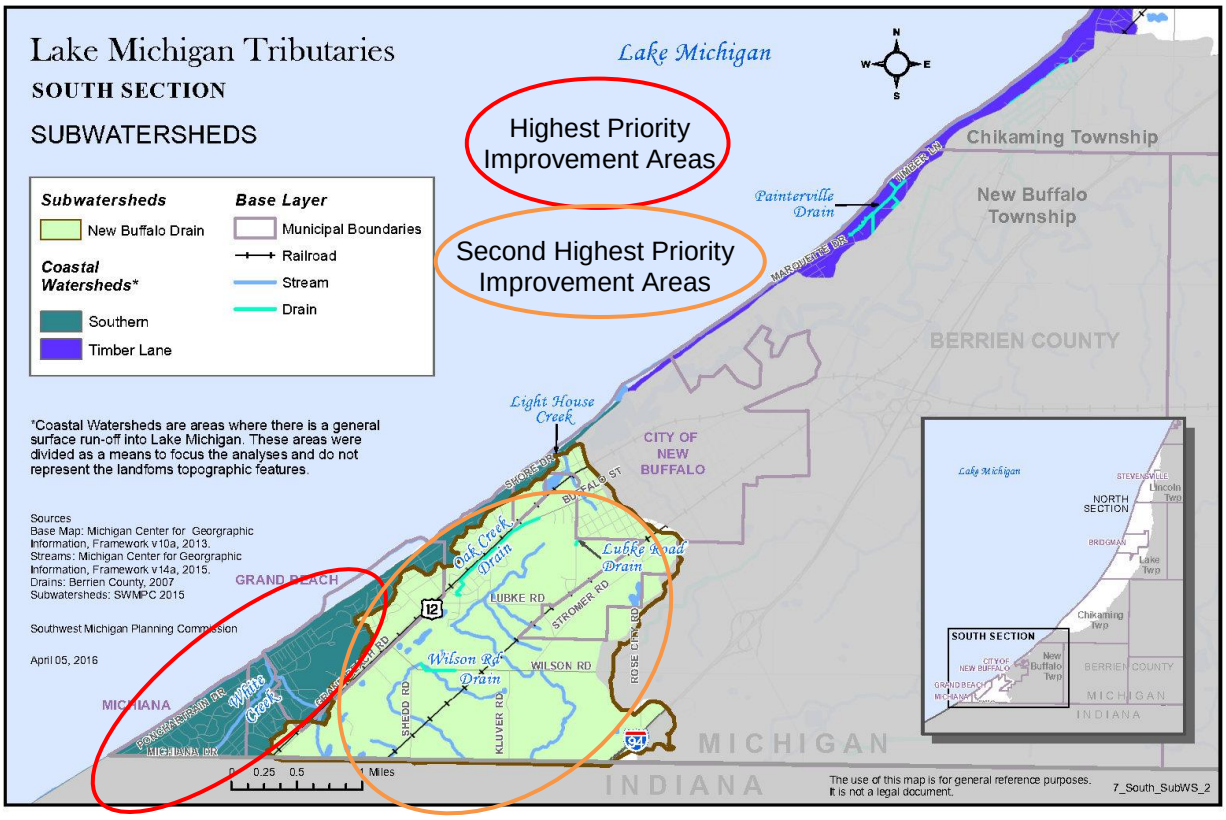


**Figure 42. Priority Improvement Subwatersheds, South Section**




## 8.2 Protection Prioritization

Priority protection areas were identified in the watershed based on criteria about natural lands, wetlands and need for water quality improvement. By identifying priority areas, implementation can be targeted to the places where the most benefit can be achieved.

The criteria for ranking protection lands for improving water quality in the Lake Michigan Tributary Watershed area is as follows:

E. coli impairment in the subwatershed,
Presence of existing wetlands,
Potential for wetland restoration, and
Parcel size.

Parcels across the project area were scored in each criterion. Scores were added to identify the highest priority areas. Lastly, protected lands were subtracted from the final ranking to focus land protection activities (refer to Land Protection Prioritization Ranking Figure). Highly ranked parcels were identified in nine of the 15 subwatersheds.

Approximately twelve parcels in four subwatersheds are identified as having the highest priority ranking for protection. These are located within the New Buffalo Drain (Lighthouse Creek) subwatershed, the Painterville Drain subwatershed, the Deer Creek subwatershed, and the Birchwood Creek subwatershed.

An additional fifty parcels are identified as having a secondary priority ranking for protection, with the greatest concentrations in the New Buffalo Drain (Lighthouse Creek) and the Painterville Drain subwatersheds.

The New Buffalo Drain and the Painterville Drain subwatersheds contain the greatest concentrations of all ranked priority parcels. Additionally, concentrations of ranked properties are located in the John Morley Drain and Birchwood Creek subwatersheds.

Approximately sixty-two parcels are identified as high priority for protection in the LMTW. Further refinement of the priority areas is useful to determine feasibility of implementing land protection activities. Additional criteria should be considered to prioritize these efforts in the future. These criteria include proximity to existing protected lands and status of the property. Those parcels contiguous with or in close proximity to an existing nature preserve, park, or conservation easement should be considered the most desirable and highest priority for protection. Expanding existing protected lands offers a greater benefit in efforts to improve water quality and wildlife habitat. These properties may also be most desirable to the local land conservancies and government units to build upon established preserves, parks, and conservation easements. The status of the highly ranked properties should also be considered in prioritizing conservation efforts. Vacant or minimally developed land may provide a greater impact for conservation efforts, while properties that are listed or have been listed for sale offer opportunities to engage with the current landowners.

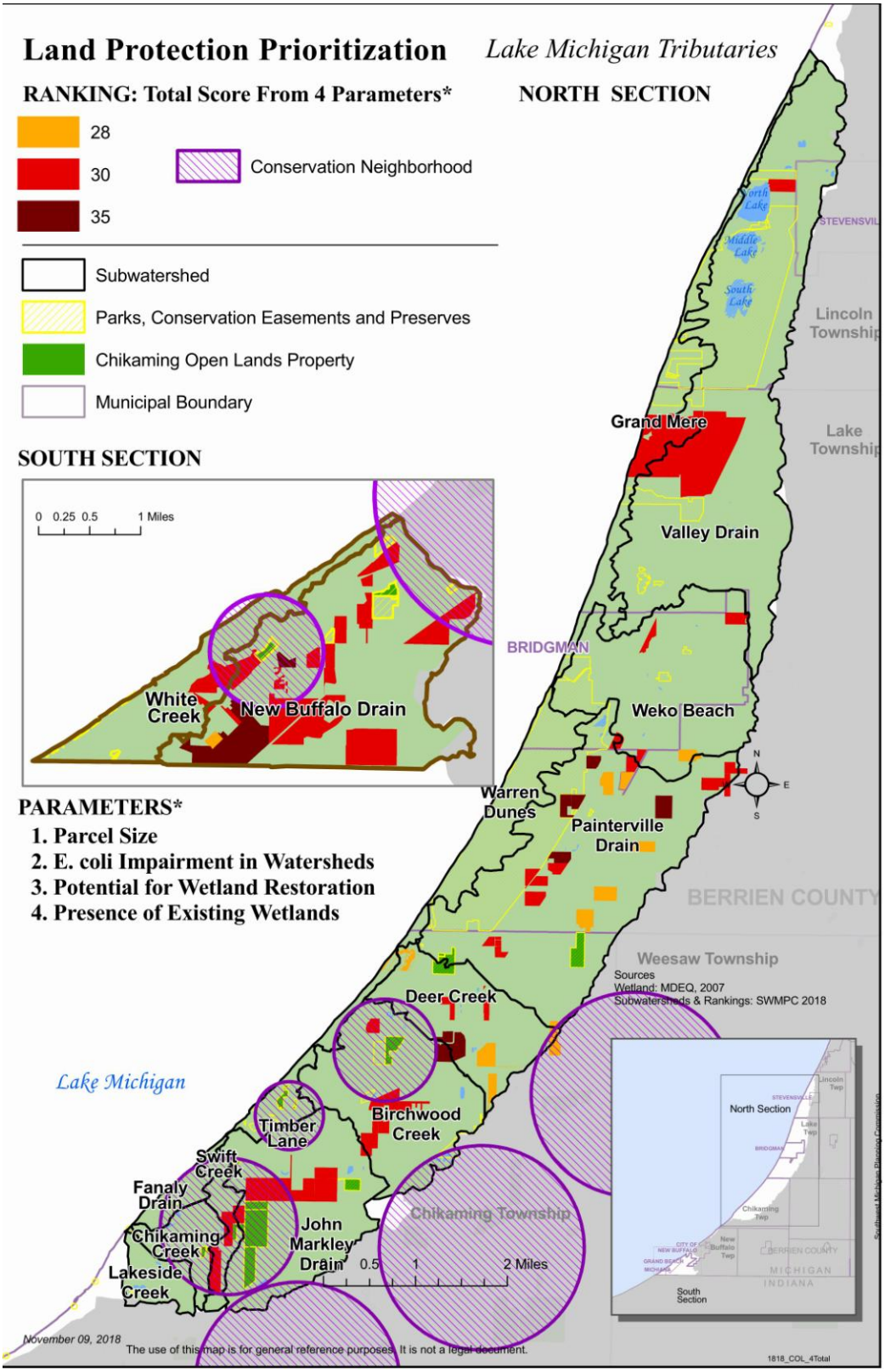
**Protection Area Pollutants and Sources**

In the protection areas the prioritization of pollutants and sources is based on their potential to threaten or impair water quality as development increases in these areas.

In the protection areas, E. coli is the priority pollutant. Septic systems are suspected to be a source. In addition, the failure of sewer system infrastructure has also led to releases of untreated wastewater. Failing septic systems are expected to become an increasing problem with additional waterfront and suburban type development occurring in protection areas.

Figure 39 ranks the priority areas for the LMTW. (For additional detailed maps on each criterion see Appendix – Priority Protection Criteria Maps.)

**Figure 43. Lake Michigan Tributaries Priority Areas, Ranked**



# 9 Goals and Objectives

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals. Goals can represent a long-term vision and also serve as guideposts established to keep everyone moving in the same direction and assess progress. Objectives are more specific actions that need to occur to achieve the stated goal. The goals and objectives for the LMTW address both water quality concerns and desired uses.

Successful implementation of a watershed management plan is more likely to occur when the objectives are based on clearly defined goals.

## 9.1 Goals for Designated Uses

The following two goals are related to restoring and protecting the designated uses of water bodies in the PPRW. Objectives for these goals are listed in the Action Plan Table as tasks to be implemented.

1. Reduce E, Coli threatening or impairing water quality to meet designated uses.

2. Prevent or reduce pollutants threatening or impairing water quality by sufficiently preserving or managing protection areas to meet designated uses.

## 9.2 Goals for Desired Uses

In addition to the Designated Uses established by state and federal water quality programs, stakeholders identified several Desired Uses for the LMTW. Desired Uses are based on factors important to the watershed community and are based and ranked on the priorities established per the following criteria: E. coli impairment in the subwatershed, presence of existing wetlands, potential for wetland restoration, and parcel size. Desired uses may or may not have a direct impact on water quality. The following Table lists the Desired Uses identified through public meetings and discussions with watershed stakeholders. The desired uses listed in the Table all have a direct or indirect impact on water quality.

**Table 22. Lake Michigan Tributaries Watershed Desired Uses**

| LMTW Desired Use | General Definition |
|---|---|
| Coordinated development | Promote and achieve the environmental and economic benefits of planned communities through coordinated land use planning and low impact development |
| Intact habitat for native and aquatic and terrestrial wildlife | Protect and enhance the habitats on which indigenous, threatened, and endangered species depend |
| Groundwater Resources Protection | Protect groundwater recharge from contamination and overdrafting |
| Watershed monitoring efforts | Continue and increase monitoring efforts to better understand issues in the LMTW and to create baselines for future reference |

The following goals were developed to address the desired uses identified by stakeholders. Objectives for these goals are listed below.

**1. Coordinated land use planning in the LMTW.**

- Review local plans, ordinances and regulations addressing stormwater management, non-point source pollution and related water quality and natural resource issues
- Develop model language for development standards and ordinances such as setback requirements along lakes, streams, rivers and wetlands
- Gain local commitments to consider the watershed context in planning efforts and to recognize stormwater planning early in site planning and evaluation
- Conduct technical workshops and provide technical assistance throughout the watershed regarding the importance of coordinated watershed and land use planning

**2. Protected habitat for native aquatic and terrestrial wildlife**

- Develop a community supported green infrastructure vision for the LMTW that includes natural and working lands
- Assist conservation organizations, local governments and landowners to preserve and manage wildlife habitat
- Conduct on the ground habitat evaluations in high priority protection areas and in high quality water bodies

**3. Protected groundwater resources**

- Continue to close abandoned wells
- Determine current and future amount of groundwater withdrawal and its potential impacts
- Develop strategies to prevent increased impervious surfaces in high recharge areas and to restore areas with high recharge potential, as appropriate

**4. Continued/increased watershed monitoring efforts**

- Partner with Drain Commissioner, MDEQ, MDNR, and agencies to develop and implement a monitoring strategy to examine the current quality of the subwatersheds as well as to monitor changes over time, particularly as it relates to E. coli levels.
- Coordinate volunteer road/stream crossing riparian survey to assess current conditions and monitor changes over time as well identify problem sites
- Develop a program for testing of private drinking water wells

# 10 Implementation Strategies

This chapter provides a management strategy to protect and improve water quality in the LMTW. The management strategy prioritizes tasks to be implemented, identifies specific problem sites and lays out a detailed action plan for implementation. The strategy also includes an information and education plan and describes current efforts.

## 10.1 Action Plan by Priority Area

The Action Plan Table below is a detailed action plan with structural, vegetative and managerial tasks, which address priority pollutants and their sources. This action plan should serve as a starting point for effective implementation. The items in the action plan should be reviewed annually and updated as conditions change in the watershed.

The Action Plan Table features specific tasks related to the high and medium protection area tasks, which are detailed later in this chapter and identified in Chapter 8. Each task addresses specific pollutants and sources as indicated. Since resources will probably not be available to implement all of the tasks at once, The Table provides a suggested timeframe for beginning implementation of each task. The implementation timeframe was based on the ranking of pollutants and sources for the priority improvement and protection areas in Chapter 8. Prioritizing the tasks will allow resources to be allocated to the tasks that address the most important pollutants and sources first. The timeframe may be changed if resources or opportunities become available for earlier implementation. The Table also provides a cost estimate for each task and identifies the potential lead agency or individuals that need to take action. Potential partners, funding sources and programs are listed, which could assist with task implementation. Lastly, milestones and proposed evaluation methods are listed for each task.

Below is a list of structural, vegetative and managerial tasks to be implemented in the LMTW, targeting implementation efforts where the most benefit can be achieved. The priority areas are based on the watershed protection and management area maps described in Chapter 8.

<u>Improvement Area Tasks</u>

The following tasks should be focused in the improvement areas as indicated in Chapter 8.

*Tasks to begin within 1-5 years:*

- Replace Failing Wastewater Collection System Infrastructure
- Identify and correct illicit connections or discharges to stormwater system
- Enact a septic system time of sale inspection ordinance or septic maintenance districts
- Restore riparian buffers and stabilize streambanks
- Improve zoning maps to locate high density or intensive uses in appropriate areas
- Identify and correct failing septic systems – establish a fund to assist landowners financially with replacement and/or repair

*Tasks to begin within 6-10 years:*

- Restore wetland areas, especially along the creeks

Protection Area Tasks

The following tasks should be focused in the priority protection areas as indicated in Chapter 8.

