

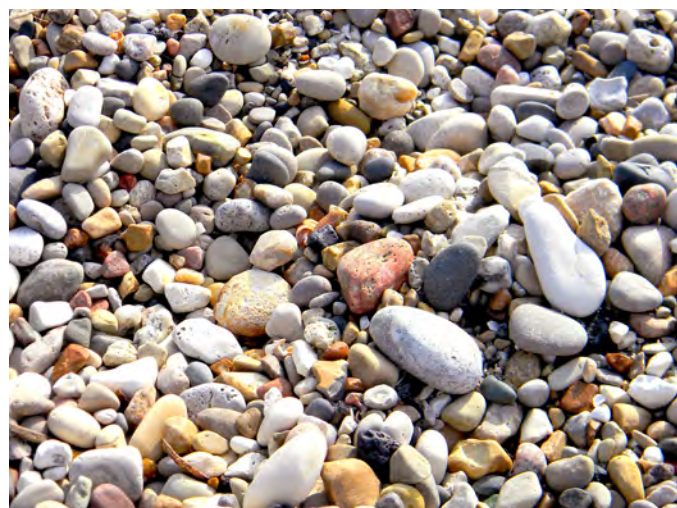
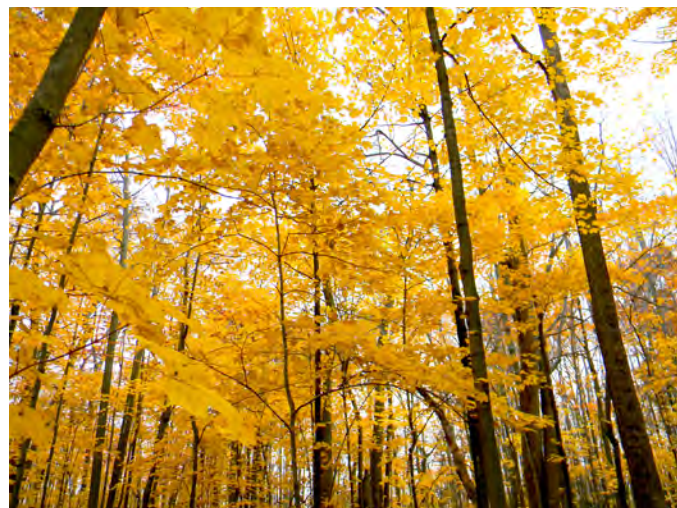
Wind Point Watershed-Based Plan

A Guide to Protecting and Restoring Watershed Health

Prepared for
Root-Pike Watershed Initiative Network
By Applied Ecological Services, Inc.
May 2015



EXECUTIVE SUMMARY



THE WIND POINT LIGHTHOUSE

To assist navigation around the point into Racine harbor, the Wind Point Lighthouse began functioning in 1880 with a kerosene lamp, focused and magnified by a third order Fresnel lens. Its light could be seen for 19 miles.

At 108 feet, it is one of the tallest and oldest lighthouses still serving navigation on the Great Lakes. Its fog horns, which last sounded in 1964, could be heard for 10 miles.

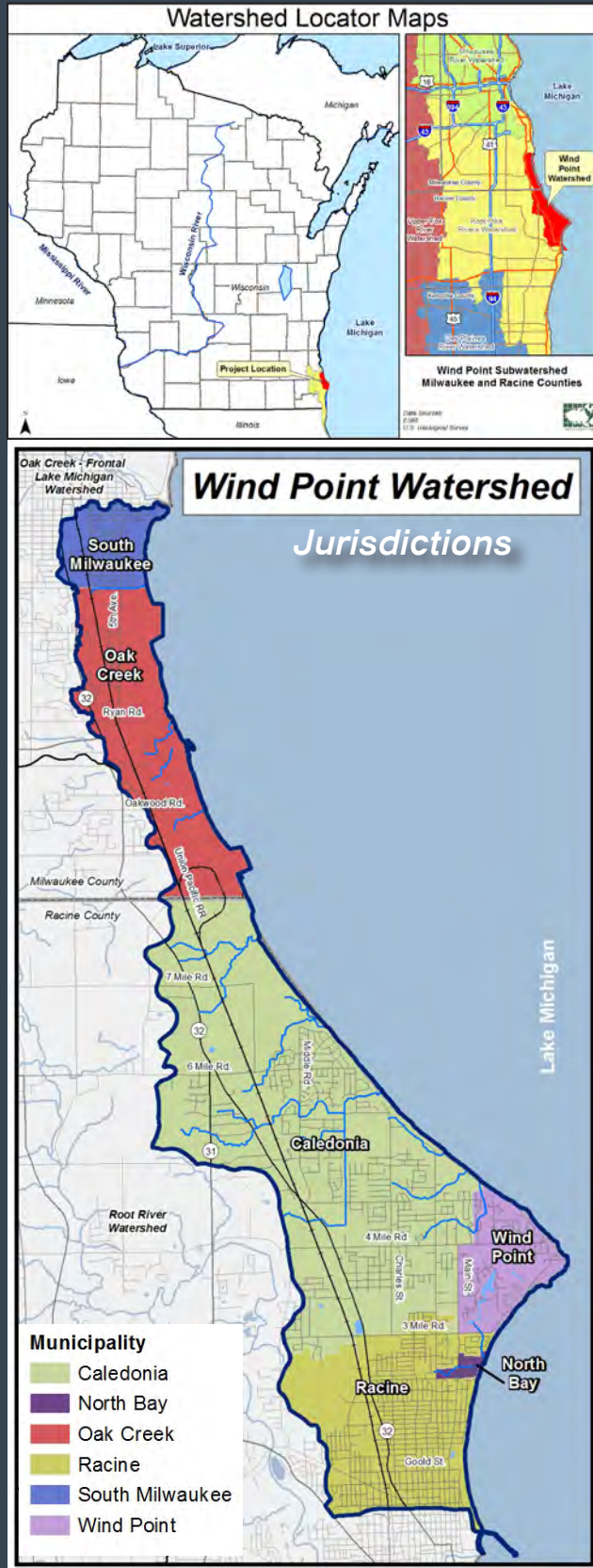
In recognition of the key role this lighthouse has played in the maritime history of Racine County, it was placed on the National Register of Historic Places in 1984.

In 1997, the National Park Service awarded ownership of the property to the Village of Wind Point. The Coast Guard still maintains the light as a public navigation aid.

Erected in 2002 by Friends of the Wind Point Lighthouse in memory of Judge Richard G. Harvey, Jr.

WHAT'S INSIDE?

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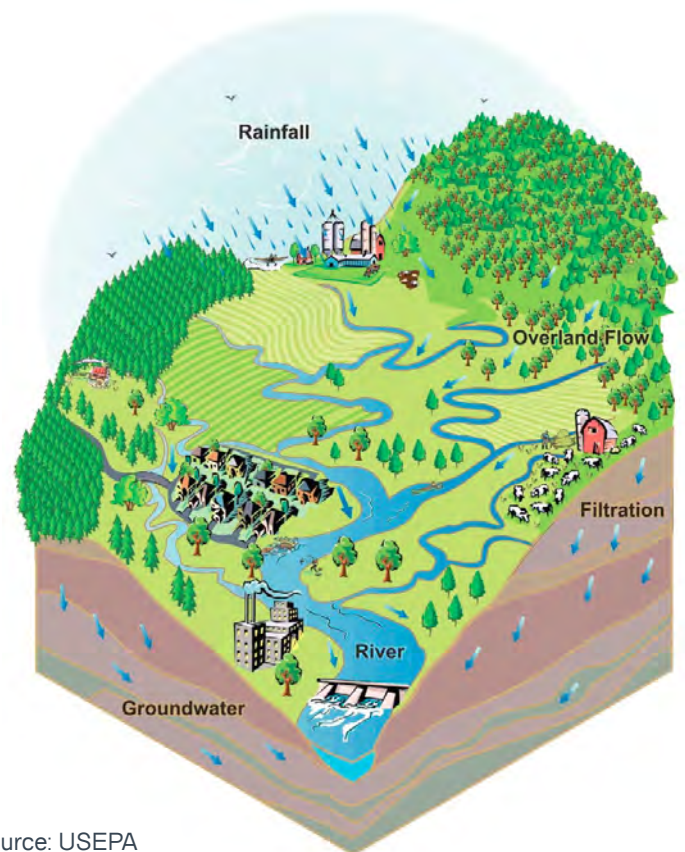


INTRODUCTION

People live, work, and recreate in areas of land known as watersheds. A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or lake (see image, below). The source of groundwater recharge to aquifers, streams, and lakes is also considered part of a watershed. Watersheds are complex systems because there is interaction between natural elements such as climate, surface water, groundwater, vegetation, and human elements. Human influences can produce polluted stormwater runoff, increase impervious surfaces, alter stormwater flows, and degrade or fragment natural areas.

Wind Point watershed (12 Digit HUC# 040400020101) is located in southeast Wisconsin in Milwaukee and Racine Counties (see map, left). It is named for the conspicuous "Point" that extends out into Lake Michigan in the southeast portion of the watershed. The watershed is relatively narrow with a north-south orientation along Lake Michigan. Many small tributary streams and stormsewer networks in the watershed drain approximately 18.7 square miles (11,996 acres) of land surface east to Lake Michigan.

The watershed falls within the borders of six municipalities including Racine, Caledonia, North Bay, Wind Point, Oak Creek, and South Milwaukee (see map, lower left). Of the six municipalities in the watershed, the Village of Caledonia is the largest (6,234 acres; 52%) followed by the City of Racine (2,334 acres; 20%) and City of Oak Creek (1,961; 16%). The Villages of North Bay and Wind Point and City of South Milwaukee account for the remaining 1,462 acres or 12% of the watershed.



Source: USEPA

PURPOSE

The Root-Pike Watershed Initiative Network (Root-Pike WIN) is a grassroots organization that awards grants to projects that will preserve, promote, and protect watershed health. Root-Pike WIN received grant funding from the Fund for Lake Michigan and SC Johnson Fund to undergo a watershed planning effort and produce a comprehensive “Watershed-Based Plan” for Wind Point watershed that meets requirements as defined by the United States Environmental Protection Agency (USEPA). Improvement projects identified within the watershed plan are eligible for state and federal grants.

MISSION

The Wind Point Watershed Planning Committee (WPWPC) is comprised of watershed stakeholders dedicated to the preservation, protection, and improvement of Wind Point watershed.

“The Wind Point Watershed Planning Committee’s mission is to realize a healthy watershed and lakefront for future generations by implementing a long term plan to protect, restore, and manage the cultural and ecological aspects of green infrastructure within Wind Point watershed through watershed plan implementation, education, and stewardship.”

GOALS

Goal 1: *Manage cultural and ecological components of the Green Infrastructure Network.*

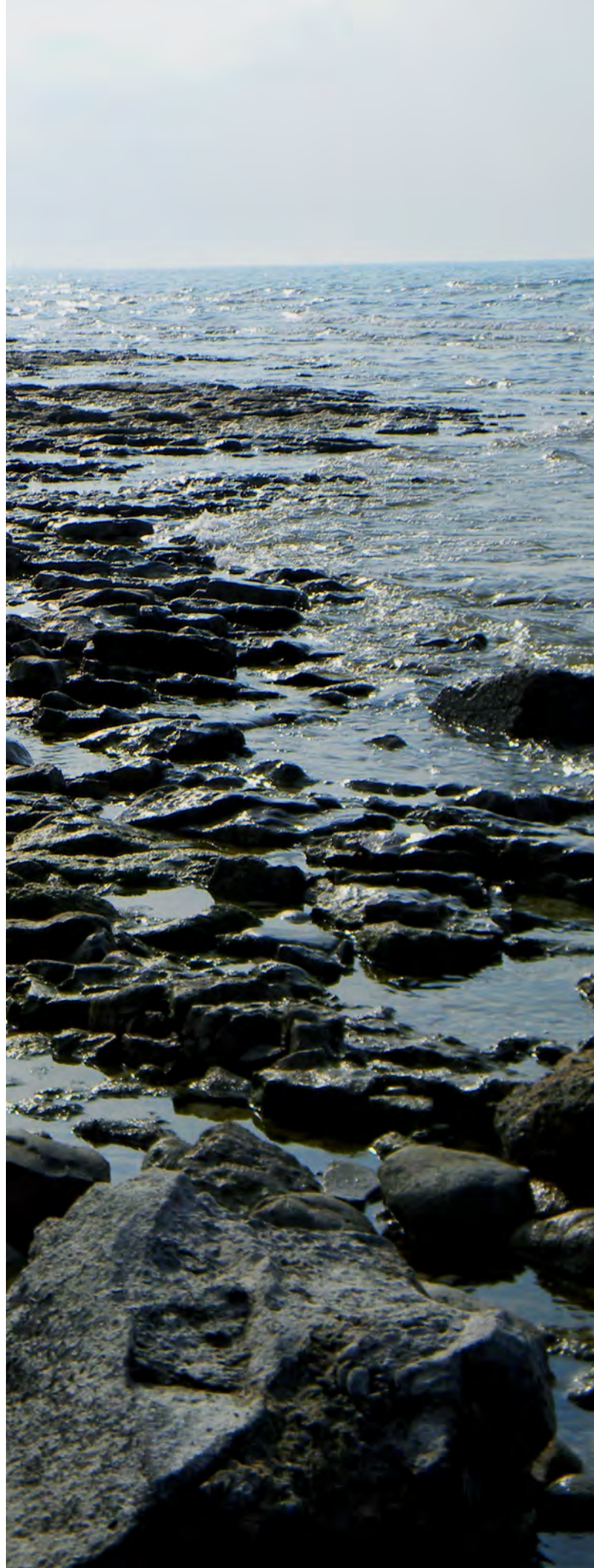
Goal 2: *Implement watershed educational, stewardship, and recreational opportunities.*

Goal 3: *Improve surface water quality to meet applicable standards.*

Goal 4: *Increase communication and coordination among stakeholders.*

Goal 5: *Improve groundwater recharge to maintain shallow aquifers and reduce stormwater runoff.*

Wind Point Watershed Planning Committee meeting overlooking Lake Michigan and at We Energies (above, inset).



THE PAST

The area of southeastern Wisconsin where Wind Point watershed now lies was covered by the most recent glacial event known as the Late Wisconsin Glaciation that ended around 9,500 years ago. During this period the earth's temperature warmed and the ice slowly retreated leaving behind moraines, ridges, and other glacial features. The receding glaciers also scoured out what have become the Great Lakes. The warming climate led to a tundra-like environment covered by spruce forest after glaciers retreated. As temperatures continued to rise, cool moist deciduous forests developed along Lake Michigan coastal areas and oak-hickory forests, oak savannas, marshes, and prairies developed more inland.

The last Native American Indian tribe to call the area home was the Potawatomie. These people lived in harmony with the environment until a treaty in 1833 resulted in their removal from the land by the U.S. Government. This treaty paved the way for European settlement in the area that began with government surveys of the land. The surveyors described about 85% of Wind Point watershed as being forested by southern mesic forest dominated by maple, basswood, and beech trees and southern dry-mesic forest, dominated by a variety of oak and hickory species. Southern lowland forest was common on the relatively flat plateau west of Wind Point. These wet areas contained black ash and alder. There were also beach and dune communities along Lake Michigan that were sculpted by waves and shifting sand.

THE PRESENT

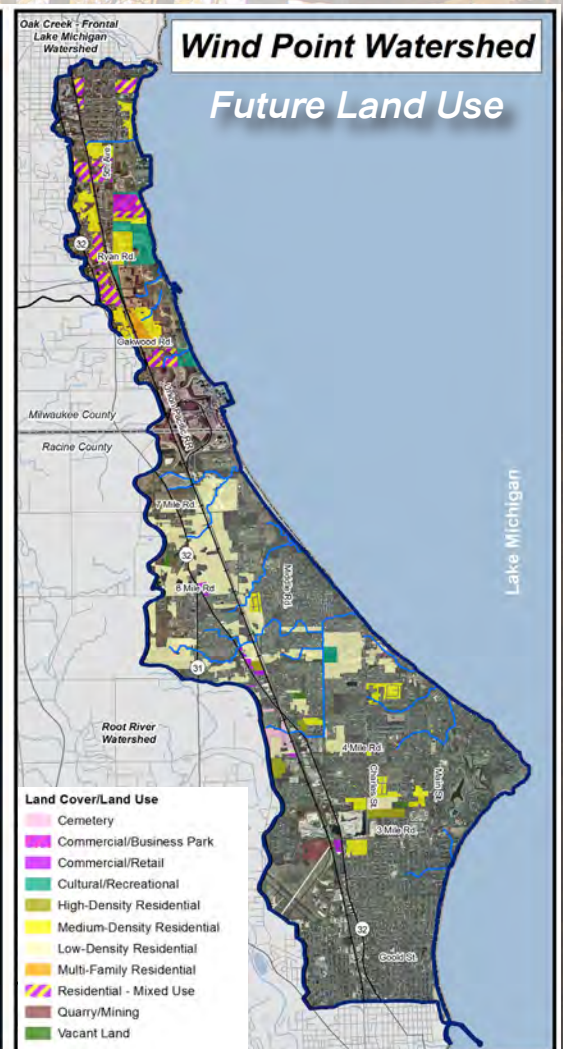
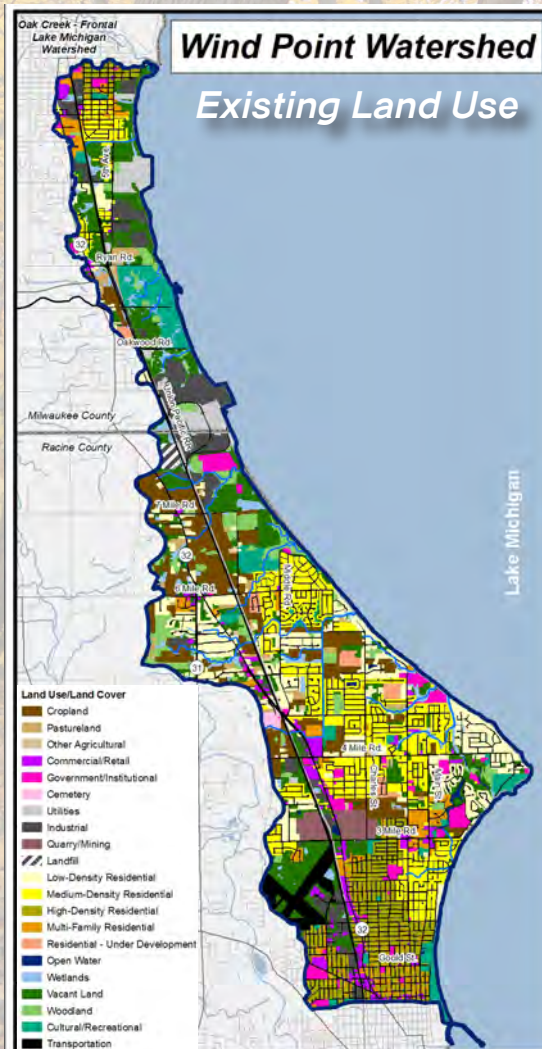
European settlement beginning in the mid 1800s resulted in drastic changes to the fragile ecological landscape. Most of the old growth forests were cleared by settlers who used the wood for fuel, to build their homes, sold it to sawmills, and farmed the cleared land. The large wetland areas west of Wind Point were also cleared and drained for farmland. The majority of streams were channelized and ditched to further drain water off the land.

Residential, commercial, and industrial development followed which led to additional alteration of the natural landscape as landowners

converted property to meet individual needs and roads were constructed adding to landscape fragmentation. By 2012, residential communities comprised 39% of the watershed (see map, below left). Unfortunately, most of this development used "traditional" practices that altered stormwater runoff and fragmented many natural areas.

THE FUTURE

Predicted land use (see map, below right) reveals that the most change is expected to occur on agricultural land where approximately 968 acres of the existing 1,111 acres (83% decrease) is expected to be converted to mostly single family residential and commercial/retail within the municipalities of Caledonia and Oak Creek. A significant loss of vacant land is also expected as 989 acres of the existing 1,649 acres (40% decrease) is predicted to become mostly residential. The remaining 500 acres of woodland is expected to decrease by at least 25% due to residential development. Future development provides one of the best opportunities for local communities to require "conservation" development that preserves green infrastructure, thereby improving water quality, wildlife habitat, groundwater recharge, and quality of life for people.



CHALLENGES & THREATS

Surface Water

- Surface water is impacted by phosphorus, sediment, and *E. coli*.
- Modeling suggests that streambank erosion contributes the most to sediment loading, cropland is the highest contributor of nitrogen, and residential areas contribute the most phosphorus.
- 66% of tributary reaches are moderately to highly channelized.
- 14% of tributary reaches are moderately to highly eroded as a result of headcutting.
- 74% of detention basins are not designed for water quality benefits.

Groundwater

- "Traditional" development trends over the past 30 years generally did not incorporate groundwater infiltration practices.
- Southeastern Wisconsin Regional Planning Commission (SEWRPC) modeling suggests that deep water aquifers are experiencing excessive drawdown.

Land

- Nearly 85% of the watershed was forested historically; only 4% remains.
- There were 2,945 acres of wetlands prior to European settlement; 577 acres or 20% remain.
- 45% of tributary buffers are in poor ecological condition.
- Bluffs along sections of Lake Michigan are experiencing accelerated erosion.
- Development policy among the communities does not adequately protect green infrastructure.
- Over 2,000 acres of open space is predicted to be developed in the future.
- 16 of 24 subwatersheds are or will likely be highly impacted by impervious cover.

Socioeconomics

- A 2010 SEWRPC study estimates a 9,239 (18%) population increase by 2035.
- 14% of the population in Racine is below poverty level.
- 42 "Critical Areas" were identified that could cost over 10 million dollars to address.



Stream Channelization



Bluff Erosion



Detention Basin Design

IMPORTANT NATURAL AND CULTURAL AREAS



Cliffside Park



Source: Jonathan Nightingale

Cliffside Park consists of over 220 acres of natural and recreational areas and is owned by Racine County (see map, lower left). The park harbors second growth mesic woodland, clay seepage bluffs, and old field communities that contain critical species habitat for uncommon bird species such as Cooper's hawk, wood thrush, bobolink, upland sandpiper (inset, left), and grasshopper sparrow. Uncommon plant species found within the park include buffaloberry, yellowish gentian, stiff gentian, balsam poplar, and blue-stemmed goldenrod. In addition, the park may be the best place to see the Lake Border moraines as they tower above the waters of Lake Michigan.

Tabor Woods

Tabor Woods, a locally significant natural area, is found in the west-central portion of the watershed and consists of 38 acres owned by the Caledonia Land Conservancy (see map, lower left). These holdings were named for the Czechoslovakian community that first settled the area. Tabor Woods includes high quality mesic, dry-mesic, and wet-mesic woodland areas harboring beech, hickory, oak, maple, and walnut trees with an abundance of spring wildflowers. Walking and horseback riding trails traverse the property.

Power Plant Ravine, Oak Creek Power Plant Woods, & Clay Ravine Woods

We Energies owns the 32-acre Power Plant Ravine Woods, 12-acre Clay Ravine Woods, and 18-acre Oak Creek Power Plant Woods (see map, lower left). These areas are made up of mesic and dry-mesic woodland and deep ravines that open onto clay banks at Lake Michigan. Oak Creek Power Plant Woods contains mostly mesic woodland that harbors a number of uncommon species such as the endangered blue-stemmed goldenrod. We Energies sites are not open to the public.

Bender Park

Bender Park is 303 acres and owned by Milwaukee County (see map, left). The natural landscape of the park varies with areas of upland and lowland hardwood forests, old orchards, beech forest, shrub-carr, cattail marsh, sedge meadow, and prairie. Hiking trails, overlooks, beach access, and a boat launch are among the recreational amenities offered at the park.

The natural communities at Bender Park harbor a number of uncommon, threatened, and endangered plant and animal species such as Henslow's sparrow, bank swallow, alder flycatcher, American redstart, chestnut-side warbler, eastern kingbird, orchard oriole, and clay-colored sparrow. Uncommon and endangered plants such as blue-stemmed goldenrod, variegated horsetail, slender bog arrow-grass, and red trillium are also found at the park.

Oak Creek Bluffs & Beach, North Bay Ravine & Beach, & Beach North of MMSD

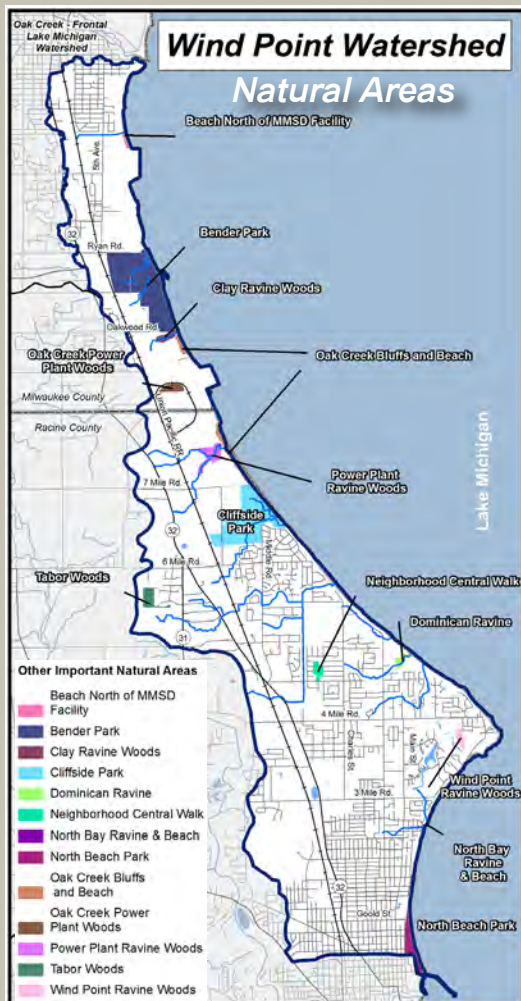
Other beach, foredune, and bluff natural areas in Wind Point watershed include Oak Creek Bluffs & Beach, Clay Ravine Woods, North Bay Ravine & Beach, and Beach North of MMSD (see map, left). All these sites potentially provide habitat for rare sea rocket and species of special concern Ohio goldenrod and false asphodel.

Dominican Ravine, Wind Point Ravine Woods, & Neighborhood Central Walk

Dominican Ravine is roughly 18 acres of woodland that was upgraded to a natural area of local significance due to species diversity and containing endangered blue-stemmed goldenrod. Wind Point Ravine Woods is a small ravine woodland harboring red trillium. Neighborhood Central Walk is a 15-acre parcel owned by the Caledonia Land Conservancy and contains a second growth woodland and neighborhood trails.



Power Plant Ravine Woods. Inset: Blue-stemmed goldenrod. Source: Bryan Hamlin.





North Bay Beach foredune



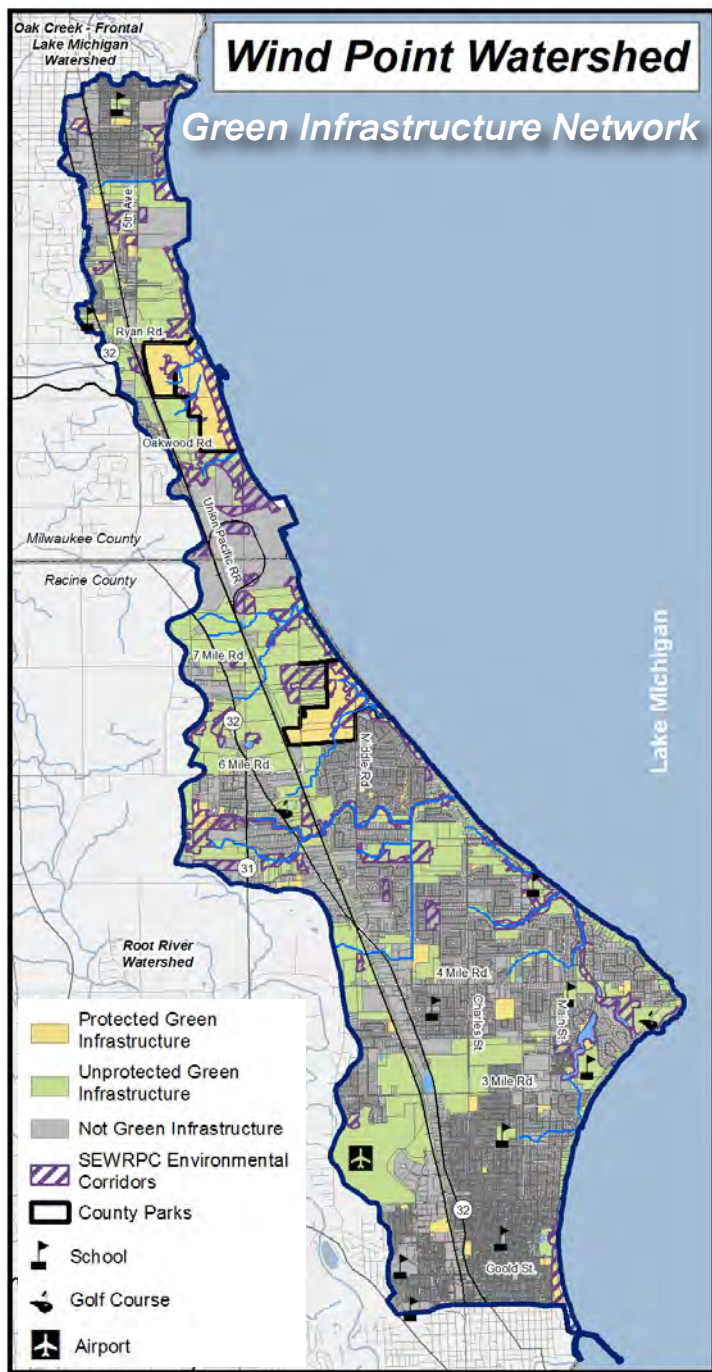
Wind Point Lighthouse was constructed in 1880 by the U.S. Lighthouse Service which later merged with the Coast Guard. It is a 108-foot-tall building built of brick with a stone foundation. The lighthouse is one of tallest and oldest in active service on the Great Lakes. In 1999 a "Friends" group formed to preserve the lighthouse and in 2006, the Fog Horn House was converted to a maritime museum.

The original beacon was powered by a 3-wicked mineral oil lamp that was converted to electric in 1923. The beacon was fully automated when the last resident keeper left in 1964 and the Village of Wind Point began to maintain the property. The grounds also harbor the keepers' quarters, several fog signal buildings, and the oil house.

In 1984, Wind Point Lighthouse was recognized as a National Historic Landmark and the National Park Service officially awarded ownership to the Village of Wind Point in 1997. The Village uses the keepers' quarters as a village hall, police headquarters, and caretakers residence. In addition, the lighthouse still acts as an aid in navigation by the Coast Guard.



GREEN INFRASTRUCTURE



A Green Infrastructure Network is a connected system of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to wildlife and people (see map, left). The network is made up of *Hubs* and linking *Corridors* (image, lower left). Hubs generally consist of the largest and least fragmented areas such as Bender Park and Cliffside Park within Wind Point watershed. Corridors are generally formed by smaller private/unprotected parcels along tributaries and Lake Michigan coast and are important because they provide biological conduits between hubs.

A major component of watershed planning includes an examination of open space to determine how it best fits into a Green Infrastructure Network. Natural features such as stream corridors, wetlands, floodplain, woodlands, and grassland are the primary components of green infrastructure. Working lands such as farms, parks/ball fields, golf courses, school grounds, detention basins, and large residential parcels can also be considered green infrastructure components.

SEWRPC Environmental Corridors

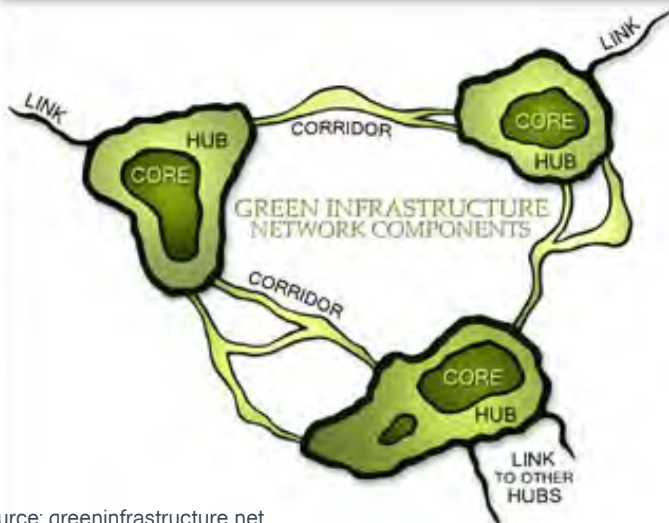
Southeastern Wisconsin Regional Planning Commission (SEWRPC) identified primary and secondary environmental corridors within southeastern Wisconsin (see map, left) to protect important natural resources in the area. Approximately 801 acres are considered Primary Environmental Corridors. An additional 66 acres and 426 acres, respectively, fall within Secondary Environmental Corridors and Isolated Natural Resource Areas. The majority of these Environmental Corridors extend along Lake Michigan and over some of the ravines and tributaries within Bender Park and Cliffside Park. The Environmental Corridors in Wind Point watershed form the backbone of the Green Infrastructure Network.

ADID Wetlands, Lakes, and Ponds

The United States Environmental Protection Agency (USEPA) uses the advanced identification of disposal areas (ADID) process to identify wetlands and other waters that are unsuitable for the discharge of dredged and fill materials. For Wind Point watershed, 130 acres of these ADID identifications were made by the USEPA in conjunction with the United States Army Corps of Engineers (USACOE) and Wisconsin Department of Natural Resources (WDNR). SEWRPC provided technical assistance in producing these maps by combining this data with their Primary Environmental Corridors (see map, upper left).

Green Infrastructure Highlights

- Nearly 5,000 acres or 57% of the watershed is open space.
- Public open space comprises about 18% of the watershed.
- 17% of public open space is protected.
- Over 2,000 acres of open space will likely be developed in the next 30 years.



Perhaps the most important aspect of green infrastructure planning is that it helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature. As additional development occurs within Wind Point watershed, it will be extremely important to consider alternatives that use conservation or low impact development designs. These types of developments facilitate density needs while preserving the most valuable natural features and ecological functions of a site.

Conservation Design & Low Impact Development



Conservation design and low impact developments are not only environmentally sound choices, but economical ones for both developers and municipalities. Conservation design can produce some of its biggest cost savings in infrastructure such as site preparation, stormwater management, site paving, and sidewalks. Studies have also shown that the average savings created by choosing conservation development over more traditional footprints is as high as 24%. In addition, lots within a development with protected open space have been shown to have a 2.6% higher annual appreciation rate over lots within traditional developments.



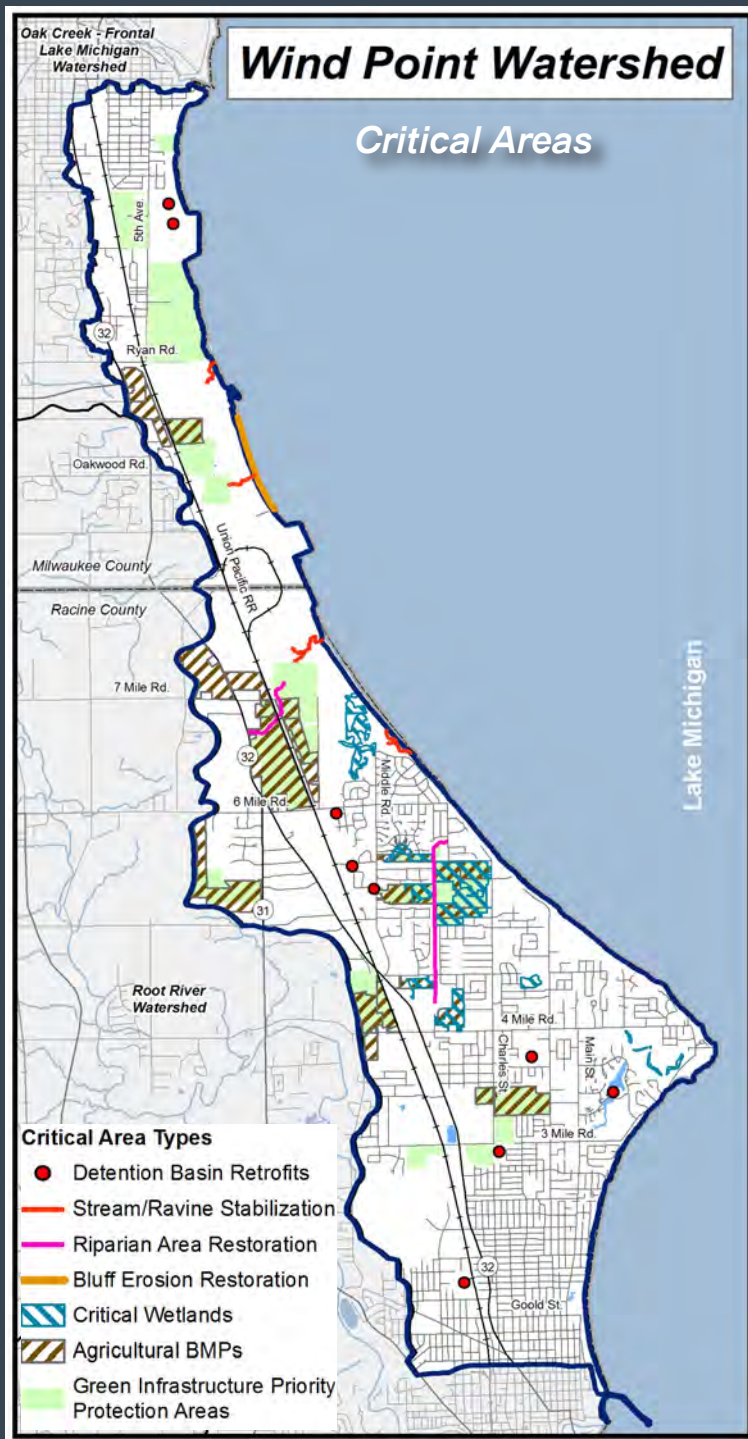
PHOTOS: Conservation/low impact development design (upper) and example of conservation subdivision at Carrington Reserve in West Dundee, IL (lower).

Green infrastructure at North Beach (upper photo) and along Lake Michigan coast (lower photo).



ACTION RECOMMENDATIONS

The Wind Point watershed plan includes an “Action Plan” developed to provide stakeholders with recommendations to address plan goals. The Action Plan includes programmatic and site specific recommendations. Programmatic recommendations are general watershed-wide remedial, preventative, and regulatory actions. Site specific recommendations include actual locations where projects can be implemented to improve surface and groundwater quality, green infrastructure, and aquatic and terrestrial habitats.



Programmatic Recommendations

Policy

- Stakeholders adopt the watershed plan to leverage green infrastructure, groundwater, stormwater management, and native landscaping/natural area restoration policy recommendations.

Surface & Groundwater Quality

- Retrofit existing detention basins with native vegetation and properly design future basins.
- Use vegetated swales, pervious pavement, and porous asphalt in future developments.
- Incorporate riparian buffers into future developments.
- Incorporate wetland restoration into future conservation developments.
- Municipalities implement minimum bi-weekly street sweeping programs.
- Implement stream and ravine restoration projects.
- Septic system owners become compliant with treatment and disposal ordinances.
- Use recommendations in the plan to identify potential water quality trading opportunities.

Habitat

- Install native landscaping on small lots and implement natural area restoration on larger lots.
- Control existing invasive species populations and prevent the spread of invasives.
- Implement dune swale restoration projects along the Lake Michigan coast.

Agricultural

- Farmers enroll in Farm Bill and NRCS incentive and assistance programs.
- Farmers implement conservation tillage (no-till) farming as a standard practice.

Education

- Educate residents and businesses about the beneficial uses of rain gardens.
- Educate residents and businesses about the beneficial uses of rain barrels and cisterns.
- Implement the Wind Point watershed Information & Education Plan.

Green Infrastructure

- Municipalities incorporate the green infrastructure network into development review maps.
- Use conservation and/or low impact development designs on future developments.
- Convert brownfields into natural areas, conservation developments, or parks.

High Priority Critical Area Site Specific Recommendations (see map, opposite page)

Detention Basin Retrofits

Traditional detention basins can be retrofitted by naturalizing with native vegetation. Naturalized basins improve water quality from developed areas, improve habitat, and require little maintenance. There are 8 critical detention basin retrofit opportunities in the watershed.

Wetland Restoration

Wetland restoration sites are generally associated with large areas that were historically wetland prior to European settlement in the 1830s but were drained for agricultural purposes. Many of these historic wetlands can be restored to improve water quality, reduce flooding, and improve wildlife habitat. There are 9 critical wetland restoration sites totaling 270 acres.

Stream and Ravine Stabilization

Stream and ravine reaches with highly eroded banks are a major source of total suspended solids (sediment). Bank stabilization using bioengineering and installation of artificial riffles would greatly reduce sediment and nutrient transport downstream while improving habitat and increasing oxygen levels. Four critical area stream and/or ravine reaches totaling 8,685 linear feet were identified.

Riparian Area Restoration

Critical riparian areas are select locations adjacent to tributary reaches that are in poor ecological condition or areas lacking a buffer but with excellent ecological restoration and remediation potential to improve water quality and habitat conditions. Two critical riparian areas totaling 14,541 linear feet were identified.

Green Infrastructure Protection Areas

The watershed plan identifies 11 critical green infrastructure protection areas totaling 1,403 acres. Most of these areas are existing agricultural land or brownfields where future development is planned. These areas should be protecting and restoring or developing using conservation or low impact development designs.

Agricultural Management Practices

Agricultural measures such as conservation tillage (no-till) would reduce pollutant loading in the watershed. Seven critical agricultural areas totaling 975 acres were identified based on their size and/or location in the watershed.

Bluff Stabilization

There is significant bluff erosion along 4,500 linear feet of the Lake Michigan coast from Fitzsimmons Rd. (within Bender Park) south to Elm Rd. (We Energies owned land). The watershed plan recommends completing a feasibility study to determine the need for and cost of stabilizing the eroded bluff.



Naturalized Detention Basin



Wetland Restoration



Stream Restoration

MAKE A DIFFERENCE!

Watershed planning and implementation is a voluntary effort. Active watershed stakeholders are needed to put the Wind Point Watershed-Based Plan into action. The Wind Point Watershed Implementation Committee is in place to support plan implementation and future planning efforts. Contact the Root-Pike Watershed Initiative Network to learn how you can help. The Wind Point Watershed-Based Plan can be downloaded at www.rootpikewin.org.

How can you help the Wind Point Watershed?

Residents & Businesses

- Reduce fertilizer use on lawns and consider using organic products.
- Use less salt on driveways, parking lots, and sidewalks during winter months.
- Use native landscaping to decrease watering needs and maintenance.
- Manage your backyard as part of the green infrastructure network.
- Attend meetings with decision makers to express concerns about the watershed.
- Install rain gardens and use rain barrels to reduce stormwater runoff.
- Attend Root-Pike WIN sponsored environmental education events.
- Become a natural area volunteer or steward.

Agricultural Community

- Consult your local Natural Resources Conservation Service (NRCS) office regarding enrollment in conservation programs to help reduce soil erosion, enhance water supplies, improve water quality, improve wildlife habitat, and reduce flood damages.

Municipalities & Park Districts

- Inform the public that a plan has been developed for Wind Point watershed.
- Adopt the Wind Point Watershed-Based Plan.
- Incorporate watershed plan goals and recommended actions into local comprehensive plans, zoning overlays, codes, and ordinances.
- Build “demonstration projects” near public facilities.
- Prepare annual budgets for restoring & managing green infrastructure and providing education.
- Increase recreational opportunities throughout the green infrastructure network.

Wind Point Watershed Implementation Committee

- Identify “Champions” to participate at future meetings, pursue projects, and discuss and evaluate watershed plan implementation progress.
- Fund a Watershed Implementation Coordinator to follow through on plan implementation.
- Build partnerships to leverage funding for implementing plan recommendations.



This plan was prepared using grant funding from the Fund for Lake Michigan, SC Johnson Fund, and We Energies Foundation. The findings and recommendations herein are not necessarily those of the funding entities.

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Applied Ecological Services, Inc.
All photos by AES unless otherwise noted.

1.0 Introduction

1.1 Wind Point Watershed Setting

People live, work, and recreate in areas of land known as “Watersheds”. A watershed is best described as an area of land where surface water drains to a common location such as a stream, river, or lake (Figure 1). The source of groundwater recharge to streams, rivers, and lakes is also considered part of a watershed. Despite the simple definition for a watershed, they are complex systems with interaction between natural elements such as climate, surface water, groundwater, vegetation, and wildlife as well as human interactions. Agriculture and urban development produce polluted stormwater runoff, increase impervious surfaces thereby altering stormwater flows, and degrade or fragment natural areas. Other common names given to watersheds, depending on size, include basins, sub-basins, subwatersheds, and Subwatershed Management Units (SMUs).

Figure 1. Hypothetical watershed setting. (Source: USEPA)

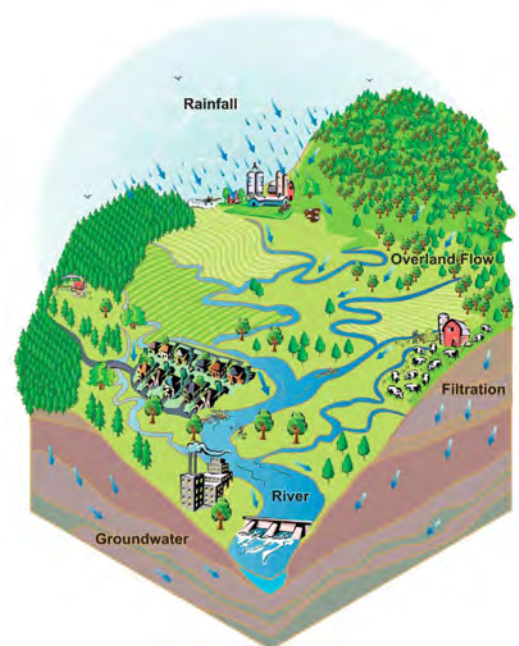
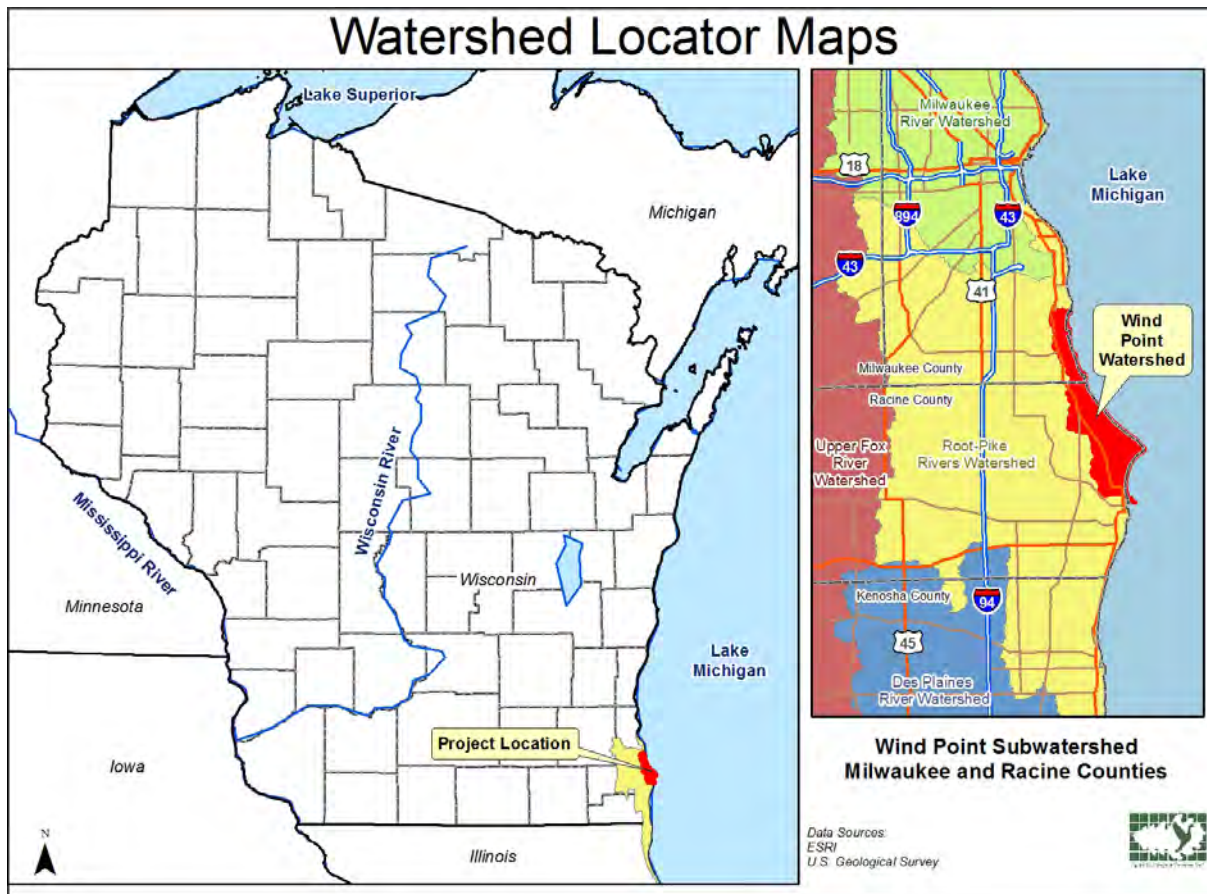


Figure 2. Watershed locator maps.



Wind Point watershed (12 Digit HUC: 040400020101) is located in southeast Wisconsin in both Milwaukee and Racine Counties (Figure 2). It is named for the conspicuous “Point” that extends out into Lake Michigan in the southeast portion of the watershed. The watershed is relatively narrow with a north-south orientation along Lake Michigan. Many small tributary streams and stormsewer networks in the watershed drain approximately 18.7 square miles (11,996 acres) of land surface east to Lake Michigan. Municipalities found in the watershed include Racine, Caledonia, North Bay, Wind Point, Oak Creek, and South Milwaukee.

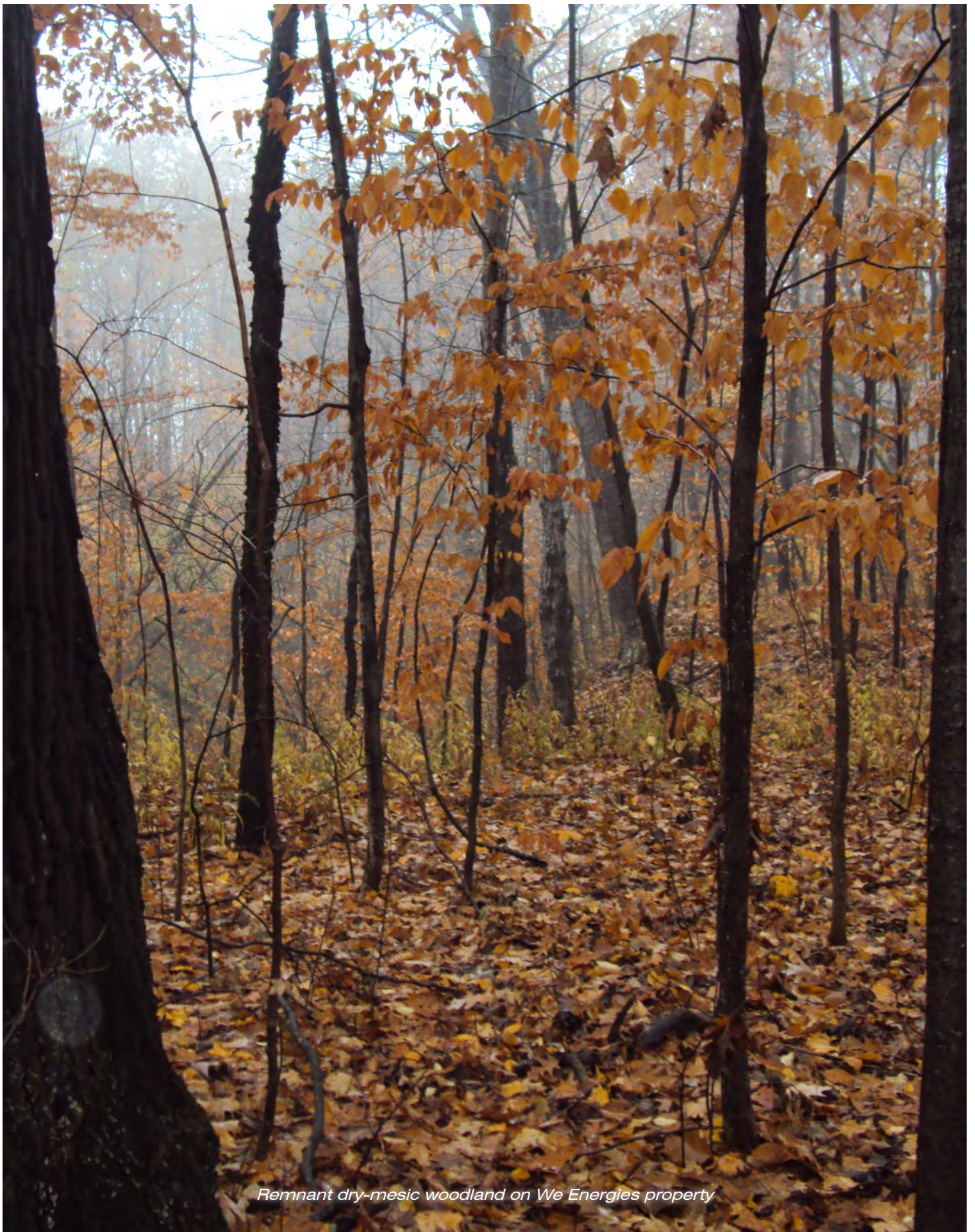
Prior to European settlement, the Wind Point watershed was ecologically intact, with clean water and a diversity of plant and wildlife

populations. The mosaic of mesic/dry-mesic/lowland forests, marshes, and beach/dune communities were preserved by the cool moist climate along Lake Michigan, unlike most of southeast Wisconsin where the landscape was shaped and maintained by frequent wildfires. During these times most of the water that fell as precipitation was absorbed in these forested and wetland communities. Southeast Wisconsin was inhabited by the Potawatomi Indian tribe until 1833 when the U.S. Government purchased 5 million acres of land and moved the Potawatomi to areas in the western United States.

Ecological conditions changed quickly and drastically following European settlement in the mid 1800s. Large scale fires no longer occurred and bison and elk were extirpated. Significant portions

of wooded communities and nearly all prairies were tilled and tile systems were installed to drain wetland areas as farming became the primary land use by the early 1900s. Conversion from farmland to primarily residential and commercial uses followed, particularly over the past 30 years because of the close proximity to Milwaukee and Chicago, affordable land costs, and existing transportation networks. Wind Point watershed is presently dominated by residential areas, vacant land, transportation (roads, etc), cropland and mixture of commercial / industrial centers.

With ongoing “Traditional” development and landscape change in the watershed comes negative impacts to the environment. Impervious surfaces greatly reduce the ability



Remnant dry-mesic woodland on We Energies property

of precipitation to infiltrate into the ground and instead cause stormwater runoff to quickly reach streams and tributaries resulting in downcutting, widening, and bank erosion causing sediment and nutrient loading downstream. Meanwhile, invasive species established in adjacent floodplain wetlands are causing loss of wildlife habitat and reduced floodplain function. In addition, nutrients from residential lawn fertilizers are negatively impacting the watershed.

Discharged water from various sources that is not properly filtered is referred to as “non-point source pollution” and is the primary focus of this plan.

According to the Wisconsin Department of Natural Resources (WDNR) 2012 Water Quality Report and Section 303d List (WDNR 2012), none of the tributary streams in Wind Point watershed are listed as impaired for any of their “Designated Uses” because they

have not been assessed by WDNR. The findings of this report however, suggest moderate impairment of the tributary streams caused by channelization, streambank erosion, draining of wetlands, and high phosphorus and E. coli in agricultural and urban stormwater runoff. Additionally, Zoo Beach and North Beach, located along Lake Michigan in the south portion of the watershed, are not impaired.

Watershed at a Glance

- Wind Point watershed lies in an area covered by the most recent glacial event - the Late Wisconsin Glaciation.
- Southern mesic, dry-mesic, and lowland forests were common prior to European settlement in the 1830s.
- The climate is temperate; Lake Michigan reduces heat of summer and buffers the cold of winter.
- Tributaries in the watershed drain 18.7 square miles of land in Milwaukee & Racine Counties, Wisconsin.
- The dominant land uses in 2012/2013 include vacant land, residential development, and transportation networks.
- Municipalities include Caledonia, Racine, Oak Creek, Wind Point, South Milwaukee, & North Bay.
- North Beach Park is well known for its swimming beaches and restored foredune complexes.
- The population of the watershed in 2000 was over 51,000 and expected to increase to over 60,000 by 2035.
- Water quality in tributaries is impacted by phosphorus, sediment, and E. coli; one of the beaches are impaired.
- 34% of streams and tributaries are naturally meandering; 66% are moderately to highly channelized.
- 86% of streams and tributaries exhibit minimal bank erosion; 14% are moderately to highly eroded.
- 22% of the riparian areas are in “Good” ecological condition, 33% are “Moderate”; and 45% are “Poor”.
- There were 2,945 acres of wetlands prior to European settlement; 577 acres or 20% remain in 2012/2013.
- There are 39 known detention basins; only 10 (26%) provide “Good” ecological/water quality benefits.
- Open space parcels comprise approximately 2,508 acres or 24% of the watershed.
- 17 “Important Natural Areas” make up 2,257 acres and are home to several threatened & endangered species.
- Shallow and deep groundwater aquifers provide the water supply for many private users and municipalities.
- Water quality modeling indicates that streambank erosion contributes the most to sediment loading.
- Cropland is modeled as the highest contributor of nitrogen while residential areas contribute the most phosphorus.
- 42 “Critical Areas” were identified for potential implementation of Management Measures.

1.2 Project Scope & Purpose

The Root-Pike Watershed Initiative Network (Root-Pike WIN) is a grassroots watershed organization that awards grants to projects that will preserve, promote, and protect watershed health. Root-Pike WIN received grant funding from the Fund for Lake Michigan, SC Johnson Fund, and We Energies to undergo a watershed planning effort and produce a comprehensive “Watershed-Based Plan” for Wind Point watershed that meets requirements as defined by the United States Environmental Protection Agency (USEPA). Ultimately, the intent is to develop and implement a Watershed-Based Plan designed to achieve water quality

standards/criteria. Root-Pike WIN, acting as fiscal agent, hired Applied Ecological Services, Inc. (AES) in September 2012 to develop the plan.

