Community Assistance Planning Report No. 330

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

Chapter 3

CHARACTERIZATION OF THE WATERSHED

3.1 INTRODUCTION

Information on the natural and constructed features of a watershed is essential to sound planning for water quality, habitat, and floodplain management and for the provision of recreational access. Watershed topography, local hydrology, and soil types influence rates and volumes of runoff, which affect instream water quality, the composition of plant and animal communities, and flooding conditions. The water quality-related problems of a watershed, and their solutions, are primarily a function of the human activities taking place within it and the ability of the natural resource base to sustain those activities. Streams and lakes are also susceptible to water quality and habitat degradation due to human activities within the watershed, which can interfere with desired water uses and are often difficult and costly to correct. Because of this, land uses and population levels in the watershed are important considerations in planning for the protection, restoration, and management of the water resources in the watershed.

This chapter presents information on the natural resource and human-made features of the Oak Creek watershed including a description of the natural resource base and environmentally sensitive areas, land use data, and demographics. This collection of information helps to establish a factual, existing conditions base upon which the watershed planning process may proceed. The characterization of the Oak Creek watershed presented in this chapter represents a refinement and updating of the inventories presented in the Southeastern Wisconsin Regional Planning Commission (SEWRPC) comprehensive plan for the Oak

Creek watershed[1] and the SEWRPC regional water quality management plan update for the Greater Milwaukee watersheds (RWQMPU).[2]

3.2 ASSESSMENT AREAS

The Oak Creek watershed is comprised of five subwatersheds, as shown on Map 3.1. These subwatersheds include the Lower, Middle, and Upper Oak Creek subwatersheds, which make up the mainstem of Oak Creek, the North Branch Oak Creek subwatershed and the Mitchell Field Drainage Ditch subwatershed, which are the main tributary streams to the mainstem of Oak Creek.

Hydrologic-hydraulic and water quality modeling that was conducted as part of the regional water quality plan update for the greater Milwaukee watersheds (RWQMPU)[3] required that subwatersheds be further subdivided into hydrologic subbasins. Hydrologic subbasins are the basic "building blocks" for simulating the hydrologic-hydraulic response of the watershed. A total of 70 subbasin areas were delineated in the watershed for simulation modeling in the RWQMPU. These subbasins were delineated to encompass areas tributary to streams, drainageways, and storm sewers using topographic mapping supplemented with street grade data and information on the location, configuration, and elevation of storm sewer systems.

To facilitate analysis for this watershed restoration planning effort, the watershed was divided into 15 "assessment areas." These assessment areas correspond to groupings of the RWQMPU hydrologic subbasins within the subwatersheds that are described above. The groupings were defined based on sites where historical stream flow and water quality data were available, or at points located upstream or downstream of known sources of pollution. The assessment areas are shown on Map 3.2 and their areas are quantified in Table 3.1.

The following are brief descriptions of the 15 assessment areas that make up the Oak Creek watershed. Further details on these areas, including land use, water quality data, biological assessments, channel conditions, and habitat assessment will be examined later in this report.

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[1]*SEWRPC Planning Report No. 36,* A Comprehensive Plan for the Oak Creek Watershed, *August 1986*.

[2]*SEWRPC Planning Report No. 39,* Water Quality Conditions and Sources of Pollution in the Greater Milwaukee Watersheds, *November 2007 and SEWRPC Planning Report No. 50,* A Regional Water Quality Management Plan for the Greater Milwaukee Watersheds, *December 2007 and SEWRPC Planning Report No. 39*.

[3]*SEWRPC Planning Report No. 50,* op. cit.

Grant Park Ravine Assessment Area

The most downstream reach in the watershed, this assessment area covers 286 acres and contains 0.8 stream miles of the mainstem of Oak Creek in the City of South Milwaukee. The Creek flows through a steep ravine in Milwaukee County's Grant Park, from the Oak Creek Mill Pond dam downstream to its confluence with Lake Michigan. This assessment area is completely contained within the City of South Milwaukee. In this assessment area, the Creek is well-buffered from roadways and other development by natural vegetation. This area is popular for recreational activities including fishing, biking, birding, photography, and hiking. The majority of the land in this assessment area is characterized as recreational, residential, and industrial land uses.

Lower Oak Creek—Mill Pond Assessment Area

This assessment area covers 932 acres and contains 2.25 stream miles of the mainstem of Oak Creek, flowing from 15th Avenue downstream to the Mill Pond dam in the City of South Milwaukee. This assessment area is located within the Cities of Cudahy and South Milwaukee. This stretch of Creek is relatively well buffered by the Milwaukee County Oak Creek Parkway. This area is popular for biking along the Parkway, and fishing and birdwatching near the Mill Pond. A U.S. Geological Survey (USGS) continuous streamflow monitoring gage is located near the most upstream crossing in this assessment area (15th Avenue). This assessment area is predominantly developed in single-family and multi-family residential land uses, with some commercial and industrial uses as well.

Lower Oak Creek Assessment Area

This assessment area covers 2,046 acres and contains 2.4 stream miles of the mainstem of Oak Creek, flowing from the confluence with the Mitchell Field Drainage Ditch in the City of Oak Creek, downstream to 15th Avenue in the City of South Milwaukee. This assessment area is located within the Cities of Cudahy, Oak Creek, and South Milwaukee. The Creek in this area is relatively well-buffered by the Milwaukee County Oak Creek Parkway. There are short reaches of concrete-lined channel found in this assessment area. This area is largely developed in residential land use, with small pockets of commercial, industrial, governmental, and agricultural uses.

Middle Oak Creek Assessment Area

This is the largest assessment area covering 3,256 acres and containing 4.6 stream miles of the mainstem of Oak Creek, flowing from the confluence with the North Branch of Oak Creek downstream to the confluence of the Mitchell Field Drainage Ditch. There are several unnamed tributaries and drainage ditches that flow into this reach of Oak Creek. The entire assessment area is within the City of Oak Creek. This area has the largest amount of remaining agricultural and open space land uses along the mainstem of Oak Creek, as well as pockets of single- and multi-family residential development.

Middle Oak Creek—Drainage Ditches Assessment Area

This assessment area covers 1,372 acres and contains about 5.25 miles of unnamed roadside drainage ditches that flow into the mainstem of Oak Creek near Puetz Road. The entire assessment area is within the City of Oak Creek. This area consists of mostly agricultural and other open space land uses, with large areas of wetland.

Upper Oak Creek Assessment Area

This assessment area covers 1,827 acres and contains 2.8 stream miles of the mainstem of Oak Creek, flowing from Ryan Road in the City of Franklin, downstream to the confluence with the North Branch of Oak Creek, in the City of Oak Creek. This assessment area is located within the Cities of Franklin and Oak Creek. This assessment area has a mix of agricultural, industrial, and residential land uses and contains a portion of the Interstate Highway 94 (IH 94) corridor.

Oak Creek Headwaters Assessment Area

The furthest upstream assessment area of Oak Creek's mainstem covers 706 acres and contains 2.3 stream miles of Oak Creek's headwaters, flowing from its intermittent origins just north of Puetz Road, downstream to Ryan Road, in the City of Franklin. The entire assessment area is located within the City of Franklin. Most of the assessment area is developed in residential land uses.

Lower Mitchell Field Drainage Ditch Assessment Area

This assessment area covers 1,443 acres and contains 1.8 stream miles of the Mitchell Field Drainage Ditch tributary to the mainstem of Oak Creek. This reach flows from College Avenue downstream to the confluence with the mainstem of Oak Creek, mostly within the City of Oak Creek. This assessment area also contains small portions of the Cities of Milwaukee and Cudahy. There are several unnamed tributaries and drainage ditches that flow from west to east into the Mitchell Field Drainage Ditch. This area has a significant amount of open space land and also contains some pockets of residential, commercial, industrial, and airport land uses.

Mitchell Field Drainage Ditch—Airport Assessment Area

This assessment area covers 1,010 acres and contains about 2.3 stream miles of the Mitchell Field Drainage Ditch and several unnamed drainage ditches, all of which are within the General Mitchell Field International

Airport property. This assessment area is located within the Cities of Milwaukee and Oak Creek. Significant portions of the stream within this assessment area are enclosed under Airport runways.

Lower North Branch Oak Creek Assessment Area

This assessment area covers 978 acres and contains 2.8 stream miles of the North Branch of Oak Creek, flowing from just upstream of Drexel Avenue to its confluence with the mainstem of Oak Creek in the City of Oak Creek. This assessment area is located entirely within the City of Oak Creek. The North Branch of Oak Creek is the largest tributary of Oak Creek. Assessment areas directly contributing streamflow to the Lower North Branch assessment area include the Upper North Branch Oak Creek, Rawson Avenue Tributary, the Drexel Avenue Tributary, and the Southland Creek Tributary. This assessment area has a mix of industrial, residential, governmental, agricultural, and other open space land uses.

Upper North Branch Oak Creek Assessment Area

This assessment area covers 1,257 acres and contains 3.5 stream miles of the North Branch of Oak Creek, flowing from its headwaters located northwest of IH 94 in the City of Milwaukee, downstream to just north of Drexel Avenue, where it flows into the Lower North Branch of Oak Creek. The assessment area includes portions of the Cities of Greenfield, Milwaukee, and Oak Creek, and contains a mix of industrial, commercial, residential, and open space land uses. A small portion of the IH 94 corridor crosses this assessment area. This assessment area receives contributing flow from the College Avenue Tributary assessment area.

Southland Creek Assessment Area

This assessment area covers 696 acres and contains 2.4 stream miles of Southland Creek which flows in a west to east direction from its headwaters in the City of Franklin to its confluence with the North Branch of Oak Creek in the City of Oak Creek, about 0.75 miles east of IH 94. This assessment area is located within the Cities of Franklin and Oak Creek. An unnamed, intermittent stream tributary to Southland Creek is also contained in this assessment area. The major land use in this area is agricultural and other open lands, with pockets of residential and commercial development and some IH 94 corridor.

Drexel Avenue Tributary Assessment Area

This assessment area covers 814 acres and contains about 3.8 stream miles of perennial and intermittent unnamed streams. The main stream in this assessment area flows southeast from its headwaters near S. 27th Street and crosses Drexel Avenue and IH 94 before flowing into the North Branch of Oak Creek just upstream of Willow Heights Park, in the City of Oak Creek. The assessment area also includes a small portion of the City of Franklin. This area has mostly agricultural, woodland, and other open lands, with small pockets of residential and commercial development. A portion of the IH 94 corridor transects this assessment area.

Rawson Avenue Tributary Assessment Area

This assessment area covers 968 acres and contains about 4.3 stream miles of intermittent unnamed streams. The assessment area is almost entirely contained within the City of Oak Creek, with a small portion within the City of Franklin. The main unnamed stream in this area flows in a south-southeastern direction, originating north of Rawson Avenue and crossing IH 94, S. 13th Avenue, and S. 6th Avenue before joining the North Branch of Oak Creek downstream of Marquette Avenue. This assessment area contains a mix of industrial, residential, commercial, agricultural and other open land uses and contains a portion of the IH 94 corridor.

College Avenue Tributary Assessment Area

This assessment area covers 453 acres and contains about 1.25 stream miles of unnamed intermittent stream that originates to the west of IH 94 and flows southeast across S. 13th Avenue and into the North Branch of Oak Creek at S. 6th Street near the Milwaukee Area Technical College Oak Creek campus. This assessment area contains portions of the Cities of Milwaukee and Oak Creek and has a mix of residential, commercial, industrial, and open space land uses and contains a portion of the IH 94 corridor.

3.3 CIVIL DIVISIONS

Superimposed over natural boundaries, such as watershed and subwatershed boundaries, is a pattern of local and political boundaries. As shown in Map 3.3, the Oak Creek watershed lies entirely within Milwaukee County and includes portions of the Cities of Cudahy, Franklin, Greenfield, Milwaukee, Oak Creek, and South Milwaukee. Geographic boundaries of the civil divisions within the watershed are an important factor because they form the basic foundation of the public decision-making framework within which intergovernmental, environmental, and development issues may be addressed. The proportions of the watershed within the jurisdiction of each city are set forth in Figure 3.1.

Jurisdictional Roles and Responsibilities

Natural resources in the United States are protected to various extents under Federal, state, and local law. The Clean Water Act regulates surface water quality at the national level. In Wisconsin, the Wisconsin Department of Natural Resources (WDNR) has the authority to administer the provisions of the Clean Water Act. The U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers, Natural Resources Conservation Service (NRCS), and the U.S. Fish and Wildlife Service work with the WDNR to protect natural lands, wetlands, and threatened and endangered species. The Federal Safe Drinking Water Act applies to all public water supply systems and helps to protect surface and groundwater resources.

The local governments in the Oak Creek watershed have ordinances regulating land development and protecting surface waters. The comprehensive zoning ordinance represents one of the most important and significant tools available to local units of government in directing the proper use of lands within their jurisdictions. Local zoning regulations include general, or comprehensive, zoning regulations and special-purpose zoning regulations governing floodplain and shoreland areas. General zoning and special-purpose zoning regulations may be adopted as a single ordinance or as separate ordinances; they may or may not be contained in the same document. Any analysis of locally proposed land uses must take into consideration the provisions of both general and special-purpose zoning. The ordinances administered by the units of government within the Oak Creek watershed are summarized in Table 3.2.

Other governmental entities with watershed jurisdictional or technical advisory roles include: the USGS, the Wisconsin Department of Agriculture, Trade, and Consumer Protection (WDATCP); the University of Wisconsin-Extension; the Milwaukee Metropolitan Sewerage District (MMSD); the Milwaukee County Department of Transportation and Public Works—Architecture, Engineering, and Environmental Services Division; the Milwaukee County Department of Parks, Recreation, and Culture; and SEWRPC.

Floodplain Zoning

Section 87.30 of the *Wisconsin Statutes* requires that cities, villages, and counties, with respect to their unincorporated areas, adopt floodplain zoning to preserve the floodwater conveyance and storage capacity of the floodplain areas and to prevent the location of new flood damage-prone development in flood hazard areas. The minimum standards that such ordinances must meet are set forth in Chapter NR 116 of the *Wisconsin Administrative Code*. The required regulations govern filling and development within a regulatory floodplain, which is defined as the area that has a one-percent-annual-probability of being inundated. The one-percent-annual-probability (100-year recurrence interval) floodplain areas within the Oak Creek watershed are shown on Map 3.4. Under Chapter NR 116, local floodplain zoning regulations must prohibit nearly all forms of development within the floodway, which is that portion of the floodplain required to convey the one-percent-annual-probability peak flood flow. Local regulations must also restrict filling and development within the flood fringe area, which is that portion of the floodplain located outside of the floodway that would be covered by floodwater during a one-percent-annual-probability flood. However, permitting the filling and development of the flood fringe area without requiring the provision of compensatory storage to replace the floodwater storage volume lost through filling, reduces the floodwater storage capacity of the natural floodplain, and may, thereby, increase downstream flood flows and stages. All cities within the Oak Creek watershed have adopted floodplain zoning ordinances.[4]

A small area of floodplains in the City of Cudahy is designated as "Zone A" where the extent of the floodplain was determined based upon an approximate study that did not calculate specific flood stage elevations. All remaining floodplains in the watershed were developed under detailed studies for which flood flows and base flood elevations were determined (see Map 3.4). All floodplains in the watershed were delineated under the September 2008 Federal Flood Insurance Study for Milwaukee County.[5]

3.4 POPULATION AND HOUSEHOLDS

Data on estimated population and numbers of households in the Oak Creek watershed from 1960 to 2010, and projections for 2050, are shown in Figure 3.2. From 1960 to 2010, the resident population grew from about 32,000 to 56,000 individuals while the number of households grew from about 8,300 to more than 24,000. The greatest increase in both population and the number of households occurred between 1990 and 2000, however there has been a steady growth in both population and households since 1960 as shown in Figure 3.2. Based upon the adopted regional land use plan,[6] the population and number of resident households in the Oak Creek watershed are projected to continue to increase through the year 2050, which is consistent with the planned land use changes as shown in Table 3.3.

3.5 LAND USE

An important concept underlying the watershed planning effort is that land use development must be adjusted to the ability of the underlying natural resource base to sustain such development. The type, intensity, and spatial distribution of land uses determine, to a large extent, the resource demands within a watershed. The demands upon water resources can be correlated directly with the quantity and type of land use in the watershed. The same is true of the deterioration of water quality. The existing land use pattern

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[4] *Although all municipalities within the watershed have adopted floodplain ordinances, this does not preclude development within the regulatory floodplains of the Oak Creek watershed.*

[5] *Federal Emergency Management Agency,* Flood Insurance Study—Milwaukee County, Wisconsin and Incorporated Areas, *September 2008.*

[6] *SEWRPC Planning Report No. 55,* VISION 2050: A Regional Land Use and Transportation Plan for Southeastern Wisconsin, *July 2017.*

can best be understood within the context of its historical development. This section presents information on past land use, existing land use, and planned land use within the Oak Creek watershed.

Changes in Land Use over Time

Historically, before European settlement in the mid-1800s, the landscape within the Oak Creek watershed consisted largely of maple-basswood forest, which could be characterized by continuous, often dense, canopies of deciduous trees and understories of shade adapted shrubs and herbs. Also prevalent in the pre-settlement landscape, particularly in the eastern portion of the watershed near Lake Michigan, were beech-maple forests, consisting of mostly American beech and sugar maple trees. Other natural habitats included wetland complexes buffering large portions of the stream channels in the watershed, and pockets of oak forest, lowland hardwood forest, and conifer swamp. The extent of these pre-settlement habitat types in the Oak Creek watershed, derived from the original 1836 land surveyor's records, is shown on Map 3.5.

The soil that covered a significant portion of the watershed was considered less productive than some other portions of the Southeastern Wisconsin region at the time. In some areas of the watershed the soil contained many boulders, varying in size from a few pounds to several tons.[7] Despite this fact, in large portions of the watershed, natural vegetation and forests were eventually cleared to make room for farming. Efforts were made to open up wetlands to cultivation through ditching and draining of wet soils. This land conversion had significant consequences on water quality and wildlife habitat within the Oak Creek watershed.

By 1963,[8] agricultural and other open lands dominated the landscape, accounting for over 57 percent of the land within the Oak Creek watershed. From that point forward, agricultural land use slowly declined in the watershed, but was still the largest use of land as recently as 1980, when 45 percent of the land was used for agriculture or other open land uses.

Historical Urban Growth

Historical urban growth within the Oak Creek watershed is shown on Map 3.6. In 1840, early settlers built a saw mill a short distance upstream from Oak Creek's confluence with Lake Michigan.[9] The saw mill derived

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[7] *Lieutenant Col. Jerome A. Watrous and the Western Historical Association,* Memoirs of Milwaukee County, Volume 1, *1909*.

[8] *1963 is the first year that SEWRPC completed a detailed land use analysis for the Southeastern Wisconsin Region.*

[9] Memoirs of Milwaukee County, Volume 1, op. cit.

power from a dam built on Oak Creek which provided a fall of twelve feet. This dam was also used to drive a small grist-mill in the area. Early urban growth (pre-1900) in the watershed was focused in a small area northwest of the location of the current dam and mill pond, and a larger area to the southwest of the mill pond in what is now the City of South Milwaukee. Between 1901 and 1940, most of the urban growth in the watershed continued to be focused in the City of South Milwaukee, with several small pockets of development in the Cities of Cudahy, Franklin, Milwaukee, and Oak Creek. The period between 1951 and 1970 saw the largest expansion of urban development throughout the watershed when the extent of urban development increased from about 8 percent to almost 33 percent of the watershed. The decades of the 1980s, 1990s, and 2000s experienced increased urban development within the watershed of 5.2, 8.6, and 5.9 percent, respectively. By 2010, 61.2 percent of the watershed had been developed for urban uses.

Existing and Planned Land Use

This section characterizes existing land use conditions as of the year 2015 and examines changes anticipated to occur through 2050. The types, intensity, and spatial distribution of land uses within the Oak Creek watershed are important elements in natural resource management and are important considerations in developing and implementing this restoration plan.

Existing Land Use: 2015

Map 3.7 shows existing land use for the Oak Creek watershed and Tables 3.4 through 3.7 set forth existing land use data, expressed as areas and percentages for the assessment areas and the entire watershed.

Map 3.8 shows the percentage of urban land uses within each assessment area in the watershed. The data set forth in Tables 3.4 through 3.7, and shown graphically on Map 3.8, indicate that the watershed is heavily urbanized, with nearly 65 percent of the watershed in urban land uses, and about 35 percent still in rural and other open space land uses as of the year 2015. Twelve of the fifteen assessment areas have a majority of the land in urban uses. In five assessment areas—the Lower Oak Creek-Mill Pond, the Lower Oak Creek, the Oak Creek Headwaters, the Mitchell Field Drainage Ditch-Airport, and the College Avenue Tributary—urban land uses account for over 80 percent of the land within the assessment area. In five additional assessment areas—the Grant Park Ravine, the Middle Oak Creek, the Upper Oak Creek, the Lower North Branch Oak Creek, and Upper North Branch Oak Creek—urban land uses account for over 60 percent of the land within the assessment area. Three assessment areas—the Middle Oak Creek-Drainage Ditches, the Lower Mitchell Field Drainage Ditch, and the Drexel Avenue Tributary have the majority of their land in non-urban land uses.

Residential development comprised the largest category of land uses in the watershed, accounting for 4,931 acres, or about 27.3 percent of the watershed. As of 2015, 1,324 acres, or about 7.3 percent of the watershed, and 848 acres, or about 4.7 percent of the watershed, were wetlands and woodlands, respectively. There were 1,664 acres, or about 9.2 percent of the watershed, in agricultural land uses in 2015.

Planned Land Use: 2050

Planned year 2050 land use in the Oak Creek watershed is shown on Map 3.9 and summarized in Tables 3.8 through 3.11, expressed as area and percentages for each assessment areas and the entire watershed. Under planned 2050 land use conditions, about 14,254 acres, or 79 percent of the watershed, are anticipated to be in urban land uses, an increase of about 22 percent from year 2015 existing conditions, as shown in Table 3.11. The percent of anticipated urban development for each assessment area is shown graphically on Map 3.10. The increase in urban development between 2015 and 2050 is anticipated to result from increases in residential, commercial, and industrial development, accounting for increases of 14 percent of the 2015 residential area (3.9 percent of the total watershed area), 94 percent of the 2015 commercial area (4.2 percent of the total watershed area), and 66 percent of the industrial area (3.1 percent of the total watershed area), respectively (see Tables 3.7 and 3.11). All of the increases in urban development are anticipated to result from the conversion to urban uses of 1,014 acres of agricultural land (a reduction of 61 percent of the 2015 area in agricultural uses, or 5.6 percent of the total watershed area), 1,529 acres of other open lands (a reduction of 65 percent of the 2015 area in other open uses, or 8.5 percent of the total watershed area), and 5 acres of woodland (a reduction of under 1 percent of the 2015 area in woodlands and of the total watershed area). Map 3.11 graphically depicts the agricultural land, woodlands, and other open lands in 2015 that are expected to be converted to urban uses under planned 2050 conditions.

It is anticipated that between 2015 and 2050 all assessment areas within the watershed, except the Grant Park Ravine assessment area, will experience increases in the levels of urban development. Comparison of Tables 3.3 through 3.10 indicate that the number of assessment areas in the watershed with greater than 80 percent urban development is expected to increase from five in 2015 to seven in 2050 (also see Map 3.10). Only one of the 15 assessment areas—the Middle Oak Creek Drainage Ditches—is anticipated to have more rural land uses than urban development in 2050. Four assessment areas are anticipated to experience an increase of urban development of greater than 20 percentage points (expressed relative to the entire watershed area) from 2015 to 2050 including the Upper Oak Creek (increase of 20.3 percentage points), the Lower Mitchell Field Drainage Ditch (increase of 31.2 percentage points), the Drexel Avenue Tributary (increase of 25.2 percentage points), and the Rawson Avenue Tributary (increase of 20.2 percentage points).

Urban Development and Impervious Surface

Urban land uses in the Oak Creek watershed have been increasing since the first SEWRPC land use inventory was conducted in 1963, and are expected to continue to increase through 2050 (see Figure 3.3). When urban development in a watershed increases, the amount of impervious surface area increases. Many researchers throughout the United States, including researchers at the WDNR, report that the amount of connected impervious surface area is the best indicator of the level of urbanization in a watershed.[10] Directly connected impervious surface areas are areas that discharge directly to the stormwater drainage system, and, ultimately to a stream, without the potential for infiltration through discharge to pervious surfaces or facilities specifically designed to infiltrate runoff. Studies have found that impervious surfaces:

- Contribute to hydrologic changes that degrade waterways
- Are a major component of intensive land uses that generate pollution
- Prevent natural pollution attenuation or removal in the soil by preventing infiltration
- Serve as an efficient conveyance system transporting pollutants to waterways

Research over the last 20 years shows a strong relationship between the connected imperviousness of a drainage basin and the health of receiving streams.[11] Studies have found that relatively low levels of urbanization—8 to 12 percent connected impervious surface—can cause subtle changes in physical (flashy flows, increased water temperatures and turbidity) and chemical (reduced dissolved oxygen and increased

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[10] *L. Wang, J. Lyons, P. Kanehl, and R. Bannerman, "Impacts of Urbanization on Stream Habitat and Fish across Multiple Spatial Scales,"* Environmental Management, *Vol. 28, 2001, pp. 255-266.*

[11] *Wang, L., J. Lyons, P. Kanehl, R. Bannerman, and E. Emmons, "Watershed Urbanization and Changes in Fish Communities in Southeastern Wisconsin Streams,"* Journal of the American Water Resources Association *36(5):1173-1189, 2000; Wang, L., J. Lyons, P. Kanehl, and R. Gatti. "Influences of Watershed Land Use on Habitat Quality and Biotic Integrity in Wisconsin Streams,"* Fisheries *22(6):6-12, 1997; Arnold, C., and C.J. Gibbons. "Impervious Surface Coverage. The Emergence of a Key Environmental Indicator,"* Journal of the American Planning Association *62(2):243-258, 1996; Schueler, T., Site Planning for Urban Stream Protection. Center for Watershed Protection, 1995; Ellicot, MD; Masterson, J.P., and R.T. Bannerman. "Impacts of Stormwater Runoff on Urban Streams in Milwaukee, Wisconsin," National Symposium on Water Quality, American Water Resources Association. Middelburg, VA, 1994; and, Schueler, T., "The Importance of Imperviousness,"* Watershed Protection Techniques *1:100-111, 1994.*

pollutant levels) properties of a stream, leading to a decline in the biological integrity. For example, each 1 percent increase in watershed imperviousness can lead to an increase in water temperature of nearly 2.5°F.[12] While this temperature increase may appear to be small in magnitude, it can have significant impacts on fish (such as trout) and other biological communities that have a low tolerance to temperature fluctuations or that require specific thermal ranges.

The amount of directly connected impervious surface in a watershed can be estimated by applying a land use-specific connected impervious factor for each urban land use development type. The Oak Creek watershed had about 34.4 percent urban land uses in 1963,[13] which approximately corresponds to 8.7 percent directly connected imperviousness in the watershed. As of 2015, the watershed had about 64.9 percent urban land overall, corresponding to about 18.3 percent directly connected imperviousness (see Figure 3.3 and Table 3.12). That level of imperviousness is well above the threshold at which changes in properties of streams can occur, as described above. These changes have likely led to a decline in the biological integrity of the streams in the Oak Creek watershed and will be discussed in further detail in Chapter 4 of this report.

