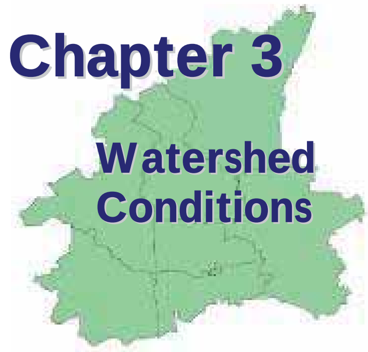


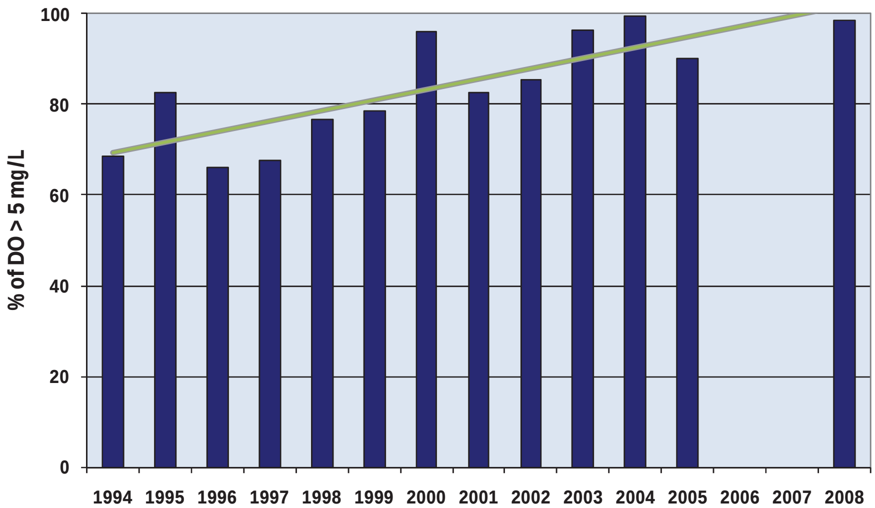
Chapter 3

Watershed Conditions

Overall Watershed Conditions

The characteristics and conditions of the Rouge River Watershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water over the last decade. Figure 3-1 summarizes the results of the millions of dollars of restoration efforts across the watershed. The percent of samples with dissolved oxygen (DO) concentrations meeting or exceeding the State minimum standard of 5 mg/L has been increasing since 1994.

Figure 3-1: Percent DO Values greater than 5 mg/L at four Continuously Monitored Sites



Five broad stream indicators reflect the conditions of the Rouge River and its tributaries. These include the following:

- ***Water quality***
- ***Stream hydrology***
- ***Aquatic diversity***
- ***Stream habitat***
- ***Stream corridor***

Challenges still remain with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in dry and wet weather conditions. This chapter provides an overall summary of existing conditions with more detailed information for each subwatershed available in subsequent sections.

The previous chapter, *Characteristics of the Rouge River Watershed*, described the original personality of the watershed. Man's influence, however, has changed this personality. The environmental characteristics have been altered over time due to changes in the landscape. Five broad stream quality indicators allow us to determine the health of the watershed. (Schueler, 2005) They are:

- Changes in water quality;
- Modifications to stream hydrology;
- Physical alteration of the stream corridor;
- Degradation of stream habitat; and
- Loss of aquatic diversity.

This section describes general watershed conditions and studies that have been completed relating to each of these stream quality indicators. Following these discussions, additional sections contain more detailed information on the status of the indicators for each of the seven (7) subwatersheds, including the Lower 1, Lower 2, Middle 1, Middle 3, Upper, Main 1-2, and Main 3-4.

Impervious Cover and Stream Quality

The impervious cover in the watershed ranges from less than 10% to greater than 60%. A major problem with the Rouge River (and most urban rivers) is that it experiences more bankfull flood events each year and the streambanks are stressed by higher velocities and flow rates for longer periods of time. Bankfull refers to the conditions where the flow in the stream channel reaches the point at which it begins to overflow. This causes erosion within the stream channels and an increase in sediment deposition in the streambed.

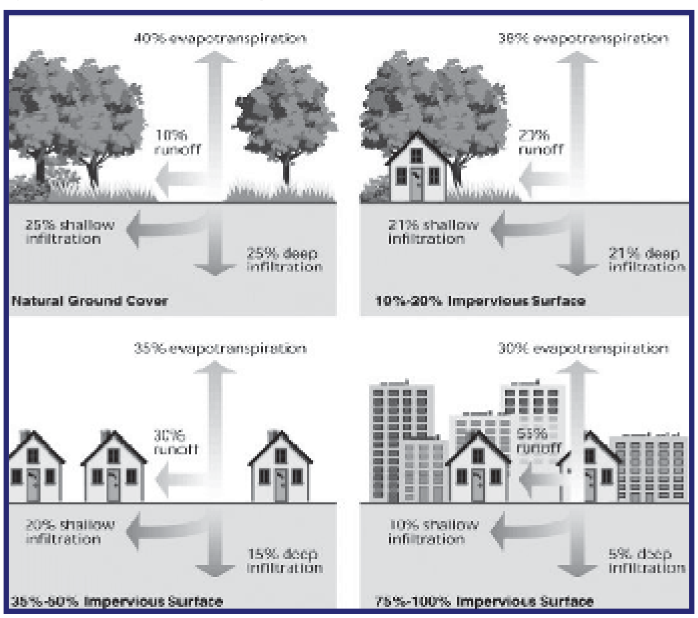
Eroded streambank in Tonquish Creek

As development has progressed across the watershed, natural areas have been converted to a variety of land use types that consist of higher percentages of impervious cover. Thus, land that was once wetlands, woodlands, riparian corridors and vegetated areas has slowly been converted to streets, parking lots, rooftops, and compacted ground with turf vegetation. The watershed impacts due to the increased impervious cover causes an increase in the total volume of storm water runoff, the frequency of runoff reaching the streams, the peak flow rate of runoff and the quality of runoff. Figure 3-2 shows how an increase in impervious cover directly affects the quantity of storm water runoff. The natural hydrologic process is also affected through reductions in both infiltration and evapotranspiration. Table 3-1 shows the average impervious cover for each subwatershed in 1991 and 2002.

Table 3-1: Average Impervious Cover 1991 and 2002

	Lower 1	Lower 2	Middle 1	Middle 3	Upper	Main 1-2	Main 3-4
1991	19%	60%	31%	69%	47%	34%	80%
2002	36%	71%	47%	78%	62%	45%	84%

Figure 3-2: Effects of Impervious Surfaces on Runoff



In general as the impervious area increases, the health of the watershed decreases. The Center for Watershed Protection has shown through the Impervious Cover Model that areas with less than a 25% impervious cover have the greatest potential for restoration (Schueler, 2005). As the percent of imperviousness surfaces increases it is less likely the stream will be restored to its original nature. Typically, stream corridors within areas that have 60% or greater impervious cover act as a conduit for storm water and not a living system.

Instream DO is a key factor for a healthy river ecosystem. The improving trend in dissolved oxygen concentrations across the watershed demonstrates the success of the ongoing watershed planning and implementation activities.

Figure 3-3 shows the range of impervious cover per subarea across the Rouge River Watershed.

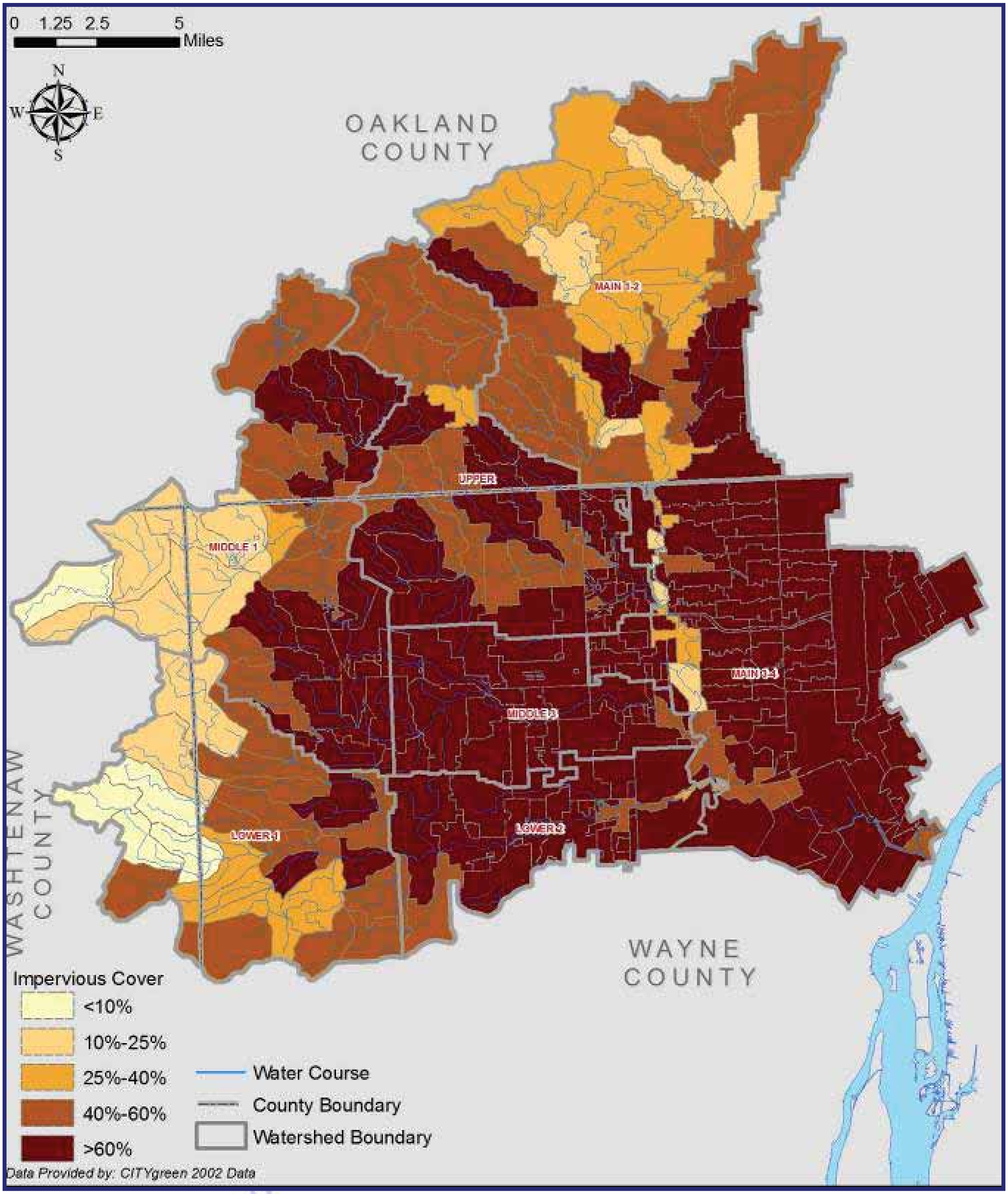
Water Quality

The State of Michigan's Part 4 Rules (of Part 31, Water Resources Protection, of Act 451 of 1994) specify water quality standards (WQS) to protect the Great Lakes connecting waters and all other surface waters of the state. These standards consist of three components; designated uses, criteria and an anti-degradation policy. The rules require that the designated uses of the receiving water be protected.

The designated uses for the Rouge River are:

1. Agriculture - A water source suitable for agricultural uses including livestock watering, irrigation and crop spraying
2. Industrial water supply — A water source intended for use in commercial or industrial applications or for non-contact food processing
3. Navigation — A water source suitable for navigation. The majority of the mainstem is large enough to be physically navigable by small boats or canoes, as are the branches for most of their length. Only the first 15 miles upstream from the mouth however, are legally defined as navigable as adjudicated by the Michigan Supreme Court (Beam & Braunscheidel, 1998). This lower portion therefore is public and subject to public trust protection. The mainstem downstream of the Henry Ford Estate in Dearborn is also under the jurisdiction of Section 10 of the River and Harbor Act, 1899, administered by the United States Army Corps of Engineers.
4. Warmwater fishery — A warmwater fishery is generally considered to have summer temperatures between 60-70°F and is capable of supporting warmwater species such as large and small mouth bass on a year-round basis.
5. Other indigenous aquatic life and wildlife — The use of the surface waters of the state by fish, other aquatic life, and wildlife for any life history stage or activity and the protection of fish for human consumption.
7. Partial body contact recreation — Any activities normally involving direct contact of some part of the body with water, but not normally involving immersion of the head or ingesting water, including fishing, wading, hunting, and dry boating.

Figure 3-3: Impervious Cover by Subarea



8. Total body contact recreation between May 1 and October 31 — Any activities normally involving direct contact with water to the point of complete submergence, particularly immersion of the head, with considerable risk of ingesting water, including swimming.
9. Coldwater fishery (for Johnson Creek only) — Waterbodies that contain fish species which thrive in relatively cold water. The Johnson Creek, in the headwaters of the Middle Rouge River, is the only designed cold water trout stream in the watershed.

When water quality does not support these designated uses it is considered impaired. Monitoring data in the Rouge River Watershed has demonstrated that current water quality conditions do not support designated uses. Section 303(d) of the federal Clean Water Act and the USEPA's Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations, Part 130) require states to develop a list of impaired water bodies every two years. This list is commonly known as the 303(d) list or the Impaired Waters List.

The ARC Five-Year Monitoring Plan monitored flow, precipitation, dissolved oxygen, temperature, E. coli, ammonia, sediment, oxygen demand and phosphorus

The Rouge River and its tributaries are included on the Impaired Waters List for the following:

- *E. coli* water quality standard exceedences (watershed- wide);
- Biota impairments (watershed-wide);
- Dissolved oxygen (DO) deficiencies (watershed- wide);
- PCBs in fish tissue and in the water column (watershed- wide);
- Mercury in fish tissue at Newburgh Lake and Walled Lake, and
- Mercury in the water column in the Johnson Creek, Sump Drain and main stem of the Rouge River from the confluence with Detroit River upstream to the Lower Rouge Branch.

The ARC Five-Year Monitoring Plan objectives included:

- ***Health of the river***
- ***Watershed-wide trends***
- ***Meet storm water Phase II requirements.***

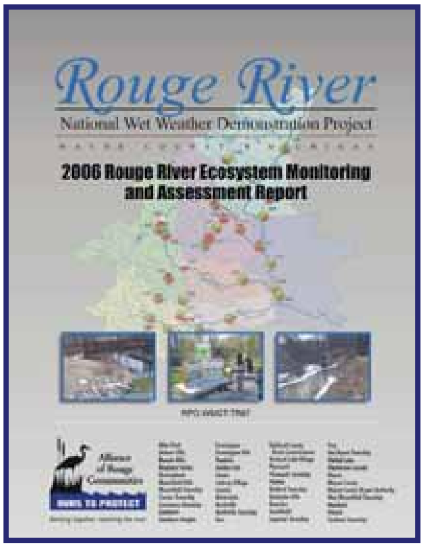
Once on the Impaired Waters list, states are required to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting water quality standards (WQS). The TMDL assessment process establishes the loadings of pollutants for a water body that do not exceed the assimilative capacity of the specific water body. The analysis is based on the relationship between pollution sources, in-stream water quality conditions and the river-specific physical characteristics. The TMDL process requires regulators to determine the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of the specific water body.

Three TMDL assessments were completed for the Rouge River and approved by the EPA in 2006. These assessments include two watershed-wide TMDLs for *E. coli* and biota, and a DO TMDL for Johnson Creek. A watershed- wide DO TMDL is anticipated to be complete in 2012 per the MDEQ. PCBs and mercury are generally not transported by storm water, therefore these impairments are not addressed in this document.

Five-Year Monitoring Plan in the Rouge River Watershed

The water quality of the Rouge River has been extremely well documented over the past 30 years. More recently, the ARC (formerly the Assembly of Rouge

Communities) developed a Five-Year Monitoring Plan that included continuous monitoring at numerous locations throughout the watershed along with intermittent dry and wet weather sampling activities by subwatershed between 2003 and 2007. Figure 3-4 shows the River Level/Flow & Dissolved Oxygen/Temperature Continuous Measurement Locations. Intermittent dry and wet weather monitoring of the Rouge River for dissolved oxygen (DO), temperature, *E. coli*, ammonia (NH_3-N), total suspended solids (TSS), carbonaceous biochemical oxygen demand ($CBOD_5$) and total phosphorus (TP) was conducted in each subwatershed on an annual rotating basis (see Table 3-2).



Trends show progress in water quality, but improvements are still necessary.

Table 3-2: Rouge River Watershed, Five-Year Monitoring Plan Rotation Schedule, 2003-2007

Subwatershed	Year
Main 1-2	2003-2004
Main 3-4	2007
Upper	2004
Middle 1	2005
Middle 3	2005
Lower 1	2006
Lower 2	2006

The monitoring data collected as part of the ARC Five-Year Monitoring Plan has been summarized in the annual Rouge River Ecosystem Monitoring and Assessment Reports (RREMAR) (Catalfio et al., 2006) (http://www.rougeriver.com/pdfs/sampling/RPO-WMGT-TR67.pdf). Each of these reports thoroughly describes the most recent water quality data and trends in each of the Rouge River subwatersheds. Beyond the RREMAR reports, additional water quality information can be found in the TMDL assessments completed for the Rouge River Watershed (Appendix A).