The watershed planning process is a collaborative effort involving voluntary stakeholders with the primary scope to restore impaired waters and protect unimpaired waters by developing an ecologically-based management plan for Wind Point watershed that focuses on improving water quality by protecting green infrastructure, creating protection policies, implementing ecological restoration, and educating the public. Another important outcome is to improve the quality of life for people in the watershed for current and future generations.

The primary purpose of this plan is to spark interest and give stakeholders a better understanding of Wind Point watershed to promote and initiate plan recommendations that will accomplish the goals and objectives of this plan. This plan was produced via a comprehensive watershed planning approach that involved input from stakeholders and analysis of complex watershed issues by watershed planners, ecologists, GIS specialists, water quality specialists, and environmental engineers. In addition, ideas and recommendations in this plan are designed to be updated through adaptive management that will strengthen the plan over time as additional information becomes available.

1.3 USEPA Watershed-Based Plan Requirements

In March 2008, the United States Environmental Protection Agency (USEPA) released watershed protection guidance entitled “Non-point Source Program and Grant Guidelines for States and Territories.” The document was created to ensure that Section 319 funded projects make progress towards restoring waters impaired by non-point source pollution. Applied Ecological Services, Inc. consulted USEPA’s “Handbook for Developing Watershed Plans to Restore and Protect Our Waters” (USEPA 2008) to create this watershed plan. Having a Watershed-Based Plan will allow Wind Point watershed stakeholders to access 319 Grant funding and other funding for watershed improvement projects recommended in this plan. Under USEPA guidance, “Nine Elements” are required in order for a plan to be considered a Watershed-Based Plan.

USEPA Nine Elements

- Element A:** Identification of the causes and sources or groups of similar sources of pollution that will need to be controlled to achieve the pollutant load reductions estimated in the watershed-based plan;
- Element B:** Estimate of the pollutant load reductions expected following implementation of the management measures described under Element C below;
- Element C:** Description of the BMPs (non-point source management measures) that are expected to be implemented to achieve the load reductions estimated under Element B above and an identification of the critical areas in which those measures will be needed to implement
- Element D:** Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement the plan;
- Element E:** Public information/education component that will be implemented to enhance public understanding of the project and encourage early and continued participation in selecting, designing, and implementing/maintaining non-point source management measures that will be implemented;
- Element F:** Schedule for implementing the activities and non-point source management measures the plan; identified in this plan that is reasonably expeditious;
- Element G:** Description of interim, measurable milestones for determining whether non-point source management measures or other control actions are being implemented;
- Element H:** Set of environmental or administrative criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards;
- Element I:** Monitoring component to evaluate the effectiveness of the implementation efforts over time.

1.4 Planning Process

Watershed Stakeholder Planning Committee

Planning for Wind Point watershed utilized a unique approach that was designed in three phases. Phase I, included four public meetings that occurred between June and November, 2013. This phase was focused on building early stakeholder engagement in support of the planning process, educating stakeholders on watershed conditions, challenges, and threats, and determining stakeholder visions and goals for the watershed. Phase II of the planning process included

seven meetings between January 2014 and February 2015. This phase revolved around the development of the Watershed-Based Plan, including all of the nine Elements required by the USEPA. Information gathered from municipalities, townships, state and federal agencies, nonprofit organizations, and watershed residents during Phase I of the planning process and interests, issues, and opportunities identified by Root-Pike WIN were addressed and incorporated into the watershed plan. Phase III follows plan completion and is centered around implementation and restoration projects as identified

in the plan.

Root-Pike WIN played an important role in the early identification of watershed issues, stakeholder goals, and an overall vision for watershed improvements. Meetings were initiated by the Watershed Coordinator, Susan Greenfield/ Allison Thielen, and covered a wide range of topics specific to Wind Point watershed. Meeting schedules for both Phases I and II, including the topics of those meetings, are included in Table 1. Meeting minutes are included in Appendix A.

Site visit along North Beach following August 15, 2013 meeting



Table 1. Phase I and II meeting agendas and summaries.

Date	Agenda	Summary
Phase I Meetings		
June 13, 2013	• Recognition of funders • Introduction to Watershed Planning Presentation • Overview of Wind Point Watershed Presentation	Project funders were recognized followed by presentations by Applied Ecological Services that described the planning process and what to expect. As well as a summary of the field inventory work completed in fall 2012.
August 15, 2013	• Areas of Interest Exercise • Water Quality Presentation • Tour of Lake Michigan Shoreline	Root-Pike WIN started with the Areas of Interest exercise. Next, Racine Health Department provided a snapshot summary of their water quality sampling in the watershed. Last, Racine Health Department led a tour of Lake Michigan Shoreline Projects.
October 17, 2013	• Areas of Interest Exercise • Land Use Planning Presentation • Protecting the Water's Edge Presentation	Root-Pike WIN started with the Areas of Interest exercise. Next, SEWRPC provided a presentation about land use planning in the watershed. SEWRPC also presented on the importance of buffers around waterways.
November 16, 2013	• Watershed Overview Presentation • World Café Exercise - Mission & Vision - Watershed Goals	Applied Ecological Services first gave summary of the Wind Point watershed to prepare stakeholders for a visioning session. The visioning session followed a World Café Exercise format whereby stakeholders provided valuable information about the group's mission/vision and goals for the watershed.
Phase II Meetings		
January 16, 2014	• Present Introduction & portions of Plan Section 3.0	Applied Ecological Services presented the Introduction section of the plan and portions Section 3.0 (Watershed Resource Inventory) including climate, geology, topography, watershed boundary, pre-European settlement landscape, soils, jurisdictions, demographics, policy, existing & future land use, transportation network, and impervious cover.
March 20, 2014	• Present remaining portions of Plan Section 3.0 • Role of Land Trusts, Existing Easements, & Preserved Land	Applied Ecological Services presented portions of Section 3.0 (Watershed Resource Inventory) including open space, green infrastructure, natural areas, drainage system, and groundwater. Caledonia Conservancy then discussed the role of land trusts in preserving conservation easements and permanently preserving lands.
May 15, 2014	• Watershed Tour	Root-Pike WIN organized a watershed tour that visited North Beach, Tabor Woods, WE Energies Fishing Pier, Bender Park, Klema Ditch, and a detention basin. Multiple individuals explained the conditions at each site and importance in the watershed.
July 17, 2014	• Water Quality Data Summary • Pollutant Loading Model • Causes & Sources of Impairment	Applied Ecological Services presented plan Section 4.0 (Water Quality & Pollutant Modeling Assessment). It was explained to the group that sediment, phosphorus, and E. coli are the primary water quality threats in the watershed.
September 11, 2014	• Critical Areas • Programmatic Action Plan • Site Specific Action Plan	Applied Ecological Services presented plan Section 5.0 (Causes & Sources of Impairment & Reduction Targets) and 6.0 (Management Measures Action Plan). This also included a discussion of the "Critical Areas" within the watershed and potential projects.
November 20, 2014	• Executive Summary • Information & Education Plan • Future Water Quality Monitoring	Applied Ecological Services presented the Executive Summary. This was followed by an in depth presentation of the plan Section 7.0 (Information & Education Plan) by Root-Pike WIN. The Racine Health Department presented the Future Water Quality Monitoring Plan from plan Section 8.0.
May, 2015	• Present Final Watershed Plan • Discuss Phase III Implementation	Applied Ecological Services and Root-Pike WIN presented the Final Watershed Plan to the public.

1.5 Using the Watershed-Based Plan

The information provided in this Watershed-Based Plan is prepared so that it can be easily used as a tool by any stakeholder including elected officials, federal/state/county/municipal staff, and the general public to identify and take actions related to watershed issues and opportunities. The pages below summarize what the user can expect to find in each major “Section” of the Watershed-Based Plan.

Section 2.0: Mission, Goals, and Objectives

Section 2.0 of the plan contains the Root-Pike WIN mission and goals/objectives. Goal topics include Green Infrastructure Network, Education & Stewardship, Surface Water Quality, Communication & Coordination, and Groundwater Quantity & Quality. In addition, “Measurable Objectives” were developed where possible for each goal so that the progress toward meeting each goal can be measured in the future by evaluating information included in Section 9.0 (Measuring Plan Progress & Success).

Section 3.0: Watershed Resource Inventory

An inventory of the characteristics, problems, and opportunities in Wind Point watershed is examined in Section 3.0. Resulting analysis of the inventory data led to recommended watershed actions that are included in Section 6.0 (Management Measures Action Plan). Inventory results also helped identify causes and sources of watershed impairment as required under USEPA’s Element A.

Section 3.0 includes summaries and analysis of the following inventory topics:

Watershed Resource Inventory Topics *Included* in the Plan

- 3.1 Geology & Climate
- 3.2 Pre-European Settlement Landscape & Present Landscape
- 3.3 Topography, Watershed Boundary, Subwatersheds
- 3.4 Soils
- 3.5 Jurisdictions
- 3.6 Existing Policies
- 3.7 Demographics
- 3.8 Transportation Network
- 3.9 Existing & Future Land Use
- 3.10 Impervious Cover Impacts
- 3.11 Open Space and Green Infrastructure
- 3.12 Highly Productive Agricultural Land
- 3.13 Natural Areas
- 3.14 Watershed Drainage System
 - Tributaries
 - Detention Basins
 - Wetlands
 - Floodplain
- 3.15 Groundwater

Section 4.0: Water Quality & Pollutant Modeling Assessment

A summary and analysis of available water quality data for the watershed and pollutant modeling assessment is included in its own section because of its importance in the watershed planning process. This section includes a detailed summary of physical, chemical, and biological data available for Wind Point watershed. Water quality data combined with pollutant loading data provides information that sets the stage for developing pollutant reduction targets and identifying “Critical Areas” as outlined in Section 5.0 (Causes & Sources of Impairment & Reduction Targets).

Section 5.0: Causes & Sources of Impairment & Reduction Targets

This section of the plan includes a list of causes and sources of watershed impairment as identified in Section 3.0 (Watershed Resource Inventory) and by watershed stakeholders that affect Wisconsin DNR “Designated Uses” for water quality and other watershed features. As required by USEPA, Section 4.0 also addresses

all or portions of *Elements A, B, & C* including an identification of the “Critical Areas”, pollutant load reduction targets, and estimate of pollutant load reductions following implementation of recommended Critical Area Management Measures identified in Section 6.0.

Section 6.0: Management Measures Action Plan

A “Management Measures Action Plan” is included in Section 6.0. The Action Plan is divided into a Programmatic Action Plan and a Site Specific Action Plan. Programmatic recommendations are described in paragraph format; site specific recommendations are presented in paragraph, figure, and table formats with references to entities that would provide consulting, permitting, or other technical services needed to implement specific measures. The site specific tables also outline project priority, pollutant reduction efficiency, implementation schedule, sources of technical and financial assistance, and cost estimates. This section also contains a watershed-wide summary table of specific information for all recommended site specific management measures combined including “Units,” “Cost,” and “Estimated Pollutant Load Reduction”. This section addresses all or a portion of USEPA *Elements C & D*.

Section 7.0: Information & Education Plan

This section is designed to address USEPA *Element E* by providing an Information/Education component to enhance public understanding and to encourage early and continued participation in selecting, designing, and implementing recommendations provided in the Watershed-Based Plan. This is accomplished by providing a matrix that outlines each recommended education action, target audience, package or vehicle for implementing the action, who will lead the effort, what the expected outcomes or behavior change will be, and estimated costs to implement.

Sections 8.0 & 9.0: Plan Implementation & Measuring Plan Progress & Success

A list of key stakeholders and discussion about forming a Watershed Implementation Committee that forms partnerships to implement watershed improvement projects is included in Section 8.0. Section 9.0 includes two monitoring components; 1) a "Water Quality Monitoring Plan" that includes specific locations and methods where future sampling should occur and a set of water quality "Criteria" that can be used to determine whether pollutant load reduction targets are being achieved over time and 2) "Report Cards" for each plan goal used to measure milestones and to determine if Management Measures are being implemented on schedule, how effective they are at achieving plan goals, and need for adaptive management if milestones are not being met. Sections 8.0 and 9.0 address USEPA *Elements F, G, H, and I*.

Sections 10.0 & 11.0: Literature Cited and Glossary of Terms

Section 10.0 includes a list of literature that is cited throughout the report. The Glossary of Terms (Section 11.0) includes definitions or descriptions for many of the technical words or agencies that the user may find useful when reading or using the document.

Appendix

The Appendix to this report is included on the attached CD located on the back cover (hard copies only). It contains watershed stakeholder meeting minutes (Appendix A), Center for Watershed Protection local ordinance review summary (Appendix B), results of the watershed resource field inventory (Appendix C), Racine Health Department water quality monitoring data and report (Appendix D), a raw data used to develop pollutant loading and reduction models (Appendix E), list of potential funding opportunities (Appendix F), and a stakeholder Environmental Issues Identification Survey (Appendix G).

1.6 Prior Studies and Projects

Various studies have been completed describing and analyzing conditions within Catfish Creek watershed. Several ecological restoration

efforts have also been implemented. This Watershed Management Plan uses existing data to analyze and summarize work that has been completed by others and integrates new data and information. A list of known studies or restoration work is summarized below.

1. In 2002 the Wisconsin Department of Natural Resources (WDNR) and the Root-Pike WIN researched the current conditions of the Root-Pike River Basin and created a report entitled "The State of the Root-Pike River Basin" (WDNR 2002). This report provides an overview of the land and water resource quality and identifies challenges within this basin.
2. In 2003/2004, the Bay-Lake Regional Planning Commission produced "A Guide to Planning for Coastal Communities in Wisconsin" (BLRPC 2004). This document identifies and provides guidance on issues facing coastal communities in comprehensive planning efforts.
3. In 2003 the Wisconsin Department of Natural Resources (WDNR) prepared a navigability determination on the waterways located within the proposed Elm Road Generating Station project for We Energies (WDNR 2003). The purpose was to determine where Chapter 30 permits will be needed from future projects impacting "navigable" waterways.
4. We Energies created close to 25 acres of wetland mitigation with surrounding prairie and woodland buffer that is protected in perpetuity. The mitigation was required as a result of a WDNR/USACOE permit issued for construction activities in 2005.
5. In 2000, Applied Ecological Services, Inc. (AES) prepared a Master Plan (AES 2000) for the Frank Lloyd Wright designed home and 35-acre campus now known as The Johnson Foundation at Wingspread. The intent of the Master Plan was to propose sustainable campus solutions for the conference center and its grounds while preserving the historical integrity of Wingspread and its surrounding landscape. Since 2000, many of the proposed Master Plan improvements have been implemented. In 2009, AES completed a Master Plan update to make adjustments/ accommodations as necessary to improve site ecological health, decrease campus carbon footprint, and extend the initial sustainability operational goals.
6. In 2000 the City of Racine undertook a study of the English Street stormsewer outfall and its impact upon bacteria levels near the North Beach area. The sewer system connected to the outfall drains approximately 400 acres. The City undertook a unique project to reconstruct the outfall by including Vortechs Systems as primary treatment and a wetland filter near the beach as secondary treatment. During rain events, water is now directed through the vortex structures then into wetland cells where bacteria and nutrient levels are lowered by uptake. Wildlife habitat is another beneficial outcome of the wetland areas along the beach.
7. Several demonstration rain gardens have been constructed in Wind Point watershed under the guidance of Root-Pike Watershed Initiative Network. Rain gardens are located at the Prairie School, Village of Wind Point Clerk's Office, Caledonia Fire Station No. 2, YMCA River bend Nature Center, and Glynn residence.
8. In 2006 the Village of Caledonia completed a study entitled "Ravine Erosion and Natural

Resources Assessment Study” (Hey & Associates 2006). The study examines erosion and ecological issues within five ravine systems including Rifle Range Ravine, Cliffside Park Ravine, Breaker’s Ravine, Dominican Creek Ravine, and

Birch Creek Ravine. This study provides a comprehensive inventory and analysis of each ravine and its watershed to address unfavorable impacts of urban development. The study provides the Village of Caledonia with the information

necessary to provide proactive stewardship of the ravines and their natural resources.

9. In the early 1990's Milwaukee County appropriated funds to complete a Master Plan and feasibility study for Bender

RIGHT: Native planting in swale at Wingspread. BELOW: Rain garden at Caledonia Fire Station No. 2



Park. The Master Plan was developed in 1995-1996 and identified the critical need for bluff and shoreline stabilization along 6,000 linear feet of Lake Michigan shoreline. Although shoreline and bluff erosion is considered a natural process, historical records indicated that since 1945 the shoreline at Bender Park had eroded 8-9 feet per year. Between 1993 and 1998

- Phase I of the Bender Park Master Plan, *Shoreline Protection and Bluff Stabilization Project*, was implemented and completed at a cost of approximately \$7 million dollars. This project included regrading the bluff slope behind 3,000 linear feet of revetment in the northern portion of the park, installation of stone revetment along the 6,000 linear feet of shoreline, creation of an access road from the upland park area down to the waterfront, and the prairie seeding of the regraded slopes. Via implementation of this stabilization project 20 acres of lost park land was recreated at the base of the bluff in Bender Park.
- Phase II of the Bender Park Master Plan involved the installation of a Marina.
- Phase III of the Bender Park Master Plan would have involved the construction

of a golf course within the 207 acres of Bender Park just north and south of Fitzsimmons Road. Regrading of the slope along the southern portion of Bender Park would have been done in concurrence with golf course construction, however, Phase III of the Bender Park Master Plan was not implemented. The 207 acres originally selected for construction of a golf course remain as natural area within the park.

The significant bluff slope erosion on the southern portion of the Bender Park shoreline was later addressed in 2003-2005 with the *Bender Park Slope Stabilization Demonstration Project*. The project was funded via the Great Lakes Basin Program with matching contributions from Gillen Construction Company. This project included the installation of approximately 3,000 linear feet of wick drains below the existing top of the Lake Michigan shoreline bluff between Oakwood Road and Fitzsimmons Road. After installation a slope stability analysis was done and groundwater levels were recorded with results displaying that there had been a successful lowering of the water levels with the wick drains along the southern bluffs in Bender Park.

10. In response to financial and environmental impacts in recent years, Milwaukee County set forth a series of initiatives to promote practices intended to control operating costs and improve the quality of life for the citizens of Milwaukee County through sound environmental stewardship. In 2007, the Milwaukee County Board of Supervisors and County Executive approved the Milwaukee County Green Print Initiative. Details regarding the initiative can be view at <http://county.milwaukee.gov/sustain>
11. In 2013, the Milwaukee County DPRC received \$125,300 in funding to implement green infrastructure improvements and invasive species control at 3 Lake Michigan coastal properties, including Bender Park. This project, funded by the Fund for Lake Michigan and a cooperative agreement with the Alliance for the Great Lakes through the Sustain Our Great Lakes Program involved converting approximately 48 acres of County owned, leased agricultural fields to native prairie at Bender Park.
12. Surface water (beach) and stormwater outfall/stream monitoring was conducted by the Racine Health Department (RHD) since 2002. The Johnson swale has been monitored by the Prairie School.



2.0 Mission, Goals, & Objectives

2.1 Wind Point Watershed Planning Committee Mission

The Wind Point Watershed Planning Committee (WPWPC) is comprised of watershed stakeholders dedicated to the preservation, protection, and improvement of Wind Point watershed. The WPWPC's mission follows:

"The Wind Point Watershed Planning Committee's mission is to realize a healthy watershed and lakefront for future generations by implementing a long term plan to protect, restore, and manage the cultural and ecological aspects of green infrastructure within Wind Point watershed through watershed plan implementation, education, and stewardship"

2.2 Goals & Objectives

Watershed stakeholders were first presented with information about the character and quality of watershed resources over the course of several Phase I meetings prior to developing goals. Next, five general goals topics that address the issues in Wind Point watershed were selected. Stakeholders were then given the opportunity to vote on goals they felt were most important.

The voting process occurred following the Phase I Wing Point Summit meeting held on November, 2013. Each stakeholder was given

five votes. Each person was allowed to use up to two votes on a single goal if he or she felt strongly about it. The voting process helped focus on goals that need to be adequately addressed in the planning process and within this watershed plan report. Tallied votes by goal topic are as follows:

1. Green Infrastructure Network – *23 votes*
2. Education & Stewardship – *18 votes*
3. Surface Water Quality– *16 votes*
4. Communication & Coordination – *15 votes*
5. Groundwater Quantity & Quality– *7 votes*

Objectives for each goal were also formulated and are very specific where appropriate and designed to be measurable so that future progress toward meeting goals can be assessed. Goals and objectives ultimately lead to the development of action items. The Management Measures Action Plan section of this report is geared toward addressing watershed goals by recommending programmatic and site specific Management Measure actions to address each goal. The goals and objectives are examined in more detail when measuring plan progress and success via milestones and “Report Cards” in Section 9.2.

Goal 1: Manage cultural and ecological components of the Green Infrastructure Network.

Objectives:

1. Include the identified Green Infrastructure Network in all county and municipal comprehensive plans and development review maps.
2. Develop recommendations for adoption of conservation or low impact design standards for all new and redevelopment within the Green Infrastructure Network.
3. Develop and implement restoration and management plans for all protected natural areas.
4. Incorporate natural landscaping into golf courses.

Goal 2: Implement watershed educational, stewardship, and recreational opportunities.

Objectives:

1. Increase environmental and recreational stewardship by recruiting volunteers.
2. Inform public officials on the benefits of conservation and low impact development and importance of ordinance language changes that promotes these developments.
3. Create targeted educational information for land owners adjacent to tributaries and lakeshore.
4. Install watershed interpretation signage at public access points and major roads.
5. Develop recommendations and alternatives for fertilizer, road salt, and pet waste disposal.
6. Educate the public about protecting shallow aquifer water quality and quantity.

Goal 3: Improve surface water quality to meet applicable standards.

Objectives:

1. Stabilize 8,685 linear feet of highly eroded streambanks & ravines located along four “High Priority-Critical Areas”. This includes stabilizing four stream headcuts as identified along Tributaries B, E, and F.
2. Stabilize 4,500 linear feet of highly eroded bluffs located along one “High Priority-Critical Area”.
3. Restore 14,541 linear feet of riparian buffer along two “High Priority-Critical Areas”.
4. Restore 270 acres of wetland at nine “High Priority-Critical Areas”.
5. Retrofit eight “High Priority-Critical Area” detention basins.
6. Implement agricultural best management practices on seven sites totaling 975 acres identified as “High Priority-Critical Areas”.
7. Continue water quality monitoring programs, specifically including Nitrogen, Phosphorus, Total Suspended Solids, and *E.coli*.

Goal 4: Increase communication and coordination among stakeholders.

Objectives:

1. Encourage governing bodies to adopt the Wind Point Watershed-Based Plan.
2. Develop a “Watershed Planning Council” as part of Phase III efforts that meets quarterly to discuss implementation and restoration campaigns.
3. Encourage amendments of municipal comprehensive plans, codes, and ordinances to include watershed plan recommendations.
4. Encourage and support business and agricultural communities and other stakeholder efforts to implement recommended actions within the watershed plan.

Goal 5: Improve groundwater recharge to maintain shallow aquifers and reduce stormwater runoff.

Objectives:

1. Encourage residents and businesses to install rain gardens and rain barrels.
2. Implement model groundwater recharge policies for development in all “High” and “Very High” groundwater recharge potential areas.
3. Encourage use of Stormwater Treatment Train designs within new and redevelopment.

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3.0 Watershed Resource Inventory

3.1 Geologic History & Climate

Geologic History

The terrain of the Midwestern United States was created over thousands of years as glaciers advanced and retreated during the Pleistocene Era or “Ice Age”. Some of these glaciers were a mile or more thick. The area of southeastern Wisconsin where Wind Point watershed now lies was covered by the most recent glacial event known as the Late Wisconsin Glaciation that began approximately 30,000 years ago and ended around 9,500 years ago (Figure 3). During this period the

earth’s temperature warmed and the ice slowly retreated leaving behind moraines and glacial ridges where it stood for long periods of time (Hansel 2005). As the glaciers from this period receded, they scoured out what have become the Great Lakes and left behind a nearby terminal moraine known as the Kettle Moraine. Massive amounts of meltwater also carved out many of the ravines found along the coastline.

The composition of the soil in Wind Point watershed is also a remnant of the ancient ice movement. Above the bedrock lies a layer of deposits

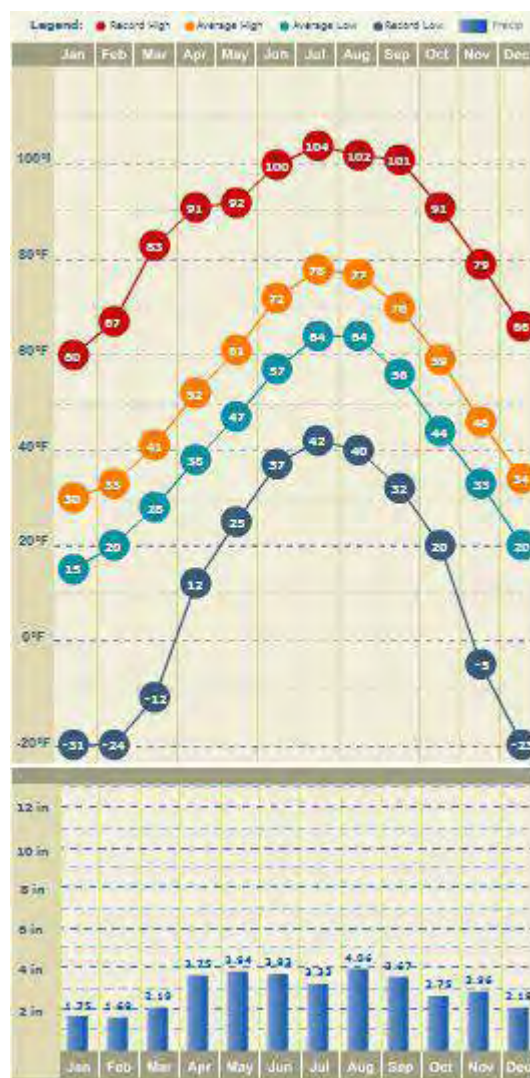
Climate

The southeast Wisconsin climate can be described as temperate with cold winters and warm summers where great variation in temperature, precipitation, and wind can occur on a daily basis. Surges of polar air moving southward or tropical air moving northward causes daily and seasonal temperature fluctuations. The action between these two air masses fosters the development of low-pressure centers that generally move eastward and frequently pass over the study area, resulting in abundant rainfall. Prevailing winds are generally from the west, but are more persistent and blow from a northerly direction during winter. Lake Michigan significantly influences the study area as it reduces the heat of summer and buffers (warms) the cold of winter by several degrees on average.

The Weather Channel website (www.weather.com) provides an excellent summary of climate statistics including monthly averages and records for most locations in Southeast Wisconsin. Data for Racine was selected to represent the climate and weather patterns experienced in Wind Point watershed (Figure 4). The winter months are cold averaging highs around 32° F while winter lows are around 18° F. Summers are warm with average highs around 74° F and summer lows around 61° F. The highest recorded temperature was 104° F in July 1995 while the lowest temperature was -31° F in January 1982.

Fairly typical for the Midwest, the current climate of Wind Point watershed consists of an average rainfall around 36 inches and snowfall around 38 inches. According to data collected in

Figure 4. Monthly averages, highs, and lows for temperature and precipitation in Racine. Source: the Weather Channel.



Racine, the most precipitation on average occurs in August (4.06 inches) while January receives the least amount of precipitation with 1.7 inches on average.

According to Wisconsin Initiative on Climate Change Impacts (WICCI) Wisconsin's climate is changing. On average, Wisconsin

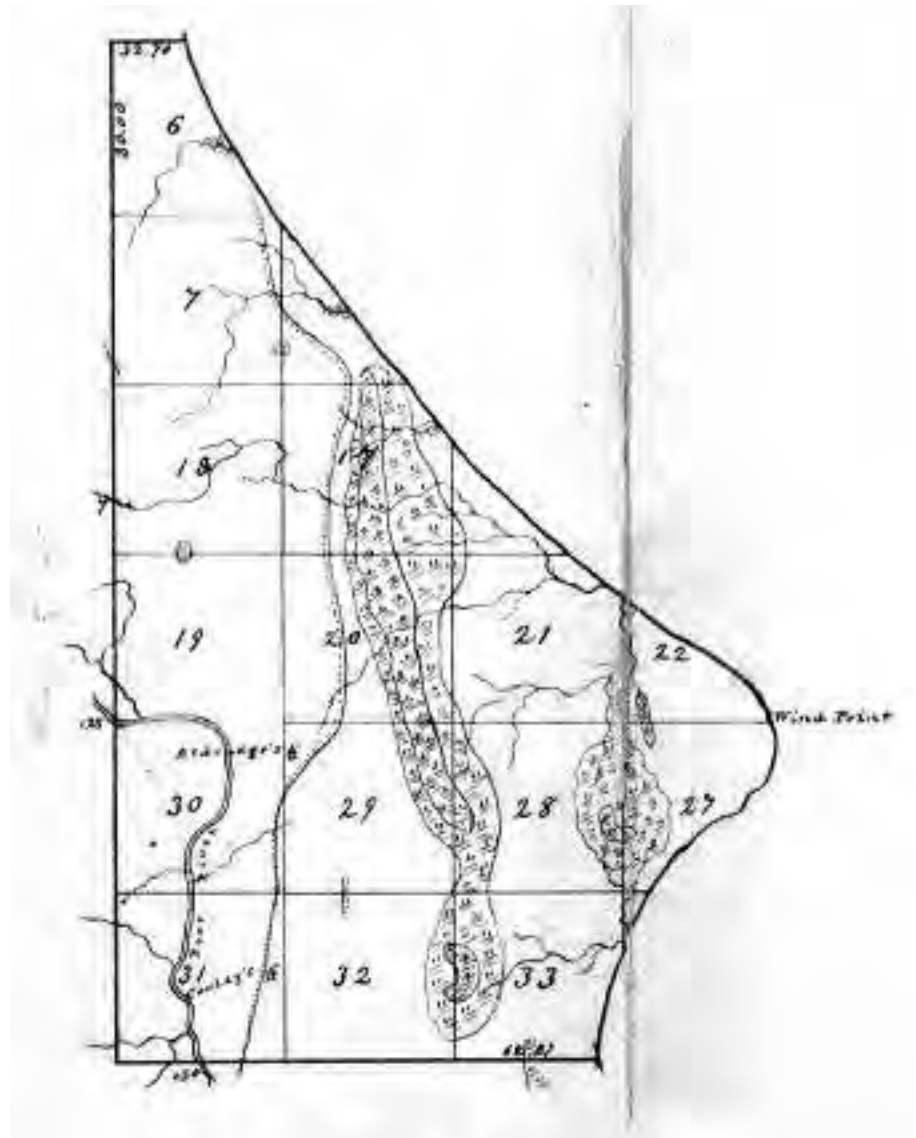
has become warmer and wetter over the past 60 years. Future projections for Wisconsin created by University of Wisconsin-Madison suggest Wisconsin's warming trend will continue and increase considerably. By the middle of the century, statewide annual average temperatures are likely to warm by 6-7 ° F.

3.2 Pre-European Settlement Landscape Compared to Present Landscape

The last Native American Indian tribe to call the area home was the Potawatomie. These people lived in harmony with the environment until a treaty in 1833 resulted in their removal from the land by the U.S. Government. This treaty paved the way for European settlement in the area that began with surveys of the land. The original public land surveyors that worked for the office of U.S. Surveyor General in the early and mid 1800s mapped and described natural and man-made features and vegetation communities while creating the township, range, and section ("Rectangular Survey System") for mapping and sale of western public lands of the United States (Daly & Lutes et. al., 2011). Ecologists know by interpreting survey notes and hand drawn Federal Township Plats of Wisconsin (1833-1866) and from documents written by the earliest settlers in the area that a complex interaction existed between several ecological communities including beach/dune, forests, and wetland prior to European settlement in the 1830s (Figures 5 & 6).

The surveyors described about 85% of Wind Point watershed as being forested with a variety of tree species. Forested areas were comprised of two primary sub-communities as described by Curtis (1959). Southern mesic forest dominated by maple, basswood, and beech trees was likely the most common in the watershed. Southern dry-mesic forest, dominated by a variety of oak and hickory species, was also common. Southern lowland forest (10% of watershed) was common on the relatively flat plateau west of Wind Point. These wet areas contained black ash and alder. The beach and dune communities along Lake Michigan make up the third most common ecological community in the watershed. Historically, these areas were sculpted by waves and shifting sand. It is also important to note that most of Wind Point watershed was

Figure 5. Sketch map from survey of Wind Point



protected from wildfires that were common to the west.

European settlement beginning in the 1830s resulted in drastic changes to the fragile ecological communities as most of the old growth forests were cleared by settlers who used the wood for fuel, to build their homes, sold it to sawmills, and farmed the cleared land. The large wetland areas west of Wind Point were also cleared and drained for farmland. The majority of streams were channelized and ditched to further drain water off the land. The earliest aerial photographs taken in 1937 (Figure 7) depict Wind Point watershed when row crop farming was the primary land use but before much of the

residential, commercial, and industrial development seen today. By 1937, very few forested areas that once dominated the watershed remain.

Figure 8 shows a 2010 aerial photograph of Wind Point watershed. It is clear that residential, commercial, and industrial development have replaced much of the farmland, particularly in the southern half of the watershed. Newer residential development is common between 3 Mile Road and 6 Mile Road within the municipalities of Racine, Wind Point, and Caledonia. Industrial land uses are common along the Union Pacific Railroad and along Lake Michigan from 7 Mile Road north to South Milwaukee. There is also a large

History of Wind Point Lighthouse

Wind Point Lighthouse was constructed in 1880 by the U.S. Lighthouse Service which later merged with the Coast Guard. It is a 108 foot tall building built of brick with a stone foundation. The lighthouse is one of the tallest and oldest in active service on the Great Lakes. In 1999 a "Friends" group formed to preserve the lighthouse and in 2006, the Fog Horn House was converted to a maritime museum.

The original beacon was powered by a 3 wick mineral oil lamp that was converted to electric in 1923. The beacon was fully automated when the last resident keeper left in 1964 and the Village of Wind Point began to maintain the property. The grounds also harbor the keepers quarters, several fog signal buildings, and the oil house.

In 1984, Wind Point Lighthouse was recognized as a National Historic Landmark and the National Park Service officially awarded ownership to the Village of Wind Point in 1997. The Village uses the keepers quarters as a village hall, police headquarters, and caretakers residence. In addition, the lighthouse still acts as an aid in navigation by the Coast Guard.



quarry operation north of 3 Mile Road and an airport south of 3 Mile Road. Only small isolated natural areas remain but many are owned by local conservation groups.

With degraded ecological conditions comes the opportunity to implement ecological restoration to improve the condition of Wind Point watershed. Present day knowledge of how pre-European settlement ecological communities formed and evolved provides a general template for developing present day natural area restoration and management plans and projects. One of the primary goals of this watershed plan is to identify, protect, restore, and manage remaining natural areas.

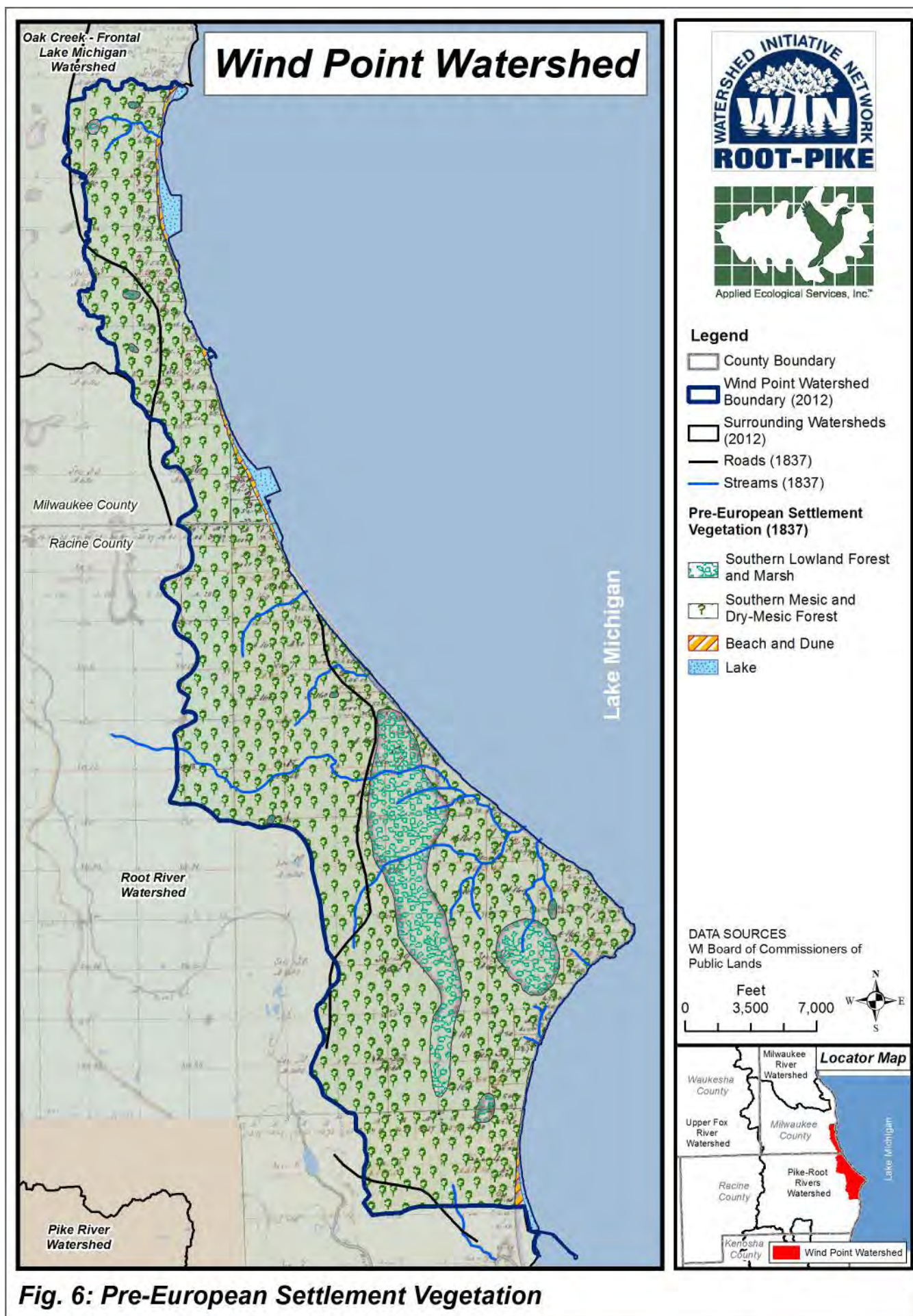
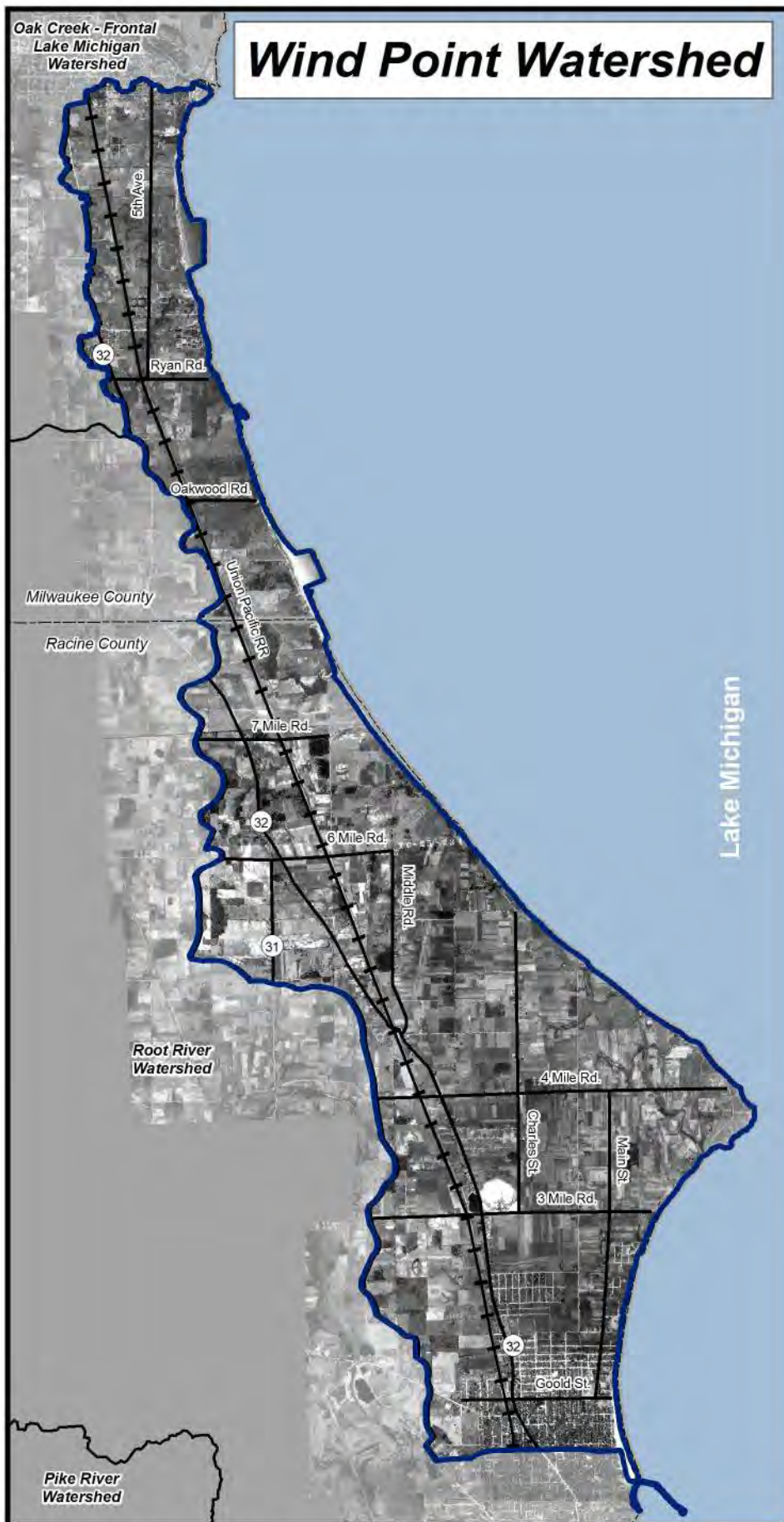


Fig. 6: Pre-European Settlement Vegetation



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Major Roads
- Railroad

The location of streams and open water in 1937 is not known.

DATA SOURCES
University of Wisconsin-Madison

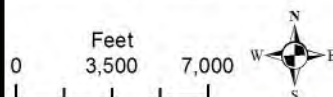


Fig. 7: 1937 Aerial Image

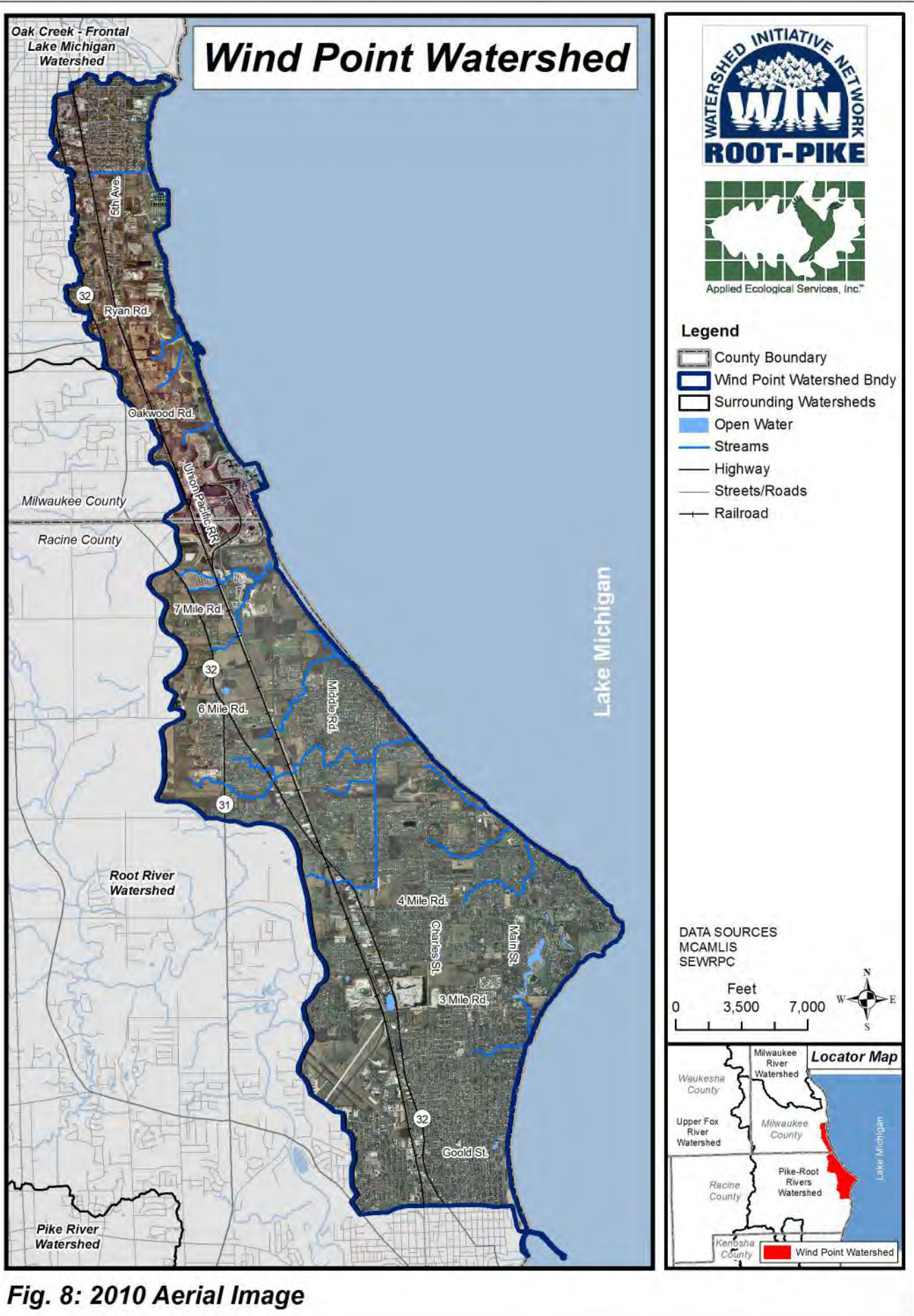


Fig. 8: 2010 Aerial Image

3.3 Topography, Watershed Boundary, & Subwatershed Management Units

Topography & Watershed Boundary

The Wisconsin glacier that retreated about 10,000 years ago formed much of the topography and defined the Wind Point watershed boundary observed today. Topography refers to elevations of a landscape that describe the configuration of its surface and ultimately defines watershed boundaries. And, the specifics of watershed planning can not begin until a watershed boundary is clearly defined.

The Wind Point watershed boundary used in this study is a combination of boundaries provided by both Wisconsin Department of Natural Resources (WDNR) and Southeast Wisconsin Regional Planning Commission (SEWRPC). Small discrepancies noted during field inventories were also used to alter the boundary where appropriate. The refined watershed boundary and available 2-foot elevation data from Milwaukee and

Racine Counties was then input into a GIS model (Arc Hydro) that generated a Digital Elevation Model (DEM) of the watershed (Figure 9).

Wind Point watershed is 11,996 acres or 18.7 square miles in size. The entire watershed drains from west to east and eventually to Lake Michigan. Elevation within the watershed ranges from a high of 751 feet above mean sea level (AMSL) to a low of 577 feet AMSL along the Lake Michigan coast for a total relief of 174 feet (Figure 9). The highest point is found just south of 6 Mile Road on a ridge that extends north to the Lake Michigan coast where severe bluff erosion can be found generally between 7 Mile Road and Ryan Road.

An interesting feature is the large relatively flat plateau in the southeast portion of the watershed

generally between 6 Mile Road and the southern watershed boundary and east of Route 32. According to the original public land survey conducted in the mid 1800s, this plateau harbored significant areas of wet southern lowland forest and marsh whereas higher elevations to the west harbored dryer southern mesic and dry-mesic forest. Most of the wetlands that once existed on the plateau have been drained. This area is now dense with residential development within the municipalities of Racine, North Bay, Wind Point, and Caledonia.



Wind Point watershed coast



Eroded bluff east of Oakwood Road

Subwatershed Management Units (SMUs)

The Center for Watershed Protection (CWP) is a leading watershed planning agency and has defined watershed and subwatershed sizes appropriate to meet watershed planning goals. In 1998, the CWP released the "Rapid Watershed Planning Handbook" (CWP 1998) as a guide to be used by watershed planners when addressing issues within urbanizing watersheds. The CWP defines a watershed as an area of land that drains anywhere from 10 to 100 square miles. Broad assessments of conditions such as soils, wetlands, and water quality are generally evaluated at the watershed level and provide some information about overall conditions. Wind Point watershed is about 19 square miles and therefore this plan allows for a detailed look at watershed characteristics, problem areas, and management opportunities. However, an even more detailed look at smaller drainage areas must be completed to find site specific problem areas or "Critical Areas" that require immediate attention.

A watershed can be divided into subwatersheds called Subwatershed Management Units (SMUs) to address issues at a smaller scale. Wind Point watershed was delineated into 24 SMUs using a combination of the Digital Elevation Model (DEM), stormsewer information, and personal contacts with local municipal engineers (Table 2; Figure 10). Most SMUs drain to Lake Michigan via a stream outlet or storm sewer outfall point. SMUs 3, 4, 5, 9, 16 and 24 have no known single outlet point. SMU 24 is not a single subwatershed but rather a compilation of several small areas that drain to Lake Michigan via overland flow. Information obtained at the SMU scale allows for detailed analysis and better recommendations for site specific "Management Measures" otherwise known as Best Management Practices (BMPs). Delineation into SMUs also allows for better identification of areas contributing to water quality problems as summarized in Section 4.0.

Table 2. Subwatershed Management Units and size.

SMU #	Total Acres	Total Square Miles
SMU 1	493.9	0.8
SMU 2	278.6	0.4
SMU 3	273.1	0.4
SMU 4	310.3	0.5
SMU 5	92.7	0.1
SMU 6	238.5	0.4
SMU 7	146.1	0.2
SMU 8	242.7	0.4
SMU 9	374.9	0.6
SMU 10	947.0	1.5
SMU 11	788.6	1.2
SMU 12	2,138.4	3.3
SMU 13	332.1	0.5
SMU 14	442.8	0.7
SMU 15	1,040.3	1.6
SMU 16	473.0	0.7
SMU 17	573.9	0.9
SMU18	382.2	0.6
SMU19	71.5	0.1
SMU 20	242.3	0.4
SMU 21	134.8	0.2
SMU 22	1,324.0	2.1
SMU 23	274.5	0.4
SMU 24	377.2	0.6
Totals	11,996	18.7

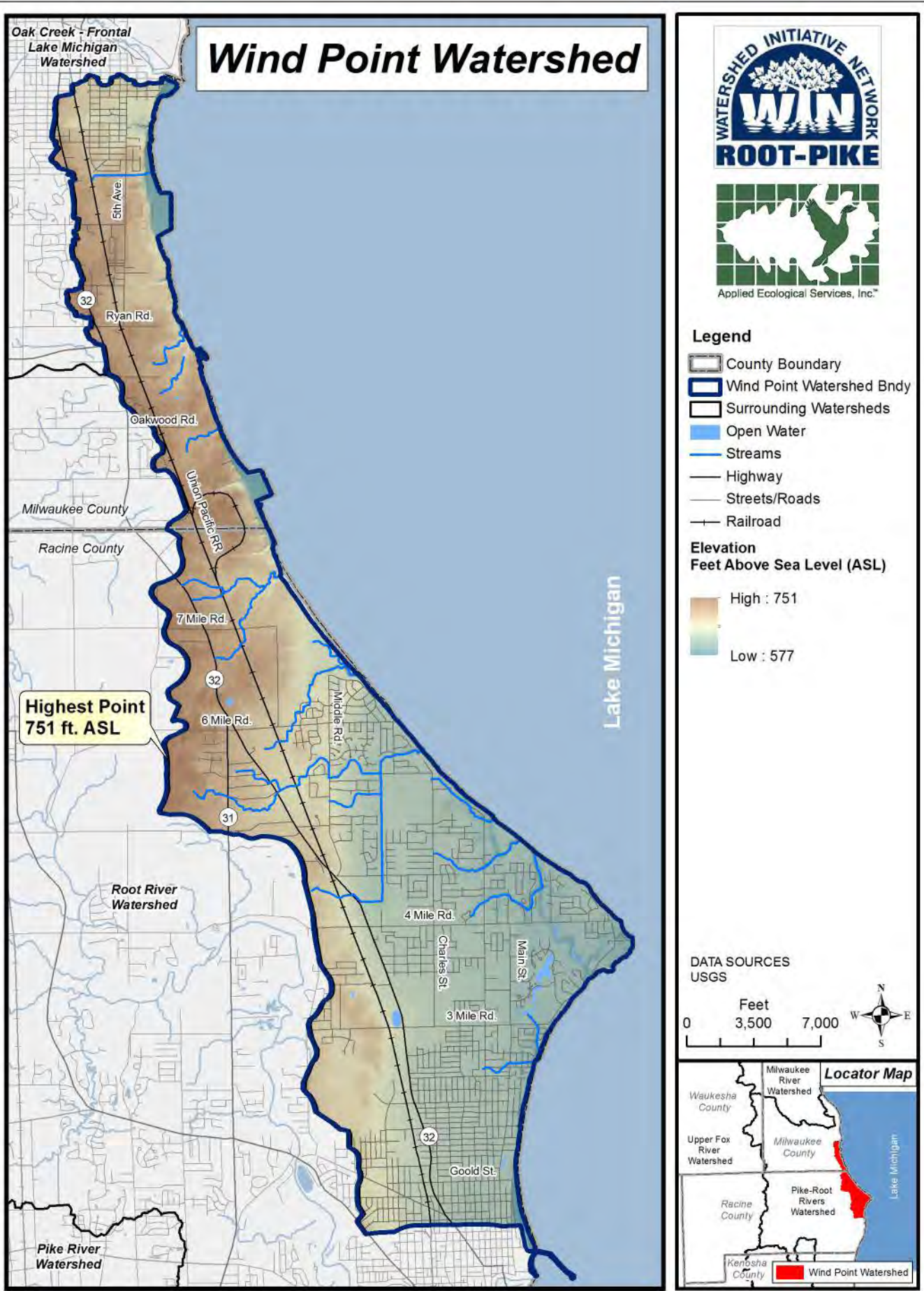
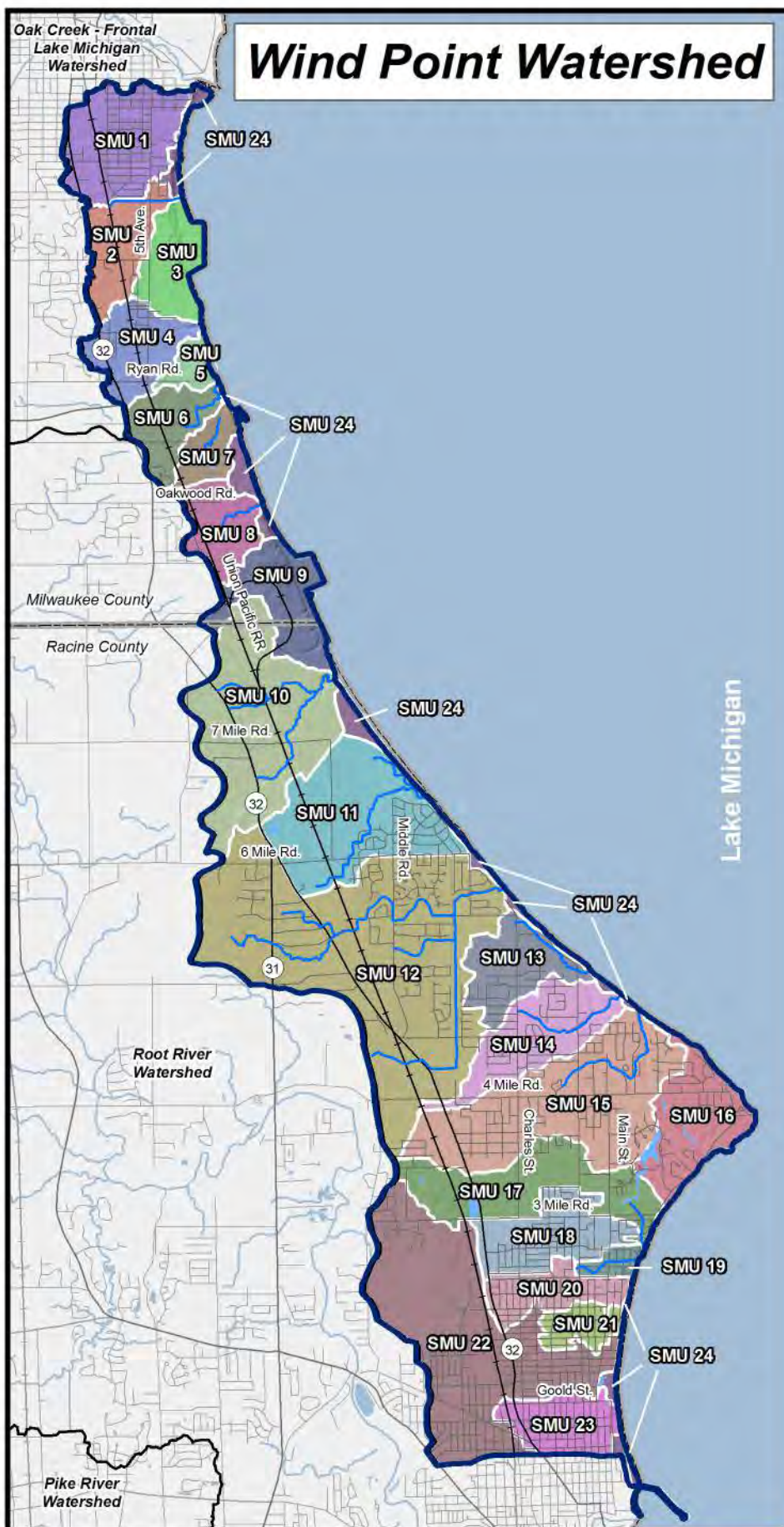


Fig. 9: Digital Elevation Model



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Subwatershed Mgmt Units

- | | |
|--------|--------|
| SMU 1 | SMU 13 |
| SMU 2 | SMU 14 |
| SMU 3 | SMU 15 |
| SMU 4 | SMU 16 |
| SMU 5 | SMU 17 |
| SMU 6 | SMU 18 |
| SMU 7 | SMU 19 |
| SMU 8 | SMU 20 |
| SMU 9 | SMU 21 |
| SMU 10 | SMU 22 |
| SMU 11 | SMU 23 |
| SMU 12 | SMU 24 |

DATA SOURCES
USGS

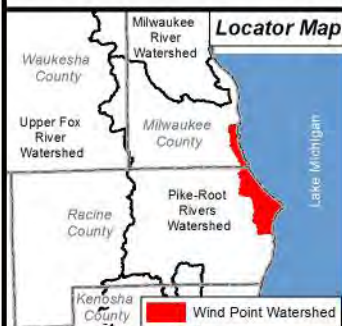
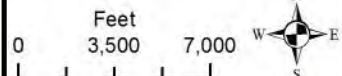


Fig. 10: Subwatershed Management Units (SMUs)

3.4 Hydric Soils, Soil Erodibility, & Hydrologic Soil Groups

Soils

Deposits left by the Wisconsin glaciation 10,000 years ago are the raw materials of present soil types in the watershed. These raw materials include till (debris) and outwash. A combination of physical, biological, and chemical variables such as topography, drainage patterns, climate, and vegetation, have interacted over centuries to form the complex variety of soils found in the watershed. Most soils formed under wetland, woodland, and prairie vegetation. The most up to date soils mapping provided by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) for Milwaukee and Racine Counties was used to summarize the extent of hydric soils, soil susceptibility to erosion, and infiltration capacity of soils in Wind Point watershed (Tables 3-6; Figures 11-13).