*Tasks to begin within 1-5 years:*

- Enact/improve water quality protection related ordinances (see Chapter 4.3 of this plan for recommendations on ordinances)
- Protect conservation lands and wetlands (see Appendix – Priority Protection Criteria Maps)
- Identify and correct problem road/stream crossing sites
- Utilize stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, constructed wetlands, vegetated swales, etc)

## 10.2 Information and Education

The structural, vegetative and managerial tasks listed in the Action Plan Table 17 are voluntary. Therefore, individuals, before they are motivated to action, will need to understand the watershed concerns and how their actions can play a role in protecting water quality. An Information and Education (I&E) plan was developed to offer a strategy for informing and motivating responsible parties to implement the tasks listed in the Action Plan Table. The I&E plan provides goals and outlines the relationship between target audiences, watershed issues and outreach activities.

### Introduction

The purpose of the plan is to provide a framework to inform and motivate the various stakeholders, residents and other decision makers within the LMTW to take appropriate actions to protect water quality. This plan will also provide a starting point for organizations within the watersheds looking to provide educational opportunities or outreach efforts.

### Information & Education Goal

The I&E plan will help to achieve the watershed management goals by increasing the involvement of the community in watershed protection efforts through awareness, education and action. The watershed community can become involved only if they are informed of the issues and are provided information and opportunities to participate.

### Target Audiences

The level of understanding of watershed concepts and management, the concerns, values and level of enthusiasm can all vary between different audience groups. Recognizing differences between groups of target audiences is critical to achieving success through education and outreach efforts. Educational messages may need to be tailored to effectively reach different audiences. It is important to understand key motivators of each target audience to establish messages that will persuade them to adopt behaviors or practices to protect and improve water quality. The table below lists

and describes the major target audiences for the Lake Michigan Tributaries Watershed and specific messages and activities that could be used to reach each audience.

**Table 23. Education and Information Plan Target Audience**

| Target Audiences | Description of Audience | General Message Ideas | Potential Activities |
|---|---|---|---|
| Government Officials and Employees | This audience includes elected (board and council members) and appointed (planning commissions and zoning board of appeals) officials of cities, townships, villages and the county. This audience also includes the drain commission and road department staff. It also includes state and federal elected officials. | Water quality impacts economic growth potential.<br>Water quality impacts property values and the tax revenue generated in my community to support essential services.<br>Clean water protects public health.<br>Improving infrastructure is imperative for clean beaches. | One-on-one contact<br>Trainings<br>Workshops and presentations<br>Brochures/flyers/fact sheets<br>Watershed tours<br>Educational videos<br>Watershed Management Plan User Guide |
| Kids / Students | This audience includes any child living or going to school in the watershed. | Clean water is important for humans and wildlife. We all depend on water.<br>Clean water = clean beaches. | Student stream monitoring<br>Teacher training workshops<br>Curriculum<br>Educational videos<br>Coloring Pages<br>Social Media |
| Property Owners/ Businesses | This audience includes any property owner in the watershed. | Septic system maintenance is essential for clean water.<br>Funding improvements to infrastructure is imperative to keep our beaches safe for swimming. | PSAs and press releases<br>Display/materials at festivals<br>Workshops and presentations<br>Watershed Tours<br>Tax/utility bill inserts<br>Website/YouTube video/Social Media<br>Brochures/flyers/fact sheets<br>One-on-one contact |
| Riparian Property Owners | This audience includes those property owners that own land along a river, stream, drain or lake. | Water quality impacts my property value and my health. | Newsletter articles<br>Door knob hangers<br>One-on-one contact<br>Videos<br>Workshops and presentations |
| Recreational Users | This audience includes any person who engages in recreational activities. | Water quality is important for enjoying recreational activities. | Website/YouTube video<br>Kiosks/signs<br>Newsletter articles<br>Brochures/flyers/fact sheets<br>Social media |

## Watershed Issues

### Septage Waste

Septage waste is the primary focus for priority improvement of water quality. Failing or incorrectly installed septic systems impact water quality by adding excess nutrients,

bacteria or other pollutants to the system. Education activities should seek to educate audiences about the impacts of septic systems on water quality. Proper maintenance of septic systems is a key practice for homeowners. Educational efforts should also target governmental units to encourage them to enact point of sale septic system inspection ordinances and to plan and zone for higher density development only in areas served by municipal sewer systems.

The proper operation and maintenance of municipal sewer infrastructure is necessary for protecting water quality. There is a widespread problem with aging infrastructure in the LMTW. Municipalities must ensure that combined sewer overflow events and other untreated releases of septage waste do not impact water quality. Educational efforts should target municipal officials and employees to encourage planning for adequate capacity, management, operation, and maintenance of sewer collection and treatment systems.

**Watershed Awareness**

The LMTW has significant problems with water quality. Watershed residents need to understand that their everyday activities affect the quality of those resources. All watershed audiences need to be made aware of the priority pollutants and their sources and causes in each of the watersheds. Lastly, education efforts should, whenever possible, offer audiences solutions to improve and protect water quality.

One effective way to increase general watershed awareness is through recreational activities. Activities such as fishing, paddling, boating and swimming are directly impacted when beaches are closed due to elevated E. coli levels. It is important for recreational users to understand and appreciate the natural resources within the watershed and to gain a level of knowledge about the protection of those natural resources

**Natural Resources Management and Preservation**

Preserving land and managing natural resources is crucial for effective watershed management. Current and past wetland loss is a major concern in the LMTW. The partnership with Chikaming Open Lands to educate landowners to grow the amount of conservation easements by will be a key education component.

**Distribution Formats**

Because of the differences between target audiences, it will sometimes be necessary to utilize multiple formats to successfully get the intended message across. Distribution methods include the printed and social media, newsletters and direct mailings, email lists and websites, and passive distribution of printed materials

## 10.3 Planning and Studies

In some areas, further study and investigation, as well as subwatershed planning may be needed before more specific recommendations can be made. Limited DNA sampling was conducted in White Ditch, but other subwatersheds could benefit from this type of sampling and analysis.

A targeted wetland restoration and protection project based on the Landscape Level Wetland Functional Assessment in conjunction with an educational campaign to landowners and municipal officials would be extremely helpful in advancing the wetland-related tasks in the action plan. A few demonstration projects would be beneficial even in lower priority areas, because there has not been much wetland restoration work in the watershed.

## 10.4 Current Efforts

There are several opportunities to coordinate with and build upon existing local programs and projects. Below is a description of some key local initiatives that have developed during the planning phase of the LMTW project.

The most important current effort is the GRSD's SAW grant implementation. Their SAW plan was completed in Fall of 2018.

SWMPC has been working with MDEQ, the Berrien County Health Department and Andrews University to establish a laboratory that will be able to do a rapid assessment of E.coli for beach testing in Berrien County. Currently it takes 24 hours to get lab results back and know if a beach is safe for swimming. This new lab would be able to produce results on the same day.

SWMPC will continue to work with homeowners associations, such as Shorewood Homeowners Association to conduct volunteer sampling for Ship and Sniff Canine Scent Tracking and E. coli levels.

Chikaming Open Lands already has established Conservation Neighborhoods to prioritize their land protection efforts. As shown in Chapter 8 on the Priority Protection Area map, these neighborhoods overlap with several high priority sites for implementation.

**Table 24. Lake Michigan Tributaries Watershed Action Plan**

| Improvement Areas (See Chapter 8) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Task** | **Priority Pollutant** | **Source** | **Cause** | **Begin Implementation** | **Potential Lead (Partners)** | **Estimated Cost** | **Potential Funding or Partner Programs** | **Milestones (after implementation begins)** | **Proposed Evaluation Method** |
| Replace Failing Wastewater Collection System Infrastructure | E. coli (and other bacteria/ pathogens) | Human Waste | Failing wastewater collection system infrastructure | 2019-2024 | GRSD, Municipalities | Depends on system needs See GRSD and individual municipal SAW plans | Municipalities, MDEQ state revolving loans, USDA Rural Development | See GRSD and individual municipal SAW plans | Number of system improvements; Number of municipalities with regular system inspection |
| Identify and correct illicit discharges or connections | E. coli (and other bacteria/ pathogens) | Human Waste | Illicit connections or discharges | 2019-2024 | Drain Commissioner, Municipalities, Road Department, Berrien Health Department | $500 - $5,000/site | Landowner, Drain Commissioner, Municipalities, Road Department | By 2020: 3 sites<br>By 2024: 8 additional sites | Number of connections or discharges identified and corrected |
| Enact a septic inspection time of sale ordinance | E. coli (and other bacteria/ pathogens) | Human Waste | Improper design/ maintenance or failing or lack of septic system | 2019-2024 | Berrien Health Department (SWMPC) | $8,000 | Berrien County | Draft language for consideration by 2021 | Ordinance enacted |
| Restore riparian buffers and stabilize streambanks | E. coli (and other bacteria/ pathogens) | Human Waste - runoff | Lack of riparian buffers | 2019-2024 | Landowners (Drain Comm., Conservation District, NRCS) | $200-1,00/acre for restoration $400/ft for stabilization | Drain Assessments, MDEQ 319, Farm Bill Programs, | By 2021: 200 feet<br>By 2024: 1400 feet | Linear feet of restoration/stabilization; Estimate pollutant loading reduction |
| Improve zoning maps to locate high density or intensive uses in appropriate areas | E. coli (and other bacteria/ pathogens) | Human Waste | Insufficient site planning for locating septic systems | 2019-2024 | Municipalities (SWMPC) | $5,000/municipality | Municipalities | By 2021: 2 municipalities<br>By 2023: 2 additional municipalities<br>By 2028: 2 additional municipalities | Number of municipalities with improved zoning maps |
| Identify and correct failing septic systems | E. coli (and other bacteria/ pathogens) | Human Waste | Improper design or maintenance of septic systems | 2019-2024 | Landowners (Health Department) | $200-6,000/system | USDA Rural Development | By 2025: 4 systems<br>By 2028: 5 additional systems<br>By 2033: 10 additional systems | Number of systems identified and corrected; |
| Restore wetlands | E. coli (and other bacteria/ pathogens) | Human Waste | Wetland Loss of Filtration Function | 2025-2030 | Landowners (COL, NRCS, USFWS, Ducks Unlimited) | $1,000 – 15,000/acre | USDA Farm Bill, Partners for Wildlife, , DU, National Fish and Wildlife Foundation, MDEQ 319 | 40 acres within 5 years | Number of acres restored; Number of landowners restoring wetlands; Estimate loading reduction |
| **Protection Areas (See Chapter 8)** **High priority waterbodies –** These are located within the New Buffalo Drain (Lighthouse Creek) subwatershed, the Painterville Drain subwatershed, the Deer Creek subwatershed, and the Birchwood Creek subwatershed.<br>**Medium priority waterbodies –** The greatest concentrations are in the New Buffalo Drain (Lighthouse Creek) and the Painterville Drain subwatersheds | | | | | | | | | |
| **Task** | **Priority Pollutant** | **Source** | **Cause** | **Begin Implementation** | **Potential Lead (Partners)** | **Estimated Cost** | **Potential Funding or Partner Programs** | **Milestones (after implementation begins)** | **Proposed Evaluation Method** |
| Enact/improve water quality protection related ordinances | E. coli (and other bacteria/ pathogens) | Septic systems and municipal sanitary sewer collection infrastructure | Improperly maintained systems | 2019-2024 | Municipalities (SWMPC,) | $10,000/municipality | Municipalities, MDEQ 319 | By 2023: 2 municipalities<br>By 2024: 3 additional municipalities | Number of ordinances enacted; Number of municipalities with ordinances |
| Identify and correct problem road/stream crossing sites | Sediment | Streambanks | Improper design or maintenance of road/stream crossings | 2019-2024 | Road Department | $5,000 - $100,000/site | Road Commission, MDEQ 319, MDNR Aquatic Habitat Grant | Inventory and assess road stream crossings within 3 years. | Number of sites corrected; Estimate sediment loading reduction |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Protect conservation lands and wetlands | E. coli (and other bacteria/ pathogens) | Polluted Runoff – impervious surfaces and storm drains | Lack of conservation lands/Potential conversion to developed lands | 2019-2024 | SWMLC, TNC, Sarett Nature Center | $3,000-6,000/acre for purchase<br>~$3,000/acres for conservation easement | Chikaming Open Lands, MDEQ 319, private foundations | Conduct on the ground habitat evaluations in high priority protection areas and in high quality water bodies within 2 years | Number of acres protected;<br>Estimate pollutant loading reduction |
| Implement stormwater best management practices (road/parking lot sweeping, stormceptors, rain gardens, vegetated swales, constructed wetlands, wet/dry ponds, etc) | Sediment/ Flashy Flows | Polluted runoff – impervious surfaces and storm drains/ Streambanks | Lack of stormwater management/ increased flow fluctuations | 2019-2024 | Landowners, Municipalities, Drain Commissioner, Road Department, SWMPC | Depends on practice | Landowners, Municipalities, MDEQ 319, Drain Assessments | | Number of landowners or municipalities implementing practices;<br>Estimate pollutant loading reduction |

# 11 Evaluation

An evaluation process will determine if the plan implementation is effective and if improvements in water quality are being achieved. Measuring improvements and sharing results will increase community support for plan implementation. Since watersheds are extremely dynamic systems influenced by many factors, evaluation can be a difficult and expensive endeavor. As a result, different levels of evaluation are proposed to illustrate levels of success in the watershed. The level of evaluation and the methods utilized will largely be dependent on the formation of a sustainable watershed organization being able to carry out the proposed evaluation methods and on the amount of resources and funding available. Lastly, this Watershed Management Plan should be reviewed and updated periodically.

## 11.1 Knowledge and Awareness

The first level of evaluation is documenting a change in knowledge or increase in awareness. Measures and data collection for this level can take place in three specific ways:

1. A pre- and post-test of individuals at workshops focused on specific water quality issues in the LMTW. This should be an on-going activity.
2. The tracking of involvement in or increases in attendance at water quality workshops or other events. This should be an on-going activity.
3. A large-scale social survey effort of the LMTW population to understand individual watershed awareness and behaviors impacting water quality. Surveys are expensive, so this level of evaluation will not be able to happen until funding is secured.

Additional evaluation methods for measuring and tracking knowledge and awareness can be found in the Information and Education Plan in Chapter 10.

## 11.2 Documenting Implementation

The second level of evaluation is BMP adoption or implementation. The measurement is mostly a documentation of successful implementation. The evaluation will involve identifying and tracking individuals, organizations and governmental units involved in implementing and adopting BMPs whether they be structural, vegetative or managerial. Data about the BMP implementation can be gathered simply through tracking the number of BMPs installed or adopted. This evaluation should be done annually.

The Action Plan Table has milestones and specific evaluation methods proposed for measuring the progress of BMP implementation and improvements to water quality for each task in the LMTW action plan. The action plan should be reviewed at least annually to ensure progress is being made to meet the milestones. During the annual review, the action plan should be updated as tasks are completed, and as new tasks are identified.