Table 3.12 sets forth estimated connected impervious area percentages by assessment area for existing year 2015 and planned year 2050 land use conditions. The 2015 connected impervious area percentages by assessment area range from a low of 6.7 percent in the Middle Oak Creek-Drainage Ditches assessment area to a high of 31.4 percent in the Mitchell Field Drainage Ditch-Airport assessment area. Projections for the connected impervious area percentages for planning year 2050 conditions range from a low of 10.9 percent in the Grant Park Ravine assessment area to a maximum of 34.1 percent in the Upper Oak Creek assessment area. Under 2015 conditions, all assessment areas except the Middle Oak Creek-Drainage Ditches assessment area have connected impervious area percentages above the 8 percent lower bound of the threshold level at which changes in stream properties may occur in the absence of mitigating measures on the landscape. Under planned year 2050 conditions, all assessment areas are expected to have connected impervious area percentages above 8 percent.

These estimated levels of connected impervious surface in the Oak Creek watershed indicate that local stormwater management practices affecting runoff volume and water quality, such as those promoting

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[12] *L. Wang, J. Lyons, and P. Kanehl, "Impacts of Urban Land Cover on Trout Streams in Wisconsin and Minnesota,* Transactions of the American Fisheries Society. *Vol. 132, 2003, pp. 825-839.*

[13] *SEWRPC Planning Report No. 36,* op. cit.

detention, infiltration, green infrastructure projects, and preservation and expansion of riparian buffers, will be crucial to mitigate the consequences of continued urban development within this watershed.

Sanitary Sewer Service Areas

The existing areas that are served by sanitary sewers and the extent of urban development not served by public sewerage systems within the Oak Creek watershed are shown on Map 3.12. Under existing conditions, approximately 60 to 70 percent of the watershed area is served by public sanitary sewerage systems. The remaining unserved areas are mostly made up of primary and secondary environmental corridor or agricultural and other open lands that have not been developed for urban uses. The small enclaves of urban development that are not served by sanitary sewerage systems are shown in red on Map 3.12, and total about 52 acres, or 0.2 percent of the watershed. These small areas consist of mostly low density and rural density residential, commercial, and wholesaling and storage land uses. Urban development in these areas is likely to be served by onsite sewage disposal systems. In addition, some buildings located within the sanitary sewer service area are not connected to the sewer system and are still served by onsite sewage disposal systems. An onsite sewage disposal system may be a conventional septic tank; a mound system; a holding tank; or an alternative system, such as an aerobic treatment unit or sand filter.

Transportation

The transportation system within the Oak Creek watershed provides the basis for movement of goods and people into, out of, and through the watershed. Road culverts and bridges can have a major influence on the hydrology and habitat of a stream, and the connectivity to upstream and downstream areas for both aquatic and terrestrial wildlife. The need for application of deicing products to maintain safe functionality of roads and airports during the winter season can have an impact on water quality conditions in both surface and groundwater resources within a watershed. In addition, runoff from roadways can carry other contaminants from automobiles.

If designed and planned correctly, road construction projects often present opportunities to incorporate improvements to stream channel hydrology, habitat, and aquatic and terrestrial wildlife migration. However, when the health of nearby streams, rivers, and lakes are not sufficiently considered, roads and related construction projects can have negative consequences. Thus, a basic understanding of the existing transportation system within the Oak Creek watershed is a factor to be considered in the preparation of a restoration plan for the watershed.

Arterial Streets and Highways

The western assessment areas of the Oak Creek watershed are traversed in a north-south direction by Interstate Highway 94 (IH 94). IH 94 is a major corridor used extensively for freight transport as well as daily commutes. Major north-south arterials within the watershed include STH 241 (South 27th Street), STH 38 (Howell Avenue), and STH 32 (Chicago Avenue). Major east-west arterials include STH 100 (Ryan Road), Puetz Road, Drexel Avenue, CTH BB (Rawson Avenue), and CTH ZZ (College Avenue). The watershed also contains many collector and land access streets serving residential neighborhoods.

Airports

Part of General Mitchell International Airport property lies within the northern portion of the Oak Creek watershed. General Mitchell International Airport is the largest airport in the State and serves more than 4 million passengers per year. The Mitchell Field Drainage Ditch traverses the southern portion of the runway areas of the airport and is a major tributary to the mainstem of Oak Creek.

3.6 CLIMATE AND CLIMATE CHANGE

Climate, which is the long term weather conditions in an area, is an important consideration for assessing the current conditions of the Oak Creek watershed and planning for the future health of its water resources. Recent assessments have documented changes in Wisconsin's climate over the late 20th century.[14] Projections of Wisconsin's future climate based on downscaled data from 14 global climate models indicate that additional changes will occur through the 21st century.[15] The following sections describe the changes that have occurred in Wisconsin's climate since 1950 and the changes that are projected to occur by the middle of the 21st century.

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[14] *For example, Christopher J. Kucharik, Shawn P. Serbin, Steve Vavrus, Edward J. Hopkins, and Melissa M. Motew, "Patterns of Climate Change across Wisconsin from 1950-2006,"* Physical Geography*, Volume 31, pages 1-28, 2010.*

[15] *Wisconsin Initiative on Climate Change Impacts,* Wisconsin's Changing Climate: Impacts and Adaptation*, Nelson Institute for Environmental Studies, University of Wisconsin-Madison and Wisconsin Department of Natural Resources, 2011. Downscaling is an analysis approach that enables climatological data generated by Intergovernmental Panel on Climate Change general circulation models developed at a relatively coarse geographic scale (e.g., climate change data for several large regions in an entire state) to be modified to represent a finer geographic scale (e.g. at the scale of a county or watershed).*

Air Temperature

Based on the 30-year average temperature data during the period of 1981 to 2010 from the official NOAA National Weather Service records, the average annual temperature at Milwaukee's General Mitchell International Airport was 47.8 degrees Fahrenheit. Average annual temperatures in Wisconsin increased over the last half of the 20th century. Between 1950 and 2006, average annual temperature in the State increased by 1.1°F.[16] In the vicinity of the Oak Creek watershed, the increase was between 1.5 and 2.0°F. Much of this increase in average annual temperature occurred in the form of higher night-time low temperatures. For example, over the period 1950 through 2006, the average number of days in which the daily low temperature fell below 0°F decreased by about six days per year. The greatest increase in temperatures occurred during winter and spring months. Depending on location within the Oak Creek watershed, average winter temperatures increased by 3.0 to 3.5°F over this period.

The consensus of downscaled results from climate models is that average annual temperatures will continue to increase through the 21st century.[17] Depending on location, the models project that average annual temperatures in Wisconsin will increase by between 4.0°F and 9.0°F over the period 1980 through 2055. This increase is projected to be on the order of 5.5°F in the vicinity of the Oak Creek watershed. The greatest changes are estimated to occur during the winter months, with average winter temperatures being projected to increase by about 7.5°F. By contrast, average temperatures in the watershed during the summer are projected to increase by about 5.5°F. Changes in extreme temperatures will accompany these changes in average temperature. The frequency of extreme daily high temperatures is also predicted to increase based on modeling results. The average number of days per year with daily high temperatures greater than 90°F is currently about 12 in southern Wisconsin. This is likely to double to about 25 days per year by 2055. By contrast, the frequency of extreme daily low temperatures is expected to decrease. The average number of days per year with daily low temperatures below 0°F is currently about 15 in southern Wisconsin. This is projected to decrease to about nine days per year by 2055.

Precipitation

Based on the 30-year average precipitation data during the period of 1981 to 2010 from the official NOAA National Weather Service records, the average annual precipitation at Milwaukee's General Mitchell

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[16] *Kucharik and others, 2010,* op. cit.

[17] *Wisconsin Initiative on Climate Change, 2011,* op. cit.

International Airport was 34.8 inches. Average annual precipitation in Wisconsin increased over the last half of the 20th century. Between 1950 and 2006, average annual precipitation in the State increased by about 3.1 inches.[18] It should be noted that there was substantial variability in the change in average annual precipitation across the State, with some areas experiencing increases up to 7.0 inches, while areas in parts of northern Wisconsin experienced decreases in annual precipitation. Areas within the Oak Creek watershed experienced annual precipitation increases over this period of between 4.5 and 6.0 inches. Much of the increase in average precipitation occurred during autumn months. In the Oak Creek watershed, average precipitation during autumn months increased between 2.0 and 2.5 inches over the period from 1950 through 2006. Increases in precipitation also occurred to a lesser degree during winter, spring, and summer.

The frequency and magnitude of heavy precipitation events has also been increasing in Wisconsin. Extreme rainfall patterns in the City of Madison illustrate this trend. In the decade between 2001 and 2010, there were 24 days in which 2.0 inches or more of precipitation fell in a single event. This is twice the previous maximum of 12 days with 2.0 inches or more of precipitation, which occurred in the decade between 1951 and 1960.

The consensus from downscaled results of climate models predict several changes in precipitation through the 21st century.[19] Most of the models project an increase in average annual precipitation in southeastern Wisconsin of about 1.5 to 2.0 inches. The models indicate that the amount of precipitation falling during winter is likely to increase by about 25 percent. Due to the projected increase in temperatures, it is estimated that a greater amount of precipitation occurring during the winter will fall as rain rather than snow.[20] This will be accompanied by both an increase in the likelihood of freezing rain events and decreases in snow depth and snow cover. Model projections also show that Wisconsin will receive more precipitation and more frequent and intense precipitation events during the spring, especially during early spring. As in winter, it will become more likely for early spring precipitation to fall as rain rather than snow. The total amount of precipitation occurring during the summer is not projected to change much, but the models also indicate that the frequency of intense rainfall events will increase. In southern Wisconsin, the frequency of precipitation events in which two or more inches fall in a 24-hour period is expected to increase from about

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[18] *Kucharik and others, 2010,* op. cit.

[19] *Wisconsin Initiative on Climate Change Impacts, 2011,* op. cit.

[20] *Michael Notaro, David J. Lorenz, Daniel Vimont, Stephen Vavrus, Christopher Kucharik, and Kristie Franz, "21st Century Wisconsin Snow Projections Based on Operational Snow Model Driven by Statistically Downscaled Climate Data,"* International Journal of Climatology, *Volume 31, pages 1615-1633, 2011.*

12 events per decade to 15 events per decade by the middle of the 21st century. These changes will be concentrated in the spring and fall. The projections also indicate that the magnitude of the heaviest precipitation events will also increase. The shift to more heavy rainfall events but little change in total summertime precipitation implies that more dry days will occur in Wisconsin during the summer. More dry days, coupled with higher summer temperatures and the increases in evapotranspiration that may result from higher temperatures, may lead to an increase in the likelihood of summer droughts.

Effects of Climate Change on Water Resources

Climate directly affects water resources and such resources can serve as indicators of climate change at various temporal and spatial scales. The Wisconsin Initiative on Climate Change Impacts (WICCI) has concluded that projected future climate conditions may influence the quantity and quality of the State of Wisconsin's water resources. WICCI also found clear evidence from analysis of past trends and probable future climate projections that there will be different hydrologic responses to climate change in different geographic regions of the State (see Figure 3.4). The differences reflect local variations in land use, soil type and surface deposits, groundwater characteristics, and runoff and seepage responses to precipitation which illustrates the importance of considering the potential climate change effects on local hydrologic conditions and as part of a watershed restoration plan strategy.

Climate change appears to be altering the availability of water (volume), the distribution of rainfall over time, and whether precipitation falls as rain or snow, each of which affects the water cycle. As shown in Figure 3.5, most of the water entering the landscape arrives as precipitation (rain and snowfall) that falls directly on waterbodies; or runs off the land surface and enters streams, rivers, wetlands, and lakes; or percolates through the soil, recharging groundwater that flows underground and re-emerges as springs discharging into lakes, wetlands, and streams. Even in the absence of climate change, when one part of the system is affected, all other parts are impacted. For example, an overdrawn groundwater aquifer used to irrigate crops or to provide potable water supply can lead to a reduction or complete loss in discharge of a local stream. More importantly, climate change exposes the vulnerabilities of water availability within a given area, and this vulnerability is proportional to how much humans have altered how water moves through the water cycle (e.g., through reducing groundwater recharge potential during land development and/or withdrawals from aquifers). This vulnerability becomes particularly evident during periods of prolonged drought conditions.

As discussed above, downscaled climate models predict that there will be an increase in annual precipitation in southeastern Wisconsin, as well as an increase in precipitation falling as rain rather than snow due to higher temperatures. In addition, the frequency and magnitude of rainfall events is projected to increase. The combination of the above projections will likely lead to higher peak stream flows which can often lead to increased streambank erosion and sediment transport, as well as increases in nutrients and other pollutants entering the streams. While intense rainfall events are expected increase, there is projected to be little change in total summertime precipitation, implying that there will be longer stretches of dry weather. These periods of dry weather could lead to decreased summertime baseflows, and when combined with warmer air temperatures, may produce increased water temperatures which can have a harmful impact on fish and other aquatic life. Streambank erosion and water temperatures within the Oak Creek watershed will be discussed in further detail in Chapter 4 of this Report.

The WICCI Water Resources Working Group (WRWG) incorporated WICCI's 1980-2055 projections for temperature, precipitation (including occurrence of events), and changes in snowfall to guide their evaluation of potential impacts to hydrologic processes and resources.[21] This team of experts prioritized the highest potential climate change impacts on water resources and proposed adaptation strategies to address impacts across the State of Wisconsin as summarized below:

- Minimize threats to public health and safety by anticipating and managing for extreme events through effective planning;

- Increase resiliency of aquatic ecosystems to buffer the impacts of future climate changes by restoring or simulating natural processes, ensuring adequate habitat availability, and limiting human impacts on resources. Examples include limiting groundwater and surface water withdrawals, restoring or reconnecting floodplains and wetlands, and maintaining or providing migration corridors for fish and other aquatic organisms;

- Stabilize future variations in water quantity and availability by managing water as an integrated resource, keeping water "local," and supporting sustainable and efficient water use for humans and the environment; and

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[21] *The Water Resources Working Group (WRWG) included 25 members representing the Federal government, State government, the University of Wisconsin System, the Great Lakes Indian Fish and Wildlife Commission, and the Wisconsin Wetlands Association. For more details on climate change, impacts, adaptation, and resources visit www.wicci.wisc.edu/water-resources-working-group.php .*

- Maintain, improve, or restore water quality under a changing climate regime by promoting actions to reduce nutrient and sediment loading.

Changing climatic conditions are drivers of water quality conditions within the Oak Creek system and these adaptation strategies are important considerations for the protection of surface water and groundwater quality and quantity as future development occurs within this watershed.

3.7 TOPOGRAPHY AND GEOLOGY

Topography is an important consideration in watershed planning since it is one of the most important factors determining the hydrologic response of a watershed to rainfall and snowmelt events. Topographic considerations enter into the selection of sites and routes for public utilities such as sewerage and water supply systems, flood control facilities, and roads. Topographical features, particularly slopes, have a direct bearing on the potential for soil erosion and the accumulation of sediment on the beds of surface waters.

Glaciation has largely determined the topography and physical geography of the Southeastern Wisconsin Region. Glacial deposits overlying the bedrock formations form the surface topography of the watershed, consisting primarily of gently sloping ground moraine. The generalized topographic elevations within the Oak Creek watershed are shown on Map 3.13. Generalized surface elevations range from 575 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD 29) near the confluence of Oak Creek with Lake Michigan to about 775 feet above NGVD 29 in the Upper North Branch Oak Creek assessment area, a variation of about 200 feet.

Bedrock and surface deposits directly and indirectly affect the quantity and quality of surface waters in the Oak Creek watershed. Discharge from groundwater is the source of baseflows in streams of the watershed. Especially at low flows, stream water chemistry reflects the influence of the composition of the bedrock and surface deposits. The surface deposits in the watershed consist of unconsolidated sediments that were deposited by glaciers during the Pleistocene glaciations that ended about 11,000 years ago. These are mostly unsorted tills consisting of sand, silt, clay, gravel, and boulders.

The Oak Creek watershed is underlain by Niagara dolomite, a sedimentary rock similar to limestone. This dolomite bedrock layer slopes downward in an easterly direction. Map 3.14 shows that the bedrock is located between 50 to 300 feet below the unconsolidated surficial deposits within the watershed.

3.8 SOILS

The glaciers deposited a wide variety of soil-forming materials and sculpted many different landforms that influence soil type and stream hydrology in the Southeastern Wisconsin Region. Soil type and characteristics, along with land slope, surrounding land use, and vegetative cover are important factors in determining erosion potential and runoff in a watershed.

Soil data for the Oak Creek watershed was obtained from the NRCS SSURGO soils database. The soils within the Oak Creek watershed can be classified into three soil associations that are described below:

- Ozaukee-Morley-Mequon association is comprised of well-drained to somewhat poorly drained soils that have a subsoil of silty clay loam and silty clay. This association is formed in glacial till consisting of thin loess and silty clay loam and is found on glacial moraines.

- Montgomery-Martinton-Hebron-Saylesville association is comprised of poorly drained to well-drained soils that have a subsoil of clay to clay loam. This association consists of nearly level, wet soils that lie on flats and in depressions and are intermingled with better drained soils in slightly higher areas.

- Houghton-Palms-Adrian association is comprised of very poorly drained organic soils in marshy depressions over old lakebeds or on floodplains. These soils have mostly formed from dead and decaying remains of plants.

The dominant soil type within the watershed is the Ozaukee-Morley-Mequon group, composing nearly 90 percent of the soils. The remaining soils include the Mongomery-Martinton-Hebron association and Houghton-Palms-Adrian association, each comprising about 5 percent of the watershed and occurring only within the Middle Oak Creek and Middle Oak Creek—Drainage Ditches assessment areas.

Hydrologic Soil Group

Soils are classified into hydrologic soil groups based on soil infiltration and transmission rate (permeability). Hydrologic soil groups along with land use, management practices, and hydrologic condition determine a soil's runoff curve number as established by NRCS. Runoff curve numbers are used to estimate direct runoff from rainfall. There are four hydrologic soil groups: A, B, C, and D. Descriptions of runoff potential, infiltration rate, and transmission rate of each group are shown in Table 3.13. Some soils fall into a dual hydrologic soil group (A/D, B/D, and C/D) based on their hydraulic conductivity and the water table depth. The first letter applies to the drained condition (lower water table) and the second letter applies to the undrained condition. Table 3.14 summarizes the percent of each hydrologic soil group present in each of the watershed assessment areas, and Map 3.15 shows the distribution of the groups. The dominant hydrologic soil groups in the Oak Creek watershed are Group C (48 percent of the watershed) and Group C/D (37 percent of the watershed). This composition suggests that the majority of the soils in the watershed have a moderately high to high runoff potential and are considered to be poorly to very poorly drained.

Hydric Soils

Soils that are saturated with water or that have a water table at or near the surface are known as hydric soils, and they pose significant limitations for most types of development. High water tables often cause wet basements and poorly functioning absorption fields for private onsite waste treatment systems. The excess wetness may also restrict the growth of landscaping plants and trees. Wet soils also restrict or prevent the use of land for crops, unless the land is artificially drained. Map 3.16 shows the locations of hydric soils within the Oak Creek watershed, as identified by NRCS. The land areas covered by hydric soils total 2,221 acres, or 12.3 percent of the watershed. Although such areas are generally unsuitable for development, they may serve as important locations for restoration of wetlands, wildlife habitat, and stormwater retention.

Soil Erodibility

The susceptibility of a soil to wind and water erosion depends on soil type and slope. Coarse-textured soils, such as sand, are more susceptible to erosion than fine textured soils, such as clay. Land slope steepness affects the velocity, and accordingly, the erosive potential of rain and snowmelt runoff. As slopes increase, the rate of soil erosion increases. Soils with slopes that are above 2 percent are prone to erosion without proper management. Land areas that are greater than 6 percent slope are of most concern for soil erosion. Highly erodible lands are those areas in the watershed that have slopes between 6 and 12 percent; areas with greater than 12 percent slope are considered to have very highly erodible soils.[22] Soils in areas of greater than 6 percent slope are difficult to manage, not only for agriculture, but also for urban development.

Map 3.17 shows soil slopes and erodible lands in the Oak Creek watershed. The slopes of the soils are classified into four major groups: slight slopes (less than 2 percent), moderate slopes (2 to 5 percent), steep

[22] *Outagamie County Land Conservation Department*, Nonpoint Source Implementation Plan for the Plum and Kankapot Creek Watersheds, *2014*.

slopes (6 to 12 percent), and very steep slopes (greater than 12 percent). Approximately 15.6 percent of the watershed is characterized as having slight slopes, 74.2 percent as having moderate slopes, 9.5 percent as having steep slopes, and 0.7 percent as having very steep slopes. The steepest slopes in the watershed are found within the Lower Oak Creek—Mill Pond and Grant Park Ravine assessment areas where slopes are as steep as 38 percent.

3.9 NATURAL RESOURCE ELEMENTS

Many important interlocking and interacting relationships occur between living organisms and their environment. The destruction or deterioration of any one element may lead to a chain reaction of deterioration and destruction among the others. The drainage of wetlands, for example, may have far-reaching effects. Such drainage may destroy fish spawning grounds, wildlife habitat, groundwater recharge areas, and natural filtration and floodwater storage areas. The resulting deterioration of surface water quality may, in turn, lead to a deterioration of the quality of the groundwater. In certain areas of southeastern Wisconsin groundwater serves as a source of domestic, municipal, and industrial water supply as well as providing base flows in rivers and streams. The destruction of woodland and other upland cover types, which may have taken hundreds or thousands of years to mature may result in soil erosion and stream siltation, more rapid runoff and increased flooding, as well the local extinction of native plants and animals. Although the effects of any one of these environmental changes in isolation may not be overwhelming, the combined effects may lead eventually to the deterioration of the underlying and supporting natural resource base, and of the overall quality of the environment. The need to protect and preserve the natural areas and environmental corridors with their associated complexes of wetland, upland, and critical species habitats within the watershed is, thus, apparent. The following sections describe the important natural resource elements present within the Oak Creek watershed.

Environmental Corridors

Remaining natural resource elements and resource-related features, when mapped on the landscape, concentrate in an essentially linear pattern of relatively narrow, elongated areas that have been termed "environmental corridors" by SEWRPC. SEWRPC has identified two types of these corridors, primary environmental corridors (PEC) and secondary environmental corridors (SEC). In addition, SEWRPC has identified smaller concentrations of natural resource features that, though isolated from the environmental corridors, still constitute natural resource areas of significant value. These are referred to as isolated natural resource areas (INRAs). The protection of the environmental corridors and INRAs from intrusion by incompatible land uses, and, thereby, from degradation and destruction of their functions, should be one of the principal objectives of this watershed restoration plan. The PECs, SECs, and INRAs in the Oak Creek watershed are shown on Map 3.18.

Primary Environmental Corridors

PECs include a wide variety of important resource and resource-related elements. By definition, they are at least 400 acres in size, two miles in length, and 200 feet in width.[23] As shown on Map 3.18, the PECs in the Oak Creek watershed are located along the lower reaches of the mainstem of Oak Creek in the Lower Oak Creek—Mill Pond and Grant Park Ravine assessment areas, and in the Middle Oak Creek and Middle Oak Creek Drainage Ditches assessment areas, encompassing an area of the largest remaining wetlands and woodlands in the watershed. Primary environmental corridors accounted for 744 acres, or about 4.1 percent of the total watershed area in 2015. These lands represent a composite of the best remaining elements of the natural resource base in the watershed, and contain the best remaining connected uplands, wetlands, and wildlife habitat areas (see "Natural Areas and Critical Species Habitat Sites" subsection below) in the watershed.

Secondary Environmental Corridors

SECs are at least 100 acres in size and one mile long. As shown on Map 3.18, the SECs in the Oak Creek watershed are located along most of the mainstem of Oak Creek, the entire North Branch of Oak Creek, a portion of the Mitchell Field Drainage Ditch, and along several unnamed and intermittent tributary streams. These SECs encompassed 1,304 acres, or about 7.2 percent of the total watershed area in 2015. These corridors contain a variety of resource elements, often remnant resources from PECs which have been developed for intensive agricultural or urban purposes. SECs facilitate surface water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species.

Isolated Natural Resource Areas

Smaller concentrations of natural resource features that have been separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These natural resource areas, which are at least five acres in size, are referred to as INRAs and are shown on Map 3.18. Widely scattered throughout the watershed, INRAs covered about 250 acres, or about 1.4 percent of the

[23] *SEWRPC Planning Report No. 42,* A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997.*

total study area in 2015. These areas should be protected and preserved in their natural state whenever possible and linked to primary and secondary environmental corridors when opportunities exist.

Natural Areas and Critical Species Habitat Sites

Natural areas, as defined by the Wisconsin Natural Areas Preservation Council, are tracts of land or waters so little modified by human activity, or sufficiently recovered from the effects of such activity, that they contain intact native plant and animal communities believed to be representative of the pre-European settlement landscape (see presettlement vegetation on Map 3.5). As such, these are generally exceptionally biodiverse and irreplaceable natural resource elements for which protection and stewardship are of critical importance. Natural areas are generally comprised of wetland or upland vegetation communities and/or complex combinations of both of these fundamental ecosystem units. In fact, some of the highest quality natural areas within the Southeastern Wisconsin Region are wetland complexes that have maintained adequate or undisturbed linkages (i.e., landscape connectivity) between the upland-wetland habitats, which is consistent with research findings in other areas of the Midwest.[24]

Natural areas have been identified for the seven-county Southeastern Wisconsin Region in SEWRPC Planning Report No. 42, "A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin," published in September 1997, and amended in 2008 and 2010. This plan was developed to assist Federal, State, and local units and agencies of government and nongovernmental organizations in making environmentally sound land use decisions, including acquisitions of priority properties, management of public lands, and location of development in appropriate locations that will protect and preserve the natural resource base of the Region.

The identified natural areas were classified into three categories:

1. Natural area of statewide or greater significance (NA-1)

2. Natural area of countywide or regional significance (NA-2)

3. Natural area of local significance (NA-3)

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[24] *O. Attum, Y.M. Lee, J.H. Roe, and B.A. Kingsbury, "Wetland complexes and upland-wetland linkages: landscape effects on the distribution of rare and common wetland reptiles,"* Journal of Zoology, *Vol. 275, 2008, pages 245-251.*

Classification of an area into one of these three categories was based upon consideration of several factors, including the diversity and rarity of plants, animals, and natural community types present; the structural integrity of the native plant or animal community; the extent of disturbance by human activity, such as logging, grazing, water level changes, and pollution; the frequency of occurrence within the Region of the plant and animal communities present; the occurrence of unique natural features within the area; the size of the area; and the educational value.

The Oak Creek watershed has 12 identified natural areas totaling nearly 390 acres (see Map 3.19). Three of the natural areas are categorized as being of countywide or regional significance (NA-2) and eight of the natural areas are categorized as local significance (NA-3). The 12 natural areas are listed in Table 3.15 and further profiled in Appendix B.

