



# **Red Cedar River Watershed Management Plan**

*Submitted by:*

**Michigan State University  
Institute of Water Research**

*Originally Submitted November 6, 2014*

*Amended March 24, 2015*

**Amended June 25, 2015**

**MDEQ tracking code: #2011-0014**

# ACKNOWLEDGEMENTS

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This document was developed with funding provided by a Clean Water Act, Section 319 grant from the Michigan Department of Environmental Quality (MDEQ), grant number 2011-0014. Financial and in-kind assistance was provided by Michigan State University (MSU).

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The authors wish to acknowledge the following individuals who assisted in the development of the plan:

Jason Piwarski, MSU-IWR and Joe Welsh, MSU-RSGIS, who created the GIS maps  
Lois Wolfson, MSU-IWR who assisted with data analysis and summarization  
Laura Young, MSU-IWR, who provided valuable design and editorial assistance

In addition, the authors extend appreciation to the following communities, organizations, and agencies that contributed expertise, time and resources in support of the watershed management planning process:

City of East Lansing, City of Lansing, City of Williamston, Clinton Conservation District, Clinton County Drain Commissioner, Delhi Charter Township, Eaton Conservation District, Ingham Conservation District, Ingham County Drain Commissioner, Ingham County Health Department, Lansing Charter Township, Livingston County Drain Commissioner, Livingston County Health Department, Meridian Charter Township, Michigan Department of Environmental Quality, and Williamstown Township.

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## List of Acronyms

<b>ACEP</b>	Agricultural Conservation Easement Program
<b>AUID</b>	Assessment Unit Identification
<b>BMP</b>	Best management practice
<b>CAFO</b>	Concentrated animal feeding operation
<b>C-CAP</b>	Coastal Change Analysis Program
<b>CD</b>	Conservaiton district
<b>CFU</b>	Colony forming unit
<b>COD</b>	Chemical oxygen demand
<b>DC</b>	Drain commissioner
<b>DO</b>	Dissolved oxygen
<b><i>E. coli</i></b>	<i>Escherichia coli</i>
<b>ECD</b>	Eaton Conservation District
<b>EQIP</b>	Environmental Quality Incentives Program
<b>FIRM</b>	Flood Insurance Rate Maps
<b>FORC</b>	Friends of the Red Cedar
<b>GIS</b>	Geographic information system
<b>GLRC</b>	Greater Lansing Regional Committee for Stormwater Management
<b>GMM</b>	Green Mid-Michigan
<b>HIT</b>	High Impact Targeting model
<b>HUC</b>	Hydrologic Unit Code
<b>HUD</b>	United States Department of Housing and Urban Development
<b>I/E</b>	Information and education
<b>ICD</b>	Ingham Conservation District
<b>ICHD</b>	Ingham County Health Department
<b>IWR</b>	Institute of Water Research
<b>LCD</b>	Livingston Conservation District
<b>LCDH</b>	Livingston County Health Department
<b>LLFWA</b>	Landscape level functional wetland assessment
<b>MAEAP</b>	Michigna Agricultural Environmental Assurance Program
<b>MDARD</b>	Michigan Department of Agriculture and Rural Development
<b>MDEQ</b>	Michigan Department of Environmental Quality
<b>MDNR</b>	Michigan Department of Natural Resources
<b>MGROW</b>	Middle Grand River of Watersheds
<b>MGRWP</b>	Middle Grand River Watershed Planning Project
<b>Mid-MEAC</b>	Mid-Michigan Environmental Action Council
<b>MMPGS</b>	Mid-Michigan Program for Greater Sustainability
<b>MNFI</b>	Michigan Natureal Features Inventory
<b>MS4</b>	Municipal separate storm sewer systems
<b>MSU</b>	Michigan State University
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NPDES</b>	National Pollutant Discharge Elimination System
<b>NRCS</b>	Natural Resources Conservation Service
<b>NREPA</b>	Natural Resources Enviornmental Protection Act
<b>NSA</b>	Neighborhood source assessment
<b>PBC</b>	Partial Body Contact
<b>PCA</b>	Potential Conservation Area
<b>PEP</b>	Public Education Plan
<b>QAPP</b>	Quality Assurance Project Plan
<b>RCPP</b>	Regional Conservation Partnership Program
<b>RCRW</b>	Red Cedar River Watershed
<b>SCD</b>	Shiawasee Conservation District
<b>SIDMA</b>	Social Indicators Data Management and Analysis
<b>SMNITP</b>	Southern Michigan Northern Indiana Till Plains
<b>TBC</b>	Total Body Contact

<b>TCRPC</b>	Tri-County Regional Planning Commission
<b>TDS</b>	Total dissolved solids
<b>TMDL</b>	Total maximum daily load
<b>TOC</b>	Total organic carbon
<b>TSS</b>	Total suspended solids
<b>U.S. EPA</b>	United States Environmental Protection Agency
<b>USDA FSA</b>	United States Department of Agriculture Farm Service Agency
<b>USGS</b>	United States Geological Survey
<b>WMP</b>	Watershed management plan
<b>WQS</b>	Water quality standards
<b>WWTP</b>	Wastewater treatment plant

# 1. INTRODUCTION

The Red Cedar River originates near Cedar Lake, which is located in the southwestern corner of Livingston County, in the south-central portion of the Lower Peninsula. The river flows in a westerly direction for about 51 miles from the area surrounding Cedar Lake, into Ingham County, through Meridian Township, the City of East Lansing and the campus of Michigan State University, and into Lansing, where it joins the Grand River (MDTMB, 2012).

The Red Cedar River Watershed (RCRW) (Hydrologic Unit Code 04050004) (see Figure 1.1), is approximately 294,496 acres (461 sq. miles) and land use in the watershed area is varied. The Red Cedar River has West and Middle Branches, which also originate in southern Livingston County.



**Figure 1.1 Red Cedar River Watershed**

The RCRW contains a diverse mix of rural lands dominated by agricultural land use and small communities, suburban areas and highly urbanized lands. The watershed is home to thousands of residents who live, learn, work and recreate within its lands and waters. Farms, factories and shopping malls are necessary for our quality of life. Equally important are clean water for fishing, swimming and drinking, and natural landscapes for aesthetic relief. The river and its watershed are also home to a myriad of plants and animals that rely on a clean, protected environment to flourish.

This watershed management plan (WMP) was developed for the protection of lands and waters of the RCRW. It was developed to serve as a guide for protecting and improving the waters that bisect the landscape, flowing adjacent to our homes, under our roads and through our farms.

This WMP is authored by the RCRW management team, comprised of representatives from the Michigan State University (MSU) Institute of Water Research (IWR); Streamside Ecological Services, Inc.; and the Tri-County Regional Planning Commission (TCPRC). The management team coordinated and guided all efforts related to the planning process and overall WMP

development, including stakeholder engagement. Several community partners provided in-kind support to the project. A complete list of stakeholders is available in Appendix A.

## 1.1 Goal of Watershed Planning

The goal of the Red Cedar River Watershed Management Project is to protect, enhance, restore and maintain water quality in order to meet all designated uses and to inspire residents to responsibly manage the land and water in the watershed. Designated uses are recognized uses of water established by state and federal water quality programs.

WMPs are a resource to be used to prevent and improve water quality problems by understanding and addressing nonpoint and point source pollution contributing to a watershed. These plans document impaired areas for improvement or restoration and high-quality areas for long-term protection. A WMP should outline an action-oriented approach for improving and protecting water quality.

This WMP is intended, among other things, to provide a shared strategy for moving community jurisdictions and organizations forward with respect to the watershed's water quality as affected by nonpoint source pollutants. This plan is intended to supplement, but not replace, the body of work that other organizations in the region have already completed regarding the land, water and policies affecting them.

## 1.2 Key Elements of Developing a WMP

Watershed planning and implementation is a process that includes building partnerships, characterizing the watershed, setting goals and identifying solutions, designing an implementation program, implementing the watershed plan, and measuring progress and making adjustments (US EPA, 2008a).

The EPA recommends developing a WMP by following their defined planning and implementation process, which includes the following nine elements:

1. **Identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan.
2. **Estimate the load reductions** expected for the management measures described in element (3.) below.
3. Describe the **NPS management measures** that will need to be implemented to achieve the load reductions estimated in element (2.) above, and identify the critical areas in which those measures will be needed to implement the plan.
4. Estimate the amounts of **technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan.
5. Develop an **information/education component** that will be used to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing the NPS management measures.
6. Develop a **schedule for implementing the NPS management measures** identified in the plan that is reasonably expeditious.
7. Develop a description **of interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.
8. Develop a **set of evaluation criteria** that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards (WQS) and, if not, the criteria for determining whether the watershed-based plan needs to be revised.
9. Develop a **monitoring component** to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under element (8.) above.