## 11.3 Monitoring Water Quality

Another level of evaluation is documenting changes in water quality through monitoring. The monitoring of water quality is a very complex task, which involves gathering data from a number of sources. Periodic assessments of the water quality in the LMTW are conducted as part of federal and state water quality monitoring programs. Local efforts to monitor water quality include those of homeowner associations, drain commissioners, and conservation organizations. Combining data gathered under these programs, with other periodic water quality assessments will provide a picture of water quality in the watershed. Continuing and expanding current monitoring efforts across the subwatersheds will allow for ongoing evaluation and determination of E. coli levels and potential sources and better direct appropriate BMPs for implementation

## 11.4 Estimating Pollutant Load Reductions

The last level of evaluation is to estimate a reduction in pollutant loadings. A pollutant loading is a quantifiable amount of pollution that is being delivered to a water body. Pollutant load reductions can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Calculating pollutant loads is difficult with E. coli. So, for this plan, the goal is to reduce the source, human septage, to meet water quality standards. Removal of the listed water bodies from the 303(d) list for the impaired uses of Total and Partial Body Contact through TDML level achievement is the primary target.

In the Action Plan Tables, under the last column proposed evaluation methods are listed. Estimating pollutant loads and load reductions for many of the action tasks is not feasible.

## 11.5 Evaluating the Watershed Management Plan

The watershed management plan should be reviewed and updated as needed. The Berrien Conservation District should take the lead in the management and action plan review process. As general guidance, the review should at a minimum include the following updates:

- Land Cover (Chapter 2.4) – at a minimum every 10 years
- Demographics (Chapter 3.3) – with every new US Census
- Future Growth and Development (Chapter 3.4) – every 5-10 years
- Local Water Quality Protection Policies (Chapter 4.3 and 4.4) – every 3 years
- Water Quality Summary (Chapter 7) – every two years with the release of MDEQ Integrated Reports
- Scheduled TMDLs – every two years with the release of MDEQ Integrated Reports or when a TMDL is completed
- Prioritization of areas, pollutants and sources (Chapter 8) – every 5-10 years
- Goals and Objectives (Chapter 9) – every 5-10 years
- Implementation Strategy (Chapter 10) – review annually and update as needed
- ) – review annually and update as needed

# Appendix – Localized E. coli Maps

The maps in the section are in support of Chapter 6. SWMPC created the following maps for each municipality and held follow up meetings with all of the municipalities and the GRSD to go over sampling strategy and to do some in the field investigations.

