***Chapter 2:***

Maps and tables for chapter 2: State and National Forest map, climate table, population table, soils map, base geology map, wetlands map, planning/zoning table/map, convert water body list to table format.

Watershed Overview

Insert state and national forest map

The Little Manistee River Watershed encompasses 145,280 acres in Lake, Mason, Manistee and a small corner of Wexford counties in Michigan’s northwestern Lower Peninsula.

 Significant surface water features include the Little Manistee River and tributaries as well as several dozen small lakes. The river and tributaries are fed year-round by stable groundwater aquifers and are all designated as coldwater trout streams.

The Little Manistee is one of several high-quality streams – including the White, Pere Marquette, Pine, Big Manistee, Betsie and Platte rivers – which flow east to west into Lake Michigan, draining an extensive, forested area of the Lower Peninsula between the Muskegon River and Grand Traverse Bay.

Among those rivers, the Little Manistee is distinguished by its stable flow and cold water temperatures. Those features make it an ideal habitat for migratory steelhead trout. A Michigan Department of Natural Resources weir on the river is the site of an egg-taking operation that provides stock for hatchery operations that supply Little Manistee strain steelhead to streams throughout the Great Lakes region.

The weir is open to the public and is a popular stop for visitors during the egg-taking seasons. The only fish stocked in the Little Manistee are Chinook salmon, of which 150,000 were stocked into the river at or below the weir in 2016 (Tonello, 2016).

Portions of 16 townships and two incorporated villages lie within the watershed, as follows:

In Lake County: Parts of the townships of Cherry Valley, Dover, Eden, Elk, Ellsworth, Newkirk, Peacock, Pinora and Sauble, and the entire village of Luther.

In Manistee County: Portions of the townships of Filer, Manistee, Norman and Stronach, and a portion of the village of Stronach.

In Mason County: Portions of Meade Township and Free Soil Township

In Wexford County: Part of South Branch Township.

The watershed arises from wetlands in Lake County’s Ellsworth Township, east of the village of Luther, and extends westward just over 60 miles before discharging into Manistee Lake near the community of Stronach in Manistee County.

Manistee Lake is not included in the Little Manistee Watershed. It is, however, connected to Lake Michigan through the Manistee River Channel, and provides a link for migratory fish between the Great Lakes and the Little Manistee Watershed. The Little Manistee (HUC 0406010306) is a subwatershed of the Manistee River system.

 The drop in altitude from the headwaters to the exit point is approximately 600 feet, or an average of 10 feet per mile. Soil types are primarily well-drained sands and gravels, which provide high rates of groundwater infiltration.

Public lands in the Pere Marquette State Forest and the Huron-Manistee National Forest make up more than half of the total acreage within the watershed. The Village of Luther and the community of Irons each have populations of several hundred persons within the watershed. Services are provided in and around the city of Manistee, just west of the watershed.

 Private lands are largely forested, and sparsely populated. The 2010 census shows a majority of the dwellings in the watershed are used as cottages or seasonal recreation properties.

Agricultural land uses, primarily row crops and small cattle operations, occupy about 5 percent of the watershed’s acreage. The largest farm area is in Ellsworth Township, near the headwaters.

The Little Manistee mainstream has one dam, at the village of Luther, which impounds a millpond of about 8 acres. The Luther Dam washed out in 1986 and again in 1993, contributing significant sediment into the river below. From Luther to the mouth – a distance of about 55 miles – the river is free-flowing. A smaller dam on U.S. Forest Service property in Stronach Township impounds a small tributary to form a water body known as Linke’s Pond. The Forest Service is studying possible removal of that impoundment, which has been shown to increase water temperature.

The lower section of the river – from the weir to the mouth – is popular with canoeists and kayakers. Upper segments are narrow and considered more difficult except for experienced paddlers.

Off Road Vehicle trails criss-cross much of the public land, and are well used. The public and private forest land is also popular with deer hunters. The Carrieville State Forest Campground and the Bear Track and Old Grade campgrounds on U.S. Forest Service land offer rustic tent and R.V. camping on the river. The watershed also has several private campgrounds.