Critical species are defined as those species that are considered to be endangered, threatened, or of special concern by the State or Federal government. There are 42 critical species known to occur within the Oak Creek watershed. These critical species are listed in Table 3.16. Critical species habitats sites are tracts of land which include abiotic and biotic factors necessary for the long-term support of the critical species population. The regional natural areas plan amendment identified 128 acres of critical species habitats sites within the Oak Creek watershed. SEWRPC staff are continually evaluating habitat areas and incorporating reputable occurrences of critical species made by others in the Region. Since the publication of the plan amendment in 2010, these surveys conducted by SEWRPC staff, Milwaukee County Parks staff, and others have led to the identification of an additional 1,044 acres of critical species habitat within the Oak Creek watershed for a total of 1,172 acres. The critical species habitat sites identified in the 2010 plan amendment as well as the additional areas identified as of February 2017 are shown on Map 3.19.

Wetlands

Wetlands form at the transition between surface water, groundwater, and land resources. Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency, and with a duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally occur in depressions and near the bottom of slopes, particularly along lakeshores and streambanks, and on large land areas that are poorly drained. Wetlands may, however, under certain conditions, occur on slopes and even on hilltops. They provide essential breeding, nesting, sanctuary, and feeding grounds for birds; offer escape cover for many forms of fish and wildlife; and provide the environmental conditions required by hundreds of plant species. In addition, wetlands perform an important set of natural functions which include: water quality protection; stabilization of lake levels and streamflows;

reduction in stormwater runoff by providing areas for floodwater impoundment and storage; and protection of shorelines from erosion.

The location, extent, and types of wetlands within the Oak Creek watershed are shown on Map 3.20. These wetland areas are defined based on the Wisconsin Wetland Inventory originally completed for the southeastern Wisconsin region in 1982, and then updated to the year 2015 as part of the regional land use inventory. The land area covered by wetlands within the watershed and each assessment area is presented in Tables 3.4 through 3.7. In total, wetlands within the watershed encompassed about 1,324 acres, or 7.3 percent of the area of the watershed, in 2015. Wetlands comprise between 1.5 and 10 percent of the land in most of the assessment areas of the watershed; however the Middle Oak Creek-Drainage Ditches assessment area has 31 percent of its land classified as wetland.

The wetlands in the Oak Creek watershed can be further characterized by the Wisconsin Wetland Inventory vegetated class categories which describes the uppermost layer of vegetation that covers 30 percent or more of a particular wetland. Below are descriptions of the main wetland types and acreages of each category found within the watershed:

- Forested wetlands (670 acres) are mostly made up of woody plants that are taller than 20 feet. Dominant vegetation in these areas includes ash trees (dying or dead), elm, silver maple, boxelder, eastern cottonwood, and quaking aspen.

- Emergent/wet meadows (454 acres) are mostly made up of herbaceous plants which stand above the surface of the water or soil. Dominant vegetation in these areas include cattail, most sedges and grasses, stinging nettle, bulrush, arrowhead, and pickerel weed.

- Scrub/shrub wetlands (168 acres) are mostly made up of woody plants that are less than 20 feet tall. Dominant vegetation in these areas include willows, dogwoods, buckthorn, and young hardwood trees.

- Flats/unvegetated wet soil (25 acres) are exposed wet soils which do not support vegetation. This class of wetland is typically found within agricultural fields.

- Open water wetlands (6 acres) are lakes and ponds with a depth of six feet or less as well as unvegetated river sloughs.

- Filled or drained wetlands (1 acre)

Wetlands are constantly changing in response to changes in drainage patterns and climatic conditions. While wetland inventory mapping provides a sound basis for area-wide planning, it should be viewed as a starting point to be supplemented with detailed field investigations for regulatory purposes. The highest quality wetlands within the watershed fall within the natural areas identified in SEWRPC's natural areas and critical species habitat protection and management plan[25] and are further described and characterized with photos in Appendix B of this Report.

The Oak Creek watershed also contains ephemeral wetlands/ponds. These are depressional wetlands that are hydrologically isolated from other waterbodies and temporarily hold water in the spring and early summer, or after heavy rains. Periodically these wetlands dry up, often in mid- to late-summer. Ephemeral wetlands are free of fish, which makes them important breeding habitat for certain amphibian and invertebrate species. These habitats are typically smaller than two acres, with some being as small as six to 12 feet across. It should be noted that ephemeral wetlands can be difficult to define, identify, and protect because they tend to be small, isolated, and dry during certain times of the year. Milwaukee County Parks staff have identified 71 ephemeral ponds within the Oak Creek watershed (see Map 3.19).

Wetlands located within the PECs have been designated as Advanced Delineation and Identification (ADID) wetlands under Section 404(b)(1) of the Federal Clean Water Act and are deemed generally unsuitable for the discharge of dredge and fill material. There are about 598 acres of ADID wetlands within the Oak Creek watershed (see Map 3.20). These wetlands have additional protections from being filled and from being encroached upon by future development. The nonagricultural performance standards set forth in Section NR 151.125 of the *Wisconsin Administrative Code*, require establishment of a 75-foot protective area from impervious surfaces adjacent to these higher-quality wetlands. This designated protective area boundary is measured horizontally from the delineated wetland boundary to the closest impervious surface.[26]

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[25] *SEWRPC Planning Report No. 42*, A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin, *September 1997, amended December 2010.*

[26] *Runoff from impervious surfaces located within the protective area must be adequately treated with stormwater best management practices.*

Woodlands

With sound management, woodlands serve a variety of beneficial functions. In addition to contributing to clean air and water and regulating surface water runoff, woodlands support diverse communities of plants and animals and provide recreational opportunities and aesthetic values that enhance quality of life. The destruction of woodlands, particularly on hillsides, can contribute to excessive stormwater runoff, siltation of lakes and streams, and loss of wildlife habitat. Woodlands identified under the 2015 SEWRPC land use inventory are shown on Map 3.20. The lands that are covered by woodlands within the Oak Creek watershed and each assessment area is set forth in Tables 3.4 through 3.7. In 2015, woodlands encompassed 848 acres, or about 4.7 percent of the area of the watershed.[27] The highest quality woodlands within the watershed fall within the natural areas identified in SEWRPC's natural areas and critical species habitat protection and management plan[28] and are further described and characterized with photos in Appendix B of this Report.

3.10 WATER RESOURCES

The surface water resources within the Oak Creek watershed include streams, ponds, wetlands, and flooded gravel pits, and form one of the most important elements of the natural resource base of the watershed. Their contribution to the economic development, recreational activity, and aesthetic quality of the watershed are immeasurable. The groundwater resources of the Oak Creek watershed are hydraulically connected to the surface water resources and provide the baseflow of the streams. Lake Michigan is the main source of water supply for domestic, municipal, and industrial users in the watershed. The protection, enhancement, and proper development of these invaluable water resources constitute the basis for this watershed restoration plan.

Historical Stream Channel and Wetlands

Water resources are not static and can change greatly over time. One of the most variable features of the watershed is its stream system, which can have widely fluctuating discharges, stages, and geometry. When available, information from original land surveys can be an important tool to provide a best estimation of the shapes, sizes, and lengths of surface water features prior to European settlement. It should be noted, however, that these surveys, and maps drawn based on them, represent an approximation of what was present on the landscape at the time, and not an exact representation as would be possible with today's surveying and map-making technology.

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[27] *These data include upland woods only, not lowland woods, such as tamarack swamps, which are classified as wetlands.*

[28] *SEWRPC Planning Report No. 42*, op. cit.

Land surveyors conducted the first official Federal government survey of the area containing the Oak Creek watershed in 1837. The survey was done to divide the vast public domain into salable-sized lots that could be sold by the government to encourage settlement. The basic units of the public land survey are six-mile square townships that are further subdivided into one-mile square sections. These units were established by surveyors walking the grid and marking points that indicated each corner of the square sections, known as section corners, and the mid-point along each side of the sections, known as quarter-section corners. These markers established townships, sections, and quarter sections that are still used in surveys of the Region today.

To document their work, the surveyors kept books of field notes which became the official record of the surveys. These field notes include descriptions of features of the land including notes on the major timber and vegetation types present, and identification of locations where a surveyor entered or left a field or wetland, and where a surveyor encountered a stream or lake. Where the surveyors encountered a body of water of significant size along a section line, they set a meander post at the shoreline. Once these meander posts were set on all the section lines that intersected the lake or river, the shoreline was surveyed by connecting the bended corners by tangential lines. When surveys were completed for a township, a map laying out the locations and shapes of larger streams, lakes, and wetlands was drawn using the surveyed posts and field notes.

The map drawn from the 1837 survey can be compared to maps from subsequent surveys to show relative changes in the watershed. Additional surveys were conducted for U.S. Geological Survey quadrangle maps published in 1891, 1901, and 1958. Examination of historical 1937 aerial photos[29] can also be used to compare changes within the watershed to streams, rivers, and wetlands as the watershed became more influenced by human impacts on the land. The original 1837 survey plat map, and the 1891 and 1958 USGS quadrangle maps are shown in Figure 3.6.[30] The historical stream lines have been darkened and the current Oak Creek watershed boundary has been superimposed for reference.

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[29] *Historical aerial photos were obtained online from the Wisconsin State Cartographer's Office, Historic Aerial Imagery Finder website at maps.sco.wisc.edu/WHAIFinder/.*

[30] *The presence and locations of surface water features shown on the 1901 USGS quadrangle map did not differ appreciably from those shown on the1891 map. The locations of the surface water features visible on the 1937 historical aerial photographs were similar to those shown on the 1958 USGS quadrangle maps.*

The most apparent difference between the 1837 and 1891 survey maps and more recent maps is the lack of discernable channels on the older maps in the locations of the Mitchell Field Drainage Ditch and the North Branch Oak Creek. The earlier survey maps show an elongated wetland complex that runs the length of where the present day Mitchell Field Drainage Ditch flows. The 1891 map shows this wetland complex extending west to a location near the headwaters of the present day North Branch Oak Creek. Interestingly, the 1891 survey also shows large wetland complexes extending outside of the current watershed boundary, both to the north into the Kinnickinnic River watershed, and to the south into the Root River watershed. The topography in the latter area near the Root River watershed is very flat, indicating that the Oak Creek/Root River watershed boundary is fluid and could shift based on installation of agricultural drain tiles, maintenance of drainage channels, or even changes in amounts of precipitation.

Perhaps the most interesting difference between the 1837 survey map and the twentieth century maps is the presence of a stream channel in the area of what is now the headwaters of the mainstem of Oak Creek flowing east and then south before flowing into the Root River. If this connection to the Root River was accurate, it no longer existed by the time that the 1891 USGS quadrangle map was drawn (see Figure 3.6). It is unclear whether this difference reflects more accurate mapping in 1891 or was the result of hydrologic changes brought on by anthropogenic alterations on the landscape.

Examination of historical aerial photos indicate that by 1937 the watershed had been greatly altered by settlement and conversion of the land to agricultural uses. Much of the land that was reported in the 1837, 1891, and 1901 surveys as wetland was drained to the newly constructed channels that are today known as the Mitchell Field Drainage Ditch and the North Branch of Oak Creek. These alterations to the landscape are confirmed by the 1958 U.S. Geological Survey quadrangle map. As shown in Figure 3.6, by 1958, the mainstem of Oak Creek and its major tributaries, the Mitchell Field Drainage Ditch and the North Branch of Oak Creek appear with mostly the same geometry and location as they do in the present day. It should be noted that there have been additional minor channel alterations, channel straightening, and channel deepening that has occurred since 1958. A more detailed comparison of the historical stream channels to the current stream channels, and further discussion of specific channel alterations are provided in Chapter 4 of this Report.

Geographic information systems (GIS) analysis indicates that the total acreage of wetlands has decreased from 3,805 acres in 1891 to about 1,324 acres in 2015, a decrease of about 65 percent. It should be noted that several wetland complexes in 1891, shown in Figure 3.6, extended beyond the current day watershed boundary as discussed above.

Current Surface Water Features

River and stream systems can have widely fluctuating discharges and stages. The stream system of the Oak Creek watershed receives a relatively uniform flow of water from the shallow groundwater reservoir underlying the watershed. This groundwater discharge constitutes the base flow of the streams. Agricultural drain tiles also contribute to this base flow. The streams also receive surface water runoff from rainfall and snowmelt. This runoff, combined with the baseflow, can sometimes cause the streams to leave their channels and occupy the adjacent floodplains in areas where the streams have not been deeply channelized.

Perennial streams are those streams which maintain at least a small continuous flow throughout the year. Within the watershed there are 21.3 miles of such perennial streams. The watershed contains an additional 41 miles of intermittent streams, or those streams that only flow during certain times of the year when smaller upstream waters are flowing and when groundwater and precipitation runoff provide enough water for streamflow. During dry periods, these intermittent streams may not have flowing surface water. Intermittent streams can provide important spawning and feeding habitat for some fish and aquatic life at specific times of the year.

The mainstem of Oak Creek is approximately 14.5 miles in length, extending from its intermittent headwaters in the City of Franklin to its confluence with Lake Michigan in the City of South Milwaukee. There are two major tributary streams that flow into Oak Creek's mainstem: the North Branch of Oak Creek and the Mitchell Field Drainage Ditch. The North Branch of Oak Creek is approximately 6.3 miles in length, flowing from its intermittent headwaters northwest of IH 94 in the City of Milwaukee, to its confluence with the mainstem of Oak Creek just north of Ryan Road in the City of Oak Creek. The Mitchell Field Drainage Ditch is approximately 4.2 miles in length, flowing from the westernmost portion of General Mitchell International Airport to its confluence with the mainstem of Oak Creek in the City of Oak Creek. Some portions of the Mitchell Field Drainage Ditch within the Airport property are considered to be intermittent.

There are approximately 109 acres of open water ponds within the Oak Creek watershed, a majority of which are stormwater detention basins constructed during urban development to capture water during storm events. The Oak Creek Mill Pond is an approximately five-acre constructed impoundment maintained by a dam located at Mill Street in the City of South Milwaukee.

Groundwater

All of the communities within the Oak Creek watershed use Lake Michigan as their source for potable water supply and for commercial and industrial uses; however, groundwater sustains pond levels and wetlands and provides the perennial base flow for streams within the watershed. Thus, groundwater resources constitute an important element of the natural resource base within the watershed. The amount, movement, recharge, and discharge of groundwater is controlled by several factors, including: precipitation, topography, drainage, land use, soil, and the lithology and water-bearing properties of rock units. The continued growth of population and industry within the watershed necessitates the wise development and management of groundwater resources.

Groundwater occurs in three major aquifers that underlie the Oak Creek watershed and lands adjacent to the watershed. From the land's surface downward they are: 1) the sand and gravel deposits in the glacial drift; 2) the shallow dolomite layers in the underlying bedrock; and 3) the deeper sandstone, dolomite, siltstone, and shale strata. Because of their proximity to the land's surface and their hydraulic interconnection, the first two aquifers are commonly referred to collectively as the "shallow aquifer," while the latter is referred to as the "deep aquifer" or the "sandstone aquifer." Within the Oak Creek watershed, the shallow and deep aquifers are separated by the Maquoketa shale, which forms a relatively impermeable barrier between the two aquifers (see Figure 3.7).

Groundwater quality conditions can be impacted by sources of pollution such as infiltration of stormwater runoff, landfill leachate, agricultural fertilizer and pesticide runoff, manure storage and application sites, chemical spills, leaking surface or underground storage tanks, and onsite sewage disposal systems. Compared to the deep aquifer, the shallow aquifers are more susceptible to pollution from the surface because they are nearer to the source, thus minimizing the potential for dilution, filtration, and other natural processes that tend to reduce the potential detrimental effects of pollutants. The potential for groundwater pollution in the shallow aquifer is dependent on the depth to groundwater, the depth and type of soils through which the polluted water must percolate, the location of groundwater recharge areas, and the subsurface geology. Map 3.21 shows the depth to shallow groundwater within the Oak Creek watershed.

Recharge to groundwater is derived almost entirely from precipitation. The amount of precipitation (and snowmelt) that infiltrates at any location depends mainly on the permeability of the overlying soils, bedrock or other surface materials, including human-made surfaces. As development occurs, stormwater management practices can be instituted that encourage infiltration of runoff. However, it is important to note that such practices were generally not required to be installed prior to 1990 in the Oak Creek watershed. Ideally, practices that promote infiltration need to be located on soils with permeable subsoils and adequate groundwater separation to allow infiltration, but minimize the potential for groundwater contamination. Most of the precipitation that does infiltrate (either naturally or through a stormwater management practice) will generally only migrate within the shallow aquifer system and discharge in a nearby wetland or stream system. This process helps support base flows, wetland vegetation, and wildlife habitat in these water resources. As is the case for surface waters (lakes and streams), the quality of groundwater resources is clearly linked to the health of the biological communities (including humans) inhabiting those waters and their surrounding watersheds.[31]

Understanding recharge and its distribution is key to making informed land use decisions so that the groundwater needs of society and the environment can continue to be met. Fortunately, a groundwater recharge potential map derived from a soil-water balance recharge model was developed under the SEWRPC water supply planning program for the Southeastern Wisconsin Region. Groundwater recharge potential in the Oak Creek watershed is shown on Map 3.22. This map can be used for identifying and protecting recharge areas that contribute the most to the baseflow of the ponds, streams, springs, and wetlands in the Oak Creek watershed.[32]

Groundwater recharge potential was divided into four main categories defined as low, moderate, high, and very high. Any areas that were not defined in the modeling were placed into a fifth category as undefined. These undefined areas make up about 5.4 percent of the Oak Creek watershed and are most often associated with groundwater discharge, which is why they tend to be located adjacent to streams and within wetland areas, as shown on Map 3.22. Much of the Oak Creek watershed can be considered to have either low (32.3 percent) or moderate (46.1 percent) groundwater recharge potential. Groundwater recharge potential is considered to be high in about 14.1 percent of the watershed and very high in about 2.1 percent of the watershed. Preserving recharge areas, particularly those located on agricultural and other open lands that have not yet been developed, is an important goal for protecting water resources in the Oak Creek watershed.

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[31] *David Hambright, "Golden Algae & the Health of Oklahoma Lakes,"* LAKELINE*, Volume 32(3), Fall 2012.*

[32] *SEWRPC Technical Report No. 47*, Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model, *July 2008.*

Community Assistance Planning Report No. 330

A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

Chapter 3

CHARACTERIZATION OF THE WATERSHED

TABLES

Table 3.1
Assessment Areas in the Oak Creek Watershed

Assessment Area[a]	Acres
Mainstem	
Grant Park Ravine	286
Lower Oak Creek – Mill Pond	932
Lower Oak Creek	2,046
Middle Oak Creek Drainage Ditches	1,372
Middle Oak Creek	3,256
Upper Oak Creek	1,827
Oak Creek Headwaters	706
Mitchell Field Drainage Ditch	
Lower Mitchell Field Drainage Ditch	1,443
Mitchell Field Drainage Ditch – Airport	1,010
North Branch Oak Creek	
Lower North Branch Oak Creek	978
Upper North Branch Oak Creek	1,257
Southland Creek	696
Drexel Avenue Tributary	814
Rawson Avenue Tributary	968
College Avenue Tributary	453
Total	18,044

[a] *Assessment areas are shown on Map 3.2.*

Source: SEWRPC

Table 3.2
Land Use Regulations Within the Oak Creek Watershed: 2018

Community	General Zoning	Floodplain Zoning	Shoreland or Shoreland Wetland Zoning	Subdivision Control	Erosion Control and Stormwater Management
Milwaukee County[a]	None	None	None	None	None
City of Cudahy	Adopted	Adopted	Adopted	Adopted	Adopted
City of Franklin[b]	Adopted	Adopted	Adopted	Adopted	Adopted
City of Greenfield	Adopted	Adopted	Adopted	Adopted	Adopted
City of Milwaukee	Adopted	Adopted	Adopted	Adopted	Adopted
City of Oak Creek	Adopted	Adopted	Adopted	Adopted	Adopted
City of South Milwaukee	Adopted	Adopted	Adopted	Adopted	Adopted

[a] *All communities in Milwaukee County are incorporated and contain land use regulations specified in this table.*

[b] *The City of Franklin Unified Development Ordinance contains all land use regulations specified in this table.*

Source: SEWRPC

#243441 – CAPR-330 Table 3.3 Projected Changes in Land Use in the Oak Creek Watershed: 2015 to 2050
300-4010
MGH/LKH/AWO/mid
6/25/2018, 10/25/2018, 10/29/2018, 10/30/2018

Table 3.3
Projected Changes in Land Use Within the Oak Creek Watershed: 2015 to 2050

Land Use Categories	Percent of Watershed 2015	Percent of Watershed 2050	Percent Change[a] 2015 to 2050
Urban			
Residential			
Single-Family, Rural Density[b]	0.4	0.3	-0.1
Single-Family, Suburban Density[c]	0.0	0.0	--
Single-Family, Low Density[d]	9.4	11.8	+2.4
Single-Family, Medium Density[e]	11.5	12.3	+0.8
Single-Family, High Density[f]	2.0	2.1	+0.1
Multi-Family	4.0	4.7	+0.7
Commercial	4.6	8.8	+4.2
Industrial	4.7	7.8	+3.1
Governmental and Institutional	4.0	4.6	+0.6
Transportation, Communication, and Utilities	20.4	22.6	+2.2
Recreational	3.9	4.0	+0.1
Subtotal	64.9	79.0	+14.1
Nonurban			
Agricultural	9.2	3.6	-5.6
Other Open Lands	13.1	4.6	-8.5
Wetlands	7.3	7.3	--
Woodlands	4.7	4.7	--
Water	0.5	0.5	--
Extractive	0.3	0.3	--
Landfill	0.0	0.0	--
Subtotal	35.1	21.0	-14.1

Note: Off-street parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Percent change is relative to the total watershed area*

[b] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[c] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[d] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[e] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[f] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#242121 v2 – CAPR-330 Table 3.4 Land Use in the Oak Creek Watershed: 2015
300-4010
MGH/LHK/AWO
6/22/2018. 10/25/2018 10/26/18, 10/30/2018

Table 3.4
Land Use in Assessment Areas Within the Oak Creek Mainstem Subbasins: 2015

Land Use Categories	Grant Park Ravine		Lower Oak Creek Mill Pond		Lower Oak Creek		Middle Oak Creek		Middle Oak Creek Drainage Ditches		Upper Oak Creek		Oak Creek Headwaters		Mainstem Subbasins
	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Total Acres
Urban															
Residential															
Single-Family, Rural Density[a]	0	0.0	0	0.0	1	0.0	25	0.8	12	0.9	11	0.6	4	0.6	53
Single-Family, Suburban Density[b]	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Single-Family, Low Density[c]	13	4.5	0	0.0	54	2.6	426	13.1	177	12.9	169	9.3	318	45.2	1,157
Single-Family, Medium Density[d]	26	9.1	123	13.2	647	31.6	426	13.1	57	4.2	108	5.9	126	17.8	1,513
Single-Family, High Density[e]	21	7.3	76	8.2	224	10.9	0	0.0	0	0.0	0	0.0	0	0.0	321
Multifamily	4	1.4	129	13.8	94	4.6	137	4.2	0	0.0	85	4.7	0	0.0	449
Commercial	1	0.3	70	7.5	20	1.0	164	5.0	3	0.2	202	11.1	0	0.0	460
Industrial	11	3.8	112	12.0	12	0.6	36	1.1	18	1.3	94	5.1	0	0.0	283
Governmental and Institutional	1	0.3	75	8.0	129	6.3	148	4.5	8	0.6	60	3.3	5	0.7	426
Transportation, Communication, and Utilities	27	9.4	189	20.5	441	21.6	476	14.6	157	11.4	330	18.1	111	15.7	1,731
Recreational	114	40.2	28	3.0	146	7.1	179	5.5	11	0.8	59	3.2	3	0.4	540
Subtotal	218	76.3	802	86.2	1,768	86.3	2,017	61.9	443	32.3	1,118	61.3	567	80.4	6,933
Nonurban															
Agricultural	0	0.0	0	0.0	39	1.9	433	13.3	247	18.0	208	11.4	25	3.5	952
Other Open Lands	1	0.3	32	3.4	132	6.5	412	12.7	154	11.2	306	16.7	42	5.9	1,079
Wetlands	14	4.9	32	3.4	63	3.1	270	8.3	431	31.4	86	4.7	27	3.8	923
Woodlands	52	18.2	43	4.6	38	1.9	97	3.0	69	5.0	92	5.0	43	6.1	434
Water	1	0.3	6	0.6	6	0.3	27	0.8	12	0.9	17	0.9	2	0.3	71
Extractive	0	0.0	17	1.8	0	0.0	0	0.0	16	1.2	0	0.0	0	0.0	33
Landfill	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Subtotal	68	23.7	130	13.8	278	13.7	1,239	38.1	929	67.7	709	38.7	139	19.6	3,492
Total	286	--	932	--	2,046	--	3,256	--	1,372	--	1,827	--	706	--	10,425

Table continued on next page.

Table 3.4 (Continued)

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#245256 – CAPR-330 Table 3.5 Land Use in the Mitchell Field Drainage Ditch: 2015
300-4010
MGH/LHK/AWO/mid
6/22/2018, 10/25/2018 10/26/2018, 10/30/2018, 01/25/2019

Table 3.5
Land Use in Assessment Areas Within the Mitchell Field Drainage Ditch Subbasin: 2015

Land Use Categories	Lower Mitchell Field Drainage Ditch		Mitchell Field Drainage Ditch – Airport		Subbasin Total Acres
	Acres	Percent of Area	Acres	Percent of Area	
Urban					
Residential					
Single-Family, Rural Density[a]	1	0.1	1	0.1	2
Single-Family, Suburban Density[b]	0	0.0	0	0.0	0
Single-Family, Low Density[c]	72	5.0	9	0.9	81
Single-Family, Medium Density[d]	72	5.0	39	3.9	111
Single-Family, High Density[e]	0	0.0	0	0.0	0
Multifamily	20	1.4	5	0.5	25
Commercial	51	3.5	32	3.2	83
Industrial	85	5.9	70	6.9	155
Governmental and Institutional	34	2.4	112	11.1	146
Transportation, Communication, and Utilities	263	18.2	651	64.4	922
Recreational	101	7.0	3	0.3	104
Subtotal	699	48.5	922	91.3	1,621
Nonurban					
Agricultural	228	15.8	0	0.0	228
Other Open Lands	339	23.5	54	5.3	393
Wetlands	59	4.1	15	1.5	74
Woodlands	97	6.7	19	1.9	116
Water	5	0.3	0	0.0	5
Extractive	16	1.1	0	0.0	16
Landfill	0	0.0	0	0.0	0
Subtotal	744	51.5	88	8.7	832
Total	1,443	--	1,010	--	2,453

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

Table 3.6
Land Use in Assessment Areas Within the Oak Creek North Branch Subbasin: 2015

Land Use Categories	Lower North Branch Oak Creek		Upper North Branch Oak Creek		Southland Creek		Drexel Avenue Tributary		Rawson Avenue Tributary		College Avenue Tributary		Subbasin Total Acres
	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	
Urban													
Residential													
Single-Family, Rural Density[a]	1	0.1	1	0.1	2	0.3	4	0.5	1	0.1	0	0.0	9
Single-Family, Suburban Density[b]	0	0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0
Single-Family, Low Density[c]	73	7.5	56	4.5	198	28.5	78	9.6	51	5.3	1	0.2	457
Single-Family, Medium Density[d]	75	7.7	226	18.0	42	6.0	20	2.5	2	0.2	90	19.9	455
Single-Family, High Density[e]	0	0	0	0	0	0.0	0	0.0	2	0.2	46	10.2	48
Multifamily	102	10.4	54	4.3	31	4.5	5	0.6	36	3.7	22	4.9	250
Commercial	14	1.4	110	8.8	15	2.2	35	4.3	77	8.0	31	6.8	268
Industrial	133	13.6	100	8.0	1	0.1	14	1.7	133	13.7	31	6.8	412
Governmental and Institutional	43	4.4	63	5.0	3	0.4	10	1.2	23	2.4	6	1.3	148
Transportation, Communication, and Utilities	128	13.1	298	23.5	111	15.9	134	16.5	221	22.8	135	29.8	1,027
Recreational	24	2.5	22	1.8	0	0.0	0	0.0	11	1.1	6	1.3	63
Subtotal	593	60.7	930	74.0	403	57.9	300	36.9	557	57.5	368	81.2	3151
Nonurban													
Agricultural	99	10.1	1	0.1	70	10.1	207	25.4	107	11.1	0	0.0	484
Other Open Lands	162	16.5	230	18.2	99	14.2	146	17.9	174	18.0	72	15.9	883
Wetlands	78	8.0	50	4.0	65	9.3	69	8.5	52	5.4	13	2.9	327
Woodlands	37	3.8	41	3.3	57	8.2	88	10.8	75	7.7	0	0.0	298
Water	9	0.9	5	0.4	2	0.3	4	0.5	3	0.3	0	0.0	23
Extractive	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0
Landfill	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0
Subtotal	385	39.3	327	26.0	293	42.1	514	63.1	411	42.5	85	18.8	2,015
Total	978	--	1,257		696	--	814	--	968	--	453	--	5,166

Table continued on next page.