**Figure 1. E. coli Sampling Results, Lincoln Township**

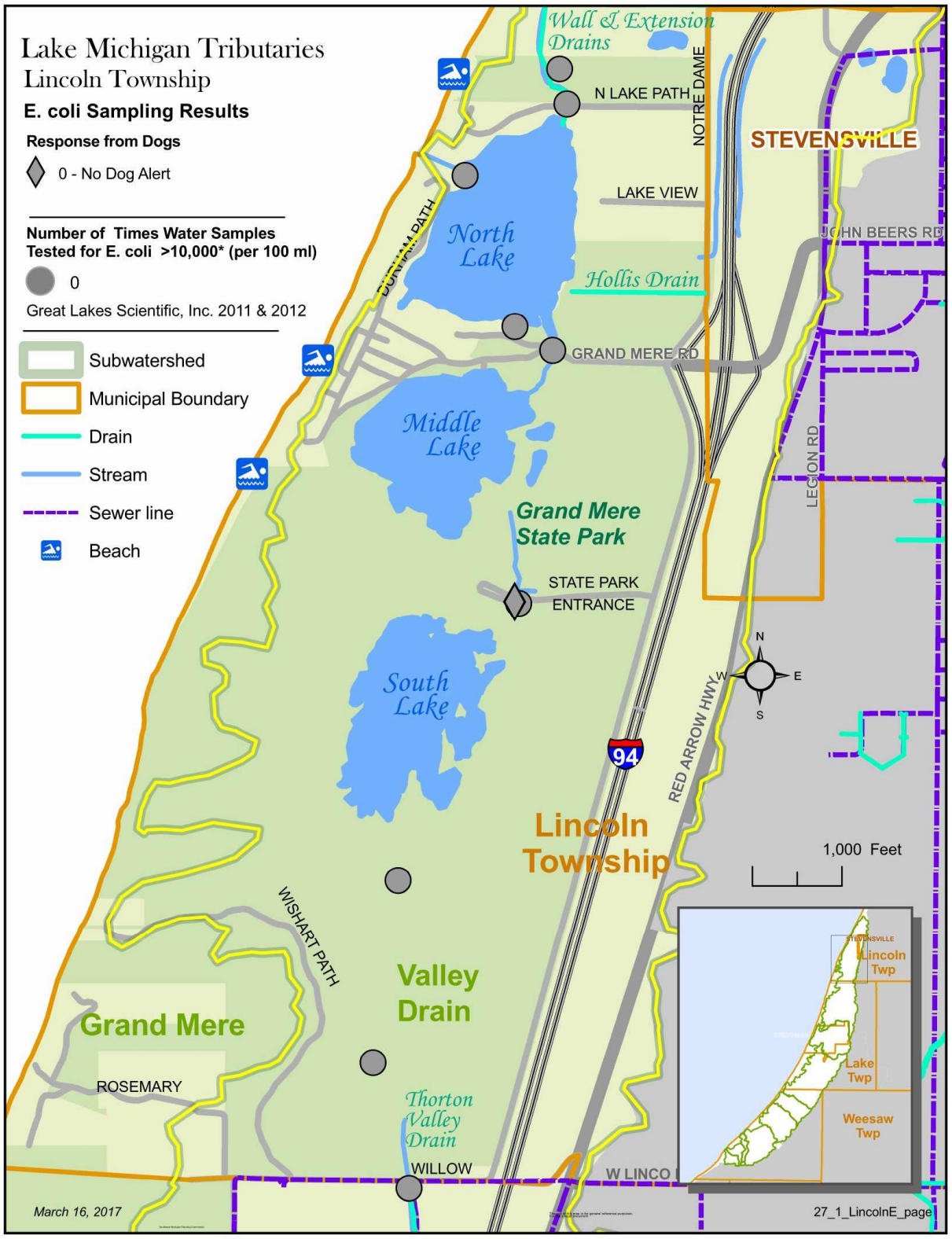


**Figure 2. E. coli Sampling Results, Lake Township (North) & City of Bridgman**

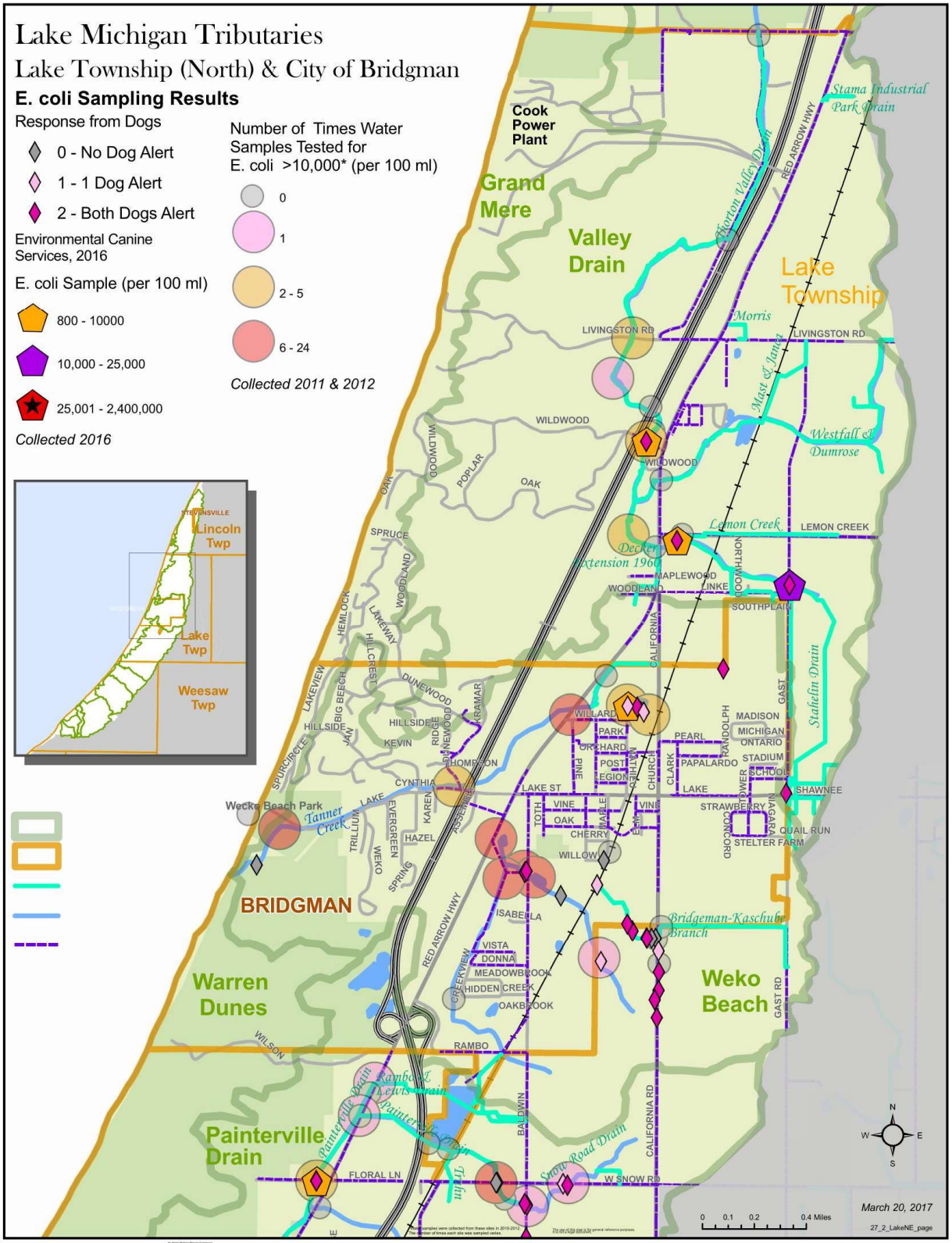


**Figure 3. E. coli Sampling Results, Lake Township South**

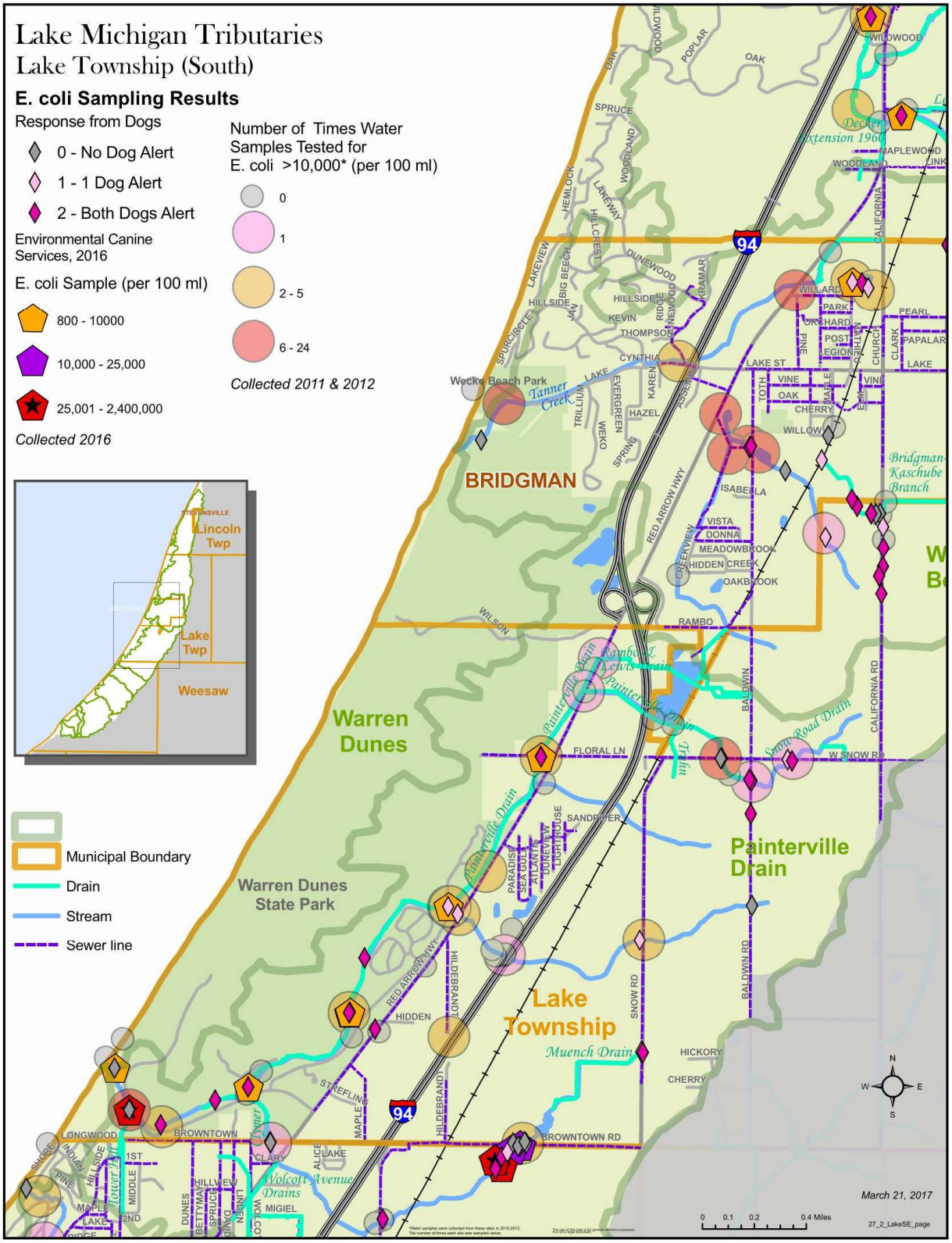


**Figure 4. E. coli Sampling Results, Chikaming Township (North)**

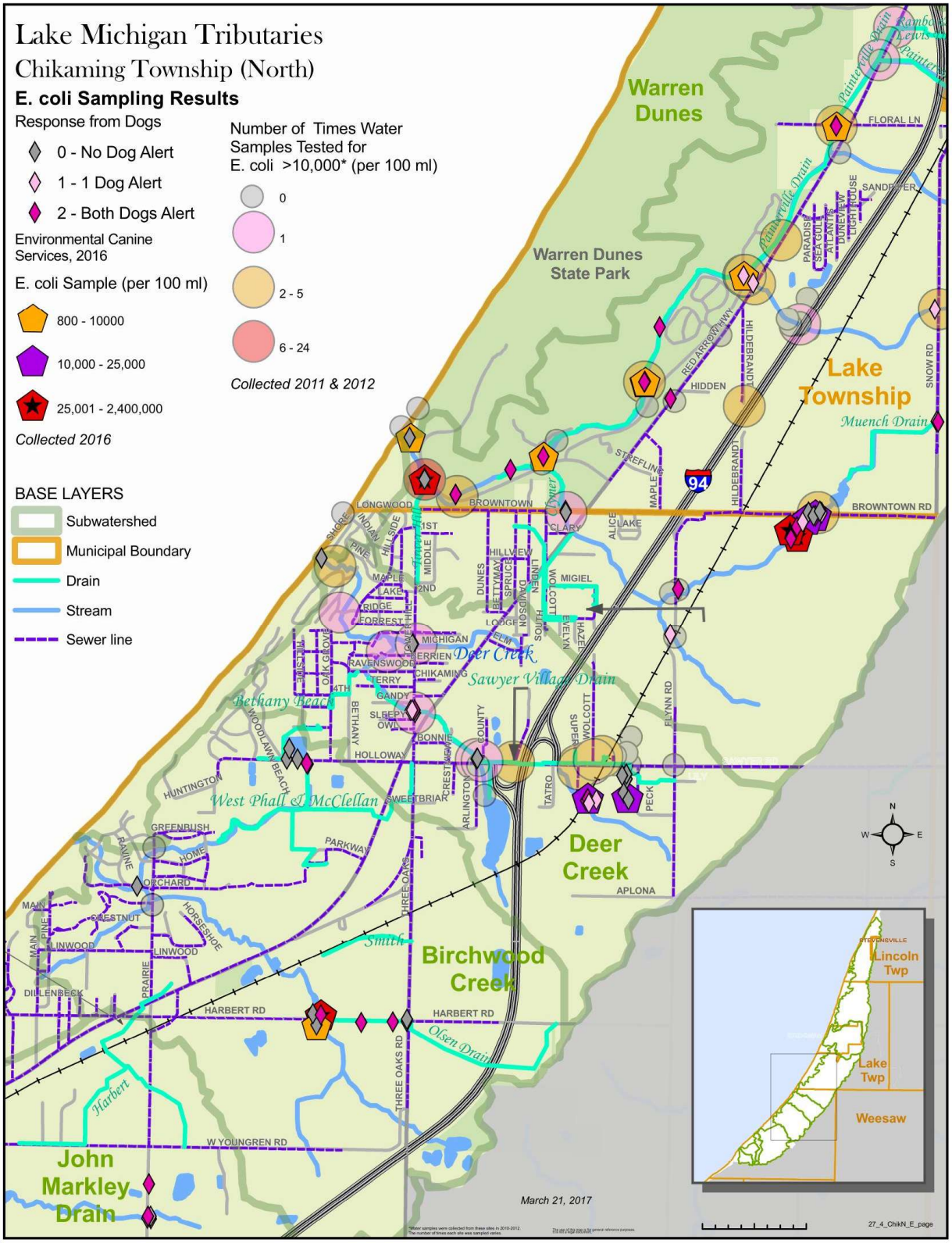


**Figure 5. E. coli Sampling Results, Chikaming Township (South)**

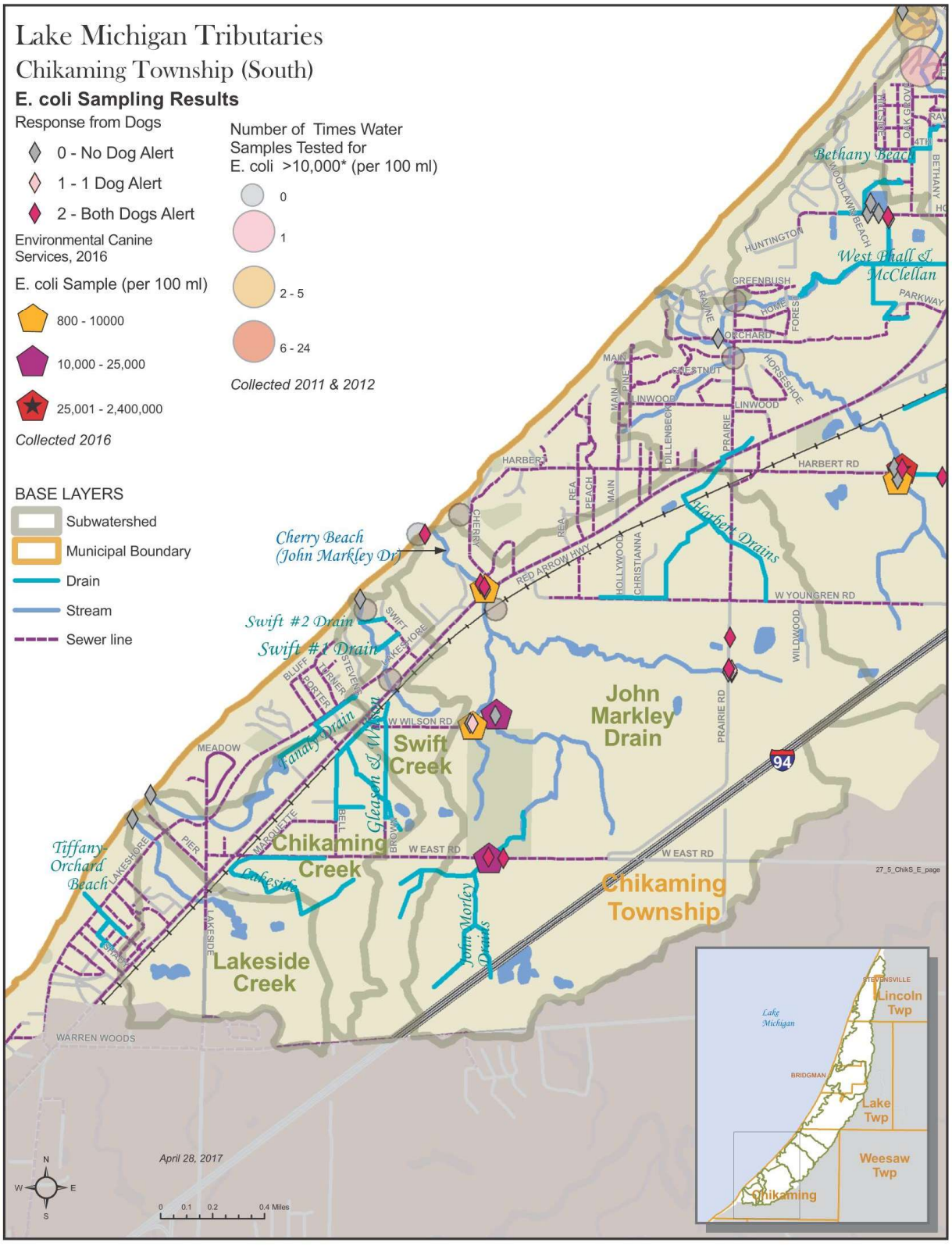


**Figure 6. E. coli Sampling Results, New Buffalo Township**

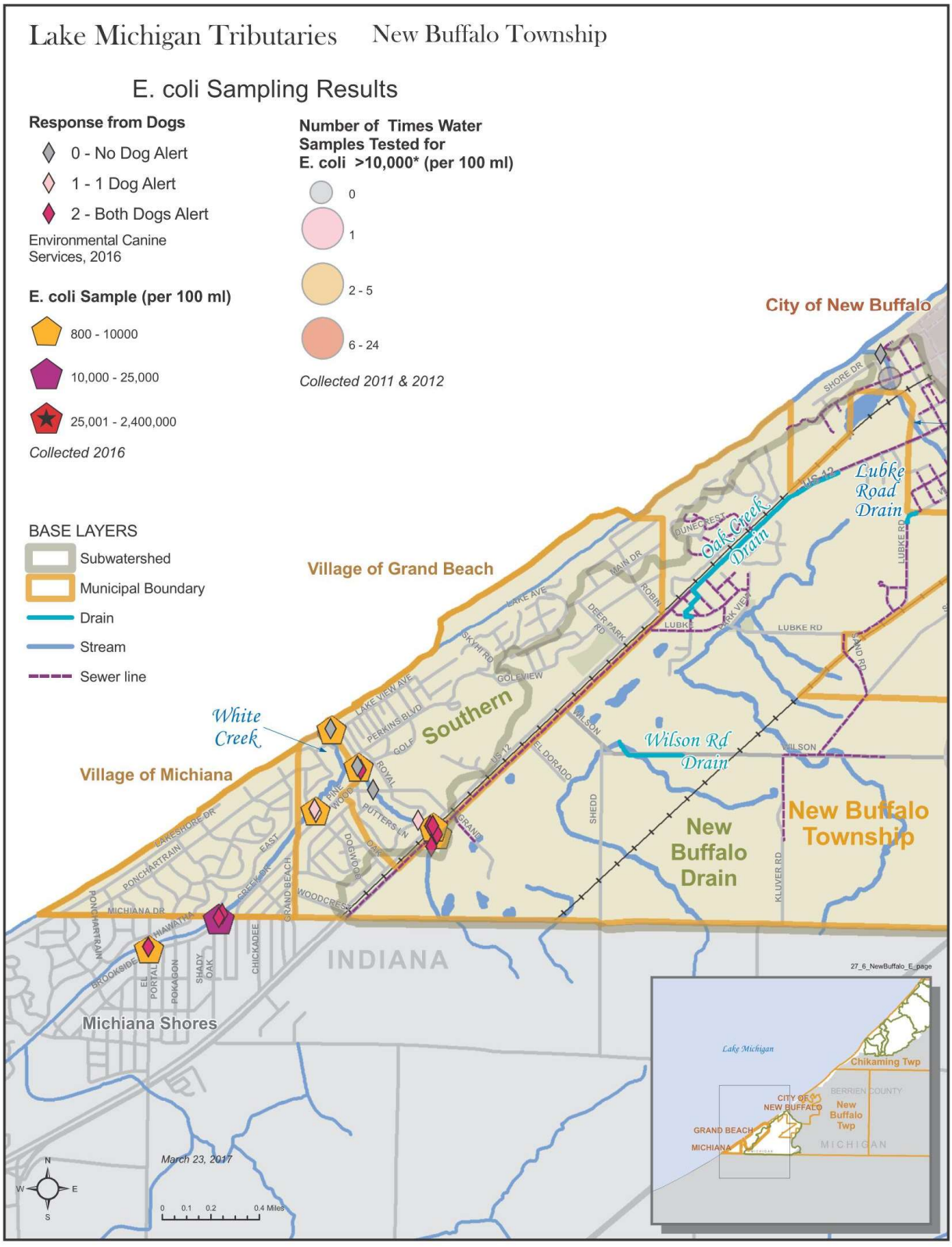
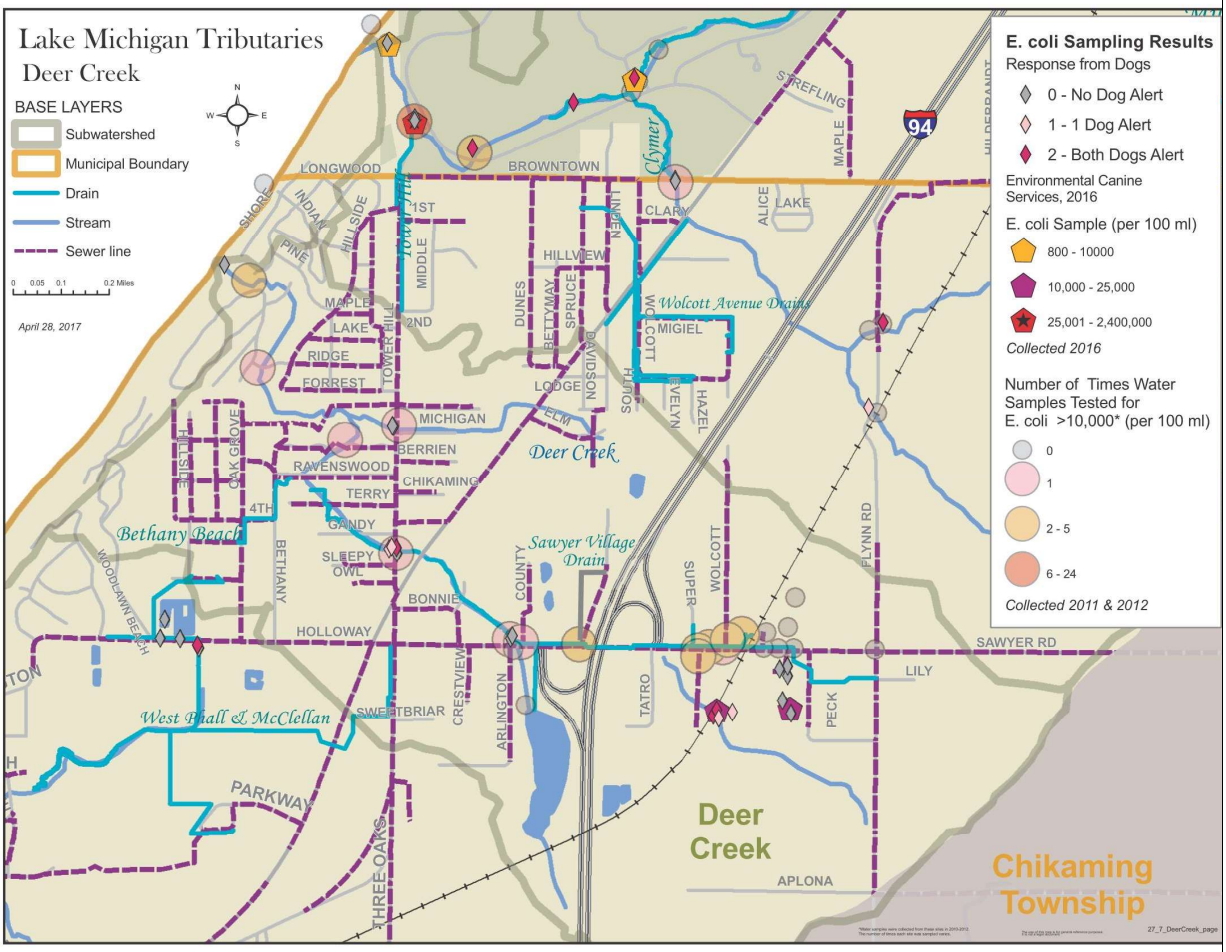


**Figure 7. E. coli Sampling Results, Deer Creek**



# Appendix – Priority Protection Criteria Maps

The following maps are provided to support Chapter 8: Prioritization – Areas, Pollutants, Sources, showing the priorities bases on the criteria Parcel Size, E. coli Impairment, Potential Wetland Restoration, and Water Quality Function.

Priority protection areas were identified in the watershed based on lands that are contributing, or have the potential to contribute, a majority of the pollutants impacting water quality and that have high potential for protection. By identifying priority areas, implementation can be targeted to the places where the most benefit can be achieved.