The watershed was heavily logged beginning as early as the 1850s, when a sawmill was built at Old Stronach on the lower river. Historical records indicate that virtually all the native timber had been removed from the Little Manistee and adjoining watersheds by the early 20th century.

The ecosystem was dramatically altered by removal of vegetation, coupled with “log drives” on the river. Banks were eroded; gravel beds were covered with sand; the stream became wider and slower; and woody debris was scoured from the water course. Among the negative impacts was the eradication of the native grayling, which had thrived in the river’s natural condition.

River habitat restoration began in the 1930s with Civilian Conservation Corps members who built campgrounds, stabilized streambanks and planted trees, helping to create what would become the Manistee National Forest.

Two overlapping local groups – the Little Manistee Watershed Conservation Council and the Little Manistee River Restoration Committee – have continued that work to the present time.

The Little Manistee River meets eligibility criteria for state and national natural river designation programs. For that reason, public lands in the river corridor are managed to prevent any degradation of those conditions. For example, managed timber cutting is generally allowed on Manistee National Forest land, but is restricted within a quarter mile of the river.

**Lakes and Streams in the Little Manistee Watershed**

**Named Streams (all considered coldwater streams):**

Little Manistee River

Tank Creek (Stronach Township)

Cool Creek (Elk Township)

Stronach Creek (Elk Township)

Twin Creek (Newkirk Township)

Syers Creek (Peacock Township)

Lincoln Creek (Newkirk and Ellsworth Townships)

Manistee Creek (Ellsworth Township)

**Named Lakes/ponds:**

Linke Pond (Stronach Township)

Black Lake (Meade Township)

Lake of the Woods (Norman Township)

Mud Lake (Norman Township)

Maple Lake (Elk Township)

Beaver Lake (Elk Township)

Upper Pickerel Lake (Elk Township)

Littles Lake (Elk Township)

Cool Lake (Elk Township)

Sand Lake (Elk Township)

Midget Lake (Elk Township)

List Lake (Elk Township)

Walton Lake (Elk Township)

Elbow Lake (Elk Township)

Harper Lake (Elk Township)

Horseshoe Lake (Elk Township)

Wile Lake (Elk Township)

Coon Lake (Elk Township)

Sawmill Lake (Elk Township)

Ingerman Lake (Peacock Township)

Syers Lake (Eden and Peacock Townships)

Water Tank Lake (Eden Township)

Lost Lake (Newkirk Township)

Stewart Lake (Newkirk Township)

Ahmikwan Lake (Newkirk Township)

Rockwell Lake (Ellsworth Township)

Howe Lake (Ellsworth Township)

Luther Millpond (Village of Luther)

**Climate (and Climate Change)**

Insert climate table

The Little Manistee River Watershed is located in a temperate “four-season” region of the Northwest Lower Peninsula of Michigan. Daily average high temperatures are 75 to 80 degrees in July and August; nightly average lows are in the teens in January and February.

Climate in this watershed is significantly moderated by proximity to Lake Michigan. Western sectors of the Watershed, near the Great Lake, are generally snowier than the eastern sectors, with warmer winters and cooler summers. The lake water acts as a heat “sink” in warm weather, and releases some of that warmth in winter.

Snowfall averages more than 100 inches per winter in Manistee, near Lake Michigan, but about 25 percent less than that at the inland site of Baldwin in Lake County. Much of the snowfall is related to the “lake effect,” which results when cold winds absorb moisture while crossing Lake Michigan, and then release that moisture as snow over land.

The four-season climate is important to the local economy. While summer is clearly the busiest tourist time, the region also draws visitors for skiing, snowmobiling and ice fishing in winter; steelhead fishing in spring; leaf-color viewing, deer hunting and salmon runs in autumn, and general touring year round.

In planning for future water quality it is important to consider the potential impacts of climate change. “Greenhouse gases” such as carbon dioxide have the physical effect of trapping a portion of the sun’s heat in the atmosphere. Global data indicate that increases in atmospheric CO2 have been occurring in line with burning of fossil fuels since the beginning of the industrial revolution.

Impacts such as rising sea levels, decreasing arctic ice cover and higher average global temperatures have been documented over recent decades, lending strong support to models that show a link between atmospheric CO2 levels and increasing climate change.