Water Quality Indicators

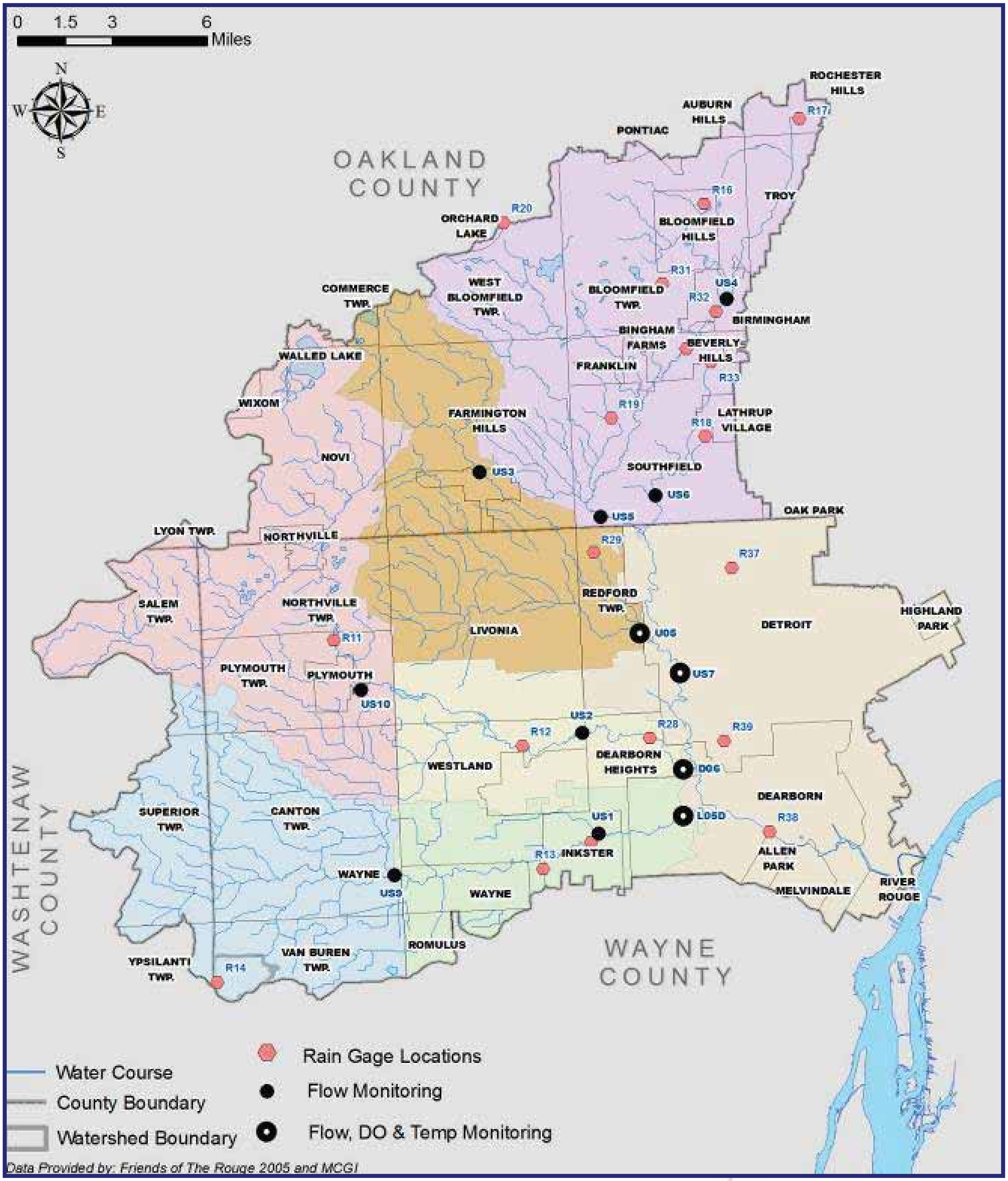
Water quality standards are the minimum water quality requirements by which the waters of the state are managed. A standard means a definitive numerical value or narrative statement promulgated by the MDEQ to maintain or restore water quality to provide for and fully protect a designated use of the waters of the state.

Johnson Creek Fish Hatchery Park Bug Hunt

Many water quality standards are based on the concentration of water quality indicators which are used to measure the health of the river. Nutrients, sediments, heavy metals, oils and bacteria are all pollutants that can be washed over land, into storm drains and into creeks and the river. Measuring the concentrations and loads of these pollutants in our surface water system can illustrate how certain land uses and management of land areas are contributing to the quality of the river.

Pollutants, from both point source and non-point sources, that are commonly found in rivers and tributaries include bacteria, phosphorus, nitrogen, and suspended solids. Other indicators of water quality include dissolved oxygen,

Figure 3-4: Water Quality Sampling and Flow Monitoring Locations (Catalfio et al., 2006)



biochemical oxygen demand and temperature. A detailed description of each of these parameters follows along with the applicable water quality standard.

In 2006, DO concentrations met the Michigan standard 100% of the time in the Lower 1 subwatershed and 99.7% of the time in the Lower 2 subwatershed.

Dissolved Oxygen

The dissolved oxygen (DO) in the Rouge River is sufficient to support a warmwater fishery in most parts of the river during most of the year. Nonetheless, the entire river, including Johnson Creek the watershed's only cold water stream, is considered impaired by the MDEQ due to occasionally low DO levels. In 2007, A TMDL assessment was completed for Johnson Creek from the confluence of the Walled Lake Branch upstream to Six Mile Road (see Figure 3-5). A TMDL for the remainder of the watershed is scheduled to be completed by 2015. Further discussion on the Johnson Creek DO TMDL is provided in the Middle 1 section of this Chapter.

Certain levels of DO are essential for the survival of fish and aquatic organisms. DO is essential for fish and is an important component in the respiration of aerobic plants and animals, photosynthesis, oxidation-reduction processes, solubility of minerals, and decomposition of organic matter, all of which affect DO levels in any water body. In addition, oxygen levels also change through a daily or diurnal cycle. Algae and rooted aquatic plants produce excess oxygen during the daylight hours when they are photosynthesizing, but they consume oxygen during dark hours for their growth and sustainability. Various forms of pollution, such as high water temperatures and untreated sewage can lead to low DO levels. Physical conditions in the river and its tributaries that help maintain optimum DO levels include a stable flow regime, presence of riffles, shading from riparian vegetation and intact vegetation along streambanks.

The amount of oxygen an organism requires varies according to species and stage of life. DO levels below 1 or 2 mg/L (milligrams/liter) will not support fish. DO levels below 3 mg/L are stressful to most aquatic organisms. DO levels of 5 to 6 mg/L are usually required for growth and activity. Low DO levels encourage the growth of anaerobic organisms and nuisance algae causing poor odors and low food supply for aquatic organisms. State water quality standards specify that a minimum of 5 mg/L of DO shall be maintained at all times for all of the Rouge, except Johnson Creek. As a designated cold water fishery that supports brown trout, Johnson Creek should have DO levels above 7 mg/L.

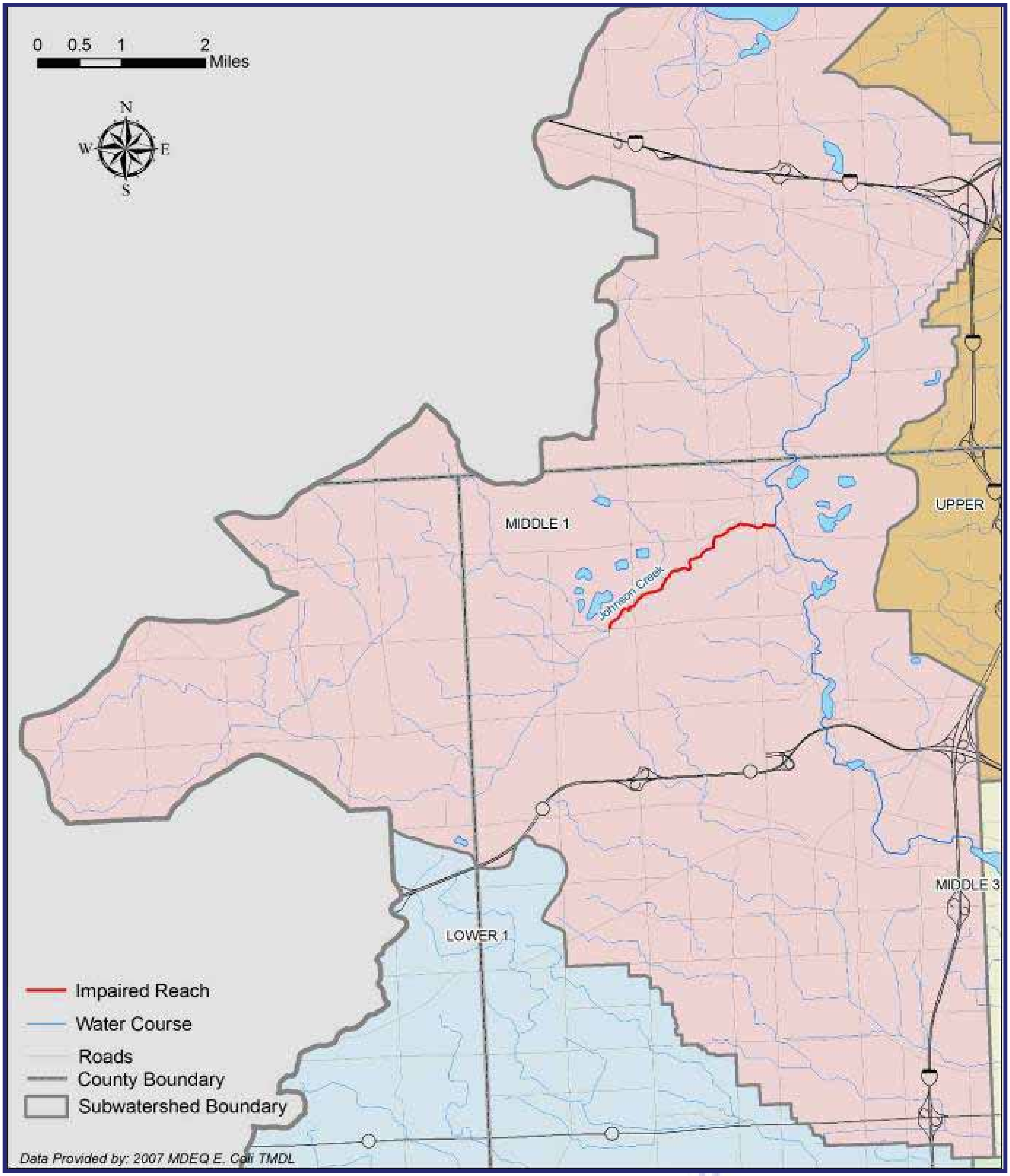
Pools and riffles increase DO concentrations to support aquatic life in Johnson Creek

Brown Trout in Johnson Creek

Temperature

In some reaches, the Rouge River, like most urban rivers, struggles to maintain cool water temperatures during summer months. Water temperature is a critical indicator of and directly affects many physical, biological, and chemical characteristics of a river. Temperature affects the amount of oxygen that can be dissolved in water; the rate of photosynthesis by algae and larger aquatic plants;

Figure 3-5: Dissolved Oxygen TMDL Reach



the metabolic rates of aquatic organisms, and the sensitivity of organisms to toxic wastes, parasites and diseases.

Thermal pollution is the discharge of heated water from industrial operations or runoff from impervious surfaces, such as roads and parking lots, which increases water temperature. Changes in water temperature affect the rate of photosynthesis by aquatic plants. Higher temperatures equal higher rates of photosynthesis until temperatures become so high that tissue damage or death of the plant occurs. Temperature also affects the sensitivity of organisms to pollutants, parasites and disease.

A maximum summer temperature of 29°C (85°F) should be maintained in order to support warm water fish species. A maximum summer temperature should be below 20°C (68°F) for cold water fish species. When water temperature rises, DO decreases and populations of aquatic life are threatened. Reducing directly connected impervious surfaces and increasing native streambank vegetation and shading along the Rouge River and its tributaries will work towards maintaining optimum temperatures in the water.

E. coli Bacteria

The *E. coli* levels of the Rouge River continue to improve but do not meet the Michigan water quality standards at all times. Elevated levels of *E. coli* bacteria, a species of fecal coliform, suggest the presence of microorganisms, parasites and viruses that threaten public health from untreated human and/or animal waste. Figure 3-6 shows the impaired reaches in the watershed as listed in the Rouge River *E. coli* TMDL. These impaired reaches include the following:

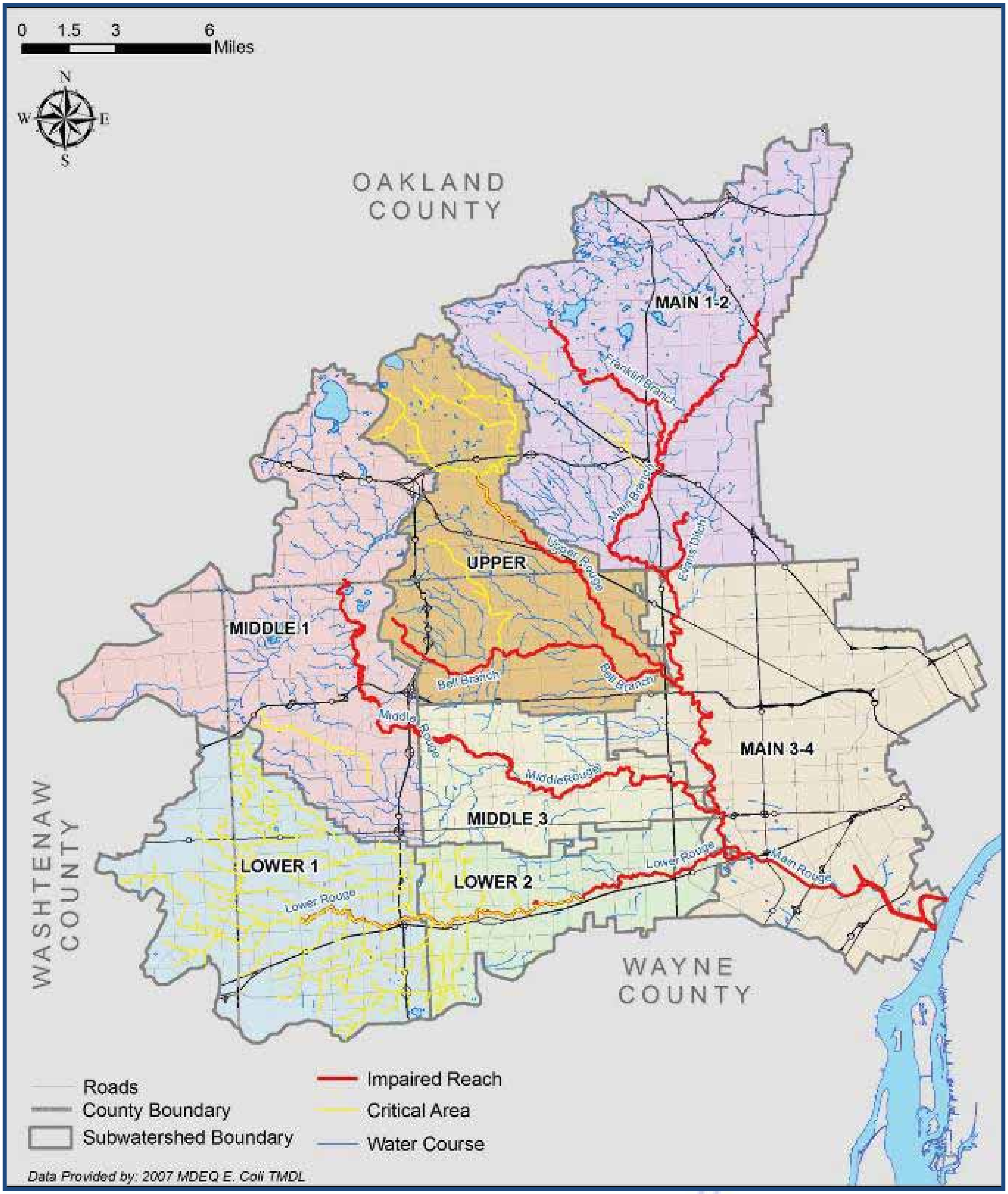
- Main Rouge River from the Detroit River confluence upstream to Big Beaver Road;
- Upper Rouge River upstream to I-696;
- Middle Rouge River upstream to Eight Mile Road;
- Lower Rouge River upstream to Beck Road;
- Bell Branch upstream to Seven Mile Road;
- Evans Ditch upstream to Lahser Road and the
- Franklin Branch upstream to Big Beaver Road.

***E. coli* bacteria**

More detailed assessment of the *E. coli* conditions in the watershed indicates that there are several critical reaches. These areas have elevated *E. coli* concentrations in dry weather conditions or have *E. coli* from human sources in dry conditions as determined by DNA analysis (see Figure 3-6).