Hydric Soils
Wetland or “Hydric Soils” generally form over poorly drained clay material associated with wet prairies, marshes, and other wetlands and from accumulated organic matter from decomposing surface vegetation. Hydric soils are important because they indicate the presence of existing wetlands or drained wetlands where restoration may be possible. Most of the wetlands in Wind Point watershed were intact until the late 1830s when European settlers began to alter significant portions of the watershed’s natural hydrology and wetland processes. Where it was feasible wet areas were cleared of vegetation and drained to farm the rich soils. The location of hydric, partially hydric, and upland soils in the watershed is summarized and depicted on Table 3 and Figure 11 respectively.

Hydric soils comprise 2,945 acres or 24.5% of the watershed. Most of these soils are located on the relatively flat plateau east of Route 32 and south of 6 Mile Road. Early

vegetation mapping suggests this area was southern lowland forest and marsh. Most of this once large wetland complex is now gone. According to wetland inventories conducted by SEWRPC and WDNR in 2005, about 580 acres or 20% of the pre-European settlement wetlands remain.

3,474 acres or 29% of the watershed is comprised of partially hydric soils which exhibit some, but not all, of the characteristics of hydric soils. These soils are scattered throughout the watershed but again, they are concentrated on the flat plateau in the southeast portion of the watershed adjacent to hydric soils. These soils likely did not support true wetland communities.

Approximately 5,215 acres (43.5%) are not hydric and the remaining 331 acres (2.7%) have unknown classification because they have been disturbed by human land practices such as quarry mining occurring north of 3 Mile Road.

Table 3. Percent coverage of hydric soils and non-hydric soils within the watershed.

Soil	Total Area (acres)	Percentage of Watershed
Hydric Soil	2,945	24.5
Partially Hydric Soil	3,474	29.0
Non-Hydric Soil	5,215	43.5
Not Classified/Unknown	331	2.8
Totals	11,996	100.0

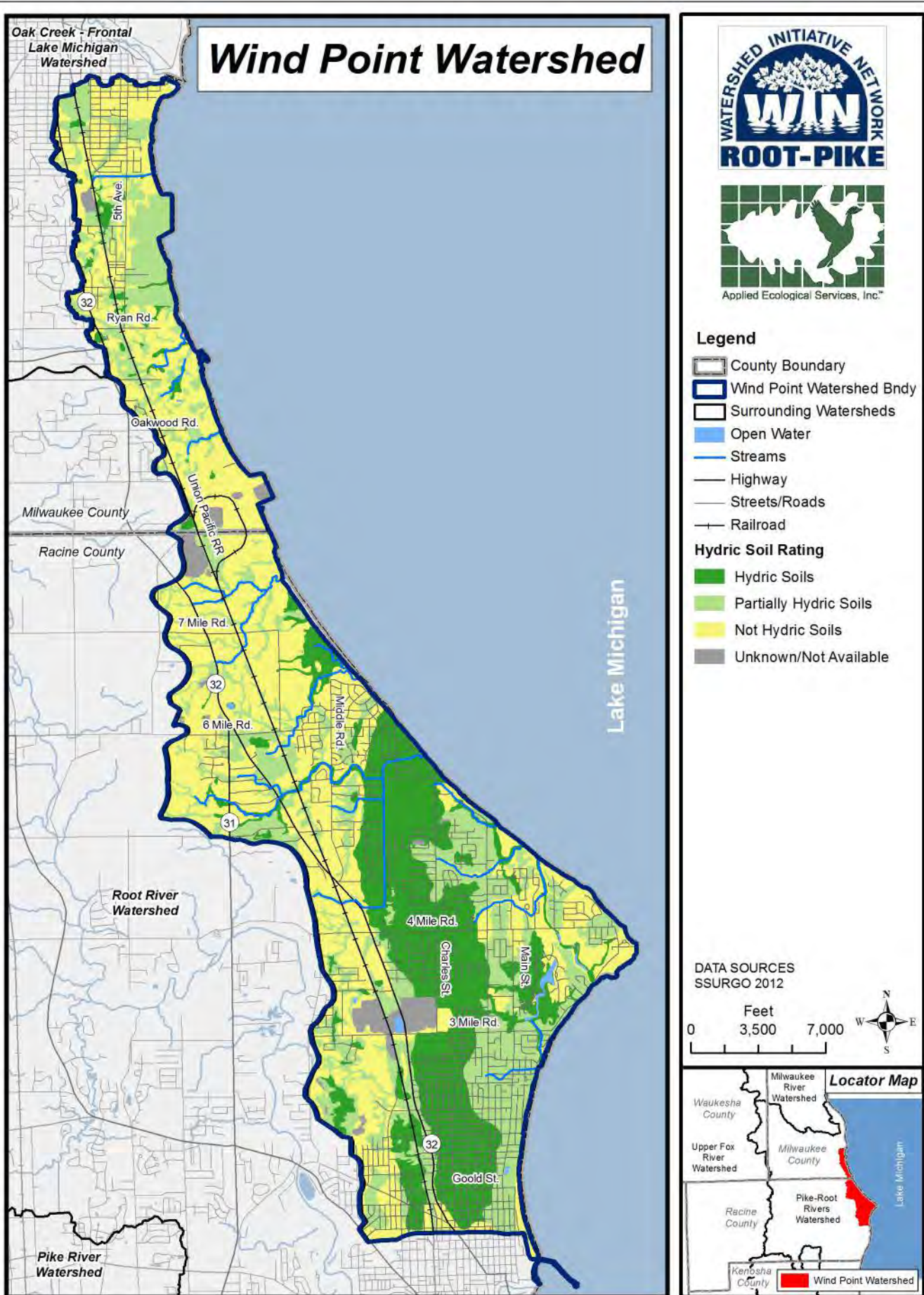


Fig. 11: Hydric Soils

Soil Erodibility

Soil erosion is the process whereby soil is removed from its original location by flowing water, wave action, wind, and other factors. Sedimentation is the process that deposits eroded soils on other ground surfaces or in bodies of water such as streams and lakes. Soil erosion and sedimentation reduces water quality by increasing total suspended solids (TSS) in the water column and by carrying attached pollutants such as phosphorus, nitrogen, and hydrocarbons. When soils settle in streams and lakes they often blanket rock, cobble, and sandy substrates needed by fish and aquatic macroinvertebrates for habitat, food, and reproduction.

A highly erodible soils map was created based on soil information provided by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (Figure 12). Highly erodible soils have attributes that when located on slopes are susceptible to erosion. It is important to know the location of highly erodible soils because these areas have the highest potential to degrade water quality during farm tillage, development, or other factors such as what caused a bluff failure at WE Energies Oak Creek Power Plant in October, 2011. Based on mapping, 334 acres or about 3% of the soils in the watershed are "Highly Erodible", 4,838 acres or 40% of soils are "Potentially Erodible", and the remaining 6,794 (57%) acres are "Not Highly Erodible" (Table 4).

Fortunately, much of the highly erodible areas are currently stabilized by existing land uses/cover. But others are located on bluffs or row crop farmland where erosion following annual tilling is a possibility. One option for farmers is to convert highly erodible areas to vegetative cover under the USDA NRCS's Conservation Reserve Program (CRP). Under this program farmers receive an annual rental payment for the term of the multi-year contract.

Table 4. Percent coverage of highly erodible, potentially erodible, and not highly erodible soils.

Soil Erodibility	Total Area (acres)	Percentage of Watershed
Highly Erodible	334	2.8
Potentially Erodible	4,838	40.3
Not Highly Erodible	6,794	56.6
Totals	11,996	100.0

October, 2011 bluff failure at We Energies Oak Creek Power Plant. Source: WDNR & We Energies



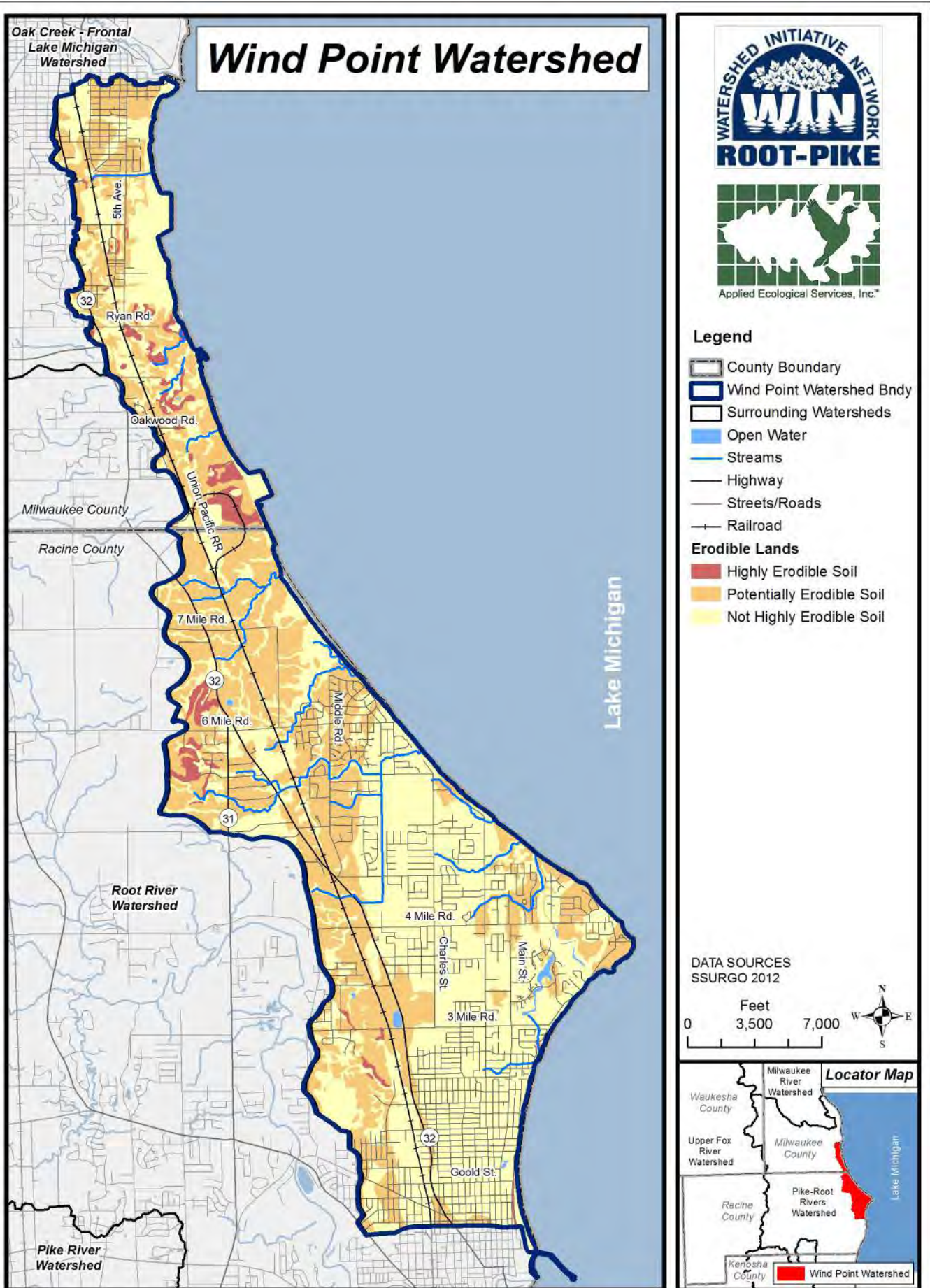


Fig. 12: Highly and Potentially Highly Erodible Soils

Hydrologic Soil Groups

Soils also exhibit different infiltration capabilities and have been classified to fit what are known as “Hydrologic Soil Groups” (HSGs). HSGs are based on a soil’s infiltration and transmission (permeability) rates and are used by engineers and planners to estimate stormwater runoff potential. Knowing how a soil will hold water ultimately affects the type and location of recommended infiltration Management Measures such as wetland restorations and detention

basins. More importantly however is the link between hydrologic soil groups and groundwater recharge areas. Groundwater recharge is discussed in detail in Section 3.14.

HSG’s are classified into four primary categories; A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Figure 13 depicts the location of each HSG in the watershed. The HSG categories and their corresponding soil texture, drainage description, runoff potential, infiltration rate,

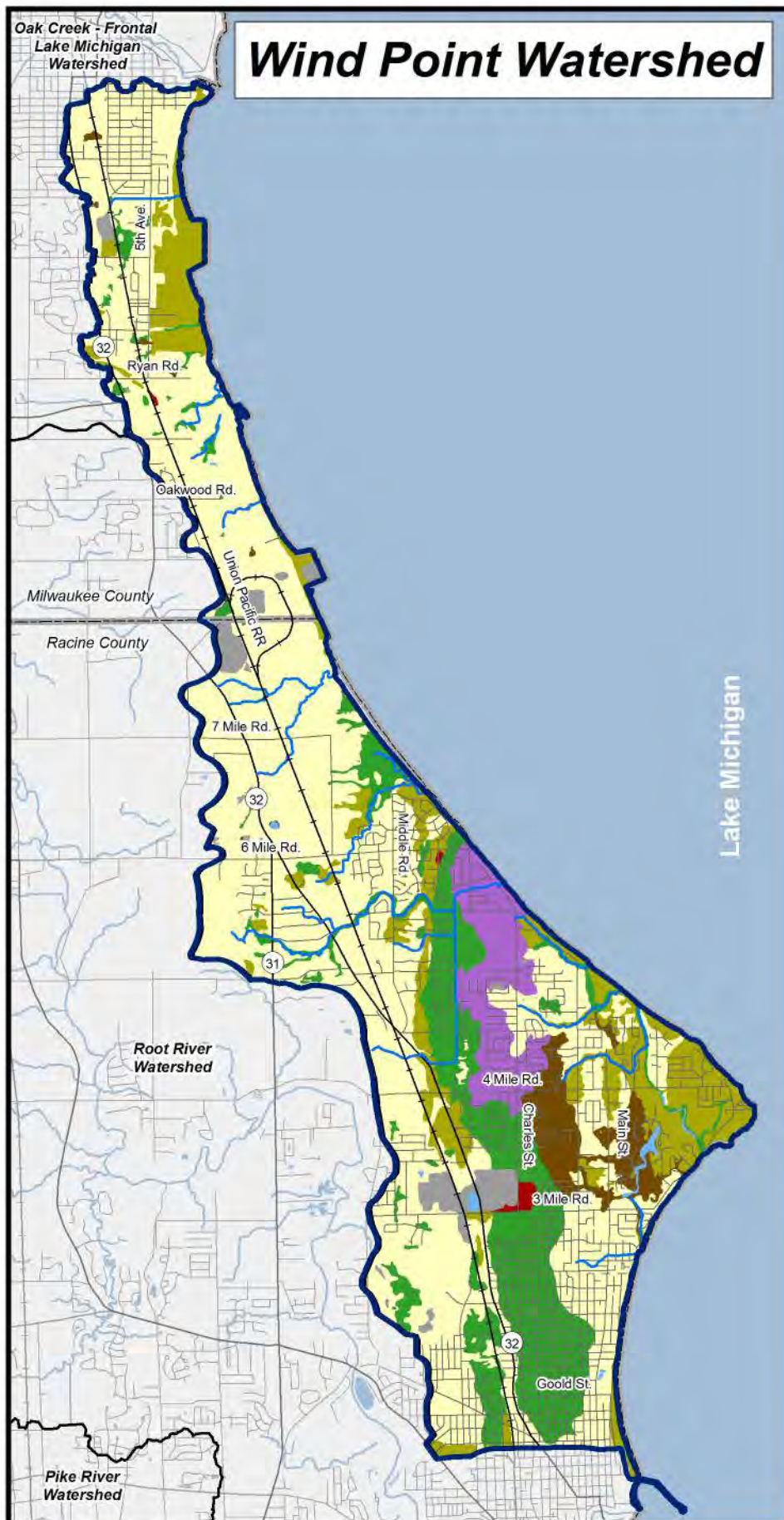
and transmission rate are shown in Table 5 while Table 6 summarizes the acreage and percent of each HSG. Group C soils are dominant throughout the watershed at about 52% coverage and are found in most upland areas. Group B and B/D soils together make up another 3,587 acres or 30% of the watershed. Group D soils comprise 584 acres or another 5% of the watershed. Group B/D and D soils generally line up with areas exhibiting hydric soils in the southeast portion of the watershed.

Table 5. Hydrologic Soil Groups and their corresponding attributes.

HSG	Soil Texture	Drainage Description	Runoff Potential	Infiltration Rate	Transmission Rate
A	Sand, Loamy Sand, or Sandy Loam	Well to Excessively Drained	Low	High	High
B	Silt Loam or Loam	Moderately Well to Well Drained	Moderate	Moderate	Moderate
C	Sandy Clay Loam	Somewhat Poorly Drained	High	Low	Low
D	Clay Loam, Silty Clay Loam, Sandy Clay Loam, Silty Clay, or Clay	Poorly Drained	High	Very Low	Very Low

Table 6. Hydrologic Soil Groups including acreage and percent of watershed.

Hydrologic Soil Group	Area (acres)	% of Watershed
A	33	0.3
A/D	447	3.7
B	1,672	13.9
B/D	1,915	16.0
C	6,984	58.2
D	584	4.9
Unknown	331	2.8
Totals	11,996	100.0



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Hydrologic Soil Groups

- A
- A/D
- B
- B/D
- C
- D
- Unclassified

DATA SOURCES
SSURGO 2012

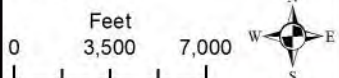


Fig. 13: Hydrologic Soil Groups

Wind Point watershed is located in two counties and six municipalities (Table 7, Figure 14). The northern 1/3 of the watershed (2,534 acres; 21%) is located in Milwaukee County while the southern 2/3 (9,427 acres; 79%) is in Racine County. The entire watershed falls within the borders of a municipality. Of the six municipalities in the watershed, the Village of Caledonia is the largest (6,234 acres; 52%) followed by the City of Racine (2,334 acres; 20%) and City of Oak Creek (1,961; 16%). The Villages of North Bay and Wind Point and City of South Milwaukee account for the remaining 1,462 acres or 12% of the watershed. There are no large state or federally owned nature/forest preserves or parks in the watershed.

Jurisdictional Roles and Protections
Water quality and land protection throughout the United States are protected to some degree under federal, state, and/or local law.

Water Quality Protection
At the federal level, the Clean Water Act (CWA) is the strongest tool in protecting water resources. Within the state of Wisconsin, the authority to administer the provisions of the CWA has been delegated to the Wisconsin Department of Natural Resources (WDNR). Section 402 of the CWA establishes the National Pollution Discharge Elimination System (NPDES), while Section 319 Nonpoint Source Management Program was created in order to further support state and local nonpoint pollutant source efforts not addressed by NPDES permits. Section 319 permits states to receive grant money towards activities such as technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of nonpoint pollutant source implementation projects. Section 303 of the CWA requires

Table 7. County and municipal jurisdictions.

Jurisdiction	Area (acres)	% of Watershed
County	11,960	100
Milwaukee	2,534	21
Racine	9,427	79
Municipalities	11,960	100
Caledonia	6,234	52
North Bay	64	<1
Oak Creek	1,961	16
Racine	2,334	20
South Milwaukee	573	5
Wind Point	825	7

Source: Milwaukee County, Racine County, SEWRPC

states to catalogue impaired waters, prioritize them, and calculate Total Maximum Daily Loads (TMDLs) of pollutants a waterbody can receive and still safely meet the water quality standards. Wisconsin has also utilized Section 208, or the Priority Watershed Program, to develop a nonpoint pollutant source program. WDNR identified watersheds and lakes in most need of nonpoint pollution abatement and encouraged the use of nonpoint source controls to improve water quality (Kent & Dudiak 2001).

The Safe Drinking Water Act also plays a role in protecting surface and groundwater resources. In Wisconsin, the Wellhead Protection Program includes both mandatory and voluntary initiatives aimed at protecting groundwater resources.

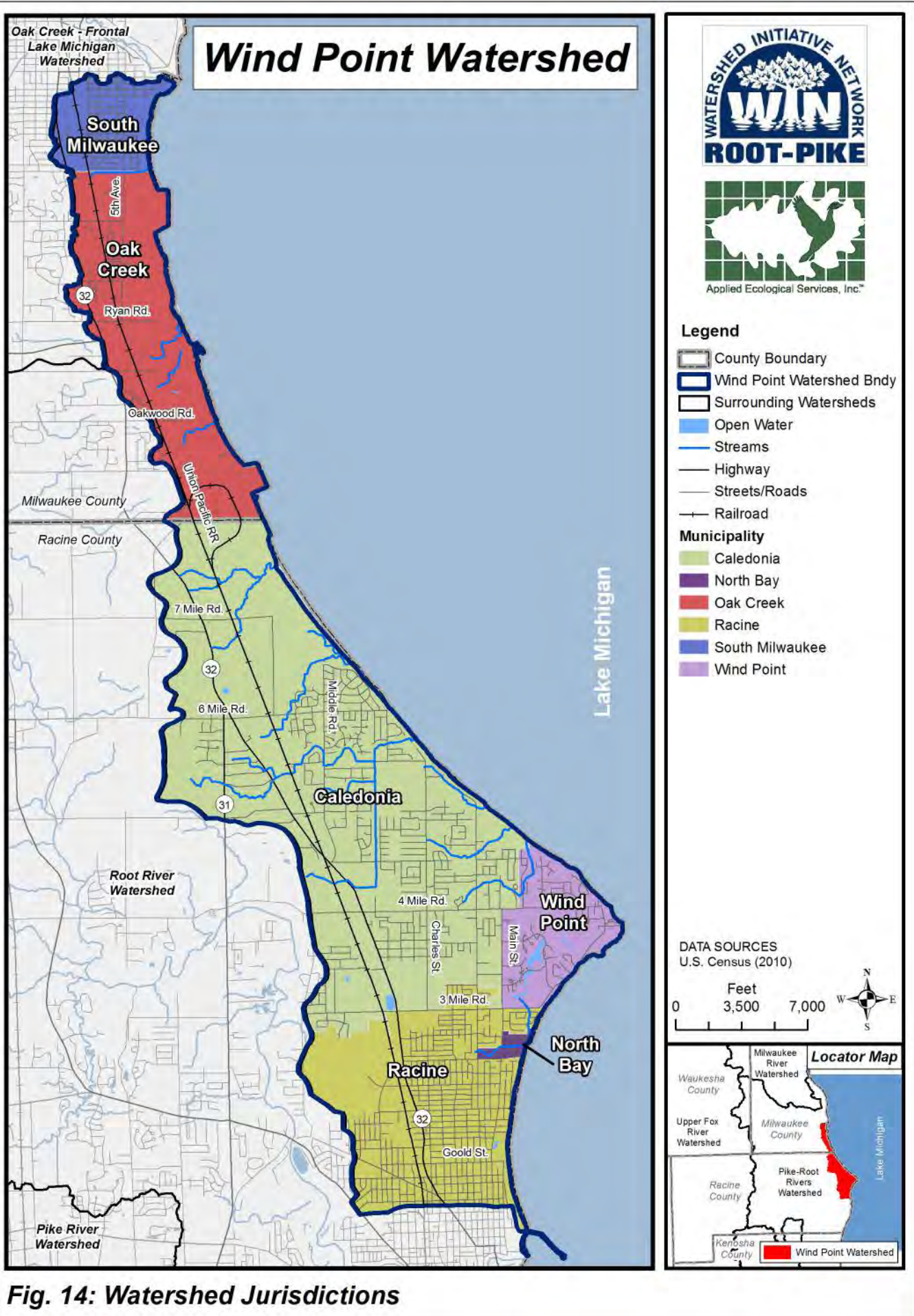
Additionally, Wisconsin is part of three interstate compact agreements that also have jurisdiction over Lake Michigan. The first is the Great Lakes Basin Compact which established the Great Lakes Commission and gave it the authority to research and make recommendations regarding water use and development in the Great Lakes. The Council of Great Lakes Governors established the Great Lake Protection Fund to finance projects used to protect and

restore the Great Lakes. Finally, the Great Lakes Charter, signed by the Council of Great Lakes Governors, regulates water transfers out of the Great Lakes Drainage basin in excess of 100,000 gallons per day.

The Wisconsin Coastal Management Program, established under the Federal Coastal Zone Management Act, also serves to protect the Lake Michigan coast and manage this valuable resource.

Land Protection
The U.S. Fish and Wildlife Service (USFWS) and WDNR protect various dedicated natural areas and threatened and endangered species. Local conservation groups such as the Caledonia Conservancy and Root-Pike Watershed Initiative Network also serve in a similar capacity by working to protect and restore natural areas.

The U.S. Army Corps of Engineers (USACE), with approval of WDNR, regulates wetlands through Sections 401 and 404 of the Clean Water Act (CWA). Land development affecting water resources (rivers, streams, lakes, wetlands, and floodplains) is regulated by the USACE when "Waters of the U.S." are involved. These types of waters include any wetland or stream/river that



is hydrologically connected to navigable waters. The USACE primarily regulates filling activities and requires buffers or wetland mitigation for developments that impact jurisdictional wetlands. Wind Point watershed falls within USACE's Detroit District of the Great Lakes & Ohio River Division.

Land development in the watershed is regulated by county and municipal ordinances. Racine County has a Subdivision Ordinance and Zoning Ordinance, but no dedicated regulating ordinances for either stormwater or erosion control. Milwaukee County does not have either dedicated Zoning or Subdivision regulations.

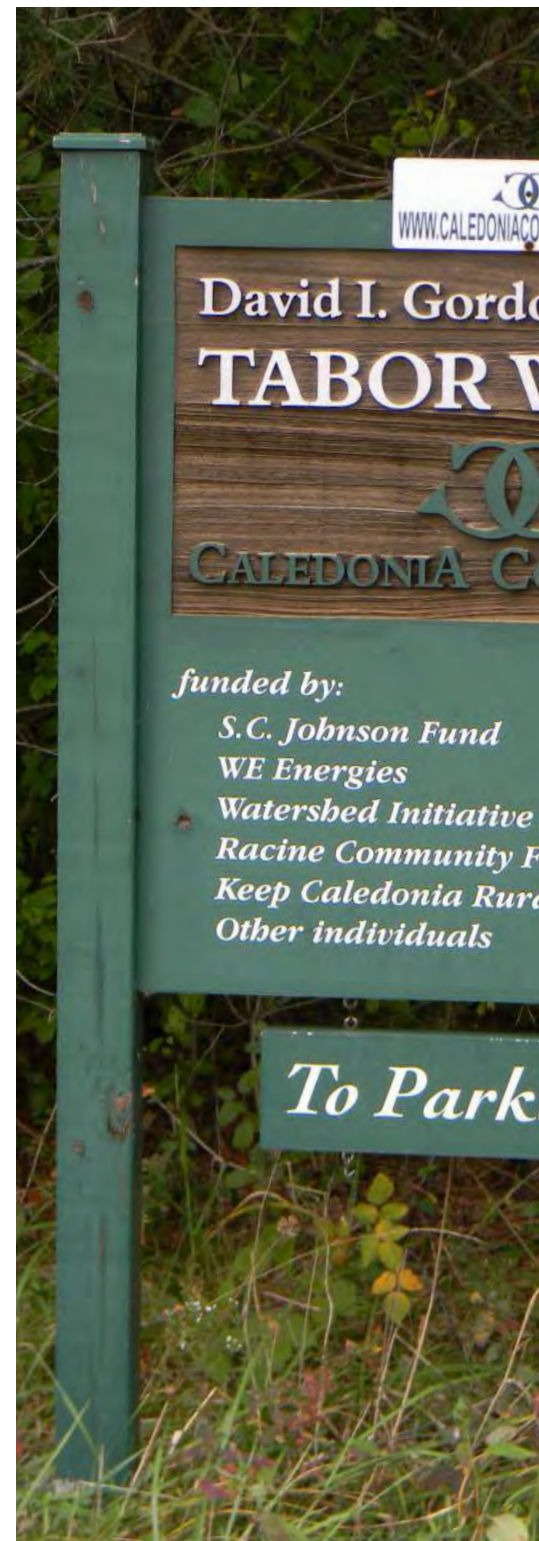
Beyond county-level regulations, each municipality has their own applicable regulations. Municipalities in the watershed may or may not provide additional watershed protection above and beyond existing local municipal codes. Most municipal codes provide ordinances covering businesses regulations, building regulations, zoning regulations, new subdivision regulations, stormwater management, streets, utilities, landscaping/restoration, tree removal, etc.

Municipal codes and ordinances include:

- *Village of Caledonia:* Land development is regulated under both subdivision and zoning codes. Dedicated ordinances include Subdivision Controls, Conservation Subdivisions, Construction Site Erosion Control, Floodplain Regulations, and Pollution Abatement.
- *Village of North Bay:* This small, fully developed community consisting of 97 homes has no additional applicable land development ordinances.

- *City of Oak Creek:* Land Use, Subdivision and Zoning Codes regulate the City of Oak Creek which include Erosion and Sediment Control, Stormwater Runoff, Shoreland Wetland Conservancy, Floodway regulations.
- *City of Racine:* Development is regulated under their Zoning Ordinance. Municipal codes present opportunities for outlining and requiring some of the recommendations in this plan such as conservation and/or low density development, Special Service Area (SSA) or watershed protection fees, and use of native trees and plants in landscapes.
- *City of South Milwaukee:* This community has dedicated Wetland, Stormwater Management, Illicit Discharge, Construction Site Erosion Control, and Flood Plain Regulations Ordinances within the city's Zoning Code.
- *Village of Wind Point:* this small community regulates its land development through Subdivision and Zoning Codes which include Environmental Preservation, Floodplain, and Shoreland/Wetland Overlay Districts as well as Construction Site Pollutant Control, Post Construction Stormwater Management, and Floodplain Ordinances.

Other governments and private entities with watershed jurisdictional or technical advisory roles include the Federal Emergency Management Agency (FEMA), the USDA's Natural Resources Conservation Service (NRCS), and Southeastern Wisconsin Planning Commission (SEWPC). County Boards are also important because they oversee decisions made by respective county governments and therefore have the power to override or alter policies and regulations.



Caledonia Conservancy sign at Tabor Woods



NPDES Phase II Stormwater Permit Program

The Wisconsin Department of Natural Resources (WDNR) oversees the National Pollutant Discharge Elimination System (NPDES) program. The NPDES program was initiated under the federal Clean Water Act to reduce pollutants to the nation's waters. This program requires permits for discharge of: 1) treated municipal effluent; 2) treated industrial effluent; and 3) stormwater from municipal separate stormsewer systems (MS4's) and construction sites.

The NPDES Phase I Stormwater Program began in 1990 and applies only to large and medium-sized municipal separate stormsewer systems (MS4's), several industrial categories, and construction sites hydrologically disturbing 5 acres of land or more.

The NPDES Phase II program began in 2003 and differs from Phase I by including additional MS4 categories, additional industrial coverage, and construction sites hydrologically disturbing greater than 1 acre of land. Under NPDES Phase II, all municipalities with small, medium, and large MS4's are required to complete a series of Best Management Practices (BMPs) and measure goals for six minimum control measures:

1. Public education and outreach
2. Public participation and involvement
3. Illicit discharge detention and elimination
4. Construction site runoff control
5. Post-construction runoff control
6. Pollution prevention and good housekeeping

The Phase II Program also covers all construction sites over 1 acre in size. For these sites the developer or owner must comply with all requirements such as completing and submitting a Notice of Intent (NOI) before construction occurs, developing a Stormwater Pollution Prevention Plan (SWPPP) that shows how the site will be protected to control erosion and sedimentation, completing final stabilization of the site, and filing a Notice of Termination (NOT) after the construction site is stabilized.

All six municipalities in the Wind Point watershed are covered under a NPDES Phase II permit. The Village of North Bay has current permit for their lift stations only.

Planning, Policy and Regulation

Planning, policy, and regulation are the foundation of watershed protection, because the process sets the minimum standards for development that occurs or is proposed to occur in the vicinity of water resources. It is hoped that recommendations from this watershed plan would be referenced in future comprehensive plans and implemented in ordinances. In many cases, municipal codes also lay the foundation for the types of trees that can be removed from sites as well as what types of plant communities and species that can be replanted. County stormwater ordinances are the primary preventative measure that can be used to standardize for the respective county the requirements that proposed developments must meet. Monitoring and enforcement of implemented municipal codes and county regulations falls in the hands of local municipalities or County

agencies. It is up to these enforcing bodies to communicate effectively and discuss often the problems with how ordinance language is interpreted and amendments that may help clarify certain regulations.

Planning/zoning guidance provides another level of watershed and natural resource protection. Most planning and zoning guidance is in the form of local floodplain or zoning ordinances that regulate onsite land use practices to ensure adequate floodplain, wetland, stream, lake, pond, conservancy soil, and other natural resource protection. Zoning ordinances and overlay districts in particular define what type of development is allowed and where it can be located relative to natural resources. For example, Village of North Bay's Code of Ordinances contains a section related to "Residential Conservation Overlay District Establishment." Other examples of planning/zoning forms of resource

protection include riparian and wetland buffers, impervious area reduction, open space/greenway dedication, conservation easements and conservation and/or low density development.

To improve the impact of planning/zoning guidance on water resource protection, there needs to be improved coordination and communication between county and local government. Watershed development regulations should be made very clear to local enforcement officers; local planners and zoning boards should consider revisions to local ordinances that address watershed, subwatershed, and/or site-specific natural resource issues. For example, communities with less impervious development now should revise their zoning ordinances sooner rather than later in order to adequately prevent the types of development that contribute to flooding, degrade wildlife habitat, and reduce water quality.

3.6 Existing Policies and Ordinance Review

Protection of natural resources and green infrastructure during future urban growth will be important for the future health of Wind Point watershed. To assess how future growth might further impact the watershed, an assessment of local municipal ordinances was performed to determine how development is regulated in each municipality. In this way, potential improvements to local ordinances can be identified. As part of the assessment, municipal governments were asked to compare their local ordinances against model policies outlined by the Center for Watershed Protection (CWP) in a publication entitled *"Better Site Design: A Handbook for Changing Development Rules in*

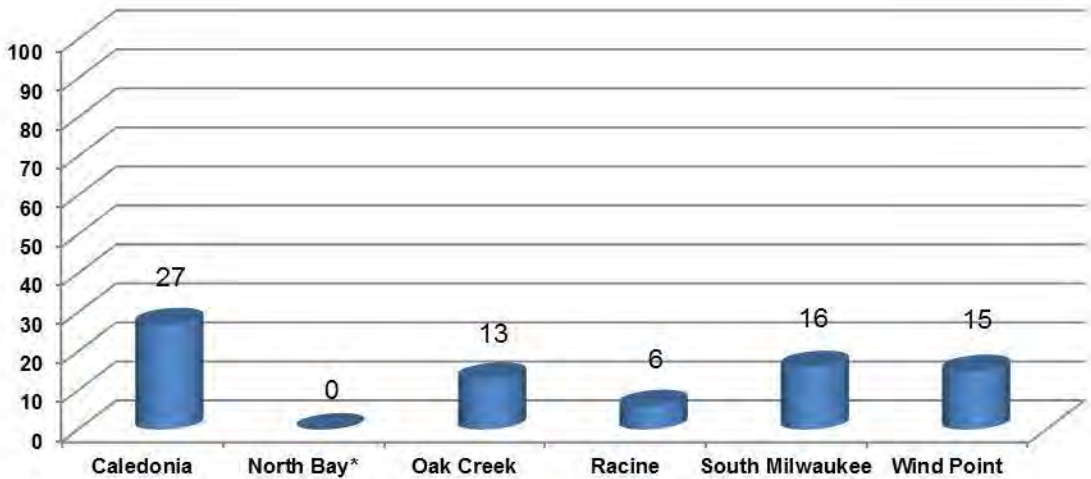
Your Community" (CWP 1998).

Applied Ecological Services, Inc. (AES) began the assessment process by reviewing local municipal ordinances including those for Caledonia, Oak Creek, Racine, South Milwaukee and Wind Point. The results of the initial review were then sent to each municipality for review and update if needed. The municipality of Wind Point was the only entity to review and update the findings. The results of the review for each municipality can be found in Appendix B.

CWP's recommended ordinance review process involves assessments of three general categories including "Residential Streets & Parking Lots", "Lot Development" and "Conservation of Natural Areas". Various questions with point totals are examined

under each category. The maximum score is 100. CWP also provides general rules based on scores. Scores between 60 and 80 suggest that it may be advisable to reform local development ordinances. Scores less than 60 generally mean that local ordinances are not environmentally friendly and serious reform may be needed. Municipal scores ranged from 6 to 27 with an average score of 15 (Figure 15). Caledonia scored the highest with 27 points followed by South Milwaukee with 16 points and Wind Point with 15 points. Although all scores are low, it should be noted that this assessment is meant to be a tool to local communities to help guide development of future ordinances. Various policy recommendations are included in the Action Plan section of the report to address general ordinance deficiencies.

Figure 15. Center for Watershed Protection ordinance review results for local municipalities.



3.7 Demographics

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) provides a Multi-Jurisdictional Comprehensive Plan for both Milwaukee and Racine Counties that projects regional change out to 2035 and provides reliable growth forecasts. This was produced as part of the “Smart Growth Initiative” in 2009 which also let to development of comprehensive plans for the municipalities in the watershed. SEWRPC also predicts demographics data extending to 2050 but this data is only available at the County level so it is not particularly useful in this watershed plan. The County data is published in SEWRPC Technical Reports No. 10 and 11 (fifth edition), available on SEWRPC’s website. SEWRPC will convert the data to quarter-section data in 2015.

SEWRPC’s 2000 to 2035 forecasts of population, households, and employment were used to project how these attributes will impact Wind Point watershed. These forecasts were created under the guidance of SEWRPC’s Advisory Committee on Regional Population and Economic Forecasts (SEWRPC 2004). The Committee utilized the cohort-component method to develop their population projections; used the projection of the population in households, the projection of average household size, and the application of the projected household size to the projected household population to achieve household projections; and used a disaggregate approach to the preparation of employment projects that took into account the explicit consideration of employment in selected industry groups and the preparation of projections for those groups.

Table 8 includes SEWRPC’s population, households, and employment forecast changes between 2000 and 2035 for the Wind Point watershed area. The

Table 8. SEWRPC 2000 data and 2035 forecast data.

Data Category	2000	2035	Change (2000-2035)	Percent Change
Population	51,163	60,402	9,239	18
Household	19,864	24,648	4,784	24
Employment	15,107	14,781	-326	-2

Source: Southeastern Wisconsin Regional Planning Commission 2035 Forecasts

data is generated by Township, Range, and quarter Section and is depicted on Figures 16 & 17. Note: AES used GIS to overlay the Wind Point watershed boundary onto SEWRPC’s quarter Section data. If any part of a quarter Section fell inside the watershed boundary, the statistics for the entire quarter Section were included in the analysis.

The combined population of the watershed is expected to increase from 51,163 in 2000 to 60,402 by 2035, an 18% increase. The highest population increase is expected in the northern portion of the watershed within the City of Oak Creek. Much of this area is currently vacant and multiple residential developments are currently in progress. Moderate population growth is expected in the south-central portion of the watershed within the Village of Caledonia. Some of this growth is already occurring or is anticipated in areas that are currently farmed or vacant. Similarly, projected household change generally follows change in population. The combined number of households in the watershed is expected to increase from 19,864 in 2000 to 24,648 by 2035, a 24% increase.

Employment is expected to decrease slightly from 15,107 jobs in 2000 to 14,781 jobs by 2035, a 2% decrease. Employment reduction is projected to be highest in the northern tip of the watershed/City of South Milwaukee and along Route 32 in the City of Racine. Despite a general decrease in employment, there are a few areas

that are projected to see increased employment opportunities. These areas are associated with population and household increases in the south-central and northern portion of the watershed.

Socioeconomic Status

The communities within the watershed can best be described as middle class. Active growth slowed beginning in 2007 due to an economic downturn. However, the region did experience a mixture of residential, industrial, and commercial growth over the past 20 years and offers amenities such as parks, shopping, conservation areas, beaches, schools and libraries, and is in somewhat close proximity to interstate highway access.

2010 U.S. Census Bureau data for the Village of Caledonia, City of Racine, and City of Oak Creek, the largest communities in the watershed, were averaged and used as a basis for profiling the socioeconomic status of Wind Point watershed. To summarize, the area is comprised of a mostly white population (>80%); the African American population exceeds 22% in Racine. The median household income is about \$60,000 although nearly 14% of the population in Racine is below poverty level. In addition, approximately 67% of housing units are owner occupied; the remainder are rented. Owner occupied units are valued at about \$210,000 on average in Oak Creek and Caledonia and about \$130,000 per unit on average in Racine.

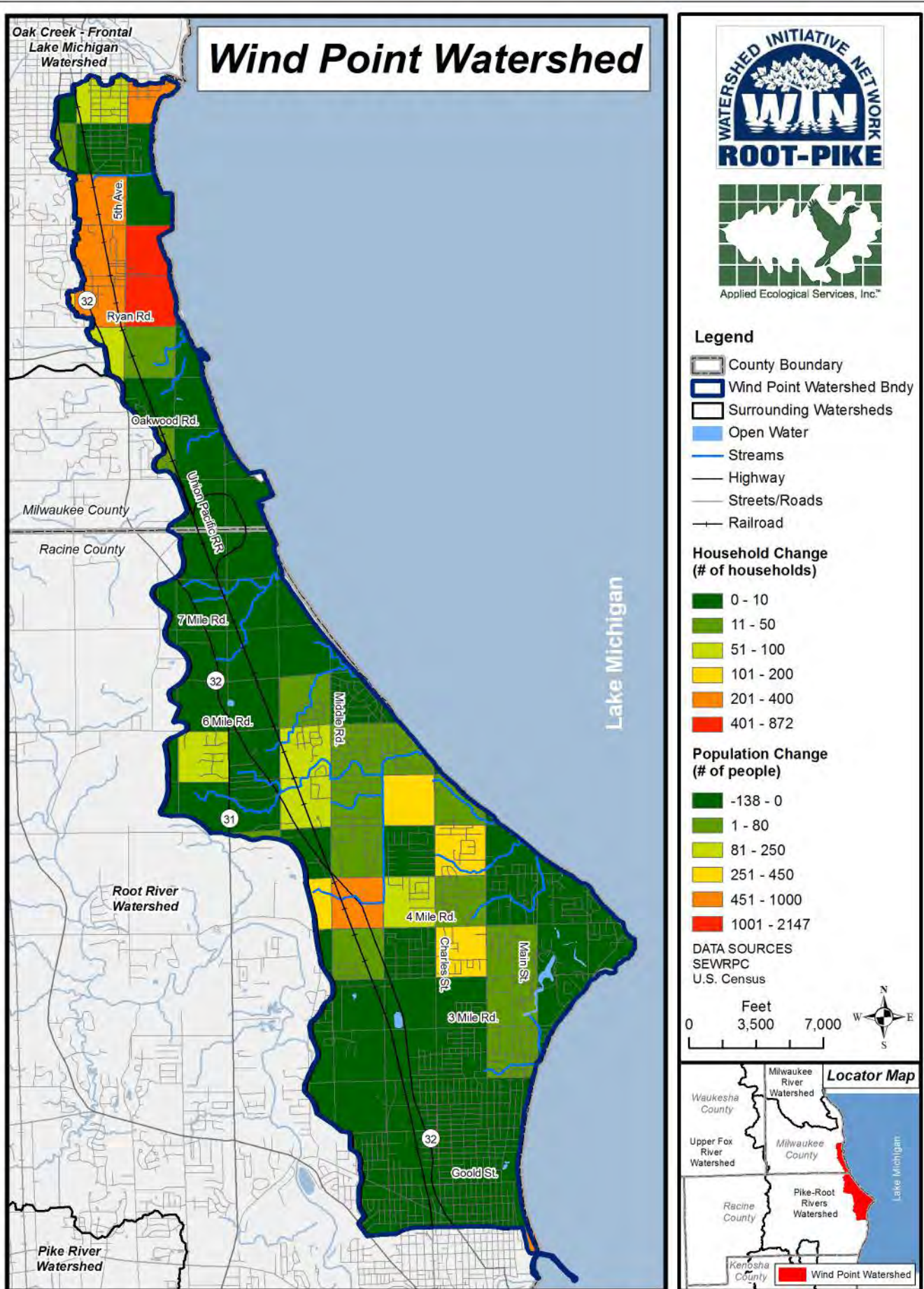
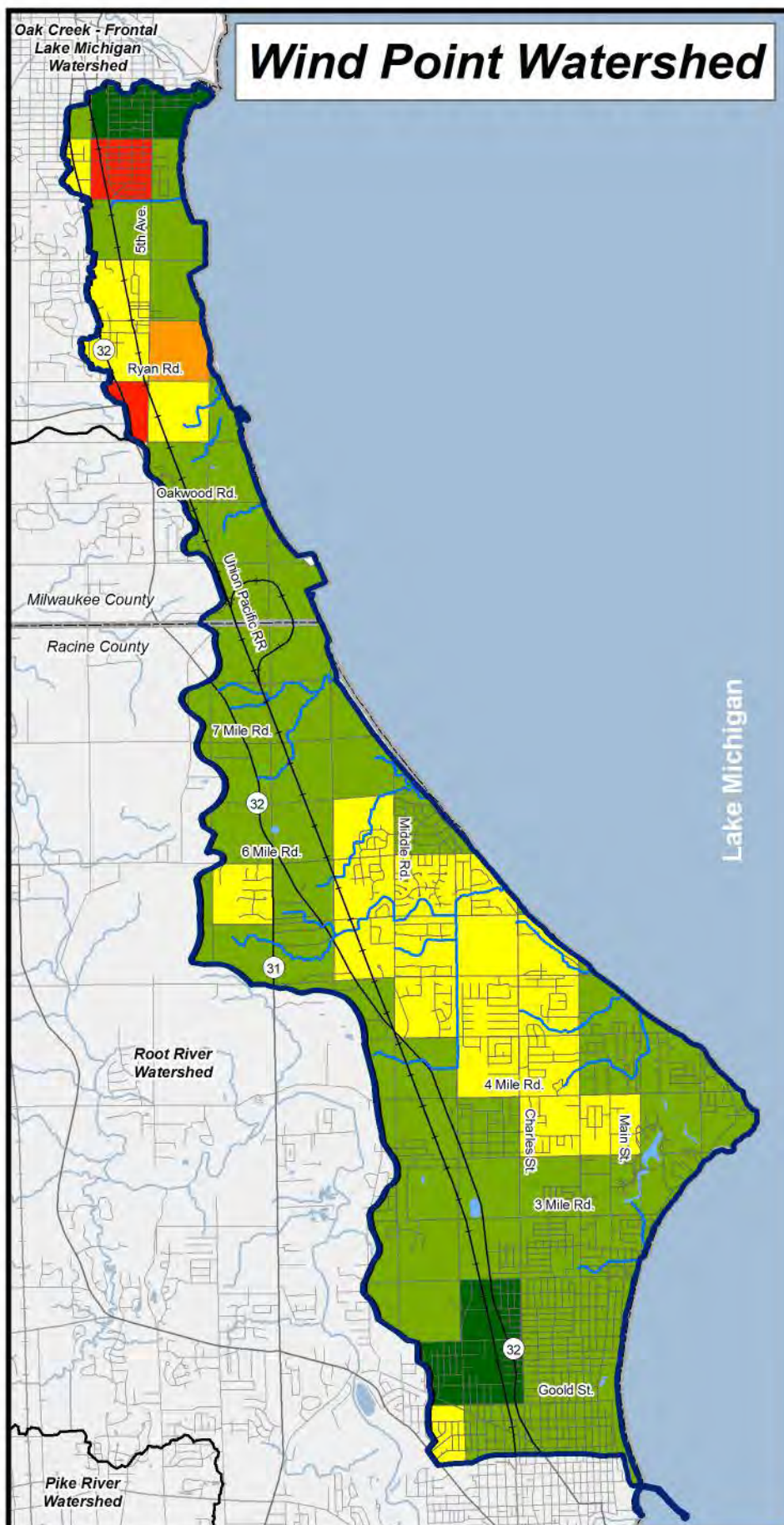


Fig. 16: Household and Population Change Year 2000 - 2035



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Employment Change (# of people)

- 148 - -50
- 49 - 0
- 1 - 50
- 51 - 150
- 151 - 234

DATA SOURCES
SEWRPC
U.S. Census

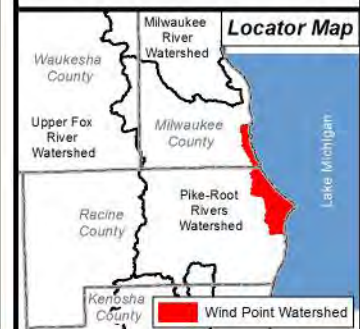
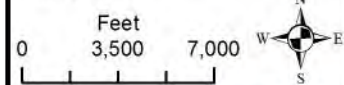


Fig. 17: Employment Change Year 2000 - 2035

3.8 Transportation Network

Roads

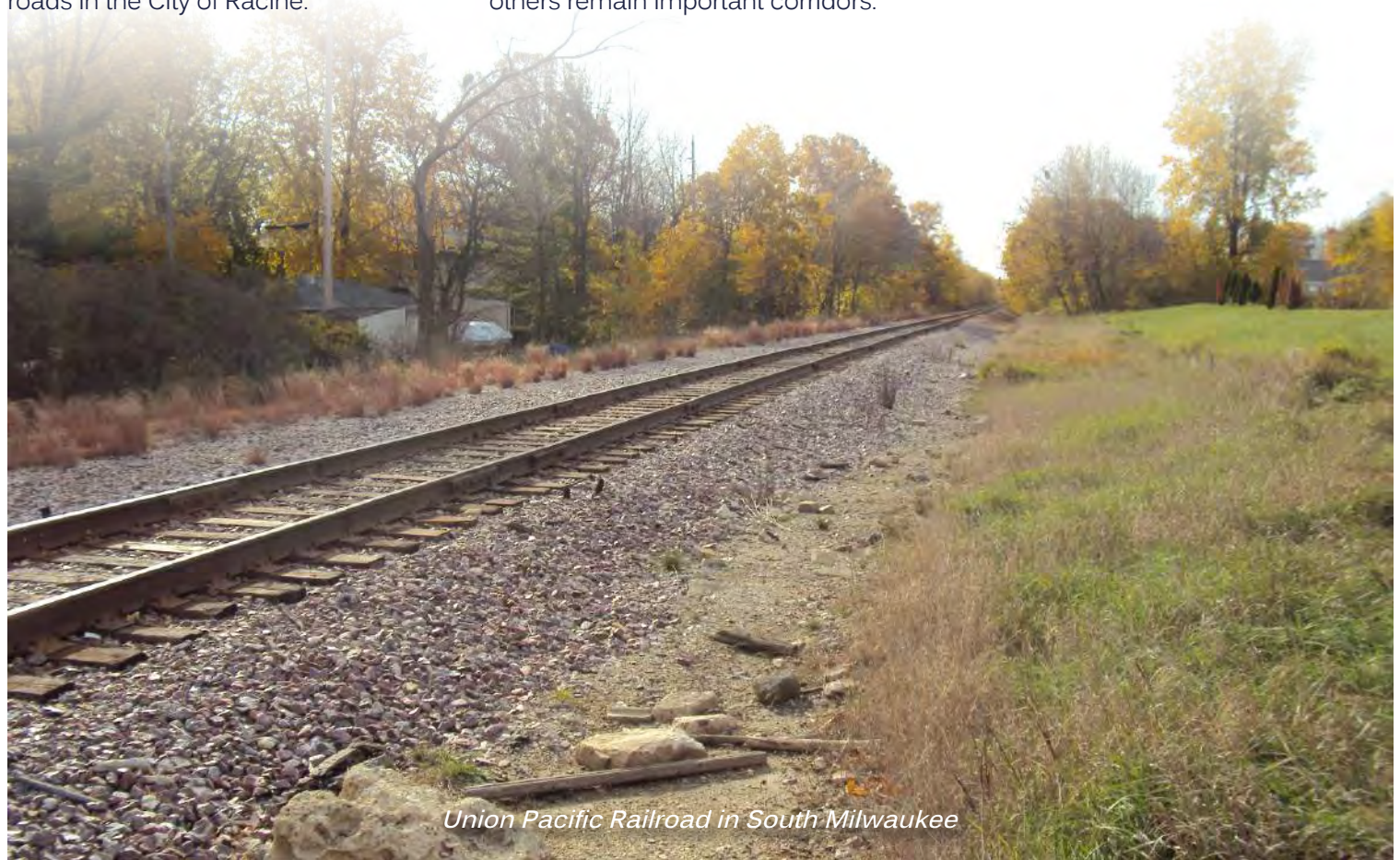
A diverse network of roads traverse Wind Point watershed (Figure 18). State Highway 32 is the most used road in the watershed. It generally runs north-south from South Milwaukee to Racine along the western half of the watershed. State Highway 31, another major north-south road, has a small section that joins Route 32 south of 6 Mile Road. There are various major secondary roads that generally run either north-south or east-west. Some of these major secondary roads include Marion Ave and Columbia Avenue in the City of South Milwaukee. Puetz Road, Ryan Road, Fitzsimmons Road, Oakwood Road, and 5th Avenue are located in the City of Oak Creek. 7 Mile Road, 6 Mile Road, 5 Mile Road, 4 Mile Road, 3 Mile Road, Middle Road, Charles Road, and Erie Street run through the Village of Caledonia. Carlton Drive, South Street, Goold Street, High Street, and Rapids Drive are all major secondary roads in the City of Racine.

Railroads

The Union Pacific Railroad, formerly Chicago and North Western Railway (C&NW), runs north-south across the western half of Wind Point watershed. The railroad is one of the oldest and best remembered rail lines in the Midwestern United States and is the first to operate a train out of Chicago. Throughout much of the rail line's life it did two things; serve the Heartland and northern Great Lakes regions as well as ferry traffic to and from Chicago. Aside from freight operations it was quite successful with its passenger operations as well. It's most famous was its fleet of "400s". Aside from its long-distance trains the rail line also operated a number of commuter operations, particularly around the Chicago and Milwaukee regions. In 1995 C&NW became part of Union Pacific. Although the C&NW is no longer an independent company almost all of its main lines continue to serve as important arteries under the Union Pacific banner. Today, large sections of the rail line have been abandoned or severed while others remain important corridors.

Airports

John H. Batten Airport (Batten International Airport) is located on over 450 acres of land in the City of Racine (Figure 18) and provides services to corporate, business and private aircraft twenty-four hours a day, seven days each week. The general-aviation terminal is complete with pilot and passenger lounges, a flight planning facility equipped with computerized weather data and a conference room with audio/video services. The airport is the largest privately-owned, public-use, reliever airport in the United States owned by the Racine Commercial Airport Corporation. The airport was founded in 1941 by Carlyle Godske on roughly 160 acres of land purchased from local businessman J.A. Horlick. For most of its history, the airport was known as Racine-Horlick Field, but on September 5, 1989, the name was changed to John H. Batten Field. John H. Batten was one of the airport's early founders and supporters.



Union Pacific Railroad in South Milwaukee

Harbors

Three area harbors are located along the Lake Michigan coast adjacent to Wind Point watershed. The first is South Milwaukee Harbor located in the far north end of the watershed within the City of South Milwaukee and includes South Milwaukee Yacht Club. This 14 acre site has 95 boat slips, a clubhouse with bar, fuel dock, fish cleaning station, outdoor pavilion, and 24/7 bathroom/shower facilities. The facility has been in existence for over 60 years and is funded and maintained by Club members.

The second is Bender Park Harbor located within Milwaukee County's Bender Park. This harbor provides public access to Lake Michigan and also includes a swimming beach.

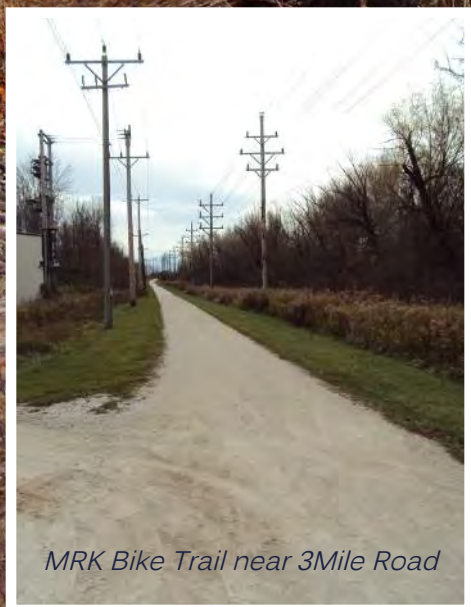
A portion of Racine Harbor is located at the southeast tip of the watershed in the City of Racine near the mouth of the Root River. The harbor houses the Racine Yacht Club founded in 1914. The private membership Club offers many attractions including its own slip system, dry sailing area, bar, dining area, patio, and private beach with play ground. The Club also has a racing fleet and offers adult sailing classes.