Table 3.6 (Continued)

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#245258 – CAPR-330 Table 3.7 Land Use in the Oak Creek Watershed: 2015
300-4010
MGH/LHK/AWO/mid
6/22/2018, 10/25/2018, 10/26/2018, 10/30/2018

Table 3.7
Land Use in Assessment Areas Within the Oak Creek Watershed: 2015

Land Use Categories	Oak Creek Mainstem Subbasins Total Acres	Mitchell Field Drainage Ditch Subbasin Total Acres	Oak Creek North Branch Subbasin Total Acres	Watershed Total	
				Total Acres	Percent of Total Area
Urban					
Residential					
Single-Family, Rural Density[a]	53	2	9	64	0.4
Single-Family, Suburban Density[b]	0	0	0	0	0.0
Single-Family, Low Density[c]	1,157	81	457	1,695	9.4
Single-Family, Medium Density[d]	1,513	111	455	2,079	11.5
Single-Family, High Density[e]	321	0	48	369	2.0
Multifamily	449	25	250	724	4.0
Commercial	460	83	268	825	4.6
Industrial	283	155	412	850	4.7
Governmental and Institutional	426	146	148	720	4.0
Transportation, Communication, and Utilities	1,731	922	1,027	3,672	20.4
Recreational	540	104	63	707	3.9
Subtotal	6,933	1,621	3151	11,705	64.9
Nonurban					
Agricultural	952	228	484	1,664	9.2
Other Open Lands	1,079	393	883	2,355	13.1
Wetlands	923	74	327	1,324	7.3
Woodlands	434	116	298	848	4.7
Water	71	5	23	99	0.5
Extractive	33	16	0	49	0.3
Landfill	0	0	0	0	0.0
Subtotal	3,492	832	2,015	6,339	35.1
Total	10,425	2,453	5,166	18,044	--

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#243421 – CAPR-330 Table 3.8 Planned Land Use in the Oak Creek Mainstem Subbasins: 2050
300-4010
MGH/LKH/AWO
6/25/2018, 10/26/2018, 10/25/2018, 10/30/2018

Table 3.8
Planned Land Use in Assessment Areas Within the Oak Creek Mainstem Subbasins: 2050

Land Use Categories	Grant Park Ravine		Lower Oak Creek Mill Pond		Lower Oak Creek		Middle Oak Creek		Middle Oak Creek Drainage Ditches		Upper Oak Creek		Oak Creek Headwaters		Mainstem Subbasins
	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Total Acres
Urban															
Residential															
Single-Family, Rural Density[a]	0	0.0	0	0.0	1	0.0	22	0.7	9	0.7	3	0.2	4	0.6	39
Single-Family, Suburban Density[b]	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Single-Family, Low Density[c]	13	4.5	0	0.0	78	3.8	559	17.2	267	19.5	187	10.2	354	50.2	1,458
Single-Family, Medium Density[d]	26	9.1	123	13.2	670	32.8	471	14.5	61	4.4	112	6.1	126	17.8	1,589
Single-Family, High Density[e]	21	7.3	78	8.4	228	11.1	0	0.0	0	0.0	0	0.0	0	0.0	327
Multifamily	4	1.4	135	14.5	103	5.0	171	5.3	0	0.0	85	4.7	0	0.0	498
Commercial	1	0.3	80	8.6	28	1.4	249	7.6	23	1.7	358	19.6	0	0.0	739
Industrial	11	3.8	119	12.8	67	3.3	54	1.7	87	6.3	243	13.3	0	0.0	581
Governmental and Institutional	1	0.3	75	8.0	132	6.5	161	4.9	8	0.6	93	5.1	5	0.7	475
Transportation, Communication, and Utilities	27	9.4	189	20.3	454	22.2	525	16.1	183	13.3	350	19.2	120	17.0	1,848
Recreational	114	40.2	28	3.0	146	7.1	182	5.6	11	0.8	59	3.2	3	0.4	543
Subtotal	218	76.3	827	88.8	1,907	93.2	2,394	73.6	649	47.3	1,490	81.6	612	86.7	8,097
Nonurban															0
Agricultural	0	0.0	0	0.0	7	0.3	268	8.2	132	9.6	59	3.2	0	0.0	466
Other Open Lands	1	0.3	7	0.8	25	1.2	200	6.1	63	4.6	86	4.7	22	3.1	404
Wetlands	14	4.9	32	3.4	63	3.1	270	8.3	431	31.4	86	4.7	27	3.8	923
Woodlands	52	18.2	43	4.6	38	1.9	97	3.0	69	5.0	89	4.9	43	6.1	431
Water	1	0.3	6	0.6	6	0.3	27	0.8	12	0.9	17	0.9	2	0.3	71
Extractive	0	0.0	17	1.8	0	0.0	0	0.0	16	1.2	0	0.0	0	0.0	33
Landfill	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Subtotal	68	23.7	105	11.2	139	6.8	862	26.4	723	52.7	337	18.4	94	13.3	2,328
Total	286	--	932	--	2,046	--	3,256	--	1,372	--	1,827	--	706	--	10,425

Table continued on next page.

Table 3.8 (Continued)

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

Table 3.9
Land Use in Assessment Areas Within the Mitchell Field Drainage Ditch Subbasin: 2050

	Lower Mitchell Field Drainage Ditch		Mitchell Field Drainage Ditch – Airport		
Land Use Categories	Acres	Percent of Area	Acres	Percent of Area	**Subbasin Total Acres**
Urban					
Residential					
Single-Family, Rural Density[a]	0	0.0	1	0.1	1
Single-Family, Suburban Density[b]	0	0.0	0	0.0	0
Single-Family, Low Density[c]	58	4.0	11	1.1	69
Single-Family, Medium Density[d]	96	6.7	45	4.5	141
Single-Family, High Density[e]	0	0.0	0	0.0	0
Multifamily	32	2.2	3	0.3	35
Commercial	254	17.6	39	3.9	293
Industrial	113	7.8	94	9.3	207
Governmental and Institutional	47	3.3	115	11.4	162
Transportation, Communication, and Utilities	443	30.8	660	65.2	1,103
Recreational	106	7.3	3	0.3	109
Subtotal	1,149	79.7	971	96.1	2,120
Nonurban					0
Agricultural	39	2.7	0	0.0	39
Other Open Lands	78	5.4	5	0.5	83
Wetlands	59	4.1	15	1.5	74
Woodlands	97	6.7	19	1.9	116
Water	5	0.3	0	0.0	5
Extractive	16	1.1	0	0.0	16
Landfill	0	0.0	0	0.0	0
Subtotal	294	20.3	39	3.9	333
Total	1,443	--	1,010	--	2,453

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#245261 – CAPR-330 Table 3.10 Land Use in the Oak Creek North Branch Subbasin: 2050
300-4010
MGH/LHK/AWO/mid
6/22/2018, 10/25/2018, 10/26/2018, 10/30/2018

Table 3.10
Land Use in Assessment Areas Within the Oak Creek North Branch Subbasin: 2050

Land Use Categories	Lower North Branch Oak Creek		Upper North Branch Oak Creek		Southland Creek		Drexel Avenue Tributary		Rawson Avenue Tributary		College Avenue Tributary		Subbasin Total Acres
	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	Acres	Percent of Area	
Urban													
Residential													
Single-Family, Rural Density[a]	1	0.1	0	0.0	2	0.3	4	0.5	0	0.0	0	0.0	7
Single-Family, Suburban Density[b]	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Single-Family, Low Density[c]	78	8.0	38	3.0	239	34.4	168	20.5	85	8.8	0	0.0	608
Single-Family, Medium Density[d]	109	11.1	228	18.1	42	6.0	20	2.5	4	0.4	90	19.9	493
Single-Family, High Density[e]	0	0.0	0	0.0	0	0.0	0	0.0	3	0.3	46	10.1	49
Multifamily	116	11.9	56	4.5	47	6.8	16	2.0	54	5.6	22	4.9	311
Commercial	23	2.4	184	14.6	65	9.3	107	13.1	148	15.3	34	7.5	561
Industrial	199	20.2	177	14.1	0	0.0	16	2.0	166	17.1	66	14.6	624
Governmental and Institutional	53	5.4	72	5.7	6	0.9	15	1.8	33	3.4	6	1.3	185
Transportation, Communication, and Utilities	139	14.2	316	25.1	133	19.1	160	19.7	248	25.7	140	30.9	1,136
Recreational	24	2.5	22	1.8	0	0.0	0	0.0	11	1.1	6	1.3	63
Subtotal	742	75.8	1,093	86.9	534	76.8	506	62.1	752	77.7	410	90.5	4037
Nonurban													0
Agricultural	35	3.6	0	0.0	8	1.1	77	9.5	25	2.6	0	0.0	145
Other Open Lands	77	7.9	68	5.4	32	4.6	70	8.6	61	6.3	30	6.6	338
Wetlands	78	8.0	50	4.0	65	9.3	69	8.5	52	5.4	13	2.9	327
Woodlands	37	3.8	41	3.3	55	7.9	88	10.8	75	7.7	0	0.0	296
Water	9	0.9	5	0.4	2	0.3	4	0.5	3	0.3	0	0.0	23
Extractive	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Landfill	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Subtotal	236	24.2	164	13.1	162	23.2	308	37.9	216	22.3	43	9.5	1,129
Total	978	--	1,257	--	696	--	814	--	968	--	453	--	5,166

Table continued on next page.

Table 3.10 (Continued)

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

Table 3.11
Land Use in Assessment Areas Within the Oak Creek Watershed: 2050

Land Use Categories	Oak Creek Mainstem Subbasins Total Acres	Mitchell Field Drainage Ditch Subbasin Total Acres	Oak Creek North Branch Subbasin Total Acres	Watershed Total: Total Acres	Watershed Total: Percent of Total Area
Urban					
Residential					
Single-Family, Rural Density[a]	39	1	7	47	0.3
Single-Family, Suburban Density[b]	0	0	0	0	0.0
Single-Family, Low Density[c]	1,458	69	608	2135	11.8
Single-Family, Medium Density[d]	1,589	141	493	2223	12.3
Single-Family, High Density[e]	327	0	49	376	2.1
Multifamily	498	35	311	844	4.7
Commercial	739	293	561	1593	8.8
Industrial	581	207	624	1412	7.8
Governmental and Institutional	475	162	185	822	4.6
Transportation, Communication, and Utilities	1,848	1,103	1,136	4087	22.6
Recreational	543	109	63	715	4.0
Subtotal	8,097	2,120	4037	14,254	79.0
Nonurban	0	0	0		
Agricultural	466	39	145	650	3.6
Other Open Lands	404	83	338	825	4.6
Wetlands	923	74	327	1,324	7.3
Woodlands	431	116	296	843	4.7
Water	71	5	23	99	0.5
Extractive	33	16	0	49	0.3
Landfill	0	0	0	0	0.0
Subtotal	2,328	333	1,129	3,790	21.0
Total	10,425	2,453	5,166	18,044	--

Note: Offstreet parking area is included with the associated land use. Wetlands associated with specific land uses were grouped in the wetland category except for farmed wetlands which were grouped as agricultural land use.

[a] *Rural density residential reflects less than 0.2 dwelling units per acre.*

[b] *Suburban density residential reflects 0.2 – 0.6 dwelling units per net residential acre.*

[c] *Low density residential reflects 0.7 – 2.2 dwelling units per net residential acre.*

[d] *Medium density residential reflects 2.3 – 6.9 dwelling units per net residential acre.*

[e] *High density residential reflects 7 or more dwelling units per net residential acre.*

Source: SEWRPC

#244292 – CAPR-330 (Oak Creek Watershed) Table 3.12 Estimated Percent of Connected Impervious Surface Within Assessment Areas of the Oak Creek Watershed: 2015 and 2050
300-4010
MGH/ LKH/AWO/mid
8/23/2018 10/25/2018, 10/29/2018, 10/31/2018

Table 3.12
Estimated Percent of Connected Impervious Surface Within Assessment Areas of the Oak Creek Watershed: 2015 and 2050

Assessment Area[a]	2015	2050
Mainstem		
Grant Park Ravine	10.9	10.9
Lower Oak Creek – Mill Pond	29.2	30.7
Lower Oak Creek	18.5	21.2
Middle Oak Creek Drainage Ditches	6.7	12.3
Middle Oak Creek	15.1	18.8
Upper Oak Creek	21.3	34.1
Oak Creek Headwaters	12.2	13.1
Mitchell Field Drainage Ditch		
Lower Mitchell Field Drainage Ditch	14.7	30.9
Mitchell Field Drainage Ditch – Airport	31.4	34.0
North Branch Oak Creek		
Lower North Branch Oak Creek	19.7	26.4
Upper North Branch Oak Creek	24.9	33.9
Southland Creek	11.3	18.8
Drexel Avenue Tributary	11.3	20.6
Rawson Avenue Tributary	24.1	33.8
College Avenue Tributary	25.1	30.9
Total Watershed	18.3	24.9

[a] *Assessment areas are shown on Map 3.2.*

Source: SEWRPC

Worldox # 242446 – CAPR-330 Table 3.13 Description of Hydrologic Soil Groups
300-4010
LKH/AWO/mid
10/25/2018, 5/3/2018, 10/29/2018

Table 3.13
Description of Hydrologic Soil Groups

Hydrologic Soil Group	Runoff Potential	Infiltration Rate	Transmission Rate
A	Low	High	High
B	Moderately Low	Moderate	Moderate
C	Moderately High	Low	Low
D	High	Very Low	Very Low

Source: Natural Resources Conservation Service

#242448 – CAPR-330 Table 3.14 Hydrologic Soil Composition by Assessment Area
300-4010
LKH/AWO/mid
10/25/2018, 5/3/2018, 10/29/2018

Table 3.14
Hydrologic Soil Group Composition by Assessment Area

	Oak Creek Mainstem							Mitchell Field Drainage Ditch		North Branch of Oak Creek						
Hydrologic Soil Group	Grant Park Ravine (% of area)	Lower Oak Creek – Mill Pond (% of area)	Lower Oak Creek (% of area)	Middle Oak Creek (% of area)	Middle Oak Creek – Drainage Ditches (% of area)	Upper Oak Creek (% of area)	Oak Creek Headwaters (% of area)	Lower Mitchell Field Drainage Ditch (% of area)	Mitchell Field Drainage Ditch – Airport (% of area)	Lower North Branch Oak Creek (% of area)	Upper North Branch Oak Creek (% of area)	Southland Creek (% of area)	Drexel Avenue Tributary (% of area)	Rawson Avenue Tributary (% of area)	College Avenue Tributary (% of area)	**Watershed (% of area)**
A	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	<1
A/D	0	0	0	1	13	0	0	1	0	1	1	4	3	<1	0	2
B	0	0	1	1	3	1	5	2	0	5	1	0	2	1	<1	1
B/D	0	0	0	6	3	4	0	10	0	7	3	<1	<1	2	53	3
C	81	75	63	35	35	45	62	48	29	35	58	54	51	54	35	48
C/D	0	9	32	54	44	48	33	30	7	46	26	40	43	37	9	37
D	1	12	3	3	<1	<1	0	6	63	3	8	2	1	4	3	7
Unclassified	18	4	1	<1	1	1	<1	2	1	3	3	<1	0	2	0	2

Source: Natural Resources Conservation Service and SEWRPC

#242662-2 – CAPR-330 (Oak Creek Watershed) Table 3.15 Natural Areas Within the Oak Creek Watershed
300-4010
LKH/AWO/mid
10/25/2018, 5/17/2018, 10/29/2018, 12/7/2018, 2/20/2019, 10/16/2019

Table 3.15
Natural Areas Within the Oak Creek Watershed

Name [a]	Owner	Acreage
Cudahy Nature Preserve	Milwaukee County	47
Falk Park Woods	Milwaukee County and Private	78
Rawson Park Woods	Milwaukee County and City of South Milwaukee	23
Barloga Woods	Milwaukee County and Private	64
Fitzsimmons Road Woods	Milwaukee County and Milwaukee Area Land Conservancy	39[b]
Franklin (Puetz Road) Woods	City of Franklin	34
Grant Park Woods – South	Milwaukee County	45[c]
Oak Creek Low Woods	Milwaukee County and Private	68[d]
Oak Creek Parkway Woods	Milwaukee County	24
Ryan Road Woods	Milwaukee County and Private	42
Wedge Woods	Private	17
Wood Creek Woods	Milwaukee County and Private	49

Note: Natural areas within the Oak Creek watershed are further profiled in Appendix B.

[a] *Site names correspond to the areas shown on Map 3.19.*

[b] *13 acres are within the Oak Creek watershed.*

[c] *14 acres are within the Oak Creek watershed.*

[d] *33 acres are within the Oak Creek watershed.*

Source: SEWRPC

Table 3.16
Endangered and Threatened Species and Species of Special Concern Within the Oak Creek Watershed: 2018

Common Name	Scientific Name	Status under the U.S. Endangered Species Act	Wisconsin Status	Source
Crustaceans				
Prairie Crayfish	*Procambarus gracilis*	Not listed	Special concern	Milwaukee County Parks
Insects				
Plains Emerald Dragonfly	*Somatochlora ensigera*	Not listed	Special concern	WDNR Natural Heritage Inventory
Rusty Patched Bumble Bee	*Bombus affinis*	Endangered	Endangered	USFWS
Reptiles and Amphibians				
Blanding's Turtle	*Emydoidea blandingii*	Species of Concern	Special concern	WDNR Natural Heritage Inventory
Butler's Garter Snake	*Thamnophis butleri*	Not listed	Special concern	WDNR Natural Heritage Inventory, SEWRPC
Plains Garternsnake	*Thamnophis radix*	Not listed	Special concern	WDNR Natural Heritage Inventory
Birds				
Acadian Flycatcher	*Empidonax virescens*	Not listed	Threatened	Milwaukee County Parks and the Cornell Lab of Ornithology eBird
American Bittern	*Botaurus lentiginosus*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
American Black Duck	*Anas rubripes*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
American Woodcock	*Scolopax minor*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird
Bell's Vireo	*Vireo bellii*	Not listed	Threatened	Milwaukee County Parks and the Cornell Lab of Ornithology eBird
Black-crowned Night-heron	*Nycticorax nycticorax*	Not listed	Special concern	WDNR Natural Heritage Inventory
Bobolink	*Dolichonyx oryzivorus*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
Brewer's Blackbird	*Euphagus cyanocephalus*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
Caspian tern	*Hydroprogne caspia*	Not listed	Endangered	Cornell Lab of Ornithology eBird Project
Cerulean Warbler	*Setophaga cerulea*	Species of Concern	Threatened	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Common Goldeneye	*Bucecephala clangula*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
Common Nighthawk	*Chordeiles minor*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Common tern	*Sterna hirundo*	Species of Concern	Endangered	Cornell Lab of Ornithology eBird Project
Dickcissel	*Spiza americana*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project

Table continued on next page.

Table 3.16 (Continued)

Common Name	Scientific Name	Status under the U.S. Endangered Species Act	Wisconsin Status	Source
Birds (continued)				
Eastern Meadowlark	*Sturnella magna*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Eastern Whip-poor-will	*Antrostomus vociferus*	Not listed	Special concern	SEWRPC
Forster's tern	*Sterna forsteri*	Not listed	Endangered	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Great Egret	*Ardea alba*	Not listed	Threatened	Cornell Lab of Ornithology eBird Project
Hooded Warbler	*Setophaga citrina*	Not listed	Threatened	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Least Flycatcher	*Empidonax minimus*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Peregrine falcon	*Falco peregrinus*	Not listed	Endangered	Cornell Lab of Ornithology eBird Project
Piping plover	*Charadrius melodus*	Endangered	Endangered	Cornell Lab of Ornithology eBird Project
Purple Martin	*Progne subis*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
Ruby-crowned Kinglet	*Regulus calendula*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Rusty Blackbird	*Euphagus carolinus*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Swainson's Thrush	*Catharus ustulatus*	Not listed	Special concern	Milwaukee County Parks and the Cornell Lab of Ornithology eBird Project
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Not listed	Special concern	Cornell Lab of Ornithology eBird Project
Plants				
Black Haw Viburnum	*Viburnum prunifolium*	Not listed	Special concern	SEWRPC
Blue-stem Goldenrod	*Solidago caesia*	Not listed	Endangered	SEWRPC
Downy Willow-herb	*Epilobium strictum*	Not listed	Special concern	WDNR Natural Heritage Inventory
False Hop Sedge	*Carex lupuliformis*	Not listed	Endangered	SEWRPC
Golden-seal	*Hydrastis canadensis*	Not listed	Special concern	SEWRPC
Handsome Sedge	*Carex formosa*	Not listed	Threatened	SEWRPC
Heart-leaved Skullcap	*Scutellaria ovata*	Not listed	Special concern	SEWRPC
Ravenfoot Sedge	*Carex crus-corvi*	Not listed	Endangered	SEWRPC
Waxleaf Meadowrue	*Thalictrum revolutum*	Not listed	Special concern	WDNR Natural Heritage Inventory

Note: No mammal or fish endangered species, threatened species, or species of special concern are currently found within the watershed.

Source: Cornell Lab of Ornithology eBird Project, Milwaukee County Parks, U.S. Fish and Wildlife Service, Wisconsin Department of Natural Resources, and SEWRPC

Community Assistance Planning Report No. 330

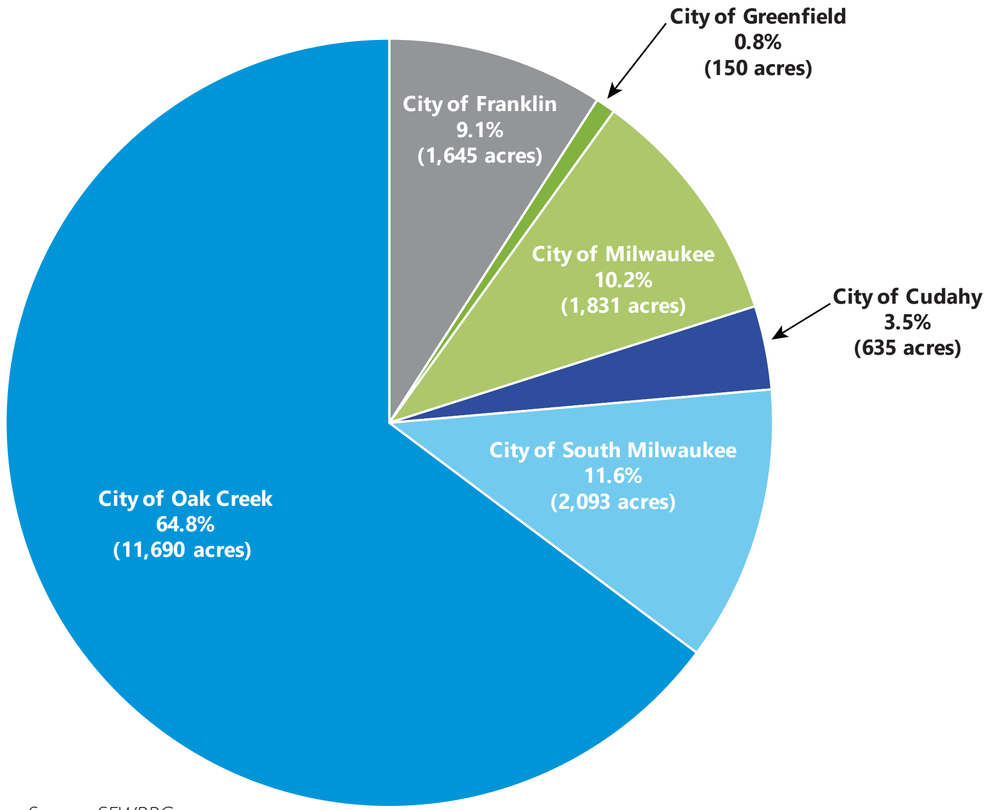
A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

Chapter 3

CHARACTERIZATION OF THE WATERSHED

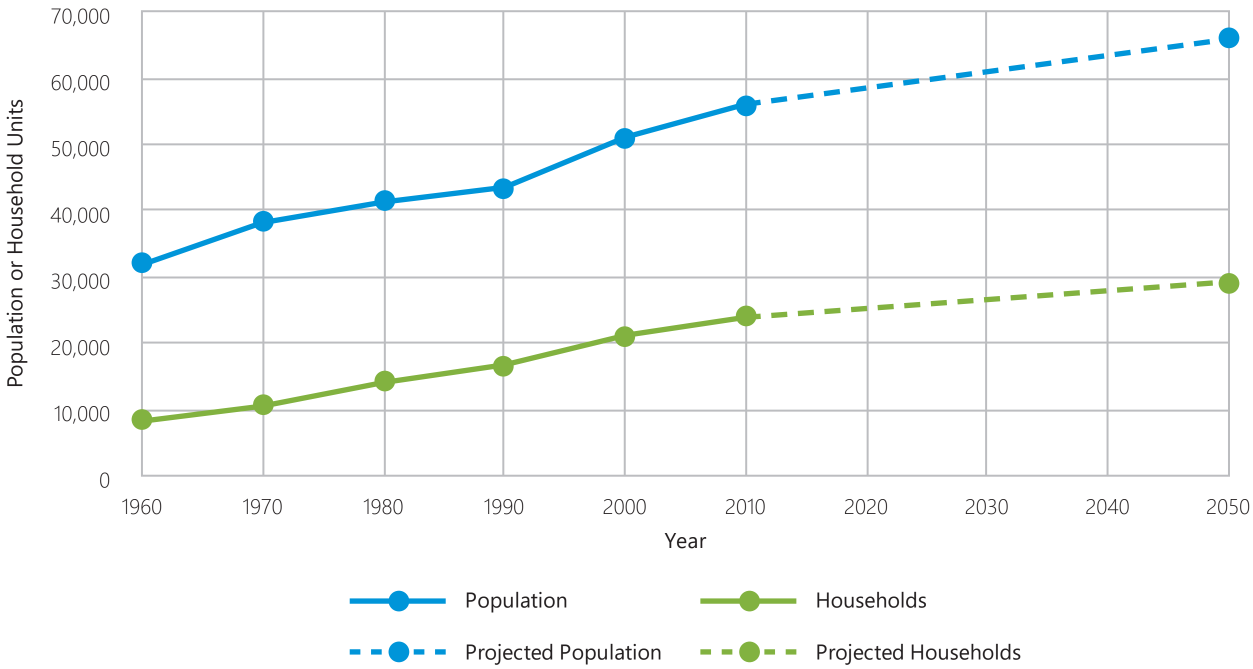
FIGURES

Figure 3.1
Civil Divisions Within the Oak Creek Watershed: 2018



Source: SEWRPC

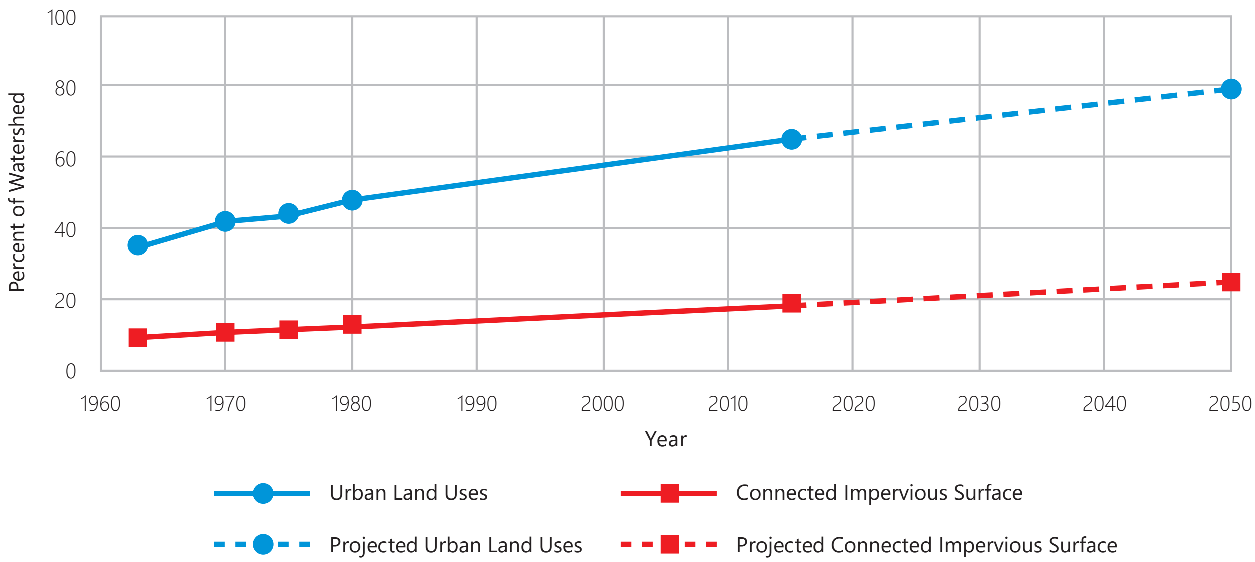
Figure 3.2
Populations and Households Within the Oak Creek Watershed: 1960-2050



Note: Watershed area approximated by whole U.S. Public Land Survey quarter sections.