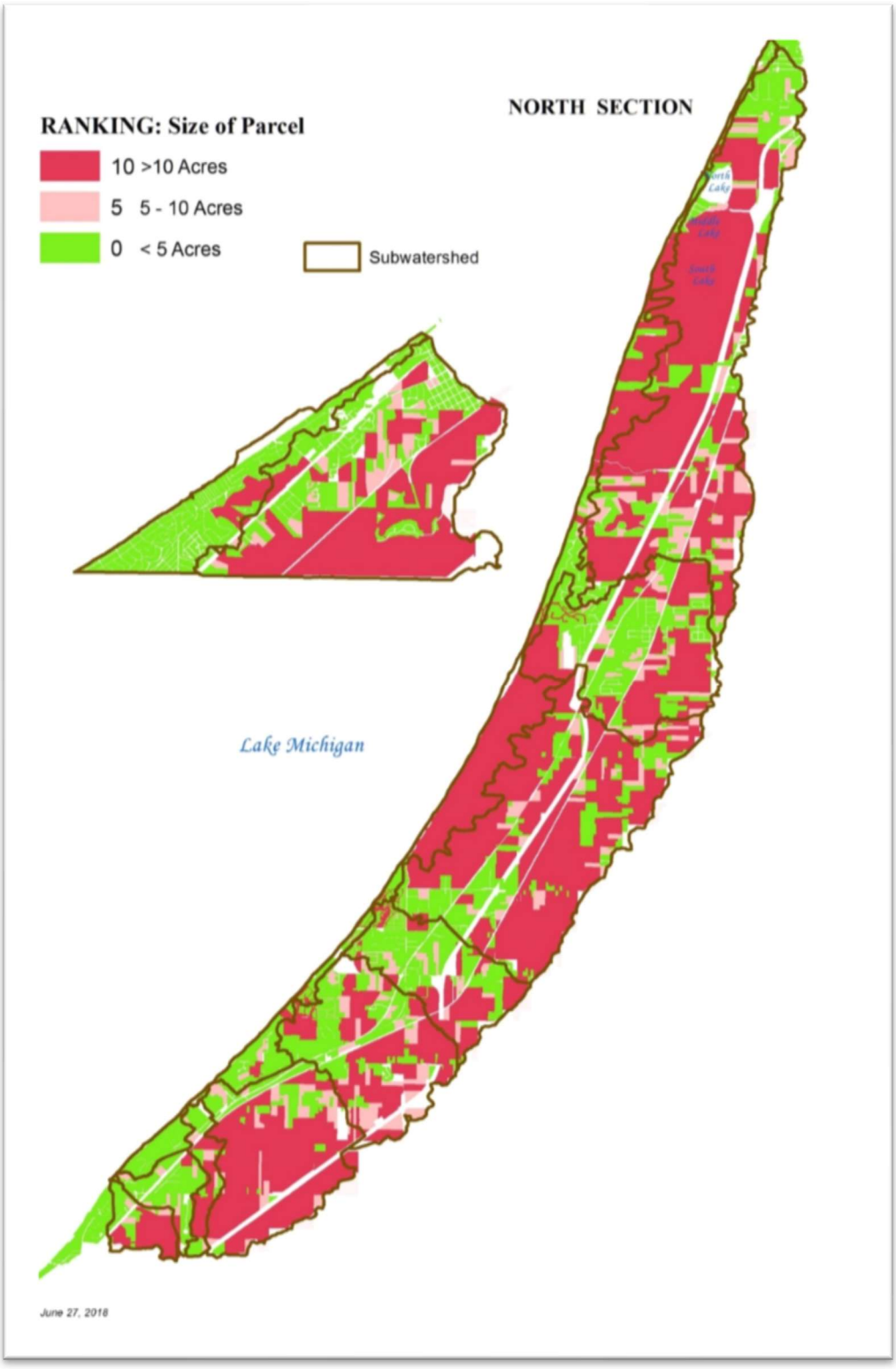
The following Figure shows the priority based on the Parcel Size criterion.

Parcel Size

Parcel size was identified as factor based on the potential impact of and feasibility for protection. Parcels were scored based on acreage with parcels less than five acres scoring zero to parcels greater than ten acres scoring ten.

- 0- 4 acres – 0 points
- 5-10 acres – 5 points
- Over 10 acres – 10 points

**Figure 1. Lake Michigan Tributaries Watershed, Priority: Parcel Size**



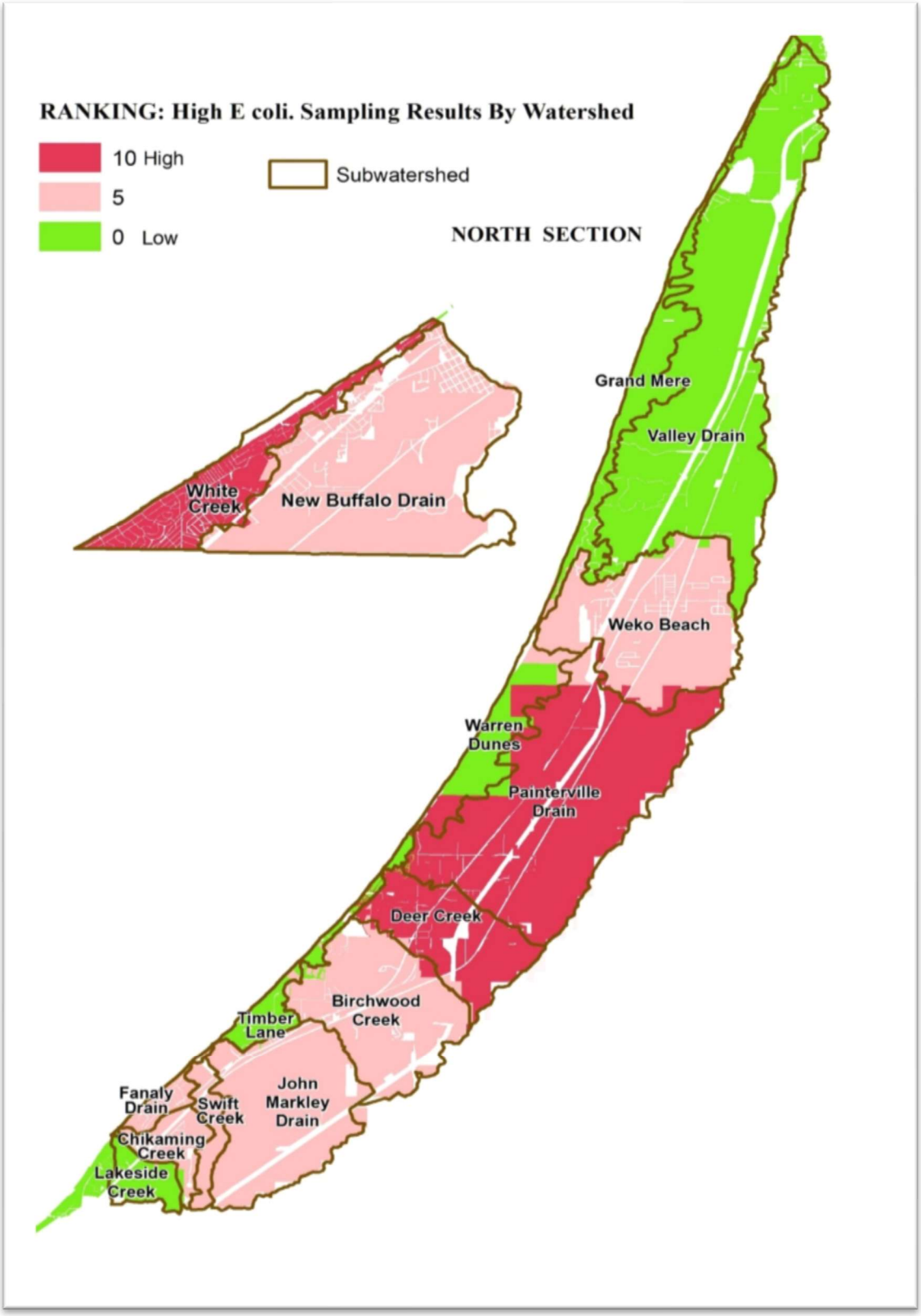
The following Figure shows priority based on the E. coli Impairment criterion.

E. Coli Impairment

E. coli impairment was identified as a significant pollution issue in 10 of the 15 subwatersheds of the project area. Each parcel was scored based on sampling results of its subwatershed, from zero, for low E. coli counts to ten for high E. coli counts.

- E. coli TMDL watershed – White Creek, Deer (Sawyer) Creek, Painterville Creek - 10
- Non-TMDL watershed – Tanner Creek (Weko Beach), Birchwood Creek, John Markley (Cherry Beach), Swift Drain, Fanaly Drain, Chikaming Creek, Birchwood Creek, Lighthouse Creek – 5
- Has no direct stream drainage into Lake Michigan – Grand Mere – 0

**Figure 2. Lake Michigan Tributaries Watershed, Priority: E. Coli Impairment**



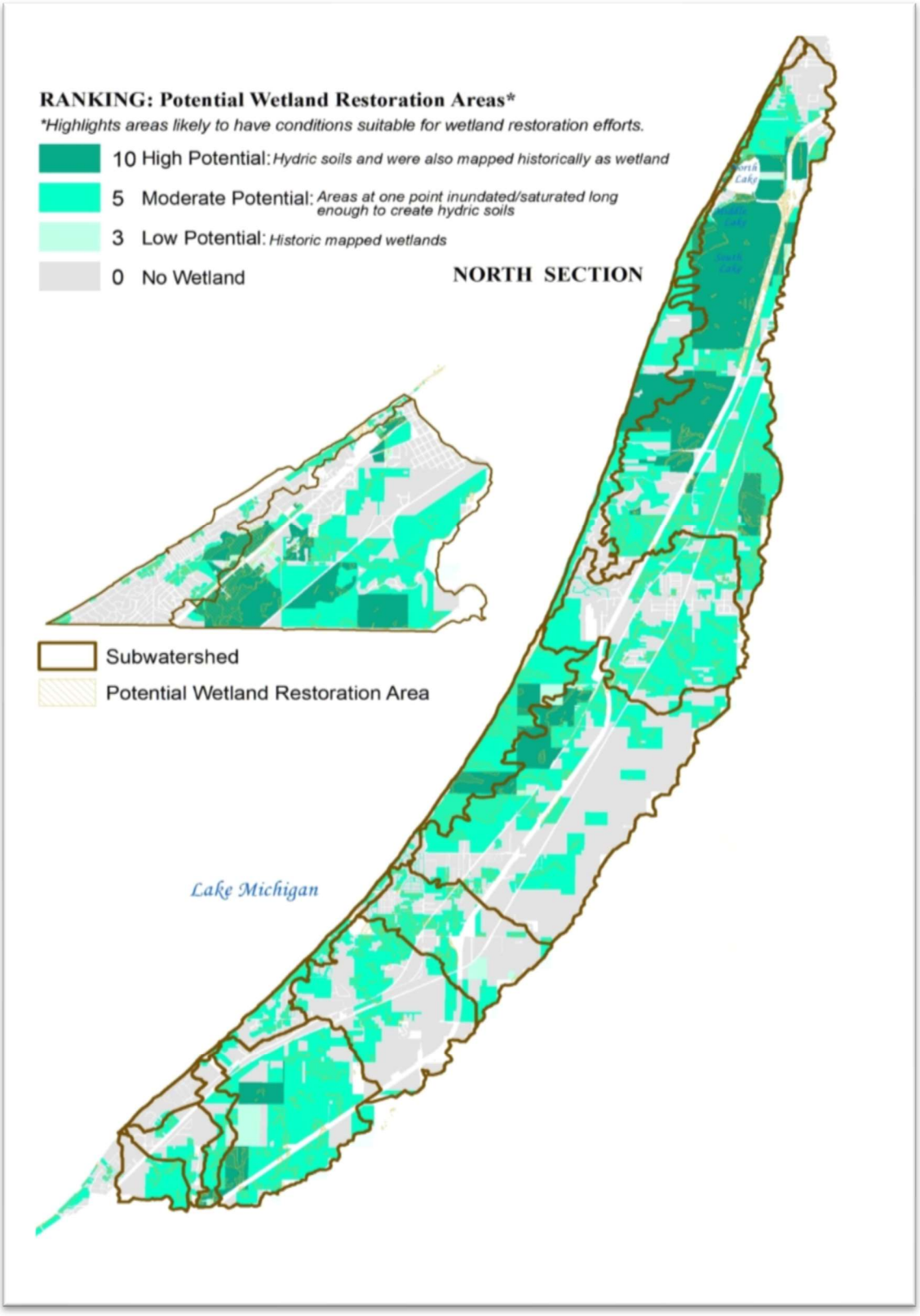
The following Figure shows priority based on the Potential Wetland Restoration criterion.

Potential Wetland Restoration

Restoration of wetlands is also important for addressing a variety of water quality issues. Each parcel was scored based on the potential for wetland restoration based on MDEQ data and maps, from zero having low potential for restoration based on no historically mapped wetlands and no hydric soils to ten having high potential for restoration based on presence of hydric soils and historically mapped wetlands. The points are as follows for Potential Wetland Restoration: High – 10 Medium – 5 Low – 3.

- High –10 – Represent the highest potential for wetland restoration based on the datasets. Include areas that are hydric soils and were also mapped historically as wetland.
- Medium – 5 – Represent the next best potential for restoration and are hydric soils. These areas at one point or another have been inundated/saturated long enough to create hydric soils and are great candidates for restoration.
- Low – 3 – Represent moderate potential for restoration and are the historic mapped wetlands.

**Figure 3. Lake Michigan Tributaries Watershed, Priority: Potential Wetland Restoration**



The following Figure shows priority based on the Water Quality Function criterion.

**Existing Wetland – Water Quality Function**

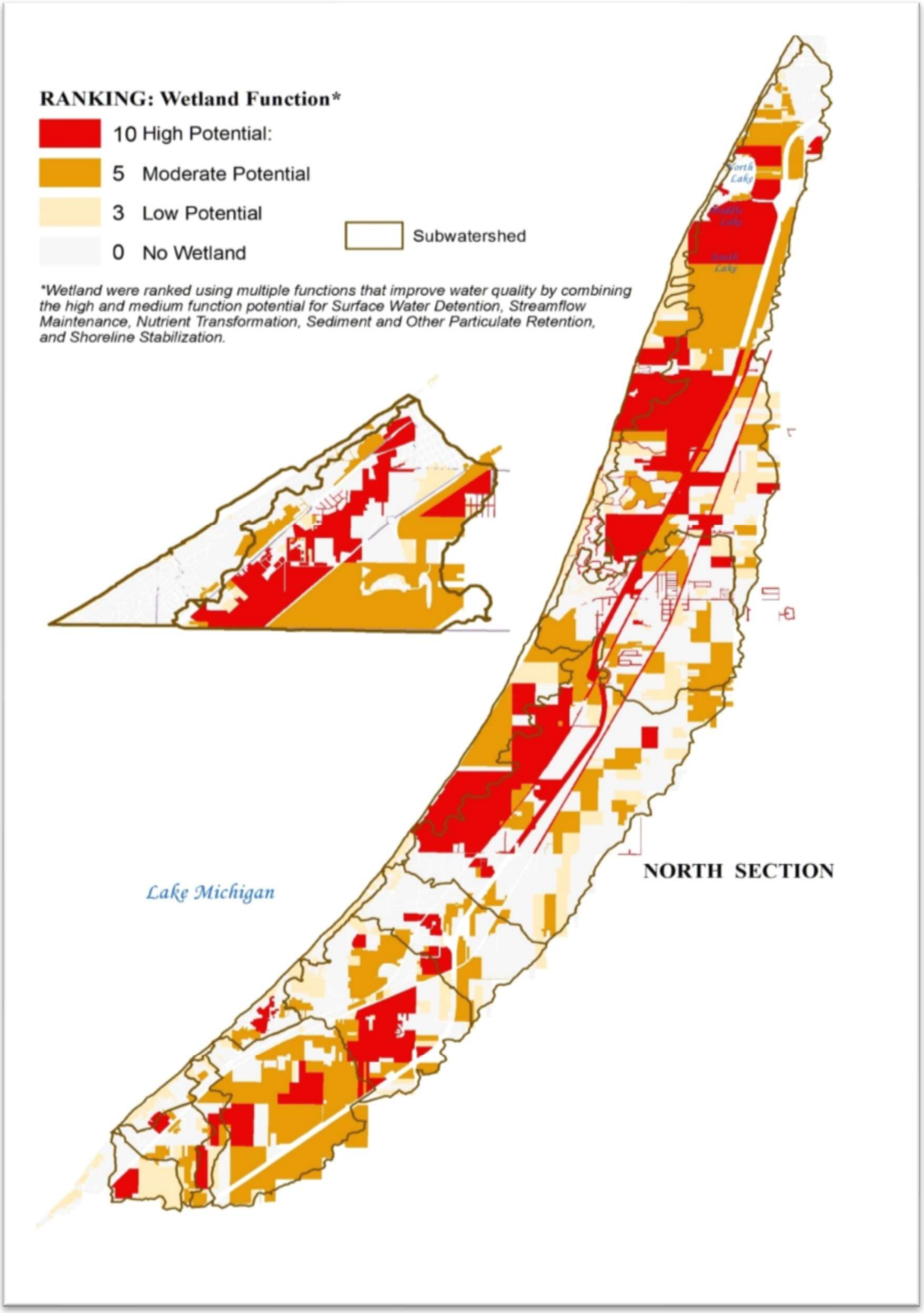
Protection of existing wetlands is critical to addressing and improving water quality. Existing wetlands were identified based on MDEQ data and maps. The wetlands were ranked using multiple functions which improve water quality, and each parcel was scored based on the presence and function of the existing wetlands, with zero having no wetlands to ten having wetland that ranked highest in function. The points are as follows for Water Quality Function:

- High – 10
- Medium – 5
- No Rank (wetland present) – 3

Additionally, Water Quality: Function potential was rated as follows, by adding the functions of flood water storage, streamflow maintenance, nutrient transformation, sediment retention, and shoreline stabilization:

- High = 2
- Moderate = 1

**Figure 4. Lake Michigan Tributaries Watershed, Priority: Wetland –Function**



# Appendix – Lake Michigan Tributaries Watershed Management Plan: Public Engagement Framework

The Southwest Michigan Planning Commission has contracted with Wightman and Rb Strategy to develop and implement a broad-based public engagement framework as a part of the Education & Information plan for the Lake Michigan Tributaries Watershed Management Plan. Education and outreach are essential components of successful plan implementation; it is crucial that the businesses, residents, tourists, and municipal representatives be made fully aware of the issues that exist in the watershed and what needs to be done to remediate them, and to protect what they have.