## 1.3 Impaired and Threatened Designated Uses

Surface water that is determined by the Michigan Department of Environmental Quality (MDEQ) to be exceeding WQS and therefore not attaining subsequent designated uses is defined as an impaired water body by the State of Michigan and in this report. Part 4 Rules issued in accordance with Part 31 of the Natural Resources and Environmental Protection Act (1994 PA 451, as amended) specify eight designated uses for waters of the state. The designated uses of Partial Body Contact (PBC) and Total Body Contact (TBC) recreation are impaired due to high *Escherichia coli* (*E. coli*) levels throughout much of the watershed. The warmwater fishery designated use is impaired due to low dissolved oxygen (DO) levels and sedimentation in certain portions of the watershed. Based on water quality and land use data in the watershed, sediment and nutrients are additional potential pollutants of concern in the watershed. Potential sources include: agricultural practices, animal waste from cattle/pasture land, fertilizers, pesticides, stream channelization and failing septic systems.

For the purpose of this watershed management planning process, a surface water body that trends towards exceeding WQS as determined through investigations by those other than the MDEQ, is considered threatened.

## 2. DESCRIPTION OF THE RED CEDAR RIVER WATERSHED

### 2.1 Land Use

Land use based on the National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) in the Red Cedar River is approximately 35% agricultural lands including cultivated crops, pasture and hay; 23% shrubland which includes grazing land; 18% developed land; 14% open water and wetlands and; 10% forest (NOAA, 2008) (Table 2.1).

**Table 2.1. Land Use in the Red Cedar River Watershed (NOAA, 2008)**

<b>Land Use Category</b>	<b>Percent of Watershed</b>
Open Water	1%
Developed Open Space	4%
Developed Low Intensity	7%
Developed Medium Intensity	3%
Developed High Intensity	1%
Barren Land	0%
Forest	10%
Grassland and Shrubland	23%
Agriculture	35%
Wetlands	16%

Historically, the RCRW was predominately forests and wetlands. The upland ecosystem contained mostly Beech/Sugar Maple Forests or Oak/Hickory Forests. Lowlands contained an abundance of conifer swamps, which still can be seen in Lake Lansing Park North (Tetra Tech, 2006).

Permanent human settlement changed the landscape of this watershed. Wetlands were drained to provide land for farming, settlement, and transportation (Tetra Tech, 2006). To this day, the trend continues as agricultural commodity prices are high and wetlands are drained to provide more farmland, urban and suburban development expands, and the demand for increased tile and open ditch drainage continues.

In the western portions of the watershed, compared to pre-settlement conditions, the current landscape contains 90% less forest cover and 60% less wetlands (Figure 2.1). Based on projected land use for various watershed communities on the western part of the watershed, residential, industrial, and commercial land uses will continue to expand. The south-central portion of the watershed is projected to continue to be dominated by agricultural use (Tetra Tech, 2006).

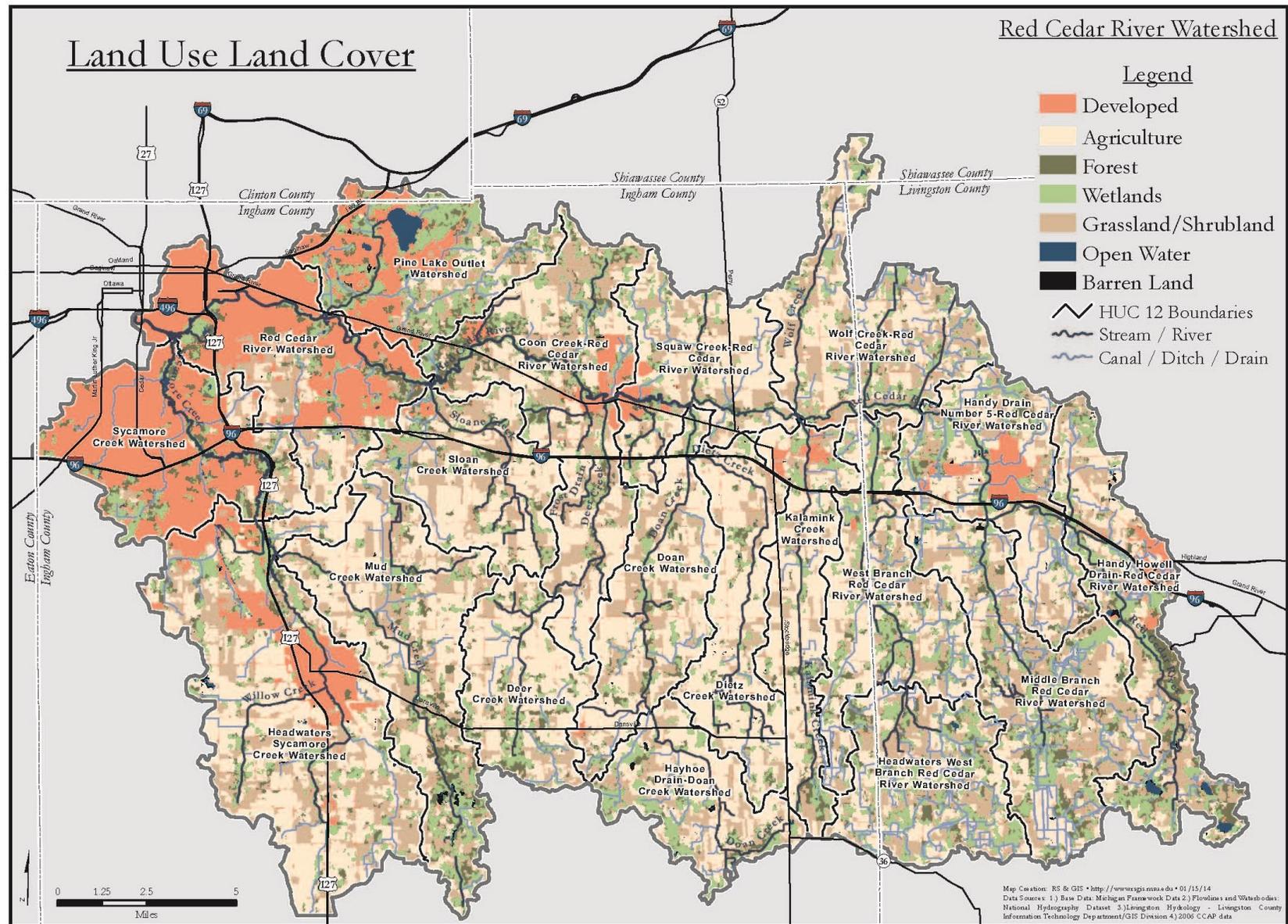


Figure 2.1 Land Use Land Cover

## **2.2 Geographic Scope**

This watershed management plan (WMP) was developed for the RCRW in lower central Michigan. The watershed is identified as Hydrologic Unit Code (HUC) 04050004 by the United States Geological Survey (USGS). The entire watershed, which encompasses approximately 294,496 acres (461 sq. miles), is located in portions of five counties, with the vast majority of its area in Ingham and Livingston Counties. The watershed contains approximately 675 miles of tributaries and 19 subwatersheds (12-digit HUC) (Figure 2.2), ranging from about 16 to 49 square miles in size (MDTMB, 2012). Although field inventory and water quality analyses were conducted in most of the subwatersheds, due to the large size of the watershed, a prioritization strategy was developed to identify the most critical subwatersheds in order to focus initial implementation efforts to protect and improve water quality. This is further discussed in [Chapter Seven](#).