Trails/Bike Paths

Over 7 miles of major trails/bike paths have been constructed within Wind Point watershed (Figure 18). Hiking/multi use trails within Bender Park account for another 4.25 miles. The Milwaukee-Racine-Kenosha (MRK) Trail is 5 mile long crushed limestone path that runs along a power line next to the Union Pacific Railroad right-of-way. The northern end of the trail is at 7 Mile Road's intersection with railroad. The southern end is at Layard Street in Racine. This trail has no direct connection to any other trail at its

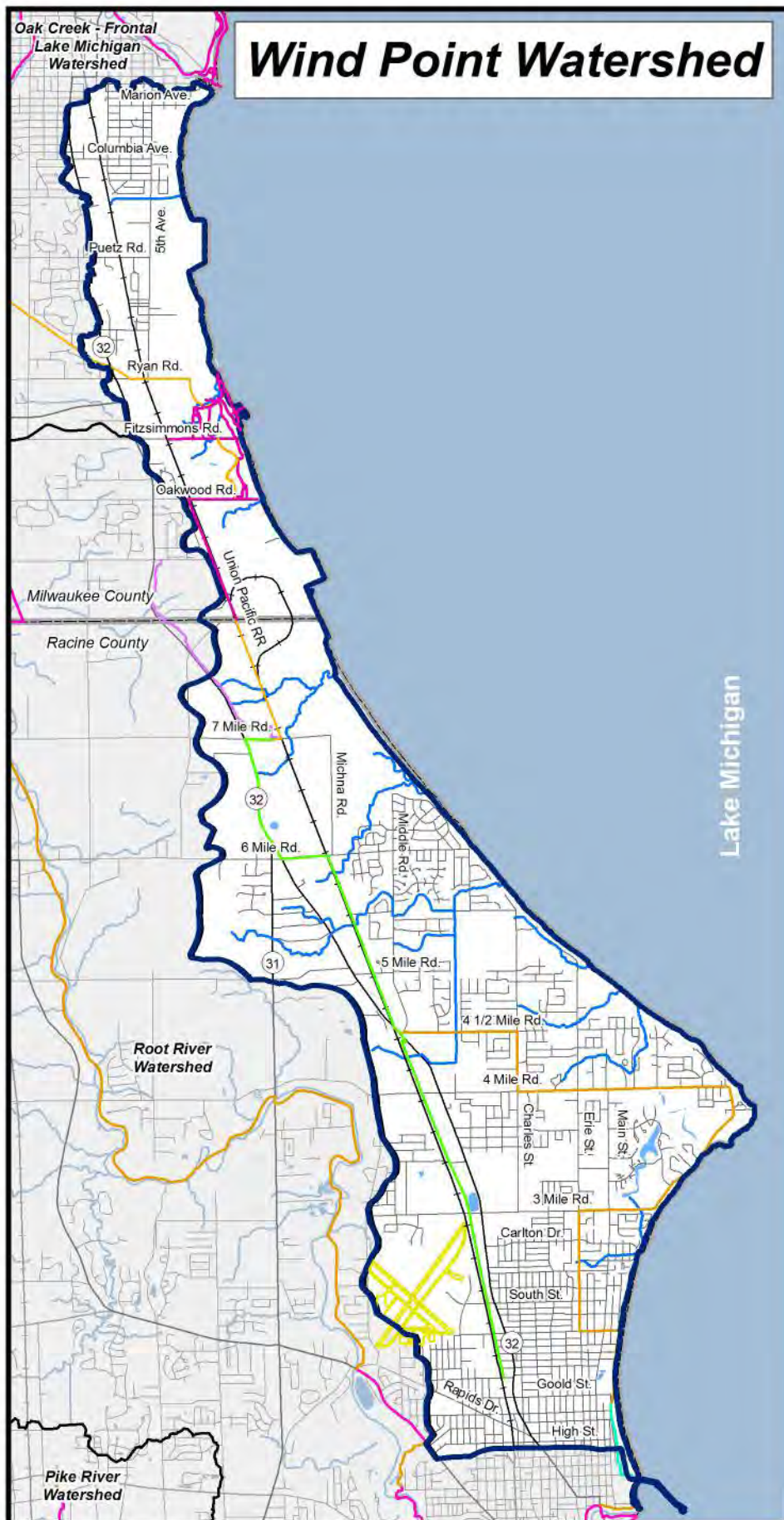
south terminus. The north terminus hooks up with We Energies Trail. This trail continues for another mile north on the east side of Route 32 and continues out of the watershed before ending at Elm Road. The Lake Michigan Pathway is located along Lake Michigan in the far southeast portion of the watershed. This path connects to Racine County's Milwaukee-Racine-Kenosha Trail (MRK) at 3-Mile Road and South Street via an on-road connection. On the south side of Racine, it connects to Racine County's North Shore Trail at Chicory Road. The Lake Michigan Pathway provides users with a beautiful view of Lake Michigan and connects to North Beach and Racine Zoological Gardens.

SEWPC's 2035 Comprehensive Plan also identifies various proposed trails and bike path extensions in the watershed (Figure 18). The first is a relatively long path that would pick up where Lake Michigan Pathway ends at August Street and wind its way along Lake Michigan, along 4 Mile and 4 ½ Mile Roads, and eventually to MKR Trail. Another proposed trail is located between Ryan and Oakwood Roads within Bender Park. Future plans for Bender Park include a 0.75 mile trail extension.



MRK Bike Trail near 3 Mile Road

Lake Michigan Pathway



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Transportation**
 - Highway
 - Streets/Roads
 - Railroad
 - Batten International Airport
 - MRK Bike Trail
 - WE Energies Trail
 - Lake Michigan Pathway
 - Other Existing Trails & Bike Paths
 - Proposed Trails & Bike Paths

DATA SOURCES
SEWRPC

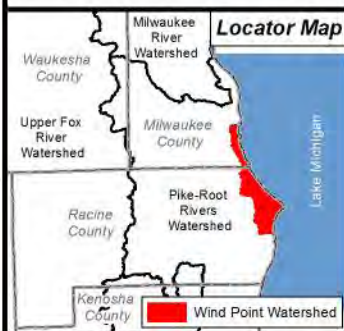
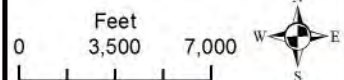


Fig. 18: Transportation Network

3.9 Existing & Future Land Use/ Land Cover

2012 Land Use/Land Cover

Highly accurate land use/land cover data was produced for Wind Point watershed using several sources of data. First, the most recent land use/land cover data from Southeastern Wisconsin Regional Planning Commission (SEWRPC) was used as a base layer. Recent aerial photography of the watershed was also overlaid on SEWRPC land use data in GIS so that additional discrepancies could be corrected. Finally, several corrections were made to land use based on field notes taken by Applied Ecological Services, Inc. (AES) during the fall 2012 watershed resource inventory and suggestions made by stakeholders. 2012 land use/land cover data and map for Wind Point watershed is included in Table 9 and depicted on Figure 19.

Residential areas combined are the most abundant land use in the watershed. Medium density single family residential comprises 1,544.6 acres or 12.9% of the watershed followed by low density at about 1,182 acres/10%, high density at 673.6 acres/5.6%, and multifamily at 410.5 acres/3.4%. Most residential development is located in the northern portion of Racine, throughout Caledonia, and the southern portion of South Milwaukee. Residential development is also common along Lake Michigan in Wind Point and Caledonia.

Vacant land is the second most abundant land use/cover in the watershed at 1,649 acres or 13.8%. This land use includes private and public property that generally has not been developed for human purposes or land that was once developed but is no longer in use such as abandoned industrial areas. Large areas of vacant land can be found in parks and natural areas and unused turf areas surrounding features such as John H. Batten Airport and two wastewater treatment plants.

Table 9. 2012 land use/land cover classifications and acreage.

Land Use	Area (acres)	% of Watershed
Cemetery	32.6	0.3
Commercial/Retail	274.1	2.1
Cropland	1,111.2	9.3
Cultural/Recreational	582.6	4.9
Government/Institutional	326.8	2.7
Industrial	725.7	6.1
Landfill	43.7	0.4
Residential (Low Density ≥ 0.45 ac ≤ 1.43 ac)	1,181.7	9.9
Residential (Medium Density ≥ 0.16 ac ≤ 0.44 ac)	1,544.6	12.9
Residential (High Density ≤ 0.15 ac)	673.6	5.6
Residential-Multifamily	410.5	3.4
Residential-Under Development	116.9	1.0
Open Water	44.4	0.4
Other Agricultural	29.4	0.2
Pastureland	170.0	1.4
Quarry/Mining	163.0	1.4
Transportation	1,631.4	13.6
Utilities	366.5	3.1
Vacant Land	1,649	13.8
Wetlands*	356.3	3.0
Woodland	500	4.2
Total	11,945.0	100

**Wetland acreage is based off SEWRPC2000 land use mapping and not 2005 SEWRPC wetland inventory.*

Transportation land uses such as railroads, streets, highways, and airport runways make up the third largest land use/cover in the watershed at about 1,631 acres or 13.5% of the watershed.

Agricultural land dominated the watershed from the late 1800s to the 1990s. Cropland is now the fourth largest land use with about 1,111.2 or 9.3% in production. Agricultural areas are spread out through portions

of Caledonia with large crop fields remaining between 6 Mile Road and the County line.

Industrial is another important land use in the watershed at about 726 acres or 6% of the watershed. Most industrial use is associated with We Energies in the central portion of the watershed with other scattered industrial parcels in the northern portion of the watershed.



*Above: Typical high density residential area
in S. Milwaukee*

In addition, total open space land uses such as agricultural lands, vacant land, open water, wetlands, cultural, recreational, and woodlands make up 4,453.5 acres or 37.3% of the watershed. Many natural areas can be found in public parks including Bender Park, Cliffside Park, Tabor Woods, and other parcels owned by Caledonia Conservancy. Developed land uses account for the remaining 7,491.5 acres or 62.7% of the watershed.

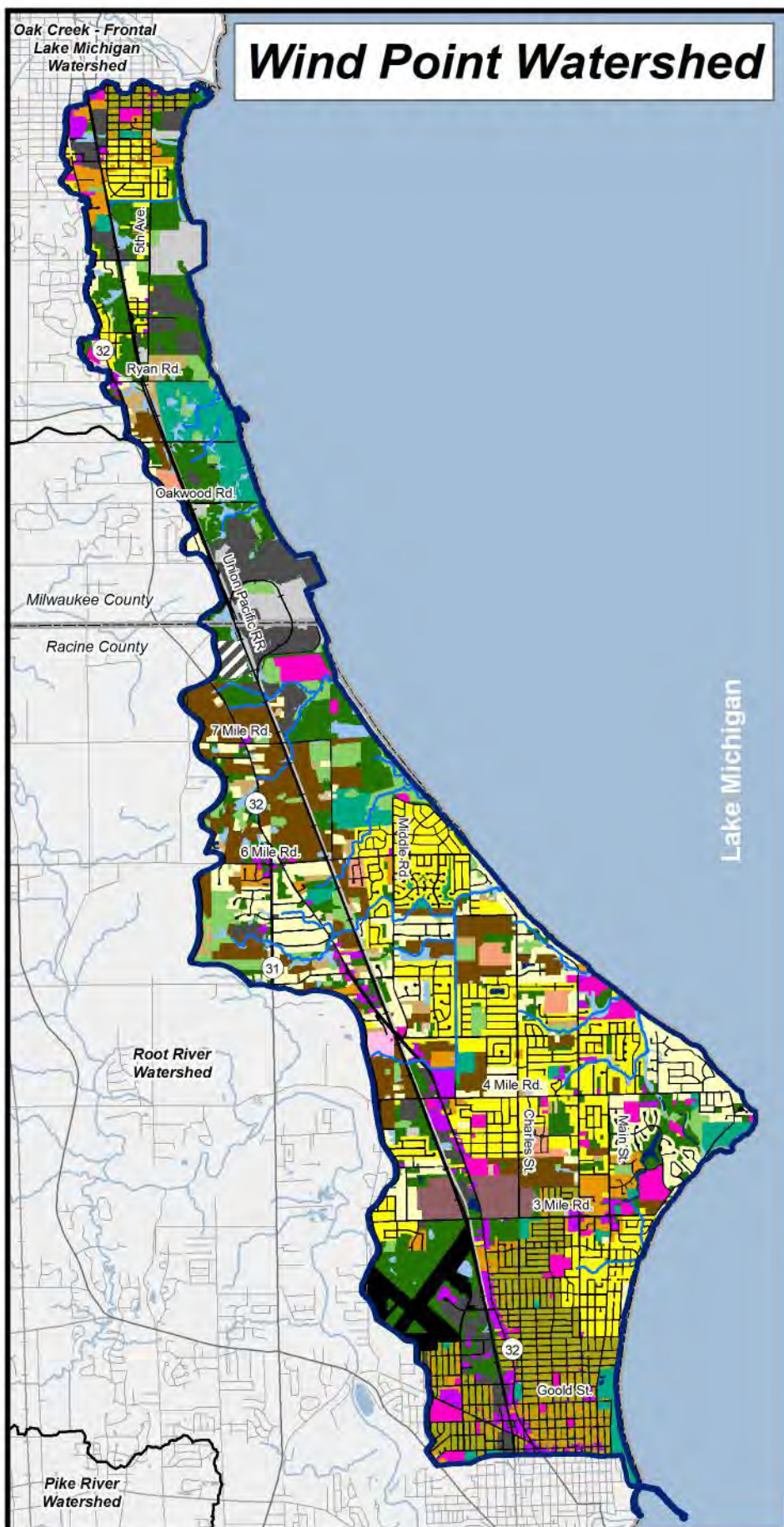
We Energies

We Energies is the trade name of two utility subsidiaries of Wisconsin Energy Corporation. We Energies serves over 2.2 million customers including those in portions of Wisconsin, and Michigan's Upper Peninsula. The environment is important to We Energies as the corporation's mission includes a commitment to enhance the quality of life in the areas it serves.

We Energies' Oak Creek Power Plant is located almost entirely within Wind Point watershed and occupies more than 400 acres of land on the shore of Lake Michigan within the City of Oak Creek. The site contains two coal-based power plants that run four steam turbines that typically operate 24 hours a day. The byproduct of burning coal is fly ash which is transported to nearby landfills. In addition, Oak Creek Plant uses up to 1.5 million gallons of cooling water from Lake Michigan every day.



WE Energies Oak Creek Power Plant



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Streams
- Highway
- Streets/Roads
- Railroad
- Land Use/Land Cover**
- Cropland
- Pastureland
- Other Agricultural
- Commercial/Retail
- Government/Institutional
- Cemetery
- Utilities
- Industrial
- Quarry/Mining
- Landfill
- Low-Density Residential
- Medium-Density Residential
- High-Density Residential
- Multi-Family Residential
- Residential - Under Development
- Open Water
- Wetlands
- Vacant Land
- Woodland
- Cultural/Recreational
- Transportation

DATA SOURCES: SEWRPC, AES, WE Energies

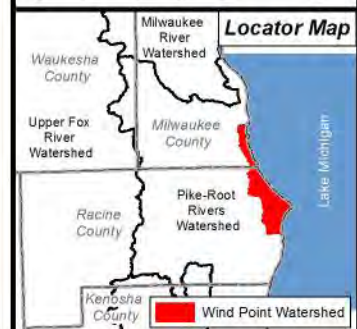
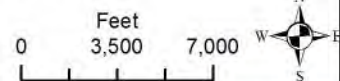


Fig. 19: Land Use/Land Cover

Land Use/Land Cover Definitions:

Cropland, Other Agricultural, Pastureland: Land use that includes out-buildings and barns, row & field crops and fallow field farms and pasture, includes dairy and other livestock agricultural processing. Also includes nurseries, greenhouses, orchards, tree farms, and sod farms.

Cemetery: Local and regional cemeteries of any size and related administration buildings, maintenance areas, and landscaped areas within the cemetery ownership.

Commercial/Retail: Land use that includes food and drug stores, eating and drinking places, general merchandise stores, legal, insurance, and real estate offices, doctors offices, personal services, business services, shopping malls and their associated parking, single structure office/hotels.

Cultural/Recreational: Land use that includes parks, playgrounds, athletic fields, museums, zoos, historic sites, amphitheaters, stadiums, race tracks, conference centers, fairgrounds, and amusement parks.

Government/Institutional: Land use that includes administration, safety, assembly, group quarters, medical facilities, educational facilities, government buildings, religious facilities, and others.

Industrial: Land use that includes manufacturing and processing, industrial, warehousing and wholesale trade, such as mineral extraction, associated parking areas, truck docks, etc.

Landfill: Those areas in which landfill operations and dumps and associated activities have taken place.

Residential-Low Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≥ 0.45 ac ≤ 1.43 ac and impervious cover less than 20%.

Residential-Medium Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≥ 0.16 ac ≤ 0.44 ac and impervious cover around 30%.

Residential-High Density: Land use that includes single family homes and farmhouses and immediate residential area around them with lot sizes ≤ 0.15 ac and impervious cover around 50%.

Residential-Multifamily: Land use that includes multifamily residences of more than one family per residence. These include duplex and townhouse units, apartment complexes, condominiums, and associated parking.

Residential – Under Development: Lands committed to residential use but not yet fully developed.

Open Water: Land cover that includes rivers, streams and canals, lakes, reservoirs, and lagoons.

Quarry/Mining: Place where dimension stone or aggregate (sand, gravel, crushed rock) is mined. Also includes all grounds associated with the mining operation.

Transportation: Land use that includes railroads, rail rapid transit and associated stations, rail yards, linear transportation such as streets and highways, and airport transportation.

Utilities: Land use that includes communication and utilities such as telephone, radio and television towers, dishes, gas, sewage pipeline, utility plants, rights-of-way, power transmission lines, waste water facilities, etc.

Vacant Land: Land cover that includes private and public property that generally has not been developed for any human purpose or land that was once developed but is no longer in use.

Wetlands: Land cover that includes all wetlands on public and private land characterized by both hydric soils and the growth of hydrophytes. Note: wetland mapping is based off SEWRPC 2000 land use data and not 2005 wetland inventory.

Woodland: Land cover generally consisting of remnant or second growth forest.

Future Land Use/Land Cover Predictions

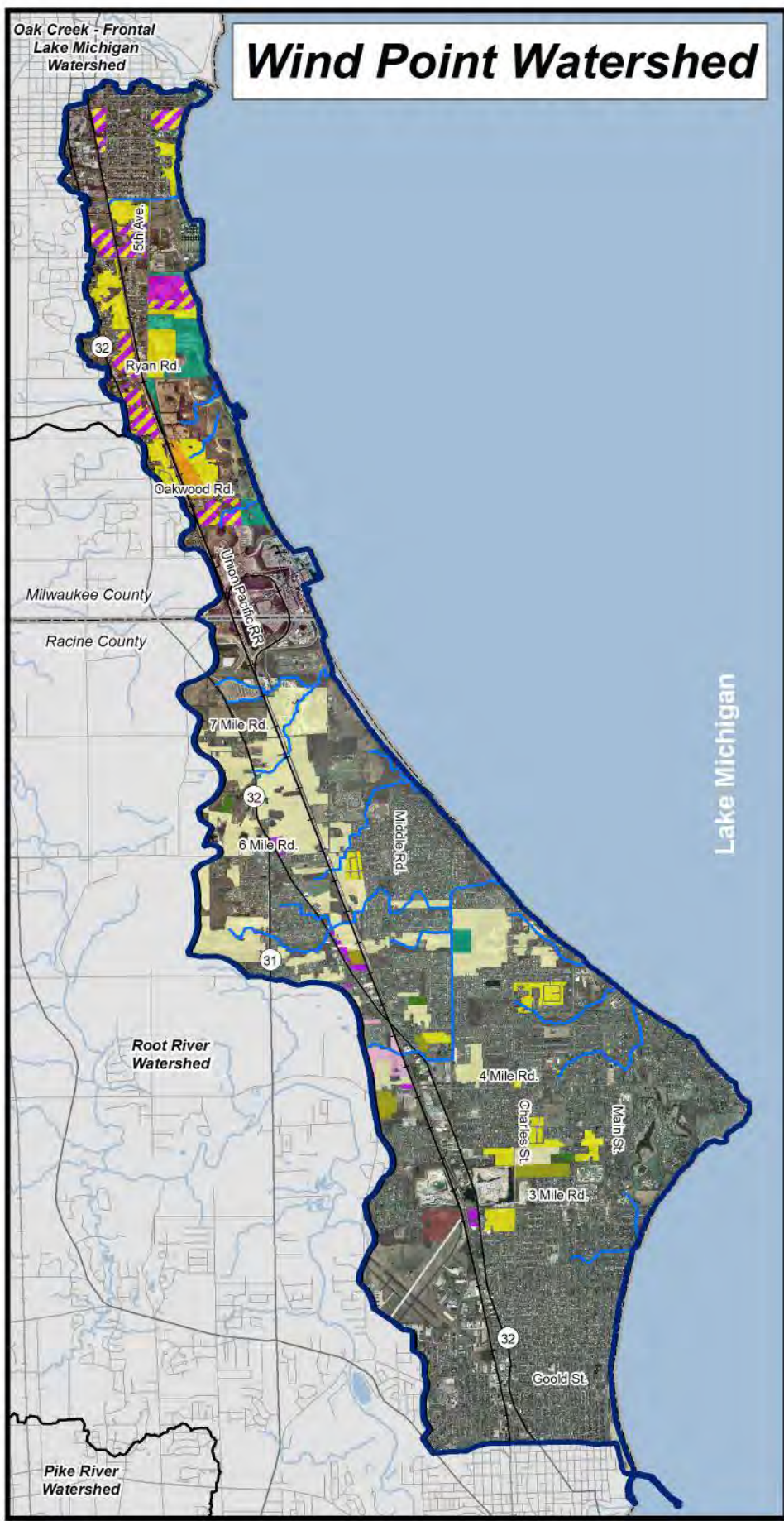
Table 10 and Figure 20 compare 2012 land use/land cover acreage to predicted future land use/land cover acreage that was determined from available municipal comprehensive plans and SEWRPC data. The largest loss of current land use/land cover acreage is expected to occur on cropland and pastureland where

approximately 968 acres of the existing 1,111 acres (83% decrease) is expected to be converted to mostly low and medium density single family residential and commercial/retail. The majority of these changes are expected to occur in the central and northern portions of the watershed within the municipalities of Caledonia and Oak Creek. A significant loss of vacant land is also expected as 989 acres

of the existing 1,649 acres (40% decrease) is predicted to become mostly residential. Finally, the remaining 500 acres of woodland is expected to decrease by at least 25% as residential development expands meaning it will be important to develop around these remaining woodlands if possible using conservation/low impact development design standards.

Table 10. Comparison between 2012 and predicted future land use/land cover statistics.

Land Use/ Land Cover	Current Area (acres)	2012 % of Watershed	Predicted Area (acres)	Predicted % of Watershed	Change (acres)	Percent Change
Cemetery	32.6	0.3	73.9	0.6	+41.3	+127%
Commercial/Retail	274.1	2.1	327.5	2.7	+53.4	+19.5%
Cropland	1,111.2	9.3	193.5	1.6	-968.2	-83%
Cultural/Recreational	582.6	4.9	751.1	6.3	+388.6	+107%
Government/Institutional	326.8	2.7	326.8	2.7	0	0%
Industrial	725.7	6.1	509.0	4.3	-216.7	-30%
Landfill	43.7	0.4	43.7	0.4	0	0%
Residential (Low Density ≥ 0.45 ac ≤ 1.43 ac)	1,181.7	9.9	2,271.4	19.0	+1,089.7	+92%
Residential (Medium Density ≥ 0.16 ac ≤ 0.44 ac)	1,544.6	12.9	2,003.8	18.7	+459.2	+29.7%
Residential (High Density ≤ 0.15 ac)	673.6	5.6	744.6	6.2	+71.0	+10.5%
Residential-Multifamily	410.5	3.4	448.5	3.8	+38.0	+9%
Residential-Under Development	116.9	1.0	0	0	-116.9	+100%
Open Water	44.4	0.4	44.4	0.4	0	0%
Other Agricultural	29.4	0.2	15.1	0.1	-32.4	-68%
Pastureland	170.0	1.4	29.4	-0.2	-140.6	-83%
Quarry/Mining	163.0	1.4	202.4	+1.7	+39.4	+24%
Transportation	1,631.4	13.6	1,631.4	13.6	0	0%
Utilities	366.5	3.1	366.3	3.1	-0.2	-0.05%
Vacant Land	1,649	13.8	989.4	8.3	-829.1	-40%
Wetlands	356.3	3.0	355.5	3.0	-0.8	-0.2%
Woodland	500	4.2	374.7	3.1	-125.3	-25%



Wind Point Watershed



Applied Ecological Services, Inc.™

Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Streams
- Highway
- Streets/Roads
- Railroad

Land Cover/Land Use

- Cemetery
- Commercial/Business Park
- Commercial/Retail
- Cultural/Recreational
- High-Density Residential
- Medium-Density Residential
- Low-Density Residential
- Multi-Family Residential
- Residential - Mixed Use
- Quarry/Mining
- Vacant Land

DATA SOURCES:
City of South Milwaukee
City of Oak Creek
Village of Caledonia
City of Racine

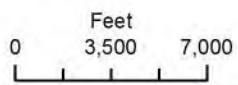


Fig. 20: Future Land Use/Land Cover

3.10 Impervious Cover Impacts

Impervious cover is defined as surfaces of an urban landscape that prevent infiltration of precipitation (Scheuler 1994). Imperviousness is an indicator used to measure the impacts of urban land uses on water quality, hydrology and flows, flooding/ depression storage, and habitat related to streams (Figure 21). Based on studies and other background data, Scheuler (1994) and the Center

for Watershed Protection (CWP) developed an Impervious Cover Model used to classify streams within subwatersheds into three quality categories: Sensitive, Impacted, and Non-Supporting (Table 11). In general, Sensitive subwatersheds have less than 10% impervious cover, stable stream channels, good habitat, good water quality, and diverse biological communities. Impacted subwatersheds have between 10% and 25% impervious cover, somewhat degraded streams,

altered habitat, and decreasing water quality. Non-Supporting subwatersheds generally have greater than 25% impervious cover, highly degraded streams, degraded habitat, poor water quality, and poor-quality biological communities. In addition, runoff over impervious surfaces collects pollutants and warms the water before it enters a stream resulting in negative biological impacts.

Figure 21. Relationship between impervious surfaces, evapotranspiration, & infiltration. Source: The Federal Interagency Stream Restoration Working Group, 1998 (Rev. 2001).

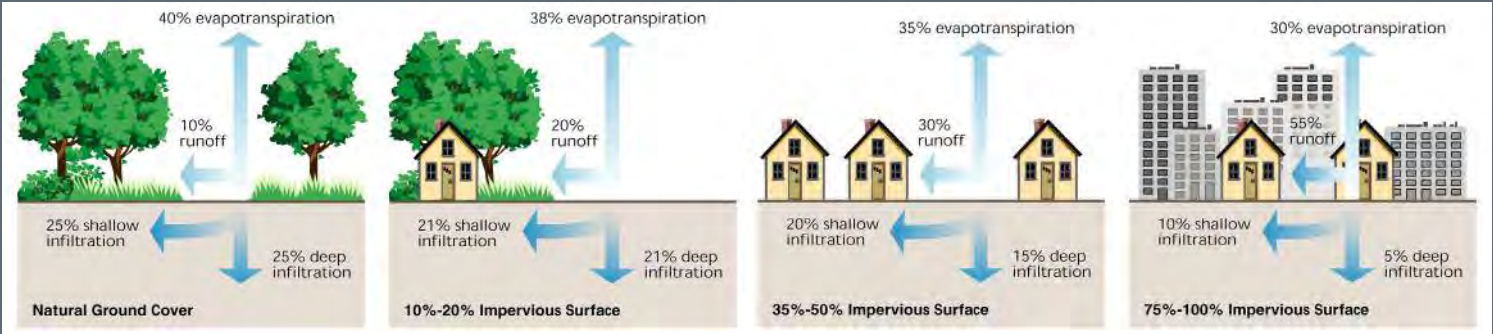


Table 11. Impervious category & corresponding stream condition via the Impervious Cover Model. Source: (Zielinski 2002)

Category	% Impervious	Stream Condition within Subwatershed
Sensitive	<10%	Stable stream channels, excellent habitat, good water quality, and diverse biological communities
Impacted	>10% but <25%	Somewhat degraded stream channels, altered habitat, decreasing water quality, and fair-quality biological communities.
Non-Supporting	>25%	Highly degraded stream channels, degraded habitat, poor water quality, and poor-quality biological communities.



The following paragraphs describe the implications of increasing impervious cover:

Water Quality Impacts

Imperviousness affects water quality in streams and lakes by increasing pollutant loads and water temperature. Impervious surfaces accumulate pollutants from the atmosphere, vehicles, roof surfaces, lawns and other diverse sources. During a storm event, pollutants such as nutrients (nitrogen and phosphorus), metals, oil/grease, and bacteria (*E. coli*) are delivered to streams and lakes. According to monitoring and modeling studies, increased imperviousness is directly related to increased urban pollutant loads (Schueler 1994). Furthermore, impervious surfaces can increase stormwater runoff temperature as much as 12 degrees compared to vegetated areas (Galli, 1990). Water temperatures exceeding 90°F (32.2°C) can be lethal to aquatic fauna and can generally occur during hot summer months.

Hydrology and Flow Impacts

Higher impervious cover translates to greater runoff volumes thereby changing hydrology and flows in streams. If unmitigated, high runoff volumes can result in higher floodplain elevations (Schueler 1994). In fact, studies have shown that even relatively low percentages

of imperviousness (5% to 10%) can cause peak discharge rates to increase by a factor of 5 to 10, even for small storm events. Impervious areas come in two forms: 1) disconnected and 2) directly connected. Disconnected impervious areas are represented primarily by rooftops, so long as the rooftop runoff does not get funneled to impervious driveways or a stormsewer system. Significant portions of runoff from disconnected surfaces usually infiltrate into soils more readily than directly connected impervious areas such as parking lots that typically end up as stormwater runoff directed to a stormsewer system that discharges directly to a waterbody.

Flooding and Depressional Storage Impacts

Flooding is an obvious consequence of increased flows resulting from increased impervious cover. As stated above, increased impervious cover leads to higher water levels, greater runoff volumes, and high floodplain elevations. Higher floodplain elevations usually result in more flood problem areas. Furthermore, as development increases, wetlands and other open space decrease. A loss of these areas results in increased flows because wetlands and open space typically soak up rainfall and release it slowly via groundwater discharge

to streams and lakes. Detention basins can and do minimize flooding in highly impervious areas by regulating the discharge rate of stormwater runoff, but detention basins do not reduce the overall increase in runoff volume.

Habitat Impacts

A threshold in habitat quality exists at approximately 10% to 15% imperviousness (Booth and Reinelt 1993). When a stream receives more severe and frequent runoff volumes compared to historical conditions, channel dimensions often respond through the process of erosion by widening, downcutting, or both, thereby enlarging the channel to handle the increased flow. Channel instability leads to a cycle of streambank erosion and sedimentation resulting in physical habitat degradation (Schueler 1994). Streambank erosion is one of the leading causes of sediment suspension and deposition in streams leading to turbid conditions that may result in undesirable changes to aquatic life (Waters 1995). Sediment deposition alters habitat for aquatic plants and animals by filling interstitial spaces in substrates important to benthic macroinvertebrates and some fish species. Physical habitat degradation also occurs when high and frequent flows result in loss of riffle-pool complexes.

Impervious Cover Estimate & Future Vulnerability

In 1998, the Center for Watershed Protection (CWP) published the Rapid Watershed Planning Handbook. This document introduced rapid assessment methodologies for watershed planning. The CWP released the Watershed Vulnerability Analysis as a refinement of the techniques used in the Rapid Watershed Planning Handbook (Zielinski 2002). The vulnerability analysis focuses on existing and predicted impervious cover as the driving forces impacting potential stream quality within a watershed. It incorporates the Impervious Cover Model described at the beginning of this subsection to classify Subwatershed Management Units (SMUs). SMUs are defined and examined in more detail in Section 3.3.

AES used a modified Vulnerability Analysis to compare each SMU's vulnerability to predicted land use changes across Wind Point watershed. Three steps were used to generate a vulnerability ranking of each SMU. The results were used to make and rank recommendations in the Action Plan related to curbing the negative effects of predicted land use changes on the watershed. The three steps are listed below and

described in detail on the following pages:

Step 1: Existing impervious cover classification of SMUs based on 2012 land use/land cover

Step 2: Predicted future impervious cover classification of SMUs based on predicted land use/land cover changes

Step 3: Vulnerability Ranking of SMUs based on changes in impervious cover and classification

Step 1: Existing Impervious Cover Classification

Step 1 in the Vulnerability Analysis is an existing classification of each SMU based on 2012 land use/land cover and measured impervious cover. 2012 impervious cover was calculated by assigning an impervious cover percentage for each land use/land cover category based upon the United States Department of Agriculture's (USDA) Technical Release 55 (TR55) (USDA 1986). Highly developed land such as commercial/retail for example is estimated to have over 70% impervious cover while a typical medium density residential development exhibits around 25% impervious cover. Open space areas generally have less than

5% impervious cover. GIS analysis was used to estimate the percent impervious cover for each SMU in the watershed using 2012 land use/land cover data. Each SMU then received an initial classification (Sensitive, Impacted, or Non-Supporting) based on percent of existing impervious cover (Table 12; Figure 22).

To summarize, three SMUs (SMUs 6, 7, and 24) were classified as Sensitive, ten as Impacted (SMUs 2, 3, 4, 5, 10, 11, 12, 13, 16 and 17), and eleven as Non-Supporting (SMUs 1, 8, 9, 14, 15, 18, 19, 20, 21, 22 and 23) based on 2012 impervious cover estimates. Sensitive SMUs 6 and 7 are generally located between Ryan Road and Oakwood Road and include residential areas and Bender Park. Sensitive SMU 24 is associated with multiple small direct drainage areas along Lake Michigan that are mostly vacant land or natural areas. Most of the Impacted SMUs are found in Wind Point, Caledonia, and Oak Creek in areas of medium and large lot residential development. All of the Non-Supporting SMUs are associated with highly impervious industrial and high density residential development in Racine, Caledonia, Oak Creek, and South Milwaukee.

Table 12. 2012 & predicted future impervious cover by Subwatershed Management Unit.

SMU #	Step 1: Existing Impervious %	Existing (2012) Impervious Classification	Step 2: Predicted Impervious %	Predicted Impervious Classification	Percent Change	Step 3: Vulnerability
SMU1	55.3%	Non-Supporting	53.6%	Non-Supporting	-1.7%	Low
SMU2	23.5%	Impacted	31.2%	Non-Supporting	7.7%	High
SMU3	19.0%	Impacted	22.4%	Impacted	3.4%	Low
SMU4	23.1%	Impacted	32.2%	Non-Supporting	9.1%	High
SMU5	14.3%	Impacted	7.4%	Sensitive	-6.9%	Low
SMU6	5.3%	Sensitive	18.5%	Impacted	13.2%	High
SMU7	6.2%	Sensitive	22.7%	Impacted	16.5%	High
SMU8	27.5%	Non-Supporting	37.3%	Non-Supporting	9.8%	Medium
SMU9	44.8%	Non-Supporting	44.8%	Non-Supporting	0%	Low
SMU10	17.3%	Impacted	20.9%	Impacted	3.6%	Low
SMU11	15.3%	Impacted	20.4%	Impacted	5.1%	Medium
SMU12	23.9%	Impacted	29.3%	Non-Supporting	5.4%	High
SMU13	21.1%	Impacted	27.4%	Non-Supporting	6.3%	High
SMU14	30.1%	Non-Supporting	33.5%	Non-Supporting	3.4%	Low
SMU15	34.6%	Non-Supporting	36.0%	Non-Supporting	1.4%	Low
SMU16	21.8%	Impacted	21.8%	Impacted	0%	Low
SMU17	23.9%	Impacted	29.1%	Non-Supporting	5.2%	High
SMU18	52.4%	Non-Supporting	55.5%	Non-Supporting	3.1%	Low
SMU19	36.0%	Non-Supporting	36.0%	Non-Supporting	0%	Low
SMU20	54.9%	Non-Supporting	54.9%	Non-Supporting	0%	Low
SMU21	51.3%	Non-Supporting	51.3%	Non-Supporting	0%	Low
SMU22	51.0%	Non-Supporting	51.2%	Non-Supporting	0.2%	Low
SMU23	60.4%	Non-Supporting	60.4%	Non-Supporting	0%	Low
SMU24	7.2%	Sensitive	10.0%	Sensitive	2.8%	Medium

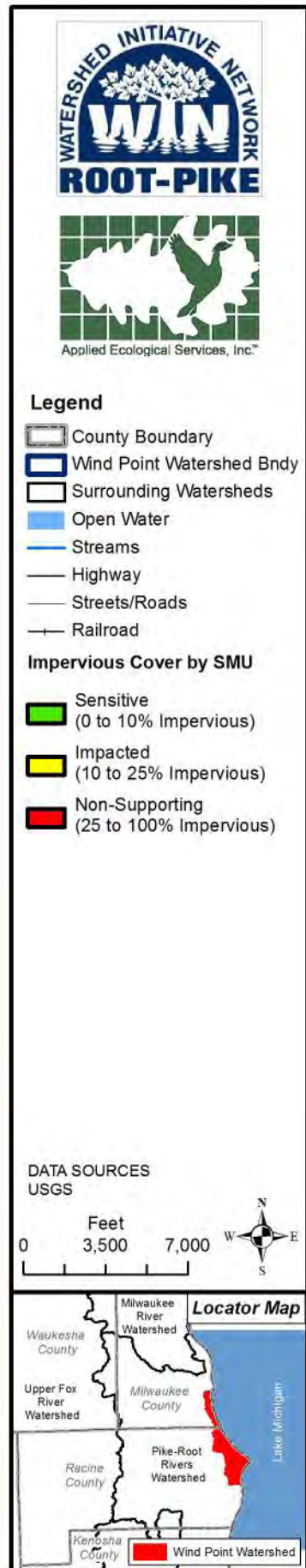
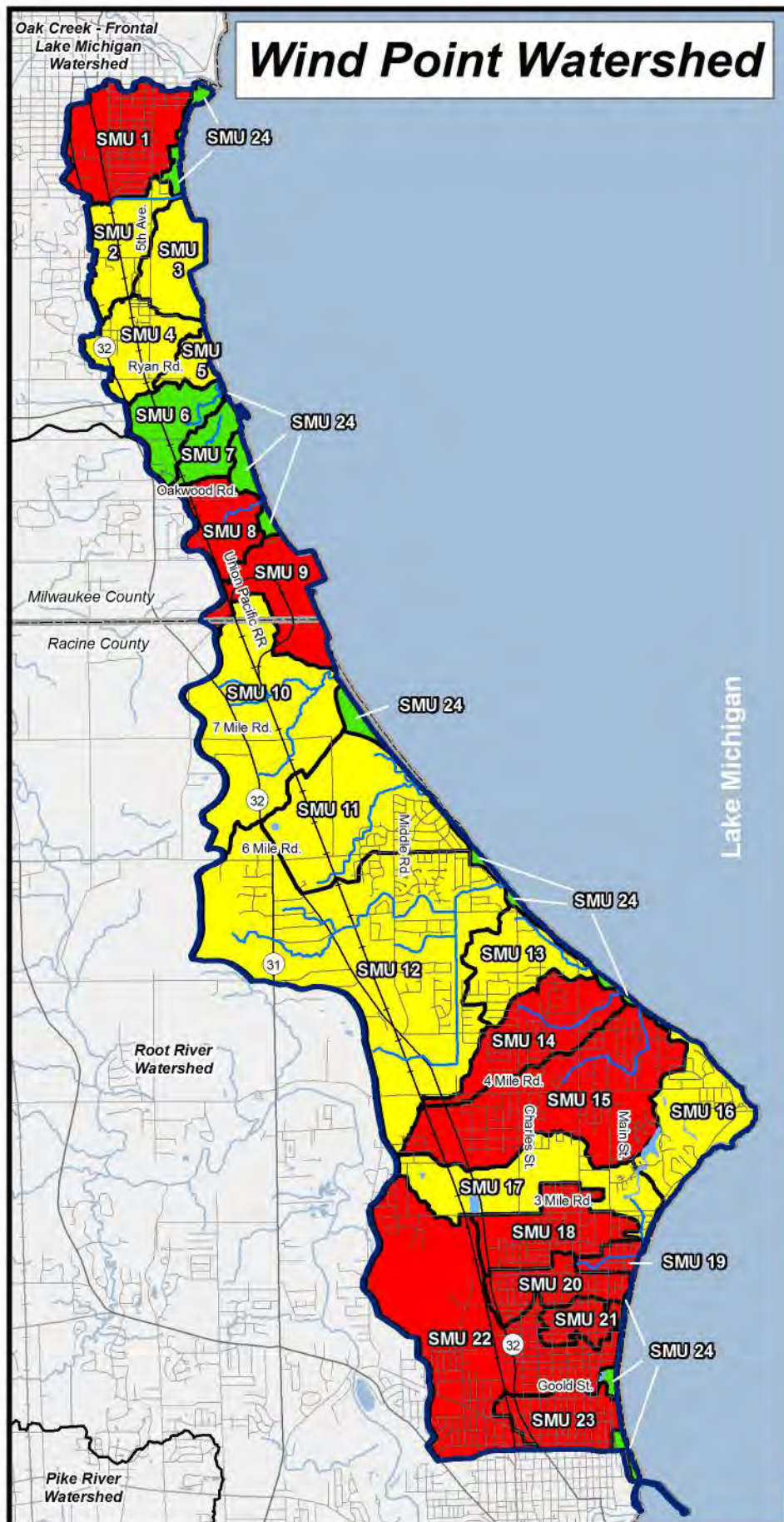


Fig. 22: Impervious Cover Classification by SMU based on 2012 Land Use/Land Cover

Step 2: Predicted Future Impervious Cover Classification

Predicted future impervious cover was evaluated in Step 2 of the vulnerability analysis by classifying each SMU as Sensitive, Impacted, or Non-Supporting based on predicted land use changes. Table 12 and Figure 23 summarize and depict predicted future impervious cover classifications for each SMU. This step identifies Sensitive and Impacted SMUs that are most vulnerable to future development pressure. SMUs 6 and 7 are predicted to change from Sensitive to Impacted while SMUs 2, 4, 12, 13, and 17 change from Impacted to Non-Supporting. These changes are attributed to mostly predicted residential and mixed use residential development. It is also interesting to note that SMU 5 is expected to change from Impacted to Sensitive as a result of abandoned industrial areas becoming recreational areas.

Step 3: Vulnerability Ranking

The vulnerability of each SMU to predicted future land use changes was determined by considering the following questions:

1. Will the SMU classification change?
2. Does the SMU classification

come close to changing (within 2%)?

3. What is the absolute change in impervious cover from existing to predicted conditions?

Vulnerability to future development for each SMU was categorized as Low, Medium, or High:

Low = no change in classification; <5% change in impervious cover

Medium = classification close to changing (within 2%) and/or 5-10% change in impervious cover

High = classification change or close to changing (within 2%) and/or >10% change in cover

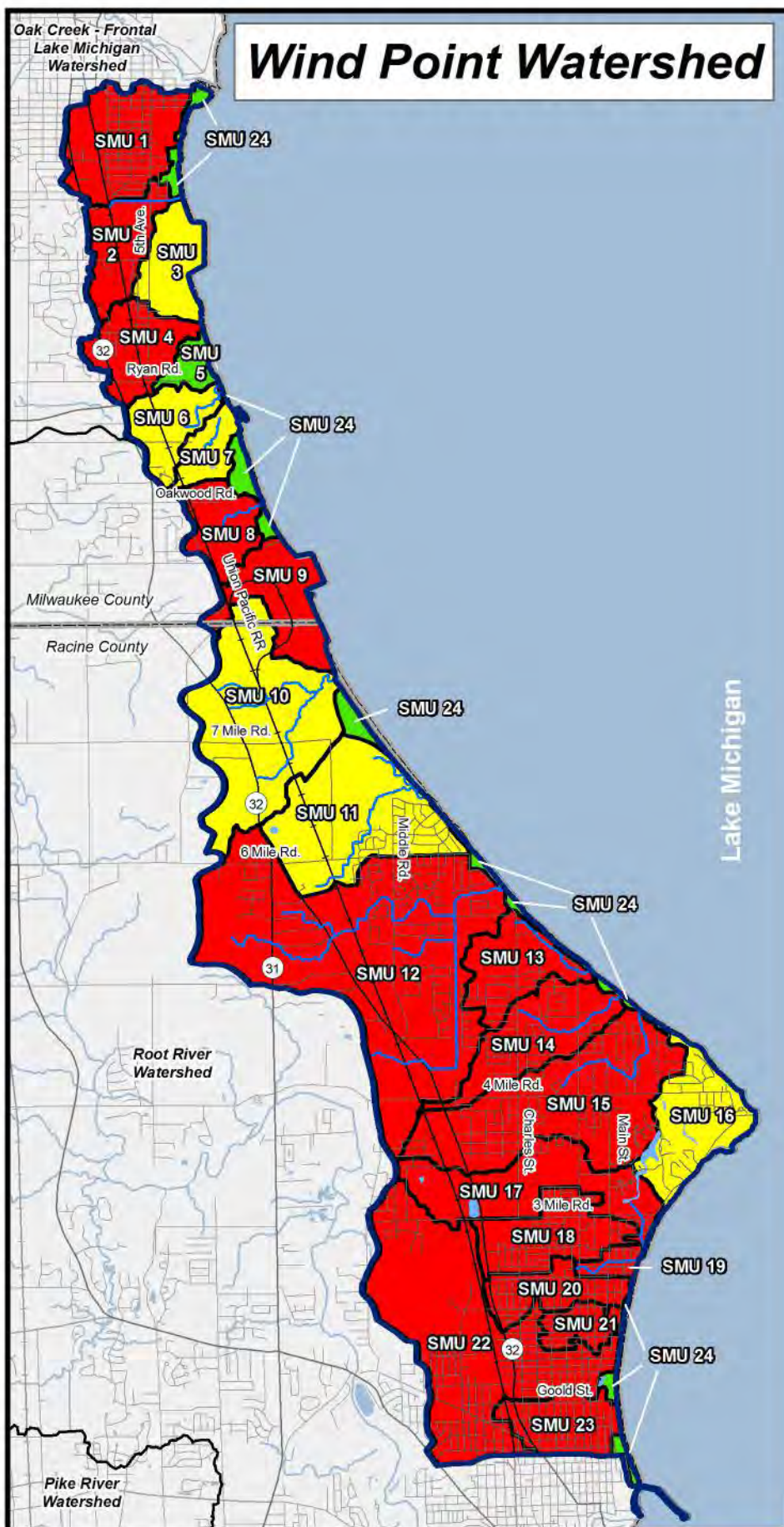
The vulnerability analysis resulted in 7 High, 3 Medium, and 14 Low ranked SMUs (Table 12; Figure 24). SMUs 2, 4, 6, 7, 12, 13, and 17 are ranked as highly vulnerable to future problems associated with impervious cover because each is expected to change classification from Sensitive to Impacted or Impacted to Non-Supporting. Predicted residential and mixed use residential concentrated in the northern and central portions of the

watershed in areas that are currently agricultural are the largest source of increased impervious cover.

SMUs 8, 11, and 24 are ranked as moderately vulnerable to predicted land use changes. SMUs 8 and 17 exhibit between 5 and 10 percent increases in impervious cover while SMU 24 is Sensitive but nearly reaches Impacted status. Again, residential and mix use residential contribute most to increased impervious cover.

The remaining SMUs are not vulnerable to predicted future land use changes based on the Center for Watershed Protection's methodology.

The results of this analysis clearly point to the potential negative impacts of traditional development. It will be important to consider developing these area using Conservation/Low Impact Development standards that incorporate the most effective and reliable Stormwater Treatment Train practices whereby stormwater is routed through various water quality and infiltration Management Measures prior to being released from the development site. The use of Conservation/Low Impact Development is discussed in the Programmatic Action Plan section of this report.



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Predicted Impervious Cover by SMU

- Sensitive (0 to 10% Impervious)
- Impacted (10 to 25% Impervious)
- Non-Supporting (25 to 100% Impervious)

DATA SOURCES Predicted Land Use

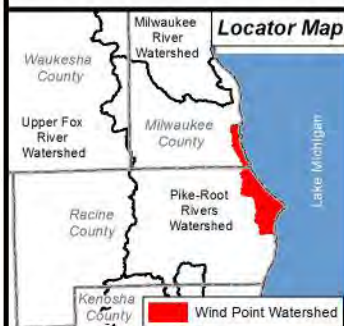
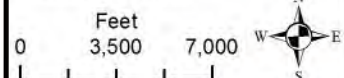
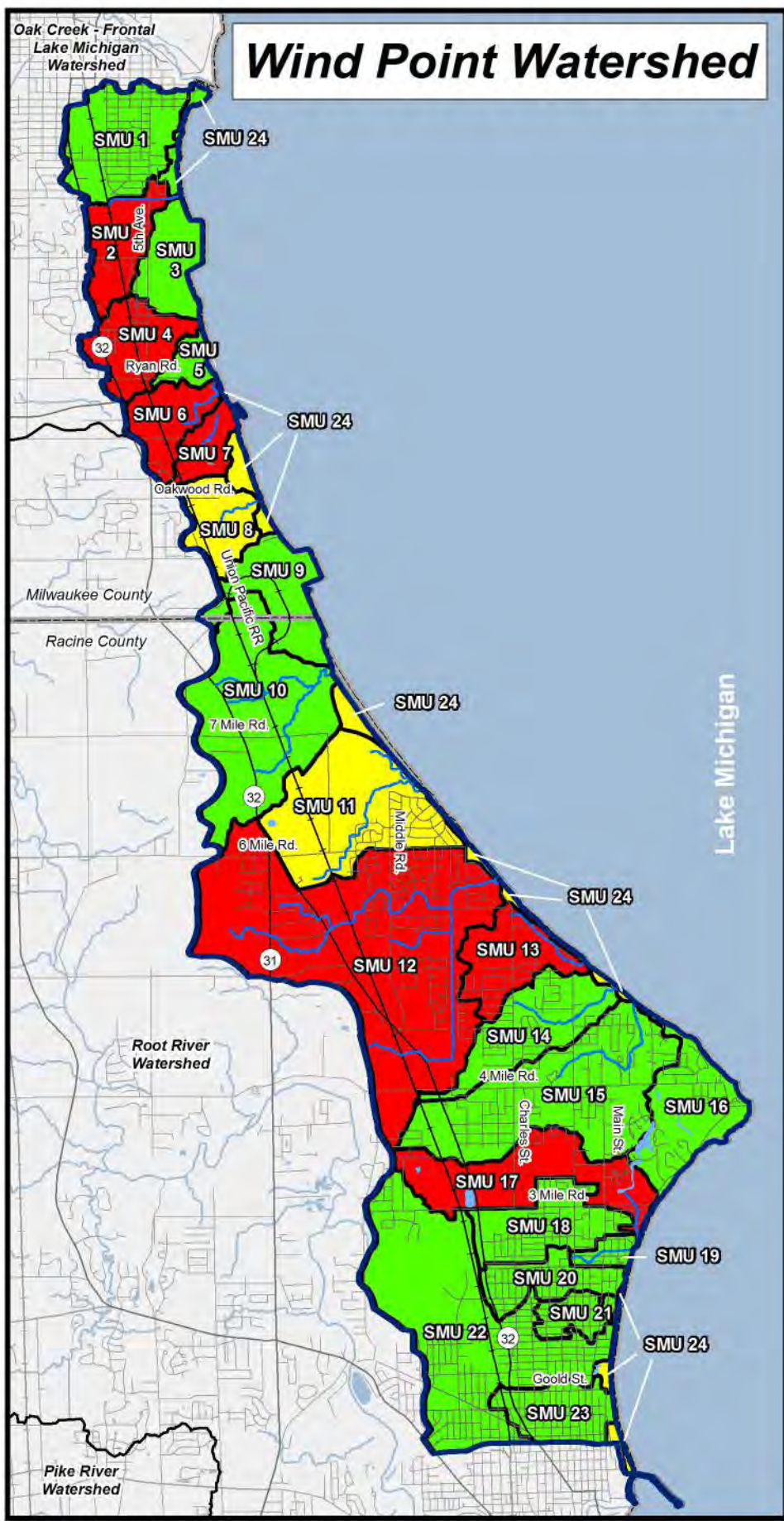


Fig. 23: Predicted Impervious Cover Classification by SMU



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Vulnerability Ranking

- High
- Medium
- Low

DATA SOURCES
Predicted Land Use

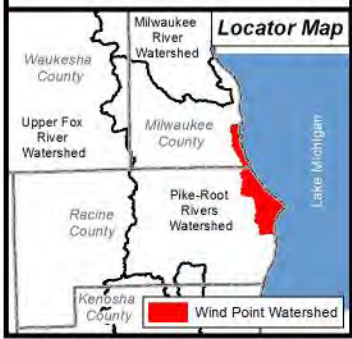
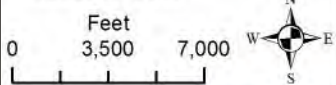


Fig. 24: Vulnerability Ranking of SMUs based on Predicted Future Land Use/Land Cover Changes

3.11 Open Space Inventory, Prioritization, & Green Infrastructure Network

A major component of watershed planning includes an examination of open space to determine how it best fits into a “Green Infrastructure Network”. Green infrastructure is best defined as an interconnected network of natural areas and other open space that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife (Benedict 2006). Natural features such as stream corridors, wetlands, floodplain, woodlands, and grassland are the primary components of green infrastructure. Working lands such as farms parks/ ball fields, golf courses, school grounds, detention basins, and large residential parcels can also be considered green infrastructure components. A three step process was used to create a parcel-based Green Infrastructure Network for Wind Point watershed:

Step 1: All parcels of land in the watershed were categorized as open space, partially open space, or developed.

Step 2: All open and partially open parcels were prioritized based on a set of criteria important to green infrastructure.

Step 3: Prioritized open and partially open parcels and some developed but linking parcels were combined to form a Green Infrastructure Network.

For this watershed plan, an “open space” parcel is generally defined as any parcel that is not developed such as a protected natural area or agricultural field. “Partially open” parcels have been developed to some extent, but the parcels still offer potential green infrastructure opportunities. Examples of partially open parcels include some school grounds, residential lots generally greater than two acres

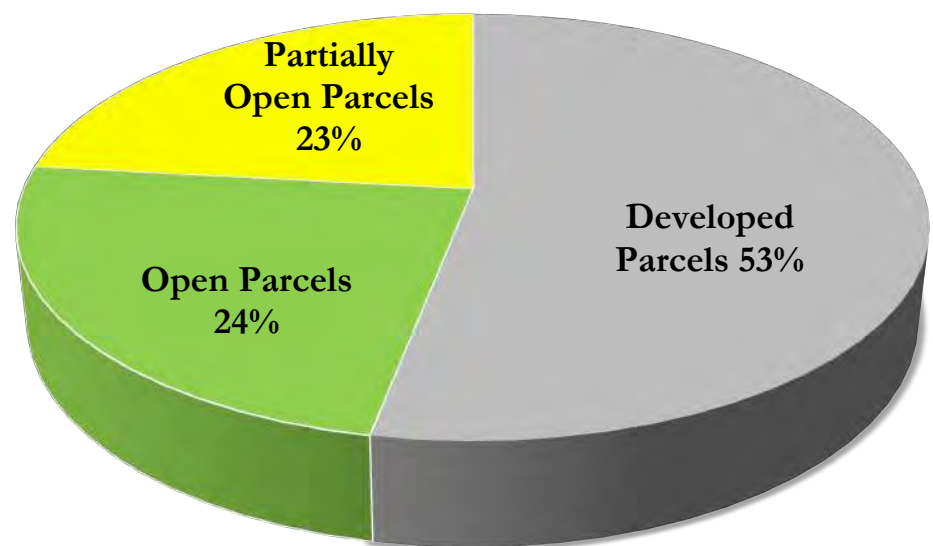
with minimal development, vacant industrial areas, and portions of airports. Parcels that are mostly built out such as medium and high density residential development, transportation, and commercial/ retail areas are considered “developed”. Public versus private and protected versus unprotected status of open and partially open space parcels are other important green infrastructure attributes that are discussed in more detail below.

Open, Partially Open, & Developed Parcels

Step 1 in creating a Green Infrastructure Network was completed by categorizing all parcels in the watershed as “open”,

“partially open”, or “developed” as described above. Figures 25 and 26 summarize and depict Step 1 results. Open space parcels comprise approximately 2,508 acres or 24% of the watershed. Open parcels range from less than 1 acre to 284 acres with a 15.9 acre average. Partially open parcels make up another 2,431 acres or 23% of the watershed. Partially open parcels range from less than 1 acre to 389 acres with a 18.2 acre average. Developed parcels account for the remaining 5,627 acres or 53% of the watershed. Most open and partially open parcels are located on agricultural land, County preserves, an airport, and large residential lots.

Figure 25. Distribution of open, partially open, and developed parcels.