Based on the theme "Cleaner Water, Better Beaches" the framework includes meetings, workshops, direct mailers, emails, posters, and a website, all incorporating a cohesive visual theme with the goal of educating the public about the importance of mitigating human waste pollution in the water systems to prevent closing of beaches and waterways.

Details of the initiatives along with examples of collateral materials follow.

## Lake MI Tributaries Public Engagement Framework

***Client Team - Southwest Michigan Planning Commission (SWMPC):*** **Marcy Hamilton** – Project Manager
***Consultant Team - Wightman Team:*** **Carl Baxmeyer -** Project Manager **Ben Baker –** Landscape Architect **Sarah Proceviat** - Environmental
***Marketing Team - Rb Strategy:*** **Russell Bodnar** – Project Manager **Amy Cross** – Designer

**Summary of Public Engagement:**
The strategic focus of public engagement for the Lake Michigan Tributaries WMP area should be two-fold, awareness and mitigation. This will be supported by a Public Workshop and a public tour of the primary water treatment plant operated by the Galien River Sanitary Department (GRSD).

### Public Workshop

*The Goal of this workshop is to raise awareness with the Harbor Country residents and visitors about E Coli pollution and the role residential septic and municipal treatment systems play in contributing to contamination. Once the audience is aware of water quality challenges, we can present opportunities for testing, prioritizing, and mitigating future pollution.*

**Agenda Item** **Advertisement**
No. 1

- *Direct Mailers Outreach:* Advertise the date and time of both the workshop and tour targeting all addresses within the WMP area, **see postcard/email example.** Due to a high percentage of second home ownership, it is best to begin advertisement in the early summer when kids have summer break. Perhaps target a weekend for both the workshop and tour.
- *Email Outreach:* This same design can be kept in PDF format for email. Utilize any existing networks for distribution, i.e.: GRSD email list, SWMPC contacts, neighborhood associations, etc….
- *Poster Outreach:* Post the workshop and tour information in local points of interest such as municipal government buildings, libraries, local businesses, etc…. **See poster example.**

- *Website:* Share information about the workshop and tour on the WMP website if developed, **see website framework example.** The website will also be a good way to share information following the public engagement phase.

**Agenda Item No. 2** **Educational Presentation**

- *Animated Video (see storyboard):* If produced, begin the presentation with the animated video which would show how sanitary waste from a home effects the E Coli levels of the thirteen tributaries in the WMP area. Beginning with individual septic systems and their neglect allowing pollutants to leach into the surrounding soils and water table, the video would then show how a municipal system can create a similar non-point pollution concern due to aging infrastructure and underutilized systems in this specific WMP area.
- *Nitrate Testing:* Perform a demonstration with Nitrate testing strips to detect the presence of lead in your household water system.
- *Canine Pollutant Detection:* Collaborate with consultants, Environmental Canine Services, to provide a demonstration of how their dogs detect E Coli and other fecal matter contaminants in water systems.

**Task 3 T3** **Mitigation Strategies**
Nov. 30

*Present the topics below to raise awareness about opportunities to make an impact on mitigating human waste pollution in our water systems and prevent closing of our beaches and waterways.*

- *Septic System Maintenance*: Educate homeowners on the importance to maintain or replace aging septic systems and their associated drain fields. These systems are the largest contributor to E Coli and other human waste contamination in the WMP area and with proper monitoring and maintenance this can easily be mitigated.
- *Point of Sale Septic System Inspections:* The State of Michigan has entertained legislation to require home owners to have their septic systems inspected prior to the sale of their home. This would create a greater likelihood of maintenance and replacement as septic systems become a liability.
- *Saw Grants:* The State of Michigan implemented a major grant program for the development of municipal asset management programs for water and sewer systems. The goal of this program is to create resources for municipalities throughout the state to analyze, monitor, and prioritize maintenance of their entire water and sanitary system. A few of the municipalities in the WMP area are Bridgman, New Buffalo, New Buffalo Twp, and GRSD.

## Galien River Sanitary Department (GRSD) Treatment Plant Public Tour

*The goal of this meeting is to further educate the public about the importance of water conservation and what the 'final mile' of sanitary waste treatment looks and smells like.*

**Task 6 T6** **Public Tour of the GRSD Treatment Plan**
Nov. 30

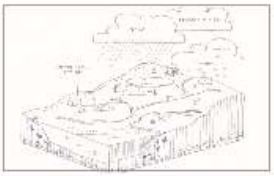
- Collaborate with GRSD and the treatment plant staff to coordinate a day and time for the public to take a tour of the various systems to treat incoming waste. This tour should follow the workshop by a few weeks and focus on how water conservation can aid better water quality in our streams and lakes while also raising the quality of drinking water.

# Lake Michigan Tributaries

## ANIMATED VIDEO—STORYBOARDS


Logo Opening/ Key Statement

You are part of the Lake Michigan watershed area...

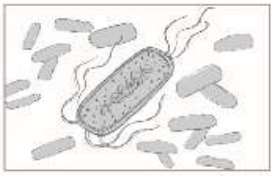


What is a watershed? A tributary?

Lake Michigan Tributary

Septic and Sewer Issue when it rains

Overflow makes it into the lakes!

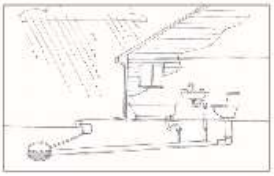


Ecoli


Show beach contamination

How this affects you... breweries, coffee houses, bath water, tap water

Dogs can find issues with nfrastructure and septic tanks



What You Can DO... Best practices! (6-8 suggestions)

End with pretty beach and happy people

**BetterBeachesSWMI.org**

CLEANER WATER
BETTER BEACHES
SOUTHWEST MICHIGAN

HOME INFORM RESOURCES CONNECT

## Let's Connect!

DEVELOPERS and LOCAL BUSINESSES
**Are you looking to become part of our future plans?**
First Last, Organization Name
000-000-0000
name@organization.org

AREA RESIDENTS
**Are you interested in finding out more?**
First Last, Organization Name
000-000-0000
name@organization.org

FARMER/AGRICULTURAL
**Are you interested in support and best practices?**
First Last, Organization Name
000-000-0000
name@organization.org

CONTACTS

NAME

COMPANY

CITY/STATE/ZIP

PHONE

EMAIL

QUESTIONS OR COMMENTS

QUESTIONS & COMMENTS

SUBMIT

OUR PARTNERS

SIGN UP FOR UPDATES

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BETTER BEACHES
SOUTHWEST MICHIGAN

HOME INFORM RESOURCES CONNECT

# Stay Informed

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## LATEST ARTICLES

SOURCE

**Story Title**

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SOURCE

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LOREM IPSUM 1h ago

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by Name Surname

LOREM IPSUM 1h ago



by Name Surname

## RESOURCES

LOREM IPSUM 1h ago



LOREM IPSUM 1h ago

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by Name Surname

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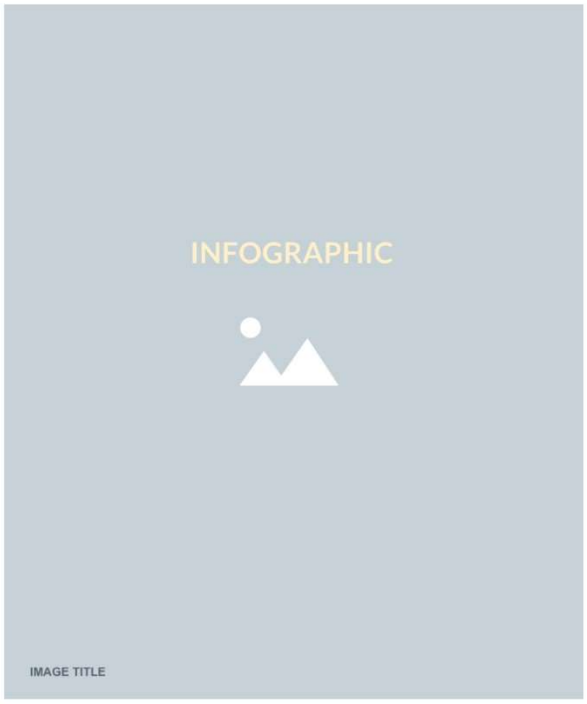


INFRASTRUCTURE

## What Is the Issue?

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## Solutions and Actions

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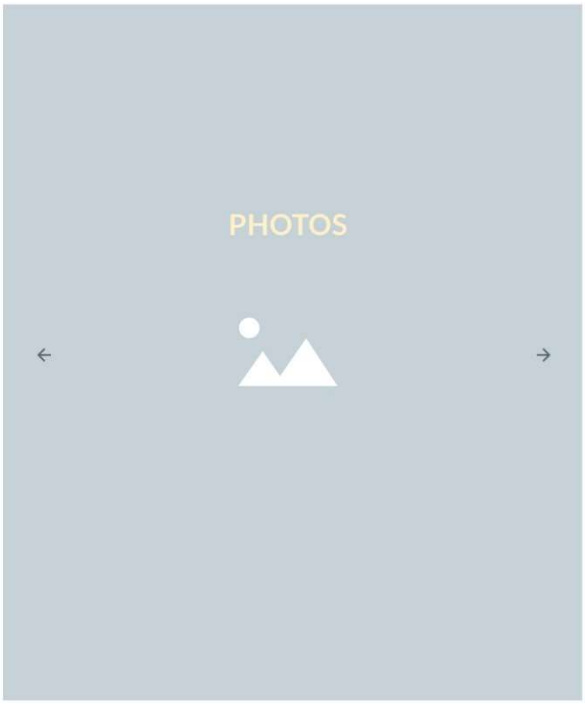

CLEANER WATER
BETTER BEACHES
SOUTHWEST MICHIGAN

HOME INFORM RESOURCES CONNECT

## Introduction

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ANIMATED VIDEO

## Why the Initiative is Important

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Read More →

SECTION B

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# Lake Michigan Tributaries

## BRANDING—LOGO & COLOR EXPLORATION

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**Ox Creek Logo as reference**

Name: Based on Geography Feature
Images: Urban, Rural, Exit 29
Action: In website name "sustain"
Colors: Dark Teal and Aqua are water colors

sustainoxcreek.org


---

**Proposed Lake Michigan Tributary Logo**

Name: "Cleaner Water, Better Beaches"
Focuses on Lake MI shoreline water
Images: Home/Business in SWMI
Recreational Water Use
Rivers/Streams (Tributaries)
Action: Cleaner Water
Colors: Light Blue represents pure water
Yellow as an accents show pollution,
it is a color that calls attention

BetterBeachesSWMI.org

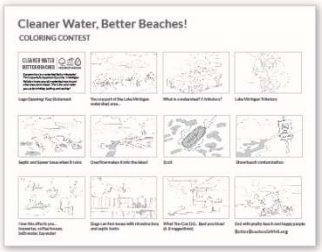
| c0 m0 y0 k0 | c15 m1 y2 k0 | c0 m15 y72 k0 | c86 m68 y54 k56 |
|---|---|---|---|
| r255 g255 b255 | r213 g235 b244 | r25 g214 b100 | r28 g47 b58 |
| #ffffff | #d5ebf4 | #ffd664 | #1c2f3a |


## EVENT INVITE


## EVENT HANDOUT



## EVENT COLORING PAGE for Kids




## SUPPORT STICKER


## EVENT POSTERS


**Michigan Department of Environmental Quality**
**Surface Water Quality Division**
**August 2002**

# Total Maximum Daily Load for *Escherichia coli* for Deer Creek, Berrien County, Michigan

## INTRODUCTION

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli*) that will result in the attainment of the applicable WQS in Deer Creek, a small waterbody with relatively low flows (Table 1) in the Galien River Watershed, located in Berrien County.

## PROBLEM STATEMENT

Deer Creek was first placed on the Section 303(d) list in 1998. This TMDL addresses approximately seven miles of stream. The TMDL reach is on the 2002 Section 303(d) list (Creal and Wuycheck, 2002) as:

Waterbody: **Deer Creek** WBID#: **083301D**
County: Berrien HUC: 4040001 Size: 7 M
Location: S. Br. Galien River confluence u/s to the headwaters in vicinity of Three Oaks
Problem: **Untreated sewage discharge, pathogens (Rule 100); Macroinvertebrate community rated poor; nuisance algae**
**TMDL YEAR(s): 2002 2004** RF3RchID: 4040001 440 0.00

This TMDL addresses pathogens. Deer Creek is also on the Section 303 (d) list for poor macroinvertebrate communities and nuisance algae. These TMDLS are scheduled in 2004.

Deer Creek (Figure 1) was placed on the Section 303(d) list for *E. coli* due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli.* Recent monitoring data (Appendix 1) collected by the Michigan Department of Environmental Quality (MDEQ) in 2001 documents continued exceedances of the WQS for *E. coli* at all Deer Creek stations sampled (Table 2), with exception of the September sampling at Lakeside Road. Monthly geometric mean *E. coli* concentrations in Deer Creek for 2001 ranged from 74 *E. coli* per 100 milliliter (ml) in September at Lakeside Road to 1,273 *E. coli* per 100 ml in June at Basswood Rd. (Table 2).

Other waterbodies sampled for this TMDL include Chestnut Drain and the South Branch of the Galien River. Chestnut Drain, a small tributary to the headwaters of Deer Creek, originates in the village of Three Oaks and exhibited the highest *E. coli* concentrations observed in the 2001 sampling (Table 2 and Figure 2). Concentrations ranged from 1,266 *E. coli* per 100 ml in June to 5,794 *E. coli* per 100 ml in May and the drain and appears to be a substantial dry weather source of *E. coli* to Deer Creek. The South Branch of the Galien River was sampled upstream (Forest Lawn Road) and downstream (Lakeside Road) of the confluence with Deer Creek.