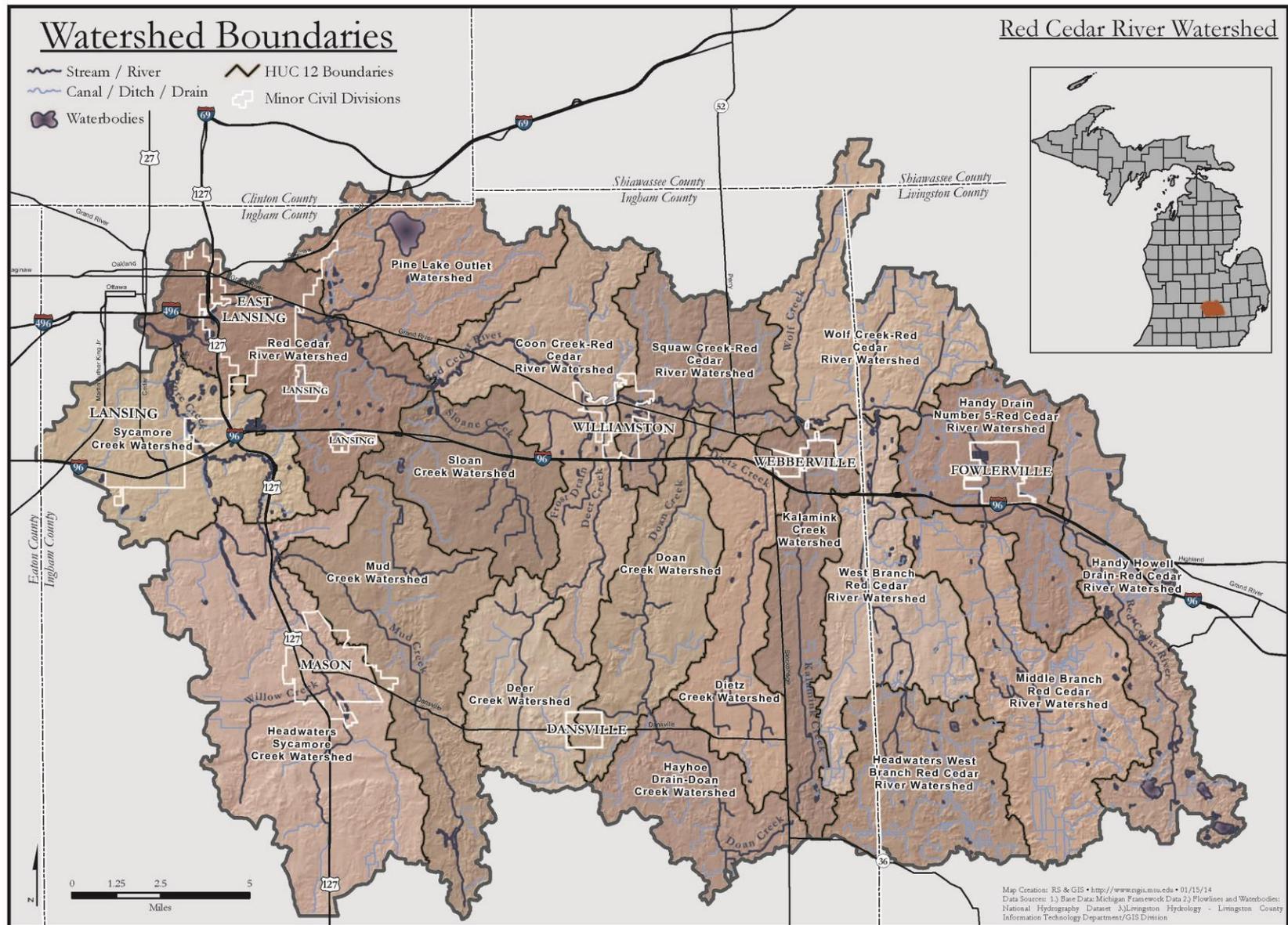


Figure 2.2. Subwatershed Boundaries

### **2.3 Topography**

The topography of the watershed ranges from approximately 800 to 1,000 ft. above sea level (MDTMB, 2012) with rolling plains having slopes ranging from 0 to 30 percent. Hills, with slopes less than six percent, are no higher than 100 feet, and low gradient stream channels are present (MDEQ, 2013a). The topography of the watershed is displayed in Figure 2.3. For the purpose of regional comparison, the average surface elevation of Lake Michigan is 577 ft., Grand Rapids is 640 ft., and Detroit is 646 ft.; the highest elevation in lower Michigan is 1,705 ft. in the vicinity of Cadillac.

From its headwaters at Cedar Lake (elevation 932 ft.) to its confluence with the Grand River (elevation 833 ft), the Red Cedar River drops about 99 feet over 51 miles (MDTMB, 2012). This equates to an average slope of about 0.04%.