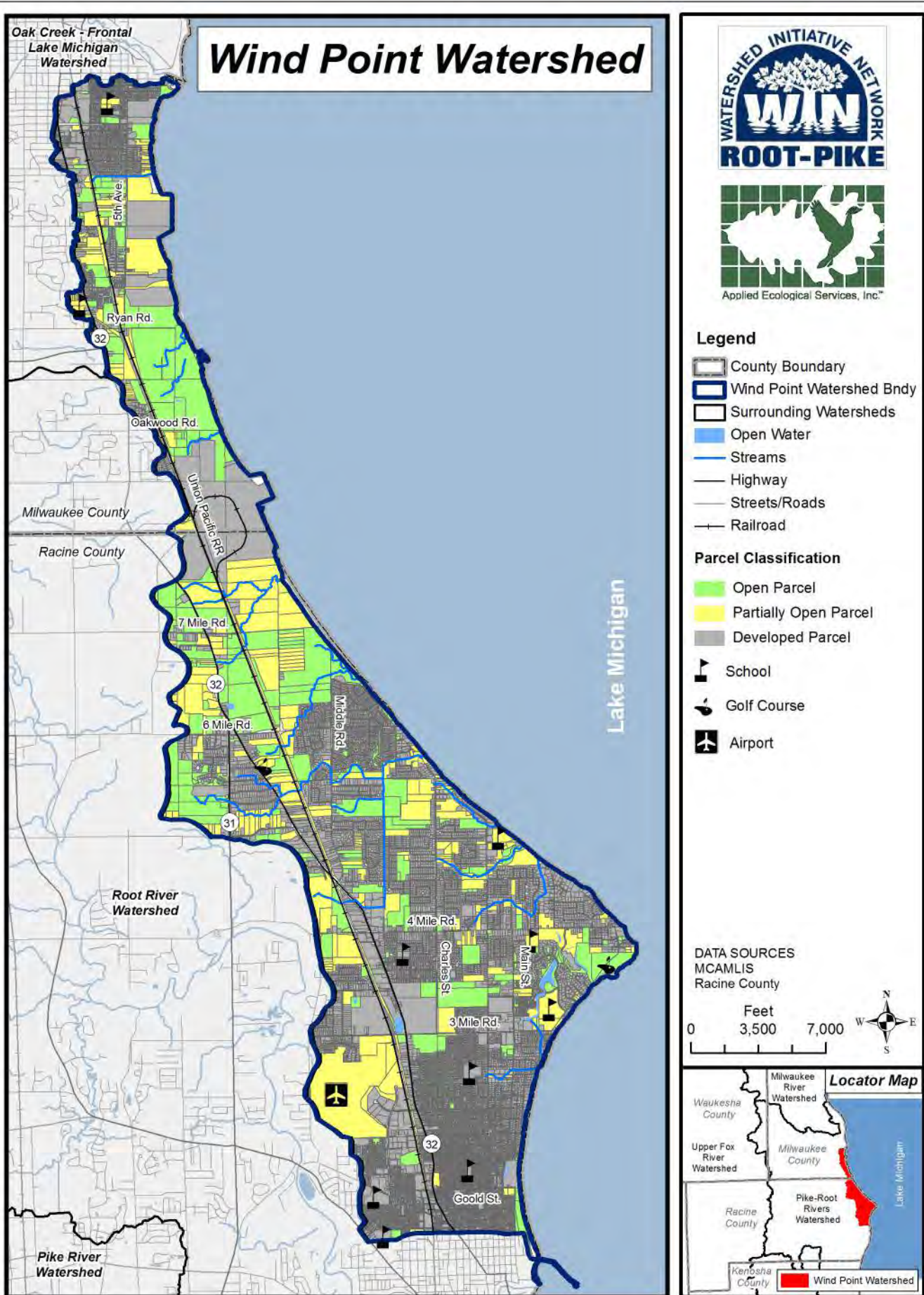


Fig. 26: Open, Partially Open, and Developed Parcels

Public/Private Ownership of Open and Partially Open Parcels

The public or private ownership of each open and partially open parcel was determined from available parcel data. Developed parcels are not included in this summary. Publicly owned parcels generally include those owned by state, county, municipal government, school districts, and park districts. Public open and partially open parcels account for 17% and 1% of the open and partially open acreage respectively (Figures 27 & 29). Private ownership types include residential, businesses, commercial, industrial, non-profit, agricultural, etc. Private open parcels comprise 34% of the open and partially open acreage whereas private partially open parcels comprise 48% (Figures 27 & 29). Public open and partially open parcels are mostly owned by counties and municipalities.

Protected Status of Open and Partially Open Parcels

Preservation of open space is critical to maintaining and expanding green infrastructure and is an important component of sustaining water quality, hydrological processes, ecological function, and the general quality of life for both wildlife and people. Without preservation, open space can be converted to other less desirable land uses in the future. Protected open and partially open parcels account for about 17% of the open and partially open parcel acreage in the watershed while unprotected open and partially open parcels account for the remaining 83% (Figures 28 & 30). Most protected open or partially open parcels are owned by counties, municipalities, homeowner associations, and non-profit groups such as Caledonia Conservancy.

Figure 27. Distribution of private and public open and partially open parcels.

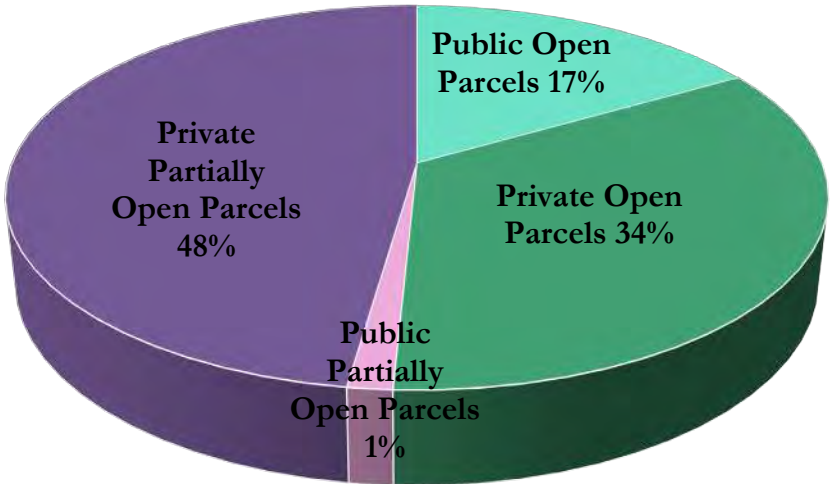
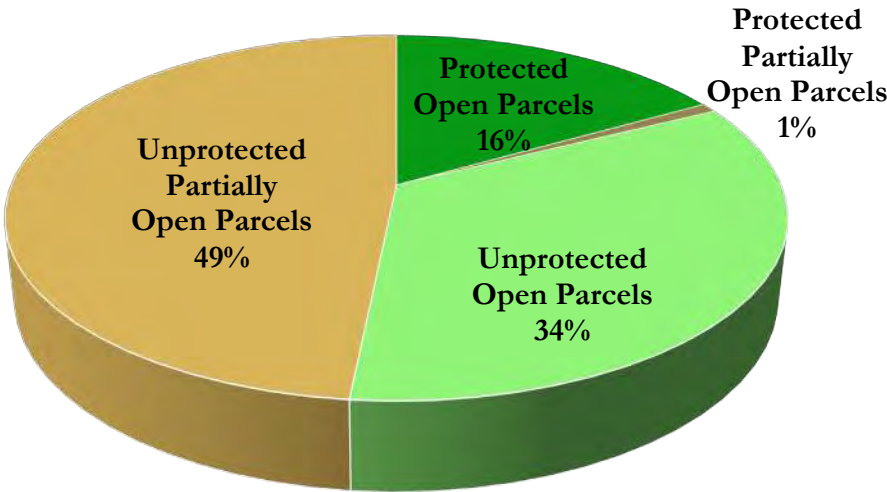


Figure 28. Distribution of protected and unprotected open and partially open parcels.



The most critical unprotected open and partially open parcels are agricultural lands. Most agricultural areas will likely be developed to residential unless agricultural preservation tools are leveraged. Utilizing the Wisconsin

Working Lands Initiative and future development that incorporates conservation design or low impact development will be extremely important in many of these areas to improve water quality and reduce stormwater runoff volume.

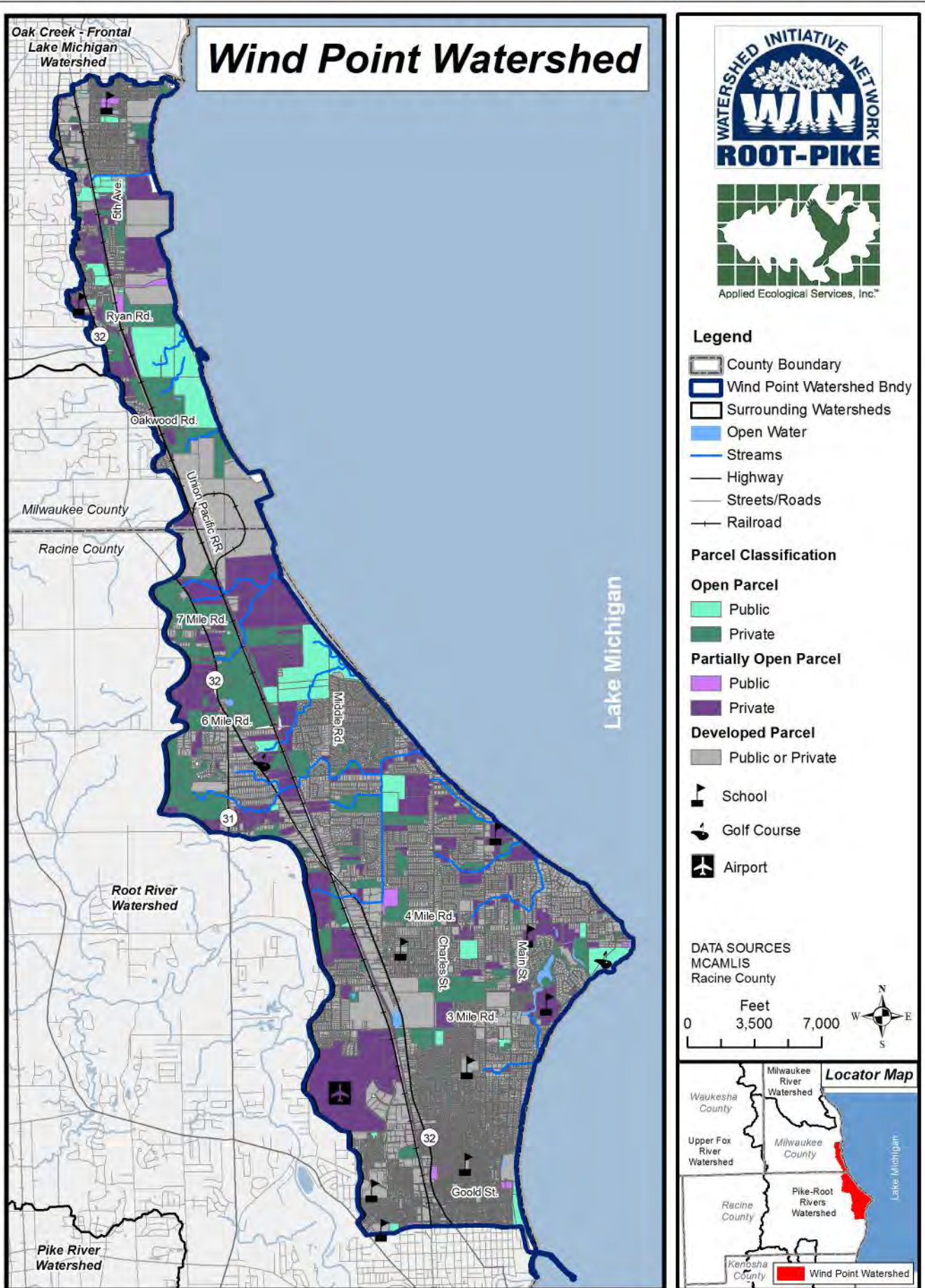


Fig. 29: Public vs. Private Ownership of Open and Partially Open Parcels

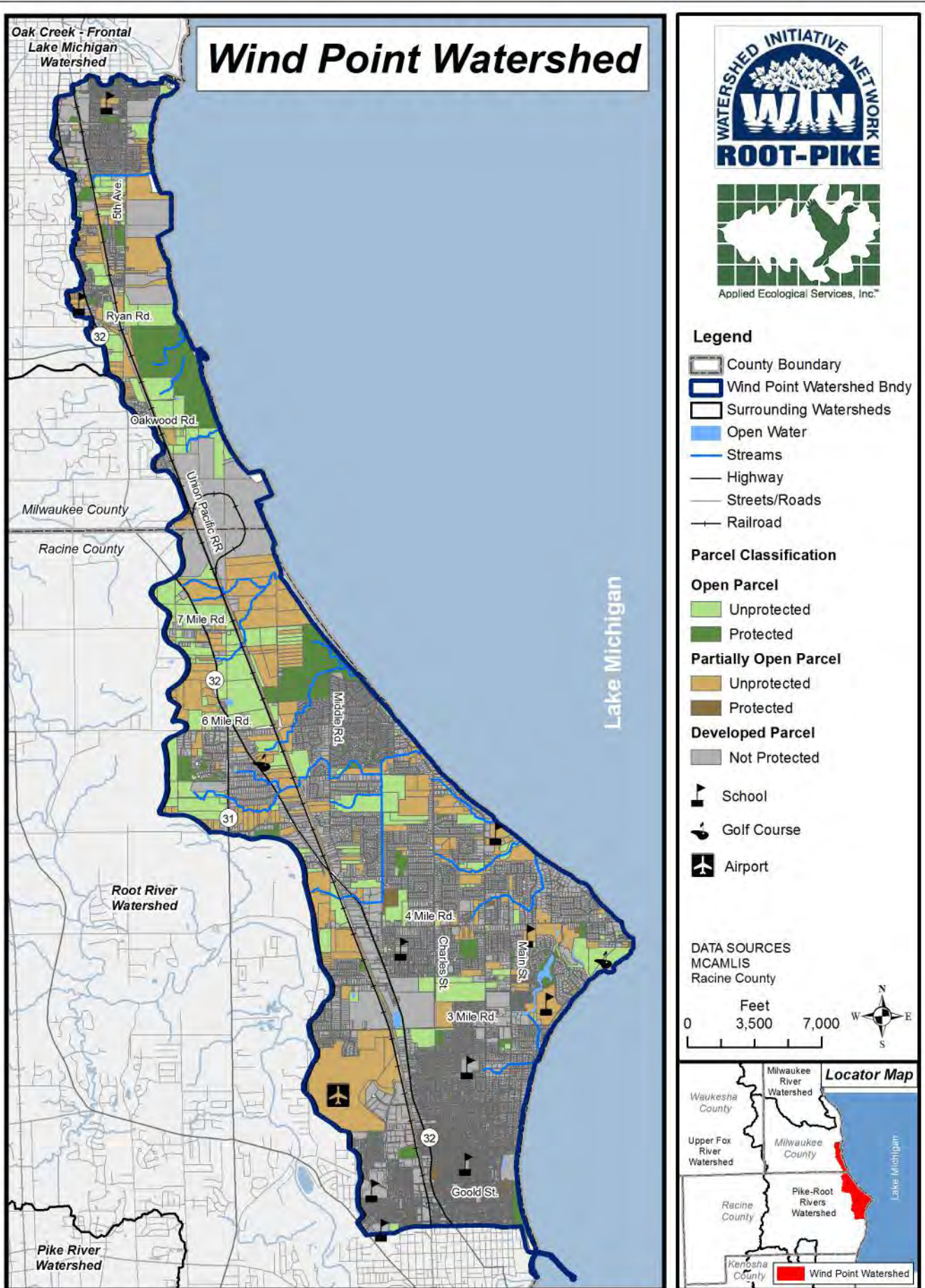


Fig. 30: Protection Status of Open and Partially Open Parcels

Open Space Parcel Prioritization

Step 2 in creating a Green Infrastructure Network for Wind Point watershed was completed by prioritizing open and partially open parcels. For this step, 10 prioritization criteria important to green infrastructure were examined via a GIS analysis (Table 13). If an open or partially open parcel met a criterion it received one point. If the parcel did not meet that criterion, it did not receive a point. This process was repeated for each open and partially open parcel and for all criteria. The prioritization process was not completed for developed parcels. The total points received for each parcel were summed to determine parcel importance for developing the Green Infrastructure Network; parcels with the highest number of points are more important to green infrastructure

than parcels that met fewer criteria.

The combined possible total of points any one parcel can accumulate is 10 (10 of 10 total criteria met). The highest total value received by a parcel in the weighting process was 9 (having met 9 of 10 criteria). After completion of the prioritization, parcels were categorized as “High Priority”, “Medium Priority”, or “Low Priority” for green infrastructure based on point totals. Parcels meeting 6-9 of the criteria are designated High Priority for inclusion into the Green Infrastructure Network while parcels meeting 3-5 criteria are designated Medium Priority. Parcels with a combined value of 0-2 are categorized as Low Priority but are not necessarily excluded from the Green Infrastructure Network based

on their location or position as linking parcels.

Figure 31 depicts the results of the parcel prioritization. First, Bender Park and Cliffside Park, the two largest protected parks in the watershed, are High Priority green infrastructure and form *hubs*. Many of the Medium Priority parcels are currently private vacant, agricultural, or large lot residential adjacent to High Priority parcels and frequently form *corridors* along streams and the Lake Michigan coast. Low Priority parcels are generally smaller isolated private residential or agricultural parcels. John H. Batten Airport (Batten International Airport) is a larger Low Priority area that meets few green infrastructure criteria but still forms a large hub of open space.

Table 13. Criteria used to prioritize parcels for a Green Infrastructure Network.

Green Infrastructure Criteria
1. Open/partially open parcels that intersect FEMA 100-year floodplain
2. Open/partially open parcels within 0.25-miles of any headwater stream
3. Open/partially open parcels that include a wetland
4. Open/partially open parcels that include an ADID wetland
5. Open/partially open parcels that are within 100 feet of a stream or open water
6. Open/partially open parcels in a “Highly Vulnerable” Land Use/Land Cover SMU
7. Open/partially open parcels adjacent to or including private or public protected open space
8. Open/partially open parcels that include an existing or planned trail
9. Open/partially open parcels that include SEWRPC environmental corridors
10. Open/partially open parcels that include “Highly Productive Agricultural Land”

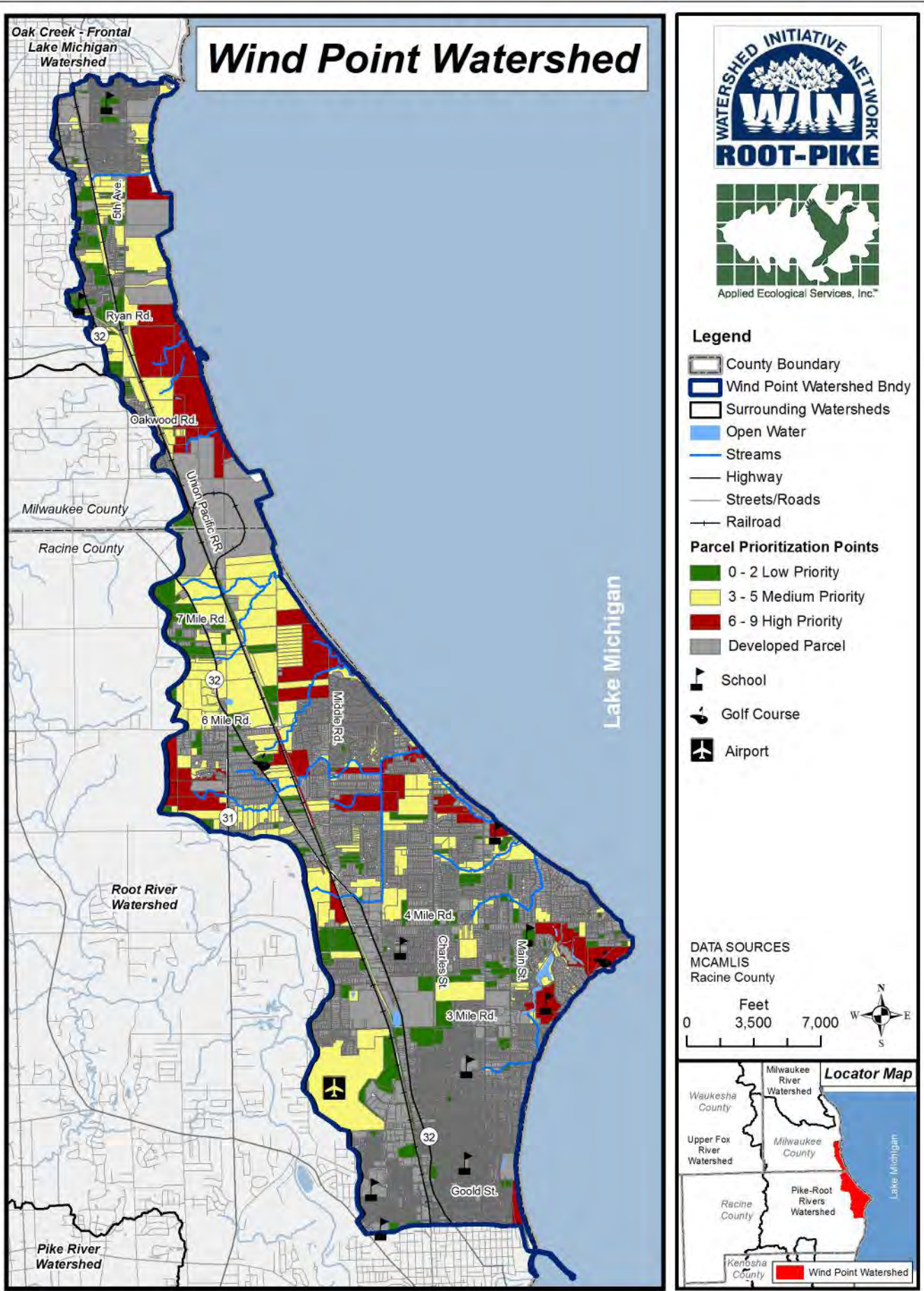
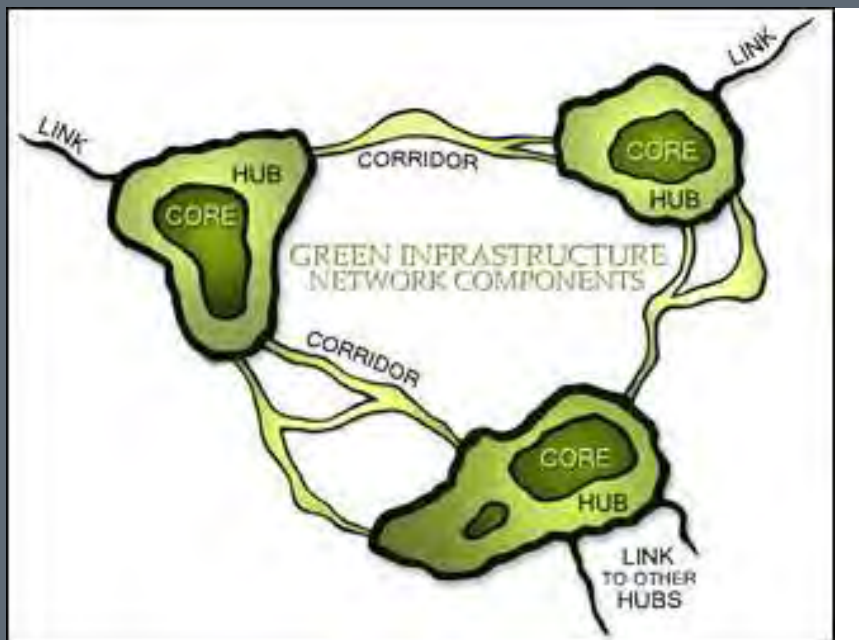


Fig. 31: Open Space Parcel Prioritization

Green Infrastructure Network

A Green Infrastructure Network is a connected system of *Hubs* and linking *Corridors*. Hubs generally consist of the largest and least fragmented areas such as Bender Park and Cliffside Park, and several agricultural areas. Corridors are generally formed by smaller private/unprotected parcels along streams and Lake Michigan shoreline. Corridors are extremely important because they provide biological conduits between hubs. However, most parcels forming corridors are not ideal green infrastructure until residents, businesses, industries, and farmers embrace the idea of naturalizing stream corridors. Unique to Wind Point watershed is a utility corridor system extending from We Energies Oak Creek plant and following the Union Pacific Railroad. Several sections of these corridors are being used for trails/bike paths.



(Left) Green Infrastructure components. Source: greeninfrastructure.net. Image (right): Wildlife utilize the green infrastructure network, traveling along corridors from hub to hub.

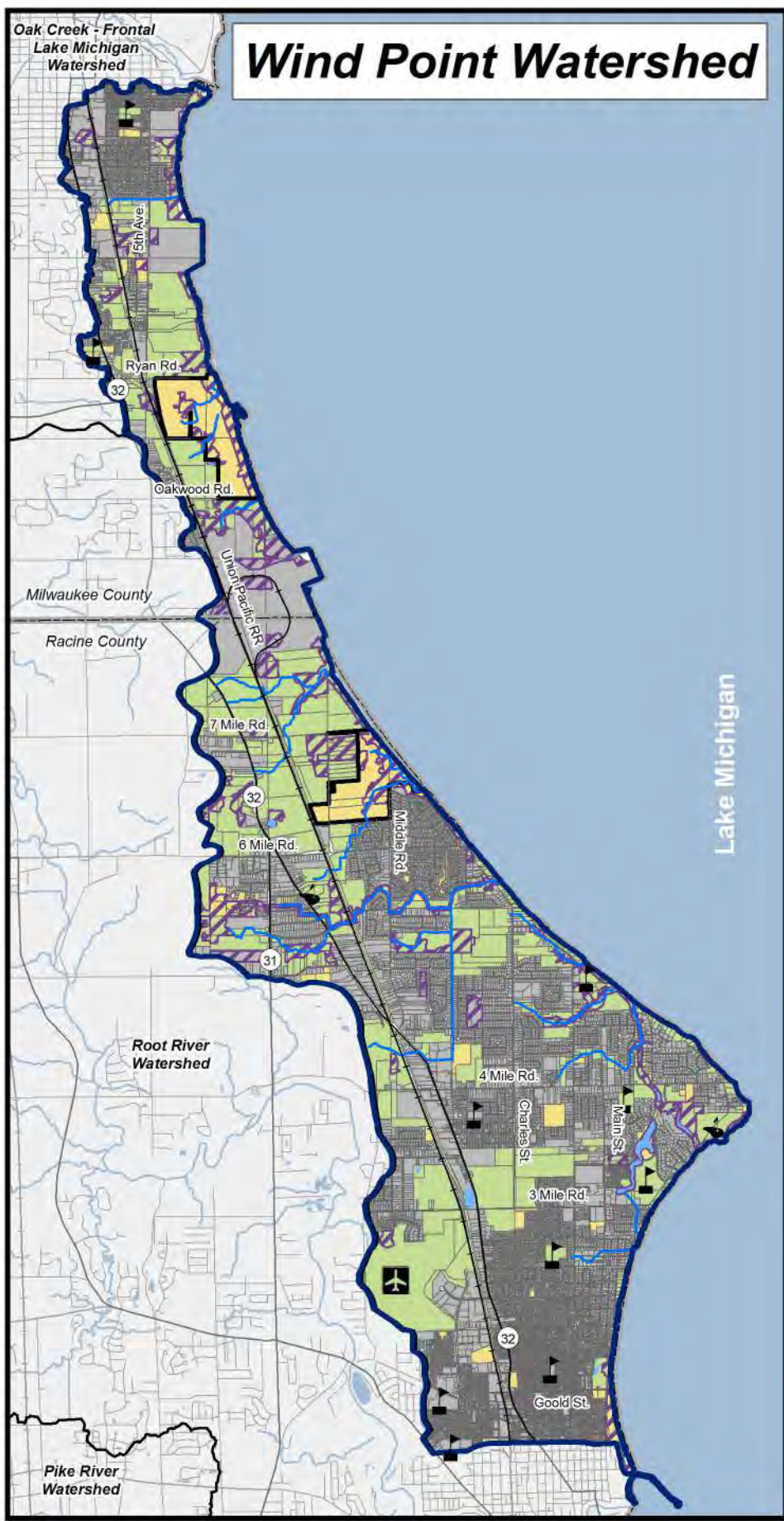
Green Infrastructure Network

The final step (Step 3) in creating a Green Infrastructure Network for Wind Point watershed involves laying out the network by using prioritized open space results from Step 2 as the base layer that includes all High Priority, nearly all Medium Priority parcels, and many Low Priority and developed parcels along streams and Lake Michigan coast corridors if they provided links, expanded existing green infrastructure, or were simply isolated sites such as protected parks. The decision was also made to include Vulcan Quarry areas north of 3 Mile Road as part of the Green Infrastructure Network because they could potentially be remediated and provide future green infrastructure

when quarry operations are complete.

County and regional wide green infrastructure plans generally focus on natural features such as stream corridors, wetlands, floodplain, buffers, and other natural components. The Green Infrastructure Network created for Wind Point watershed captures all the natural components including SEWRPC's environmental corridors and other green infrastructure such as recreational parks, large residential lots, school grounds, and golf courses at the parcel level. Parcel level green infrastructure planning is important because land purchases, acquisitions, and land use changes almost always occur at the parcel level. A Green Infrastructure Network for Wind Point

watershed is illustrated on Figure 32. Perhaps the most important aspect of green infrastructure planning is that it helps communities identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature (Benedict 2006). Green infrastructure planning provides a framework for future growth that identifies areas not suitable for development, areas suitable for development but that should incorporate conservation or low impact design standards, and areas that do not affect green infrastructure. The Action Plan section of this report includes various programmatic and site specific green infrastructure recommendations.



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad
- Protected Green Infrastructure
- Unprotected Green Infrastructure
- Not Green Infrastructure
- SEWRPC Environmental Corridors
- County Parks
- School
- Golf Course
- Airport

DATA SOURCES
MCAMLIS
Racine County
SEWRPC

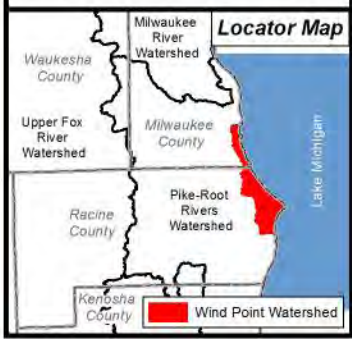
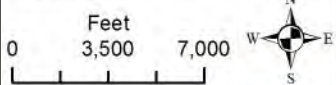


Fig. 32: Green Infrastructure Network

3.12 Highly Productive Agricultural Land

Agricultural preservation in Wind Point watershed can play a crucial role in retaining valuable open space as part of the green infrastructure network. These areas allow for increased groundwater infiltration as opposed to the conversion of these lands to more intense, urban uses. Southeastern Wisconsin Regional Planning Commission's (SEWRPC) 2006 Regional Land Use Plan for Southeastern Wisconsin: 2035, calls for the preservation of as much of the most productive farmland as practicable.

SEWRPC defines the most

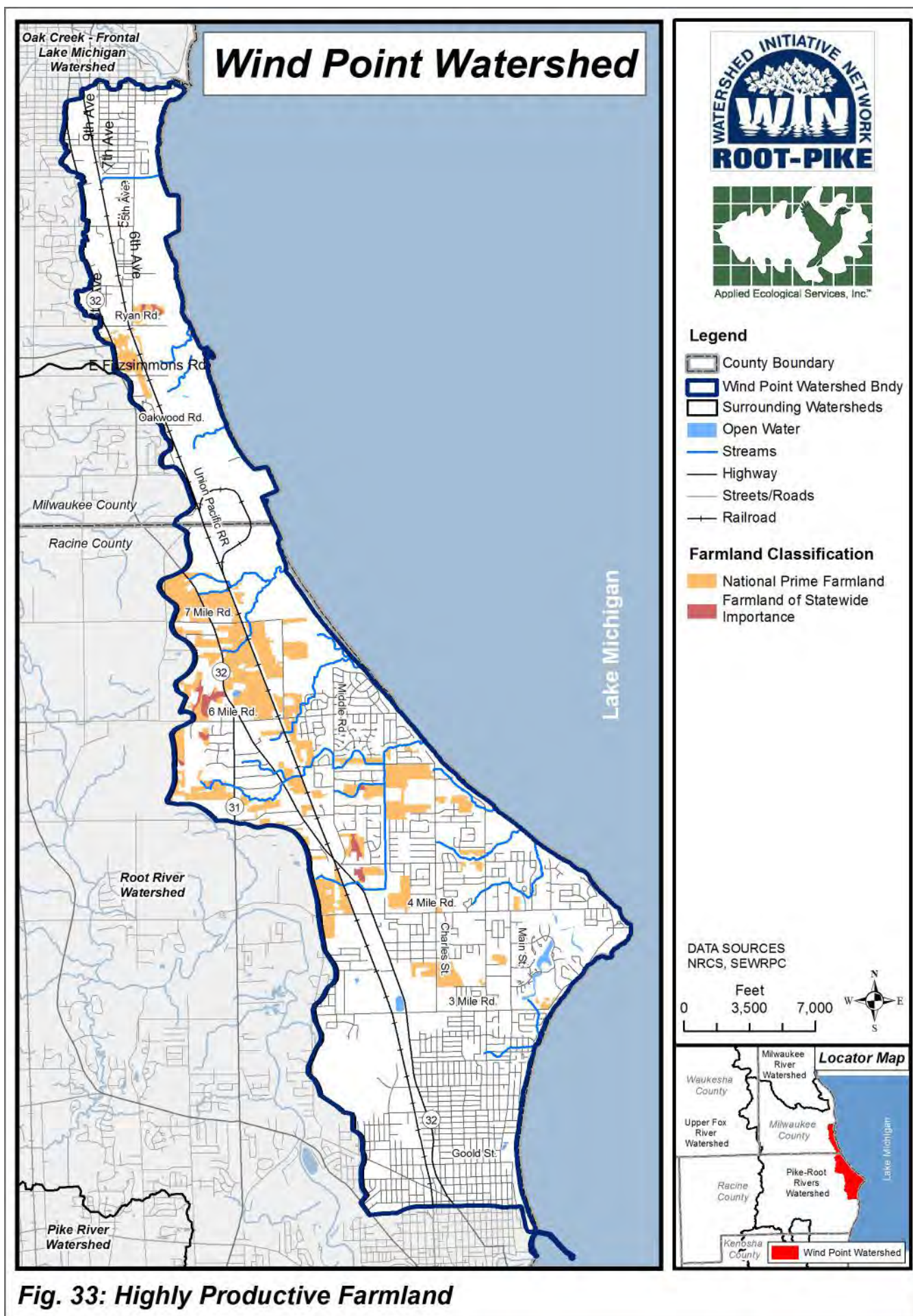
productive farmland (National Prime Farmlands) according to the agricultural capability of the soils on that land – specifically those classified by the U.S. Natural Resources Conservation Service (NRCS) as Class I and Class II soils. Agricultural land classified as Class III soils are categorized as Farmland of Statewide Significance. In Wind Point watershed, 1,195 acres have been classified as National Prime Farmlands worthy of preservation. Farmlands of Statewide Significance account for 58 acres. Figure 33 depicts the location of the National Prime Farmlands, as well as Farmlands of Statewide Significance. The SEWRPC's 2035 Land Use Plan, written in 2006 while development pressure was still at its height, called for much of

these Prime National Farmlands in Caledonia to eventually be reserved for low density residential growth, despite agricultural preservation goals, because of its location on the fringe of regional urban development.

Since that plan was written, housing pressure has since tapered back due to unforeseen changes in the housing market and economy and the 2009 Wisconsin Working Lands Initiative was introduced which includes the Farmland Preservation Program, Agricultural Enterprise Area Program, and the Purchase of Agricultural Conservation Easement Program. An opportunity may exist to expand agricultural preservation within Wind Point watershed.



Agricultural land west of St Hwy 32 in Caledonia



3.13 Important Natural Areas

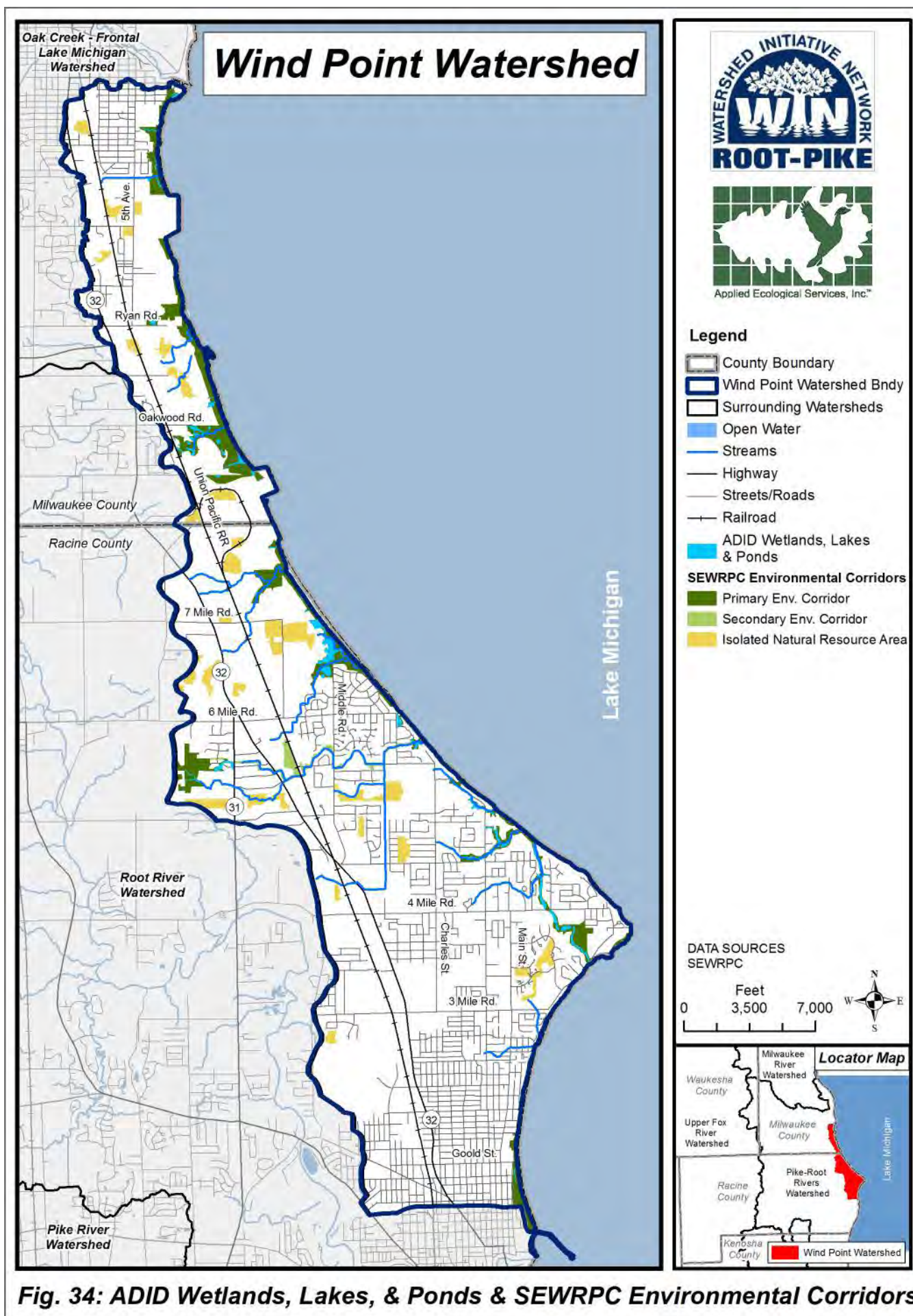
Wetlands, woodlands, beach/foredune, and other natural features that fall within concentrated corridors of the natural resource base are all considered “Important Natural Areas” within Wind Point watershed.

Many of these areas are public and owned/managed by local county, non-profit, or municipal entities. Important Natural Areas often provide high quality habitat for and harbor uncommon or even threatened and endangered (T&E) species. These areas also provide large greenway corridors that interconnect land and waterways,

support native species, maintain natural ecological processes, and contribute to the quality of life for communities of people. 1,293 acres of SEWRPC Environmental Corridors, 130 acres of ADID areas, and 819 acres in other Natural Areas are located in the watershed (Table 14; Figures 34 & 35).

Table 14. Important natural area summary data.

Natural Area	Size (acres)	Description
SEWRPC Environmental Corridors		
Primary Environmental Corridors	801	≥ 400 acres in size, two miles long, and 200 feet in length
Secondary Environmental Corridors	66	≥ 100 acres in size and one mile long, unless they connect primary environmental corridors
Isolated Natural Resource Area	426	200 feet wide down to a 5 acre minimum
ADID Wetlands, Lakes, & Ponds		
ADID Wetlands, Lakes, & Ponds	130	As delineated by USEPA, USACOE, & WDNR, with assistance provided by SEWRPC, in 2005
Other Important Natural Areas		
Cliffside Park: Woods, Clay Banks & Old Field	220	Natural area of regional significance - second-growth mesic woodland and ravine, rare clay bluffs and an adjacent old field with critical species habitat
Tabor Woods	38	Natural area of local significance - mesic, dry-mesic, and wet-mesic woodland; owned by Caledonia Conservancy
Power Plant Ravine Woods	32	Natural area of local significance - mesic woodland and a deep ravine that opens onto clay banks; critical species habitat
Oak Creek Power Plant Woods	18	Woodland and critical species habitat
Clay Ravine Woods	12	Woodland and clay ravine; critical species habitat
Bender Park	303	Woodland, ravine, meadow, and clay bluffs; critical species habitat
Oak Creek Bluffs and Beach	28	Provides critical species habitat
North Bay Ravine & Beach	2	Provides critical species habitat
North Beach Park	50	Beach and foredune complex
Beach North of MMSD Facility	15	Beach and foredune complex north of MMSD facility
Dominican Creek Ravine	18	Natural area of local significance - provides critical species habitat
Wind Point Ravine Woods	14	Provides critical species habitat
Neighborhood Central Walk	15	Second growth woodland with trail owed by Caledonia Conservancy



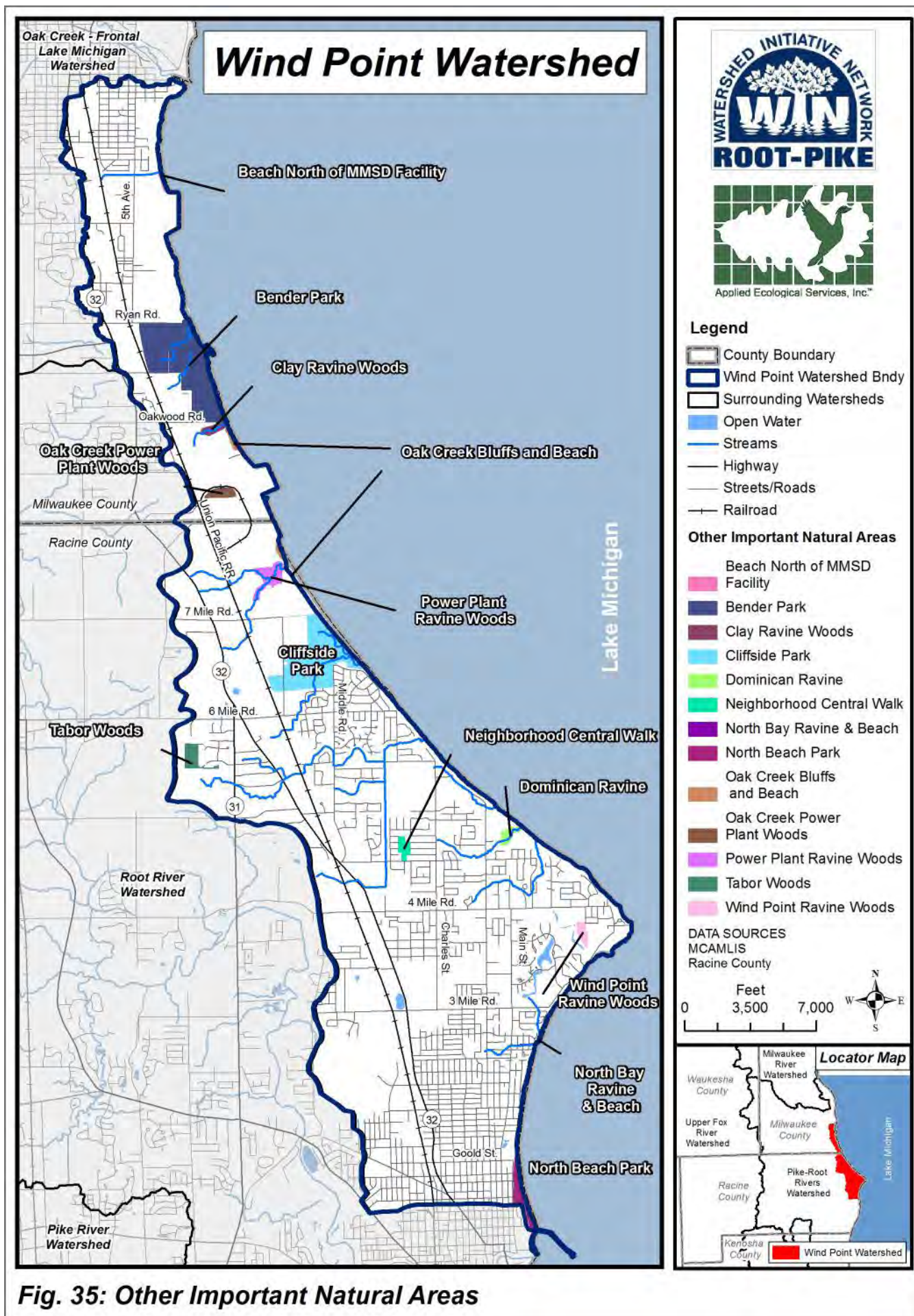


Fig. 35: Other Important Natural Areas

SEWRPC Environmental Corridors

As part of their regional planning efforts, Southeastern Wisconsin Regional Planning Commission (SEWRPC) identified primary and secondary environmental corridors within southeastern Wisconsin. These environmental corridors were designated in order to identify and protect important natural resources in the area. The Environmental Corridors for Wind Point watershed serve as an important catalogue of important natural areas within the watershed and form the backbone of the Green Infrastructure Network. The SEWRPC 2005 Environmental Corridors within Wind Point watershed are mapped on Figure 34.

SEWRPC's Environmental Corridors were determined based on the presence of water bodies, watercourses, wetlands, remnant plant communities, wildlife habitat areas, areas containing hydric or partially hydric soils, and areas of rugged terrain or high-relief topography. Additionally, the corridors take into account the relation of open space, historic sites, scenic areas, natural areas, and critical species habitat sites within the area. Primary and Secondary Environmental Corridors, as well as Isolated Natural Resource Areas were delineated for the planning area. Primary Environmental Corridors are defined as being at least 400 acres in size, two miles long, and 200 feet in length. Secondary Corridors are at least 100 acres in size and one mile long, unless they connect primary environmental corridors. Isolated Natural Resource Areas include those from 200 feet wide down to a 5 acre minimum (SEWRPC 2000).

Approximately 801 acres of Wind Point watershed lie within the Primary Environmental Corridor, according to SEWRPC's 2005 delineation. An additional 66 acres and 426 acres, respectively, fall within the Secondary Environmental Corridors and Isolated Natural

Resource Areas. The majority of these Environmental Corridors extend along Lake Michigan and over some of the ravines and tributaries leading within Bender Park and Cliffside Park. Additional areas include Tabor Woods and Isolated Natural Resource Areas scattered throughout the watershed.

ADID Wetlands, Lakes, & Ponds

The United States Environmental Protection Agency (USEPA) has a planning process known as advanced identification of disposal areas (ADID) in place that is used to identify wetlands and other waters that are unsuitable for the discharge of dredged and fill materials (USEPA 2009). For Wind Point watershed, these identifications were made by the USEPA in conjunction with the United States Army Corps of Engineers (USACE) and Wisconsin Department of Natural Resources (WDNR). The ADID wetland inventory was completed for Racine and Milwaukee Counties in 2005. SEWRPC provided technical assistance in producing these maps by combining this data with their Primary Environmental Corridors. These inventories identify wetlands where special protection should be implemented and enforced. There are 130 acres of ADID wetlands as shown on Figure 34.

Other Important Natural Areas

The Wisconsin Department of Natural Resources (WDNR) manages the State Natural Areas Program which works to identify ecological communities that remain predominantly undisturbed from pre-European settlement times. These areas have been assessed according to field inventories conducted by WDNR staff and account for the quality, diversity, extent of past disturbance, context within the greater landscape, and rarity of features. Areas that meet these qualifications and have also been identified as areas of statewide significance are designated as State Scientific Areas. Within Wind Point

watershed no sites meet these qualifications; however several sites meet the qualifications for natural areas of regional or local significance. These include the regionally significant Cliffside Park Woods and Clay Banks and the locally significant Tabor Woods and Power Plant Ravine Woods. There are also a number of other sites that serve as critical species habitat for plants or wildlife.

Cliffside Park

Cliffside Park consists of over 220 acres of both natural and recreational areas in Caledonia and is owned by Racine County. The park includes Cliffside Park Woods (a second growth mesic woodland) and Clay Banks, listed as a natural area of regional significance, as well as Cliffside Park Old Field, containing critical species habitat. According to the WDNR, clay seepage bluffs such as those found at Cliffside Park are considered an endangered resource. Cliffside Park may be the best place to see the Lake Border moraines as they tower above the waters of Lake Michigan. Here the eroding clay bluffs are slowly entering the earliest stages of ravine formation, providing an opportunity to witness a dynamic landscape process in an urban area (WDNR 2012). Cliffside Park Woods and Clay Banks harbor uncommon bird species such as Cooper's hawk (*Accipiter cooperii*) and wood thrush (*Hylocichla mustelina*). The Old Field harbors rare birds such as bobolink (*Dolichonyx oryzivorus*), upland sandpiper (*Bartramia longicauda*), and grasshopper sparrow (*Ammodramus savannarum*). Uncommon plant species include buffaloberry (*Shepherdia canadensis*), yellowish gentian (*Gentiana alba*), stiff gentian (*Gentianella quinquefolia*), balsam poplar (*Populus balsamifera*), and blue-stemmed goldenrod (*Solidago caesia*). The park also includes camping, athletic fields, pavilions, and a playground.



Clockwise from top: Cliffs Side Park, wood thrush (Steve Maslowski), upland sandpiper (Johnathan Nightingale).



Ravines and Clay Seepage Bluffs

Ravines: "Generally, ravines are defined as steep-sided or V-shaped valleys that are larger than gullies but smaller than canyons. They may contain perennial or intermittent streams, but are typically formed when moving water incises and erodes a channel into the underlying material. (ICMP 2011)"

Clay Seepage Bluff: "Steep, clay bluffs occur along some stretches of the Great Lakes shorelines and less commonly inland on streams draining into Lake Superior and Lake Michigan. Vegetative cover ranges from forested with pines (*Pinus resinosa* and *P. strobus*), white cedar (*Thuja occidentalis*) and white birch (*Betula papyrifera*), to bare clay with only a few herbaceous present. Buffaloberry (*Sheperdia canadensis*) is a characteristic shrub, but more typically, alders (*Alnus incana* and *A. crispa*), as well as herbaceous species such as Canada goldenrod (*Solidago canadensis*) and pearly everlasting (*Anaphalis margaritacea*) are dominant. Both native and exotic pioneers such as fireweed (*Epilobium angustifolium*) and Canada thistle (*Cirsium arvense*) are common, especially on unstable sites. (Epstein 2012)"



Tabor Woods

Tabor Woods, a locally significant natural area, can also be found in Caledonia and consists of 38 acres owned by the Caledonia Land Conservancy. These holdings were named for the Czechoslovakian community that first settled the area (DeBoer 2011). Tabor Woods includes mesic, dry-mesic, and wet-mesic woodland areas and includes beech, hickory, oak, maple and walnut trees. The woodland includes both walking and horseback riding trails throughout the property.

Power Plant Ravine Woods, Oak Creek Power Plant Woods, & Clay Ravine Woods

Other locally significant natural area sites on We Energies property include the 32 acre Power Plant Ravine Woods along Tributary E, 12 acre Clay Ravine Woods along Tributary D, and 18 acre Oak Creek Power Plant Woods. The areas along the tributaries include mesic

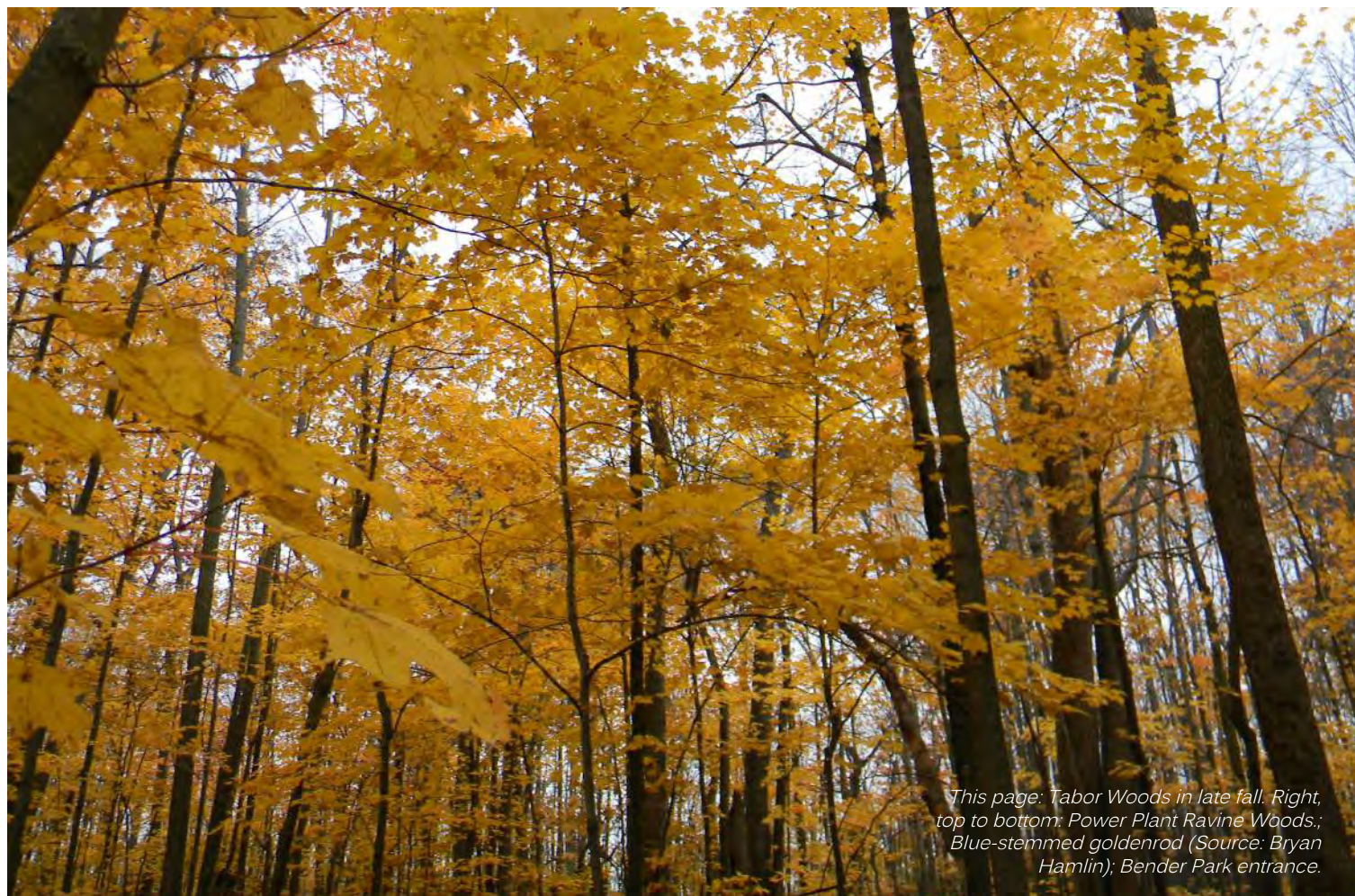
and dry-mesic woodland and deep ravines that open onto clay banks at Lake Michigan. Oak Creek Power Plant Woods includes mostly mesic woodland. A number of uncommon species are found there including the endangered blue-stemmed goldenrod (*Solidago caesia*). These sites are not open to the public.

Bender Park

Bender Park in Oak Creek is 303 acres and is owned by Milwaukee County. The natural landscape of the park varies including areas of upland and lowland hardwood forests, old orchards, beech forest, shrub-carr, surrogate grasslands, cattail marsh, sedge meadow, and planted prairie. Hiking trails, overlooks, beach access, and a boat launch are among the recreational amenities offered at the park.

Dominant canopy species found within the upland hardwoods include black walnut, American

basswood, shagbark hickory, northern red oak, ironwood, and American beech. Dominant tree species found within lowland hardwood forests include eastern cottonwood, green ash, American basswood, black willow, American elm, and boxelder. The beech forest contains American beech, ironwood, northern red oak, and sugar maple. The majority of the upland shrub communities at Bender Park are in the process of natural succession and reverting back to woodlands. Red osier dogwood, gray dogwood, high-bush cranberry, small diameter ash trees, and hawthorn are all present within these areas. The surrogate grasslands at Bender Park have a mixture of old field and prairie plant species. Canada goldenrod, tall goldenrod, New England aster, calico aster, frost aster, common milkweed, big bluestem, Kentucky bluegrass, switch grass, and wild bergamot are prevalent. Prairie





plantings are similar in composition to surrogate grasslands.

The natural communities at Bender Park harbor a number of uncommon, threatened, and endangered plant and animal species. A point count breeding bird survey conducted by DPRC staff in 2012 noted the presence of Henslow's sparrows (*Ammodramus henslowii*), a state-threatened species. Numerous species that the DPRC listed as local concern because they are breeding at only a handful of locations within Milwaukee County: bank swallow (*Riparia riparia*), alder flycatcher (*Empidonax alnorum*), American redstart (*Setophaga ruticilla*), chestnut-side warbler (*Dendrocia pensylvanica*), eastern kingbird (*Tyrannus tyrannus*), orchard oriole (*Icterus spurius*), and clay-colored sparrow (*Spizella pallida*). In addition, numerous species listed by the WDNR as species of concern have also been found breeding at the park: brown thrasher (*Toxostoma rufum*), northern harrier (*Circus cyaneus*), bobolink (*Dolichonyx oryzivorus*), eastern meadowlark (*Sturnella magna*), wood thrush (*Hylocichla mustelina*), blue-winged warbler (*Vermivora pinus*), field sparrow (*Spizella pusilla*), Dickcissel (*Spiza americana*), and the yellow-billed cuckoo (*Coccyzus americanus*). Finally, blue-stemmed goldenrod (*Solidago caesia*), rare variegated horsetail (*Equisetum variegatum*), and species of special concern slender bog arrow-grass (*Triglochin palustre*) and red trillium (*Trillium recurvatum*) are found at the park.