High bacteria concentrations in the stream during dry weather can indicate a potential illicit sanitary sewer connection to a storm drain or a failing septic system. Whereas wet weather bacteria loading can suggest that bacteria are being carried by storm water from sources such as sanitary sewer overflows (SSOs), combined sewer overflows (CSOs) or pet and animal waste runoff. Elevated levels of bacterial coliforms can prevent total body contact recreation activities such as swimming and often preclude partial body contact recreation such as wading, fishing or boating in the surface water systems.

Figure 3-6: E. coli TMDL and Critical Reaches



Rule 62 of the Michigan Water Quality Standards identifies the target for the *E. coli* as 300 *E. coli* per 100 ml expressed as a daily geometric mean from May 1 through October 31 (i.e. daily target). An additional target is 130 *E. coli* per 100 ml as a 30-day geometric mean (i.e. monthly target) (MDEQ, 2007). These targets are consistent with the limits established in the Rouge River *E. coli* TMDL assessment.

Example of algae bloom

Phosphorus

Phosphorus concentrations in the Rouge River range from areas meeting the general target of 0.05 mg/L to areas in excess of 0.7 mg/L. The variability in phosphorus concentrations is due largely, in part, to the discharge limits from wastewater treatment plants, including both Ypsilanti Community Utility Authority (YCUA) and the Walled Lake- Novi Wastewater Treatment Plant and the Commerce Township Wastewater Treatment Plant. In surface waters phosphorus is usually present as phosphate. Phosphorus is a nutrient that is the limiting factor in the growth of aquatic plants in the Rouge River Watershed. This means if all phosphorus is used, plant growth will cease no matter how much nitrogen is available. Excessive phosphorus concentrations cause extensive growth of algae blooms and aquatic plants. This growth causes reductions in DO levels due to nighttime respiration by living algae and plants. Depletion of DO adversely affects many animals and can cause fish kills.

Typical sources of phosphorus include fertilizer runoff from residential, commercial and golf course lawns, agricultural crop runoff and feedlots, pet and livestock wastes, illegal sewer connections and failing septic systems. Increasing phosphate levels in the waterways by 0.03 milligrams per liter (mg/L) can increase plant growth and thus eutrophication, or aging, of the waters. Although evidence indicates that phosphorus is not the only element contributing to eutrophication, it is often the main element required by freshwater plants.

There are no state water quality standards for phosphorus, however, wastewater treatment plants and other point source discharges are typically limited to a concentration of 1 mg/L.

Total Suspended Solids

Concentrations of suspended sediment, or total suspended solids (TSS), across the watershed are variable, however, it is a significant pollutant in each subwatershed. Headwater areas that have experienced significant development pressures have generally exhibited higher concentrations of TSS. As levels of TSS increase, there are a number of effects. The sediment in the water column absorbs heat from sunlight, which increases water temperature and subsequently decreases levels of DO. This, in turn, directly affects the river's ability to support a diversity of aquatic life. Some cold water species, such as trout and stoneflies, are especially sensitive to changes in dissolved oxygen. Sediment can also destroy habitat in the stream as it settles to in the stream channel and fills in or covers aquatic habitat. Suspended solids can smother the eggs of fish and aquatic insects, and can suffocate newly-hatched insect larvae. Suspended solids can also harm fish directly by clogging gills, reducing growth rates and lowering resistance to disease.

Given the effect that sediment load has on aquatic life, the MDEQ has established a wet weather suspended solids concentration target of 80 mg/L for the re-establishment of fish and macroinvertebrate communities in the Rouge River Biota TMDL (MDEQa, 2007)

Wet weather TSS concentrations are often much higher than dry weather concentrations, indicating storm water runoff as the main cause for sediments as opposed to wind or other vehicles. Sediment from paved surfaces, streambank erosion due to high river velocities and lack of vegetation, agricultural practices and construction activities are some of the suspected sources of TSS in the Rouge River and its tributaries.

Rouge Project Water Quality Ranking System

In addition to understanding if a particular water quality indicator meets water quality standards, it is important to know how far off an indicator is from a standard and whether or not improvements are being made. To communicate this information to the public, the Rouge Project has developed a water quality condition ranking system that categorizes each sampling location as Good, Fair or Poor by parameter for dry weather conditions. This allows easy interpretation of a large quantity of analytical data. The criteria for the ranking system are presented in Table 3-3. The State/USEPA standards are also provided for informational purposes (MDEQ, 1994; USEPA, 1986). No such ranking system has been developed for wet weather conditions.

Table 3-3: Criteria for Water Quality Rankings

Parameter	Ratings and Criteria			State/USEPA Water Quality Standards/ Guidelines
	Good	Fair	Poor	
Water Temperature (Warmwater)	≤ 27.0°C (81°F) ≥ 95% of the time	≤ 27.0°C 95% - 75% of the time	> 27.0°C > 75% of the time	≤ 29°C (85°F)
Water Temperature (Cold water)	≤ 20.0°C (68°F) ≥ 95% of the time	≤ 20.0°C 95% - 75% of the time	> 20.0°C > 75% of the time	≤ 20°C (68°F)
Dissolved Oxygen (Warmwater)	≥ 5 mg/L ≥ 95% of the time	≥ 5 mg/L 95% - 75% of the time	< 5 mg/L > 75% of the time	≥ 5 mg/L
Dissolved Oxygen (Cold water)	≥ 7 mg/L ≥ 95% of the time	≥ 7 mg/L 95% - 75% of the time	< 7 mg/L > 75% of the time	≥ 7 mg/L
Oxygen Demand ($CBOD_5$)	≤ 3 mg/L ≥ 95% of the time	≤ 3 mg/L 95% - 75% of the time	> 3 mg/L > 75% of the time	none
Ammonia (NH_3-N)	≤ 0.7 mg/L ≥ 95% of the time	≤ 0.7 mg/L 95% - 75% of the time	> 0.7 mg/L > 75% of the time	none
Phosphorus	≤ 0.05 mg/L ≥ 95% of the time	≤ 0.05 mg/L 95% - 75% of the time	> 0.05 mg/L > 75% of the time	0.033 mg/L
Suspended Solids	≤ 50 mg/L ≥ 95% of the time	≤ 50 mg/L 95% - 75% of the time	> 50 mg/L > 75% of the time	0-25 mg/L: good 25-60 mg/L: fair >60 mg/L: poor
E. coli (Geometric Means)	Monthly: ≤ 130 cfu/100mL & Daily: ≤ 300 cfu/100mL	Monthly: 130 -1,000 cfu/100mL	Monthly: > 1,000 fu/100mL	≤ 130 cfu/100mL (monthly) ≤ 300 cfu/100mL (daily)

Non-Point Source Pollutant Loading

Most subwatersheds have exhibited storm water runoff as the major source of pollutant loading, with the Main 3-4 exhibiting both point sources, such as industrial facilities as well as CSOs as the major sources of pollutant loading into the river.

Pollutant loading in the Rouge River Watershed has been reviewed from both land use and land cover perspectives. Pollutant loading reflects the estimated amount of pollutants in storm water runoff entering the creeks and the river. Loading estimates help to identify relative magnitudes of pollutant sources, the general location of sources and the timing of source loading. Pollutant loading analyses facilitate restoration strategies, target load reduction efforts and project future loads under new conditions. New conditions generally include changes in land cover or implementation of various best management practices (BMPs).

For purposes of the pollutant loading estimates the Watershed Management Model (WMM), containing 335 subareas across the watershed, was used. WMM was developed, applied, and calibrated to the Rouge River during the Rouge River National Wet Weather Demonstration Project (Rouge Project). This previous WMM work was reviewed as part of this analysis and updated to estimate existing annual pollutant loadings in the watershed based on year 2000 land use data obtained from SEMCOG. This section will provide a brief methodology summary while the subwatershed sections provide overall pollutant loading estimate results. The complete report summarizing the annual pollutant loadings and WMM is included in Appendix B.

The WMM model estimates annual pollutant loadings for base flow conditions, point sources, CSO overflows and storm water runoff. The base flow pollutant load concentrations determined during the initial model development were utilized in this analysis. Point sources, CSO flow rates and concentrations, and CSO basin and removal rates determined in the initial modeling effort were updated to account for CSO control and sewer separation projects undertaken since 1994. The pollutant loadings from storm water runoff was based on predicted storm water runoff volumes, non-point pollution loading factors that are associated with land use and percent imperviousness. The land use types and pollutants are linked via an event mean concentration (EMC), which defines concentrations of specific pollutants for various land uses. As an example residential land use has the highest nutrient and bacteria runoff where industrial, agricultural and highways contribute the most suspended solids. Specific EMCs can be found in Appendix B. Storm water runoff volumes were determined based on climatologic data, overall imperviousness associated with each land use type, and directly connected impervious area (DCIA) percentages.

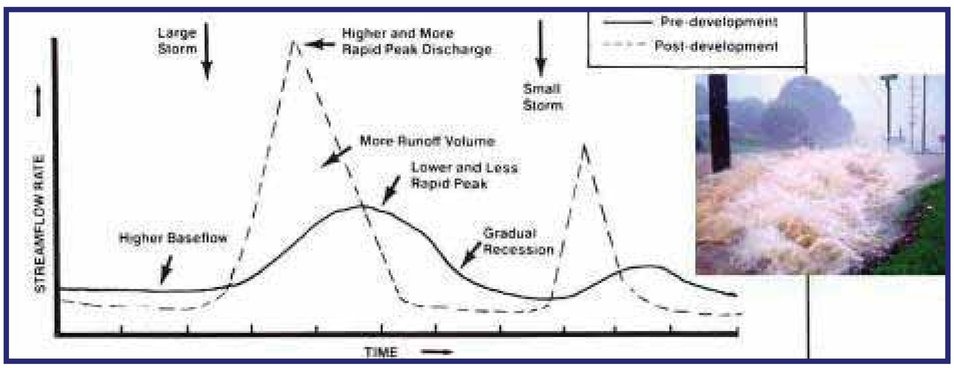
Bennett Arboretum native plant grow zone

Stream Hydrology

In a natural river system, storm water is intercepted by vegetation, stored temporarily on the land in wetlands or infiltrates into the groundwater, and then is slowly released into the surface water system, with only a small fraction of water entering the river via surface runoff. This hydrologic scenario will create a stable stream system. In an urban setting, a large percentage of storm water falls onto impervious surfaces, such as rooftops, parking lots and roads, and travels directly to the river through storm drains. In this urban setting, a storm event will cause the rate of surface water to increase quickly and dramatically and is referred to as "flashy." A flashy creek or river will provide unstable habitat, low base flows and high peak flow rates for fish and aquatic organisms. These urban creeks and rivers become degraded with high pollutant loads and scoured streambanks.

A hydrograph is an image used to show the water level or rate of flow of the river over time or during a rainfall event. Figure 3-7 depicts a typical hydrograph comparison between urban and rural conditions after a rainfall event. Urban conditions, shown as the dashed line, result in higher peak flow rates combined with increased storm water runoff volume as compared to rural conditions.

Figure 3-7: Urban and Rural Hydrograph



(Schueler, 2005)

Stable stream

As part of the 2003-2007 Rouge River Watershed Five-Year Monitoring Plan, developed by the Alliance of Rouge Communities (ARC), continuous flow and river level monitoring data were collected at nine (9) stations across the watershed. Precipitation data was collected in 15-minute totals at 26 rain gage locations (see Figure 3-4 on page 3-7). As Table 3-4 shows, the frequency of the peak flow rates is not increasing, but flashiness in the river system continues to present challenges to restoration.

Many subwatershed areas have exhibited declining trends in peak flow conditions, however, it is evident that the smaller, more frequent storms are having a larger impact on the quality of the river. The smaller, more frequent rain events generate storm water runoff that typically causes the flow in the river or stream channel to exceed its normal low flow conditions.

Table 3-4: Streamflow Trend Analyses Summary and 2006 Precipitation Totals (Catalfio et al., 2006)

SWMA	Site ID	Base Flow	Average Flow	Peak Flow Exceeding Gage-Specific Threshold	Frequency of High Flow	Streamflow Period of Record	2006 Precipitation Total (as percent of long-term average, 1994-2005)
Main 1-2	US4	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then no change	No change	1951-2006	102%
	US5	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇓	1959-2006	
	US6	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then ⇓	⇓	1959-2006	
Main 3-4	US7	⇑ from mid 1960s to mid 1990s, then ⇓	Cyclical, but no change in recent years	Cyclical, but ⇓ from mid 1990s	⇓ in very high flow	1931-2006	120%
Upper	US3	⇑ to mid 1990s, then ⇓	⇑ to mid 1990s, then no change	Cyclical, but ⇓ from mid 1990s	⇓	1959-2006	106%
	U05	⇓ since mid 1990s	⇓ since mid 1990s	⇓ since mid 1990s	⇓	1994-2006	
Middle 1	US10	No change	⇑	No change	Insufficient data	2002-2005 (2002 partial year)	120%
Middle 3	US2	⇓ since mid 1980s	No change	No change	No change	1948-1977 1984-2006	120%
	D06	⇓ since mid 1990s	No change	No change	No change	1994-2005	
Lower 1	US9	No change	No change	No change	⇑ in very high flow	2001-2006 (2001 partial year)	104%
Lower 2	US1	No change	No change	No change	No change	1948-2006*	104%
	L05D	No change	⇑	⇓	No change	1994-2006*	

⇑ Increasing trend, ⇓ Decreasing trend, *YCUA WWTP began discharging in the upstream end of the Lower Rouge in 1996.

Flashy stream

In order to continue to address flow variability across the watershed, targets have been established for storm water volume control in each subwatershed. The overall target for the entire Rouge River Watershed is to achieve close to 300 million cubic feet of storage. This is achieved by retrofitting existing properties with storm water best management practices and vegetation that promotes infiltration, evaporation, interception and evapotranspiration. At the same time, storm water or water reuse practices also work towards achieving this target.

Hydraulic Analysis

A hydraulic analysis of the Rouge River utilizing flow data from USGS stream gages was completed to assess the existing flow conditions within the river and to develop a range of BMP measures that may be applied to reduce the flashiness of the river. The annual peak flow, annual mean flow, daily mean flow, and 15-minute flow rate data for ten (10) USGS stream gages were analyzed to identify statistics and trends through the history of record for smaller, more frequent flood events. The current bankful, one-month, and 15-day flood flow rates were determined at each of the USGS stream gage locations. The full USGS Gage Trend

Analysis and Recommendation Report can be found in Appendix C (Szlaga & Ridgway, 2008).

The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

The left and right low flow channel bankfull flood stages were surveyed in February, 2008 at each USGS stream gage location. USGS stage-discharge rating tables were used to determine the bankfull flow rate associated with the lower of the two overbank flood stages identified at each site. The average bankfull frequency ranged from 0.6 to 10 times per year as shown in Table 3-5. As a point of comparison, a stable river system has an average bankfull frequency of less than 1.5 times per year.

Table 3-5: Bankfull Flood Flow Rate and Return Period

USGS Stream Gage	I.D. Number	Measured River Stage on 2/12/2008 (feet)	Overbank Flood Stage (feet)		Bankfull Discharge (cfs)	Average Annual Bankfull Frequency
			Left	Right		
Main Rouge at Birmingham (US4)	04166000	2.0	5.1	4.8	495	1.4
Main Rouge at Southfield (US5)	04166100	5.2	10.3	9.6	664	5.5
Evans Ditch at Southfield (US6)	04166200	6.0	10.8	10.1	357	4.3
Upper Rouge at Farmington (US3)	04166300	3.2	5.8	6.0	478	0.6
Upper Rouge at Detroit	04166470	1.7	5.5	6.1	314	9.2
Main Rouge at Detroit	04166500	6.5	12.9	12.8	1309	3.4
Middle Rouge near Garden City	04167000	3.1	6.8	8.6	525	5.5
Middle Rouge at Dearborn Heights	04167150	3.0	7.8	6.9	550	5
Lower Rouge at Wayne (L06)	04167625	4.1	7.6	7.9	321	10
Lower Rouge at Inkster (US1)	04168000	3.9	9.6	11.0	1047	1.7

This table demonstrates the instability of the river and its tributaries and clearly highlights the flashy nature of the river. Storm water best management practices across the watershed should focus on implementation of measures that significantly reduce the flashiness in the river by reducing the amount of storm water runoff entering the river.

Ecosystems

Ecosystems refer to aquatic diversity, stream habitat and stream corridor conditions. Although these vary across the watershed, improvements in aquatic diversity have been demonstrated in all subwatersheds. Stream habitat and stream corridor conditions have opportunities for restoration. As stream habitat and stream corridor conditions improve, populations of aquatic life will improve.

Aquatic diversity, stream corridor conditions and stream habitat conditions are all affected by various forms of urban activity, some of which are highlighted throughout this plan, and include an increase in impervious surfaces, point-source and non-point source discharges, removal/modification of riparian corridors and riparian vegetation and removal/alterations of natural features across the watershed.