While the global issue seems clear, climate predictions are considerably more difficult for a small area such as the Little Manistee Watershed. As the earth retains more of the sun’s heat energy, it is likely that air and sea currents will be impacted, making some areas wetter, some dryer, and possibly even pushing cold air into some areas.

Specific local impacts of those complex interactions remain very much in doubt. There is no consensus, for example, on the question of Great Lakes water levels. Warmer air holds more moisture, so precipitation may increase, potentially raising lake levels. On the other hand, more warmth also means more evaporation, which could result in lower levels.

Add those opposing forces to the natural variability of Lake Michigan, and it’s impossible, given our current knowledge, to accurately forecast lake level changes. (Citation 2-1)

There does, however, appear to be high probability of several local impacts resulting from climate change.

A 2014 report by the Rocky Mountain Climate Organization found that the probability of severe rainstorms – defined in the report as a rainfall of 2 inches or more in a single day – increased by 89 percent in Michigan from 1965 to 2010. (citation 2-2)

The finding comports with most climate models, since warmer air holds more energy and more moisture and is thus capable of producing stronger storms.

In another 2014 study, the United States Geological Survey found that over the next 30 years, Northern Michigan will likely see an increasing percentage of winter precipitation in the form of rain, rather than snow. That, combined with a higher likelihood of midwinter thaws, will have the dual effect of reducing the size of the late winter snowpack, and decreasing the number of days each year when the ground is snow-covered. (citation 2-3)

That will tend to moderately increase stream flows during the normally low-flow winter months, and decrease the rise of streams in the spring. While the change may appear to be modest, the USGS report stated, it may “appreciably alter ecosystem functions … that depend on seasonal dynamics at subannual time periods, such as fish spawning.”

The USGS report further notes that a decrease in days of snow cover would be expected to increase rates of evapo-transpiration which could lead to drier soils in late summer and increased reliance on groundwater for irrigation.

These potential changes reinforce the desirability of meeting the central goals of this Watershed Management Plan.

Best management practices such as native plantings, properly sized stream culverts, stormwater catchment, maintaining forest cover and preserving wetlands are all important to protecting water quality under present climate conditions. They become even more vital as climate changes.

Likewise, as climate uncertainty rises, the need for consistent monitoring of water parameters also increases.

Hydrology

Over a 30-year period, the Little Manistee River Watershed receives approximately 35 inches of precipitation annually, with the highest amounts in September-October and the lowest in late winter. A significant share of the total falls as snow, especially in the portions closest to Lake Michigan. (See table in Climate section, above)

Because of the watershed’s forested land cover and sandy, permeable soils, most of the precipitation can be expected to infiltrate into the ground, with only a relatively small amount becoming surface runoff.

Modeling software provided by the Stroud Water Research Center indicates that only about 3 percent of precipitation falling on the watershed is converted to surface runoff. The rest is accounted for by infiltration into soils, evapo-transpiration by vegetation and direct contributions to water bodies.

The 50 percent probability rainstorm for this region (that is, a 24-hour rainfall expected to occur on average once every two years) is 2.09 inches. That figure was used along with the Stroud modeling to estimate nutrient loads in runoff as part of the pollution Source Inventory in Chapter 3 of this WMP.

The impervious cover model developed by The Center for Watershed Protection indicates that stream quality degradation is likely when impervious surfaces exceed 5-10 percent of total land area. (Citation 2-4) The Little Manistee Watershed as a whole falls well below those levels, as do each of its subwatersheds.

Because of its sparse development, predominantly forested land cover and porous soils, this watershed’s hydrology is close to what existed in the pre-settlement era. However, changes in forest cover and/or significant developments could alter those conditions.

High soil permeability can be considered a positive attribute, in that it tends to reduces volumes of stormwater runoff. On the other hand, the well-drained sands that dominate in the watershed have less filtering capacity than clay or loam. That increases the chance that contaminants such as pesticides, used motor oil or fertilizers may leach into the groundwater.

The WMP envisions an education program to inform local residents and government agencies of proper use and disposal of potential contaminants, as well as general strategies (local zoning, green infrastructure plans, etc.) to protect the water quality benefits of the watershed’s natural hydrology.