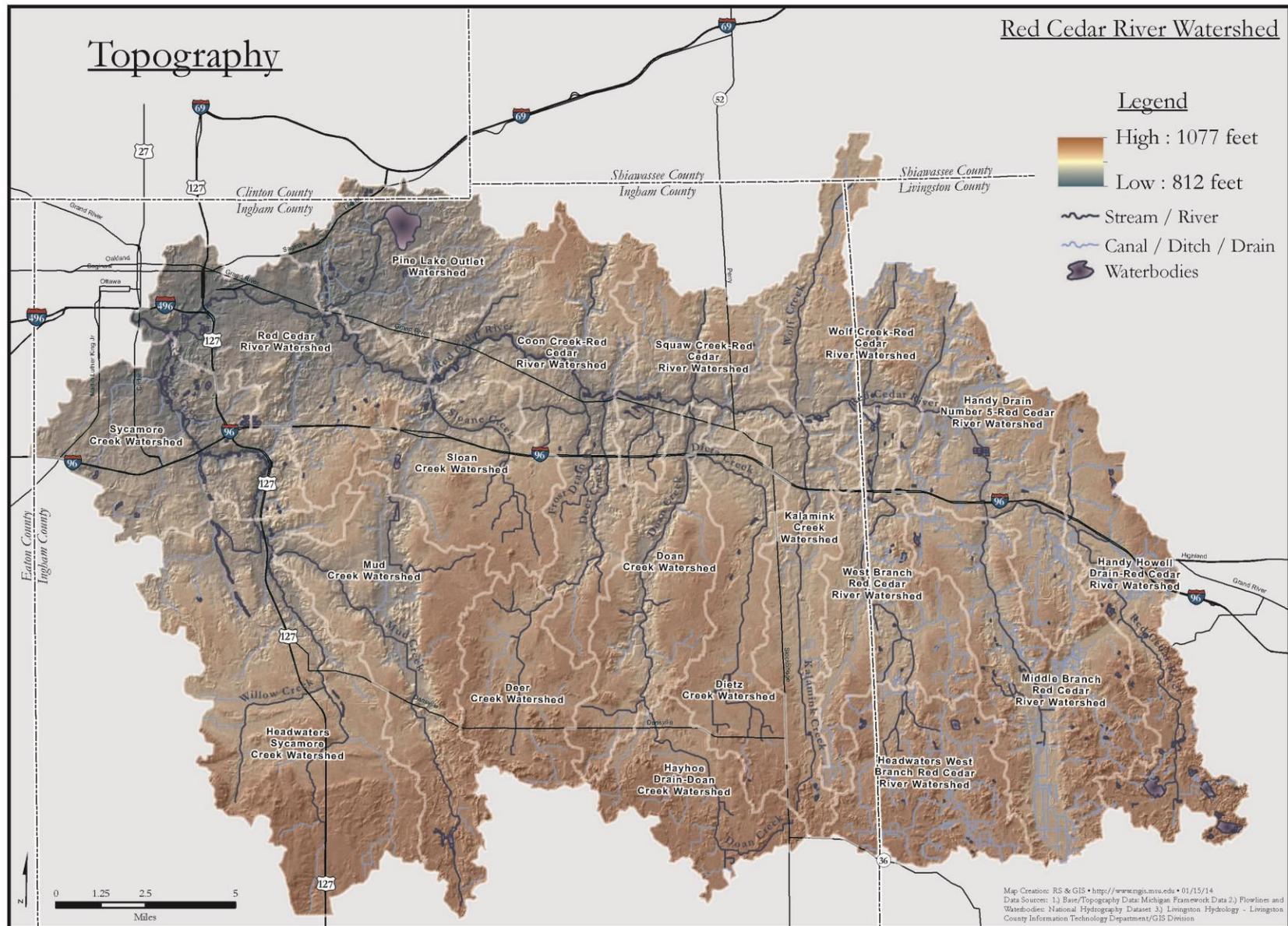


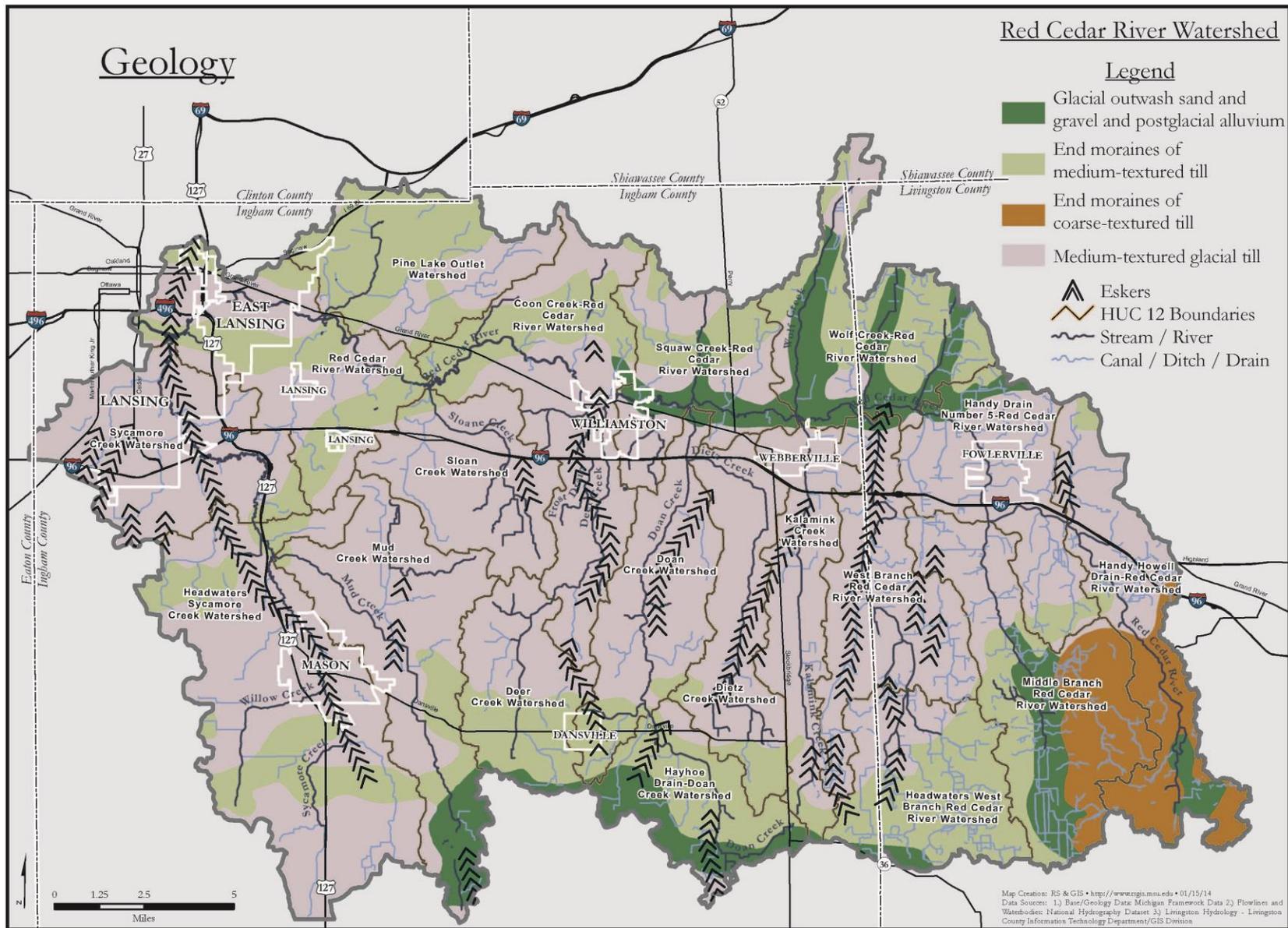
Figure 2.3 Topography

## **2.4 Geology**

Geology in the RCRW is shown in Figure 2.4. The geology was formed by the last of the four continental glaciers, the Wisconsin, which existed approximately 35,000 to 10,000 years ago (Luukkonen, 2009). This glaciation is responsible for most of Michigan's underlying geology, soils, topography, and the Great Lakes. In the RCRW the predominant underlying geology consists of: glacial till, glacial outwash, lacustrine material (deposits from still or ponded glacial meltwater), and alluvial material (recently deposited material from local rivers and streams).

According to Luukkonen (2009), Ingham County sits upon a series of aquifers including shallow glacial aquifers and the Grand River and Saginaw Formations. Closest to the surface are shallow glacial aquifers, comprised of coarse alluvial and outwash materials. Groundwater typically flows from south to north in these uppermost glacial units. Below the glacial deposits are the Grand River and Saginaw Formations. Within the Saginaw Formation are three sandstone aquifers divided by a lower shale unit and interbedded series unit, though these divisions may not be distinct in all areas. A small amount of groundwater flows toward areas of high pumping, but otherwise generally flows from south to north. Recharge within the Saginaw Formation occurs where the uppermost glacial units directly connect to the Saginaw. A small amount of recharge also occurs through confining units. The Saginaw Formation provides the majority of groundwater to communities in the area, though in certain locations the glacial aquifer is the primary groundwater source (Luukkonen, 2009).

According to groundwater statistics compiled by the MDEQ (2013c), Michigan's groundwater is used for drinking water by nearly half of the state's population. In addition, it is used for irrigation and industrial purposes and contributes to the economy and unique quality of life in Michigan.



**Figure 2.4 Geology**

## 2.5 Soils

Soil types affect the rate and ability of water to infiltrate the soil. Soil properties ultimately affect how pollutants that are land applied or absorbed, such as manure and septage, are transmitted over or through the soil. Soils are classified into hydrologic soil groups (A, B, C and D) to indicate the minimum rate of infiltration obtained for bare soil after prolonged wetting (USDA NRCS, 2007). The infiltration rate is the rate at which water enters the soil at the soil surface, and is controlled by surface conditions. The hydrologic soil group also indicates the transmission rate, or the rate at which water moves within the soil. This rate is controlled by the soil profile. The following table summarizes the differences in the four hydrologic soil groups.

**Table 2.2: Hydrologic Soil Groups**

Hydrologic Soil Group	Definition
A	High infiltration (low runoff potential, high rate of water transmission, well drained to excessively drained sands or gravely sands)
B	Medium infiltration (moderate rate of water transmission, moderately well to well drained, moderately fine to medium coarse texture)
C	Low infiltration (slow rate of water transmission, has layer that impedes downward movement of water, moderately fine to fine texture)
D	Very low infiltration (high runoff potential, very slow rate of water transmission, clays with high shrink/swell potential, permanent high water table, clay pan or clay layer at or near surface, shallow over nearly impervious material)

Different soil types also have different erosive properties, with certain soils having greater potential for overland erosion, and other soils have greater potential for transmission. Understanding how soils respond to precipitation is critical in watershed management, especially considering negative impacts connected with erosion and associated sediment. In addition, the functionality of a septic system is dependent on the ability of the soil to allow water to percolate through the soil. It is important to know how development on different soil types will affect runoff and, ultimately, how it will affect water quality of the receiving waters.

Table 2.3 highlights the percentage of hydrologic soil groups throughout the RCRW, and Figure 2.5 shows their spatial distribution. Many of soils in this watershed (29%) have a dual classification. In dual classifications, the first letter refers to the drained condition, and the second letter refers to the undrained condition. The dual classification signifies the presence of a high water table that keeps the soils saturated, and therefore the soils with a dual classification have a very low infiltration rate in their natural saturated state. Second and third to the dual classification, the other predominant soils in the watershed are in groups B (33%) and C (25%), with medium and low infiltration ratings respectively. Soils in group B have a moderately low runoff potential when thoroughly wet, and soils in group C have a moderately high runoff potential when thoroughly wet. Soils with very low or low infiltration rates (soil types C, D, and soils with dual classifications) make up 58% of this watershed in its natural state, and may be more susceptible to overland erosion and may not allow traditional septic systems to function properly when installed. When drained, 29% of the watershed has soils with low or very low infiltration rates. Soils with low infiltration rates and higher erosive properties are more susceptible to contributing sediment, along with any land applied nutrients (e.g., manure and fertilizers) that may be transported to surface water bodies by way of overland erosion. Eroded sediment and the excess nutrients and bacteria it transports can have a negative effect on water quality.

**Table 2.3. Red Cedar River Watershed Soils (USDA NRCS, 2013)**

<b>Soil Type</b>	<b>Area (Square Miles)</b>	<b>Percent of Watershed</b>
No Data	21.8	5%
A	18.0	4%
A/D	26.5	6%
B	154.2	33%
B/D	73.4	16%
C	116.0	25%
C/D	30.0	7%
D	20.7	4%
<b>Total:</b>	<b>460.6</b>	<b>100%</b>