Rock Bass

Other programs, such as the Rouge Remedial Action Plan (Rouge RAP Advisory Council, 2004) have identified and described the challenges associated with the Rouge River's ecosystems. The EPA has also approved a TMDL for biota across the watershed that explains actions necessary to achieve the biological community targets (i.e. fish and macroinvertebrate) to meet designated uses. Figure 3-8 depicts the reaches that have biota impairments (MDEQ, 2007a). Beyond the impaired reaches, the biota TMDL encompasses the entire Rouge River Watershed because of the inability to separate the drainage-wide impacts of land use and storm water runoff on the specific listed reaches and to recognize the necessity of watershed-wide efforts to address water quality, habitat quality and hydrologic modifications.

Smallmouth Bass

This biota target is the re-establishment of fish and macroinvertebrate communities that, when monitored, result in a consistent Acceptable or Excellent rating using MDEQ Procedure 51 Biological Community Assessment Protocol (http://www.deq.state.mi.us/documents/deq-swq-gleas-proc51.pdf). A secondary numeric target based on Suspended Solids (SS) concentration of 80 milligrams per liter (mg/L) for wet weather events will be used to assess improvements in the Rouge River Watershed. To achieve this approximately a 15.3% SS reduction is required (MDEQ, 2007a).

Figure 3-8: Biota TMDL Reaches

Aquatic Diversity

Fish Communities

Channelized area of the Rouge River in Dearborn

Historically, the Rouge River was home to more than 60 species of fish. The more recent fish survey (Leonardi, 1996) at 31 river sites throughout the watershed found 53 species with game fish primarily located to the Middle Branch impoundments and areas below the Henry Ford Estate dam in Dearborn.

Fish communities, both species types and populations, are often considered the best overall measure of river ecosystem status because their sustained presence indicates successful functioning of many complex habitat systems (e.g., flow, temperature, water quality, channel habitats) (Wiley, et al., 1998). In general, overall aquatic diversity decreases as the impervious cover increases and the populations of aquatic organisms are reflected by the more pollution-tolerant species. Aquatic insects or macroinvertebrates are the main source of food for the fish and as their populations are altered, the fish populations also change.

The Rouge River and its tributaries are warm-water fisheries, with the exception of Johnson Creek, which is a designated cold water fishery located in the headwaters of the Middle Branch. Game fish such as the largemouth bass, northern pike, suckers and catfish have been evident in limited numbers, but have experienced significant declines as a result of poor water quality, changes in the flow regime, degraded in-stream and riparian habitats and habitat fragmentation by dams and the concrete channel. The Henry Ford Estate dam and the channelization of the lower portions of the Main Branch have contributed to blocking fish migrations upstream, including expected game fish such as smallmouth bass, walleye and sturgeon. Johnson Creek, Seeley Creek, and Minnow Pond Drain, all headwater tributaries are home to the redside dace, a Michigan threatened species. Headwaters are also home to other sensitive fish species including northern hog sucker, mottled sculpin, rock bass, and brook lamprey.

Henry Ford Estate Dam in Dearborn

The MDNR Fisheries Division Institute for Fisheries Research and the University of Michigan, School of Natural Resources developed a correlation, known as the Wiley-Seelbach model. This model predicts what fish communities (“target communities”) could exist in segments of the Rouge River, based on the stream size, position in the watershed and seasonal variation in water flows and temperature. The report analysis was based on measurements and modeling of the structure of the fish communities in ecologically similar rivers throughout southern Michigan. The report emphasizes hydrologic regime, especially baseflow and peak flow, and temperature regime, especially summer minimum, maximum and median temperature, as the factors controlling fish community composition. It assumes that factors like water quality, in-stream habitat quality, and prey availability are already suitable for the identified fish species (Wiley, et al., 1998). The goal of the Wiley-Seelbach model was to aid in the development of management criteria based on an accurate assessment of what potential fish population assemblages should be expected to occur in a specific reach of the Rouge River and comparable streams of characteristics. The 1995 MDNR fish assessment data set was used to compare potential fish species to what was actually found during the survey.

The river segments within the entire Rouge River Watershed were defined into segments consistent with the Wiley-Seelbach model. These segment groups do not always correspond to the subwatershed designations, but reflect river characteristics that will support fish communities. Based on these segment groups, recommendations for target fish associations, including game or angling fish, is provided based on model predictions (Wiley, 1998). In addition, the MDEQ conducted biological surveys in 2000 and 2005 as part of the MDEQ Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters. Additional biological studies, including an assessment of the fish community, are anticipated in 2010. Figure 3-9 shows the overall Rouge River Watershed monitoring results for fish communities.

Hood Casemaker Caddisfly found by bug hunters in Spring 2007

Macroinvertebrate Communities

The presence, abundance and diversity of certain macroinvertebrates (aquatic insects and invertebrate animals) in the streambed is an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, and crayfish, among others. Since macroinvertebrates are relatively immobile and short-lived, the presence/absence, abundance, and diversity of certain taxanomic groups (taxa or family of macroinvertebrates) are indicative of long-term water quality.

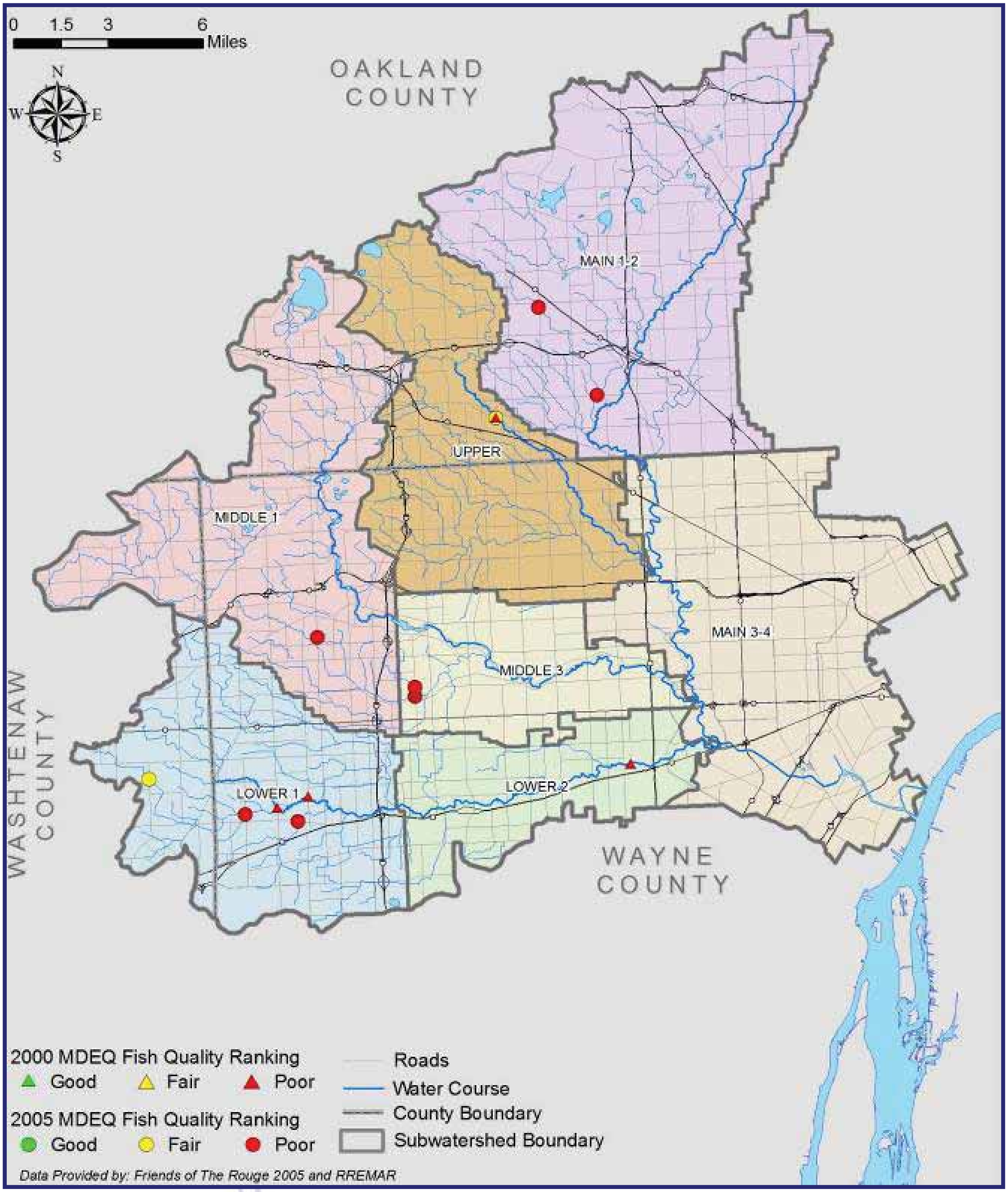
Different groups of macroinvertebrates respond differently to changes in water quality and physical habitat characteristics. Generally, a natural, unpolluted stream supports a diversity of macroinvertebrates. Examples of sensitive aquatic insect groups include the stonefly, mayfly, and caddisfly orders as well as mussels. These insect orders are almost always present in healthy stream environments and usually represent a significant portion of the overall macroinvertebrate numbers. In degraded streams, such pollution-intolerant macroinvertebrate groups are less abundant or absent, while more pollution-tolerant groups become more abundant. Examples of such pollution-tolerant macroinvertebrate groups include aquatic worms, midges, leeches, and true bugs. Many of the pollution-tolerant aquatic insect groups have the ability to survive low dissolved oxygen conditions by using atmospheric oxygen.

Clubtail Dragonfly found by Fall bug hunters in Troy in 2007

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decade. Below is a description and summary of the main studies and field surveys that have been conducted. Specific subwatershed information is included in subsequent sections.

In 2001, the Friends of the Rouge (FOTR) began its own benthic sampling program with the intent of involving a large number of volunteers to monitor the health of the watershed. Volunteers sample sites each spring and fall and a quality score is calculated for each site based on the type and number of organisms found (FOTR, 2007). Beginning in 2002, the FOTR expanded its benthic monitoring program to

Figure 3-9: Fish Quality Rankings



include the Rouge River Winter Stonefly Search. Every January, volunteers look for stoneflies which indicate higher water quality. The MDEQ also conducted Rouge River biological assessment surveys in 2000 and 2005. Figure 3-10 shows the results from these programs.

Frog and Toad Diversity

Populations of frogs and toads across the watershed have improved since the inception of this volunteer monitoring program. They provide an overall indicator of the health of the river even though they are not generally categorized as part of the aquatic life. There are 10 different species of frogs and toads that are native to the Rouge River Watershed. These amphibians live parts of their life in aquatic environments such as lakes, ponds, wetland or streams. Due to the highly permeable nature of their skins and the fact they reproduce by laying their eggs in an aquatic environment, these organisms are very sensitive to changes in water quality or other activities that cause an alteration to their habitat. These habitat alterations include the filling of wetlands or erosion and the subsequent deposition of sediments that result from adjacent construction sites or farmland.

American Toad

For several years there have been concerns nationally that the populations of some frog and toad species were declining. In addition, many individual species were exhibiting growth deformities for unknown reasons. The Michigan Department of Natural Resources (MDNR) began the Michigan Frog and Toad Survey in 1988 on a limited basis. The goal of the program was to develop a network of volunteers to monitor the population and distribution of frogs and toads in Michigan.

The volunteer network is first trained to identify the breeding calls of the different species. Subsequently they are assigned designated locations in the early spring, spring and summer to go and listen for the breeding calls of the various species and to estimate the number of each species heard. Pickerel frogs and Copes Gray Tree frogs are both native to the Rouge River Watershed but are seldom seen and are hard to identify by volunteers so they were not part of the survey.

Similar to the MDNR Frog and Toad Survey, the FOTR began a Frog and Toad Survey in a small part of the Rouge River Watershed in 1998. Due to an overwhelming response from volunteers, the survey was expanded to the entire watershed in 2000. Volunteers wishing to participate in the survey attend a workshop where they learn to identify frogs and toads by their breeding calls after which they are assigned one or more ¼ square mile block to survey. Every few weeks between March and July volunteers visit their assigned site(s) and record the number and type of species they hear.

Not only do the surveys provide an important record of frog and toad abundance and distribution over time, they also provide volunteers the opportunity to interact in a positive way with local natural areas and to develop a sense of ownership of and stewardship toward their watersheds.

Figure 3-10: Macroinvertebrate Quality Ranking

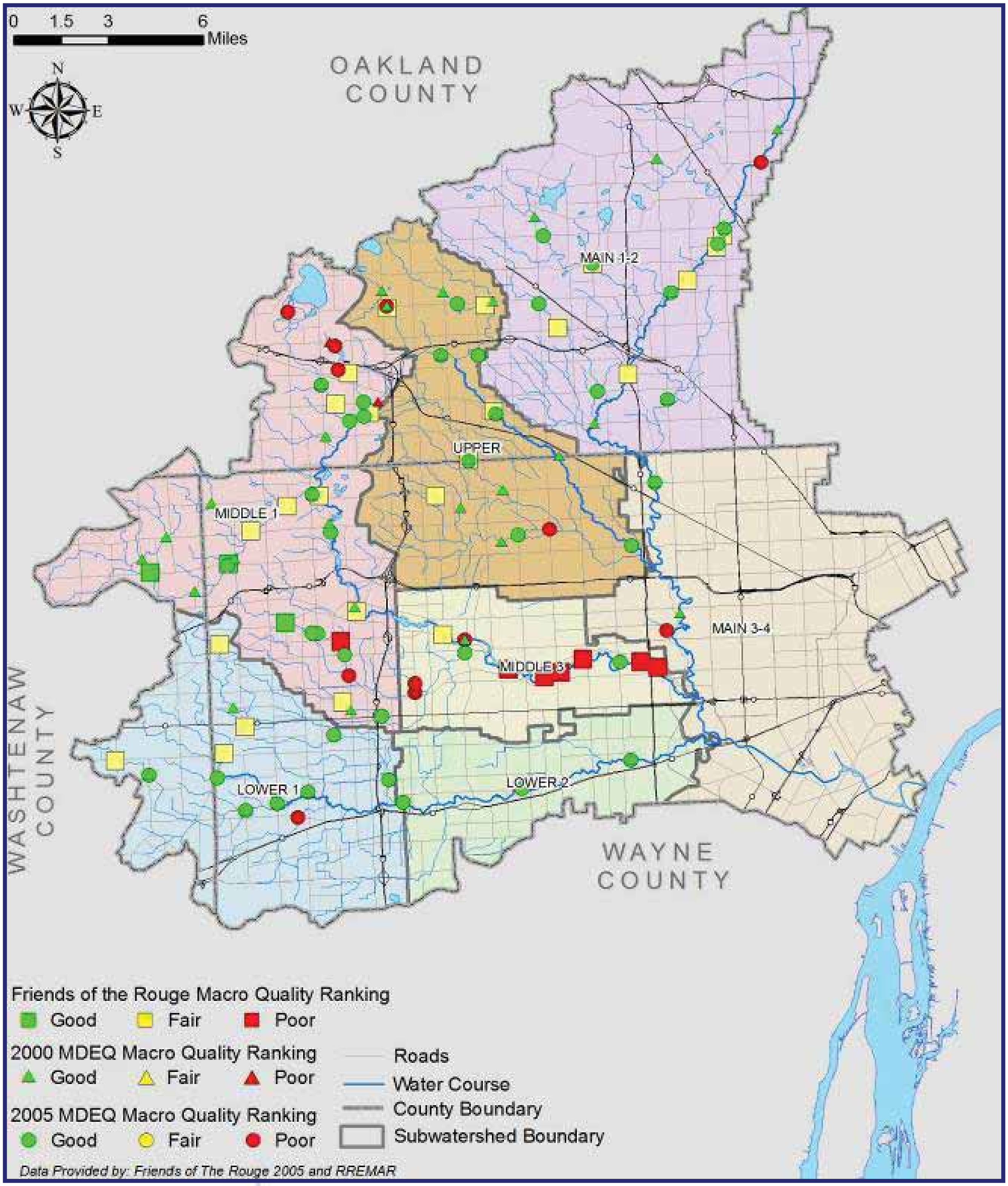


Figure 3-11 shows the total number of frog and toad species found within each area compiled from all FOTR data available. For example, if four different species were found in 2004 and an additional two species were found in 2005 it was noted that the diversity of this area is six total species.

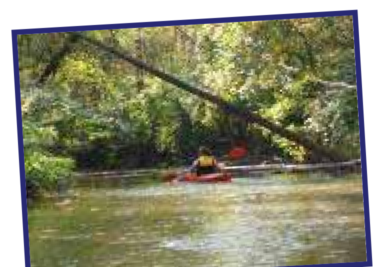
Stream Habitat

Historically, stream habitat has been significantly impacted by the flow variability in the river, both peak flows and smaller rain events. It is evident that the smaller rain events have a large impact on stream habitat by causing streambank erosion, washing away substrates and facilitating sediment deposition. The woody debris management practices developed through Wayne County have improved public perception about the importance of maintaining large woody debris areas in the river while constructing a mechanism to maintain streamflow around the debris.

Stream habitat quality is one of the factors contributing to the success of a diverse and robust fish community. Characteristics of quality habitat include: diversity (pools, riffles, woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described previously in the Stream Hydrology section, the smaller, more frequent storms have a large impact on stream habitat. In urban streams these more frequent storms cause changes in channel geometry to accommodate the increased flows and results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (Schueler, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels, and decline in undercut banks.