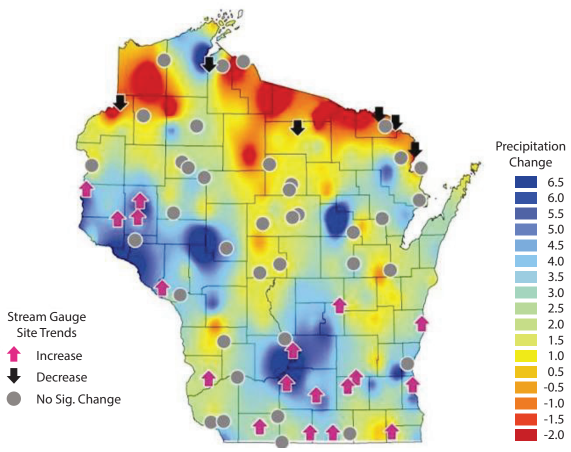
Source: U.S. Bureau of the Census and SEWRPC

Figure 3.3
Urban Land Uses and Connected Impervious Surface Within the Oak Creek Watershed: 1963-2050



Source: SEWRPC

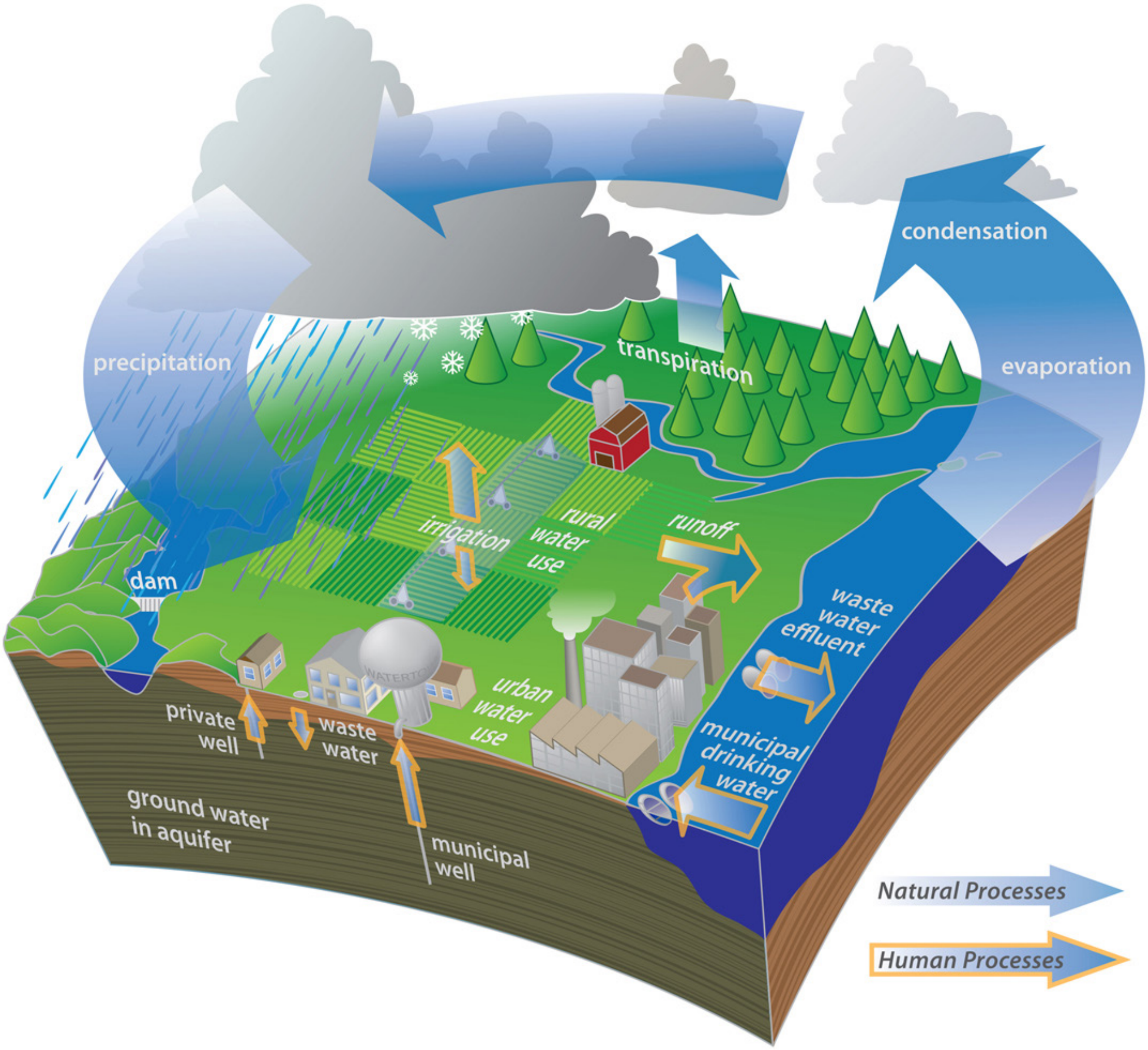
Figure 3.4
River Baseflow Trends and Precipitation Change in Wisconsin: 1950-2006



From 1950-2006, Wisconsin as a whole has become wetter, with an increase in annual precipitation of 3.1 inches. This observed increase in annual precipitation has primarily occurred in southern and western Wisconsin, while northern Wisconsin has experienced some drying. The southern and western regions of the State show increases in baseflow, corresponding to the areas with greatest precipitation increases.

Source: Water Resources Working Group of the Wisconsin Initiative on Climate Change Impacts and SEWRPC

Figure 3.5
Hydrologic Cycle of Water Movement

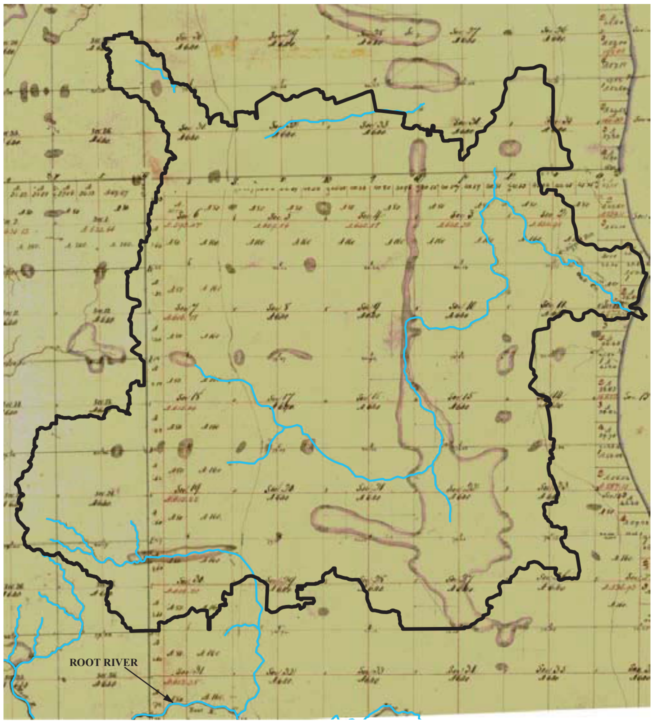


This schematic shows how human processes associated with land use development affect the natural processes of how water moves through its different states of the hydrologic cycle. Water returns to the atmosphere through evaporation (process by which water is changed from liquid to vapor), sublimation (direct evaporation by snow and ice), and transpiration (process by which plants give off water vapor through their leaves).

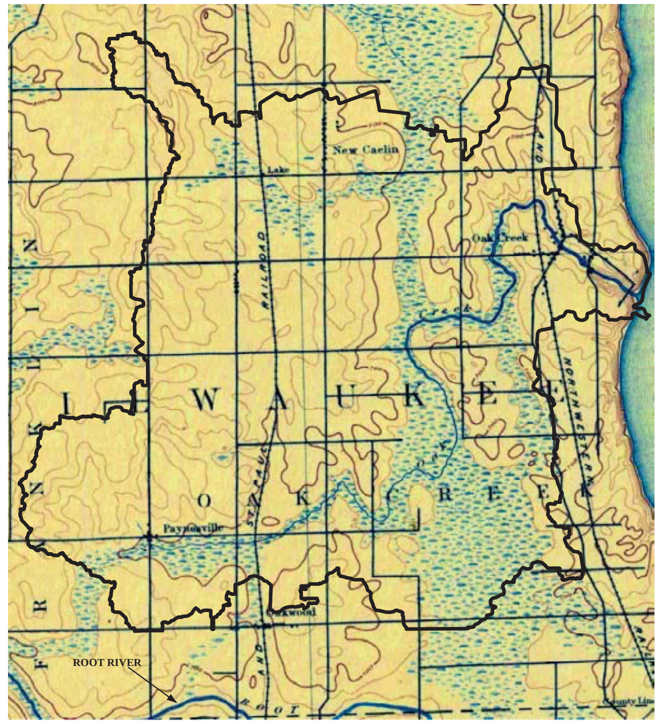
Source: Water Resources Working Group of the Wisconsin Initiative on Climate Change Impacts and SEWRPC

Figure 3.6
Comparison of Surface Water and Wetland Features from Historical Maps of the Oak Creek Watershed: 1837, 1891, and 1958

Historical 1837 Plat Map



Historical 1891 USGS Quad Map

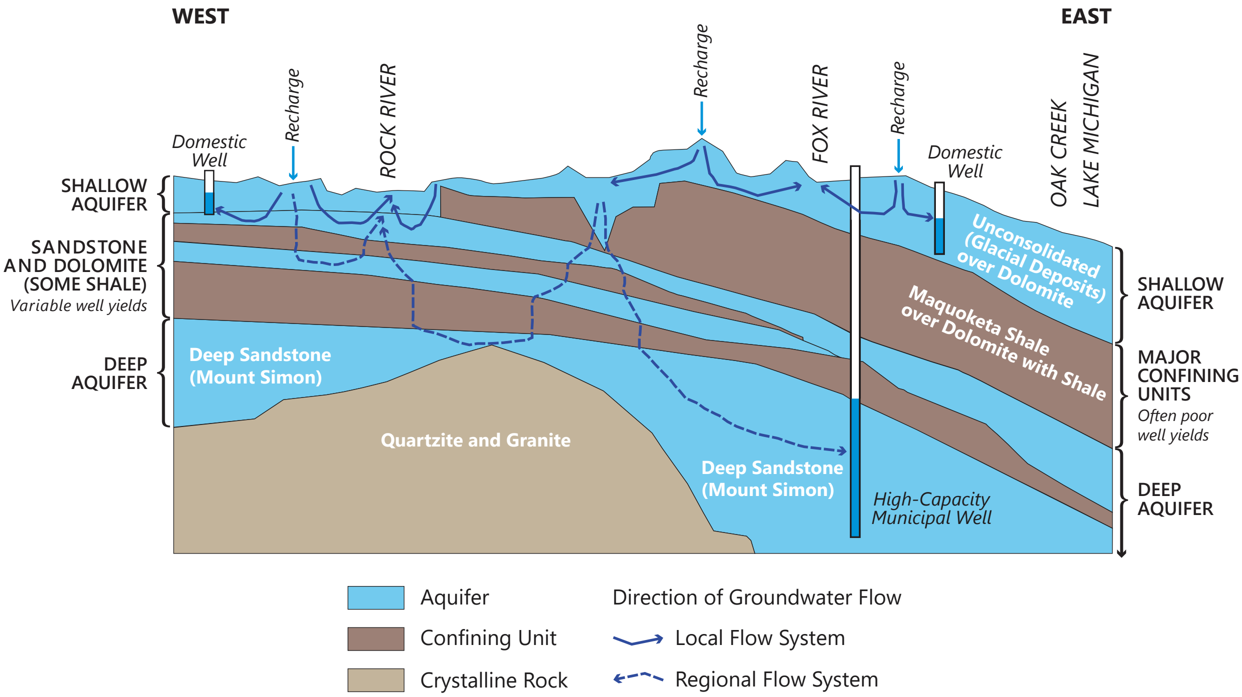


Historical 1958 USGS Quad Map

Note: The 2015 watershed boundary has been superimposed on all three maps for comparison purposes only.

Source: Wisconsin Board of Commissioners of Public Lands, U.S. Geological Survey, and SEWRPC

Figure 3.7
Conceptual Hydrogeologic Cross Section Through Southeastern Wisconsin



Source: U.S. Geological Survey, University of Wisconsin—Extension, and SEWRPC

Community Assistance Planning Report No. 330

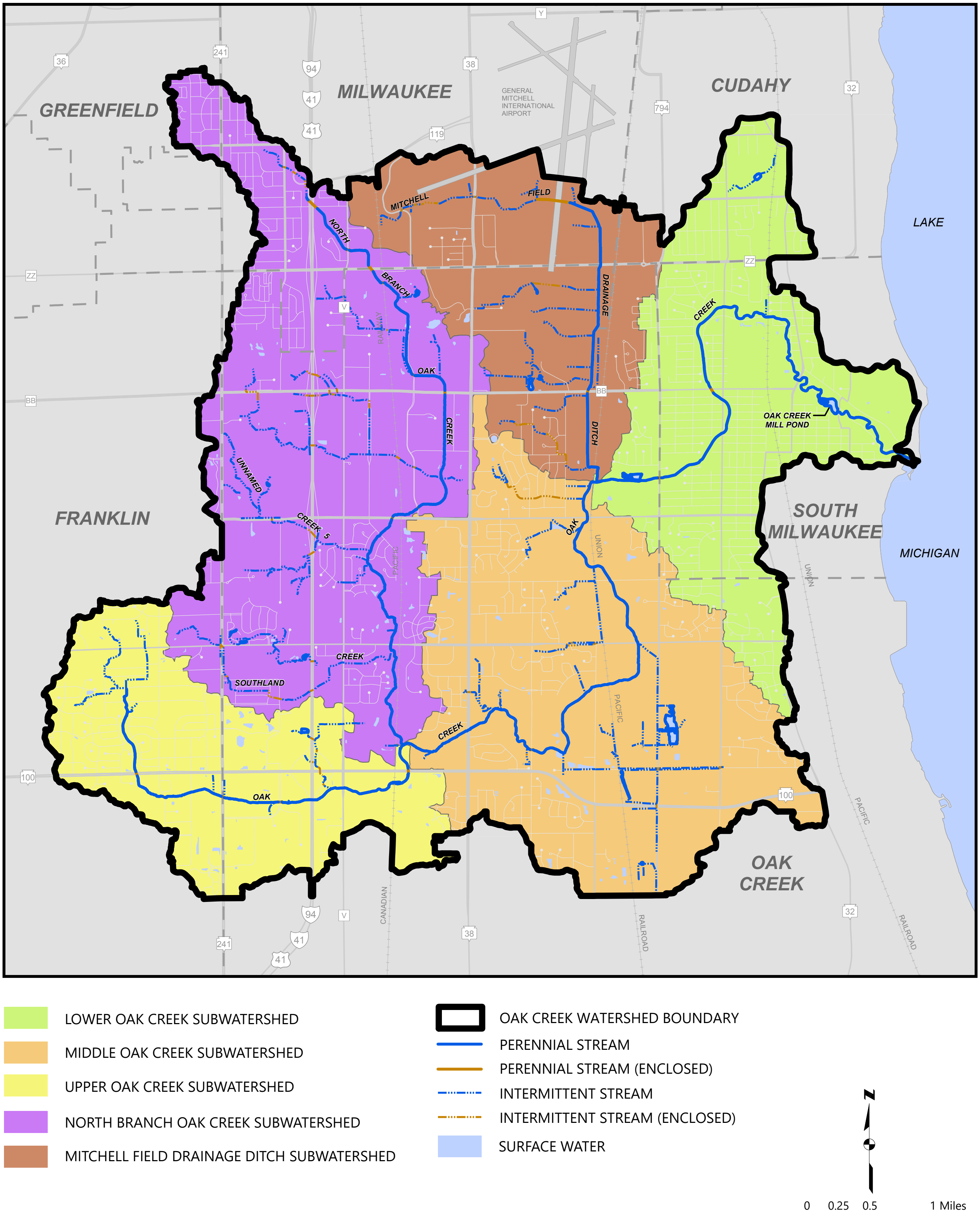
A RESTORATION PLAN FOR THE OAK CREEK WATERSHED