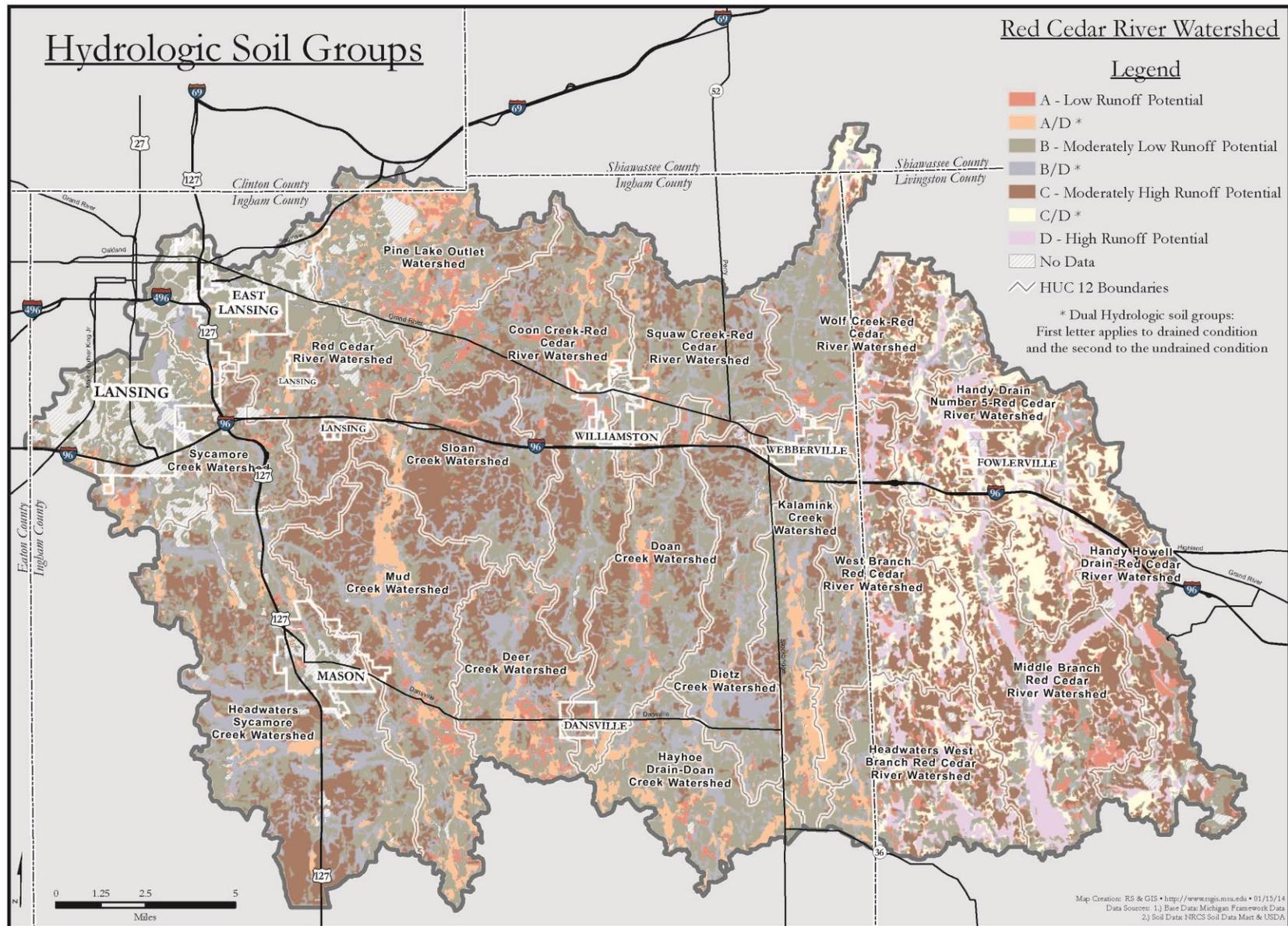


Figure 2.5 Hydrologic Soil Groups

## **2.6 Climate**

The climate of mid-Michigan can be described as having a warm summer and a cool-to-cold winter. According to the NOAA National Climatic Data Center (as cited in Tetra Tech, 2006), the average temperature for the coldest month, January, is 22.7 °F, while August, the warmest month, has an average temperature of 71.2 °F. Like temperature, precipitation is seasonally variable with February, the driest month, receiving an average of 1.57 inches of precipitation and June, the wettest month, receiving an average of 3.73 inches. The average annual precipitation is 32.82 inches. The dominant precipitation in the months of December through February is snowfall, with the largest average snowfall occurring in January (13.4 inches).

## **2.7 Upstream Watershed**

Streams often originate from small, undefined locations such as groundwater seeps or wetland pockets that provide the water that flows and maintains our river systems. In a natural state, these headwater areas can provide groundwater filtering and recharge, recycling of waste products, flood control, spawning and mating grounds for fish and wildlife, and water for human use. However, many of the headwater streams in the RCRW are altered for efficient drainage and/or maintained as designated county drains. As such, they may no longer provide some of their natural functions, but instead provide other important functions necessary for use of the land by humans.

In its natural state, water exists in wetlands or other low areas for periods of time, while water on developed or farmed lands is immediately directed into drainage systems to be moved downstream. Roadside ditches, agricultural field tile lines, and curb and gutter systems, as examples, are all part of an efficient drainage system that has been designed to bypass the natural processes which might cause standing water and flooding.

While often viewed in a negative light, the process of streams and rivers overtopping their banks and flooding adjacent lands is natural and important in a number of ways. Flooding transfers nutrients and soil from the stream to adjacent wetlands and floodplains, renews groundwater supplies, provides critical access to certain fish species for spawning and nursery habitat, and dissipates flow energy that otherwise erodes streambanks and streambeds. A component of the watershed planning process is identifying areas where flooding is acceptable; these areas can be protected or restored to ensure that natural headwaters functions are maintained to the greatest extent.

## **2.8 Hydrology**

Hydrology is a science dealing with the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere. Hydrology is heavily dependent on topography, geography, soils and climate, as discussed previously in this document. Understanding how this science relates to, and is affected by changes in land use and natural landscapes is the basis for developing successful WMPs.

A number of lakes, streams and wetlands are found throughout the RCRW. There are approximately 40,000 acres of wetlands and 1,850 acres of lakes and ponds (MDTMB, 2012); most of these lakes are smaller than 20 acres in size. The lakes greater than 20 acres in size include Lake Lansing (455 acres) and Dobie Lake (31 acres) in Ingham County and Cedar (118 acres), Pleasant (87 acres), Triangle (53 acres) and Lamoreaux (30 acres) Lakes in Livingston County.

An especially important consideration in the hydrology of the RCRW is the ongoing demand for more efficient drainage from agricultural lands, commercial development and neighborhoods. County Drain Commissioners are burdened with managing this demand for drainage and consistently busy with improving designated county drains to handle larger volumes of water and moving it downstream quicker. Essentially, this transfers problems such as flooding, streambank erosion and decreased water quality to downstream neighbors.

The watershed currently contains active USGS monitoring stations, which are located in the Cities of Williamston and East Lansing and near the City of Mason. These stations measure stream flow on an ongoing basis. The term flashiness reflects the frequency and rapidity of short-term changes in stream flow. A stream described as flashy responds to rainfall by rising and falling quickly. Conversely, a stream

that is not flashy would rise and fall less for an equivalent rainfall and would typically derive more of its overall flow from groundwater. Using the Richards-Baker Flashiness Index (R-B Index) to quantify the frequency and rapidity of short-term changes in stream flow, MDEQ (2012a) found the Red Cedar River, at both Williamston and East Lansing, to be one of the more flashy rivers in the lower peninsula of Michigan.

### Floodplains

Rivers, streams, lakes, and drains occasionally overflow their banks and into adjacent land areas, called floodplains. In regulatory terms, the word floodplain is often used to describe the land that will be inundated by water resulting from a 100-year flood. Approximately 6% of Michigan's land is flood-prone (MDEQ, 2014). However, smaller areas of the 100-year floodplain can be inundated by water during smaller floods (for example, two or five-year floods). These areas are important for habitat and nutrient connectivity between land and water and are critical for maintaining stream stability.

Riverine flooding often occurs in spring with snow melt and excess rain and in summer with storms. Rivers, streams, and drains will overflow their banks and their floodplains will become partially or fully saturated. Urban flooding is caused when storm sewer systems become overwhelmed by significant amounts of runoff. Flash floods, typically caused by fast-moving runoff, may occur during short but intense heavy rains in localized areas, but will dissipate in a relatively short amount of time. On the other hand, constant, less intense rain can cause "general flooding," in which large areas are flooded for a relatively longer period of time than a flash flood. This type of flooding can also occur from large snowmelts. During these flooding events, the soil becomes completely saturated and water ponds in depressions or other low-lying areas.

Floodplains often consist of silty soils that are deposited by recurring floods. They are categorized by the frequency of flood events. Risks to structures and people located within the floodplain are calculated. If they are located within a 10 or 100-year floodplain, the risks can impact insurance policies. The Tri-County region has Flood Insurance Rate Maps (FIRM) in place that provide a planning tool for communities and land owners to help assess flood risk. Floodplains in the RCRW are depicted in Figure 2.6.