**Fishery**

(Note: Most information in this section is derived from fishery status reports compiled by MDNR biologist Mark Tonello)

The Little Manistee River is the “parent stream” for steelhead trout planted through the Great Lakes region.

Hatchery fish raised from steelhead eggs taken at the Little Manistee Weir have been stocked in streams throughout Michigan and in nine other states, according to Michigan Department of Natural Resources records.

 The clean, cold, free-flowing stream supports populations of brook trout, brown trout, and Coho and Chinook salmon, in addition to the steelhead, which are a migratory variant of rainbow trout.

The Little Manistee River is nationally renowned for its fishing for both potomadromous steelhead and salmon and resident brown trout. Fishing pressure is extremely heavy in the spring for steelhead, and also in the summer for Chinook salmon (Tonello, 2008).

An unusual aspect of the Little Manistee fishery is that migratory species, including steelhead and Chinook salmon, have developed significant reproduction during “off-season” runs, perhaps due to the operation of the weir during the primary spawning seasons.

 A major goal of the WMP is to protect and enhance the fishery, which is important to the region as a recreational option, an economic driver and an indicator of environmental quality.

 Arctic grayling were most likely the only trout or salmon species native to the Little Manistee. Grayling were abundant in the stream before 1880, but were gone by 1900. Possible causes of the species demise are habitat destruction due to the active logging, and competition from other trout species which were introduced to the stream in the same time period.

Brook trout are native to some Michigan watersheds, but not to the Little Manistee, according to the MDNR data. Reports indicate three trout species – brook, brown and steelhead – were introduced to the watershed in the 1890s or earlier. As biologist Mark Tonello noted in a 2008 report: “Certainly, by the turn of the century (1900) brook trout, steelhead, and brown trout had all become naturalized residents of the Little Manistee River, and the Arctic grayling were gone.”

Attempts to reintroduce graying to Michigan rivers have thus far been unsuccessful. The Little Manistee is among several streams being considered for a renewed attempt at introducing grayling stock from western states.

Pacific salmon were first introduced to Michigan rivers in the 1960s as an effort to recreate a Great Lakes sport fishery that had been decimated by sea lampreys, habitat deterioration and overfishing.

The egg-taking station at the Little Manistee River Weir has been in operation since 1968. It provides the primary broodstock for hatchery-raised steelhead in Michigan. Chinook salmon eggs are also harvested at the Weir during the fall salmon run.

In addition to the egg-taking function, the river weir serves as a barrier to stop sea lamprey from swimming upriver to spawn.

The Little Manistee weir is one of two Chinook egg-take stations in Michigan. Chinook salmon eggs from the Little Manistee weir are also raised and stocked into Lake Michigan by Indiana and Illinois.

Steelhead captured at the weir are passed upstream after sufficient eggs have been taken. Salmon are harvested at the site and marketed by a private company. Some fish from both salmon species do make it upriver – especially when the weir is not in operation – and the Little Manistee has some natural reproduction of both.

In recent years, there has been no planting of steelhead or Coho in the Little Manistee. Chinook continue to be stocked in the river, though the numbers have been reduced in recent years as part of an ongoing effort to balance the prey/predator ratio in the Great Lakes.

The Little Manistee weir is open to the public during Chinook salmon and steelhead egg takes, and is heavily visited. During Chinook salmon egg take, many school groups are given tours of the facility by MDNR personnel. The children get a close up view of weir personnel taking and fertilizing the eggs and performing autopsies on Chinook salmon.

Demographics

Add population tables and mapping

The year-round population of the watershed is estimated at 3,700, including 2,300 in Lake County, 1,300 in Manistee County and fewer than 100 in Mason and Wexford counties combined.

Precise demographic calculations are impossible, since the watershed spreads into parts of 16 townships, occupying less than 1 percent of Dover and more than 95 percent of Eden Townhsip in Lake County.

Census estimates show overall population in the 16 townships fell by about 1 percent from 2010 to 2016.

Of an estimated 4,500 housing units in the watershed, 2,500, or 57 percent, were vacant during the 2010 census count and used for seasonal or occasional occupancy. That result is unsurprising, given the region’s well-known recreational and seasonal attractions.