An evaluation of stream habitats was undertaken in conjunction with the MDNR's Rouge River fish community assessment of 1995 (Leonardi, 1996). Additionally, the Rouge Project conducted an aquatic habitat survey during the summer of 1996 (Adaniya & Rathbun, 1998) and the MDEQ conducted biological assessments of the Rouge River in 2000 and 2005 (Goodwin, 2002 & MDEQ, 2006). Figure 3-12 highlights results of stream habitat surveys that have been completed in the Rouge River Watershed.



Forested riparian corridors provide numerous water quality benefits, including shading of the stream and bank stabilization.

Stream Corridor

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River.

Figure 3-11: Frog & Toad Diversity

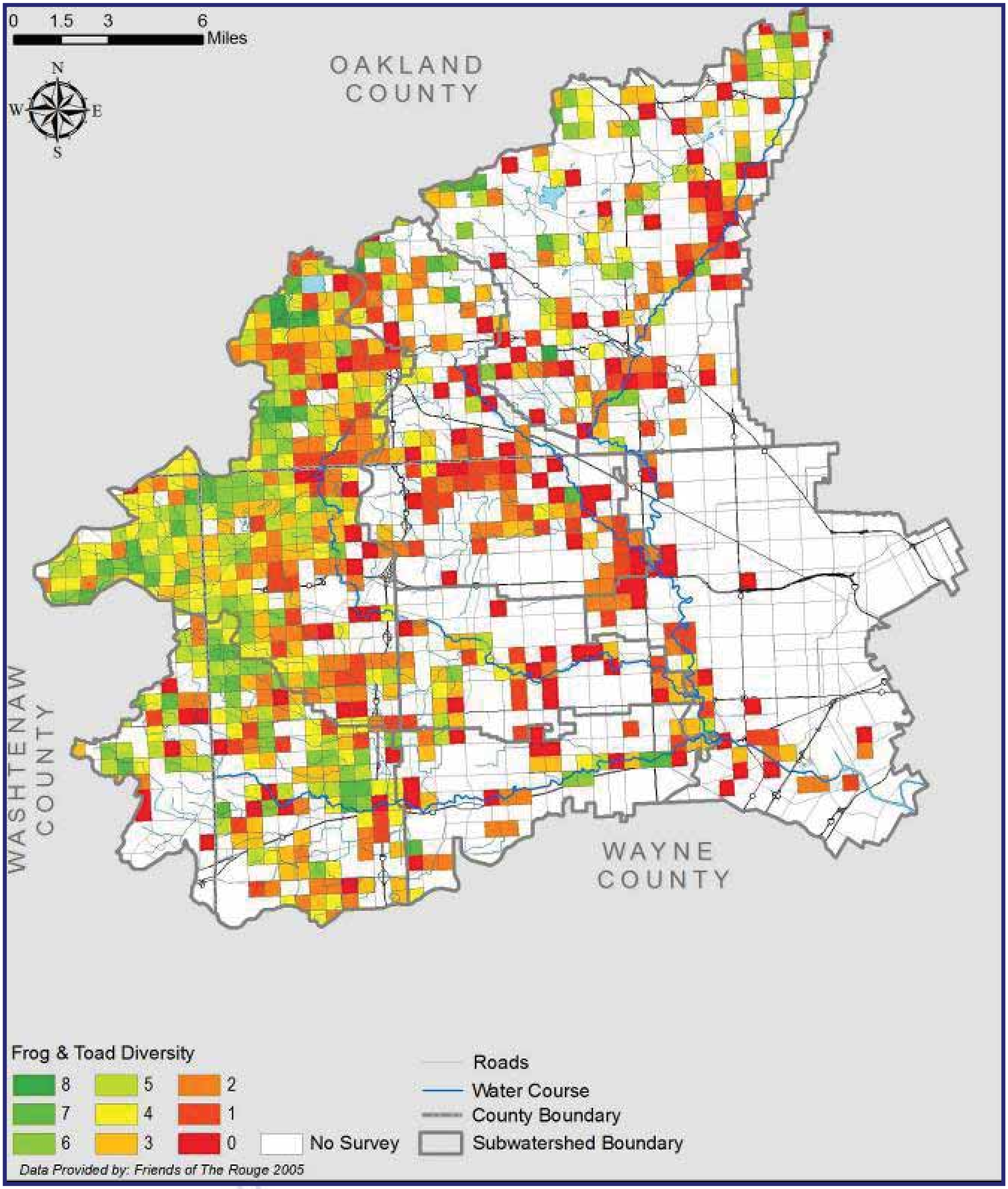
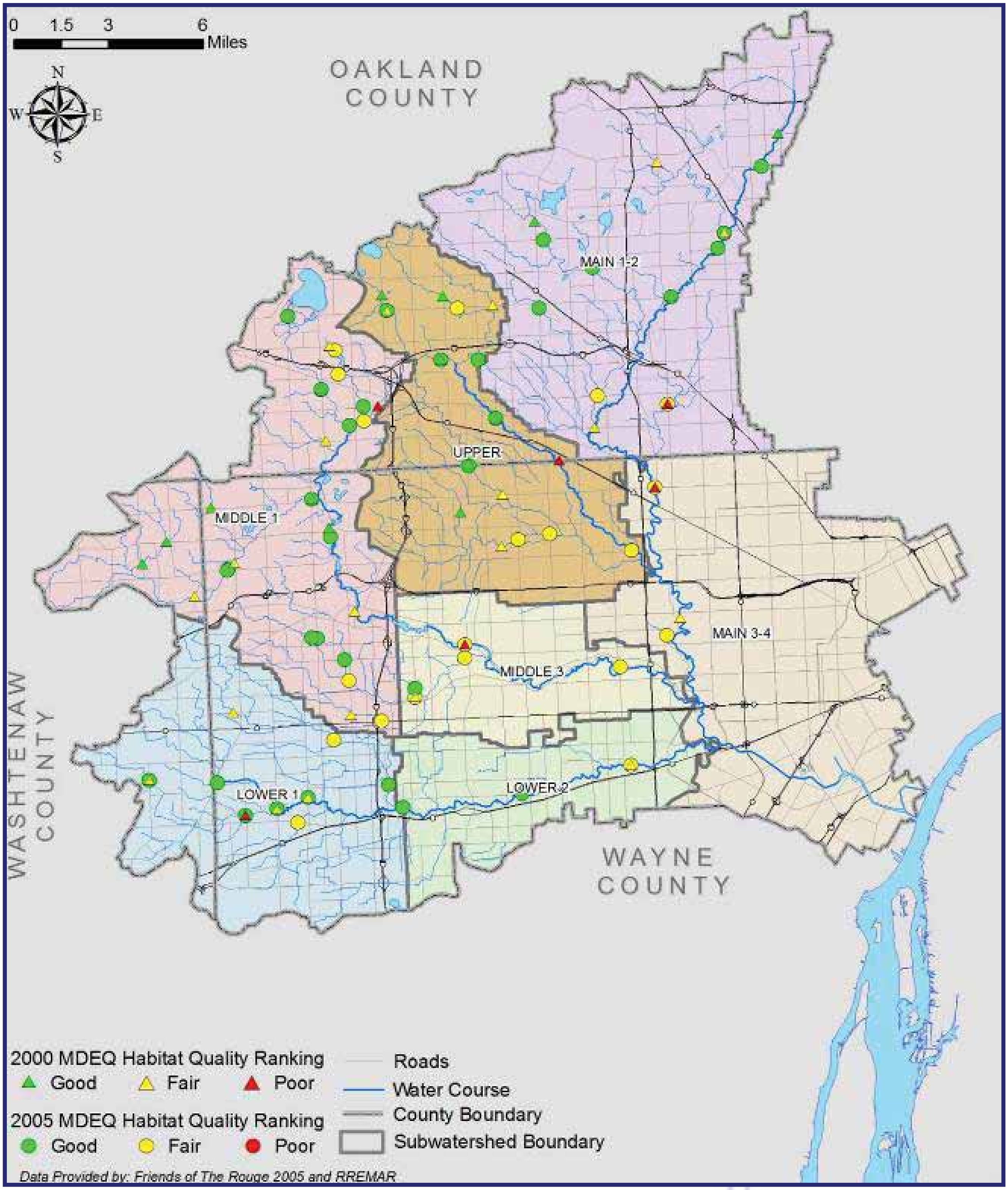


Figure 3-12: Habitat Quality Ranking



Riparian Corridor

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms, and a buffer for pollutants and sediments from surface runoff. In addition to providing habitat for aquatic organisms, the corridor is used by many birds and mammals. In many urbanized areas riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

Riverine wetlands, such as the Oxbow at The Henry Ford provide habitat for fish and wildlife while also providing education opportunities.

Wetlands

Since pre-settlement, many acres of wetlands have been lost across the watershed. According to state law, only wetlands over five acres in size or that are contiguous to or within 500 feet of a waterbody are protected by the State of Michigan. Smaller wetlands and those further away or not connected to water bodies, are not given State protection. Wetlands provide a number of beneficial functions including floral and wildlife habitat. Fish and herptile habitat, flood water storage, non-point source pollution abatement, shoreline and streambank protection, aesthetic and recreational opportunities, and groundwater recharge potential. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Maps of the remaining wetlands areas within the Rouge River Watershed can be reviewed in the specific subwatershed sections.

Lower Rouge floodplain Forested floodplain areas not only provide habitat for wildlife, but also serve a significant hydrologic function in the watershed.

Woodlands

Woodlands, forests and heavily treed areas provide many benefits to water quality, water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in this area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Maps of the remaining wooded areas within the Rouge River Watershed can be reviewed in the specific subwatershed chapters.

The communities of the Rouge River Watershed have made tremendous progress in conducting activities to improve water quality in the Rouge River. The following subchapters provide a synopsis of the conditions of the following stream indicators for each subwatershed: water quality, stream hydrology, aquatic diversity, stream habitat and stream corridor. It also identifies both high quality areas in each subwatershed and areas that present challenges to restoration. Finally, the end of each subchapter highlights significant achievements and projects that have been completed in the individual subwatersheds.

Lower 1 Subwatershed (Storm Water Management Area) Conditions

While facing significant development pressures, the Lower 1 Subwatershed communities implemented overarching storm water management standards to effectively manage the runoff from these newly developed areas. At the same time, communities have been instrumental in preserving undeveloped areas in the western edges of the subwatershed while also implementing over a dozen detention basin enhancement projects in previously developed areas. Most recently, the first recreational trail was constructed along the Lower Rouge River that not only provides local recreational opportunities, but also provides a local benefit of connecting residents to their local natural resources.

Water quality improvements have been evident through water quality sampling results and through the presence of higher quality benthic organisms throughout this subwatershed. Trout have also been observed in the headwaters of the Lower Rouge River which demonstrates improved water quality and fish habitat conditions. However, challenges continue with managing the excess storm water runoff flow and volume along with bacteria loads in dry and wet weather conditions.

Lower I highlights:
- ***Presence of higher quality benthic organisms***
- ***Trout have been observed***
- ***Lower Rouge Recreational Trail constructed.***

Subwatershed Demographics

The Lower 1 Subwatershed (Figure 3-13) is situated in the southwestern portion of the Rouge River Watershed and covers about 13% of the watershed's area or approximately 39,785 acres (approximately 62 square miles). In addition to the upstream half of the Lower Branch of the Rouge River, the Lower 1 Subwatershed's tributaries include Fellows Creek and Fowler Creek, along with many drains or smaller creek systems including the Ingall Drain, Green Drain, Mott Drain, Truesdell Creek, Hustin Drain, Parks Drain, Bazley and Foster Drain, Goodell Drain, Sines Drain, Horner Drain, Apple Run Drain, McKinstry Drain, Harrison Drain, Strong Drain, Robinson Drain, Bell Drain, McClaughrey Drain, and Bingell Drain.

Fowler Creek in Superior Township

The Lower 1 Subwatershed is located in Washtenaw and Wayne counties, and encompasses all or portions of six communities: Canton Township, Plymouth Township, Salem Township, Superior Township, Van Buren Township and Ypsilanti Township. In addition, a portion of Wayne County Airport Authority, Willow Run Airport, is also located in the Lower 1 Subwatershed. Table 3-6 summarizes the area for each member community.

Figure 3-13: Lower 1 Subwatershed

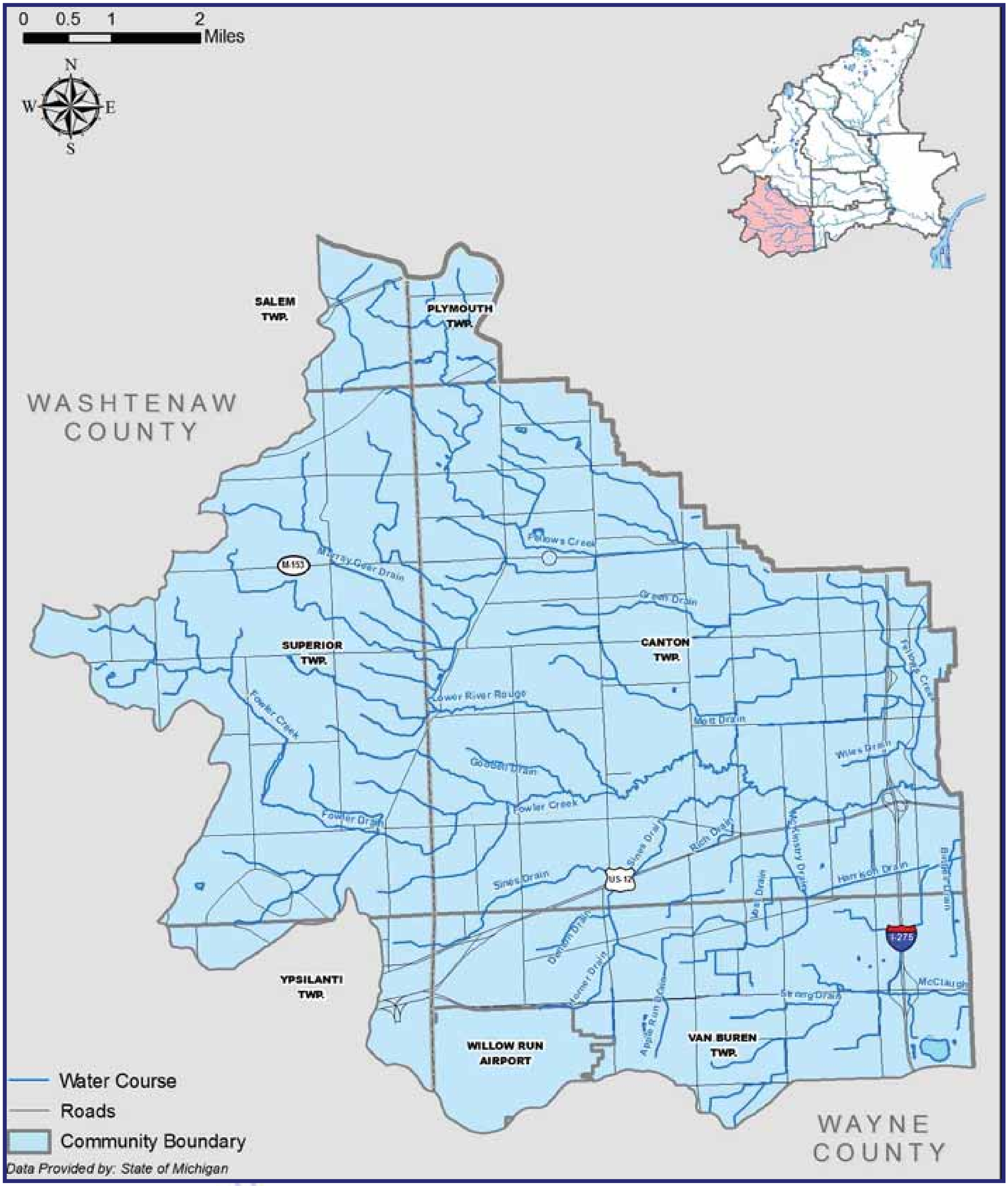


Table 3-6: Lower 1 Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Canton Township	28.6	79.4
Plymouth Township	1.3	8.3
Salem Township	1.5	4.5
Superior Township	15.8	44.6
Van Buren Township	13.2	36.8
Ypsilanti Township	1.7	5.4
Totals	**62.2**	**NA**
Counties		
Washtenaw County	19.1	
Wayne County	43.1	