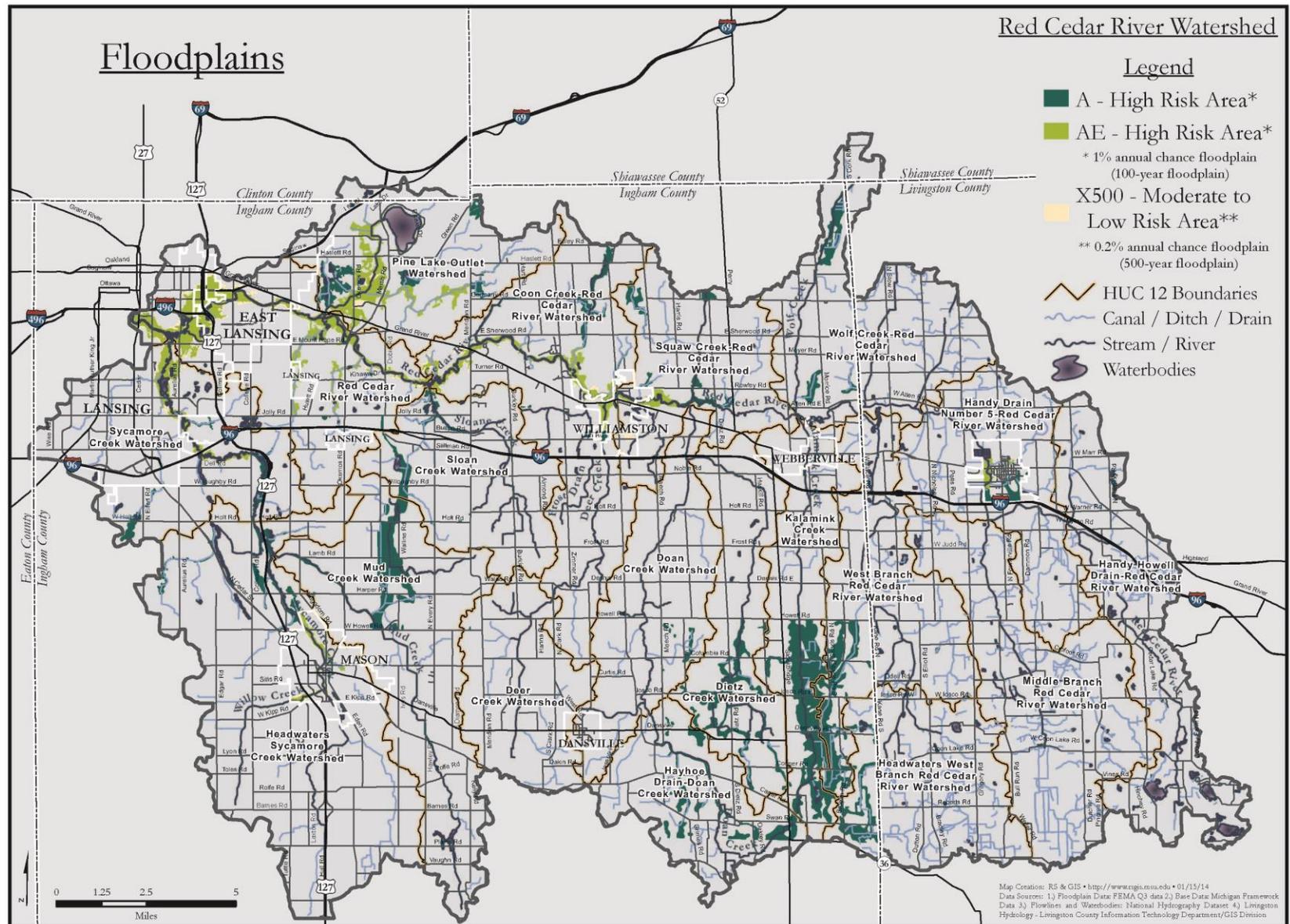


Figure 2.6 Floodplains

## Wetlands

Cowardin et. al (1979), as cited by the U.S. EPA (2013b), provided the following general definition of wetlands: “Wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface.” To many, wetlands have long been considered “worthless” lands that are an impediment to development and farming or are a breeding ground for mosquitoes and other intolerable pests. While this reasoning still prevails at times, the importance of wetlands in the hydrologic process and as features in a complete ecosystem cannot be understated. Wetlands are especially important for flood control, groundwater recharge and erosion control, and play a critical role in attenuating pollutant loads. They provide critical habitat for wildlife and fish; some species rely entirely on wetlands for reproduction or other phases of their life cycle. Wetlands provide habitat to many threatened and endangered species that are not found elsewhere; about 50 percent of Michigan’s threatened, endangered, rare or special concern plant species depend on wetlands (Cwiekal, 2003). While there are approximately 40,000 acres of wetland existing in the RCRW, about 56% have been lost to farming and development, which is highlighted in [Table 3.6](#) and discussed in [Chapter Four](#). Figure 2.7 shows existing wetland areas in the watershed.

# Existing Wetlands

# Red Cedar River Watershed

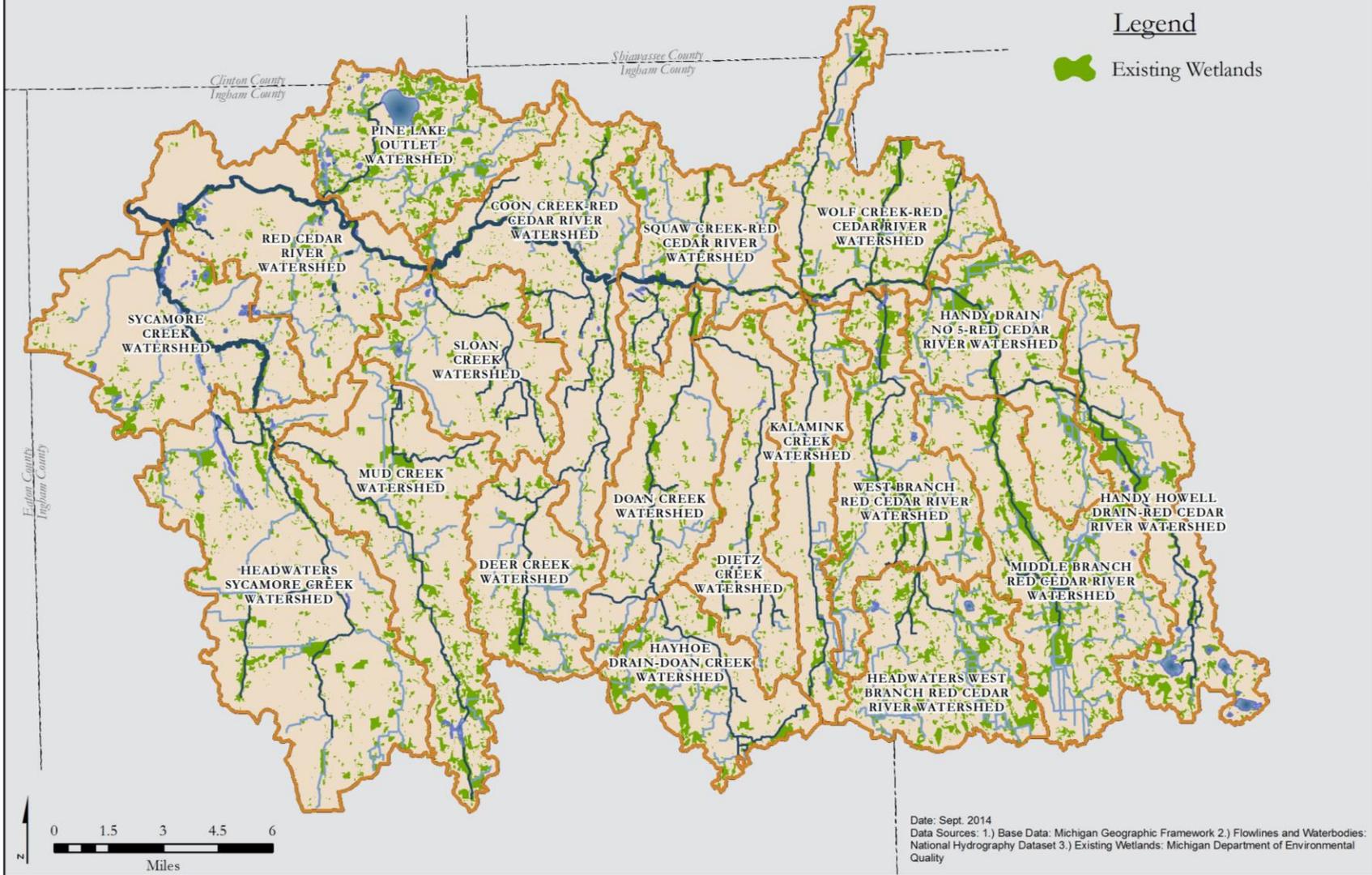


Figure 2.7 Existing Wetlands

## Dams

Only one dam is known to exist in the RCRW. This is located on the campus of Michigan State University (MSU). At this location, the Red Cedar River is free-flowing over the crest of the dam; there is no impoundment to alter the water temperature or collect sediment. The dam does, however, serve as a complete barrier to upstream migrating fish. Smaller, unregistered private dams are fairly common in most watersheds; however, none have yet been documented in the RCRW.