Slightly elevated levels of *E. coli* were found at both stations. Monthly geometric means at Forest Lawn Road (upstream) ranged from 334 *E. coli* per 100 ml in September to 698 *E. coli* per 100 ml in July. Monthly geometric means for *E. coli* at Lakeside Road (downstream) ranged from 266 *E. coli* per 100 ml in June to 730 *E. coli* per 100 ml in July.

**NUMERIC TARGET**

The impaired designated use for Deer Creek addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

> R 323.1062 Microorganisms.
> Rule 62. (1) All 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 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.

In addition, permitted sanitary wastewater discharges have an additional target:

> Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 milliliters, based on the on the geometric mean of all of 3 or more samples taken during any period of discharge not to exceed 7 days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliforms per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source dischargers are meeting their limit of 200 fecal coliform per 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent.

For this TMDL, the WQS of 130 per 100 ml as a 30-day geometric mean is the target level for the TMDL reach from May 1 to October 31. As previously stated, 2001 monitoring data indicated consistent exceedances of WQS in the TMDL reach with particularly high levels of *E. coli* in Chestnut Drain in the village of Three Oaks.

**SOURCE ASSESSMENT**

Deer Creek is located entirely in Three Oaks Township in Berrien County. The TMDL reach is from the confluence of Deer Creek with the South Branch of the Galien River upstream to the headwaters in the vicinity of the village of Three Oaks (Figure 1). There are two permitted point

source discharges to Deer Creek, the Three Oaks Waste Water Sewage Lagoon (WWSL) (MIG580294) and Vickers Engineering (MIS410232). Municipalities include Three Oaks Township and the village of Three Oaks (Figure 3).

Potential pathogen sources for this waterbody appear to be due in part to storm water from the village of Three Oaks, illicit connections, sewage overflows, and agricultural inputs. The 2001 monitoring data was collected during typical stream flow conditions and indicates both continuous and storm water-related inputs.

As stated above, there are two permitted point source discharges to Deer Creek, Vickers Engineering and the Three Oaks WWSL. Vickers Engineering has a permitted storm water discharge to Deer Creek. In addition to storm water, this facility has a septic tank drain field used for treatment of their sanitary and industry discharge. By the aid of an economic development grant, the facility's sanitary and industrial waste will be discharged to the village of Three Oaks sanitary sewer system (MDEQ district correspondence, 2002), eliminating any potential inputs to Deer Creek from their septic tank.

The Three Oaks WWSL is permitted to discharge during the months of March through May and October through December. The discharge period overlaps the recreational season in May and October only. The facility has a fecal coliform limit of 200 per 100 ml as a monthly average and will be considered in compliance with the WQS of 130 *E. coli* per 100 ml if their NPDES permit limit of 200 fecal coliform per 100 ml as a monthly average is met. As previously discussed, this is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source is meeting their limit of 200 fecal coliform of 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent. However, records maintained by the MDEQ document an overflow from the Three Oaks WWSL and an out of season discharge in 1997 and 2000, resulting in bacterial slime growth in Deer Creek. The village of Three Oaks is currently under an Administrative Consent Order (ACO) (SW99-007) to separate their sanitary sewer lines from their storm sewers. The project is expected to be completed by March 1, 2003. In addition, monitoring data collected in 2001 indicate Chestnut Drain, originating in Three Oaks, is a substantial source of *E. coli* even in dry weather (Appendix 1).

## LINKAGE ANALYSIS

The link between the *E. coli* concentration in Deer Creek and the potential sources is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. This provides the basis for estimating the total assimilative capacity of the creek and any needed load reductions. For this TMDL, the primary loading of pathogens likely enters Deer Creek by both continuous and, to some degree, storm water related nonpoint sources.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in Deer Creek depends on the control of point source *E. coli,* the control of *E. coli* in illicit connections, and storm water. If the *E. coli* inputs can be controlled, then total body contact recreation in Deer Creek will be protected.

## TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving WQS. As indicated in the Numeric Target section, the target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical

condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090. In general, the lowest monthly 95% exceedance flow for streams is used as a design condition for point source discharges. However, for pathogens in point source discharges of treated or untreated human sewage, levels are restricted to a monthly average limit of 200 per 100 ml for fecal coliform regardless of stream flow. Therefore, the design stream flow is not a critical condition for determining the allowable loading of pathogens for wastewater treatment plants. In addition, other *E. coli* sources to Deer Creek arise from a mixture of wet and dry weather-driven nonpoint sources, and there is no single critical condition that is protective for all other conditions. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli*, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL at the confluence with the South Branch of the Galien River is equal to the target concentration of 130 *E. coli* per 100 ml for each month of the recreational season (May through October).

For this TMDL, an allocation strategy for nonpoint sources has been selected that assumes equal bacteria loads per unit area for all lands within the watershed. The point sources are handled consistent with Rule 62(3).

## ALLOCATIONS

TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. As previously indicated, this pathogen TMDL will not be expressed on a mass loading basis and is concentration-based consistent with USEPA regulations in 40 CFR, Section 130.2(i).

### WLAs

The village of Three Oaks WWSL (MIG580294) is the only permitted point source discharge that contains treated or untreated human sewage to the listed reach of Deer Creek. This facility has a seasonal discharge during the months of March through May and October through December and has a limit of 200 fecal coliform per 100 ml as a monthly average. As previously stated, when the WWSL is meeting their fecal coliform limit, it is assumed the WQS will be met in the discharge. Therefore, the WLA will be equal to 130 *E. coli* per 100 ml for the months of May and October.

LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml. The assumption used in the allocation strategy is that there are equal bacteria loads per unit area for all lands within the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction of the various units of local government within the watershed. Table 3 gives the relative land in the watershed for each of the local units of governments. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the total body contact designated uses to Deer Creek. However, as noted previously, Chestnut Drain located in the village of Three Oaks appears to be a significant source of *E. coli* to Deer Creek. It is anticipated that this problem will be addressed under the current Administrative Consent Order (ACO) and on-going construction of a new sanitary sewer system within the village limits of Three Oaks.

The government entities with land area in the Deer Creek Watershed are Three Oaks Township (87%), followed by the village of Three Oaks (13%) (Table 3).

MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay was used.

## SEASONALITY

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. In addition, because this is a concentration-based TMDL, WQS will be met regardless of flow conditions in the applicable season.

## MONITORING

In 2001, pathogens were monitored at seven stations from May through September (Figure 1). Subsequent weekly sampling began at all stations on May 15, 2002 and will continue through September, 2002. If sampling in early in 2002 continues to show that WQS are exceeded, sampling will be oriented towards source identification. If these results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

Future monitoring will be conducted at appropriate stations after March 1, 2003. All hook-ups to the sanitary sewer are required by the ACO to be completed by this date. When results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

## REASONABLE ASSURANCE ACTIVITIES

Due to numerous past unauthorized lagoon discharges, sewer extensions, and lift station failures, the village of Three Oaks is under an ACO (SW99-007) to update their sanitary sewer system. The upgraded system will eliminate excessive infiltration and inflow, which will alleviate overflows from the lagoons. All construction and residential hook-ups are required by the ACO by March 1, 2003, although the project is anticipated to be completed before that date.

The Berrien County Drain Commission has been awarded a Section 319 Watershed Management Grant. The grant includes the development of a comprehensive watershed management plan and implementing an Information and Education strategy that identifies target audiences and delivers messages based on the sources and causes of nonpoint solution. The group began meeting in 2001 to conduct activities aimed at restoring the Galien River Watershed.

Prepared by: Christine Thelen, Aquatic Biologist
Great Lakes and Environmental Assessment Section
Surface Water Quality Division
Michigan Department of Environmental Quality
August 26, 2002

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Personal communication, Richard L. Whitman. United States Geological Survey, October 2001.

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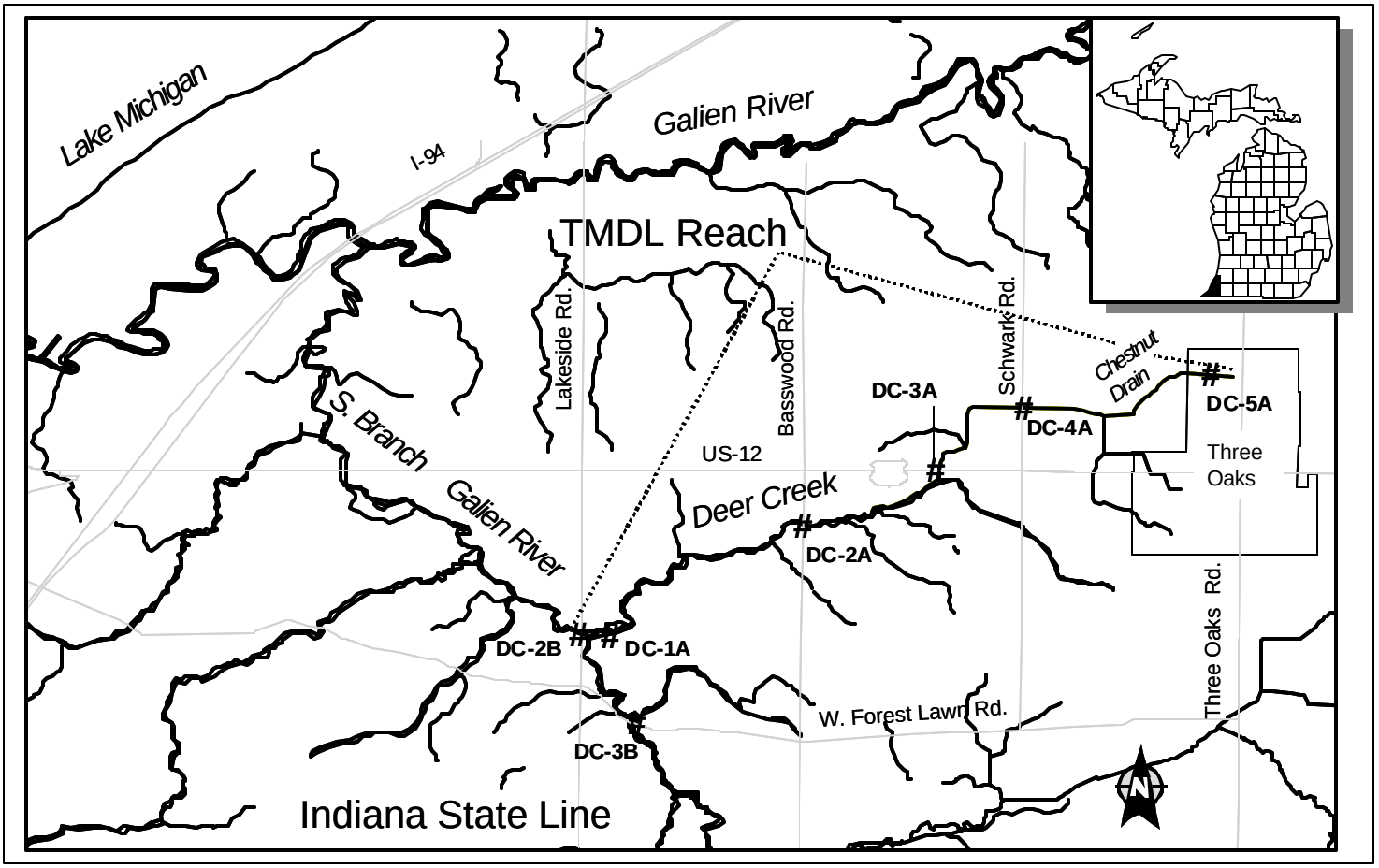


**Figure 1. Deer Creek *E. coli* sampling locations, vicinity of Three Oaks, Michigan, 2001.**

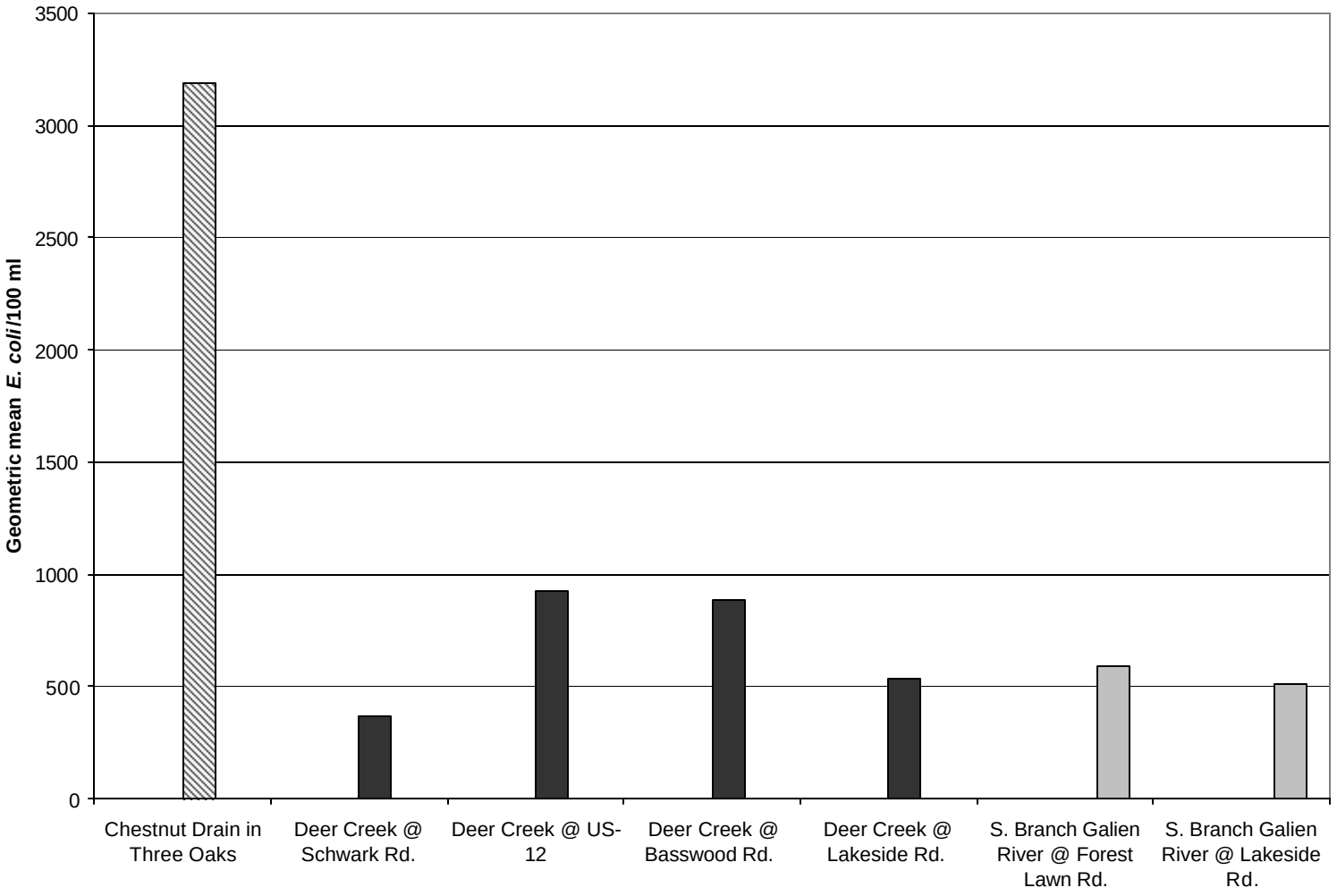


**Figure 2. Geometric mean *E. coli* results from Deer Creek and related waterbodies, vicinity of Three Oaks, Three Oaks Township, Michigan, 2001.**