The Wayne County Airport Authority is an ARC member

Impervious Cover

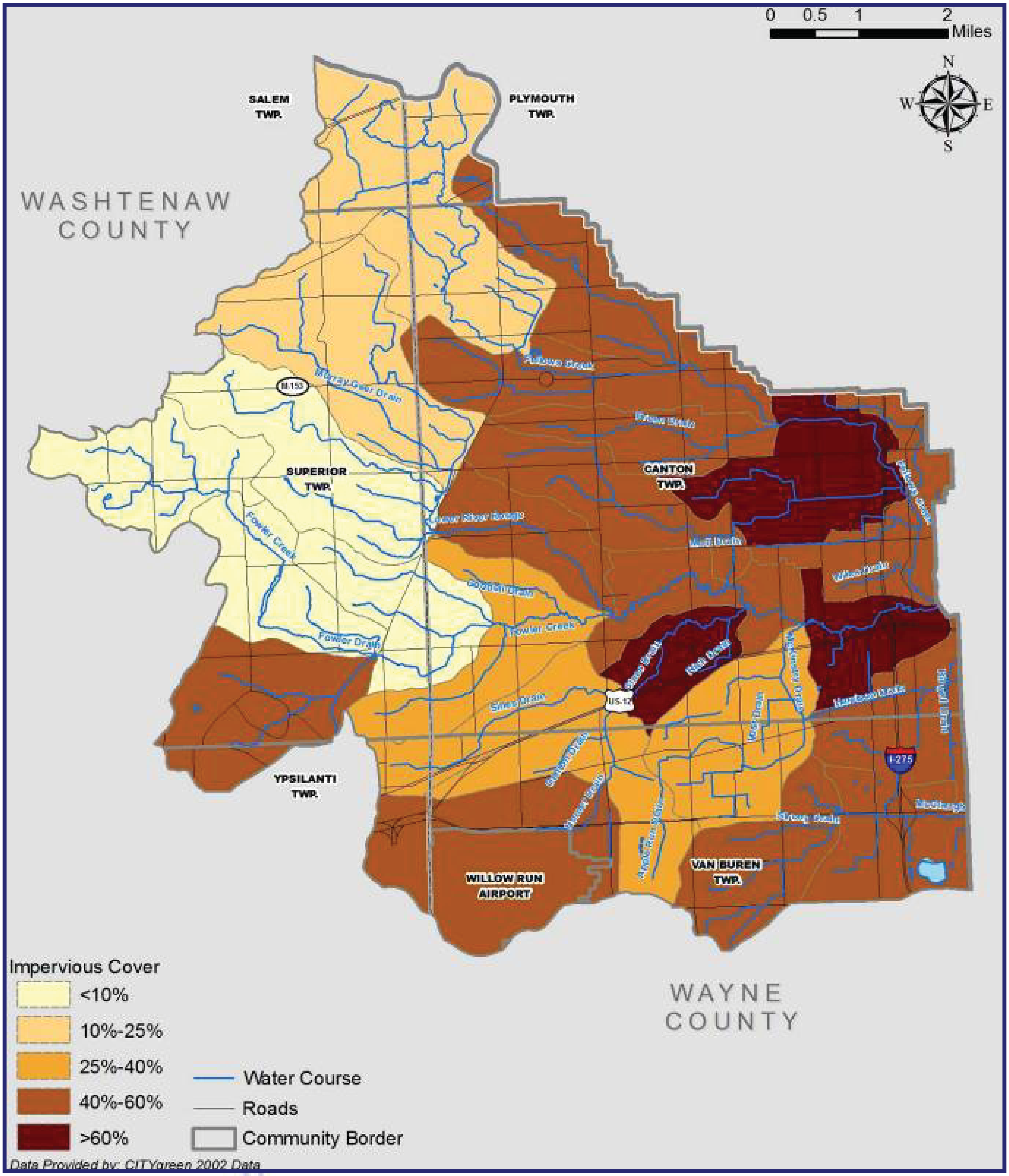
Significant changes in land use and land cover have occurred across this subwatershed between 1991-2002. Table 3-7 highlights a 16% reduction in green infrastructure with 10% attributed to a loss of open spaces and 6% attributed to a loss of trees. Impervious surfaces have replaced the green land cover as shown by a 17% increase in from 1991 to 2002.

Table 3-7: Changes in Land Cover 1991-2002

Lower 1 SWMA Land Cover	1991	2002
Open Space – Grass	44%	34%
Trees	30%	24%
SubTotal: Green Infrastructure	**74%**	**58%**
Urban: Impervious	19%	36%
Urban: Bare	7%	6%
Total	**100%**	**100%**

The western portion of the Lower 1 generally has the most pervious surfaces, while the most impervious areas are located in the downstream or eastern end of the subwatershed (See Figure 3-14).

Figure 3-14: Lower 1 Impervious Cover



Water Quality

The water quality in the Lower 1 Subwatershed is improving and has been documented by recent watershed monitoring. Since monitoring began in 2002, all measured values of dissolved oxygen (DO) on the Lower Branch have met both the State standard of 5 mg/L and the target established in the 2001 Lower 1 Subwatershed Management Plan. In fact, the mean DO concentration between 2002 and 2006 at Hannan Road (US9) was 7.8 mg/L (Catalfio, et al., 2006). The Lower 1 Subwatershed also met the dry weather target of 80 mg/L for total suspended solids (TSS) the majority of the time, but with isolated areas of higher concentrations associated with McKinstry Drain at Michigan Avenue. The Lower 1 Subwatershed still faces challenges with both dry and wet weather *E. coli* levels. Finally, it's important to recognize that the total phosphorus ratings are in comparison to a target that was established prior to the issuance of the Ypsilanti Community Utility Authority (YCUA) discharge permit. The 2001 total phosphorus target was 0.05 mg/L while the YCUA allowable total phosphorus discharge limit is 0.7 mg/L.

The Ypsilanti Community Utilities Authority (YCUA) provides water and wastewater services to communities in portions of both Washtenaw and Wayne Counties. It contracts with the Western Townships Utilities Authority (WTUA) to provide wastewater treatment services for the Townships of Canton, Northville, and Plymouth. Annually, YCUA processes over eight billion gallons of wastewater at their plant located at McGregor and State Streets near Willow Run Airport. Once treated, this water is discharged into the Lower Rouge River at Beck Road (www.ycua.org)

The Lower 1 Subwatershed Advisory Group established targets for water quality as part of the 2001 Lower 1 Subwatershed Management Plan (See Table 3-8). These targets were established prior to the development of the watershed-wide dry weather rating scale (Table 3-3 on page 3-13), but generally the Lower 1 targets are consistent with a Good rating on the watershed-wide dry weather scale.

The original total phosphorus target of 0.05 mg/L was set prior to the MDEQ permit issuance for the YCUA. The YCUA treatment plant was issued a permit with a 0.7 mg/L effluent discharge limit for Total Phosphorus (TP) and is the likely reason behind the higher TP levels in the river. The YCUA discharges into the main stem of the Lower Rouge River just downstream of the Beck Road (L01) monitoring location. The overall TP watershed plan target for the Lower Rouge River needs to be reconsidered in light of the YCUA discharge limit.

YCUA outfall

Table 3-8: Lower 1 Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Water Temperature, Warmwater Fishery (°C)	≤ 29.4 (by 2005)
Dissolved Oxygen, Warmwater Fishery (mg/L)	Daily average >5 (by 2005)
Total Phosphorus (mg/L)	Annual average ≤ 0.05 (dry weather)
Total Suspended Solids (mg/L)	< 80 by 2006 (dry weather)
E. coli (cfu/100 ml)	Partial body contact standard by 2010 when flow is > 2 cfs (dry weather)

Based on the dry weather sampling results, it is clear that progress has been made towards improving water quality conditions based on many parameters (see Table 3-9). The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. Water quality trends are indicated in Table 3-9, where sufficient data was available for a trend assessment. More detailed information is available in the most recent RREMAR. The Lower 1 monitoring sites are depicted in Figure 3-15.

*Figure 3-15: Lower 1 Water Quality Sampling and Rain Gage Locations**

*For site US9, see Figure 3-29 on page 3-65

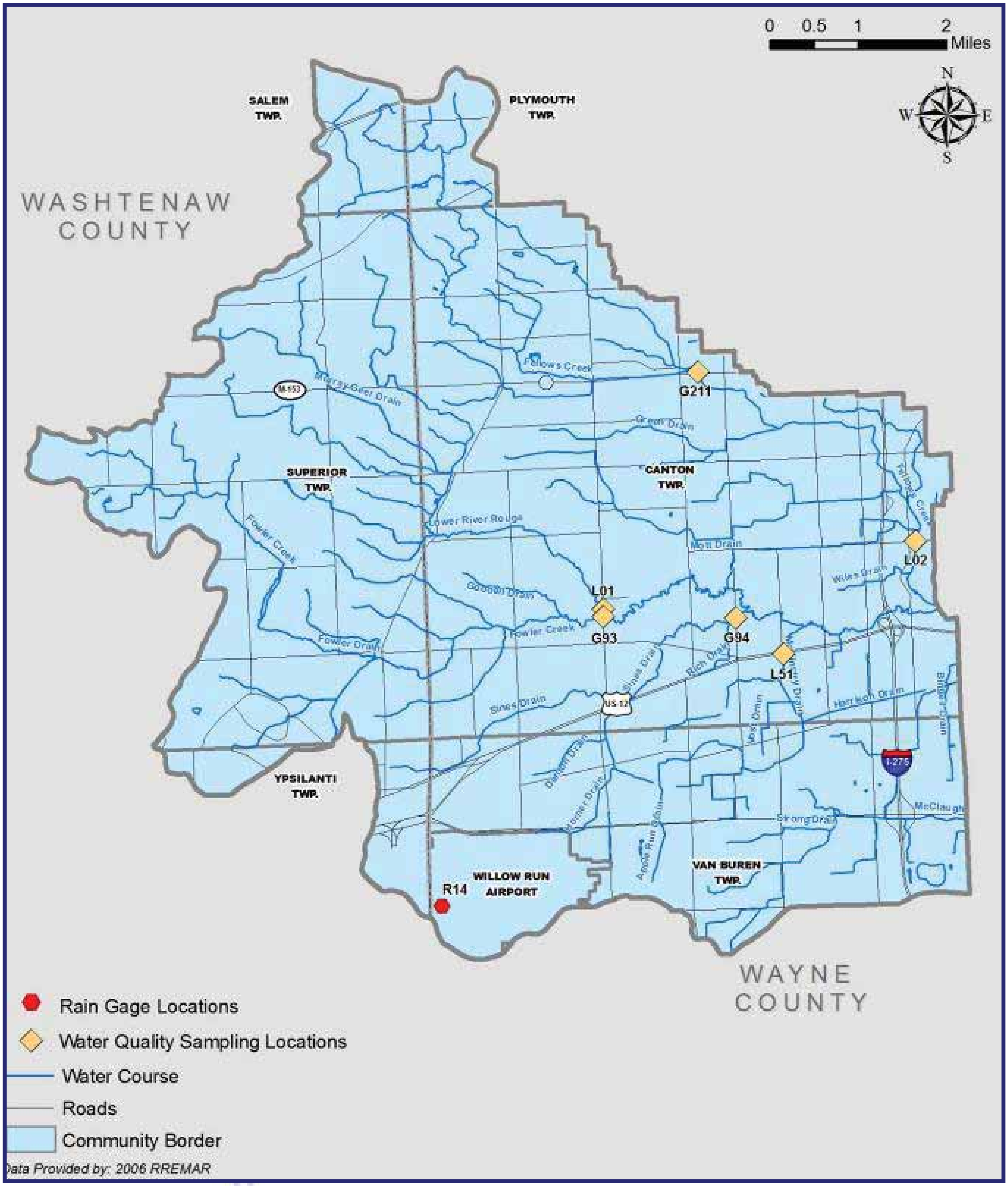


Table 3-9: Lower 1 Dry Weather Conditions - Summary

Parameter	Beck Road L01	Fowler Creek at Beck Road G93	Sines Drain at Sheldon Road G94	McKinstry Drain at Michigan Avenue L51	Fellows Creek at Ford Road G211	Fellows Creek at Palmer Road L02	Hannan Road USGS Gage US9*
Water Temperature	Good	Good	Good	Good	Good	Good	Good
Dissolved Oxygen (DO)	Good ↓	Fair ×	Fair	Good	Good ↑	Good ×	Good ↓
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Fair ↑	Poor ↑	Good	Fair ↑	Good ×	Good ↑	Good ↑
Ammonia (NH_3N)	Good ↑	Good ↑	Good	Poor ×	Good ×	Good ×	Good ↑
Total Phosphorus (TP)	Poor ×	Poor ↑	Poor	Poor ↑	Poor ×	Poor ↑	Poor ↑
Total Suspended Solids (TSS)	Fair ↑	Good ×	Good	Poor ×	Good ×	Good ↑	Good ×
E. coli	Fair ×	Fair ×	Fair	Fair ↑	Poor ×	Fair ×	Fair ↑

↑ Indicates an improving trend ↓ Indicates a declining trend × Indicates no trend

*US9 is actually located in the Lower 2 just east of the Lower 1; however, the site is included in this section because it provides a good indication of the overall conditions of the Lower 1.

DO and Temperature

The DO and temperature ratings for most monitoring sites were Good. Both the Lower 1 Subwatershed targets have been achieved for DO and water temperature at the USGS site on Hannan Road, however, most recently, a declining trend in DO was noted. Average DO concentrations between 2002 and 2006 were approximately 7.8 mg/L and all measured values met the 5 mg/L state standard. The maximum temperature recorded in 2006 was 26.6°C which is less than the Lower 1 Subwatershed target of 29.4°C (Catalfio, et al., 2006).

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

Total Suspended Solids(TSS) and Phosphorus (TP)

While there is a range of conditions for TSS results across the Lower 1 Subwatershed, the dry weather Lower 1 target of 80 mg/L was met 96 percent of the time. Elevated phosphorus concentrations persist in the Lower 1 as noted by the Poor ratings at all sites. As stated previously, the 2001 total phosphorus target was 0.05 mg/L while the YCUA allowable total phosphorus discharge limit is 0.7 mg/L. As a result, the Lower 1 TP target is not being met. However, slight improvements have been noted at some sites (Catalfio, et al., 2006).

E. coli Results

The *E. coli* information collected in the Lower 1 indicates that bacteria continue to be a problem in the river and that untreated sewage and other sources continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source

tracking (BST) analysis was also conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human sources. Continuing the efforts of the MDEQ, in 2006, the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.
The 2005 *E. coli* data indicated that the Lower 1 frequently exceeded total body contact water quality standards and it routinely exceeded partial body contact standards (see Figure 3-16). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum and agricultural animals like horses, cows or pigs. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), aging sanitary sewers and failing septic systems, also known as on-site sewage disposal systems (OSDSs).

The 2005 and 2006 BST data showed human sources of *E. coli* are suspected at seven sites during wet conditions (see Figure 3-17). Since there are no CSOs in the Lower 1, the likely *E. coli* sources are illicit connections to storm drains, aging sanitary sewers and failing septic systems. As an example of a human source, a failing septic system was found at a motel along Sines Drain upstream of the G94 monitoring location (Sines Drain at Sheldon Road). The Wayne County Health Department removed the illicit discharge pipe to the drain and declared the building unsafe for human occupancy (Catalfio, et al., 2006).

Septic systems exist in parts of all six Lower 1 Subwatershed townships, but are mostly concentrated in the rural townships of Superior, Salem, and Ypsilanti. The urbanized areas of the subwatershed are generally serviced by sanitary sewers that carry wastewater to a wastewater treatment plant. Both systems are effective in properly treating wastewater if sited, installed and maintained correctly. However, if septic systems are not constructed or maintained properly, they can be the source of pollution to receiving surface waters and cause a significant threat to public health. In addition to threatening human health, high counts of bacteria from these sources can impair fish, wildlife, and benthos populations and habitats by accelerating aquatic plant growth or eutrophication, which can cause a decrease in oxygen levels, restrict water-related recreation, and degrade aesthetic values. Septic systems can be improperly sited on clay soils that cannot percolate which also leads to failures. Because of these potential problems, most county health departments regulate the installation and repair of septic systems.