## **2.9 Aquatic Life**

The Red Cedar River begins as a first-order, warmwater stream in Livingston County and, as it gains water from several tributaries, eventually becomes a fourth-order warmwater stream as it nears its confluence with the Grand River (MDEQ, 2003). There are eleven main tributaries to the Red Cedar, all of which are considered to be warmwater ecosystems. The entire watershed is in the Southern Michigan Northern Indiana Till Plains (SMNITP) Ecoregion.

Fish communities in the Red Cedar River have not historically been managed through supplemental stocking, although in 2012 a steelhead stocking program was implemented along a short stretch of the Red Cedar River on the MSU campus, on a trial basis. The river boasts a diverse resident warmwater fish community including northern pike, largemouth bass, and smallmouth bass. The river also provides modest fisheries for salmon and steelhead that seasonally migrate upstream from Lake Michigan.

In 2001, the Michigan Natural Features Inventory (MNFI) found high densities of unionid mussels in the Red Cedar River on MSU's campus. A possible reason for this was the site's location downstream of the dam (Hyde et al., 2009).

According to MDEQ (2013a), factors impacting water quality and aquatic life in the RCRW include nonpoint sources of pollution such as nutrients, pathogens and sediment. The MDNR (2011) stated that restoring wetlands and natural hydrology (e.g., through rehabilitating channelized streams) should be the focus of aquatic habitat improvement efforts.

## **2.10 Protected Species**

An understanding of the presence or absence of threatened, endangered and special concern plant and animal species can be used to help guide land conservation and management decisions in the watershed.

Five endangered, 14 threatened and 23 special concern species have been found in the RCRW. Of the rare plants existing in the area, the species are most typically associated with upland mesic forests (mesic southern forest) and riparian zones (floodplain forest) habitats (Hyde et al., 2009). Historically, some species of concern were found in oak barrens, savannas, and prairie grasslands, which are all habitats that are now rare in Ingham County. The species normally found in these habitats may, however, exist on steep hillsides, roadsides, and hedgerows, or in inaccessible areas or places where prairie vegetation is found. The rare terrestrial animal species typically reside in forest, wetland, and grassland ecosystems. The slippershell, a state threatened mussel, and four species of special concern (elktoe, round pigtoe, ellipse, and rainbow) were found at several sites in the Red Cedar River during MNFI surveys in 2001 (Hyde et al., 2009).

Habitat change and destruction is one reason for the threatened existence of our rare species. Regional conservation efforts appear to have the greatest potential on private lands and through existing landowner habitat improvement or protections programs (Hyde et al., 2009).

## **2.11 Invasive Species**

"Invasive species" refers to a species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Like most areas of southern Michigan, the watershed contains many invasive species. Some of the more pervasive include Eurasian water milfoil, purple loosestrife and garlic mustard. Perhaps the most visibly destructive of late is the emerald ash borer, which has destroyed millions of ash trees.

Under a contract with the Michigan Department of Natural Resources (MDNR) Wildlife Division, MNFI evaluated the occurrence of invasive plants throughout the state and created a strategy to manage the harmful effects invasives pose to wildlife (Higman and Campbell, 2009). It was found that southern lower Michigan is especially susceptible to invasive plants given the area's population density. Eurasian bush honeysuckles, common and glossy buckthorn, privet, barberry, multiflora rose, Oriental bittersweet, autumn olive, spotted knapweed and *Phragmites* are prevalent in the region and often introduced through landscaping or conservation activities.

### **2.12 Recreational Uses and Government Protected Lands**

Land is available for a variety of recreational activities on or near surface waters in the RCRW. Recreational activities available include water access for canoeing, fishing, boating, and swimming, and land access available for walking or biking trails adjacent to the river, picnicking or wildlife watching. Government protected land is shown in Figure 2.8.

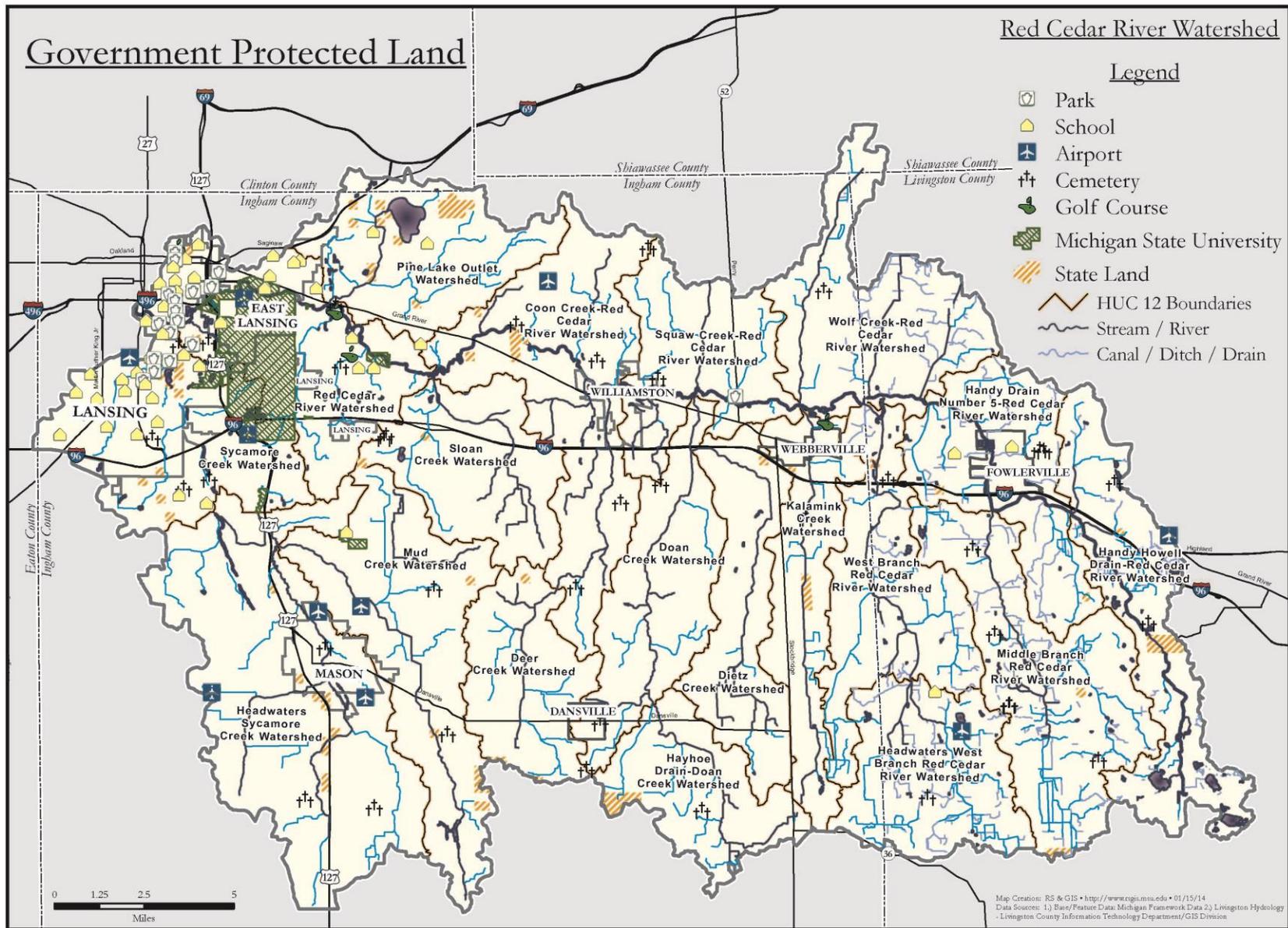


Figure 2.8 Government Protected Land

### **2.13 Political Jurisdictions**

The RCRW is a diverse watershed made up of 37 political jurisdictions. The watershed is primarily located in Ingham and Livingston Counties, with small drainage areas located in Clinton, Eaton and Shiawassee Counties. The watershed has an urbanized area in the northwestern portion of the watershed; here, the confluence of the Red Cedar and Grand Rivers occurs near downtown Lansing. The urbanized areas consist of the Cities of Lansing, East Lansing, and Mason; and Charter Townships of Lansing, Delhi and Meridian. In total, there are five counties, four cities, four charter townships, 21 general law townships and three villages that cover the geographical area of the watershed. Governmental units in the watershed are depicted in Figure 2.9.