Recent WEPP surveys have confirmed the presence of western chorus (*Pseudacris triseriata*) and northern leopard frogs (*Rana pipiens*). DPRC staff also began conducting snake surveys throughout the summer and fall of 2011. To date, surveys have shown the presence of the northern red-bellied snake (*Storeria occipitomaculata*) and the Butler's gartersnake (*Thamnophis butleri*).

Oak Creek Bluffs & Beach, North Bay Ravine & Beach, & Beach North of MMSD

Other beach, foredune, and bluff natural areas in Wind Point watershed include Oak Creek Bluffs & Beach, Clay Ravine Woods, North Bay Ravine & Beach, and Beach North of MMSD. All these sites potentially provide habitat for rare sea rocket (*Cakile edentula*), and species of special concern Ohio

goldenrod (*Solidago ohioensis*), and false asphodel (*Tofieldia glutinosa*).

Dominican Creek Ravine, Wind Point Ravine Woods, & Neighborhood Central Walk Dominican Creek Ravine is roughly 18 acres of woodland along Tributary I that was recently upgraded to a natural area of local significance due to species diversity and containing endangered blue-

stemmed goldenrod (*Solidago caesia*). Wind Point Ravine woods is a small ravine woodland harboring red trillium (*Trillium recurvatum*), a State-designated special concern species. Neighborhood Central Walk is a 15 acre parcel located in Caledonia and owned by the Caledonia Land Conservancy. It contains a second growth woodland and neighborhood trails.



Background: North Bay Ravine & Beach; Inset: Sea rocket (Source: Eleanor Saulys).

3.14 Watershed Drainage System

3.14.1 Tributary Streams and Ravines to Lake Michigan

Waterways such as streams and ravines are a barometer of the health of their watersheds. The story of waterways, as with so many natural resources, has been one of exploitation and lack of understanding. Few waterways throughout the world have escaped pollution, channel modifications, and increased flooding as a result of mismanagement of development in the watershed (Apfelbaum & Haney 2010). Fortunately, many waterways can be restored if stressors in the watershed can be mitigated.

Tributary Streams

Humans have drastically changed the geometry and location of most streams in Wind Point watershed since European settlement in the mid 1800s. Some of these changes can be observed by looking at the pre-settlement stream mapping depicted on Figure 6 in Section 3.1. Today, twelve (12) primary streams totaling 96,911 linear feet or 18.4 miles are located within Wind Point watershed; all are tributary to Lake Michigan (Table 15; Figure 36). It is important to note that there are numerous smaller secondary tributaries branching off many of the primary tributaries but that mapping and describing all secondary tributaries is beyond the scope of this project. The swale that extends south from Tributary J, across 4 Mile Road, through ponds on SC Johnson property and finally along Shoop Park Golf Course is defined as a wetland swale by SEWRPC and is not a stream. Therefore, a summary of this area is included in Section 3.14.3.

For this watershed plan, the 12 tributary streams are labeled Tributary A through Tributary L for purposes of maintaining and reporting data although it is understood that many local names may apply to these streams. Of

the 12 streams, Tributary G which is located in the central portion of the watershed, is the longest at approximately 34,679 linear feet or about 6.6 miles. Tributaries E and F, the second and third longest streams in the watershed, are 14,550 linear feet (2.8 miles) and 11,631 linear feet (2.2 miles) respectively. The remaining 9 streams account for 36,051 linear feet or 6.8 miles. Stream conditions vary greatly depending on their location, past and currently surrounding land uses, ownership, etc.

One important observation was made in fall of 2012 that all streams in the watershed are intermittent. In other words, all streams may dry up during dry periods that usually occur in summer and early fall. Aside from channelization, one of the most significant problems with streams in the watershed is the existence of headcuts adjacent to ravines on several tributaries. These headcuts likely began to form following initial changes in land use to more impervious surfaces in the early 1900s. Headcuts are described in more detail below.

Ravines

Many of the primary tributary streams in Wind Point watershed become natural ravines adjacent to Lake Michigan. Generally, ravines are defined as steep-sided or V-shaped valleys that are larger than gullies but smaller than canyons. They may contain perennial or intermittent streams, but are typically formed when moving water incises and erodes a channel into the underlying material (ICMP 2011). The shape and depth of ravines offer protection from temperature extremes as well as a more moist environment, creating a unique ecosystem within and often harboring critical species habitat. While erosion is a natural component within ravines, most of the ravines in Wind Point watershed are threatened by excessive erosion as a result of urbanization and surrounding land use changes. Significantly higher volumes of runoff are being diverted into the

streams surrounding these ravines, exacerbating the erosion process and threatening ravine habitat. In 2006, Hey and Associates, Inc. was contracted by the Village of Caledonia to conduct a study of several ravines within Caledonia including Rifle Range, Cliffside Park, Breaker's, Dominican Creek, and Birch Creek Ravines. The study, entitled Ravine Erosion and Natural Resources Assessment Study, looked at erosion and ecological and bank stability in respect to these ravines and made management recommendations accordingly.

Additional recommended ravine related resources can be found at:

Ravine Restoration Toolkit, alliance for the Great Lakes: <http://www.greatlakes.org/ravinerestoration/toolkit>

Resident Guide for Protecting Ravines and Bluffs, City of Lake forest, IL: http://www.cityoflakeforest.com/assets/1/7/Ravine_brochure_pdf.pdf

Wisconsin coastal Management: Wisconsin Shoreline Inventory & Oblique Viewer: <http://floodatlas.org/wcmp/obliqueviewer/>

Tributary Streams/Ravines Inventory In fall 2012, Applied Ecological Services, Inc. (AES) completed a field inventory of each primary tributary stream in the watershed including ravines formed near Lake Michigan. There are also numerous smaller secondary tributaries branching off many of the primary tributaries. However, mapping and describing all secondary tributaries and small ravines is beyond the scope of this project. All primary tributary streams were assessed based on divisions into "Stream Reaches" (Table 15; Figure 36). Reaches are defined as stream segments having similar hydraulic, geomorphic, riparian condition, and adjacent land use characteristics. Methodology included walking portions of each stream reach, collecting measurements, taking photos, and noting channel, streambank, and riparian corridor

conditions on Stream Inventory/ BMP Data Forms. Ravines were also documented where they were found along these stream channels. Detailed notes were also recorded related to potential Management Measure recommendations and

their corresponding priority for eventual inclusion into the Action Plan section of this report. Results of the inventory including data sheets, photos, and maps of each stream reach can be found in Appendix C.

Table 15. Summary of stream and tributary reaches and lengths.

Primary Tributary Name	Map Code	Number of Reaches	Stream Length Assessed (ft)	Stream Length Assessed (mi)
Tributary A	TRA	1	3,468	0.7
Tributary B	TRB	2	3,788	0.7
Tributary C	TRC	1	2,693	0.5
Tributary D	TRD	2	2,684	0.5
Tributary E	TRE	6	14,550	2.8
Tributary F	TRF	4	11,631	2.2
Tributary G	TRG	7	34,679	6.6
Tributary H	TRH	1	4,501	0.9
Tributary I	TRI	1	5,880	1.1
Tributary J	TRJ	1	7,468	1.4
Tributary K	TRK	1	2,428	0.5
Tributary L	TRL	1	3,141	0.6
Totals		24	96,911	18.4

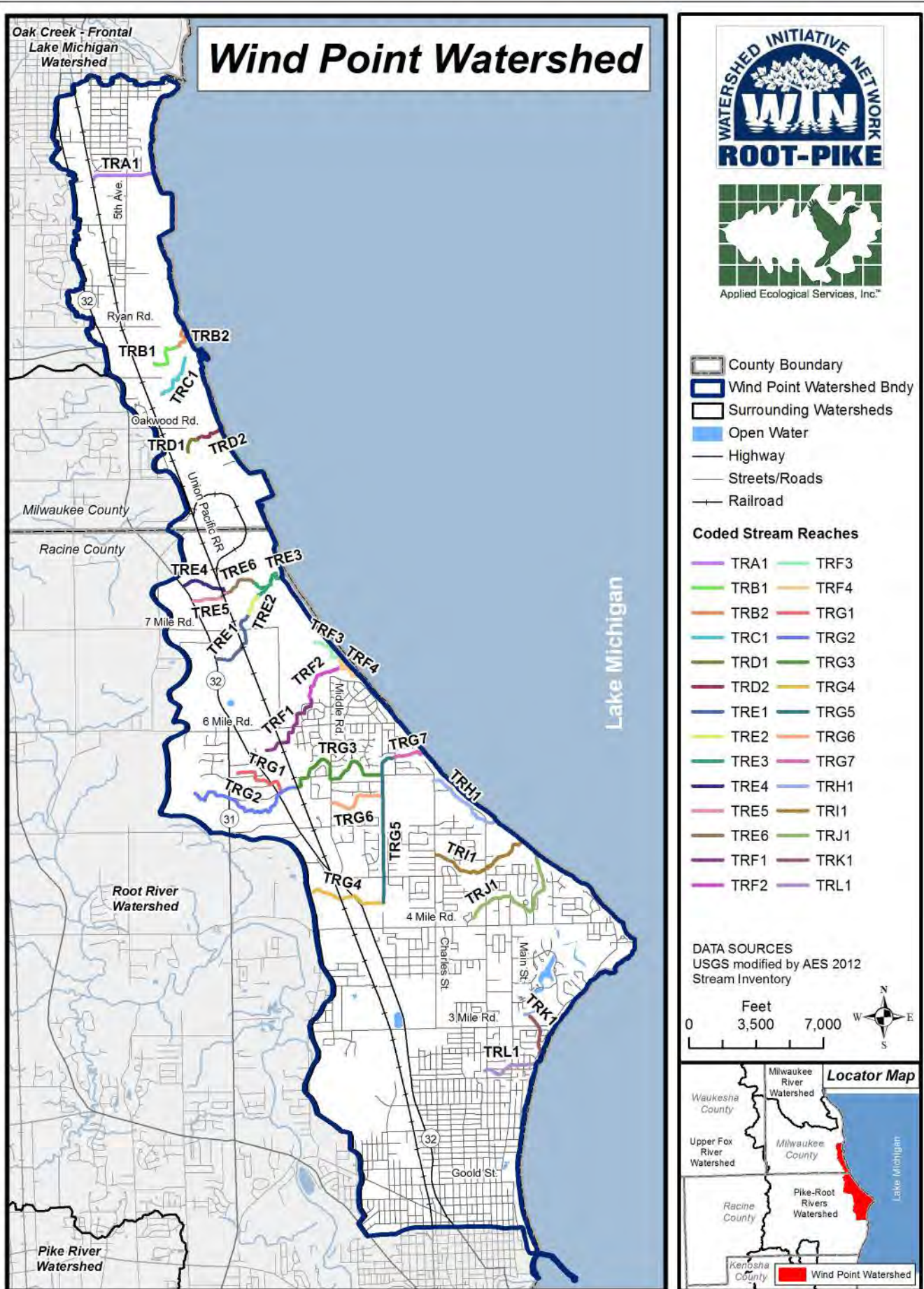


Fig. 36: Coded Stream Reaches

Tributary A

Tributary A (Reach Code: TRA) is located in the northern tip of the watershed and drains approximately 279 acres of land in South Milwaukee. Tributary A is comprised of only one reach (TRA1) beginning near the Union Pacific Railroad and continuing east for 3,468 linear feet before reaching Lake Michigan. This stream is more or less a channelized swale dominated by wetland vegetation with a riparian area consisting mostly of old field and residential lots. Despite the somewhat degraded conditions, streambank erosion is low.

Tributaries B & C

Tributaries B and C are located entirely within Milwaukee County's Bender Park and together drain 285 acres. Tributary B (Reach Code: TRB) consists of two reaches totaling 3,788 linear feet. The headwaters of Tributary B Reach 1 (TRB1) begin in a wetland complex just east of the Union Pacific Railroad. Reach 1 flows primarily through shrubland before entering a mesic woodland along Reach 2 (TRB2). Reach 1 is generally in good condition. Reach 2 becomes higher gradient as it nears Lake Michigan. As a result, streambank erosion is moderate. And a headcut was observed within Reach 2 that contributes significantly to streambank erosion and channel downcutting.

Tributary C (Reach Code: TRC) consists of only one Reach (TRC1) that is 2,693 linear feet in length. This reach flows northeast through primarily open fields and shrubland until it reaches a culvert perched above the Lake Michigan bluff. From here it is presumed that water flows through a pipe to a created wetland detention facility along the bluff. Although channelization is moderate in Tributary C, streambank erosion is low and the riparian condition is in average ecological condition.

Tributary D & Clay Ravine

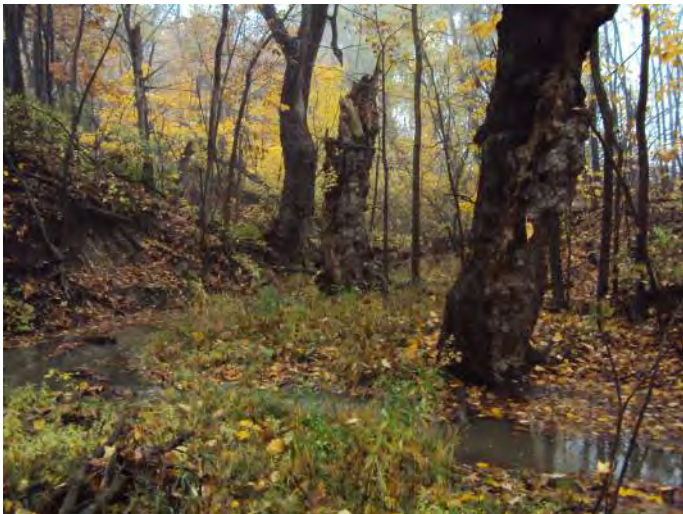
Tributary D (Reach Code: TRD) flows for 2,685 linear feet and drains 243 acres on property owned by

We Energies. Two reaches make up the tributary. Reach 1 (TRD1) flows primarily through a wetland complex but is disturbed. It is channelized, moderately eroded, and the riparian corridor is in poor ecological condition. Reach 2 (TRD2) is naturally meandering through high quality woodland prior to entering Lake Michigan but because the gradient is high, moderate streambank erosion is occurring and erosion is severe along a ravine formation near the lake known as Clay Ravine.

Images, clockwise from left: Tributary A Reach 1 at 5th Avenue; Tributary D Reach 2 & Clay Ravine; Aerial view of Clay Ravine at Trib D Reach 2 (Source: Google Maps, 2013); Tributary B Reach 2 near Lake Michigan.







Images, counter-clockwise from top left:
Aerial view of Rifle Range Ravine (Source: Google Maps, 2013); Tributary E Reach 2; Tributary E Reach 3 – Rifle Range Ravine; Tributary E Reach 5; Tributary F Reach 1; Tributary F Reach 2 upstream of headcut; Tributary F Reach 3 downstream of headcut

Tributary E & Rifle Range Ravine
Tributary E (Reach Code: TRE) is known locally as Rifle Range Tributary. The six stream reaches making up Tributary E span 14,550 linear feet draining 947 acres of land. Reach 1 (TRE1) begins in a wetland complex just west of State Highway 32 and flows northeast to just north of 7 Mile Road on We Energies property. Most of this reach suffers from past agricultural disturbance such as channelization and a narrow/degraded riparian corridor. Reach 2 (TRE2) is located entirely on We Energies property. This reach is naturally meandering with a riparian corridor in good ecological condition. The most concerning issue is the presence of a severe headcut at the end of Reach 2 that is migrating upstream causing significant erosion and sediment transport to Lake Michigan. Reach 3 (TRE3) begins at the headcut and continues downstream to Lake Michigan. This reach is a deep ravine (Rifle Range Ravine) exhibiting severe erosion through a high quality oak woodland. Reaches 4 and 5 (TRE4&5) are essentially wetland swales located between State Highway 32 and the C&NW Railroad. These two reaches come together to form the beginning of Reach 6 (TRE6) which meanders naturally through a high quality oak woodland before joining Reach 3. Similar to Reach 2, there is a headcut that is migrating upstream within Reach 6 and is causing erosion and



Stream Headcuts

A headcut is an erosional feature of both intermittent and perennial streams where an abrupt vertical drop, also known as a knickpoint in the stream bed occurs following hydrologic disturbances in the contributing watershed. As erosion of the knickpoint and the streambed continues, the headcut migrates upstream. This can cause significant streambank erosion and often results in a disconnected floodplain that then increased channel incision.

Controlling a headcut is one of the most difficult challenges in stream restoration. Common headcut treatments include installing check dams, or sloping the bank face and laying in fabric and rock to control continued upstream migration of the knick point. Other methods for headcut control are to elevate the incised channel by filling to original grade.



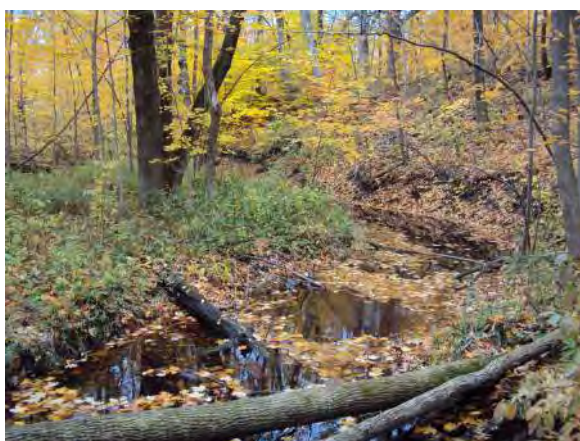
sedimentation downstream.

Tributary F & Cliffside Park Ravine

Four reaches totaling 11,631 linear feet combine to make up Tributary F (Reach Code: TRF). This tributary drains 789 acres. Reach 1 (TRF1) begins between State Highway 32 and the Union Pacific Railroad and flows northeast through mostly shrubland and agricultural fields then through a residential subdivision south of Cliffside Park. This reach is degraded by past channelization practices used by farmers and the adjacent riparian areas are in poor

ecological condition. This reach is also highly channelized through the residential area via a human constructed concrete channel. Reach 2 (TRF2) begins on the south side of Cliffside Park and meanders northeast through a floodplain forest until it reaches a headcut that is actively migrating upstream. A similar condition was observed along Reach 3 (TRF3). This reach is stable and meandering through a wooded riparian area up to a second headcut. Reach 4 (TRF4) is located between the headcuts along Reaches 2 and 3 and Lake Michigan. Reach 4 forms a ravine

known as Cliffside Park Ravine and is incised with highly eroded banks as a result of headcutting. The ravine study conducted by Hey and Associates identifies the following as erosion and stabilization problems within Cliffside Ravine: down-cutting of the streambed and erosion at the toe of the banks, slumping of the ravine banks at the toe of slope, and loss of vegetation on the side slopes. The study also denotes deteriorating culverts and headwall structures, undermining of culverts, and erosion downstream of culvert outfalls as structural issues within Cliffside Park Ravine.



Tributary G

Tributary G (Reach Code: TRG) is known locally as Turtle Creek. The seven stream reaches that combine to form Tributary G result in the longest tributary in the watershed at 34,679 linear feet or 6.6 miles. It drains about 2,138 acres or 3.3 square miles within the central portion of Caledonia. Tributary G has likely been altered the most by human activities. Many of these alterations including channelization and channel relocation can be observe by looking at the pre-settlement stream mapping depicted on Figure 6 in Section 3.1 and comparing it to existing mapping on Figure 36. Reaches 1 and 6 are the small tributaries that join two larger tributaries. Reach 1 begins just east of State Highway 31 and runs through turf grass lined channels within a residential subdivision prior to joining Reach 2 just east of State Highway 32. Reach 6 is mostly channelized within an agricultural parcel between Catherine Drive to the north and Rebecca Drive to the south. Reaches 2 and 3 are somewhat similar. Reach 2 begins west of State Highway 31 and flows east to the Union Pacific Railroad through a moderately channelized system. Reach 3 begins at the railroad and joins Reach 5 near 5 ½ Mile Road. Both reaches are buffered by relatively narrow/low quality floodplain woodlands.

Reach 4 begins as a swale at Holy Cross Cemetery and flows east through ditches between commercial areas prior to joining Reach 5 at Caledonia Park. Reach 5 flows north through a large human created drainage channel bordered primarily by residential development. Reach 7 becomes a ravine between Novak Road and Lake Michigan. There, slope erosion

is severe and hard armoring has been installed to control erosion just east of Novak Road.

Tributaries H (Breaker's Ravine), I (Dominican Creek Ravine), & J (Birch Creek Ravine)

The characteristics of Tributaries H, I, and J are somewhat similar. One 4,500 linear foot reach (TRH1) beginning near Charles Street and entering Lake Michigan near Erie Street make up Tributary H (Reach Code: TRH). This tributary drains 332 acres in Caledonia and flows southeast through large lot residential areas near the Lake Michigan coast. There are no significant problems with Tributary H; streambank erosion is low and the adjacent riparian area is mostly natural. This reach is also identified as Breaker's Ravine. Natural debris log jams, erosion and sedimentation due to a lack of erosion control measures in new development were identified as erosion and stabilization issues for this ravine, according to the Hey and Associates study, and generally the surveyed structures within the ravine were found to be in good condition.

Tributary I (Reach Code: TRI), also known as Dominican Creek Ravine, flows for 5,880 linear feet and drains 443 acres of land between Charles Street and Lake Michigan in Caledonia. The one reach (Reach TRI1) comprising the tributary flows through a wide floodplain forest that is in good ecological condition. Overall, the stream channel is also in good condition. Streambank erosion is low and the channel is naturally meandering. The Hey and Associates ravine study identified down-cutting of the streambed and the toe of the banks as well as slumping of the ravine banks at the toe of slope as general erosion and

stabilization problems for this ravine and also noted that only minor structural issues were found at one road crossing.

Tributary J (Reach Code: TRJ), also known as Birch Creek Ravine, is 7,468 linear feet in length and drains 1,040 acres of mostly residential land in the Villages of Caledonia and Wind Point. The tributary begins near the intersection of Erie Street and 4 Mile Road. From there, Tributary J flows east to near Ravenswood Lane before turning sharply to the north and to Lake Michigan. Tributary J is generally in good condition. It is naturally meandering along its length with no significant streambank erosion problems. And, the riparian corridor consists of floodplain forest in average ecological condition. The Hey and Associates ravine study concurred that generally the area was stable as were structures within this ravine, but noted excessive sediment loading in one section of the stream.

Tributaries K & L & North Bay Ravine

Tributary K (Reach Code: TRK) is the smallest stream in the watershed at 2,428 linear feet. One reach (TRK1) comprises Tributary K and drains 574 acres. The headwaters of this tributary begin just north of 3 Mile Road in a small lake west of the Prairie School. From there, the tributary flows through a channelized ditch among residential development then enters Lake Michigan near Lighthouse Drive. Tributary L (Reach Code: TRL) is 3,141 linear feet and flows east from Erie Street to Lake Michigan through residential development within the Village of North Bay. It is also referred to as the North Bay Ravine and functions as North Bay's storm water infrastructure.

Images, top to bottom, left to right: Tributary G Reach 3; Tributary G Reach 5; Tributary G Reach 7; Tributary I Reach 1; Tributary J Reach 1; Tributary L Reach 1.



Stream Channelization

Naturally meandering streams generally provide riffles and pools that benefit the system by creating habitats while oxygenating the water during low flow or summer heat. Channelized or ditched streams often lack or have poorly developed riffles and pools. Berms along channelized streams are often common where landowners spoiled soils excavated from the channel. These spoil piles often inhibit or alter natural flooding into adjacent floodplains.

Each stream reach in Wind Point watershed was characterized as either having none or low channelization (highly sinuous, no human disturbance), moderate channelization (some sinuosity but altered), or highly channelized (straightened by humans) (Table 16; Figure 37). According to the stream inventory, 34% (34,321 lf) of stream and tributary length is naturally meandering; approximately 31% (29,639 lf) is moderately channelized; 35% (34,950 lf) is highly channelized. The most severe channelization is found along

Tributary A, Tributary K, Tributary G, and the upper reaches of Tributaries E, F, and D.

Channelized areas present opportunities for Management Measure projects such as artificial riffle and pool restoration and regrading or breaking of adjacent spoil piles for reconnection of the stream to adjacent floodplains. The Action Plan section of this report addresses opportunities for improving many of the channelized reaches.

Table 16. Summary of tributary channelization.

Primary Tributary Name	Map Code	Stream Length Assessed	None or Low Channelization		Moderate Channelization		High Channelization	
		(feet)	(feet)	(%)	(feet)	(%)	(feet)	(%)
Tributary A	TRA	3,468	0	0	0	0	3,468	100
Tributary B	TRB	3,788	1,497	40	2,291	60	0	0
Tributary C	TRC	2,693	0	0	2,693	100	0	0
Tributary D	TRD	2,684	1,537	57	0	0	1,147	43
Tributary E	TRE	14,550	6,359	44	0	0	8,191	56
Tributary F	TRF	11,631	5,264	45	1,977	17	4,390	38
Tributary G	TRG	34,679	1,815	5	17,537	51	15,326	44
Tributary H	TRH	4,501	4,501	100	0	0	0	0
Tributary I	TRI	5,880	5,880	100	0	0	0	0
Tributary J	TRJ	7,468	7,468	100	0	0	0	0
Tributary K	TRK	2,428	0	0	0	0	2,428	100
Tributary L	TRL	3,141	0	0	3,141	100	0	0
Totals		96,911	34,321	34	29,639	31	34,950	35



Channelization along Tributary G

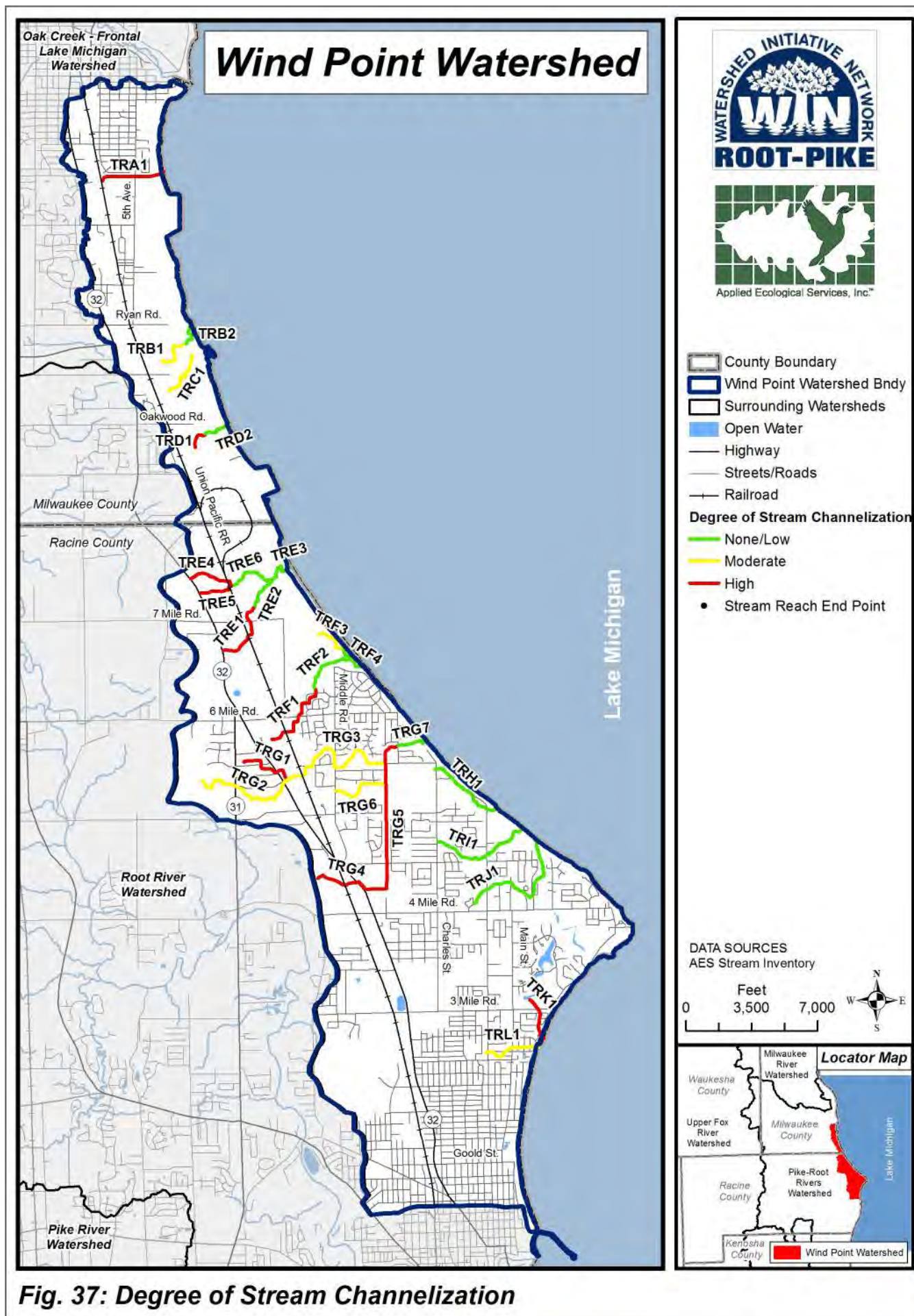


Fig. 37: Degree of Stream Channelization

Streambank Erosion

Unnatural streambank erosion generally results following an instability in flow rate or volume in the stream channel, human alteration such as channelization, or change in streambank vegetation. Resulting sediment transportation downstream can cause significant water quality problems. Streambank erosion is low on average throughout the watershed but becomes severe along Tributaries D, E, F, and G as they flow through ravines near the Lake Michigan coast. In several cases it is evident that these ravines are experiencing unnatural erosion as a result of

headcut formations that are actively migrating upstream. The headcuts likely formed following increased impervious cover and stormwater runoff in the contributing watershed beginning in the early 1900s.

The location and severity of streambank erosion in the watershed is summarized in Table 17 and depicted on Figure 38. Approximately 86% (83,274 lf) of the total tributary length exhibits no or low bank erosion while moderate erosion is occurring along 7% (6,448 lf) of streambanks. Highly eroded streambanks are all associated with ravine

systems near Lake Michigan and accounting for 7% (7,188 lf) of the total stream length. Many of these eroded ravines are considered "Critical Areas" because they are actively contributing significant sediment loads to Lake Michigan.

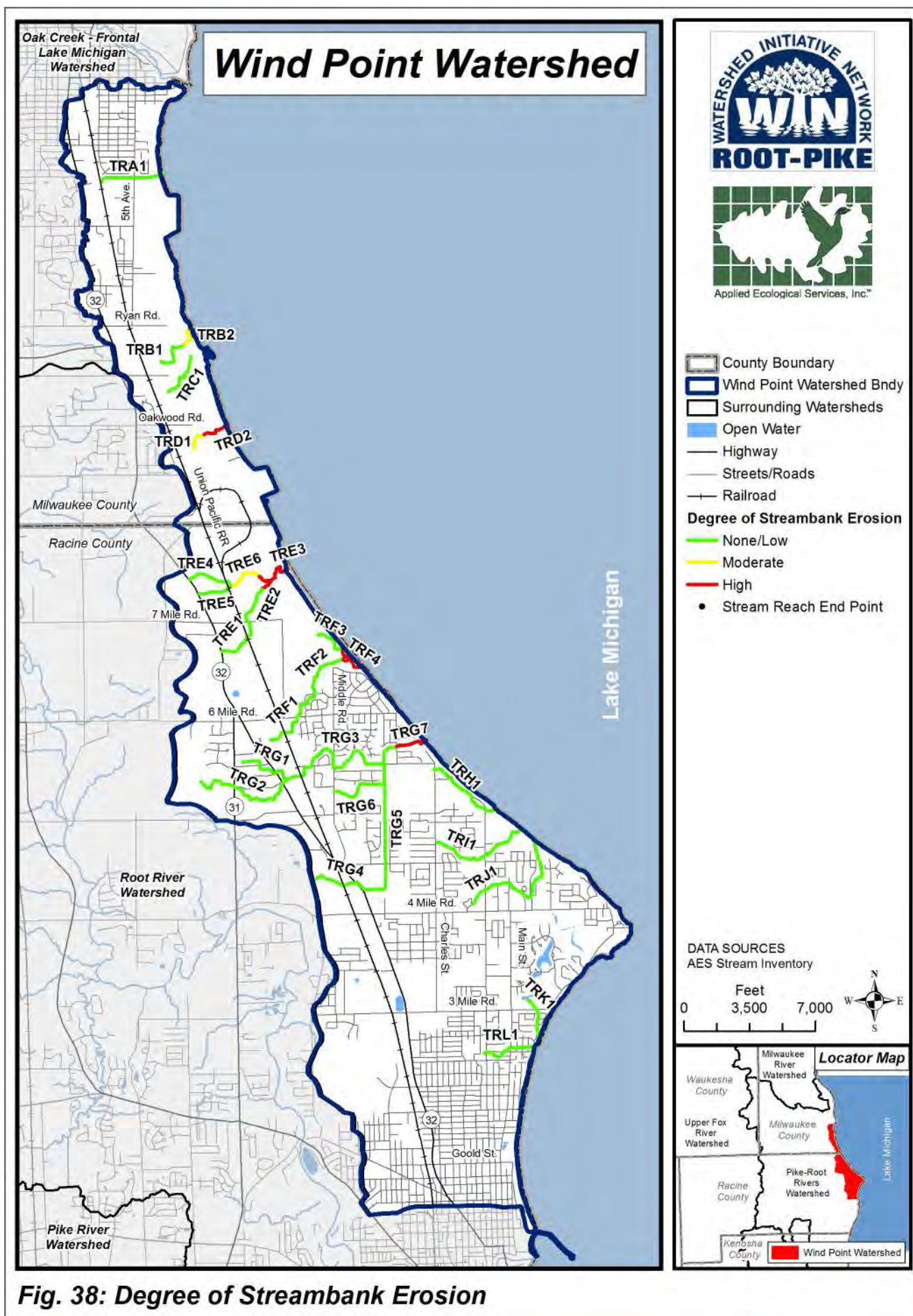
All highly eroded and some moderately eroded streambanks provide excellent opportunities for streambank or ravine stabilization projects. The Action Plan section of this report addresses and prioritizes opportunities for reducing streambank and ravine erosion.

Table 17. Summary of tributary bank erosion.

Primary Tributary Name	Map Code	Stream Length Assessed	None or Low Erosion		Moderate Erosion		High Erosion	
		(feet)	(feet)	(%)	(feet)	(%)	(feet)	(%)
Tributary A	TRA	3,468	3,468	100	0	0	0	0
Tributary B	TRB	3,788	2,291	60	1,497	40	0	0
Tributary C	TRC	2,693	2,693	100	0	0	0	0
Tributary D	TRD	2,684	0	0	1,147	43	1,537	57
Tributary E	TRE	14,550	9,360	64	1,989	14	3,201	22
Tributary F	TRF	11,631	9,181	79	0	0	2,450	21
Tributary G	TRG	34,679	32,863	95	1,815	5	0	0
Tributary H	TRH	4,501	4,501	100	0	0	0	0
Tributary I	TRI	5,880	5,880	100	0	0	0	0
Tributary J	TRJ	7,468	7,468	100	0	0	0	0
Tributary K	TRK	2,428	2,428	100	0	0	0	0
Tributary L	TRL	3,141	3,141	100	0	0	0	0
Totals		96,911	83,274	86%	6,448	7%	7,188	7%



Severely eroded ravine along Tributary E



Riparian Area Condition

Riparian areas that are in good ecological condition buffer streams by filtering pollutants, providing beneficial wildlife habitat, and connecting green infrastructure. Riparian areas along tributaries was assessed during the stream inventory by noting the “Condition” as it relates to function and quality of plant communities present and hydrologic connection with the stream. Areas in “Good” condition connect hydrologically with streams during flood events and have remnant plant communities. “Average” condition riparian areas retain some hydrological connection to the adjacent stream with somewhat degraded plant

communities. Areas in “Poor” condition are usually found along channelized streams that have been heavily farmed in the past causing degraded plant communities to establish.

The location and condition of riparian areas in the watershed is summarized in Table 18 and Figure 39. Approximately 22% of the riparian areas are in “Good” ecological condition, 33% are in “Average” ecological condition, and 45% are in “Poor” condition. The best riparian areas are found along Tributaries B, D, E, and I near the coast of Lake Michigan where remnant mesic and dry-mesic woodlands persist. There

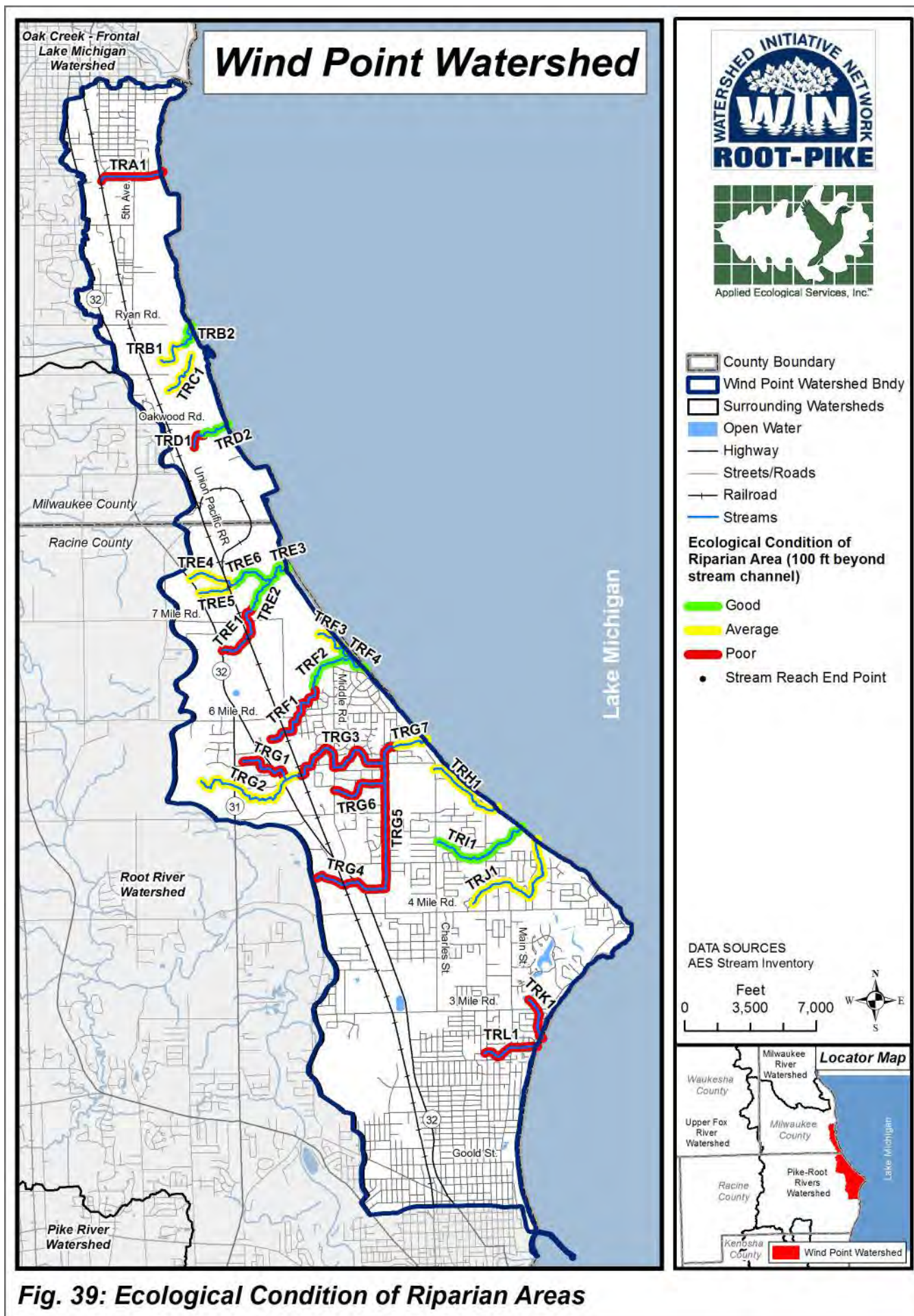
are several common attributes of riparian areas in poor condition. All are associated with past or present farming and development. Most are also narrow and degraded by invasive species including reed canary grass (*Phalaris arundinacea*), buckthorn (*Rhamnus sp.*), honeysuckle (*Lonicera sp.*), and box elder (*Acer negundo*). Others degraded riparian areas are comprised of turf grass within residential and commercial areas. Fortunately, ecological restoration helps eradicate these species and encourages native plant establishment. The Action Plan lists and prioritizes opportunities for improving riparian areas.



Degraded riparian area along Tributary A

Table 18. Summary of tributary area riparian condition.

Primary Tributary Name	Map Code	Stream Length Assessed	Good Condition		Average Condition		Poor Condition	
		(feet)	(feet)	(%)	(feet)	(%)	(feet)	(%)
Tributary A	TRA	3,468	0	0	0	0	3,468	100
Tributary B	TRB	3,788	1,497	40	2,291	60	0	0
Tributary C	TRC	2,693	0	0	2,693	100	0	0
Tributary D	TRD	2,684	1,537	57	0	0	1,147	43
Tributary E	TRE	14,550	6,359	44	4,410	30	3,781	26
Tributary F	TRF	11,631	5,264	45	1,977	17	4,390	38
Tributary G	TRG	34,679	0	0	9,046	26	25,632	74
Tributary H	TRH	4,501	0	0	4,501	100	0	0
Tributary I	TRI	5,880	5,880	100	0	0	0	0
Tributary J	TRJ	7,468	0	0	7,468	100	0	0
Tributary K	TRK	2,428	0	0	0	0	2,428	100
Tributary L	TRL	3,141	0	0	0	0	3,141	100
Totals		96,911	20,537	22%	32,386	33%	43,987	45%



3.14.2 Detention Basins

Over the past half century, the drainage system in Wind Point watershed has changed from farmland driven drain tiles, channels, and ditches to one that is driven by runoff from developed areas. Most developed areas are drained by swales and stormsewers to the tributaries of the watershed or directly to Lake Michigan. More recently, detention basins are part of a development site. A detention basin is a human-made structure that is designed by engineers for the temporary storage of stormwater runoff with a controlled release rate that is usually designed to hold and release water based on predevelopment rates. Detention basins can also provide excellent wildlife habitat and improve water quality if designed with the proper configuration, slopes, and water depths then planted with native prairie and wetland vegetation. Detention basins capture runoff from several developed areas of the watershed making the quality and quantity of water leaving these basins critically important to the health of the watershed.

Detention basins can be designed and constructed as wet bottom,

wetland bottom, or dry bottom and planted with various types of natural or manicured vegetation. Wet and wetland bottom basins typically hold water that is controlled by the elevation of the outlet structure. Wet bottom basins are usually greater than 3 feet deep and do not have emergent vegetation throughout whereas wetland bottom detention basins are shallow enough to be dominated by emergent wetland plants. These designs promote water quality treatment via settling and plant uptake and also support wildlife. Dry bottom basins are designed to drain completely after temporarily storing and infiltrating stormwater following rain events. They can be planted to either turf grasses or naturalized with native vegetation.

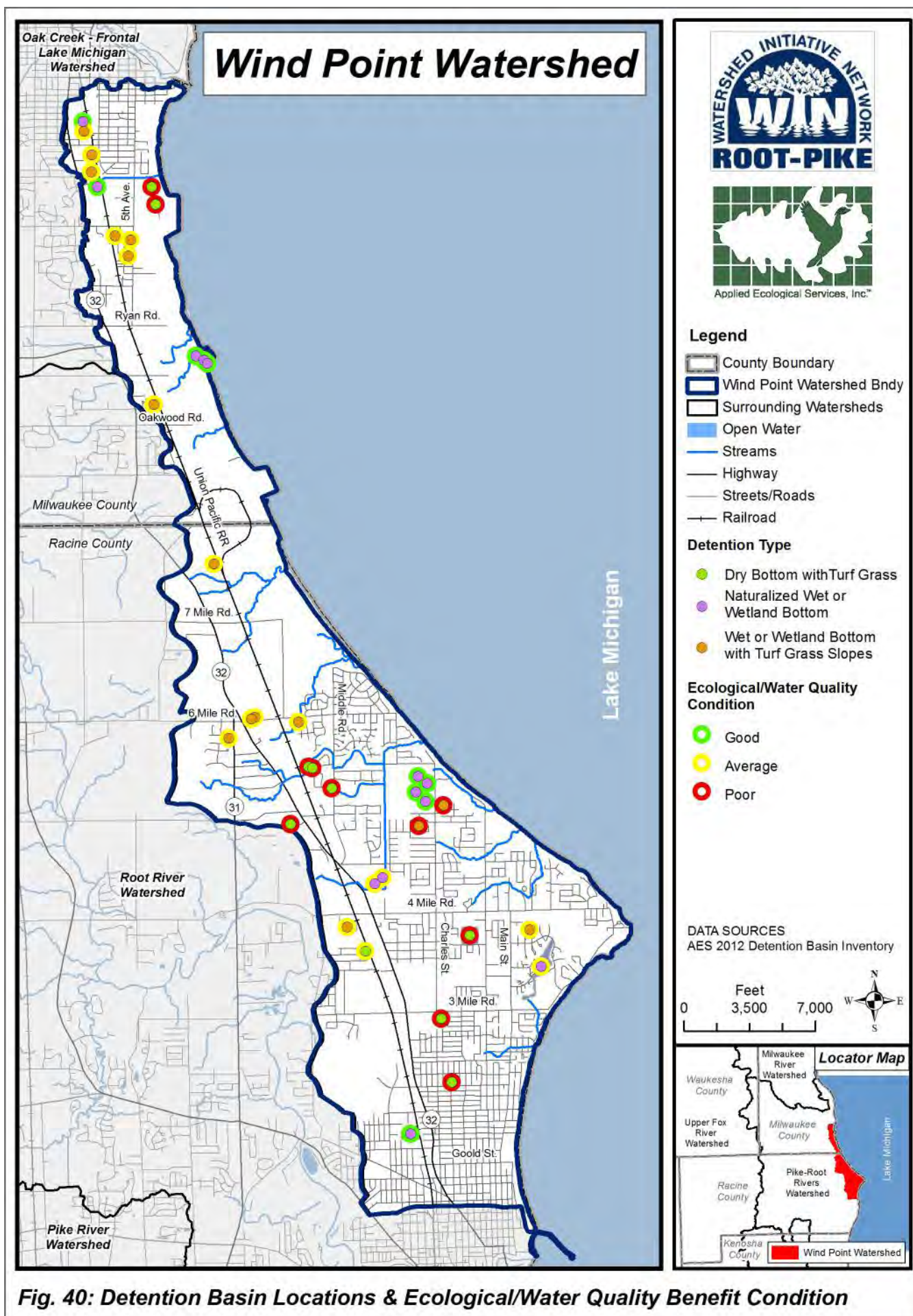
Thirty nine (39) detention basins were located and inventoried within Wind Point watershed (Figure 40). Applied Ecological Services, Inc. (AES) completed a basic assessment of each detention basin in fall 2012. Assessment methodology included a visit to each basin and collection of data relevant to existing conditions. Detailed notes were recorded related to existing ecological/ water quality benefit condition and potential retrofit Management Measures for eventual inclusion into

the Action Plan section of this report. Results of the inventory and detailed summaries of each detention basin can be found in Appendix C. Ten (10) dry bottom turf grass, 13 naturalized wet or wetland bottom, and 16 wet or wetland bottom with turf slopes detention basins were inventoried (Figure 40).

Of the 39 basins, 10 (26%) provide “Good” ecological and water quality benefits while 18 (46%) basins provide “Average” benefits. The remaining 11 (28%) basins provide “Poor” ecological and water quality benefits because most were designed simply to meet stormwater storage volume requirements. Designs that also improve water quality and wildlife habitat were not necessarily considered because they are not required under local regulations. Often, regulations require that Best Management Practices (BMPs) be part of permitted developments to provide healthy aquatic ecology, sustainability, minimize human intervention, and to treat stormwater as a multiple use resource. However, detailed examples and standardized specifications are not always provided leaving a great deal of ambiguity regarding what is actually required.



Naturalized detention basin at Audubon Arboretum Subdivision



The majority of dry bottom detention basins are located in the southern half of the watershed within the municipalities of Caledonia and Racine. Of the 10 dry bottom basins in the watershed all are planted with turf grass. Unfortunately, turf grass basins provide limited water quality benefits and wildlife habitat. Dry bottom basins planted with turf grass hold water for shorter periods following rain events and infiltrate less water compared to dry bottom basins naturalized with deep rooted native vegetation. Many of the dry bottom basins in the watershed present excellent retrofit opportunities and most would be relatively easy to naturalize with native plantings.



Wet and wetland bottom detention basins are found scattered throughout the watershed. Individual development sites tend to have basins that are all similarly planted. For example, most wet and wetland bottom basins in a development are planted with either turf grass along the basin slopes or are naturalized with native vegetation along the slopes and emergent edge. Basins planted with turf grass are designed with aesthetics in mind and not necessarily the potential water quality and wildlife habitat benefits. Because of this, most homeowner and business associations will likely disapprove of installing water quality retrofits such as native plant buffers unless they can be designed to look formal and require minimal maintenance. Thirteen (13) of the 29 wet and wetland bottom detention basins in the watershed are naturalized with native vegetation. Perhaps the best example of naturalized basins can be found at Audubon Arboretum Subdivision in Caledonia. The remaining 16 wet and wetland bottom basins have turf grass slopes. Like most dry bottom basins, the side slopes and emergent areas of wet and wetland bottom basins can be retrofitted with native vegetation relatively easily.



Images, top to bottom: Typical dry bottom turf grass detention at Stephan Rd.; naturalized section of pond at Prairie School; wet bottom basin with turf slopes in development off Shore Dr.

3.14.3 Wetlands & Potential Wetland Restoration Sites

Wetlands are a critical part of the earth's hydrologic system, receiving water from snowmelt and rain, slowly releasing it from the land to recharge streams and lakes (Apfelbaum & Haney 2010). Functional wetlands do more for water quality improvement and flood reduction than any other natural resource. In addition, wetlands typically provide habitat for a wide variety of plant and animal species. They also provide some groundwater recharge capabilities and filter sediments and nutrients. A diverse network of wetlands remained intact in Wind Point watershed until the 1830s when European settlers began to alter significant portions of the watershed's natural hydrology and wetland processes. Where it was feasible, wetlands were drained, streams channelized, and existing vegetation cleared to farm the rich soils.

There were approximately 2,945 acres of wetlands in the watershed prior to European settlement based on the most up to date hydric soils mapping provided by the USDA Natural Resources Conservation Service (NRCS). According to existing wetland inventories, about 577 acres or 20% of the pre-European settlement wetlands remain (Table 19; Figure 41). The largest loss of wetlands occurred in the southern portion of the watershed on a large flat plateau between Six Mile Road and the southern end of the watershed. Early vegetation mapping suggests this area was southern lowland forest and marsh. The vast majority of this historic wetland has since been drained and developed primarily to residential development.

Existing wetland information and mapping is available for the entire Wind Point watershed via the 2005 Regional Wetland Inventory and 2005 Advanced Disposal Identification of Disposal Areas (ADID) Wetland Inventory conducted by the Southeastern

Wisconsin Regional Planning Commission (SEWRPC) in conjunction with the Wisconsin Department of Natural Resources (WDNR). The wetland features were delineated according to the definitions of the Wisconsin Wetland Inventory Classification Guide, with the addition of special features such as drained wetlands and drainage ditches. ADID wetlands and waters include all aquatic resources located within Primary Environmental Corridors and natural areas as identified by SEWRPC and categorized as either "Wetlands", "Lakes/Ponds", or "Natural Area Wetlands". "Other Wetlands" are located outside Primary Environmental Corridors. Of the 577 total acres of wetlands in Wind Point watershed, 395 acres have been identified as ADID wetlands by SEWRPC (Table 19; Figure 41). These include 127.3 acres of ADID Wetlands and 0.33 acres of ADID Lakes/Ponds. The remaining 449.3 acres is "Other Wetlands".

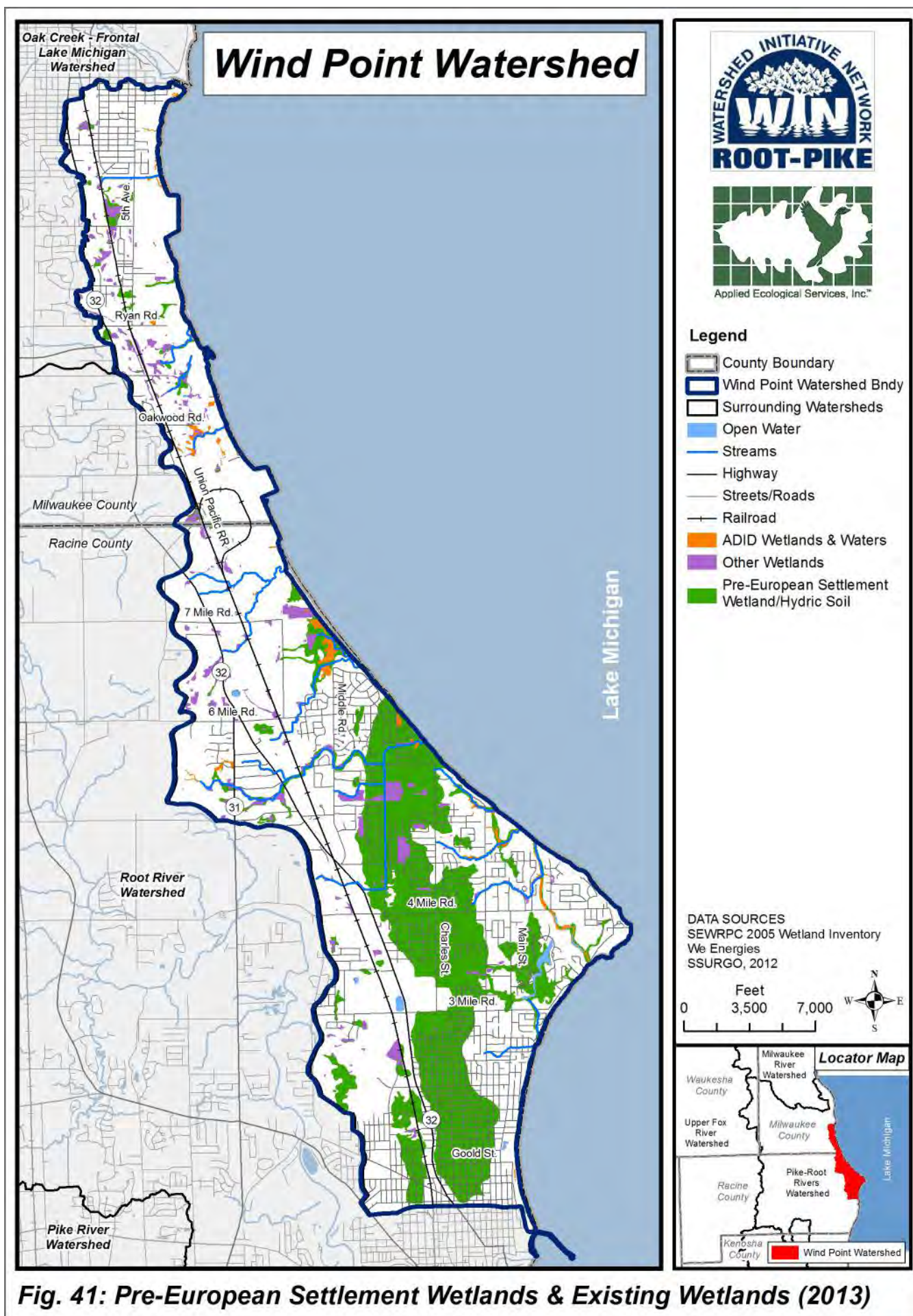
Most existing wetlands in Wind Point watershed are concentrated around

stream reaches and are relatively small and fragmented. Many of the existing wetlands were inspected by Applied Ecological Services, Inc. in fall of 2012 during reconnaissance of the watershed (Appendix C). Most have been negatively impacted by farming and other human practices at some point in the last 150 years to the extent that hydrology has changed and invasive species such as narrow leaved cattail (*Typha angustifolia*), common and glossy buckthorn (*Rhamnus sp.*), reed canary grass (*Phalaris arundinacea*), and common reed (*Phragmites australis*) now dominate.

Some of the largest existing wetland complexes can be found near the headwaters of Tributary A between the Union Pacific Railroad and 5th Avenue, along Tributaries B & C in Bender Park, Cliffside Park, at the headwaters of Tributary D on WE Energies property, and a wetland swale extending from Lake Michigan and north of Four Mile Road and through The Johnson Foundation at Wingspread.

Table 19. Milwaukee and Racine County wetlands and attributes.