Figure 3-16: 2005 E. coli Sampling Results

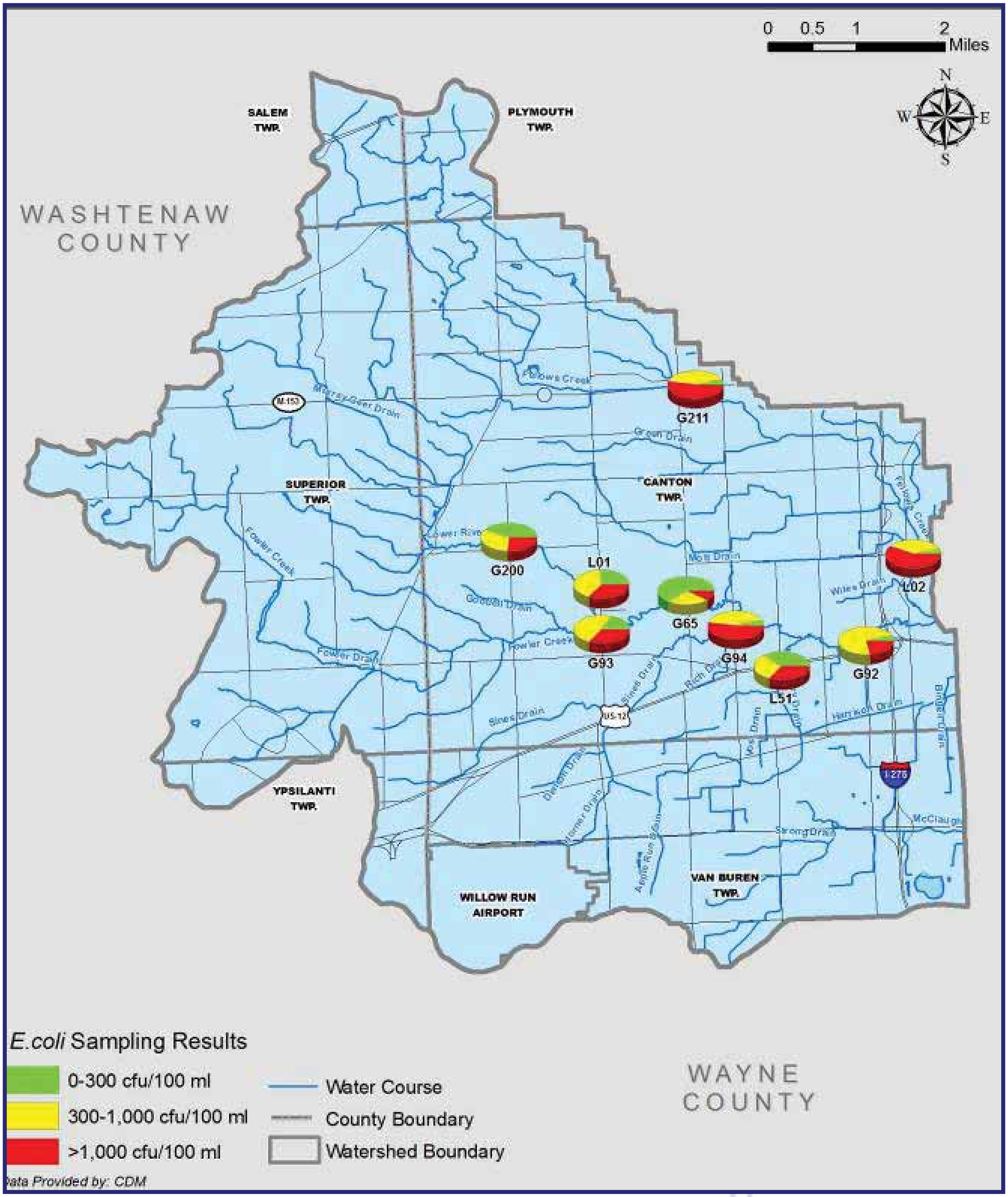
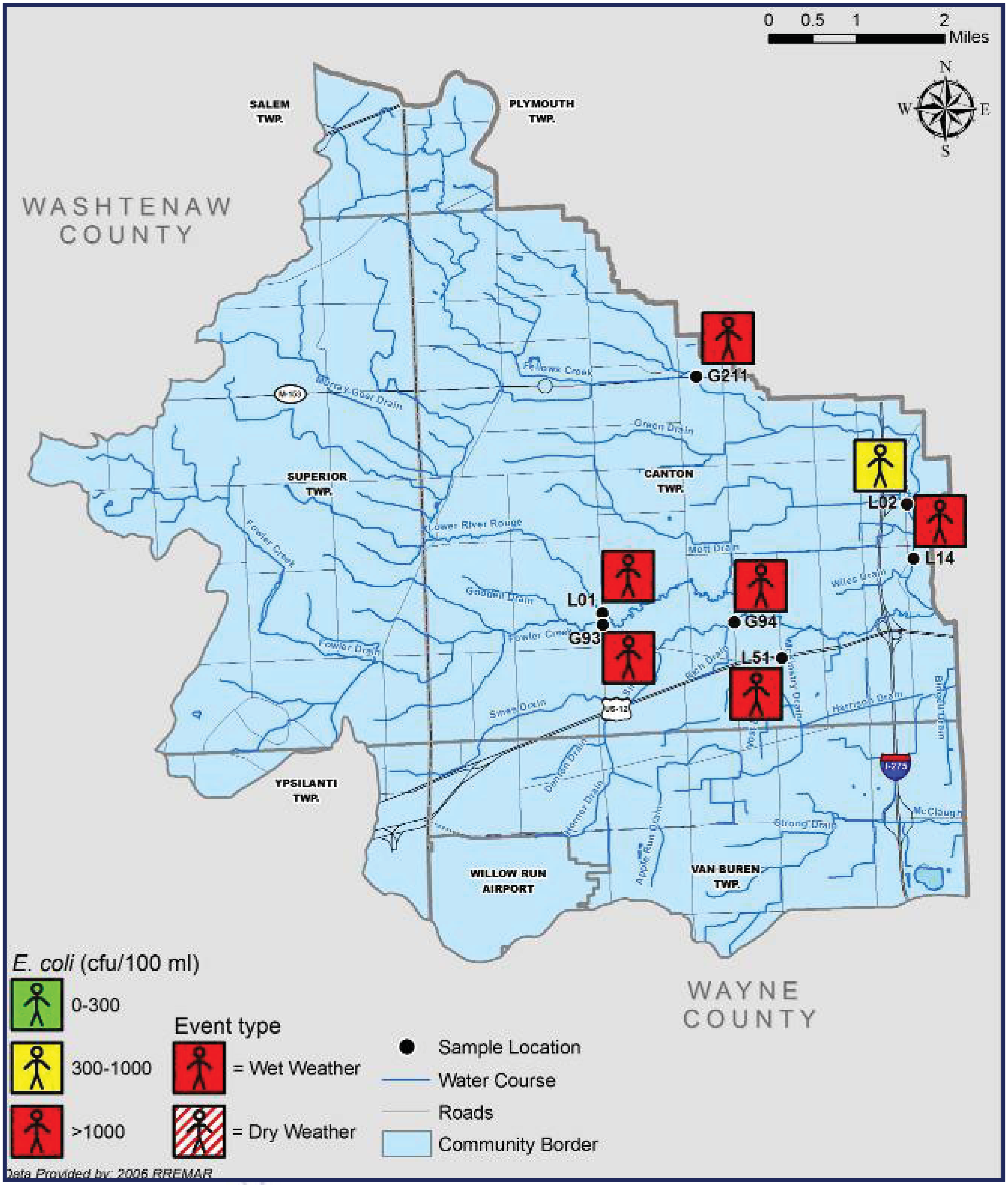


Figure 3-17: Lower 1 Bacterial Source Tracking Results



Some counties, such as Washtenaw County, require the installation and maintenance of both a main and reserve septic field for alternating use, thereby decreasing the possibility of overuse or leaking of either field. Both Washtenaw and Wayne County require time-of-sale inspection of septic systems, which require correction of leaking or improperly sited septic fields when real estate is sold. Sanitary sewer systems can also be improperly constructed and poorly maintained. For example, a sanitary sewer pipe can be mistakenly connected to a storm water system which creates an illicit discharge, conveying the wastewater directly and untreated into creeks and rivers. Additionally, sanitary sewer pipes can break and leak or can be overloaded beyond capacity, creating environmental and public health hazards.

Water Quality in Wet Weather Conditions

While the overall water quality of the Lower 1 has improved, there continues to be challenges associated with wet weather. Only the site at Hannan Road (US9) was sampled during wet weather conditions in 2006. This is the first time that this site was sampled. The following observations were made:

- Sampling results indicated that TSS concentrations were only slightly higher and *E. coli* concentrations were nine times higher than the corresponding dry weather values;
- The other three parameters were only slightly lower in wet conditions; and
- All of the *E. coli* daily geometric means exceeded the State's partial body contact standard of 1,000 cfu/100mL.

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water runoff contributes significant pollutant loading to the Lower Rouge River in this subwatershed. The estimate of pollutant loading is used as one tool to affect management practices to reduce the impact on water quality. Total pollutant loading considering base flow, point sources, CSOs and non-point sources was estimated for the Rouge River using the WMM model. The estimated existing pollutant loads for the Lower 1 subwatershed are summarized in Table 3-10.

Pollutant Abbreviations:

BOD: Biochemical Oxygen Demand
DP: Dissolved Phosphorus
NO_2: Nitrite
NO_3: Nitrate
TKN: Total Kjeldahl Nitrogen
TP: Total Phosphorus
TSS: Total Suspended Solids

Table 3-10: Existing Pollutant Loads for the Lower 1 Subwatershed

Pollutant	Units	Source (%)				Total Load
		Base Flow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	11%	66%	23%	0%	1,240,00
DP	lbs/yr	8%	20%	72%	0%	29,700
Fecal Coliform	counts/yr	<1%	100%	0%	0%	1.8×10^{15}
NO_2 & NO_3	lbs/yr	9%	15%	76%	0%	531,000
TKN	lbs/yr	27%	44%	29%	0%	200,000
TP	lbs/yr	10%	28%	62%	0%	50,200
TSS	lbs/yr	37%	51%	12%	0%	6,810,000

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the

Rouge River. When considering bacteria and total suspended solids, pollutant loadings from storm water runoff are most significant. However, when considering phosphorus and other nutrients, the contribution from point sources is most significant. These results are expected given the YCUA discharge into the Lower Rouge River.

The Lower 1 Subwatershed was subdivided into 16 subbasins as a part of the modeling effort. The total pollutant loads associated with non-point (storm water) sources for fecal coliform, total phosphorus and total suspended solids within each subarea are shown in Figures 3-18, 3-19 and 3-20. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

The non-point source loadings maps demonstrate that higher levels of impervious cover generate higher pollutant loadings in non-point source runoff. The highest TSS and TP concentrations were predicted in the headwaters of Fellows Creek, Willow Creek and the I-275/Michigan Avenue corridor. The highest fecal coliform concentrations were predicted in Fellows Creek, which is consistent with the Poor rating from *E. coli* concentrations found on Fellows Creek at Ford Road.

The primary sources of phosphorus in the critical Lower 1 subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, agricultural crop runoff and feedlots, pet and livestock wastes, illegal sewer connections and failing septic systems. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils from agricultural fields without buffer strips and from construction sites without proper soil erosion control practices.

Stream Hydrology

The hydrologic trend along the Lower Rouge demonstrates ongoing flow variability issues and continues to cause excessive erosion and habitat degradation. The 2001 Lower 1 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under two inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability while the bankfull, or overbank flood event, occurs on the order of every two years in stable river systems, this study evaluation determined that it occurs on the order of every one to two months at the mouth of this subwatershed.