The sparse population leaves local government with few resources for planning. Of the 16 townships, seven have fewer than 500 residents. Only three of the townships, all near the city of Manistee have populations in excess of 1,000.

The Local Economy

The Little Manistee River area is known primarily as a destination for outdoor recreation, fishing, boating and general tourism. There are few if any large employers directly in the Watershed, with residents more likely to seek employment in the surrounding towns of Baldwin, Manistee, Reed City and Cadillac.

There is a significant population of retirees, who live in the area either year-round or seasonally. Public and private campgrounds help to swell the summer population and provide some seasonal employment.

Fishing is an important component of the economy. A number of fishing guides run trips on the Little Manistee. Out-of-town anglers during salmon and steelhead runs support campgrounds, hotels, restaurants and other businesses in and near the Watershed.

Businesses within the watershed tend to be small and oriented toward retail or the outdoor tourism economy. The Dublin Store at the northern extremity of the watershed has a statewide following for its store-made products, including countless varieties of beef jerky. Both Irons and Luther have small business districts that cater to local and tourist trade.

Public and private woodlands provide some timber harvest employment, though milling and processing are done outside the watershed.

Fast food outlets, chain branded motels and other highway services for travelers are non-existent. Only one state highway, M37, transects the watershed and that is in a generally remote segment of Lake County.

The agricultural economy is limited to a few small row crop or pasture operations. In general, soils at the eastern end of the Watershed, in the area around Luther, are more amenable to agriculture.

Geology and Soils

Add soil map and base geology map

The surface geology of the watershed is dominated by glacial features, including moraines, outwash plains and kettle lakes. Soils are primarily well-drained sands and sandy loams, with some more productive soils in eastern Lake County, upstream of Luther.

Several historic wetlands have deep, hydric or muck soils. There are no surface outcroppings of bedrock in the watershed. Elevation in the headwaters area of eastern Lake County is approximately 1,200 feet above sea level. That drops to below 600 feet at the watershed’s exit point at Manistee Lake.,

The Udell Hills in Stronach Township contain slopes large enough to have operated in the past at the Big M downhill ski area. Today, the site is part of the Manistee National Forest and is operated as a public area for cross country skiing and mountain biking.

The underlying geology is made up of sedimentary layers, including the Antrim Shale, formed at times when the Michigan Basin was covered by shallow seas.

Wetlands

(Insert wetland mapping)

Wetlands provide vital ecological services, including flood mitigation, filtration and groundwater recharge, sediment retention, and wildlife habitat. It is an objective of the WMP to protect and restore wetlands within the watershed.

The National Land Cover Database (NLCD) classifies just over 9 percent of the Little Manistee Watershed as Wetland – including 10,370 acres of woody wetlands and 1,900 acres of emergent herbaceous wetlands.

One notable wetland complex is the large Baylor Swamp, which feeds both branches of Twin Creek in Newkirk Township. Much of the upper reach of the river flows through lowland conifer swamp.

While the majority of soils in the watershed are well-drained course mineral sands, hydric soils in these wetlands often contain thick layers of organic materials, accumulated over the centuries. Under current regulations, federal and state agencies regulate development in wetlands which are 5 acres or greater, or which exhibit a hydrologic connection to the Great lakes.

Many of the Little Manistee wetlands are protected from development through public ownership as part of the state and federal forest system.

In addition, Michigan Law protects wetlands which are located within 500 feet of a water body or which are determined by MDEQ to be essential to the preservation of natural resources.

Zoning and planning overview

(add zoning and planning information when available)

2-2 Saunders, Stephen, and Tom Easley, “Extreme Storms I Michigan, Dec. 2014, the Rocky Mountain Climate Organization

2-3 Christiansen, Daniel E., John F. Walker, and Randall J. Hunt, “Basin-Scale Simulation of Current and Potential Climate Changed Hydrologic Conditions in the Lake Michigan Basin, United States”; U.S. Geological Survey, 2014

 2-4 Impacts of Impervious Cover on Aquatic Systems, 2003, Center for Watershed Protection,