Wetland Category	Acres	Wetland Attributes
ADID Wetlands	127.3	The intersection of 2005 wetlands and primary environmental corridors as defined by SEWRPC
ADID Lakes/Ponds	0.33	Generally all deep water features within primary corridors and natural areas that are to be protected
Other Wetlands	449.3	Additional wetlands outside of the SEWRPC primary corridors that are to be protected



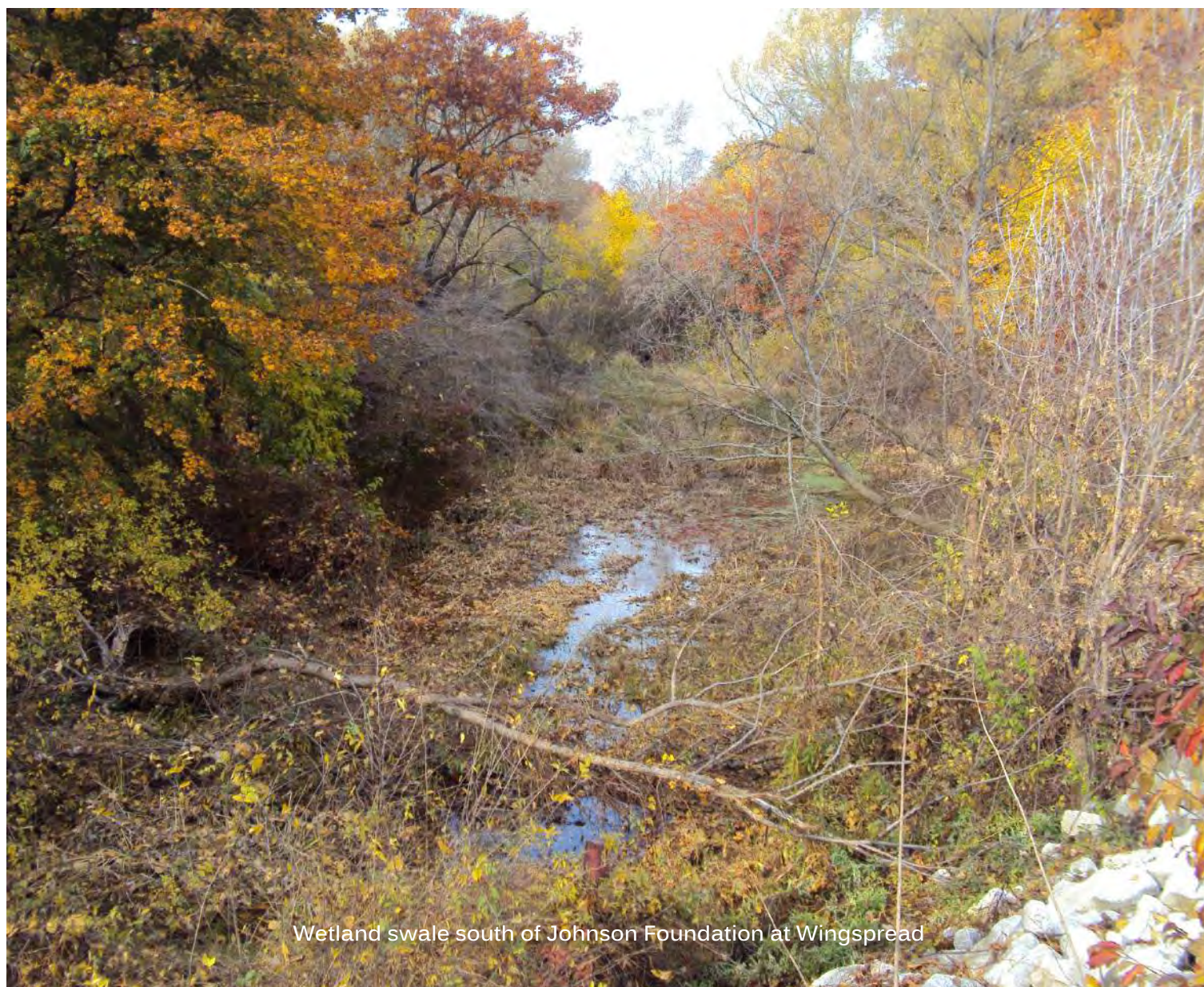
Potential Wetland Restoration Sites

Wetland restoration projects are among the most beneficial in the context of improving watershed health. Wetlands are vitally important because they improve basic environmental functions such as storing floodwaters, increasing biodiversity, creating green infrastructure, and improving water quality. The wetland restoration process involves returning hydrology (water) and vegetation to soils that once supported wetlands but no longer do because of human impacts such as tile and ditch draining and/or filling. Potential wetland restoration sites were identified using a Geographic

Information Systems (GIS) exercise whereby sites were selected that include at least 5 acres of drained hydric soils located on an open or partially open parcel where no wetlands currently exist.

The GIS exercise resulted in 28 sites meeting the above criteria. However, the extent of development in Wind Point watershed limits the number and size of potential wetland restoration sites. Of the original 28 sites, 25 sites accounting for 516 acres were determined to be potentially feasible or have at least limited feasibility after careful review of each site using 2012 aerial photography, open space inventory results, existing (2012) land use,

and field visits where appropriate (Table 20; Figure 42). Of the 25 sites, 14 are “Potentially Feasible”, and 11 have “Limited Feasibility”. Most of the wetland restoration sites are located in the southern half of the watershed on remaining agricultural fields or vacant parcels that overlap a large swath of drained hydric soils. The three sites that were eliminated were found in areas where the proximity of existing development simply would not allow for wetland restoration. It is important to note that a feasibility study beyond the scope of this project will need to be completed prior to the planning and implementation of any potential wetland restoration.

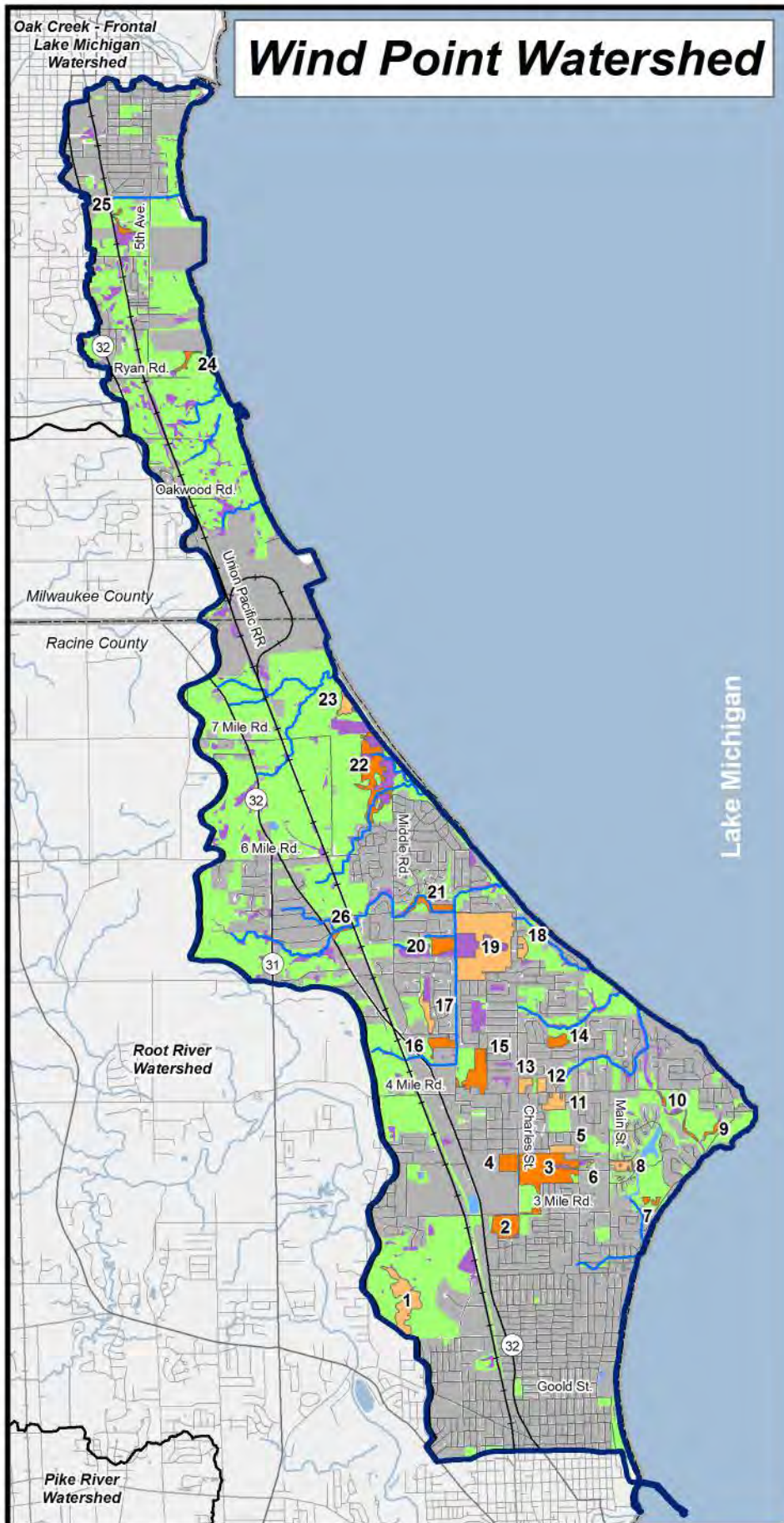


Wetland swale south of Johnson Foundation at Wingspread

Table 20. Size, feasibility, and existing condition of potential wetland restoration sites.

Map ID #	Area (ac)	Feasibility	Existing Condition
1	≈ 44	Limited Feasibility	Located at John H. Batton Airport (Batten International Airport)
2	≈ 25	Potentially Feasible	Located on vacant land owned by Vulcan Materials Company south of 3 mile road
3	≈ 76	Potentially Feasible	Located on vacant land owned by Vulcan Materials Company east of Charles Street
4	≈ 14	Potentially Feasible	Located on vacant land owned by Vulcan Materials Company west of Charles Street
5	≈ 8	Limited Feasibility	Located on private residential lot west of Erie Street
6	≈ 2	Limited Feasibility	Located in undeveloped residential area off Ruby Avenue
7	≈ 4	Potentially Feasible	Located on private agricultural land south of the Prairie School
8	≈ 8	Limited Feasibility	Located on private residential Lot east of N. Main Street
9	≈ 3	Potentially Feasible	Located on Shoop Park Golf Course
10	≈ 4	Potentially Feasible	Located in area that is currently a created pond at Johnson Foundation's Wingspread
11	≈ 14	Limited Feasibility	Located across several private residential lots south of 4 Mile Road
12	≈ 5.5	Limited Feasibility	Located on private residential/agricultural lots
13	≈ 7	Limited Feasibility	Located on private residential/agricultural lots
14	≈ 9	Potentially Feasible	Located on private agricultural land west of Erie Street
15	≈ 30	Potentially Feasible	Located on private agricultural land north of 4 Mile Road and adjacent to Crawford Park
16	≈ 12	Potentially Feasible	Located on private agricultural land south 4 ½ Mile Road
17	≈ 11	Limited Feasibility	Located across multiple private residential and agricultural lots east of Middle Road
18	≈ 7.5	Limited Feasibility	Located across multiple private residential and agricultural lots east of Charles Street
19	≈ 130	Limited Feasibility	Large drained wetland complex on land that is currently a defunct development surrounded by agricultural land between 5 Mile and 5 ½ Mile Roads
20	≈ 16.5	Potentially Feasible	Located on private agricultural land along Tributary G and east of Middle Road
21	≈ 15	Potentially Feasible	Located on private agricultural land along Tributary G and east of Middle Road
22	≈ 46.5	Potentially Feasible	Located at headwaters of Tributary F within Cliffside Park
23	≈ 9	Limited Feasibility	Located on partially developed land owned by WE Energies
24	≈ 5	Potentially Feasible	Located on vacant private land owned by DuPont
25	≈ 5	Potentially Feasible	Located near the headwaters of Tributary A
26	≈ 5	Potentially Feasible	Located on private agricultural land along Tributary G Reach 2

Note: A feasibility study will need to be completed prior to the planning and restoration of any potential wetland restoration.



Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad
- Existing Wetlands
- Open/Partially Open Parcel
- Developed Parcel

Wetland Restoration Site Feasibility

- Limited Feasibility
- Potentially Feasible

DATA SOURCES

National Wetlands Inventory (NWI)
modified during AES 2012 inventory
Racine & Milwaukee County SSURGO

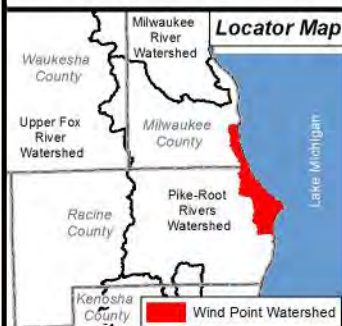
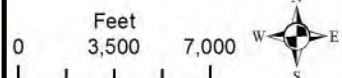


Fig. 42: Potential Wetland Restoration Sites

Wetland restoration recommendations are included and prioritized in the Action Plan section of this report. Site #s 9, 10, 11, 14, 15, 16, 19, 20, 21, and 22 are among the highest priority because of their location, size, or potential to remediate watershed problems. Municipalities should strongly consider requiring "Conservation or Low Impact Design" development that incorporates wetland restoration on parcels slated for future development.

Another potential option is to restore large wetland complexes as part of a wetland mitigation bank. In this case, wetlands are restored on private or public land and must meet certain performance criteria before they become "fully certified." Following certification, developers are able to buy wetland mitigation credits from the wetland bank for wetland impacts occurring elsewhere in the watershed. A fully certified acre of restored wetland can sell between \$40 and

\$100 thousand dollars. Although this may seem like an enormous expense to a developer, it is often cheaper than going through a long permitting process to impact wetlands and provide mitigation on the development site. It is also possible that entities such as wastewater treatment plants could purchase "water quality trading credits" from wetland mitigation banks as a way to offset phosphorus in plant effluent.



Potential wetland restoration Site #21 along Trib G Reach 3

3.14.4 Floodplain

FEMA 100-Year Floodplain

Functional floodplains along stream, river, and lake corridors perform a variety of green infrastructure benefits such as flood storage, water quality improvement, passive recreation, and wildlife habitat. The most important function however is the capacity of the floodplain to hold water following significant rain events to minimize flooding downstream. The 100-year floodplain is defined by the Federal Emergency Management Agency (FEMA) as the area that would be inundated during a flood event

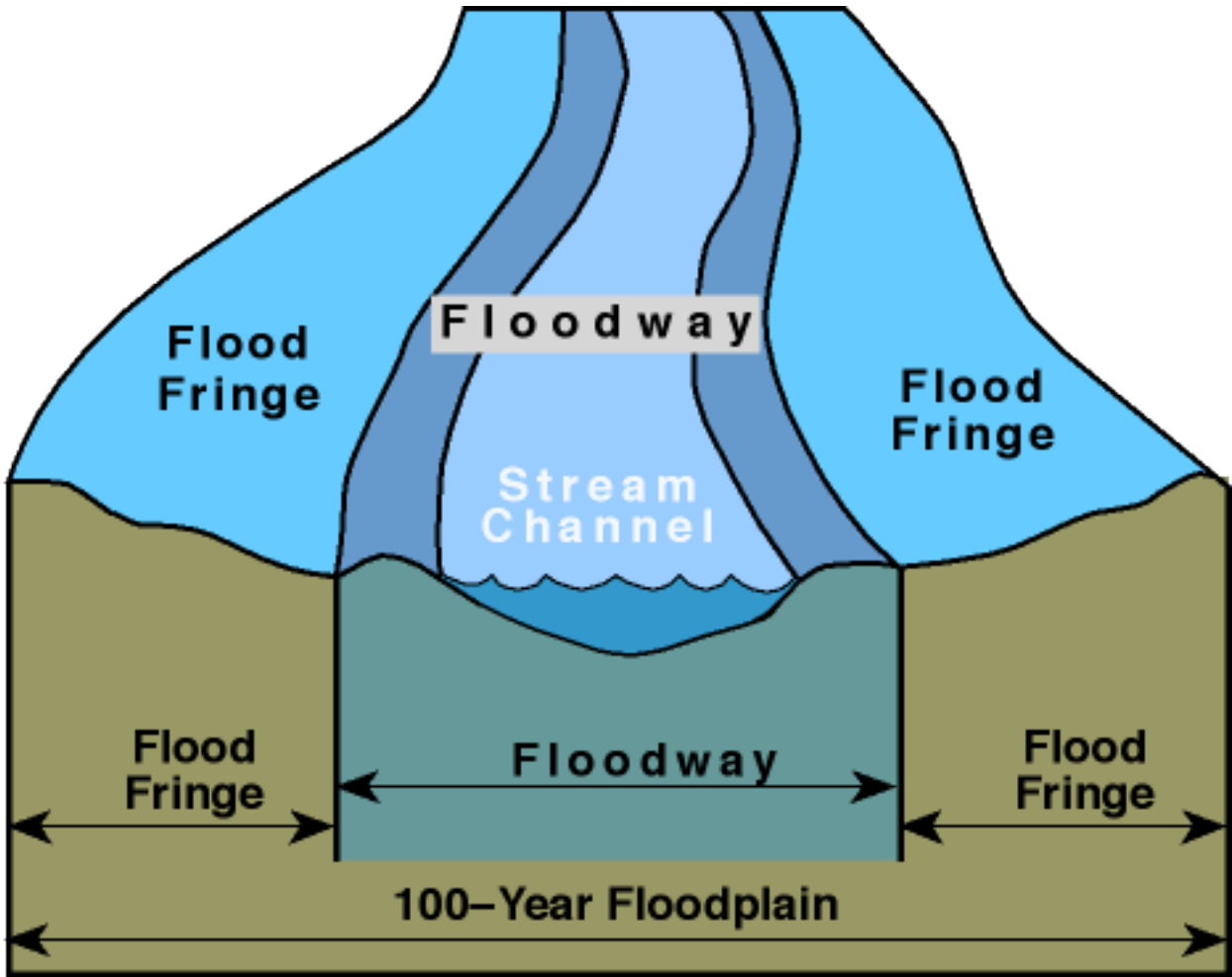
that has a one percent chance of occurring in any given year (100-year flood). 100-year floods can and do occur more frequently, however the 100-year flood has become the accepted national standard for floodplain regulatory and flood insurance purposes and was developed in part to guide floodplain development to lessen the damaging effects of floods.

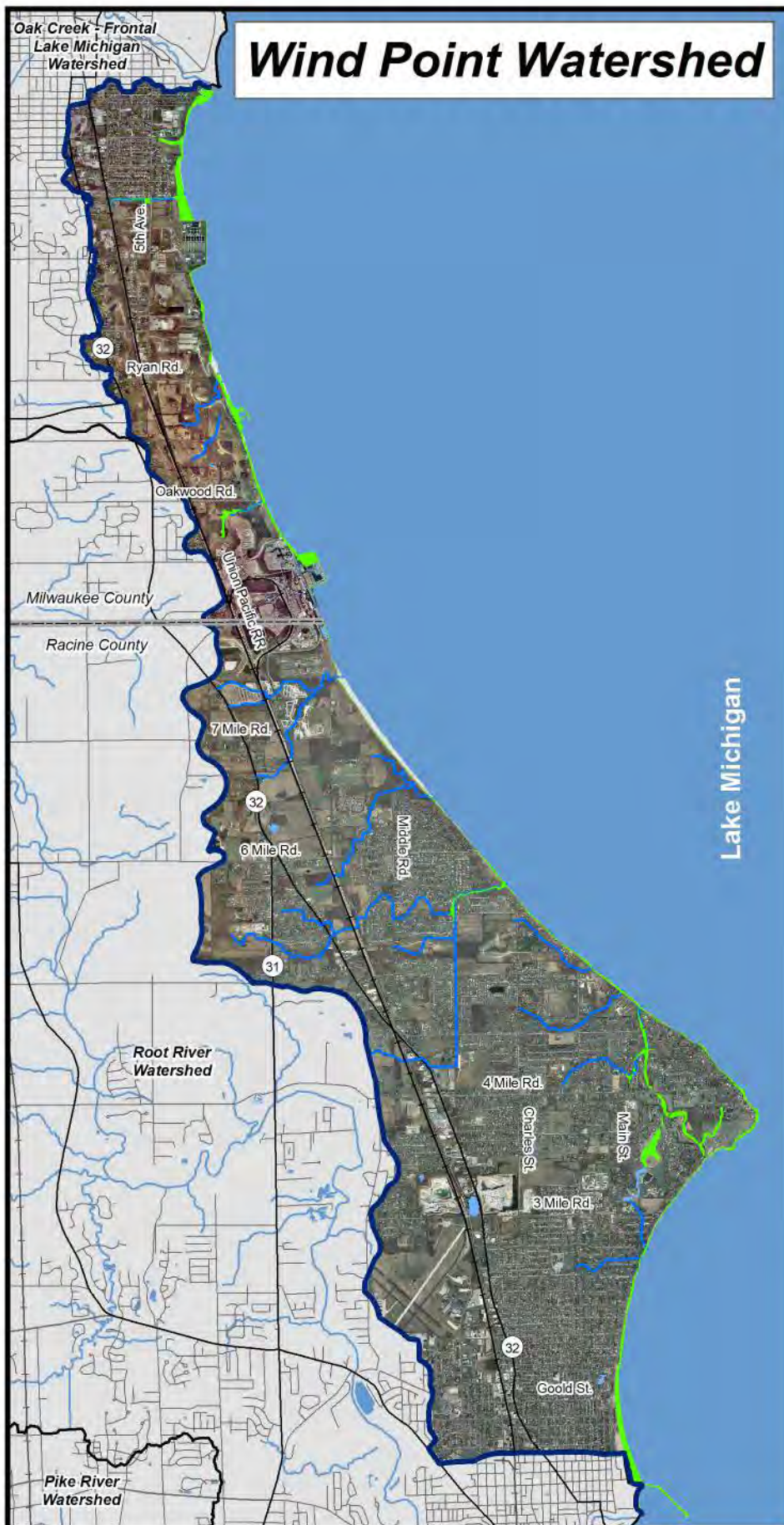
The 100-year floodplain along streams also includes the floodway. The floodway is the portion of the stream or river channel that comprises the adjacent land areas that must be reserved to discharge the 100-year flood without

increasing the water surface. Figure 43 depicts the 100-year floodplain and floodway in relation to a hypothetical stream channel.

Figure 44 depicts the 100-year floodplain which occupies 235 acres or about 2% of the watershed. The most extensive floodplain areas are associated with Lake Michigan coastal areas. Other floodplain areas have been delineated along the lower reaches of Tributaries A, D, G, and J. A large wetland swale near Wind Point and the pond adjacent to the Prairie School are also within the floodplain.

Figure 43. 100-year floodplain and floodway depiction along streams.





Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad
- FEMA 100-yr Floodplain

DATA SOURCES
FEMA (June, 2013)

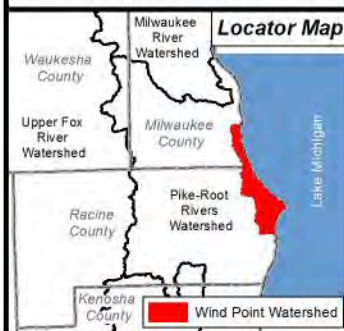
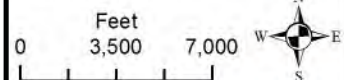


Fig. 44: FEMA 100-Year Floodplain

3.15 Groundwater Aquifers & Recharge, Contamination Potential, & Water Supply

Groundwater Aquifers and Recharge

Groundwater is water that saturates small spaces between sand, gravel, silt, clay particles, or crevices in underground rocks. Groundwater is found in aquifers or underground formations that provide readily available quantities of water to wells, springs, or streams. Groundwater sources available to southeastern Wisconsin are found in shallow, unconfined aquifer units and deep, semi-confined or confined aquifer units (Figure 45). Both shallow and deep aquifers are tapped and used by private and public users and municipalities.

The hydrogeology of Wind Point watershed falls entirely within the Silurian dolomite aquifer. This aquifer, formerly known as the Niagara dolomite aquifer, is the uppermost bedrock aquifer in the area, hydraulically connected to the adjacent sand and gravel aquifer, and generally falls under water table conditions. It is also the primary source of most public water supplies and wells within the watershed. Below the Silurian dolomite aquifer are the upper and

lower sandstone aquifers. The upper sandstone aquifer includes sandstone and dolomite of the Ancell and Prairie du Chien Groups, while the lower sandstone aquifer is made up of the thick sedimentary sequences of Cambrian sandstone (SEWRPC, 2002).

Groundwater modeling studies conducted by Southeastern Wisconsin Regional Planning Commission (SEWRPC) for the southeastern Wisconsin region in 2010 suggest that deep water aquifers are experiencing excessive drawdown centered on the area of eastern Waukesha County (see Figure 46, left image). Drawdowns in this area exceed 400 feet. This is part of a larger general drawdown occurring in Milwaukee and Chicago and the area around them. Simulated drawdowns within the shallow aquifer (see Figure 46, right image), however, appear much smaller in size and extent. This is because of the unconfined nature of the aquifer and its connection to surface water bodies. "Under natural conditions, most ground water recharge to the shallow aquifer flows through the shallow aquifer and discharges to surface water bodies as baseflow. Pumping the shallow aquifer can reduce the

natural ground-water discharge, intercepting it before it reaches surface water bodies and then discharging it to those few rivers that receive wastewater effluent (SEWRPC, 2010)." Rather than result in large drawdowns, groundwater deficits in the shallow aquifer effectively reduce groundwater baseflow (SEWRPC, 2010).

As the pumping of the deep aquifers and subsequent drawdowns has progressed, water from the shallow aquifer has been diverted downwards toward the deep aquifers. Groundwater recharge of the deep sandstone aquifer does not occur within Wind Point watershed due to the Maquoketa shale formation which underlies the area and serves as an aquitard.

Soil-water balance recharge occurs mostly along the northern portion of Wind Point watershed (Figure 47). The lower soil-water balance recharge values across the watershed generally relate to areas of increased urban development such as in the northern- and southern-most portions of the watershed, while higher recharge areas tend to occur where the land is more vegetated such as within parks and open space (SEWRPC, 2008).

Figure 45. Aquifer Systems in Southeastern Wisconsin. Source: SEWRPC, 2002.

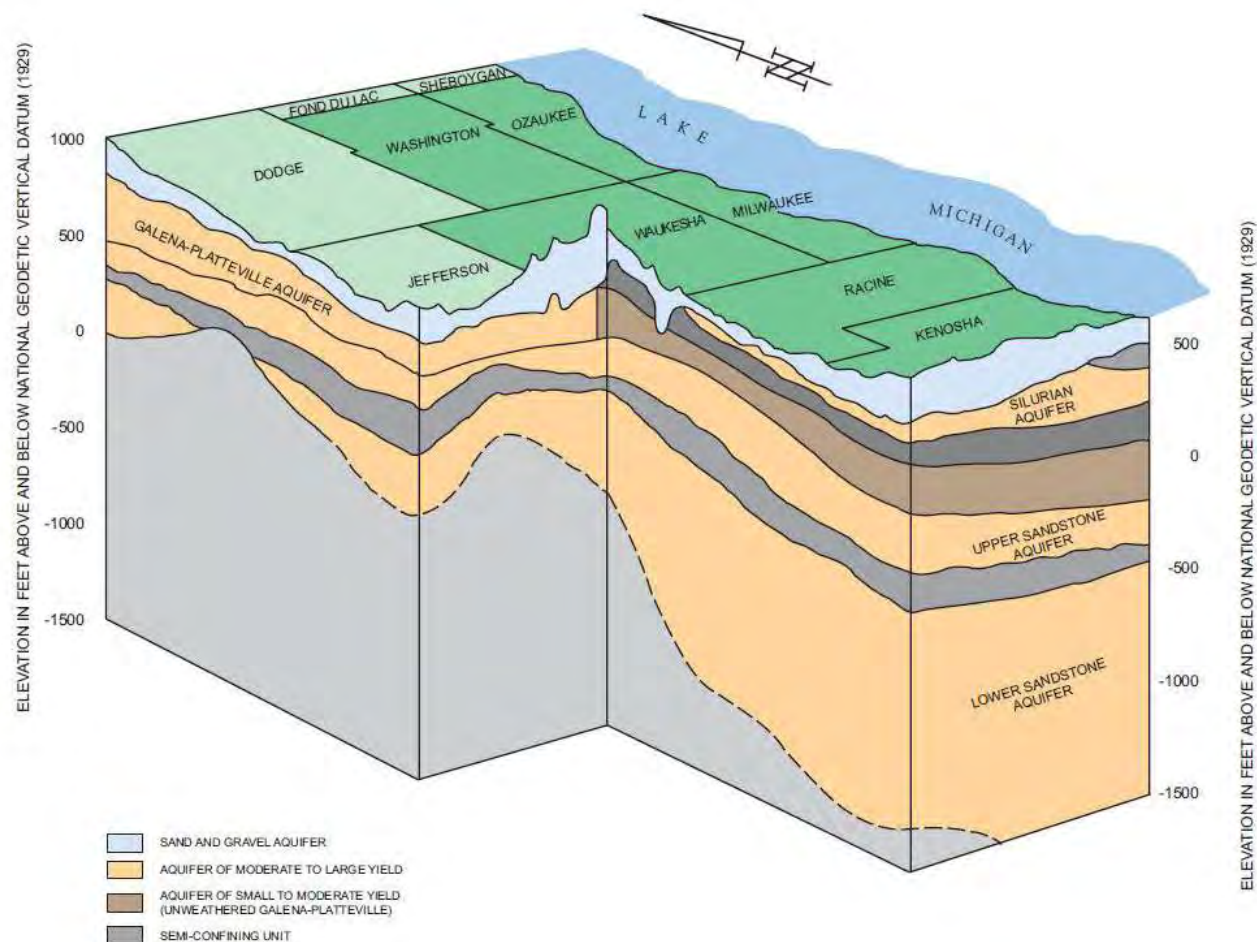
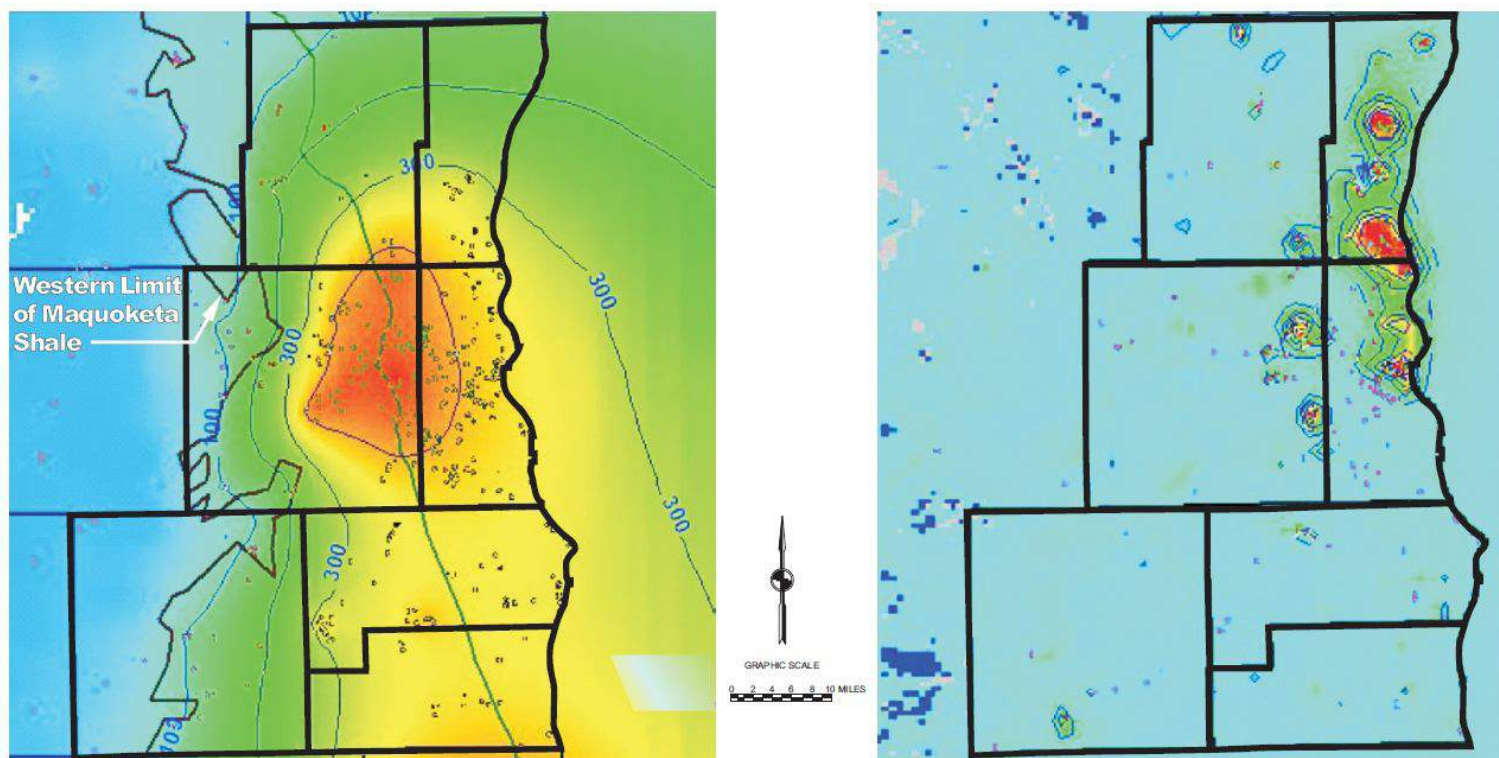
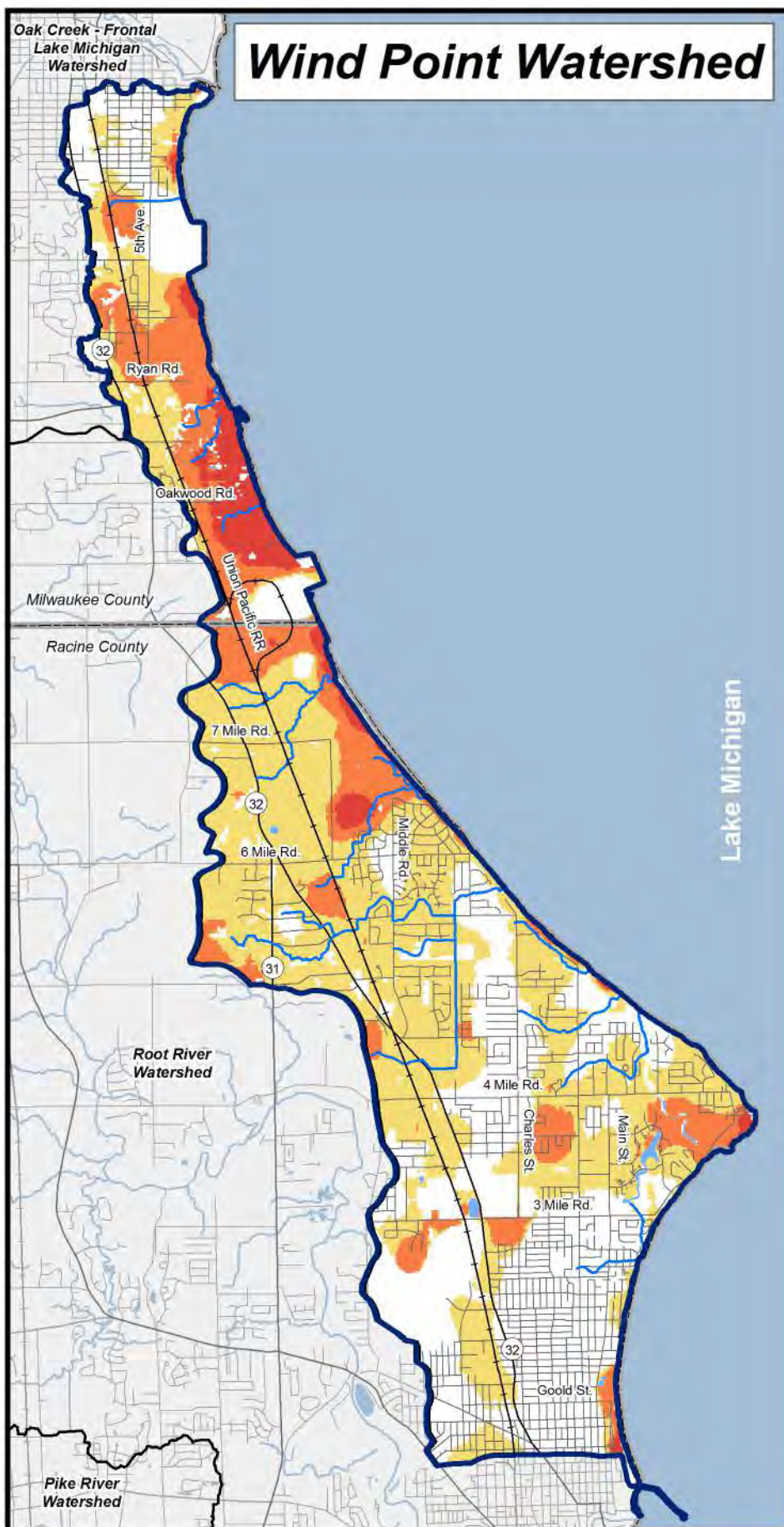


Figure 46. Simulated drawdowns for SEWRPC Region between 1860 and 2000. Left image depicts deep aquifers and right image depicts the shallow aquifer. Source: SEWRPC, 2010.





Wind Point Watershed



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Soil-Water Balance Recharge Potential

- Moderate
- High
- Very High

DATA SOURCES
SEWRPC

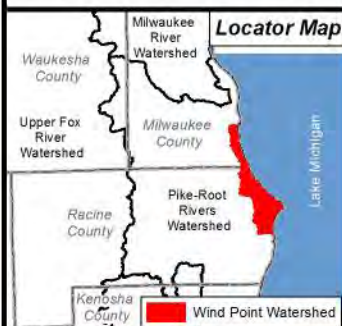
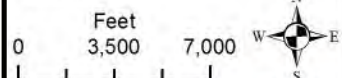


Fig. 47: Soil-Water Balance Recharge Potential

Groundwater Contamination Potential

In SEWRPC's research into groundwater resources, they determined areas in which shallow groundwater resources were potentially susceptible to contamination. They did this by measuring three parameters: 1) distance from the land surface to the aquifer, 2) properties of materials through which contaminants have to pass to reach the aquifer, and 3) rates at which such contaminants can travel (SEWRPC, 2002).

SEWRPC also identifies areas which should be targeted for groundwater protection measures. These areas are also referred to as Special Management Areas and include naturally vulnerable areas, potential problem areas, and wellhead protection areas. Naturally vulnerable areas include those identified as being vulnerable to contamination or critical groundwater recharge areas, either to deep or shallow groundwater aquifers. All of the Village of Wind Point and a portion of neighboring Caledonia were determined by the study to include areas that are highly vulnerable to potential contamination (Figure 48), due predominantly to shallow depth to aquifer. Additionally,

the southern portion of the watershed that falls generally within Racine and the Village of North Bay were determined to be moderately vulnerable where low soil percolation compensates for shallow depths to aquifer.

Potential problem areas are places where naturally vulnerable areas overlap areas where potential contaminant sources are located. For the Wind Point watershed, much of the Wind Point area and area surrounding and including North Bay fall within this category.

Finally, wellhead protection areas can be determined in order to protect municipal wells within the shallow aquifer. Wisconsin Administrative Code NR 881 requires a Wellhead Protection Plan for all municipal water supply wells built since 1992, with voluntary compliance for existing wells prior to that date. These plans are meant to delineate and protect the area of land that supplies groundwater to a well, as determined by hydrogeologic analysis (SEWRPC, 2002).

Well contamination is a real concern for southeastern Wisconsin. In January of 2013, Wisconsin Department of Natural Resources (WDNR) began

investigating the extent of well contamination in the region, which included parts of Caledonia within Wind Point watershed. Both public and private wells were affected by molybdenum and boron levels exceeding the state groundwater standard (Bergquist, 2013). WDNR completed an initial investigation into the sources of the contaminants and could not identify the source of the molybdenum and that the data on boron suggested that neither We Energies coal ash landfills nor the Hunts Landfill is the origin of the boron. WDNR recommends that private well owners in Caledonia have their water tested for molybdenum along with their recommended annual testing for bacteria and nitrates (WDNR, 2013).

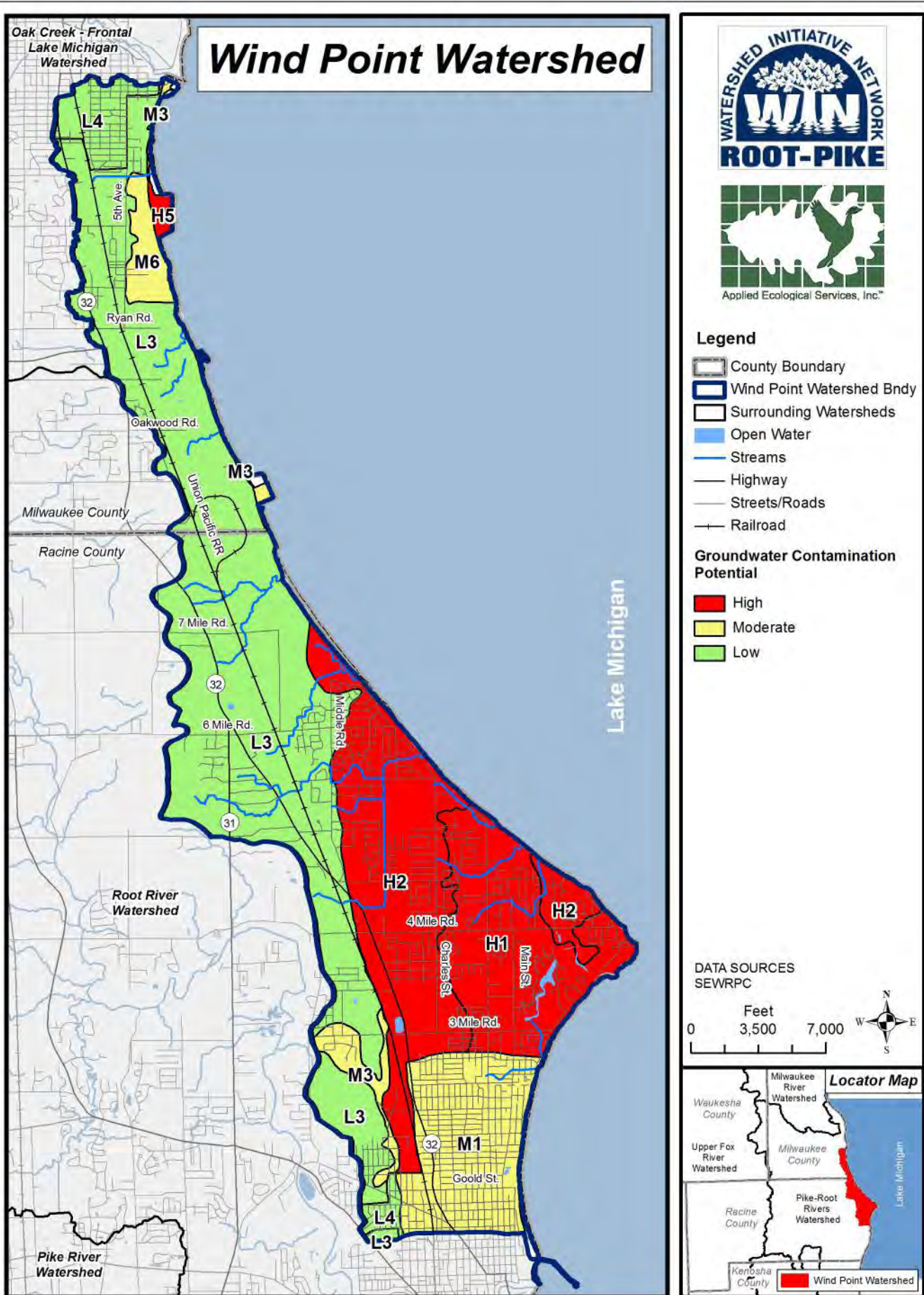
Community Water Supply

Groundwater is an essential resource to the southeastern Wisconsin region as underlying aquifers provide the drinking water supply for many people. According to a WDNR well inventory within in Wind Point watershed, there are 87 private drinking water wells with depths ranging from 83 to 325 feet, with an average depth of 155 feet. Seven (7) public water supply wells are located within Wind Point watershed but only four are active (Table 21).

Table 21. Public water supply wells within Wind Point watershed.

Well ID	Facility	Depth (ft)	Well Status	Casing Diameter
BG740	Racine Crestview San District	1,200	Permanently Filled	12
BG741	Caledonia Water Utility – Village	1,500	Inactive	12
FG771	Northside Calvary Church	N/A	Active	6
FG798	New Hope Lutheran Church	N/A	Active	6
FG805	East Side Community Center	N/A	Active	7
FG811	Prince of Peace Lutheran Church	N/A	Permanently Filled	6
GU727	Johnsons Bar	N/A	Active	6

Source: Wisconsin Department of Natural Resources – Well Inventory





4.0 Water Quality Assessment

4.1 Point and Nonpoint Source Water Quality Pollutants

Water quality can be adversely affected by both point and nonpoint source pollutants.

Point sources are identified as any discharge that comes from a pipe or permitted outfall, such as municipal and industrial discharges. Municipal and industrial discharges within Wind Point watershed are regulated by Wisconsin's stormwater runoff permits. There are two municipal wastewater treatment plant outfalls in the watershed both located on Lake Michigan in the Cities of Oak Creek and South Milwaukee. Many stormwater discharges are located throughout the Wind Point watershed; however, the location of each discharge is not available for this study.

Wisconsin WPDES Permit Program

Section 402 of the federal Clean Water Act established the National Pollutant Discharge Elimination System. This program regulates point source discharges of pollutants into United States waters and sets specific limits on discharges from point sources, establishes monitoring and reporting requirements, and establishes exceptions. The permitting program is designed to prevent storm water runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters. It also allows for the USEPA to authorize states to assume many of the permitting, administrative, and enforcement responsibilities of the program (USEPA, 2012).

The Wisconsin Department of Natural Resources (WDNR) developed the Wisconsin Pollutant Discharge Elimination System (WPDES) Storm Water Discharge Permit Program which is administered under the authority of ch. NR 216, Wis. Adm. Code. The WPDES Storm Water Program regulates the discharge of storm water from construction sites, industrial facilities, and municipal separate storm sewer systems (MS4s).

Individual WPDES permits are issued to municipal and industrial facilities discharging to surface water and/or groundwater. General permits are issued for specific categories of industrial, municipal and other wastewater discharges. Municipal Separate Storm Sewer System (MS4) permits require municipalities to reduce polluted storm water runoff by implementing storm water management programs with best management practices. The MS4 permits usually do not contain numerical effluent limits like other WPDES permits (WDNR, 2012).

WPDES Permit Sites

There are two wastewater treatment plant outfalls located in the northern portion of the watershed along Lake Michigan: the South Milwaukee Wastewater Treatment Facility in South Milwaukee and South Shore Wastewater Treatment Plant in Oak Creek (Figure 49). The South Milwaukee facility is owned and operated by the South Milwaukee while the South Shore facility is operated by Milwaukee Metropolitan Sewerage District (MMSD). Both plants discharge directly to Lake Michigan. In addition, fourteen industrial permit sites are located throughout the watershed (Table 22).

The South Milwaukee Wastewater Treatment Facility began as a primary treatment facility constructed in 1936. In 1970, a secondary treatment facility was constructed and in 1985 a new aeration system was installed. A 2.8 million gallon sludge storage dome and a ultra-violet disinfection system

were added in 1996. The treatment plant currently treats over 4 million gallons of wastewater every day.

The South Shore Wastewater Treatment Plant is located along Lake Michigan in the City of Oak Creek and began operation in 1968. What is unique about this plant is that biosolids are sent to anaerobic digesters where microorganisms convert a large part of the biosolids into methane gas which is collected and burned to produce electricity for the plant.

Nonpoint Source Pollutants

Nonpoint source pollutants are

pollutants that enter a waterway from a source other than a pipe or permitted outfall. Historically these pollutants are the most difficult to control because tracking them back to their source is difficult. Nonpoint source pollutants can include, but are not limited to, illicit discharges into waterways, excess nutrients (such as nitrogen and phosphorus), oils and chemicals washed off of roadways (such as chlorides from deicing agents), and/or excess sediment (from construction sites or streambank destabilization). Most nonpoint source pollutants are monitored via physical-chemical water quality testing.

Below: South Shore Wastewater Treatment Plant (Source: Google Maps). Far right: South Milwaukee Wastewater Treatment Plant (Source: Google Maps).





Table 22. WPDES permitted sites in Wind Point watershed.

Permit ID	Site Name	Municipality	Permit Type
S067857	We Energies Oak Creek Power Plant	Oak Creek	Storm Water Industrial Tier 2
S067849	Mid-America Steel Drum Co Inc	Oak Creek	Storm Water Industrial Tier 1
S067857	Cooper Power Systems Inc	S. Milwaukee	Storm Water Industrial Tier 2
S067857	Everbrite Inc	S. Milwaukee	Storm Water Industrial Tier 2
WI-0036820-03-0	South Shore Wastewater Treatment Plant	Oak Creek	Municipal Permit
WI-0047341-04-0	S. Milwaukee Wastewater Treat. Facility	S. Milwaukee	Municipal Permit
S067857	Knapp Mfg	Caledonia	Storm Water Industrial Tier 2
S067849	E C Styberg Engineering Co Inc	Racine	Storm Water Industrial Tier 1
S067857	Racine Container	Racine	Storm Water Industrial Tier 2
S067857	Hi-Standard Machining Co Inc	Racine	Storm Water Industrial Tier 2
S067849	Met Tek Inc	Racine	Storm Water Industrial Tier 1
S067857	Michaels Machine Co Inc	Racine	Storm Water Industrial Tier 2
S067857	John H Batten Airport	Racine	Storm Water Industrial Tier 2
S067857	S C Johnson Wax Aviation Department	Racine	Storm Water Industrial Tier 2
46515	Vulcan Materials Co Racine Quarry	Racine	Nonmetallic Mining Operations
S049158	Wiscon Products Inc	Racine	Storm Water Industrial Tier 3

4.2 Water Quality Report, Designated Use, & Impairments

The Federal Clean Water Act requires Wisconsin and all other states to submit to the United States Environmental Protection Agency (USEPA) a biannual report of the quality of the state's surface and groundwater resources and an updated Section 303 (d) list. *The Wisconsin Water Quality Report to Congress – Year 2012* was compiled by the Wisconsin Department of Natural Resources (WDNR's) Water Division and is the most recent of these reports. These reports must also describe how Wisconsin assessed water quality and whether assessed waters meet or do not meet water quality standards specific to each "Designated Use" of a stream or lake as defined in chs. NR 102, 104, and 105 of the Wisconsin Administrative Code. When a waterbody is determined through biological and/or physical-chemical sampling to be impaired, WDNR must list potential causes and sources for impairment in the 303 (d) impaired waters list.

WDNR developed four general Designated Uses which define the goals for a waterbody for all Wisconsin surface waters: Fish and Aquatic Life, Recreational Use, Public Health and Welfare, and Wildlife. Each designated

use is associated with particular water quality criteria that are either numeric or narrative in nature and set the standards a waterbody must meet in order to protect the intended use.

The Fish and Aquatic Life use designation is appropriate for the protection of fish and other aquatic life and is subdivided into further categories – coldwater, warmwater sport fish, warmwater forage fish, limited forage fish, and limited aquatic life. The recreational use designation means a stream is appropriate for recreational use unless a sanitary survey has been completed to show that humans are unlikely to participate in activities requiring full body immersion. The Public Health and Welfare use designation means it is appropriate to protect for incidental contact and ingestion by humans. Finally, the Wildlife use designation means it is appropriate to protect wildlife that relies directly on the water to exist or rely on it to provide food for existence (WDNR, 2012).

Wisconsin also utilizes an anti-degradation policy as a component of protecting waters. This policy is aimed at ensuring that high quality waters are prevented from being degraded by identifying them as either Outstanding Resource Waters

or Exceptional Resource Waters. No waterbodies within Wind Point watershed have been classified as either Outstanding or Exceptional Resource Waters.

According to WDNR's 2012 Water Quality Report and Section 303d List (WDNR, 2012), none of the tributary streams in Wind Point watershed are listed as impaired for any of their "Designated Uses" because they have not been assessed by WDNR. However, the findings of this report combined with water quality sampling results suggest moderate impairment of the tributary streams caused by channelization, streambank erosion, draining of wetlands, and high phosphorus and E. coli in agricultural and urban stormwater runoff.

None of the tributaries in Wind Point watershed have been assessed for designated uses by the WDNR. This means that all of the tributaries are classified as default FAL (fish and aquatic life) waters and assumed to support either a coldwater community or warmwater community depending on water temperature and habitat. Currently there are no Designated Use Impairments for the tributaries in Wind Point watershed.

4.3 Physical, Chemical, and Biological Water Quality Monitoring

In Wisconsin, physical, chemical, and biological monitoring, habitat monitoring are all used to assess the health of streams and to determine water quality condition and/or impairment. Fish Indices of Biological Integrity and Macroinvertebrate Indices of Biological Integrity are used to assess the biological health

of streams. Biological data is augmented by the physical-chemical sampling results obtained in the field. Several macroinvertebrate surveys have been conducted and many of the nonpoint source pollutants have been tested for via physical-chemical water quality samples conducted at various sites along the tributaries, stormwater outfalls, and Lake Michigan within and along Wind Point watershed.

Table 23 lists all known physical-chemical and biological data collected in the watershed from 2008 to late 2013 while Figure 49 displays the location of each sample site where the data was collected. In general, the most recent data is analyzed and averaged so that recommendations and management strategies are based on the most current depiction of the water quality and biological conditions.

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Table 23. List of most recent chemical, biological, and microbial water quality sample sites from 2008 to 2013.

Site ID	Location	Date(s)	Water Quality and other Parameters
WDNR-1	Rocky Creek	6/28/08, 7/20/08, 9/6/08, 9/27/08, 5/30/09, 6/21/09, 8/1/09, 9/6/09, 9/27/09, 5/15/10, 6/25/10, 7/31/10 8/21/10, 9/12/10, 10/9/10, 5/30/11, 6/25/11, 7/23/11, 10/9/11, 4/28/13, 7/13/13	DO, DO Sat, pH, Temp, Transparency
WDNR-2	Dominican Creek at Lake Michigan	3/14/09, 5/2/09, 6/21/09, 9/6/09, 7/3/10, 8/7/10, 8/22/10, 9/12/10, 10/10/10, 5/30/11, 6/25/11, 7/23/11, 3/25/12, 4/1/12, 6/5/12, 6/17/12, 8/23/12, 10/21/12, 4/28/13, 6/22/13, 7/14/13	DO, DO Sat, pH, Temp, Transparency
WDNR-3	Sienna Center Creek At Lake Michigan	6/22/08, 7/20/08, 9/6/08, 9/28/08, 10/25/08, 11/1/08, 5/2/09, 6/21/09, 7/18/09, 9/7/09, 9/27/09, 5/15/10, 7/3/10, 8/7/10, 8/22/10, 9/12/10, 10/10/10, 4/9/11, 5/30/11, 6/25/11, 7/23/11, 9/11/11, 3/25/12, 6/3/12, 7/21/12, 8/23/12, 9/16/12, 10/21/12, 4/28/13, 6/22/13	DO, DO Sat, pH, Temp, Transparency
WDNR-4	Unnamed tributary to Lake Michigan at 4 Mile Rd	6/30/12, 7/7/12, 7/21/12, 8/11/12, 8/25/12, 9/8/12, 9/23/12	DO, DO Sat, pH, Temp, TP, Transparency
WDNR-5	Prairie Stream South	7/9/11, 7/23/11, 8/6/11, 8/20/11, 9/3/11, 6/16/12, 6/30/12, 7/7/12, 7/21/12, 8/11/12, 8/25/12, 9/8/12, 9/23/12, 6/8/13, 6/22/13, 7/13/13	DO, DO Sat, pH, Temp, TP, Transparency
WDNR-6	Prairie Stream at Lake Michigan	7/23/11, 8/6/11, 8/20/11, 9/3/11, 4/20/12, 6/16/12, 6/30/12, 7/7/12, 7/21/12, 8/11/12, 8/25/12, 9/23/12, 4/19/13, 6/8/13, 6/22/13, 7/13/13	DO, DO Sat, pH, Temp, TP, Transparency
RHD-1	WWTPS and Marina Rd.	2013: 1/8/, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/7, 2/14, 2/18, 2/21, 2/25, 3/4, 3/7, 311, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, /14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-2	5th Ave. S of Edgewood Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-3s	Bender Park Bridge	2013: 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP
RHD-3	Bender Park Creek	2013: 1/10, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP
RHD-4	Oakwood Rd at WE Energies	2013:1/21, 2/18, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-5	WE Energies – Rifle Range	2013: 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-6	WE Energies - 7 Mile Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP
RHD-7s	Cliffside Trib: South (Cliffside Park Upstream)	2013: 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 3/4, 3/7, 3/11, 3/14, 3/18	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i>
RHD-7	Cliffside Park Mouth	2013: 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5/, 11/7, 11/12	AAir temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-8	Rocky Creek at Novak Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-9	Crestview at 5 ½ Mile Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-10	Klema Ditch at 5 ½ Mile Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 3/4, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-11	Harvest Lane Branch	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/24, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-12	Matthew Drive Branch	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/24, 10/31, 11/7, 11/14	Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI

Site ID	Location	Date(s)		Water Quality and other Parameters
RHD-13	Klema Ditch at 4 ½ Mile Rd.	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-14	Dominican Creek	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 3/4, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-15	Siena Center North - Erie	2013: 1/28, 2/14, 2/18, 3/4, 3/11, 3/14, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/24, 10/31, 11/7, 11/14		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-16	Birch Creek - Valley	2013: 1/28, 2/14, 2/18, 3/4, 3/11, 3/14, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/24, 10/31, 11/7, 11/14		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS
RHD-17	Prairie Stream at Shoop Park	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-18	Sheffield Court	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-19	Parkway Creek	2013: 1/8, 1/10, 1/15, 1/17, 1/21, 1/24, 1/28, 1/31, 2/4, 2/7, 2/11, 2/14, 2/18, 2/21, 2/25, 2/28, 3/4, 3/7, 3/11, 3/14, 3/18, 3/21, 3/25, 4/1, 4/4, 4/8, 4/11, 4/15, 4/22, 4/25, 4/29, 5/2, 5/6, 5/9, 5/13, 5/16, 5/21, 5/23, 5/29, 6/3, 6/5, 6/10, 6/12, 6/17, 6/19, 6/24, 6/26, 7/1, 7/3, 7/8, 7/10, 7/15, 7/17, 7/22, 7/24, 7/29, 7/31, 8/5, 8/7, 8/12, 8/14, 8/19, 8/21, 8/26, 8/28, 9/3, 9/5, 9/9, 9/17, 9/19, 9/24, 9/26, 10/1, 10/3, 10/8, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, DO Sat, DO Conc., pH, Cond., Turb., <i>E. coli</i> , TP, NO2+NO3, TSS, IBI
RHD-A	Pier (outfall)	2013: 6/26, 7/10, 7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 11/7, 11/14		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-B	BP1 (outfall)	2013: 6/26, 7/10, 7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 11/7, 11/14		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-C	BP2 (outfall)	2013: 6/26, 7/10, 7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 11/7, 11/14		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols
RHD-D	Charles (outfall)	2013: 6/26, 7/10, 7/17, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/24, 10/31, 11/7, 11/14		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-E	3 Mile (outfall)	2013: 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-F	Lighthouse (outfall)	2013: 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols
RHD-G	Lombard (outfall)	2013: 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols
RHD-H	Wolff (outfall)	2013: 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-I	Augusta (outfall)	2013: 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols
RHD-J	IEB (outfall)	2013: 5/23, 5/30, 6/6, 6/13, 6/20, 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
RHD-K	English St. (outfall)	2013: 5/23, 5/30, 6/6, 6/13, 6/20, 6/27, 7/11, 7/18, 7/24, 7/31, 8/7, 8/14, 8/21, 8/28, 9/5, 9/17, 9/26, 10/3, 10/10, 10/22, 10/29, 11/5, 11/7, 11/12		Air temp, water temp, pH, Cond., Turb, <i>E. coli</i> , Cl, detergent, Cu, phenols, TSS, TP, NO2+NO3
KEY:	DO = dissolved oxygen	DO Sat = dissolved oxygen saturation	Turb = turbidity	Cl = chlorine
	TP = total phosphorus	NO2+NO3 = nitrate and nitrite nitrogen	TSS = total suspended solids	Cu = copper
	IBI = Index of Biotic Integrity	Cond.= specific conductivity	pH=acid/base scale	

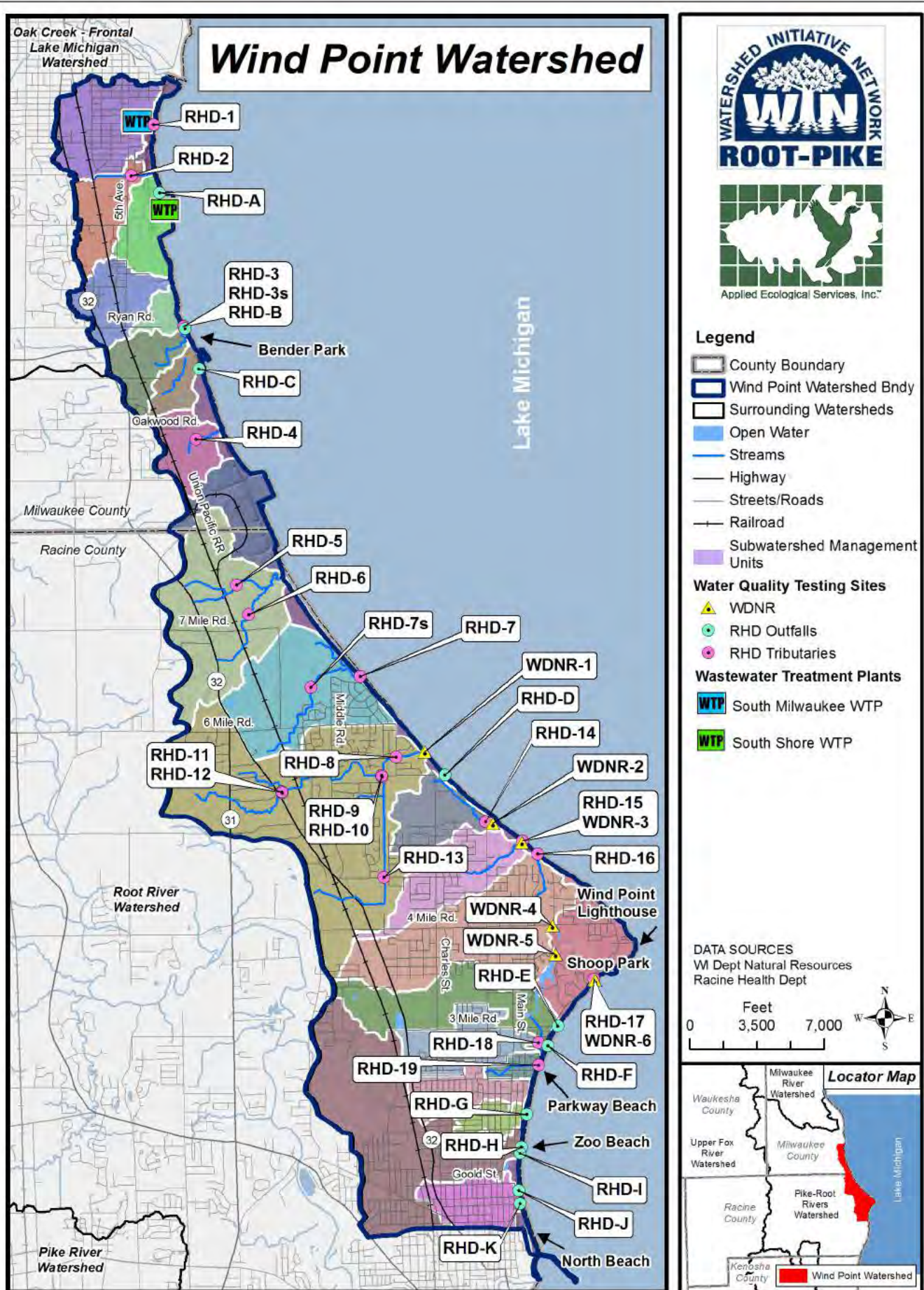


Fig. 49: Water Quality Testing Sites

Numeric Water Quality Standards

USEPA has tasked states to establish *numeric* water quality standards for nutrients (phosphorus and nitrogen) in lakes and streams. Currently, Wisconsin has a numeric phosphorus standard and is working on developing nitrogen criteria for streams by 2015. To date, Wisconsin has not developed *numeric* standards for chlorides, specific conductivity, turbidity, total suspended solids, inorganic nitrogen, kjeldahl nitrogen, and ammonia in streams. *Numeric* criteria have been proposed by USEPA for nutrients based on a reference stream method for the Corn Belt and Northern Great Plains Ecoregion (VI) which includes Wind Point watershed and the USEPA has also established general national guidelines for other criteria.