Chapter 3

CHARACTERIZATION OF THE WATERSHED

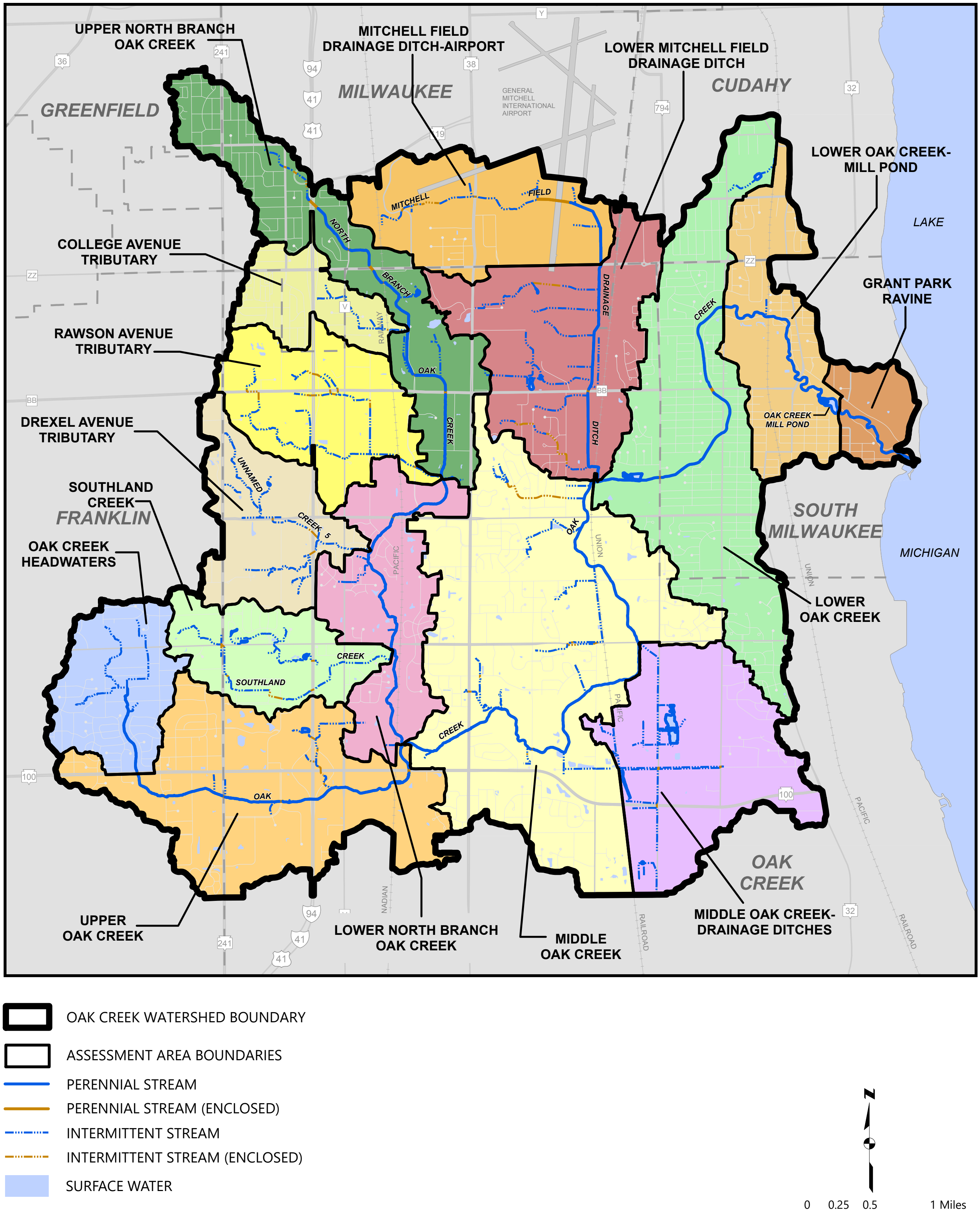
MAPS

Map 3.1
Subwatersheds Within the Oak Creek Watershed



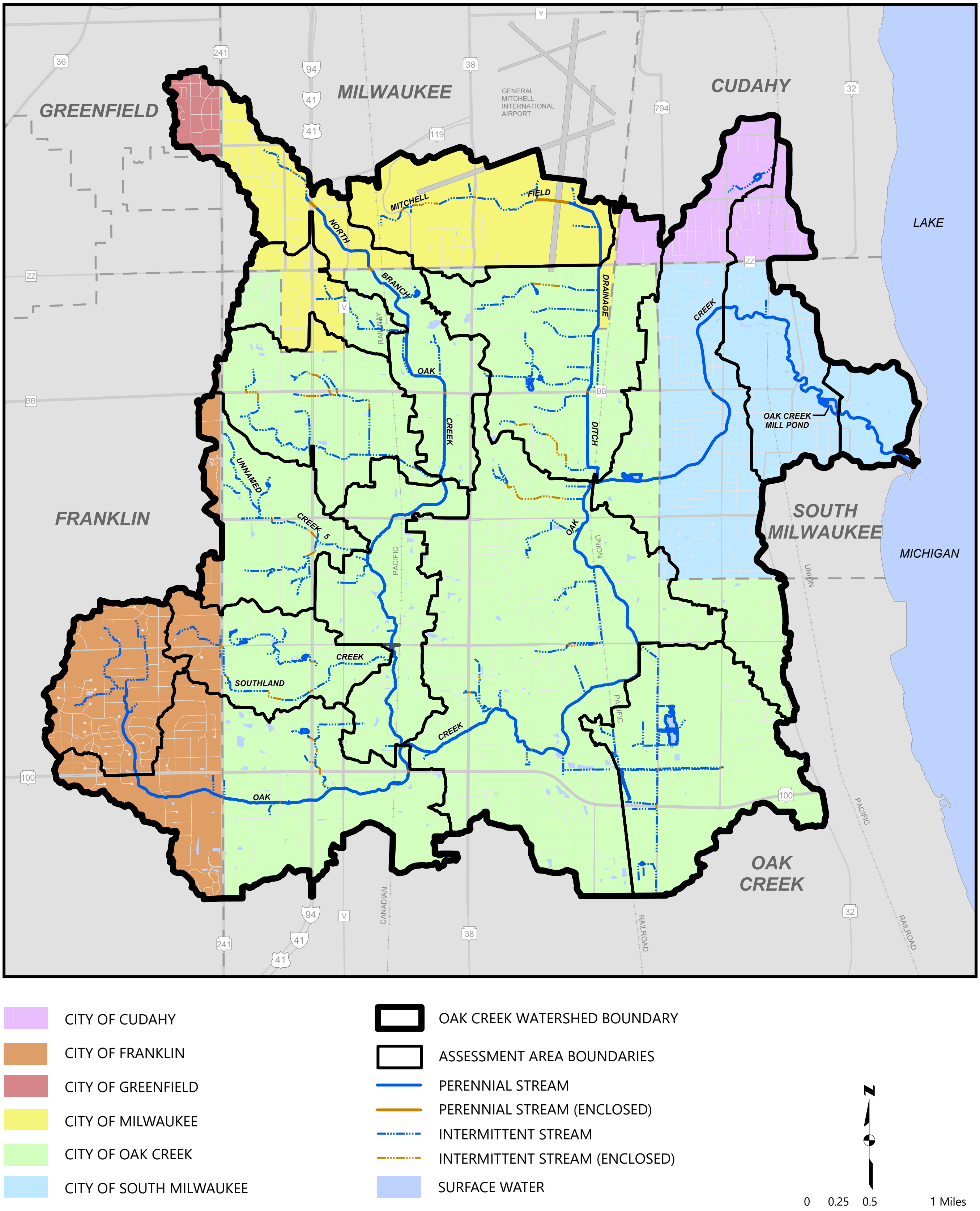
Source: SEWRPC

Map 3.2
Assessment Areas Within the Oak Creek Watershed



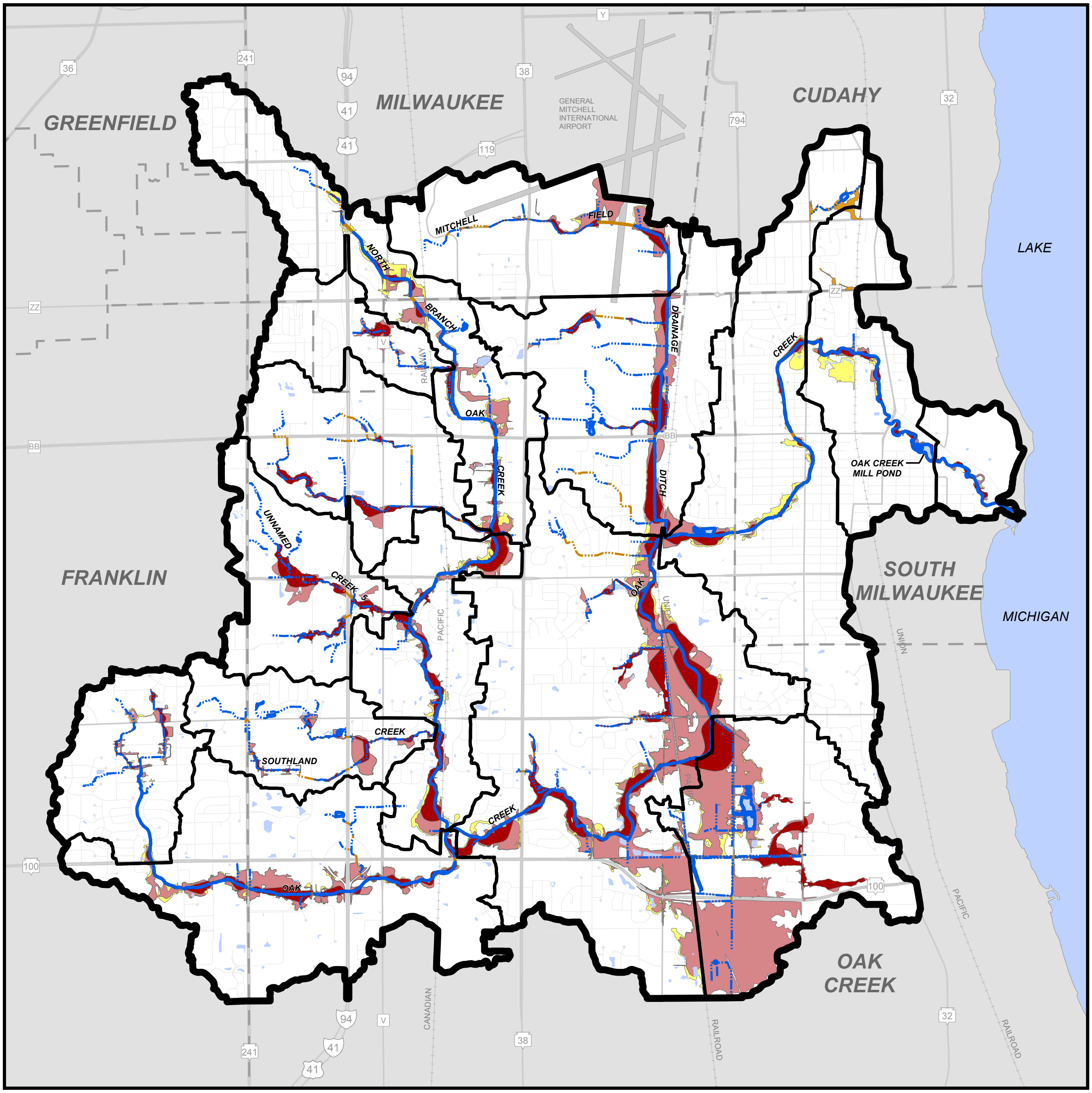
Source: SEWRPC

Map 3.3
Civil Divisions Within the Oak Creek Watershed: 2018



Source: SEWRPC

Map 3.4
Floodplain Designations Within the Oak Creek Watershed: Effective Date September 2008

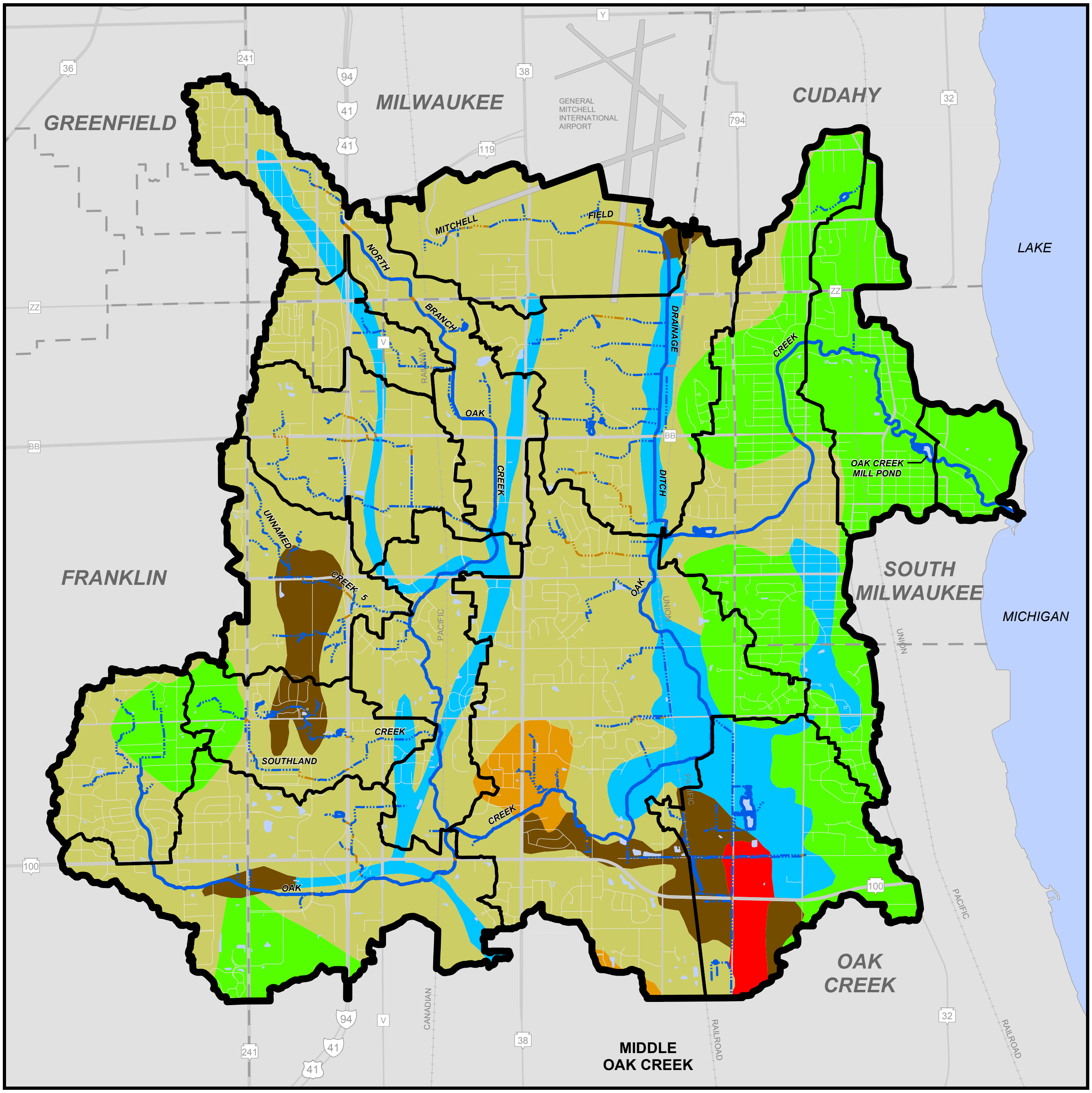


ONE-PERCENT-ANNUAL-PROBABILITY FLOODWAY (ZONE AE: BASE FLOOD ELEVATION DETERMINED): FEMA SEPTEMBER 2008	OAK CREEK WATERSHED BOUNDARY
ONE-PERCENT-ANNUAL-PROBABILITY FLOODPLAIN BEYOND FLOODWAY (WHERE APPLICABLE) (ZONE AE: BASE FLOOD ELEVATION DETERMINED): FEMA SEPTEMBER 2008	ASSESSMENT AREA BOUNDARIES
ONE-PERCENT-ANNUAL-PROBABILITY FLOODPLAIN (ZONE A: BASE FLOOD ELEVATION UNDETERMINED): FEMA SEPTEMBER 2008	PERENNIAL STREAM
0.2-PERCENT-ANNUAL-PROBABILITY FLOODPLAIN BEYOND ONE-PERCENT-ANNUAL FLOODPLAIN (500-YEAR RECURRENCE INTERVAL): FEMA SEPTEMBER 2008	PERENNIAL STREAM (ENCLOSED)
	INTERMITTENT STREAM
	INTERMITTENT STREAM (ENCLOSED)
	SURFACE WATER

0 0.25 0.5 1 Miles

Source: FEMA and SEWRPC

Map 3.5
Presettlement Vegetation Within the Oak Creek Watershed: 1836



OAK FOREST
MAPLE-BASSWOOD FOREST
BEECH-MAPLE FOREST
LOWLAND HARDWOOD FOREST
CONIFER SWAMP
WETLANDS

OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

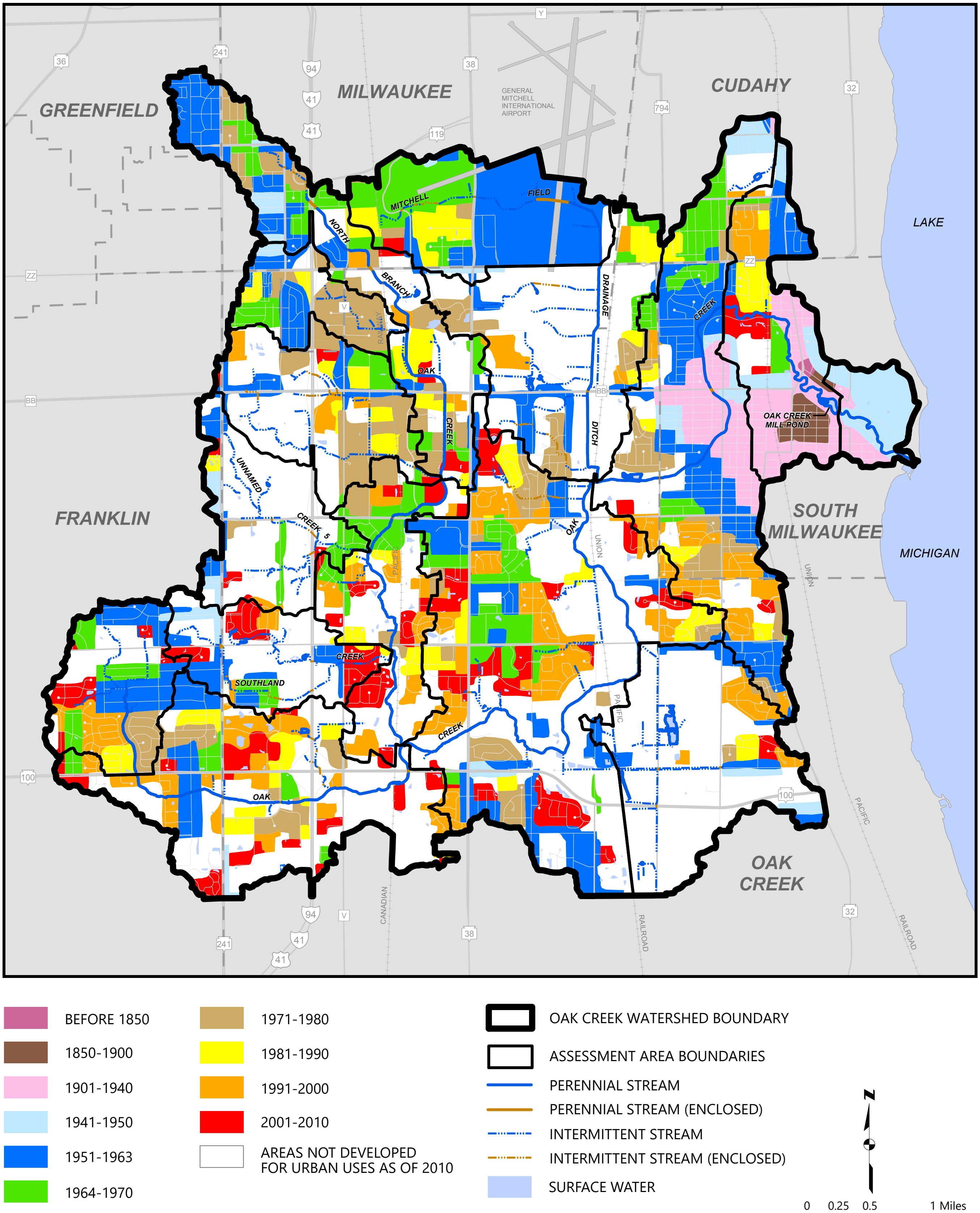
Note: The vegetation area features on this map have been interepreted from original surveyor's records and current topographic maps to illustrate the type and areal extent of native vegetation that occurred in this region in 1836.

N

0 0.25 0.5 1 Miles

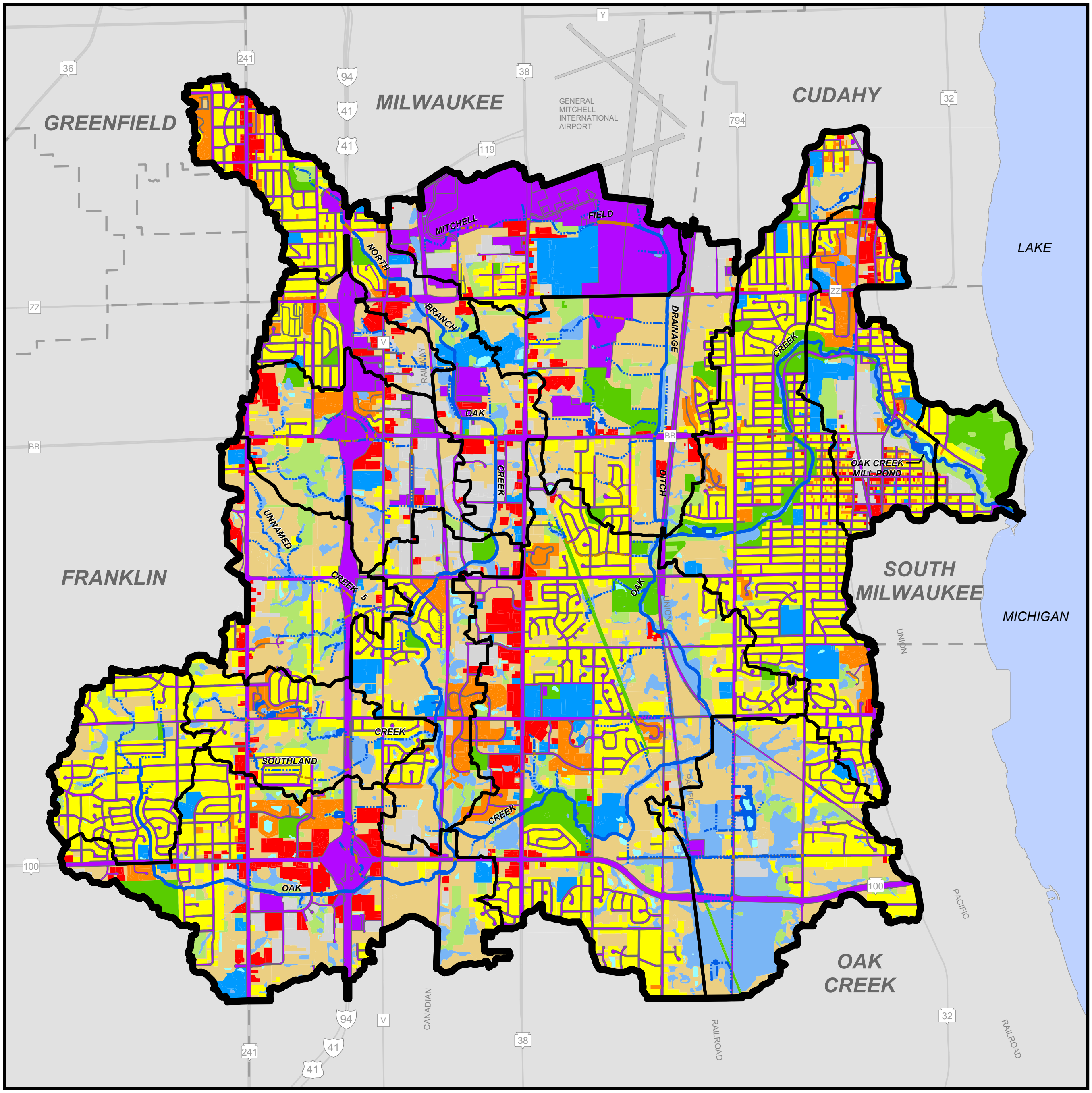
Source: SEWRPC

Map 3.6
Historical Urban Growth Within the Oak Creek Watershed: 1850-2010



Source: SEWRPC

Map 3.7
Existing Land Use Within the Oak Creek Watershed: 2015



SINGLE-FAMILY RESIDENTIAL	WETLANDS
MULTI-FAMILY RESIDENTIAL	WOODLANDS
COMMERCIAL	AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
INDUSTRIAL	EXTRACTIVE AND LANDFILL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES	SURFACE WATER
GOVERNMENT AND INSTITUTIONAL	
RECREATION	

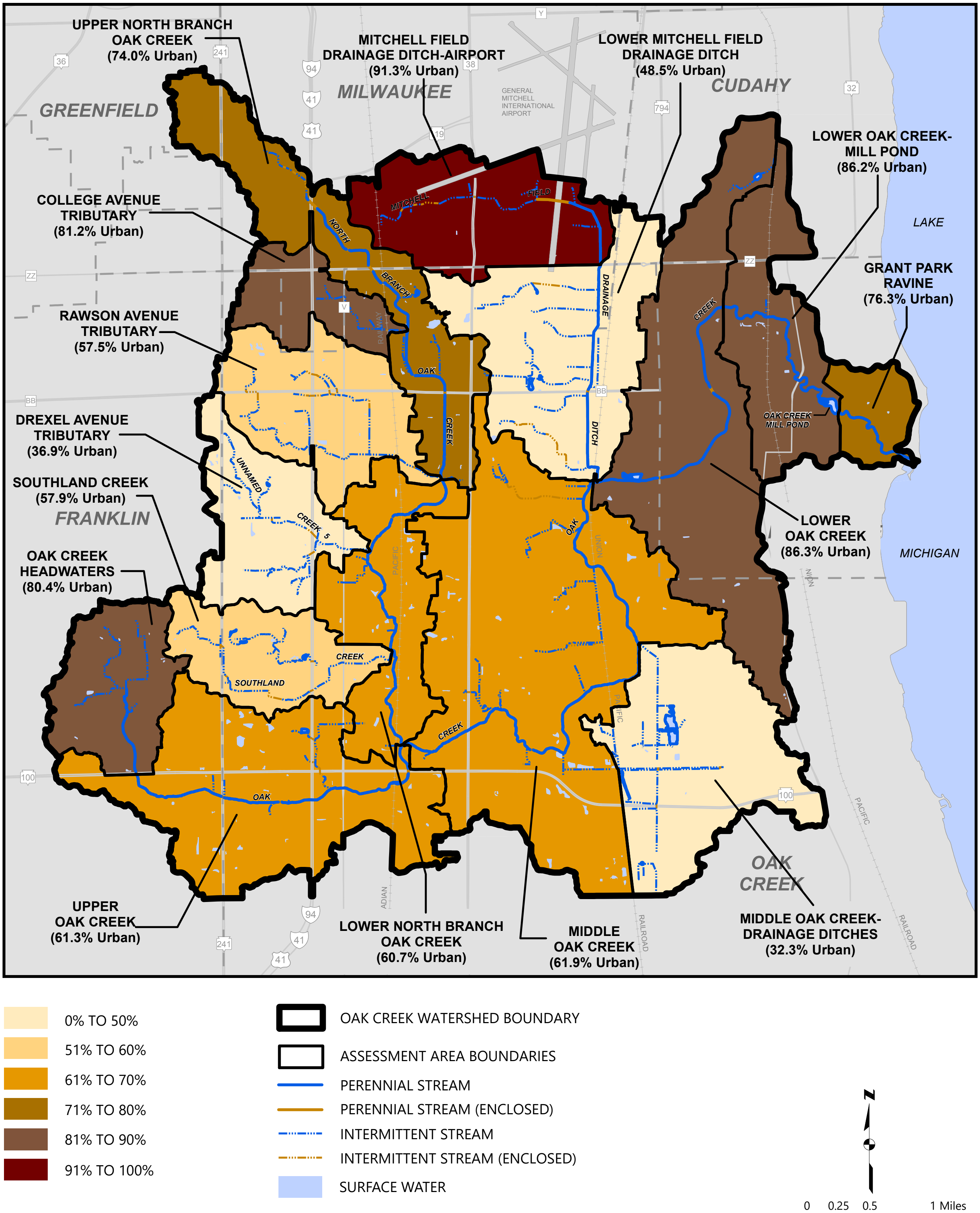
OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)
SURFACE WATER

N

0 0.25 0.5 1 Miles

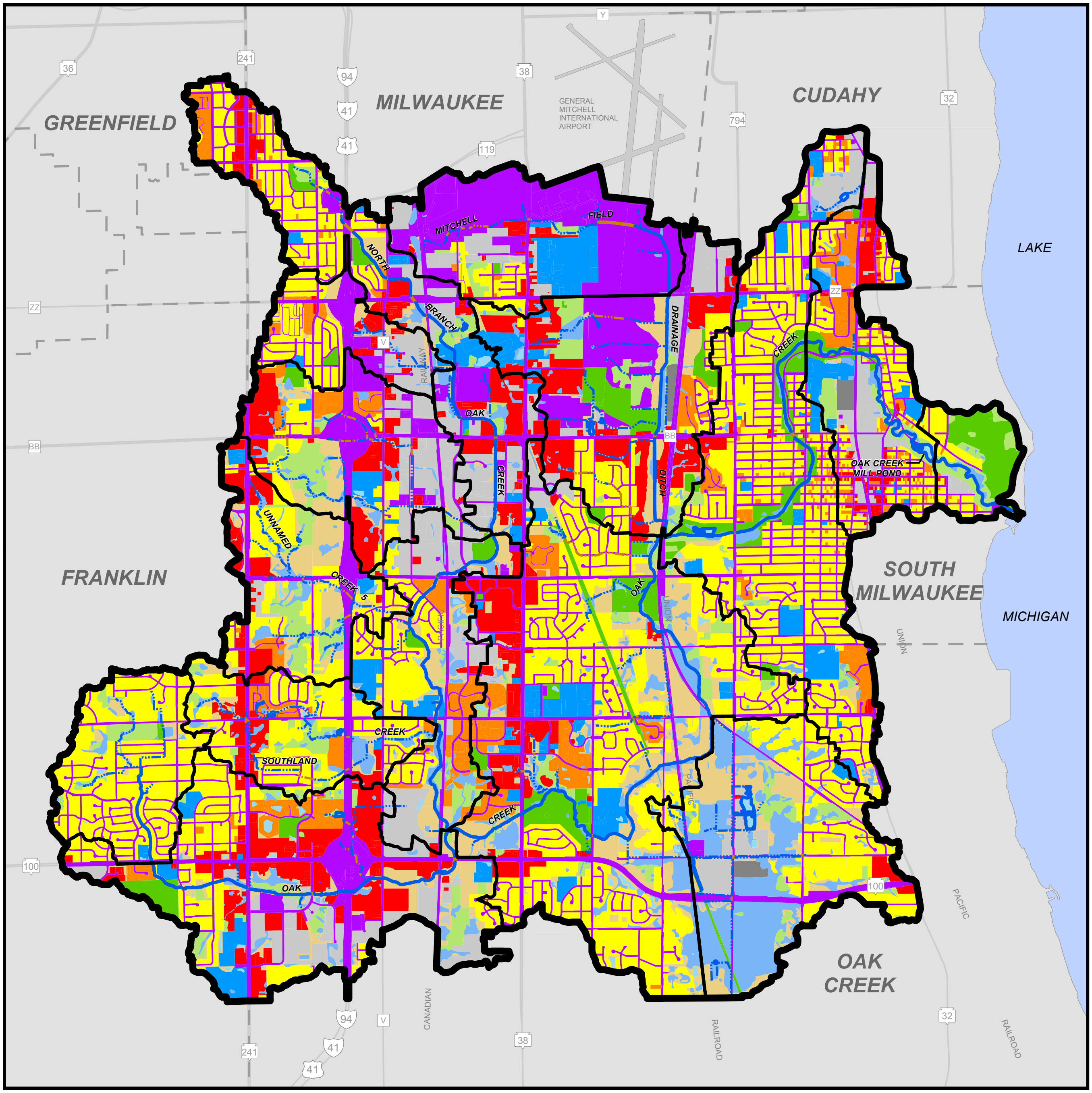
Source: SEWRPC

Map 3.8
Percent Urban Land Uses Within Assessment Areas of the Oak Creek Watershed: 2015