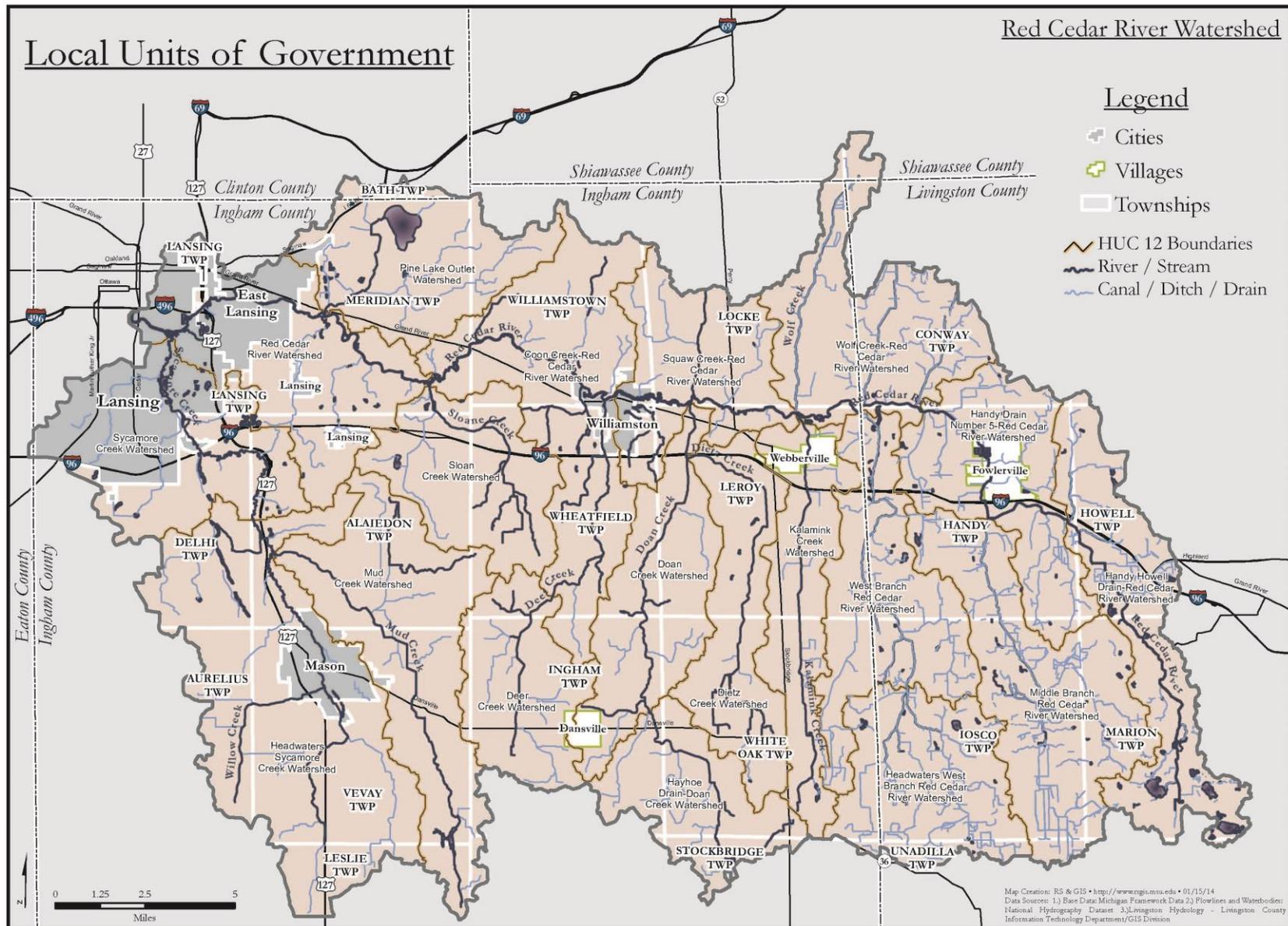
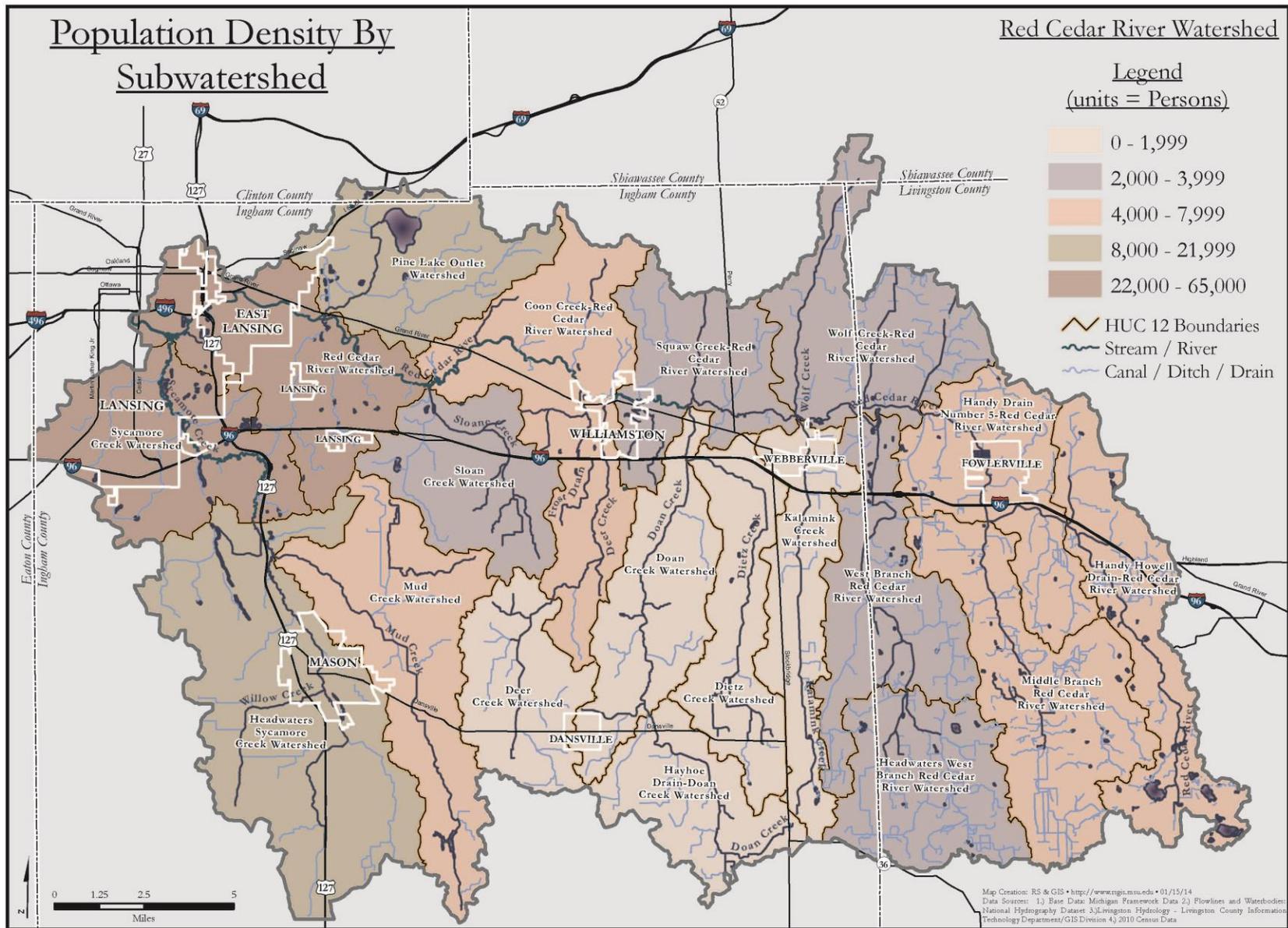


Figure 2.9 Local Units of Government

## **2.14 Demographics**

The most densely populated area in the RCRW is located in the Red Cedar River and Sycamore Creek subwatersheds, which encompass portions of the Cities of Lansing and East Lansing, Meridian Township and Delhi Charter Township. The Cities of Lansing and East Lansing had a combined population of roughly 156,000 in 2010 and have a population density greater than 2,000 people per square mile (MDTMB, 2012). The City of Mason, located in the Headwaters Sycamore Creek subwatershed, and the City of Williamston, located in the Coon and Squaw Creek subwatersheds, had population densities between approximately 1,500 and 1,600 people per square mile. The Village of Fowlerville, located in Handy Drain No. 5 subwatershed, had a population density of 1,241 people per square mile. The 2010 Census indicated that the remaining areas in the RCRW had population densities below 300 people per square mile. Alaieton, Wheatfield, Locke, Conway and White Oak Townships had population densities less 100 people per square mile (MDTMB, 2012). Population densities by subwatershed are shown in Figure 2.10.

According to Southeast Michigan Council of Governments (SEMCOG) forecasting efforts (2012), significant increases in population by 2040 will occur in portions of the Handy Howell Drain and Middle Branch Red Cedar River subwatersheds (Marion and Howell Townships). The Tri-County Regional Planning Commission (2012), estimates that by 2040, almost half of Ingham County's townships will experience a ten percent increase in population under current growth trends. Under a wise growth scenario, population increases would be concentrated in the cities of Lansing, East Lansing, and Delhi Charter Township, affecting the Red Cedar River and Sycamore Creek subwatersheds.



**Figure 2.10 Population Density by Subwatershed**