The USGS has published a document outlining recommended *numeric* criteria for sediment in streams for Ecoregion VI. These reference criteria are used in this report to assess the quality of Wind Point watershed tributaries to develop pollution reduction targets and measure future successes, even though Wisconsin has not adopted these criteria as standards.

Water Chemistry Monitoring

None of the tributary streams in Wind Point watershed are listed as impaired for any of their "Designated Uses" because they have not been assessed by WDNR. However, both chemical-physical and biological water quality sampling results suggest at least moderate impairment of the tributary streams caused by channelization, streambank erosion, draining of wetlands, and high nutrient and *E. coli* in agricultural and urban stormwater runoff.

Table 24 summarizes the WDNR water quality sample results for Wind Point watershed from 2008 to 2013 and also provides statistical and numerical guidelines for the various criteria. This data meets the data quality guidelines as determined by "WDNR Quality Management Program" and are equivalent to the EPA Quality Assurance Program Plan, including sampling techniques and use of qualified laboratories (WisCalm, 2012). Wisconsin provides numeric guidelines within its administrative code for temperature, dissolved oxygen, pH, and phosphorus within NR 102. Wisconsin has not yet derived their own guidelines for

the remaining criteria so national standards were utilized. Criteria for specific conductivity, turbidity, and nitrogen reference general guidelines set forth by the USEPA for the nation or relevant ecoregion where applicable. The United States Geological Survey (USGS) provided the reference conditions for total suspended solids.

Baseline water quality monitoring data was collected by the Racine Health Department, under the direction of Dr. Julie Kinzelman, from December 2012 through December 2013 (see Appendix D for Racine Health Department water quality data and report). Monitoring stations were selected along nineteen tributary sites, eleven stormwater outfalls, and at six Lake Michigan surface water beach sites (Figure 49). Data collected included air temperature, water temperature, dissolved oxygen saturation, dissolved oxygen concentration, pH, conductivity, turbidity, *E. coli*, total phosphorus, total suspended solids, and nitrate and nitrite nitrogen. The results of this data are displayed in Tables 25 and 26 and depicted in terms of water quality exceedences on Figure 50.

Table 24. WDNR water quality sample results for Sites WDNR1 - 6. Temperature is shown as a maximum value while all other testing results are displayed as an average of all available testing data from 2008 through 2013.

Parameter	Statistical, Numerical, or General Use Guidelines	Site WDNR-1	Site WDNR-2	Site WDNR-3	Site WDNR-4	Site WDNR-5	Site WDNR-6
Temp (F)	<86° F*	MAX 89.8	83.3	77.9	84.2	82.4	75.6
Dissolved Oxygen (DO)	>5.0 mg/l*	AVG 8.41	7.74	8.24	3.05	7.84	5.34
pH	>6.0 or <9.0*	AVG 7.73	7.58	7.71	7.63	8.31	7.53
Total Phosphorus (TP)	<0.075 mg/L*	AVG -	-	-	5.365	0.310	1.660
Turbidity (converted from cm)	<14 NTU**	AVG <10	<10	<10	185	17	<10

- Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
- Temperature listed as the maximum value available for each site, but testing was not always conducted during summer months. Data does not necessarily reflect the warmest actual values of each site.
* Water Quality Standards for WI Surface Waters NR 102 (2012)
** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VI (USEPA 2000)

Table 25. Racine Health Department water quality sample results for tributaries Sites RHD1 - 19. Temperature is shown as a maximum value; all other results are displayed as an average (mean) of all available site data for 2013.

Parameter	Statistical, Numerical, or General Use Guidelines	Site RHD-1	Site RHD-2	Site RHD-3s	Site RHD-3	Site RHD-4	Site RHD-5	Site RHD-6	Site RHD-7s	Site RHD-7	Site RHD-8	Site RHD-9	Site RHD-10	Site RHD-11	Site RHD-12	Site RHD-13	Site RHD-14	Site RHD-15	Site RHD-16	Site RHD-17	Site RHD-18	Site RHD-19
Temp (F)	<86° F*	MAX 75.2	74.7	-	79.9	70.9	75.2	80.1	-	82.4	80.8	81.3	84.9	81.1	74.8	72.9	73.4	75.9	69.6	80.2	72.9	72.9
Dissolved Oxygen (DO)	>5.0 mg/l*	AVG 10.7	7.1	11.2	9.8	7.0	9.5	10.2	12.5	9.9	10.8	10.1	10.0	11.4	8.6	11.6	8.0	9.6	10.5	9.7	9.1	10.9
pH	>6.0 or <9.0*	AVG 8.1	7.7	7.6	7.9	7.6	7.8	7.7	7.8	8.1	8.0	8.0	7.8	8.0	7.8	7.9	7.7	7.9	8.0	7.9	7.7	7.9
Total Phosphorus (TP)	<0.075 mg/L*	AVG 0.053	1.376	0.025	0.035	0.723	0.167	0.166	-	0.038	0.092	0.071	0.214	0.240	0.197	0.042	0.082	0.096	0.105	0.115	0.668	0.117
Turbidity (converted from cm)	<14 NTU**	AVG 45.9	122.1	7.5	31.9	204.3	93.0	28.7	36.4	60.3	10.1	13.9	22.2	17.9	28.5	26.5	25.6	13.5	8.0	31.9	37.0	14.5
Conductivity	<1,500 µS/cm***	AVG 2079	1,292	577	819	656	1,028	875	1,123	748	1,442	936	1,585	961	1,218	2,343	1,146	1,147	1,279	900	3,483	1,251
Inorganic Nitrogen (NO2+NO3)	<1.798 mg/L**	AVG 0.370	0.026	-	-	0.074	0.151	-	-	0.010	0.176	0.010	0.224	0.052	0.946	0.280	0.265	0.123	2.450	0.339	0.112	0.603
Total Suspended Solids (TSS)	<19 mg/L****	AVG 9.7	692.1	-	-	997.3	54.1	-	-	26.1	3.4	69.7	73.6	121.2	180.4	20.0	80.1	78.0	20.6	11.5	267.3	17.0
E. coli	<235 MPN/100mL*****	AVG 2,931	10,632	60	358	6,581	8,092	4,399	153	1,941	1,521	1,658	630	1,977	1,562	836	4,993	1,806	1,821	713	3,362	1,296

- Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines
- Temperature listed as the maximum value available for each site, but testing was not always conducted during summer months. Data does not necessarily reflect the warmest actual values of each site.
* Water Quality Standards for WI Surface Waters NR 102 (2012)
** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VI (USEPA 2000)
*** USEPA, 2012
**** Present and Reference Concentrations and Yields of Suspended Sediment in Streams in the Great Lakes Region and Adjacent Areas (USGS 2006)
***** WI DNR NR 102.12 (1); (Clayton et al. 2012)

Table 26. Racine Health Department water quality sample results for outfalls Sites RHDA - K. Temperature is shown as a maximum; all other results are displayed as an average (mean) of all available site data for 2013.

Parameter	Statistical, Numerical, or General Use Guidelines	Site RHD-A	Site RHD-B	Site RHD-C	Site RHD-D	Site RHD-E	Site RHD-F	Site RHD-G	Site RHD-H	Site RHD-I	Site RHD-J	Site RHD-K
Temp (F)	<86° F*	MAX 70.2	68.4	66.7	62.6	74.5	70.7	70.7	70.9	70.9	86.9	82.4
pH	>6.0 or <9.0*	AVG 8.2	8.2	7.8	8.0	8.1	8.3	8.3	8.1	8.3	8.0	7.9
Total Phosphorus (TP)	<0.075 mg/L*	AVG 0.099	0.101	-	0.082	0.028	-	-	0.172	-	0.014	0.019
Turbidity (converted from cm)	<14 NTU**	AVG 9.1	34.4	124.0	1.9	5.6	45.9	52.4	72.7	44.9	2.5	6.2
Conductivity	<1,500 µS/cm***	AVG 1,557	697	628	1,144	1,527	504	464	498	301	747	1,172
Nitrate plus Nitrite Nitrogen NO2+NO3	<1.798 mg/L**	AVG 0.508	0.010	-	1.045	0.897	-	-	0.434	-	0.021	0.018
Total Suspended Solids (TSS)	<19 mg/L****	AVG 38.7	229.3	-	3.8	26.1	-	-	17.7	-	10.1	2.3
<i>E. coli</i>	<235 MPN/100mL*****	AVG 2,429	1,825	1,610	4,333	1,090	154	1,569	723	91	1,118	500
Chlorine	≥0.1 mg/L*****	AVG 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Detergent	≥0.25 ppm*****	AVG 0.16	0.07	0.10	0.10	0.11	0.09	0.09	0.08	0.05	0.07	0.09
Phenols	≥0.25ppm*****	AVG 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	>0.2 mg/L*X*****	AVG 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

- Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines

- Temperature listed as the maximum value available for each site, but testing was not always conducted during summer months. Data does not necessarily reflect the warmest actual values of each site.

* Water Quality Standards for WI Surface Waters NR 102 (2012)

** Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VI (USEPA 2000)

*** USEPA, 2012

**** Present and Reference Concentrations and Yields of Suspended Sediment in Streams in the Great Lakes Region and Adjacent Areas (USGS 2006)

***** WI DNR NR 102.12 (1); (Clayton et al. 2012)

***** NR105.06; Brown et al, 2004

***** Brown et al, 2004

***** NR 105.06; (AECOM,2009)

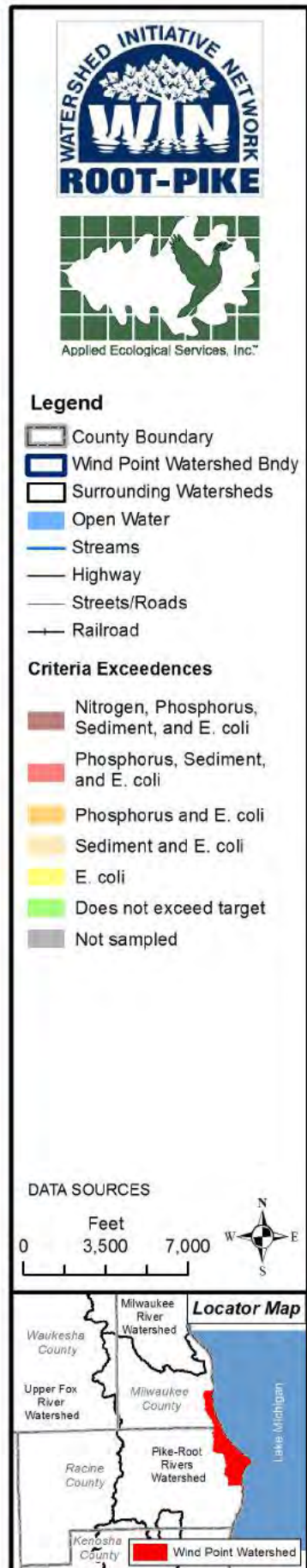
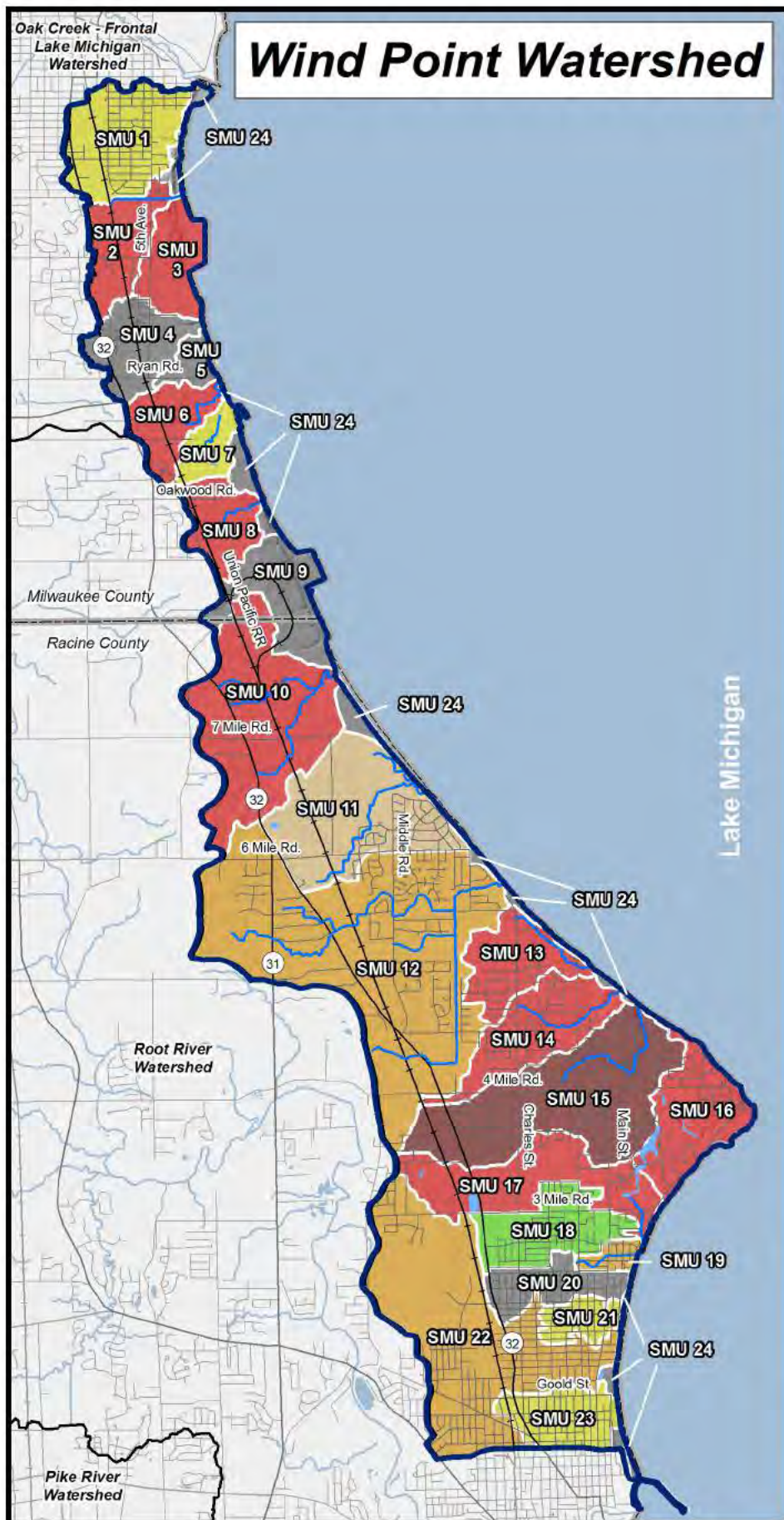


Fig. 50: Water Quality Criteria Exceedences

While nitrogen only exceeds the target in one subwatershed management unit (SMU), phosphorus, sediment and *E. coli* seem to be an issue throughout the watershed. Additionally, within the subwatersheds that exceed the targets for phosphorus, sediment, and *E. coli*, samples not only exceed the target, but are often substantially higher than target recommendations. Figures 51, 52, and 53 depict not only which subwatersheds exceed the targets for each criteria, but also show to what extent those targets are exceeded. Not only do twelve SMUs exceed the target for phosphorus, but four of them are averaging more than double the guideline and one SMU is averaging more than ten times the standard (Figure 51). Ten SMUs exceed the target guidelines for sediment with 4 of these SMUs testing an average of double the standard and another 4 testing at over ten times the sediment guideline (Figure 52). Finally, for *E. coli* all but one of the SMUs exceeded the recreational standard with 11 of these testing at more than double the standard and 7 of the SMUs testing at more than ten times the standard (Figure 53).

Nutrients such as phosphorus and nitrogen are a necessary component of plant growth and are therefore included in many fertilizers. Unfortunately, both have adverse effects on water quality, with phosphorus being particularly detrimental to aquatic systems in

excess quantities. These nutrients are applied as fertilizer, either in an agricultural setting or by applicators or residents and the excess nutrients not absorbed by plants are then washed into waterways. Excess nutrients can cause algal blooms, accelerated plant growth, decreasing oxygen levels, and can lead to fish kills. Currently there is no Wisconsin state standard for nitrogen; however the USEPA recommends a concentration of less than 1.798 mg/l. The Wisconsin state standard for total phosphorus in rivers and streams is less than 0.075 mg/L.

The ability to control erosion and excess sediment, and thereby total suspended solids, in waterways can be linked to the control of how development is handled as well as the condition of streambanks in the watershed. The construction process generally involves significant land disturbance and ecosystem destruction. The grading of sites, removal of vegetation, rerouting of natural drainage systems, and the addition of impervious surfaces, such as roads and parking lots, all interfere with water quality both in the short and long term. Removing vegetation and trees near the stream or floodplain removes the stability of the soil and increases bank erosion and sedimentation to nearby waterways. Alteration of natural drainage patterns can also significantly reduce the ability of the ecosystem to compensate for such increase in contaminants and sedimentation.

Eroding streambanks also contribute additional sediments, particularly during and after rain events as peak flows scour away banks. High suspended sediment levels are problematic when light penetration is reduced, oxygen levels decrease, fish and macroinvertebrate gills are clogged, visual needs of aquatic organisms is reduced, and when sediment settles out in streams and lakes. There is no Wisconsin state guideline for total suspended solids, but the United States Geological Survey (USGS) recommends TSS do not exceed 19 mg/l for streams in the Wind Point watershed.

E. coli is used as an indicator that a waterbody is contaminated by sewage which could carry other possible pathogens such as bacteria, viruses, and protozoans. While potential pathogens are too numerous to test for individually, the USEPA recommends *E. coli* testing "as the best indicator of health risk from water contact in recreational waters (USEPA, 2012)." Not only does the presence of excessive *E. coli* counts suggest there is a possible health risk in recreational contact with those waters, but the bacteria "can also cause cloudy water, unpleasant odors, and an increased oxygen demand (USEPA, 2012)." The Wisconsin state standard for recreational waters requires that *E. coli* levels do not exceed 235 most probable number per 100 ml of sample (MPN/100 ml).

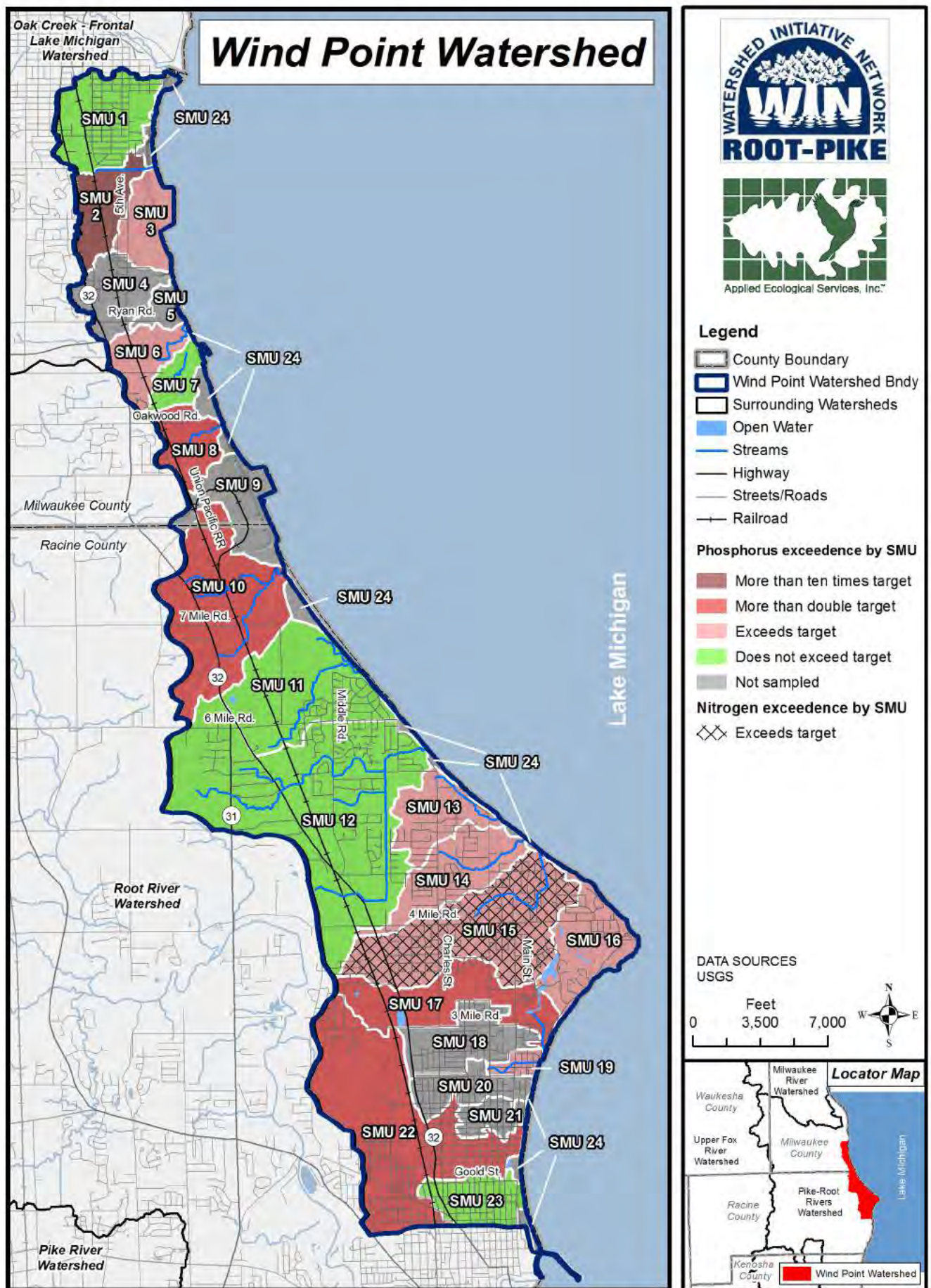
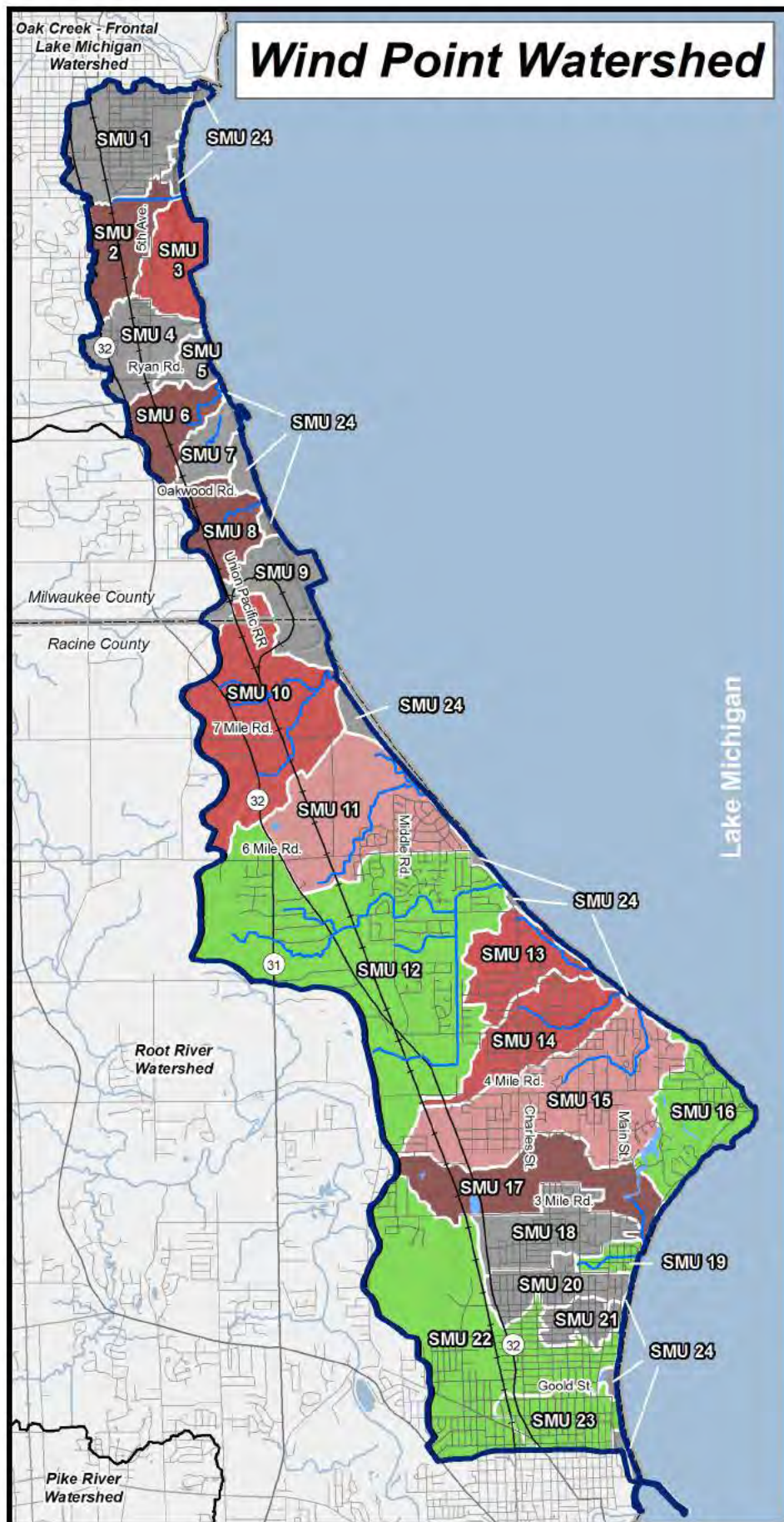


Fig. 51: Phosphorus and Nitrogen Exceedence by SMU



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

TSS exceedence by SMU

- More than ten times target
- More than double target
- Exceeds target
- Does not exceed target
- Not sampled

DATA SOURCES
USGS

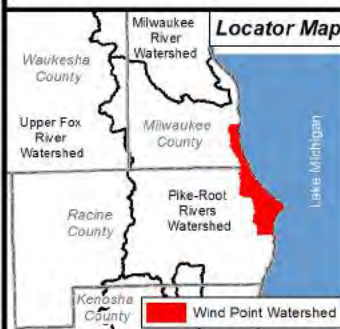
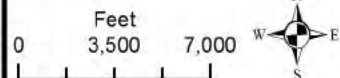
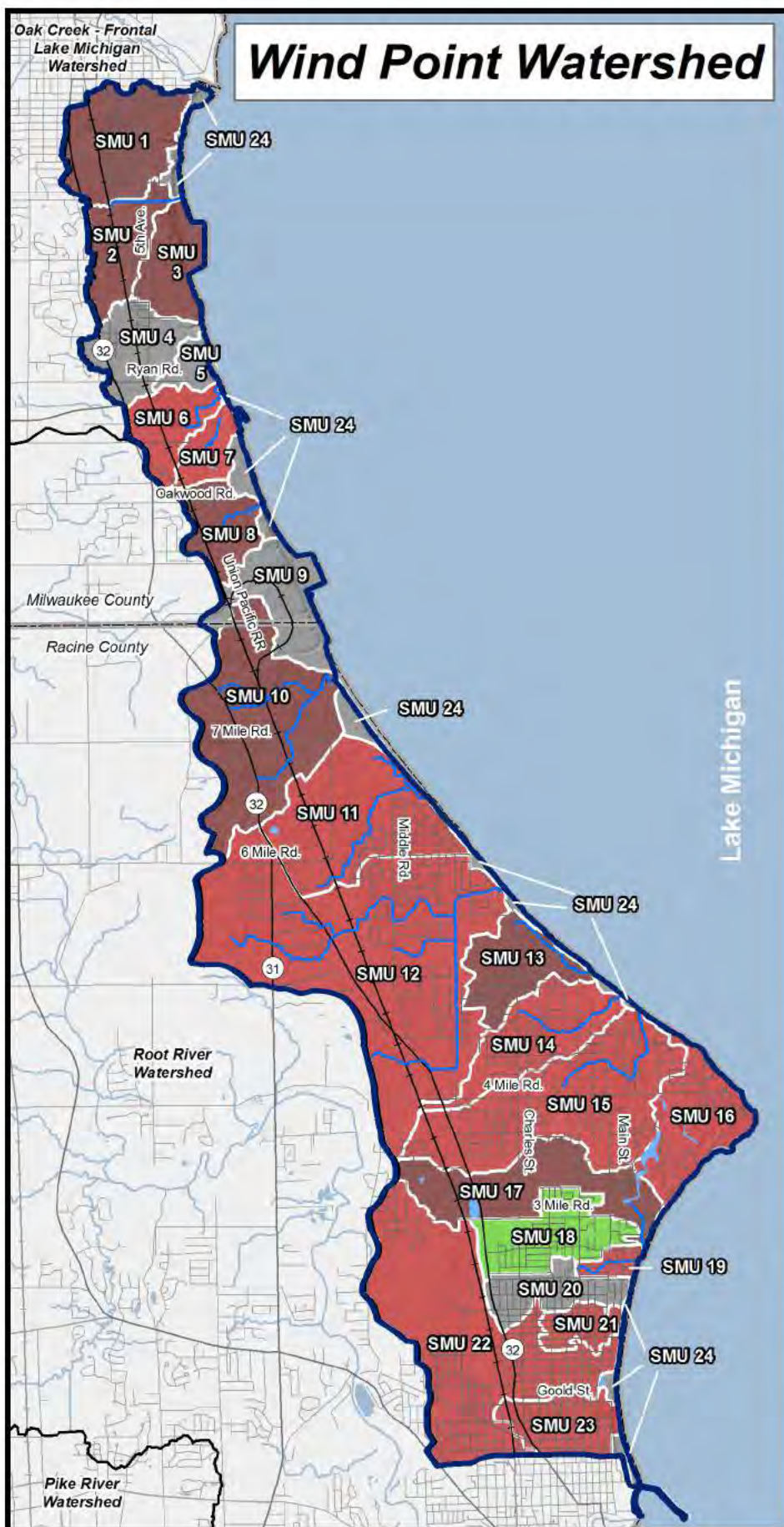


Fig. 52: TSS Exceedence by SMU



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

E. coli exceedence by SMU

- More than ten time target
- More than double target
- Exceeds target
- Does not exceed target
- Not sampled

DATA SOURCES
USGS

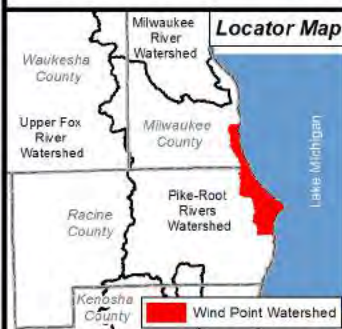
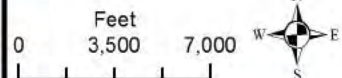


Fig. 53: E. coli Exceedence by SMU

In order to determine watershed-wide reduction targets, pollutant values across the watershed were calculated as a weighted average according to the size of each subwatershed. To summarize these results, while nitrogen sampling exceeds the target at one location, for the watershed as a whole the weighted average of nitrogen values is 0.445 mg/L, which is well under the 1.798 mg/L standard. The average total phosphorus value for the whole watershed is 0.188 mg/L, or more than twice the standard of 0.075 mg/L. The weighted average for total suspended solids across the watershed is 85.8 mg/L while the standard is less than 19mg/L. Finally, the weighted average of E. coli values in Wind Point watershed is 2,417 MPN/100mL which is over ten times the standard of less than 235 MPN/100mL. Reduction targets are discussed in more detail in Section 5.0.

Biological Monitoring

Biological data can be used alone or in conjunction with physical-chemical data to make a water

quality impairment assessment on a waterbody in Wisconsin. An index of biotic integrity is one method of assessing biological health and water quality through several attributes of fish or macroinvertebrate communities found in streams. Macroinvertebrate data for Wind Point watershed was available for review. No know stream fish surveys have been completed.

Macroinvertebrate samples were taken by the Racine Health Department throughout Wind Point watershed and evaluated based on the family-level biotic index (FBI) developed by W. Hilsenhoff of the University of Wisconsin (Hilsenhoff, 1988). The FBI is designed to rate water quality using the pollution tolerance of macroinvertebrates and human impacts as an estimate of the degree and extend or organic pollution and disturbance in streams. Following data collection, macroinvertebrates are identified and given a predetermined pollution tolerance rating. The FBI is calculated by taking an average of tolerance ratings weighted by the

number of individuals in the sample. Using this system, FBI scores less than 3.75 indicates the likelihood of having excellent water quality while scores greater than 7.26 suggest very poor water quality. Table 27, below, depicts the evaluation of water quality based on the family-level biotic index scoring criteria.

Racine Health Department conducted a total of eleven macroinvertebrate FBI surveys across Wind Point watershed in 2013. The locations and results of these surveys are detailed in Table 28. Of the eleven surveys, one was ranked as Fairly Poor and ten were ranked as Very Poor. Most of the streams within Wind Point watershed are considered intermittent (they are dry for part of the year) which would be a likely cause of the low FBI scores overall. Other factors contributing to these low rankings could include any combination of the following: the pollutants identified in the physical-chemical surveys, stream habitat changes, and/or riparian vegetation changes.

Table 27. Evaluation of water quality using the family-level biotic index (FBI).

Score	Water Quality	Degree of Organic Pollution
0.00-3.75	Excellent	Organic pollution unlikely
3.76-4.25	Very good	Possible slight organic pollution
4.26-5.00	Good	Some organic pollution probable
5.01-5.75	Fair	Fairly substantial pollution likely
5.76-6.50	Fairly poor	Substantial pollution likely
6.51-7.25	Poor	Very substantial pollution likely
7.26-10.0	Very poor	Severe organic pollution likely

Source: Hilsenhoff, 1988.

Table 28. 2013 macroinvertebrate sampling and family biotic indexing, Racine Health Department.

Biotic Indexing Results by Site in Wind Point Watershed																												
09/30/2013 - 11/04/2013																												
Site Number	Site	Ephemeroptera					Plecoptera		Trichoptera		Mollusca		Diptera		Coleoptera		Family Biotic Index											
		Caenidae	Ephemerellidae	Ephemeridae	Heptageniidae	Siphonuridae	Perlidae	Perlodidae	Plecoptera	Hydropsychidae	Leptoceridae	Hemiptera	Decapoda	Lymnaeidae	Physidae	Corydalidae	Chironomidae	Simuliidae	Elmidae	Coleoptera	Hirudinea	Tubellaria	Planorbidae	Bivalvia	Isopoda	Amphipoda	Puparium	
1	WWTPS and Marina Rd.								3				2	1					1				1	146			7.8	
2	5th Ave. S of Edgewood Rd.												1	57					3		1	2	11	7	60		7.9	
7	Cliffside Park Mouth													4					3		1				310		8.0	
8	Rocky Creek at Novak Rd.		5					1							2	1	1		9	3	109				2	176		7.7
10	Klema Ditch at 5 1/2 Mile Rd.					7						1			30				7		20	1	3	150			7.8	
12	Matthew Ln. Branch												11	24				1							5	41	27	7.7
13	Klema Ditch at 4 1/2 Mile Rd.	1			25						1			64					2		7	2	10	156	1		7.5	
15	Siema Center North - Erie	1		3				1	2		1	1		32						1	1		6	98	1		7.7	
16	Birch Creek - Valley	2											1	59							2	2	1	45	25		7.9	
17	Prairie Stream at Shoop Park	2			1								3	30								11	42	111	5		7.8	
18	Sheffield Dr.	1	4										6	112		17					1	2			3		7.6	
Samples sorted by taxonomic order and family. Organism counts are provided by family.																												
Classification and Color Code:		Excellent	Very good	Good	Fair	Fairly poor	Poor	Very poor	Source: See Evaluation of Water Quality Using Family-Level Biotic Index (Table 18)																			

4.4 Beach Water Quality

Wind Point watershed has six beaches: North Beach, Zoo Beach, Shoop Park Beach, Parkway Beach, Wind Point Beach, and Bender Park Beach. Many beaches along Lake Michigan are routinely monitored for *Escherichia coli* (*E. coli*) according to federal criteria set for open waters of the Great Lakes. *E. coli* tests are used as an indicator that fecal matter may be present in the water,

thereby suggesting an elevated risk to people due to harmful bacteria, viruses, or protozoans. When including beaches on the Impaired Waters List, WDNR relies on long-term data defined as long-term geometric mean maximum of 126 colony forming units (cfu)/100 mL, which is consistent with EPA-established criteria and a valid method of recognizing where recreational activities in water might pose chronic risk to human health (WisCALM 2012). None of the beaches within Wind Point

watershed are listed as impaired.

In addition to tributary and outfall monitoring, the Racine Health Department conducted regular testing of the beaches within Wind Point watershed between the end of May and the beginning of September 2013 (Table 29). Note that while North Beach is not currently listed as impaired, the average *E. coli* value at the site was almost double the standard for 2013.

Table 29. Racine Health Department water quality sample results for beaches in Wind Point, late May through the beginning of September 2013.

Parameter	Statistical, Numerical, or General Use Guidelines	Bender Park	Wind Point Light House	Shoop Park	Parkway Beach	Zoo Beach	North Beach
Turbidity (converted from cm)	<14 NTU*	AVG 74.2	37.4	55.3	10.2	-	-
Conductivity	<1,500 μ S/cm**	AVG 310	303	317	309	-	-
<i>E. coli</i>	<235 MPN/100mL***	AVG 200	95	106	68	172	522

- Cells highlighted in red exceed recommended statistical, numerical, or General Use guidelines

* Ambient Water Quality Criteria Recommendations: Rivers and Streams in Nutrient Ecoregion VI (USEPA 2000)

** USEPA, 2012

*** WI DNR NR 102.12 (1); (Clayton et al. 2012)

4.5 Pollutant Loading Analysis

A Wisconsin Department of Natural Resources (WDNR) approved modeling tool known as Source Loading and Management Model for Windows (WinSLAMM) version 9.4.0 was used to estimate the existing nonpoint source load of nutrients (nitrogen & phosphorus) and sediment for Wind Point watershed by individual subwatershed management unit (SMU) for all categories of land use except agricultural. The model evaluates runoff volume and pollutant loading for each SMU according to its land use, impervious surfaces, and utilizes Milwaukee 1969 rainfall data as compiled by the United States Geological Survey (USGS). WinSLAMM, however, does not account for agricultural areas or streambanks so the EPA approved Spreadsheet Tool for Estimating

Pollutant Load (STEPL) model was used in order to model pollutant loading for the agricultural areas and streambanks for each SMU. The models both output average annual pollutant load for each of the land use/cover types. The results of the WinSLAMM and STEPL modeling were then aggregated in order to achieve complete modeling for each SMU. The results of this analysis were used to estimate the total watershed load for nitrogen, phosphorus, and sediment and to identify and map pollutant load “Hot Spot” SMU’s. It is important to note that neither WinSLAMM or STEPL are calibrated models; they also do not estimate *E. coli* loading which is beyond the scope of this watershed plan.

The results of the combined WinSLAMM and STEPL models indicate that existing land use/cover in Wind Point watershed

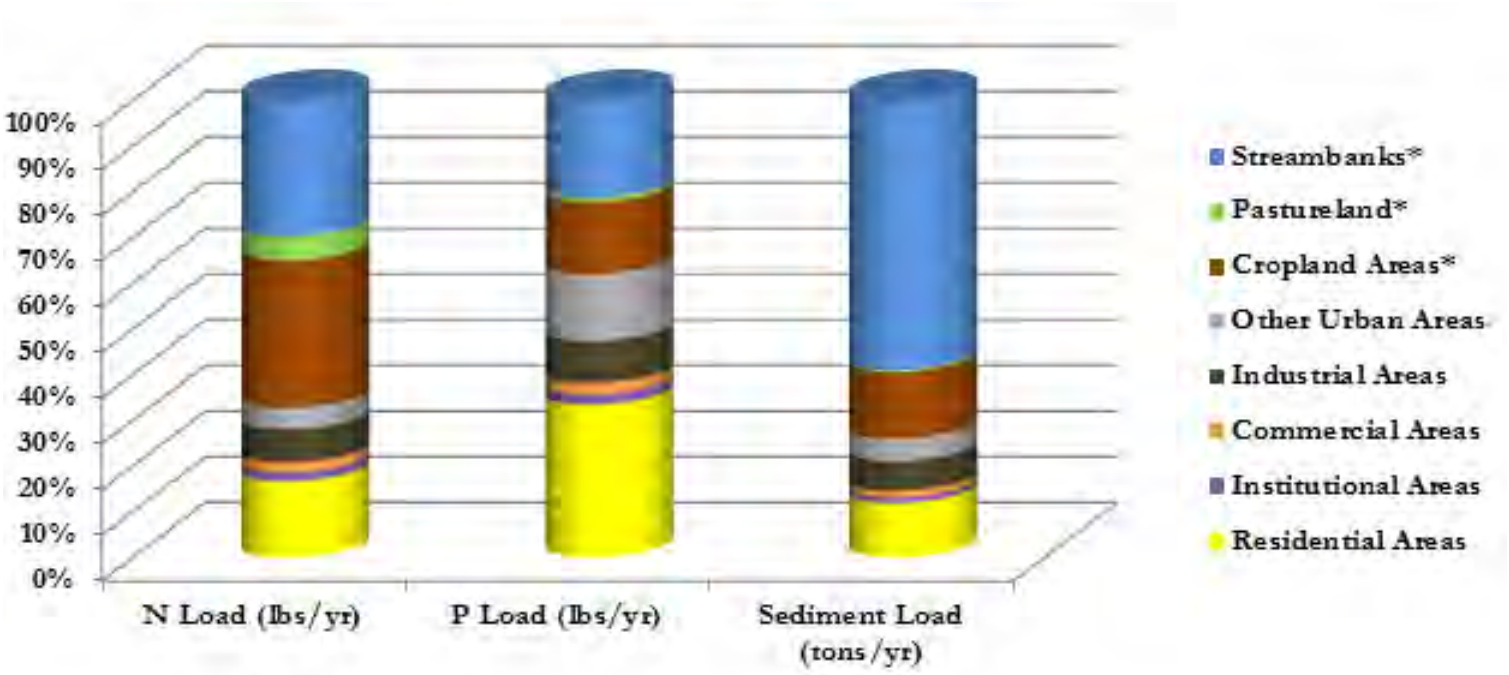
produces 29,807 lbs/yr of nitrogen, 16,058 lbs/yr of phosphorus, and 9,531 tons/yr of sediment (Table 30; Figure 54). Streambank areas contribute the highest sediment load (5,617 tons/yr; 59%) and the second highest nitrogen (8,857 lbs/yr; 30%) and phosphorus (3,410 lbs/yr; 21%) loads in the watershed. Cropland areas contribute the highest nitrogen (9,603 lbs/yr: 32%) load in the watershed, the second highest sediment load (1,386 lbs/yr: 15%), and the third highest phosphorus load (2,523 lbs/yr; 16%). Residential areas contribute the highest phosphorus loads (5,364 lbs/yr: 33%) and third highest loads of nitrogen (4,947 lbs/yr: 17%) and sediment (1,130 tons/yr: 12%). Institutional, commercial, industrial, and other urban areas contribute on a smaller scale to overall pollutant loading. Both WinSLAMM and STEPL Model results can be found in Appendix E.

Table 30. Estimated existing (2012) annual pollutant load by source at the watershed scale based on combined WinSLAMM and STEPL modeling.

STEPL Source	N Load (lbs/yr)	% of Total Load	P Load (lbs/yr)	% of Total Load	Sediment (tons/yr)	% of Total Load
Residential Areas	4,947.2	16.6%	5,364.3	33.4%	1,130.1	11.9%
Institutional Areas	601.2	2.0%	375.4	2.3%	124.2	1.3%
Commercial Areas	648.4	2.2%	387.0	2.4%	134.4	1.4%
Industrial Areas	2,168.7	7.3%	1,480.2	9.2%	622.9	6.5%
Other Urban Areas	1,387.9	4.7%	2,351.8	14.6%	469.8	4.9%
Cropland Areas*	9,603.4	32.2%	2,523.4	15.7%	1,385.7	14.5%
Pastureland*	1,593.7	5.3%	165.9	1.0%	46.7	0.5%
Streambanks*	8,856.6	29.7%	3,409.8	21.2%	5,617.4	58.9%
Total	29,807.0	100.0%	16,057.6	100.0%	9,531.1	100.0%

NOTE: All results were modeled using WinSLAMM except for * which were modeled using STEPL.

Figure 54. Estimated percent contributions to existing (2012) pollutant load by source based on combined WinSLAMM and STEPL modeling.



The results of the WinSLAMM and STEPL models were also analyzed for nonpoint source pollutant loads at the Subwatershed Management Unit (SMU) scale. This allows for a more refined breakdown of nonpoint pollutant sources and leads to the identification of pollutant load “Hot Spots.” Hot Spot SMUs were selected by examining pollutant load concentration (load/acre) for each pollutant. Next, pollutant concentrations exceeding the 75% quartile and 50% quartile

were calculated resulting in “High Concentration” and “Moderate Concentration” nonpoint source pollutant load Hot Spot SMUs. Any SMU exhibiting pollutant load concentrations below the 50% quartile contribute “Low Concentration” of pollutants relative to other SMUs. Table 31 and Figure 55 depict and summarize the results of the SMU scale pollutant loading analysis. Four of the 24 SMUs comprising Wind Point watershed are considered “High Concentration”

pollutant load Hot Spots for nitrogen, phosphorus, and sediment based on combined WinSLAMM and STEPL modeling. Five SMUs are considered “High to Moderate Concentration” pollutant load Hot Spots for various combinations of nitrogen, phosphorus, and sediment. Another 9 SMUs are considered “Moderate” or “Moderate to Low Concentration” pollutant load Hot Spots. The remaining six SMUs contribute “Low Concentrations” based on modeling.

Table 31. Pollutant load “Hot Spot” SMUs.

Hot Spot SMU	Size (acres)	N Load (lb/yr)	N Load (lb/yr)/ acre	P Load (lb/yr)	P Load (lb/yr)/ acre	Sediment Load (t/yr)	Sediment Load (t/yr)/ acre
High Concentration Hot Spot SMUs							
SMU 8	242.7	566	2.33	308	1.27	290	1.20
SMU 10	947	8,591	9.07	3,176	3.35	3,884	4.10
SMU 11	788.6	2,806	3.56	1,185	1.50	806	1.02
SMU 12	2,138.4	7,350	3.44	3,324	1.55	2,164	1.01
High to Moderate Concentration Hot Spot SMUs							
SMU 6	238.5	593	2.49	239	1.00	125	0.52
SMU 13	332.1	865	2.60	406	1.22	141	0.43
SMU 17	573.9	1,287	2.24	635	1.11	257	0.45
SMU 21	134.8	158	1.17	173	1.28	38	0.28
SMU 22	1,324.0	1,657	1.25	1,730	1.31	446	0.34
Moderate Concentration Hot Spot SMUs							
SMU 23	274.5	345	1.26	340	1.24	82	0.30
Moderate to Low Concentration Hot Spot SMUs							
SMU 1	493.9	594	1.20	563	1.14	147	0.30
SMU 4	310.3	532	1.72	263	0.85	75	0.24
SMU 9	374.9	456	1.22	270	0.72	126	0.34
SMU 14	442.8	838	1.89	498	1.12	170	0.38
SMU 15	1,040.3	1,301	1.25	1,063	1.02	295	0.28
SMU 18	382.2	416	1.09	480	1.26	99	0.26
SMU 19	71.5	88	1.23	82	1.15	30	0.43
SMU 20	242.3	301	1.24	295	1.22	70	0.29

High Concentration Hot Spot SMUs exceed the 75% quartile: N=2.33 lbs/yr/acre, P=1.27 lbs/yr/acre, Sediment= 0.45 t/yr/acre

Moderate Concentration Hot Spot SMUs exceed the 50% quartile: N=1.25 lbs/yr/acre, P=1.14 lbs/yr/acre, Sediment= 0.3 t/yr/acre

A brief summary of “High Concentration” pollutant loading Hot Spots follows:

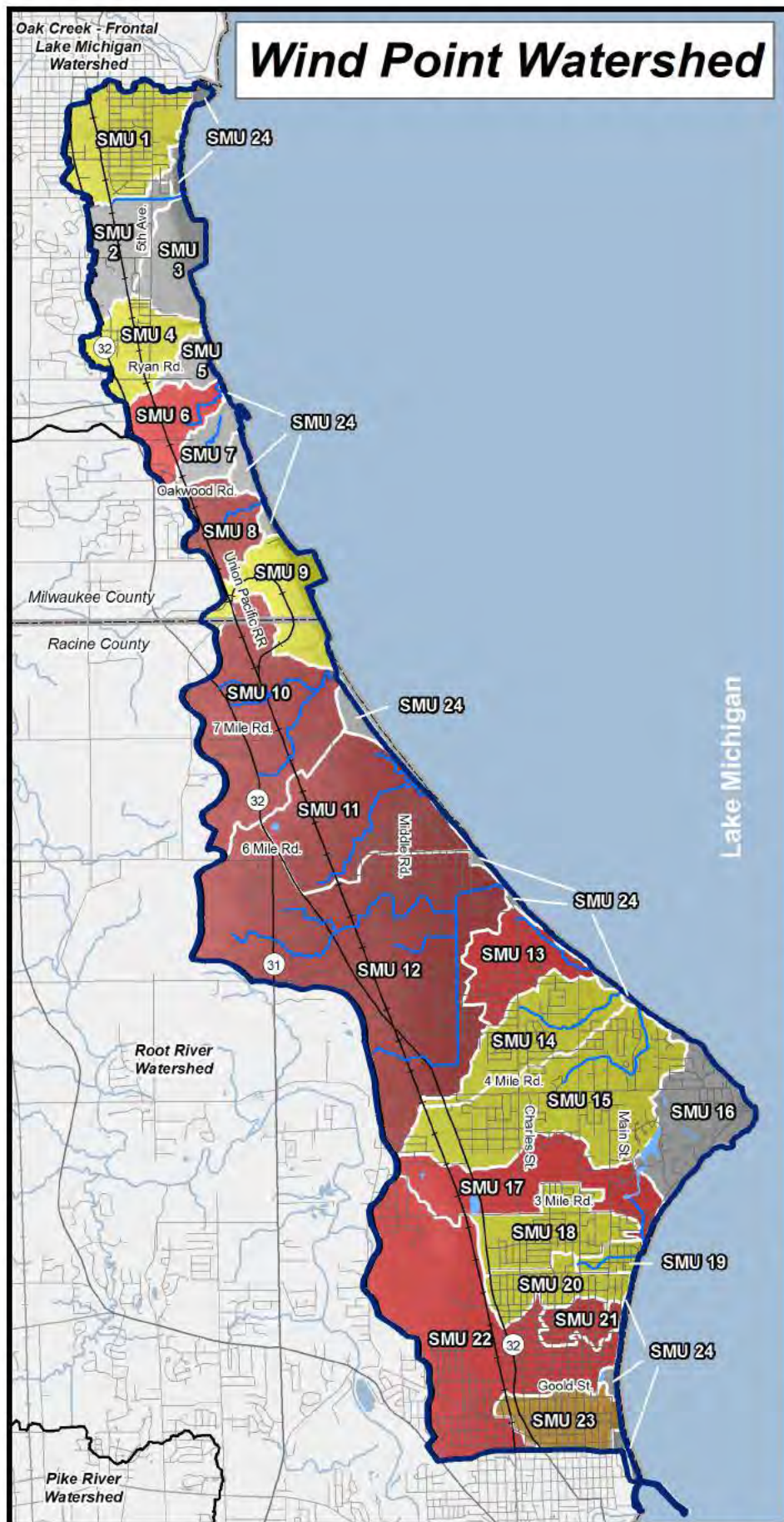
- SMU 8 comprises 243 acres. Nonpoint source pollutants in this SMU originate from a combination of industrial areas and moderate to severe streambank erosion. Eroded sediment also carries with

it attached nitrogen and phosphorus.

- Pollutants coming from SMU 10 (947 acres) originate primarily from cropland, industrial areas, and eroded streambanks throughout the SMU.
- SMU 11 (789 acres)

contributes pollutants at high concentrations originating from cropland areas and highly eroded streambanks.

- SMU 12 is the largest subwatershed (2,138 acres). Pollutants in the SMU originate from a mix of residential areas, cropland, and eroded streambanks.



Legend

- County Boundary
- Wind Point Watershed Bndy
- Surrounding Watersheds
- Open Water
- Streams
- Highway
- Streets/Roads
- Railroad

Pollutant Load Hot Spot SMUs

Nitrogen, Phosphorus, & Sediment Loading

- High Concentration
- High to Moderate Concentration
- Moderate Concentration
- Moderate to Low Concentration
- Low Concentration

DATA SOURCES
USGS

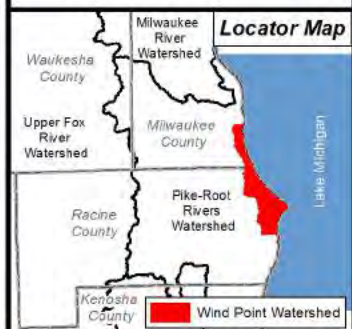
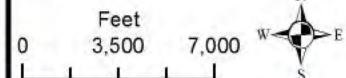


Fig. 55: Nonpoint Source Pollutant Loading "Hot Spot" SMUs