Source: SEWRPC

Map 3.9
Planned Land Use Within the Oak Creek Watershed: 2050



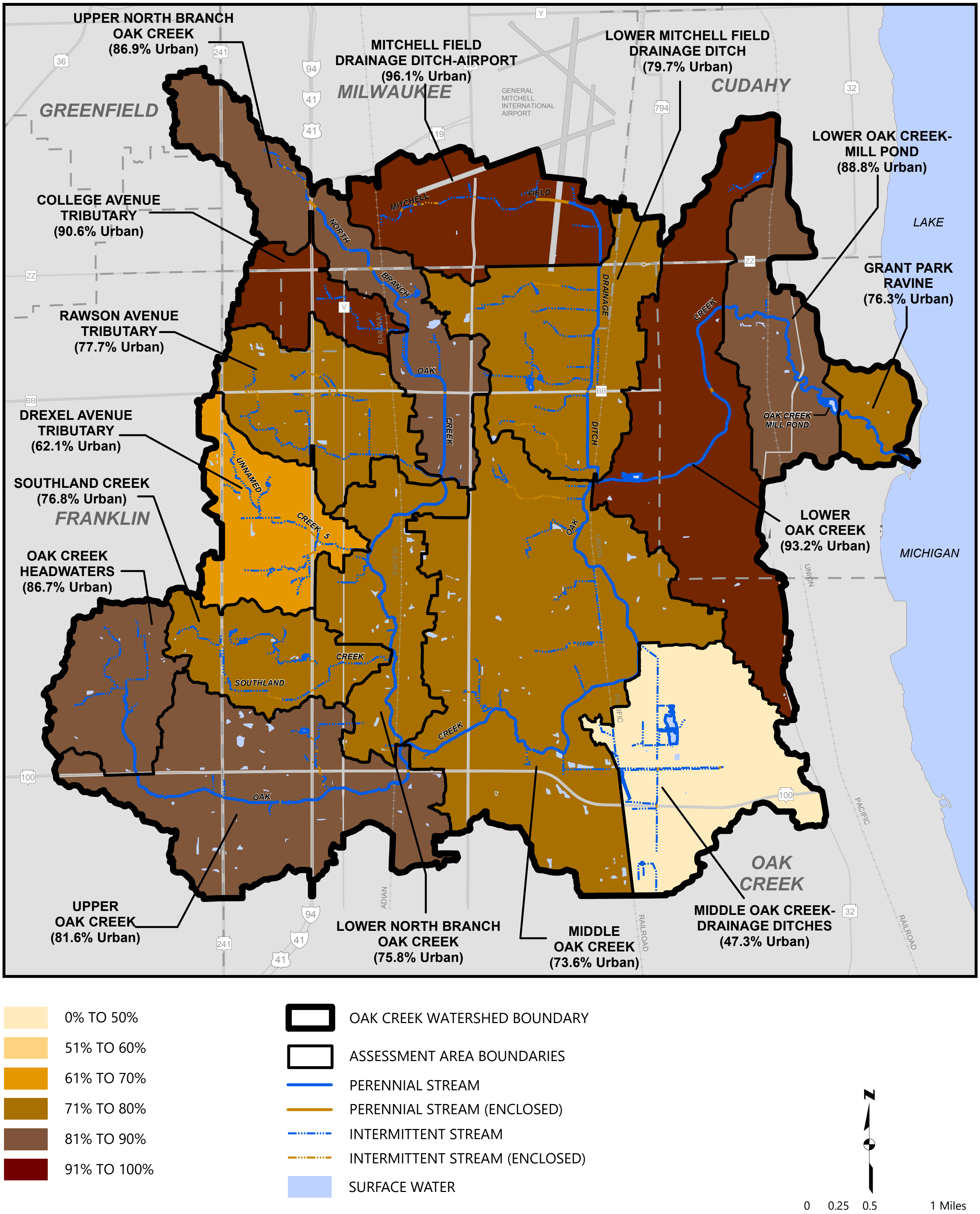
SINGLE-FAMILY RESIDENTIAL
MULTI-FAMILY RESIDENTIAL
COMMERCIAL
INDUSTRIAL
TRANSPORTATION, COMMUNICATIONS, AND UTILITIES
GOVERNMENT AND INSTITUTIONAL
RECREATION
WETLANDS
WOODLANDS
AGRICULTURAL, UNUSED, AND OTHER OPEN LANDS
EXTRACTIVE AND LANDFILL
SURFACE WATER
OAK CREEK WATERSHED BOUNDARY
ASSESSMENT AREA BOUNDARIES
PERENNIAL STREAM
PERENNIAL STREAM (ENCLOSED)
INTERMITTENT STREAM
INTERMITTENT STREAM (ENCLOSED)

N

0 0.25 0.5 1 Miles

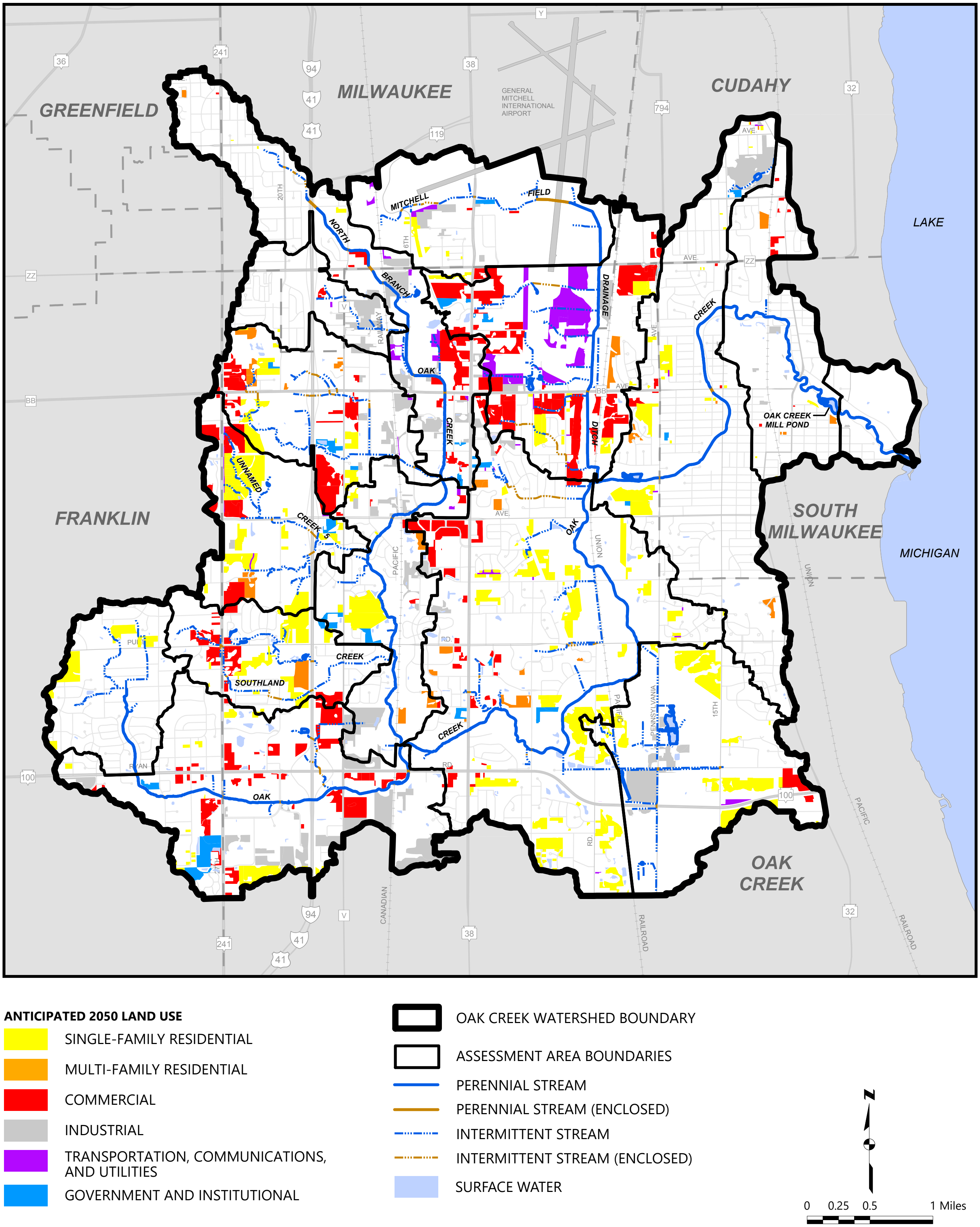
Source: SEWRPC

Map 3.10
Percent Planned Urban Land Uses Within Assessment Areas of the Oak Creek Watershed: 2050



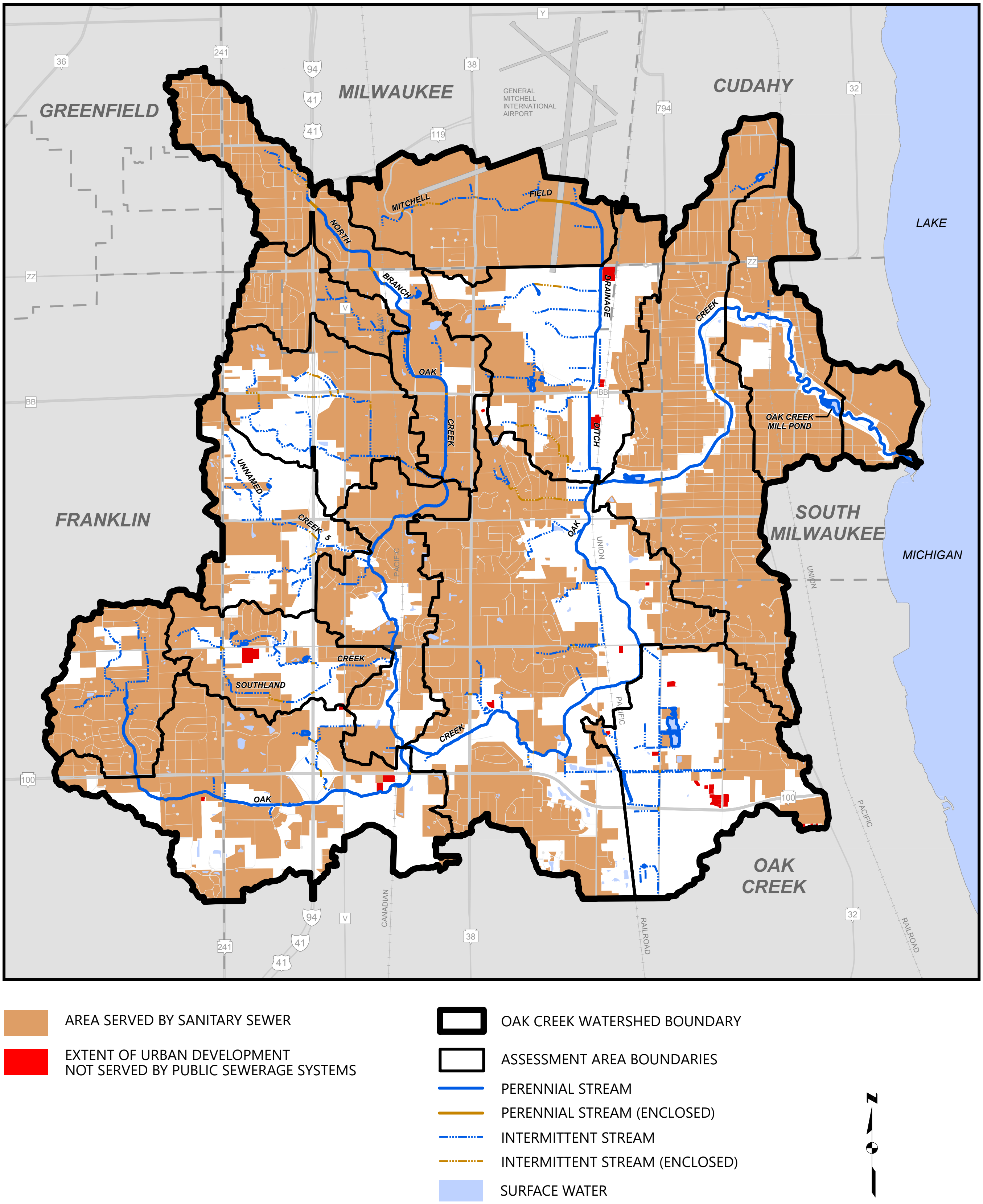
Source: SEWRPC

Map 3.11
Locations Where Existing Year 2015 Agricultural Lands, Open Lands, and Woodlands are Projected to be Converted to Urban Uses Under Planned 2050 Conditions



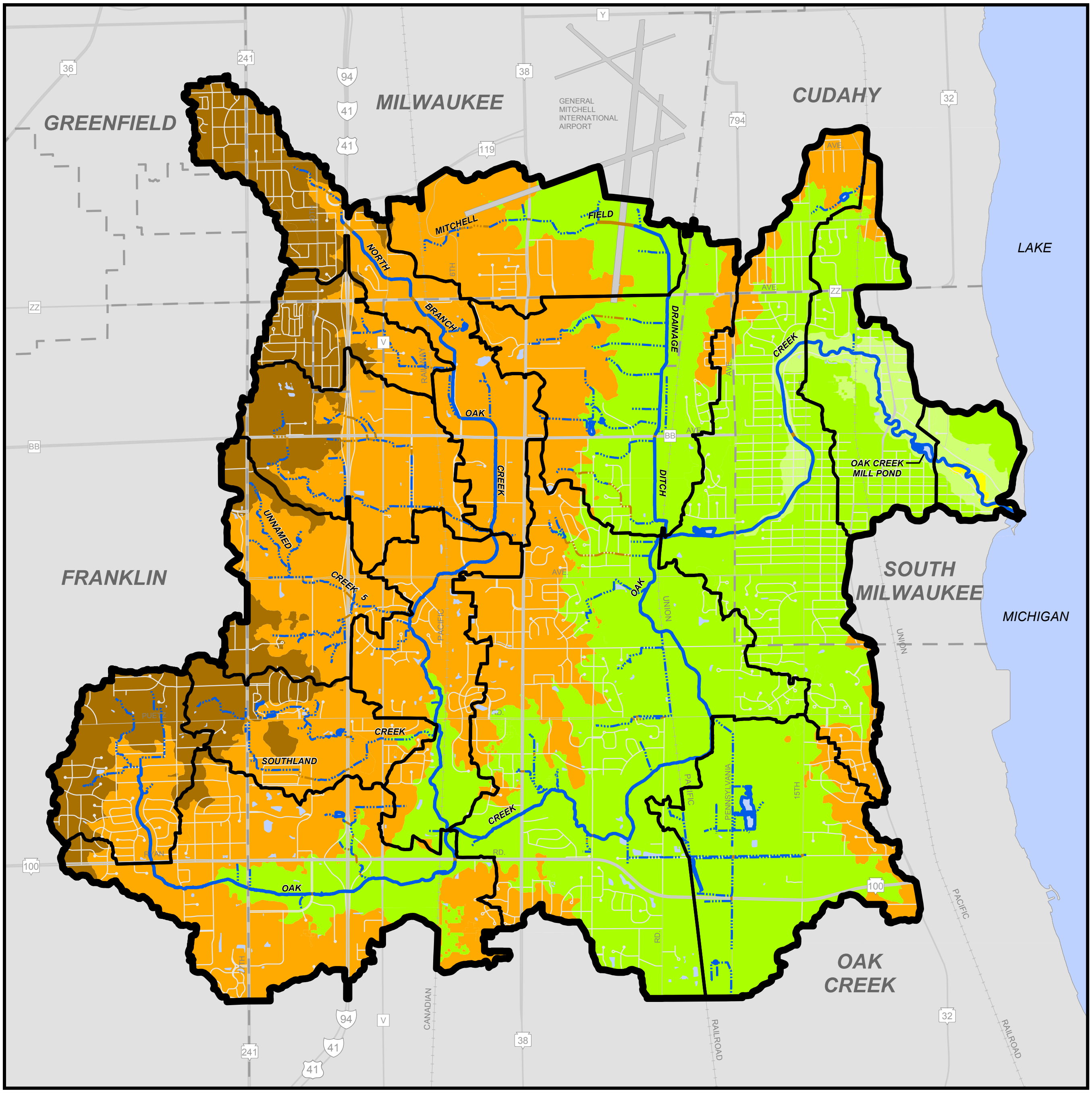
Source: SEWRPC

Map 3.12
Areas Served by Sewer Within the Oak Creek Watershed: 2010



Source: SEWRPC

Map 3.13
Generalized Surface Elevations Within the Oak Creek Watershed



ELEVATION IN FEET ABOVE NATIONAL GEODETIC VERTICAL DATUM, 1929 ADJUSTMENT

575

625

675

725

775

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

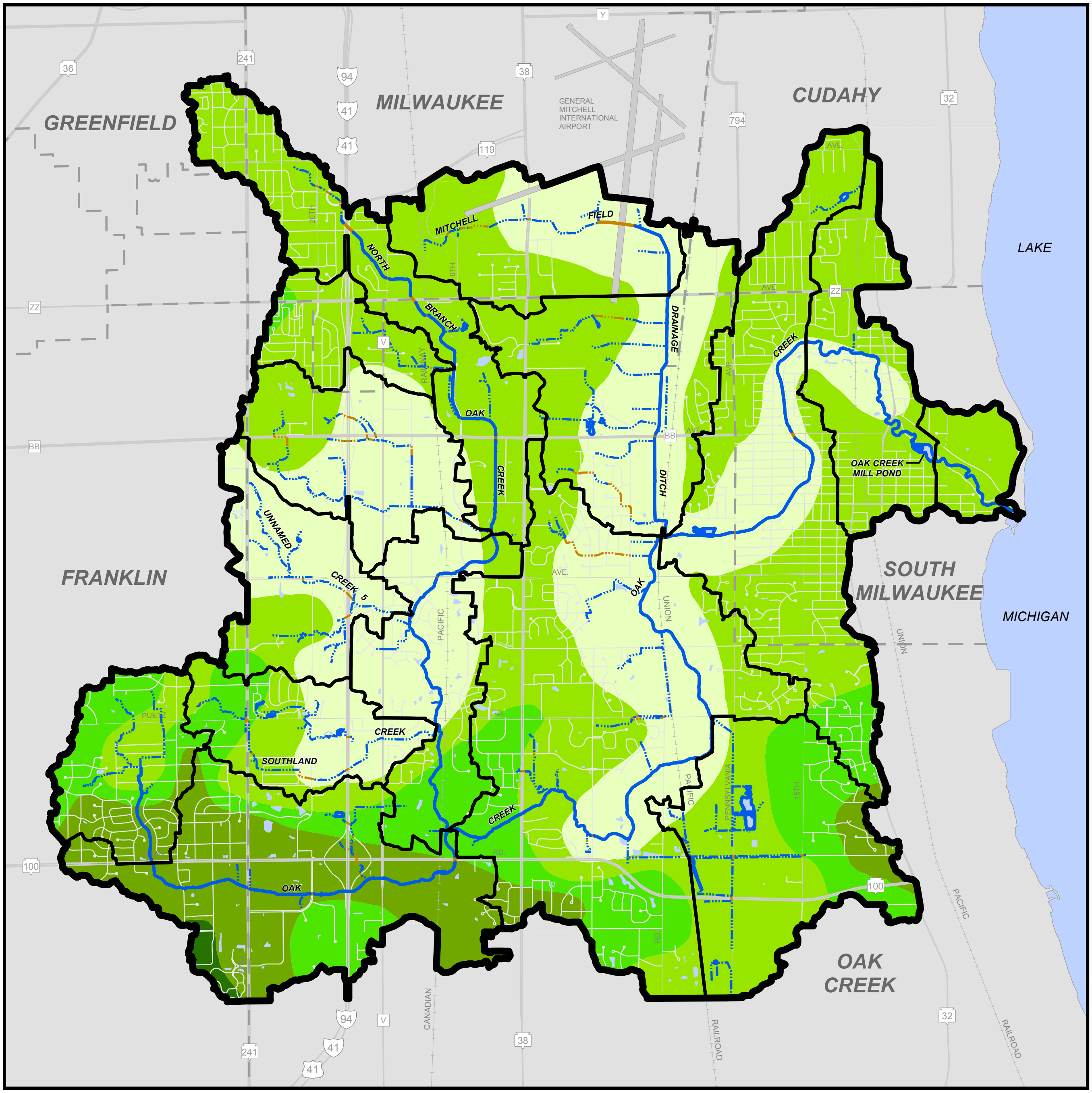
SURFACE WATER

N

0 0.25 0.5 1 Miles

Source: SEWRPC

Map 3.14
Depth to Bedrock Within the Oak Creek Watershed



DEPTH TO BEDROCK

- 50-100 FEET
- 101-150 FEET
- 151-200 FEET
- 201-250 FEET
- 251-300 FEET

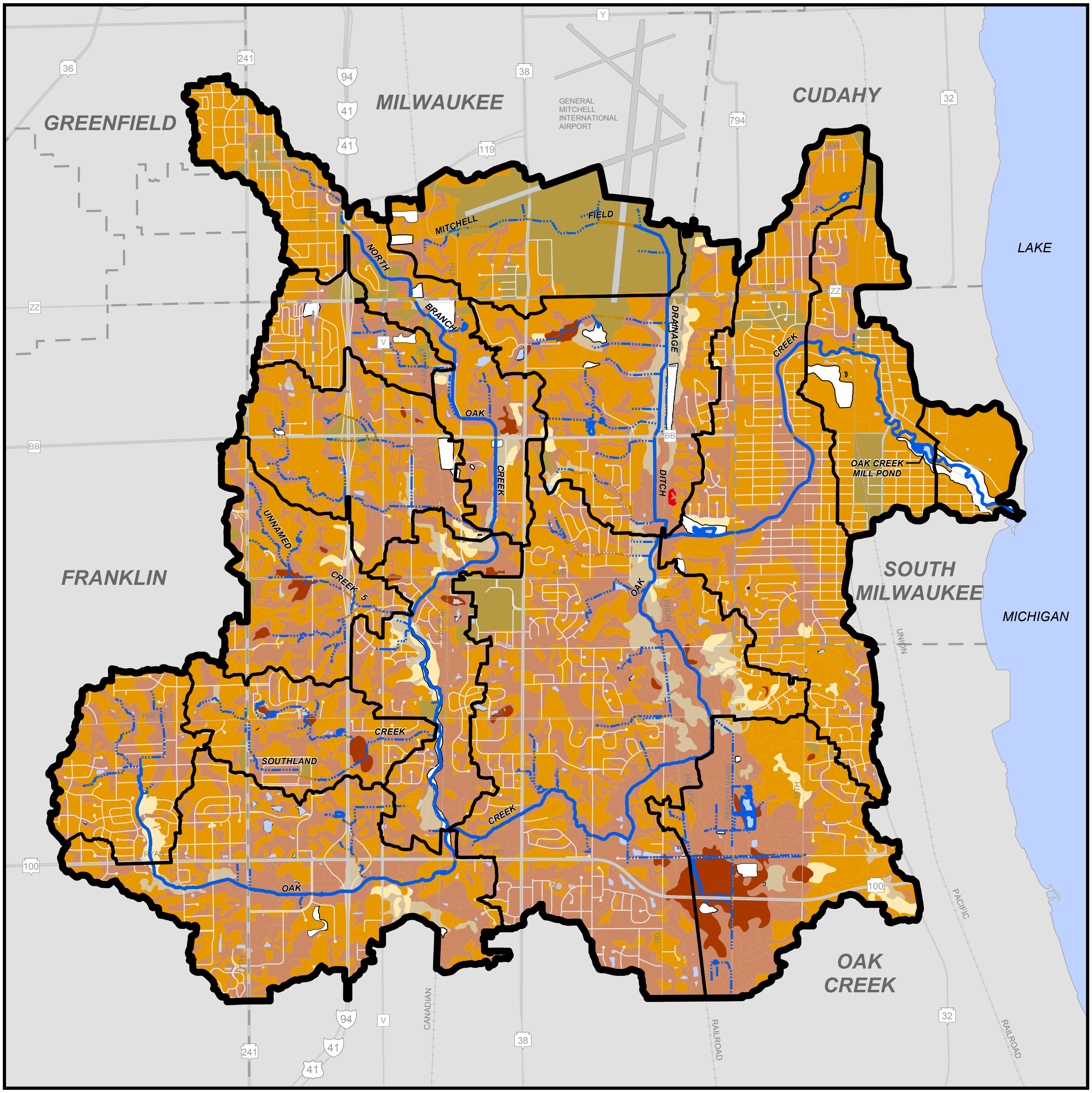
- OAK CREEK WATERSHED BOUNDARY
- ASSESSMENT AREA BOUNDARIES
- PERENNIAL STREAM
- PERENNIAL STREAM (ENCLOSED)
- INTERMITTENT STREAM
- INTERMITTENT STREAM (ENCLOSED)
- SURFACE WATER

N

0 0.25 0.5 1 Miles

Source: Wisconsin Geological and Natural History Survey and SEWRPC

Map 3.15
Hydrologic Soil Groups Within the Oak Creek Watershed



GROUP A: WELL DRAINED SOILS

GROUP A/D: WELL DRAINED SOIL/VERY POORLY DRAINED SOIL
WELL DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM, VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED

GROUP B: MODERATELY DRAINED SOIL

GROUP B/D: MODERATELY DRAINED SOIL/VERY POORLY DRAINED SOIL
MODERATELY DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM, VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED

GROUP C: POORLY DRAINED SOILS

GROUPS C/D: POORLY DRAINED SOILS/VERY POORLY DRAINED SOILS
POORLY DRAINED IF WATER TABLE IS LOWERED THROUGH PROVISION OF A DRAINAGE SYSTEM, VERY POORLY DRAINED IF WATER TABLE IS NOT LOWERED