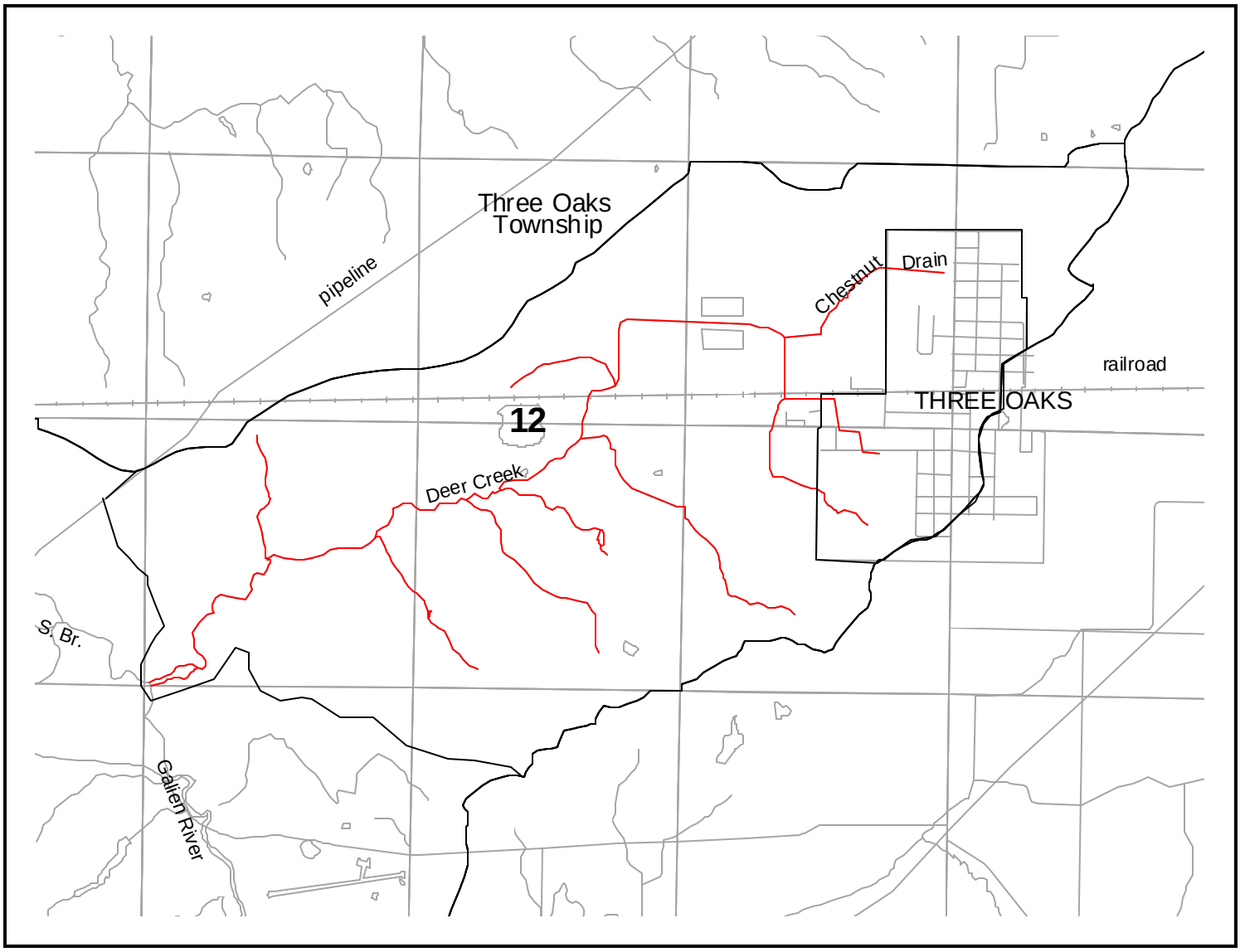


**Figure 3. The Deer Creek Watershed, including the Village of Three Oaks and Three Oaks Township.**

**Table 1. Deer Creek average flows (cfs) at the confluence of the South Branch Galien River.**

| May | June | July | August | September | October |
|---|---|---|---|---|---|
| 5.3 | 3.8 | 2.6 | 2.3 | 2.2 | 2.5 |

**Table 2. MDEQ *E. coli* data for Deer Creek and related waterbodies, vicinity of Three Oaks, Three Oaks Township, Michigan, 2001.**

| | | ***E. coli* concentration (#/100 ml)** | | | |
|---|---|---|---|---|---|
| **Sample Location** | **Month** | **minimum** | **geometric mean** | **maximum** | **# of results** |
| **Chestnut Drain in Three Oaks** | May | 3,600 | 5,794 | 7,400 | 3 |
| | June | 380 | 1,266 | 9,100 | 9 |
| | July | 1,370 | 4,491 | 8,200 | 9 |
| | August | 1,700 | 4,419 | 14,500 | 12 |
| | September | 2,200 | 2,735 | 3,100 | 3 |
| **Deer Creek @ Schwark Rd.** | May | 730 | 816 | 980 | 3 |
| | June | 60 | 245 | 830 | 12 |
| | July | 70 | 204 | 800 | 12 |
| | August | 320 | 828 | 4,900 | 12 |
| | September | 290 | 394 | 480 | 3 |
| **Deer Creek @ US-12** | May | 500 | 564 | 620 | 3 |
| | June | 890 | 1,188 | 1,700 | 6 |
| | July | * | * | * | * |
| | August | * | * | * | * |
| | September | * | * | * | * |
| **Deer Creek @ Basswood Rd.** | May | 370 | 431 | 470 | 3 |
| | June | 850 | 1,273 | 1,900 | 6 |
| | July | * | * | * | * |
| | August | * | * | * | * |
| | | * | * | * | * |
| **Deer Creek @ Lakeside Rd.** | May | 480 | 590 | 670 | 3 |
| | June | 400 | 743 | 1,900 | 12 |
| | July | 220 | 455 | 810 | 12 |
| | August | 120 | 679 | 4,500 | 15 |
| | September | 50 | 74 | 100 | 3 |
| **S. Branch Galien River @ Forest Lawn Rd.** | May | * | * | * | * |
| | June | 290 | 507 | 760 | 6 |
| | July | 360 | 698 | 1,030 | 12 |
| | August | 310 | 620 | 1,100 | 15 |
| | September | 240 | 334 | 410 | 3 |
| **S. Branch Galien River @ Lakeside Rd.** | May | * | * | * | * |
| | June | 200 | 266 | 340 | 6 |
| | July | 440 | 730 | 1,400 | 12 |
| | August | 70 | 499 | 1,070 | 15 |
| | September | 370 | 479 | 550 | 3 |

***** no data collected during this month at this location.

**Table 3. Distribution of land for each municipality in the Deer Creek Watershed.**

| Municipality | Watershed Area (sq. mi.) | Percent Land Area in Watershed |
|---|---|---|
| Three Oaks Township | 4.35 | 87 |
| Village of Three Oaks | 0.65 | 13 |
| **TOTAL** | **5.0** | **100** |

**Appendix 1. MDEQ 2001 *E. coli* monitoring data for Deer Creek and related waterbodies (E. coli/100 ml). Data are presented upstream to downstream.**

| Chestnut Drain @ Three Oaks DC-5A | Deer Creek @ Schwark Rd. DC-4A | Deer Creek @ US-12 DC-3A | Deer Creek @ Basswood DC-2A | Weather data |
|---|---|---|---|---|
| **5/29/2001** | **5/29/2001** | **5/29/2001** | **5/29/2001** | Sunny, mild |
| 3600 | 730 | 500 | 460 | |
| 7300 | 760 | 620 | 470 | |
| 7400 | 980 | 580 | 370 | |
| **6/6/2001** | **6/6/2001** | **6/6/2001** | **6/6/2001** | Foggy, light drizzle |
| 580 | 760 | 1100 | 1700 | |
| 900 | 830 | 1700 | 1700 | |
| 680 | 180 | 1000 | 1900 | |
| **6/13/2001** | **6/13/2001** | **6/13/2001** | **6/13/2001** | Partly sunny, hot |
| 9000 | 510 | 1240 | 940 | |
| 9100 | 380 | 890 | 850 | |
| 4200 | 520 | 1360 | 970 | |
| **6/20/2001** | **6/20/2001** | **6/20/2001** | **6/20/2001** | Mostly cloudy, cool |
| 380 | 90 | not sampled | not sampled | |
| 410 | 320 | not sampled | not sampled | |
| 440 | 330 | not sampled | not sampled | |
| **6/28/2001** | **6/28/2001** | **6/28/2001** | **6/28/2001** | Sunny, hot and humid |
| SITE | 100 | not sampled | not sampled | |
| DRY | 70 | not sampled | not sampled | |
| | 60 | not sampled | not sampled | |
| **7/5/2001** | **7/5/2001** | **7/5/2001** | **7/5/2001** | Clear, sunny and mild |
| 1370 | 800 | not sampled | not sampled | |
| 1820 | 660 | not sampled | not sampled | |
| 1820 | 700 | not sampled | not sampled | |
| **7/12/2001** | **7/12/2001** | **7/12/2001** | **7/12/2001** | Mostly cloudy, mild |
| SITE | 90 | not sampled | not sampled | |
| DRY | 90 | not sampled | not sampled | |
| | 70 | not sampled | not sampled | |
| **7/19/2001** | **7/19/2001** | **7/19/2001** | **7/19/2001** | Hot and humid, light fog |
| 8100 | 210 | not sampled | not sampled | |
| 8200 | 220 | not sampled | not sampled | |
| 8000 | 240 | not sampled | not sampled | |
| **7/26/2001** | **7/26/2001** | **7/26/2001** | **7/26/2001** | Clear, sunny and mild |
| 5800 | 130 | not sampled | not sampled | |
| 7700 | 110 | not sampled | not sampled | |
| 6900 | 160 | not sampled | not sampled | |
| **8/2/2001** | **8/2/2001** | **8/2/2001** | **8/2/2001** | Overcast, hot and humid, light drizzle |
| 9500 | 560 | not sampled | not sampled | |
| 9600 | 630 | not sampled | not sampled | |
| 14500 | 550 | not sampled | not sampled | |
| **8/9/2001** | **8/9/2001** | **8/9/2001** | **8/9/2001** | Overcast, hot and humid |
| SITE | 320 | not sampled | not sampled | |
| DRY | 330 | not sampled | not sampled | |
| | 350 | not sampled | not sampled | |
| **8/16/2001** | **8/16/2001** | **8/16/2001** | **8/16/2001** | Heavy rain |
| 8000 | not sampled | not sampled | not sampled | |
| 8000 | not sampled | not sampled | not sampled | |
| 8000 | not sampled | not sampled | not sampled | |
| **8/23/2001** | **8/23/2001** | **8/23/2001** | **8/23/2001** | Overcast, mild, light fog |
| 2700 | 4900 | not sampled | not sampled | |
| 2400 | 4900 | not sampled | not sampled | |
| 2400 | 3500 | not sampled | not sampled | |
| **8/29/2001** | **8/29/2001** | **8/29/2001** | **8/29/2001** | Clear, sunny and cool |
| 1720 | 610 | not sampled | not sampled | |
| 1700 | 550 | not sampled | not sampled | |
| 1800 | 510 | not sampled | not sampled | |
| **9/4/2001** | **9/4/2001** | **9/4/2001** | **9/4/2001** | Mostly sunny, mild |
| 3000 | 440 | not sampled | not sampled | |
| 3100 | 480 | not sampled | not sampled | |
| 2200 | 290 | not sampled | not sampled | |

**Appendix 1 continued. (*E. coli*/100 ml)**

| Deer Creek @ Lakeside Rd. DC-1A | S. Branch of the Galien River @ Forest Lawn DC-3B | S. Branch of the Galien River @ Lakeside Rd. DC-2B | Weather data |
|---|---|---|---|
| **5/29/2001** | **5/29/2001** | **5/29/2001** | Sunny, mild |
| 480 | not sampled | not sampled | |
| 670 | not sampled | not sampled | |
| 640 | not sampled | not sampled | |
| **6/6/2001** | **6/6/2001** | **6/6/2001** | Foggy, light drizzle |
| 1040 | not sampled | not sampled | |
| 1100 | not sampled | not sampled | |
| 1900 | not sampled | not sampled | |
| **6/13/2001** | **6/13/2001** | **6/13/2001** | Partly sunny, hot |
| 720 | not sampled | not sampled | |
| 530 | not sampled | not sampled | |
| 1060 | not sampled | not sampled | |
| **6/20/2001** | **6/20/2001** | **6/20/2001** | Mostly cloudy, cool |
| 770 | 450 | 270 | |
| 730 | 290 | 300 | |
| 680 | 330 | 280 | |
| **6/28/2001** | **6/28/2001** | **6/28/2001** | Sunny, hot and humid |
| 400 | 720 | 200 | |
| 420 | 760 | 340 | |
| 500 | 720 | 230 | |
| **7/5/2001** | **7/5/2001** | **7/5/2001** | Clear, sunny and mild |
| 560 | 530 | 760 | |
| 600 | 790 | 610 | |
| 450 | 780 | 580 | |
| **7/12/2001** | **7/12/2001** | **7/12/2001** | Mostly cloudy, mild |
| 220 | 360 | 470 | |
| 230 | 530 | 500 | |
| 250 | 530 | 440 | |
| **7/19/2001** | **7/19/2001** | **7/19/2001** | Hot and humid, light fog |
| 810 | 900 | 610 | |
| 710 | 700 | 520 | |
| 800 | 900 | 1400 | |
| **7/26/2001** | **7/26/2001** | **7/26/2001** | Clear, sunny and mild |
| 420 | 730 | 1220 | |
| 370 | 930 | 1220 | |
| 570 | 1030 | 1240 | |
| **8/2/2001** | **8/2/2001** | **8/2/2001** | Overcast, hot and humid, light drizzle |
| 330 | 670 | 500 | |
| 320 | 550 | 430 | |
| 350 | 690 | 550 | |
| **8/9/2001** | **8/9/2001** | **8/9/2001** | Overcast, hot and humid |
| 180 | 610 | 600 | |
| 160 | 600 | 620 | |
| 120 | 1100 | 520 | |
| **8/16/2001** | **8/16/2001** | **8/16/2001** | Heavy rain |
| 2800 | 1000 | 970 | |
| 4300 | 700 | 1070 | |
| 4500 | 700 | 1000 | |
| **8/23/2001** | **8/23/2001** | **8/23/2001** | Overcast, mild, light fog |
| 1000 | 780 | 530 | |
| 2000 | 740 | 70 | |
| 2200 | 660 | 630 | |
| **8/29/2001** | **8/29/2001** | **8/29/2001** | Clear, sunny and cool |
| 450 | 330 | 430 | |
| 500 | 390 | 310 | |
| 440 | 310 | 400 | |
| **9/4/2001** | **9/4/2001** | **9/4/2001** | Mostly sunny, mild |
| 50 | 240 | 370 | |
| 100 | 380 | 550 | |
| 80 | 410 | 540 | |