GROUP D: VERY POORLY DRAINED SOILS
VERY HIGH RUNOFF POTENTIAL

UNDEFINED SOILS

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

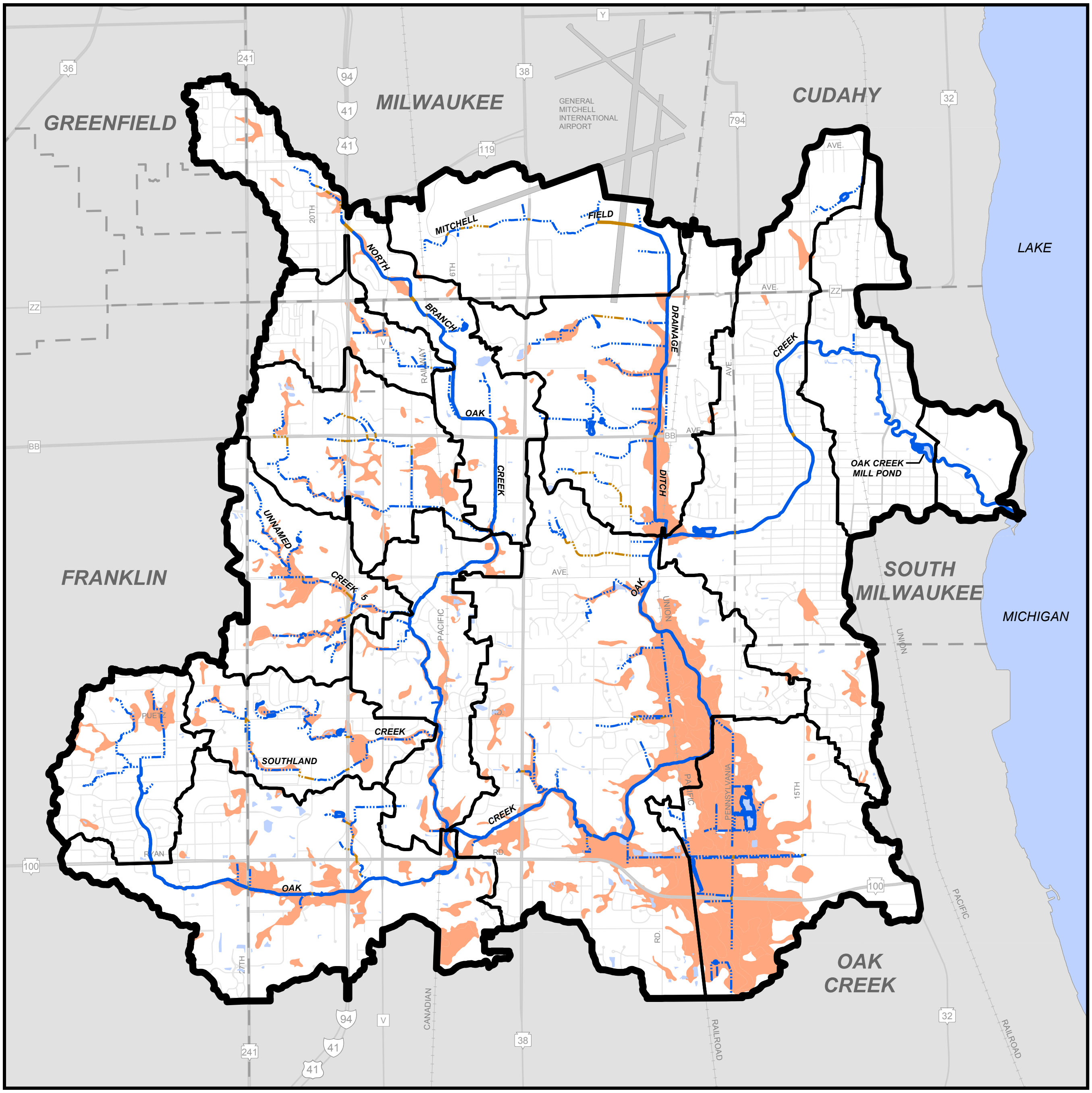
SURFACE WATER

N

0 0.25 0.5 1 Miles

Source: Natural Resources Conservation Service and SEWRPC

Map 3.16
Hydric Soils Within the Oak Creek Watershed



HYDRIC SOILS

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

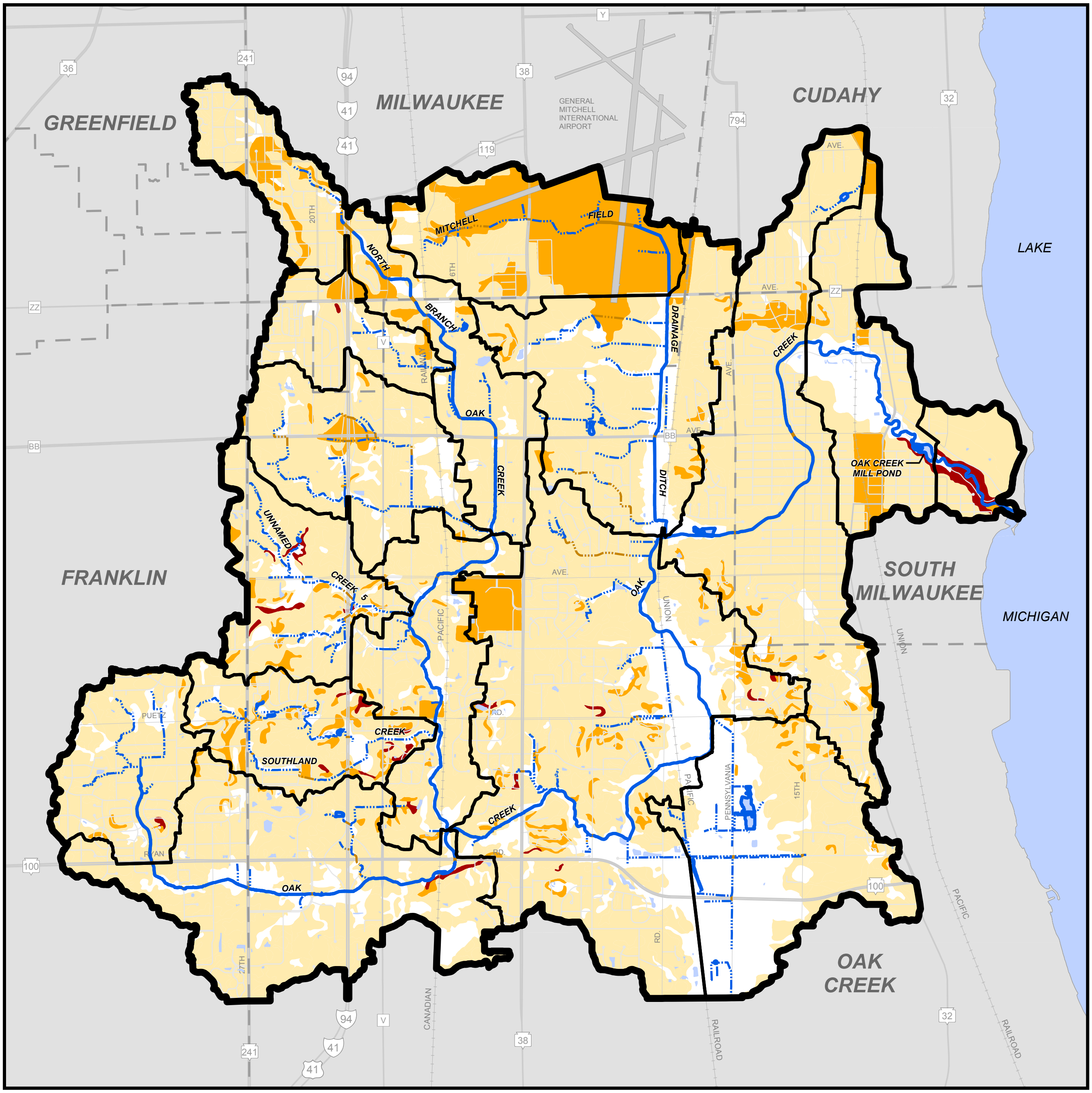
SURFACE WATER

N

0 0.25 0.5 1 Miles

Source: Natural Resources Conservation Service and SEWRPC

Map 3.17
Soil Slopes and Erodible Lands Within the Oak Creek Watershed



SLIGHT SLOPES (LESS THAN 2 PERCENT)

MODERATE SLOPES POTENTIALLY HIGHLY ERODIBLE LAND (2 TO 5 PERCENT)

STEEP SLOPES HIGHLY ERODIBLE LAND (6 TO 12 PERCENT)

VERY STEEP SLOPES VERY HIGHLY ERODIBLE LAND (GREATER THAN 12 PERCENT)

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

SURFACE WATER

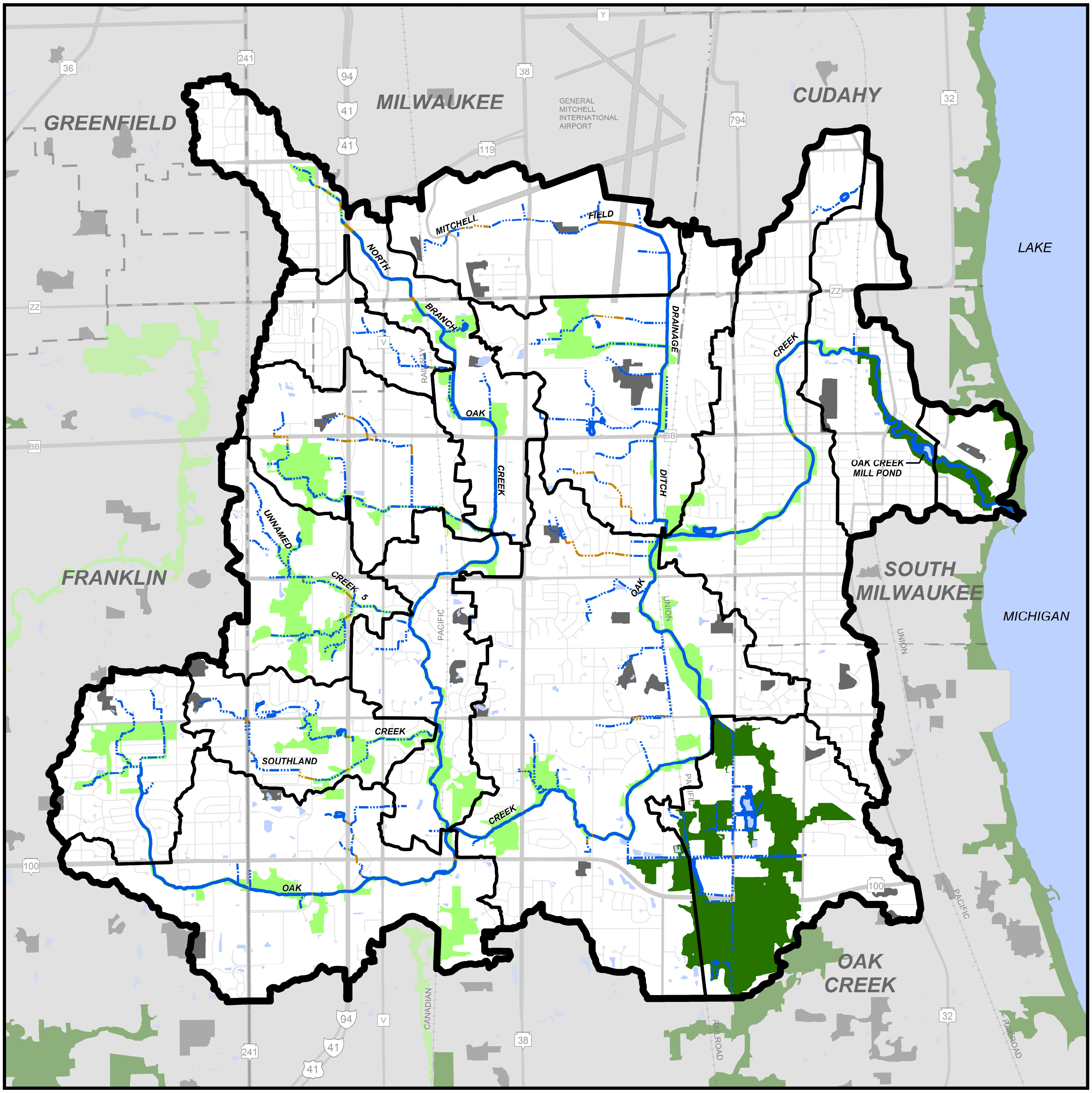
Note: Estimations of erodible lands shown on this map assume no erosion management measures are in place. Many areas shown on this map may either be developed in urban uses or have erosion management meaures installed.

N

0 0.25 0.5 1 Miles

Source: Natural Resources Conservation Service and SEWRPC

Map 3.18
Environmental Corridors Within the Oak Creek Watershed: 2015



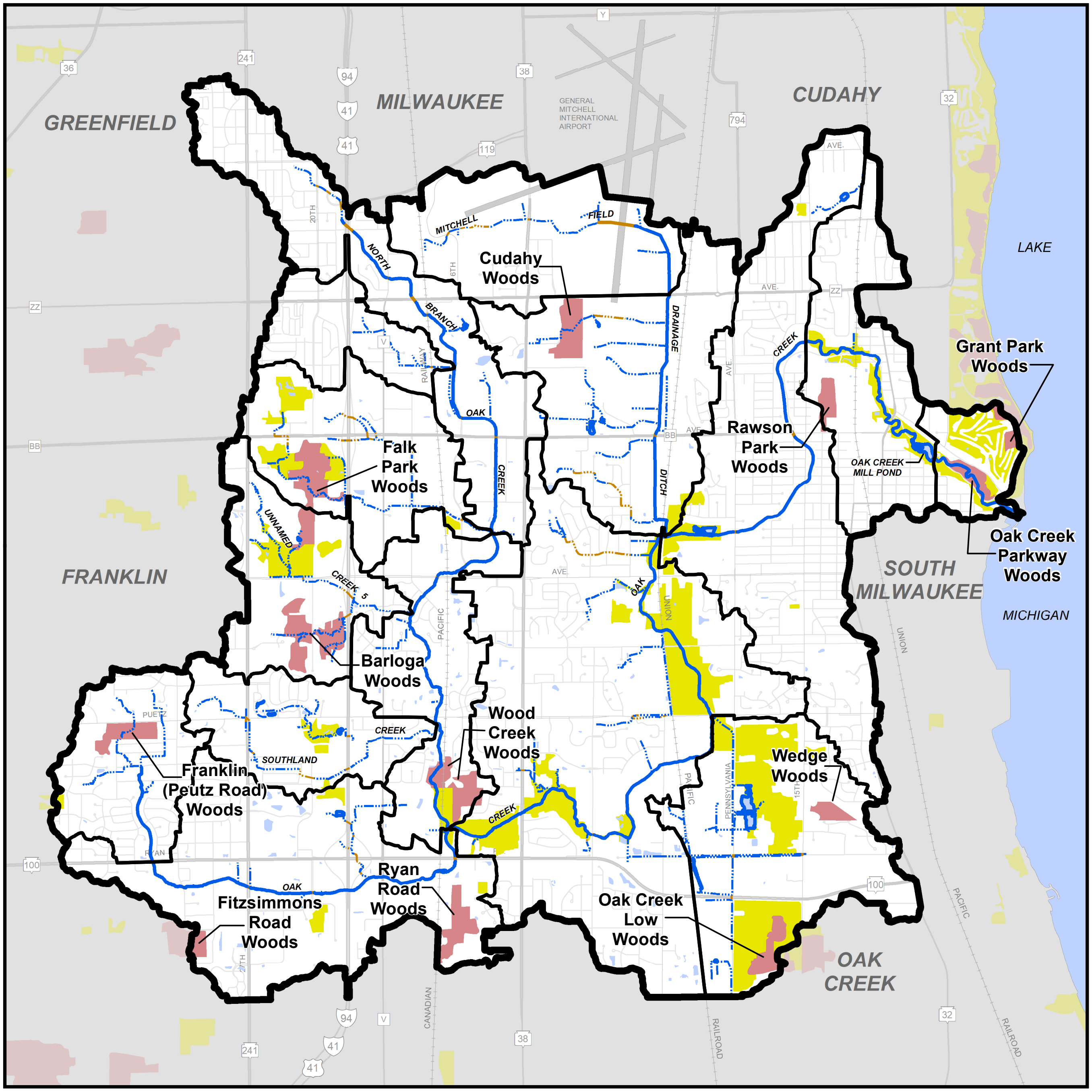
PRIMARY ENVIRONMENTAL CORRIDOR	OAK CREEK WATERSHED BOUNDARY
SECONDARY ENVIRONMENTAL CORRIDOR	ASSESSMENT AREA BOUNDARIES
ISOLATED NATURAL RESOURCE AREA	PERENNIAL STREAM
	PERENNIAL STREAM (ENCLOSED)
	INTERMITTENT STREAM
	INTERMITTENT STREAM (ENCLOSED)
	SURFACE WATER

Note: Colors oustide the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

0 0.25 0.5 1 Miles

Source: SEWRPC

Map 3.19
Natural Areas and Critical Species Habitat Sites Within the Oak Creek Watershed



NATURAL AREAS (2019)

CRITICAL SPECIES HABITAT SITES (2019)

Note: Colors oustide the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

OAK CREEK WATERSHED BOUNDARY

ASSESSMENT AREA BOUNDARIES

PERENNIAL STREAM

PERENNIAL STREAM (ENCLOSED)

INTERMITTENT STREAM

INTERMITTENT STREAM (ENCLOSED)

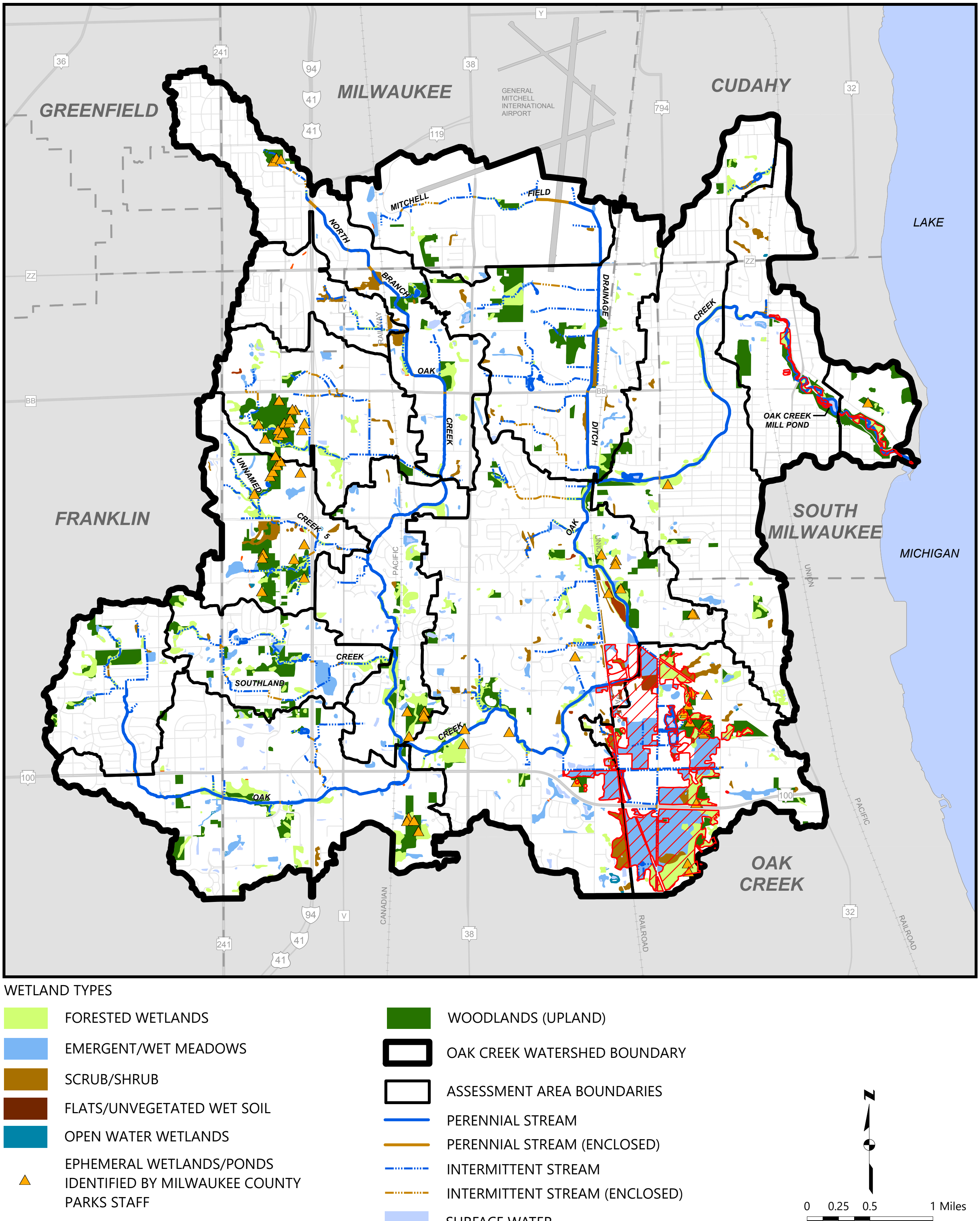
SURFACE WATER

N

0 0.25 0.5 1 Miles

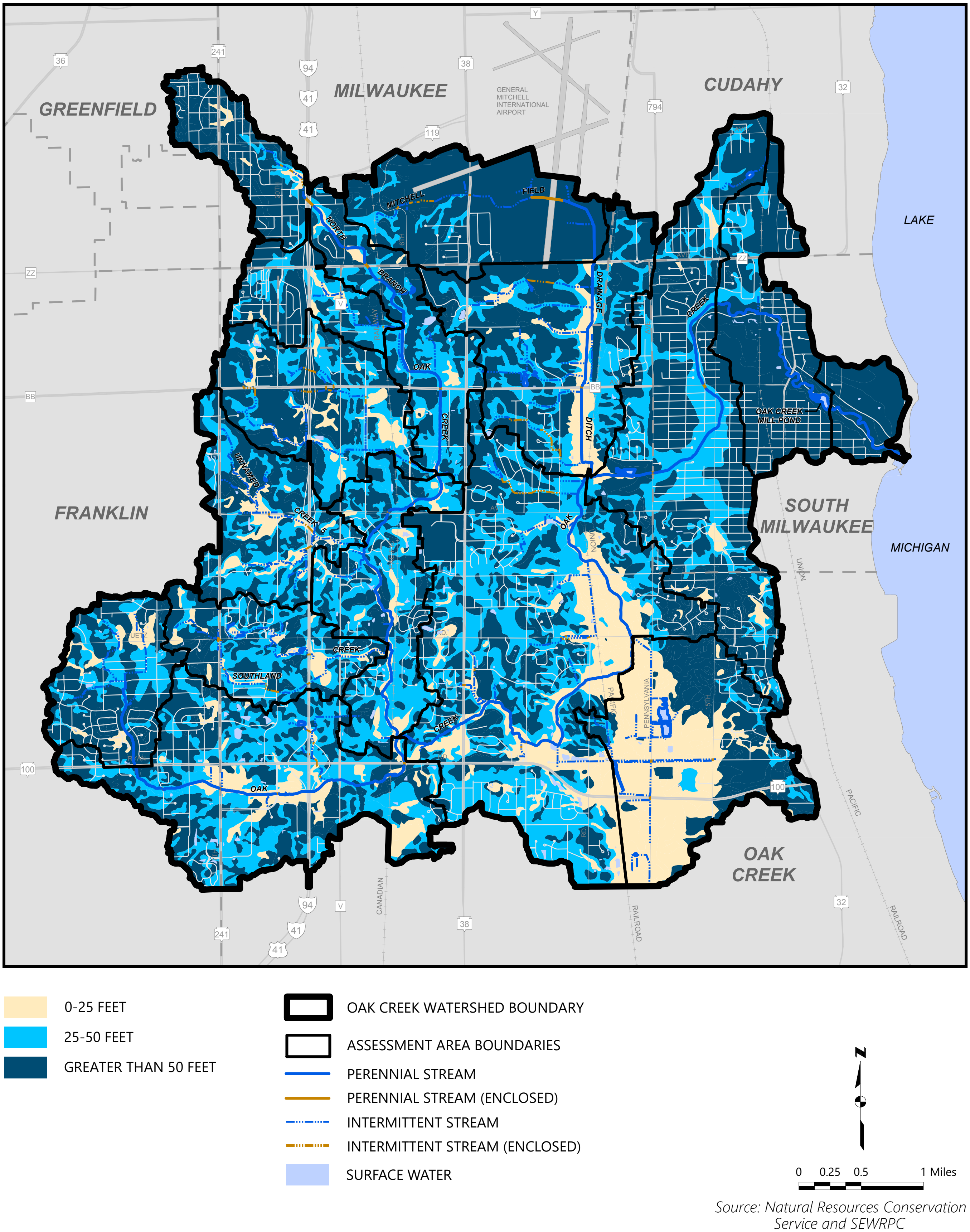
Source: SEWRPC

Map 3.20
Wetlands Types, Ephemeral Ponds, and Woodlands Within the Oak Creek Watershed



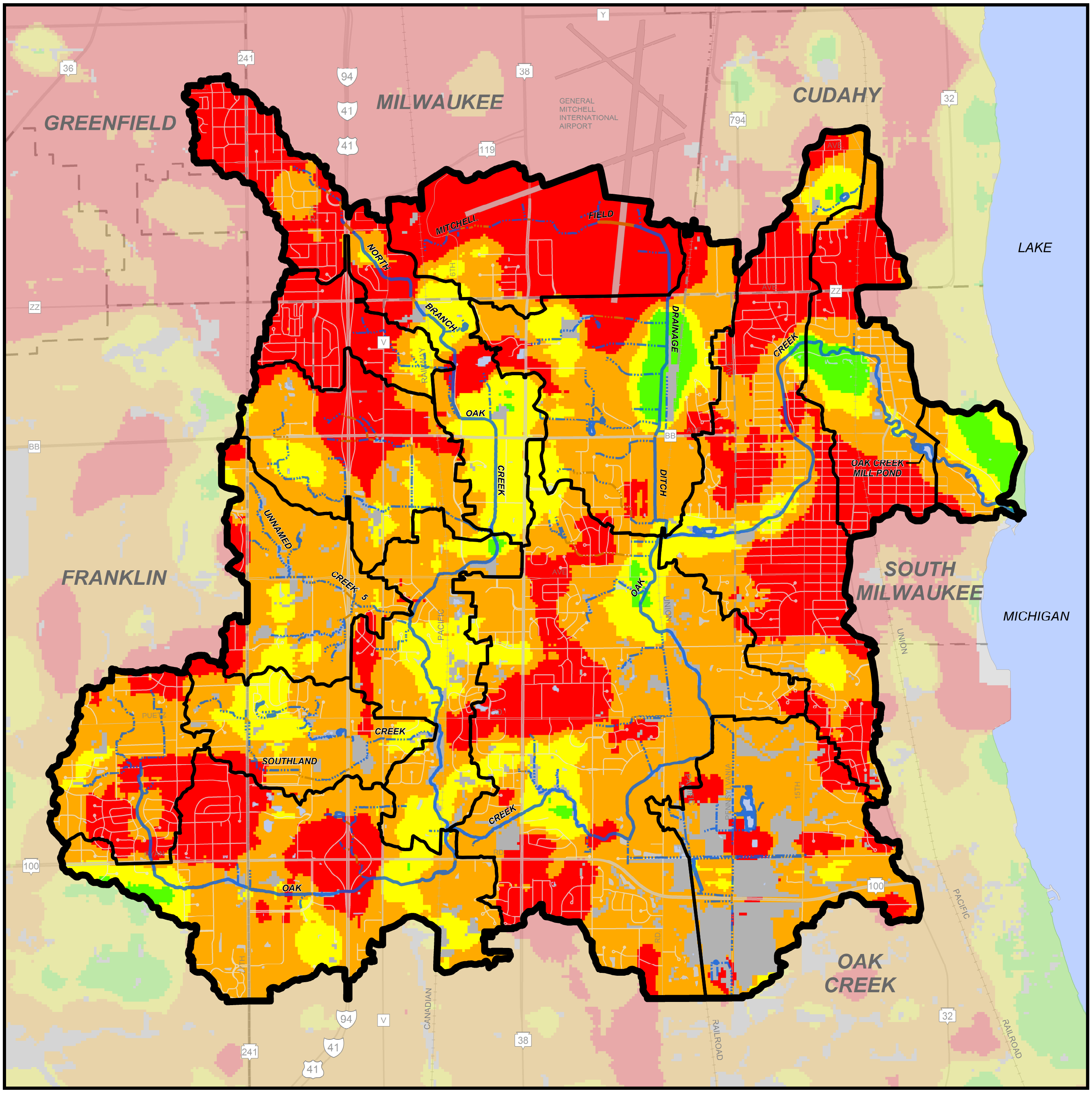
Source: SEWRPC

Map 3.21
Depth to Groundwater Within the Oak Creek Watershed



Source: Natural Resources Conservation Service and SEWRPC

Map 3.22
Estimates of Groundwater Recharge Potential Within the Oak Creek Watershed



VERY HIGH	OAK CREEK WATERSHED BOUNDARY
HIGH	ASSESSMENT AREA BOUNDARIES
MODERATE	PERENNIAL STREAM
LOW	PERENNIAL STREAM (ENCLOSED)
UNDEFINED	INTERMITTENT STREAM
	INTERMITTENT STREAM (ENCLOSED)
	SURFACE WATER

Note: Colors oustide the watershed boundary are reduced in intensity to show the adjacent extent and distribution of each legend category.

0 0.25 0.5 1 Miles

Source: Wisconsin Geological and Natural History Survey and SEWRPC