Figure 3-18: Lower 1 Fecal Coliform Estimated Non-Point Source Load

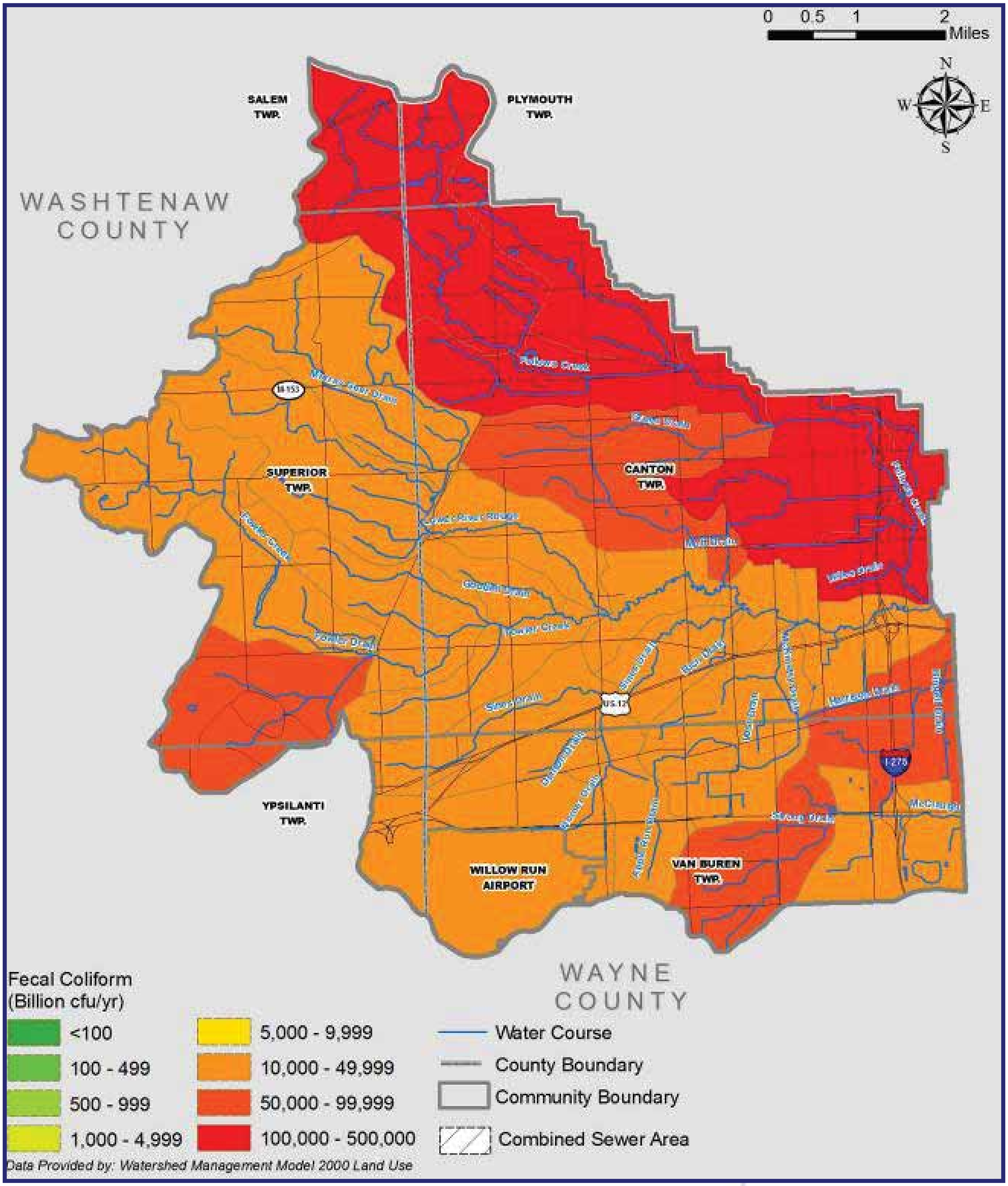


Figure 3-19: Lower 1 Total Phosphorus Estimated Non-Point Source Load

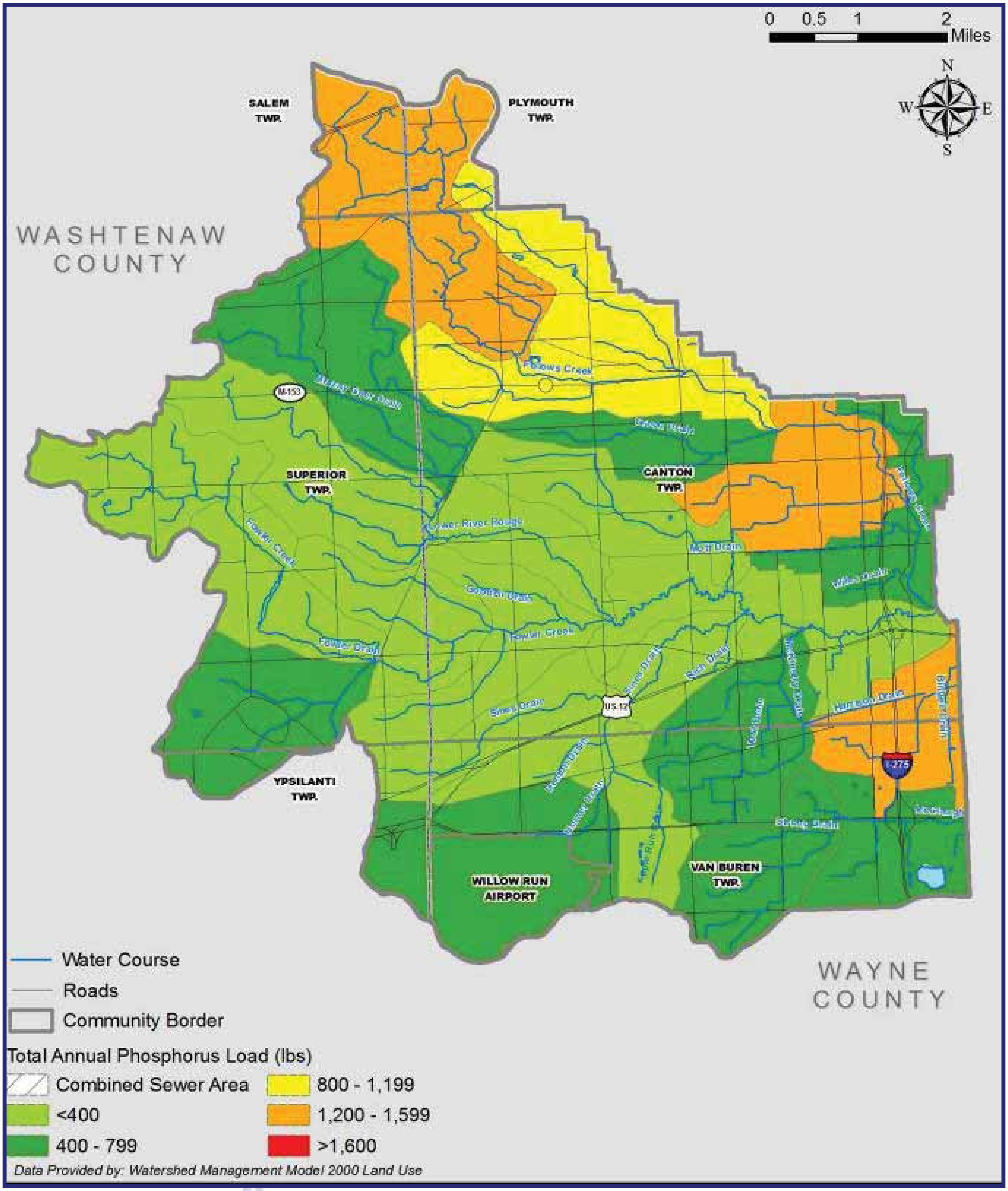
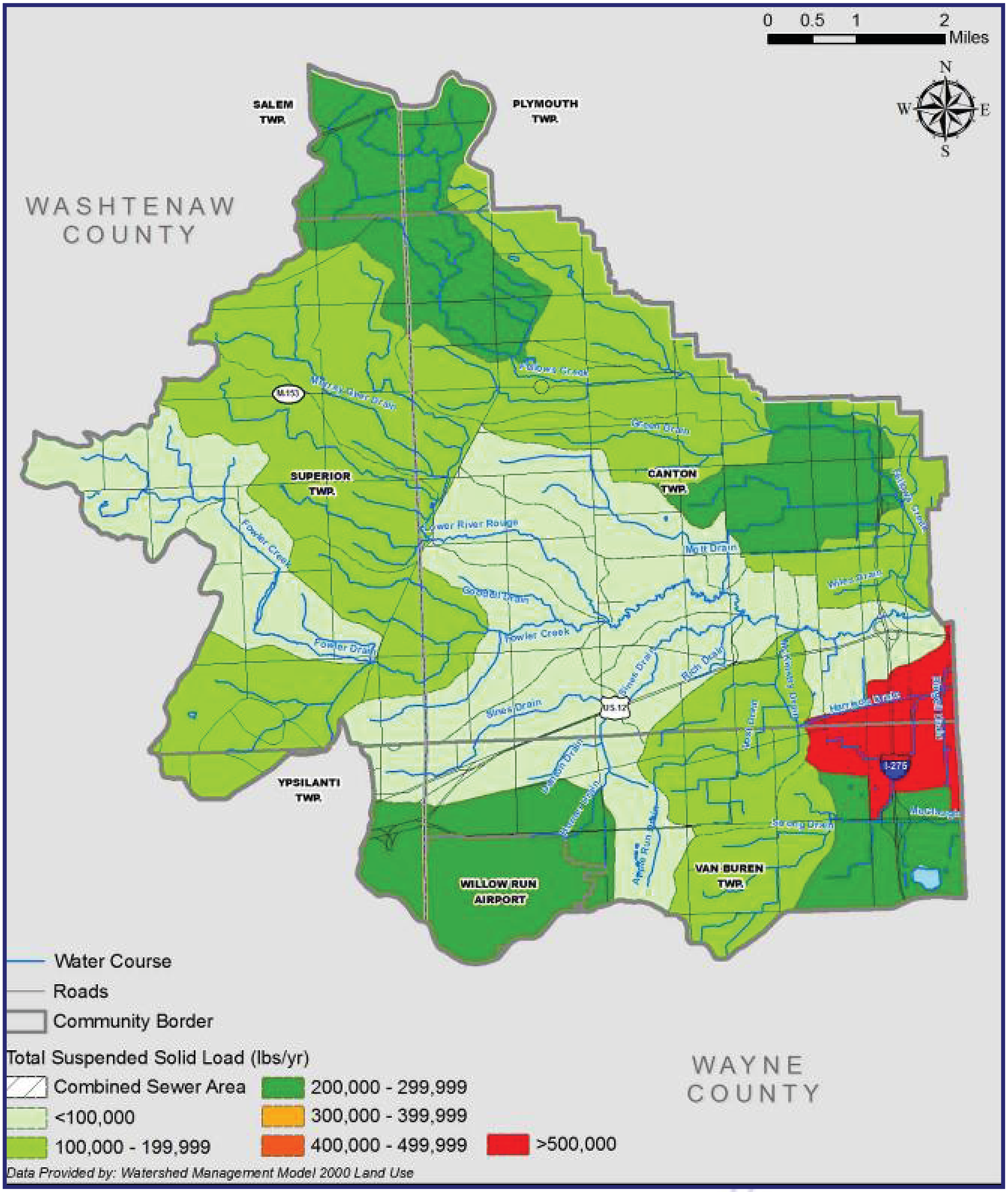


Figure 3-20: Lower 1 Total Suspended Solids Estimated Non-Point Source Load



A hydraulic analysis was completed to help identify Best Management Practices (BMPs) that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

Figure 3-14 on page 3-32 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04167625), Lower Rouge at Wayne (L06), provides appropriate flow information for identifying goals for the Lower 1 subwatershed.

Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events. These results are shown in Table 3-11.

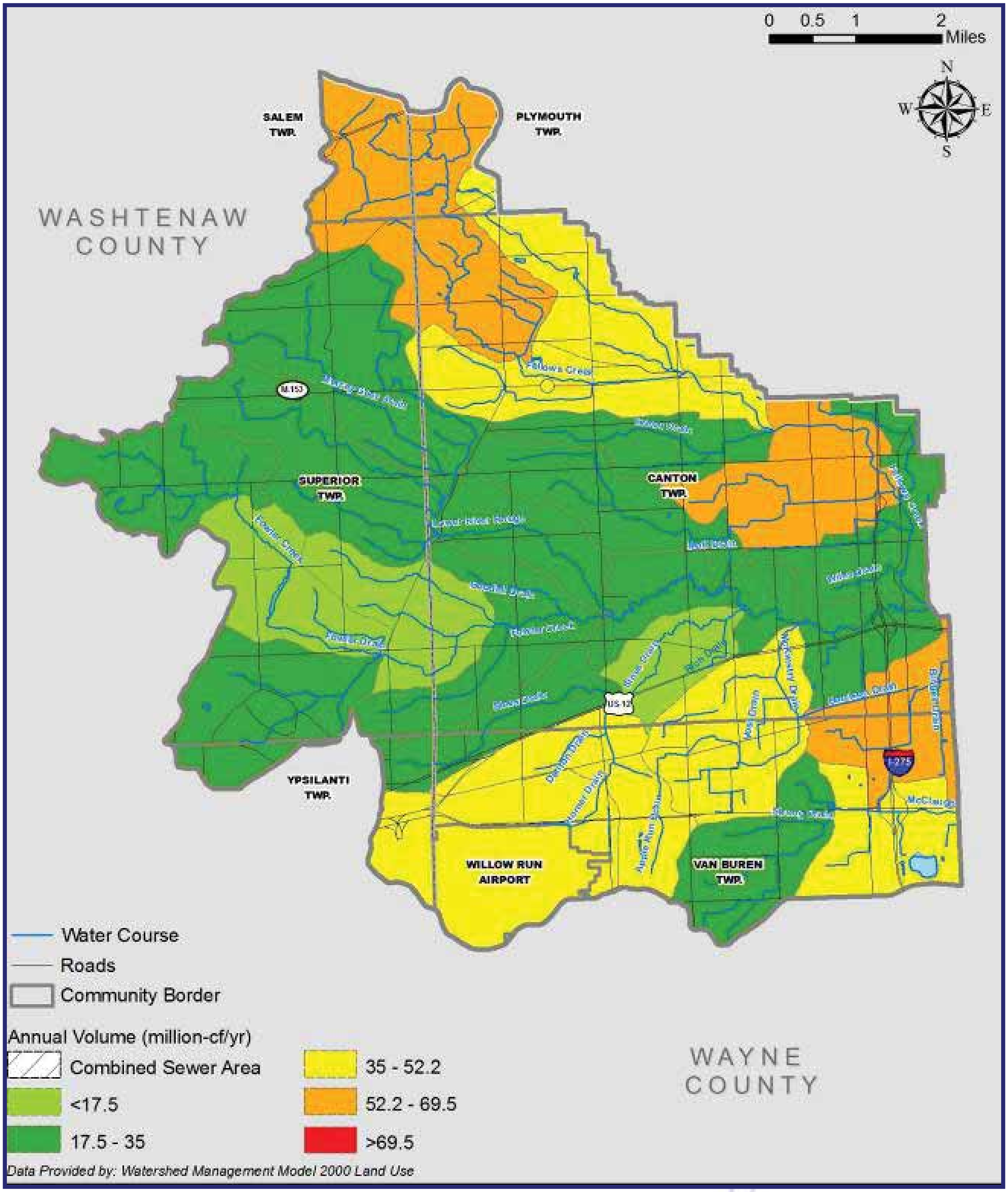
Table 3-11: Lower Subwatershed Flow Rate Trends at Site L06 (Lower Rouge River at Wayne Road)

Bankfull Flow Rate	321 cfs with return period of 1.2 months
15-day	130 cfs
30-day	266 cfs

Figure 3-21 represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

The combination of the gage analysis, impervious cover and annual storm water runoff volume across the subwatershed provide important information for focusing efforts on reducing storm water runoff volume. Reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 52,300,000 cubic feet of storm water (0.362 inches of water over the subwatershed) is needed to work towards reducing the effect of the small storms. It is important to note that the water should be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

Figure 3-21: Lower 1 Storm Water Runoff Non-Point Annual Volume



Detention pond in Canton Township

A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands, similar to the Fellows Creek Regional Wetland area, might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing road-side ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bioretention basins or rain gardens, and porous pavements can be installed on individual properties. Additional agricultural BMPs, such as buffer strips, drain tile minimization and no till drill techniques would also help reduce the amount of water flowing into the waterways.

Ecosystems

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Lower 1 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitat is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Trout caught in Canton Township
Photo credit: Kurt Kuban

Aquatic Diversity

Fish Communities

Fish communities in the Lower 1 Subwatershed have consisted of the common shiner, creek chub, fathead minnow and the central mudminnow, however, the addition of the YCUA baseflow enhancements have created opportunities for other fish populations. In fact, steelhead have been observed and caught in the area of Beck Road along the Lower Rouge River. Potential game fish that could be supported include northern pike, rock bass and smallmouth bass (Wiley, et., al. 1998).

The main factors negatively affecting fish community integrity in the Lower 1 Subwatershed are believed to be excessive flow variation and lack of appropriate spawning habitat. Stream quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities. Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

Four sites located in the Lower 1 Subwatershed were surveyed as a part of the 1995 MDNR fish assessment. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species* *composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981).

The MDEQ completed additional surveys in 2000 and 2005 using the GLEAS 51 procedure (MDEQ, 2005). Samples from two sites were collected in the Lower 1 Subwatershed during the 2000 MDEQ biological assessment and three sites were surveyed in 2005. Unfortunately, direct correlation and trends between the 1995, 2000, and 2005 surveys are not possible because the survey points were different in each study. Figure 3-22 shows the overall fish community rating for the above-referenced surveys.

Biotic integrity – a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"

(Karr & Dudley, 1981)

The dominant species found in the Lower 1 Subwatershed include the common shiner, creek chub, fathead minnow and the central mudminnow. Other common species of the Lower 1 Subwatershed included the central stoneroller, common shimmer, northern redbelly dace, fathead minnow, blacknose dace, creek chub, white sucker, central mudminnow, brook stickleback, green sunfish, pumpkinseed sunfish, bluegill, largemouth bass and the Johnny darter. Game fish, including black bullheads and largemouth bass were collected at Beck Road while largemouth bass and sunfishes were collected from Fellows Creek. The headwaters of Fellows Creek supports the most diverse fish community recorded in the Lower 1 Subwatershed. The greatest number of individual fish collected during a survey site occurred at Sines Drain at Geddes and Fowler Creek at Harris Road.

It is assumed that existing conditions are reflective of the most recent studies with the notable exception of the stream east of Beck Road in the vicinity of the YCUA outfall. The additional discharge of cool, oxygenated water contributed by the outfall is providing unique and positive changes in the ecology evidenced by the existence of trout in the immediate area downstream of the outfall.

Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Lower 1 Branch. These fish and their associated advisories were last updated in 2007, as shown in Table 3-12. As with previous advisories, polychlorinated biphenyls (PCBs) are the major contaminant preventing unlimited consumption of fish in the Lower 1 Subwatershed.

Figure 3-22: Fish Community Assessments Results

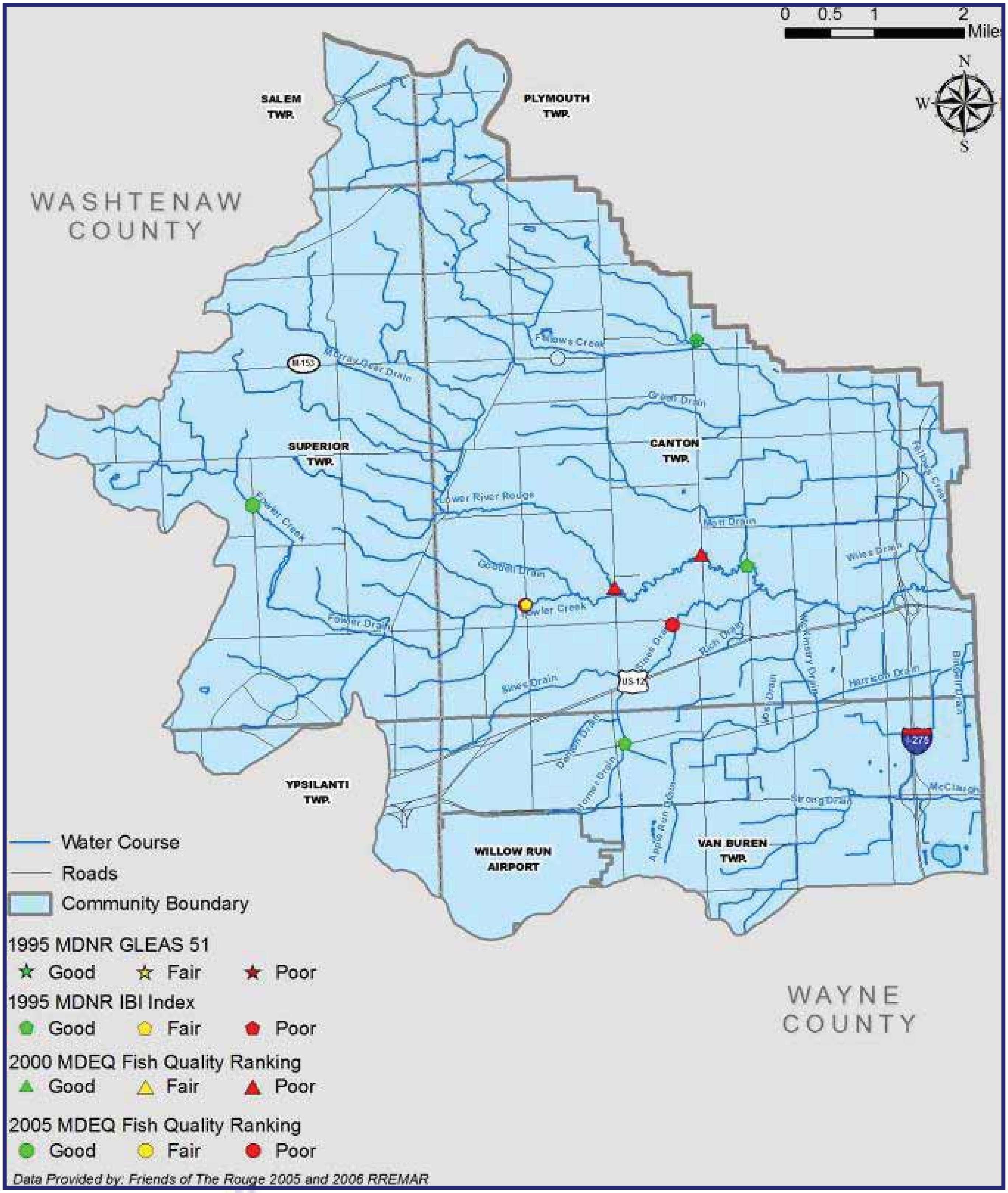


Table 3-12: 2007 Fish Consumption Advisories for the Lower 1 Subwatershed

Location	Fish Species	Contaminant	General Population*	Women and Children**
Lower Branch	Carp	PCB's	<26" Unlimited consumption, >26" Do not eat	<26" Six meals per year, >26" Do not eat
	Suckers		<14" Unlimited consumption >14" Do not eat	<14" Six meals per year, >14" Do not eat
Lakes/Impoundments	Rock Bass, Yellow Perch or Crappie	Mercury	No more than one meal per week of fish over 9 inches	No more than one meal per month
Lakes/Impoundments	Bass, Walleye, Northern Pike or Muskellunge	Mercury	No more than one meal per week of fish any size	No more than one meal per month

Notes:
* Men and boys over the age of 15 and women who are beyond childbearing years.
** Women of childbearing years and children under the age of 15.

Notable Areas

Fish communities found in headwater tributaries of the Lower 1 Subwatershed, including Fowler Creek and Sines Drain at Geddes Road, exhibit the diversity and quantity of fish species typically found in this type of system. With the increased baseflow at Beck Road from the YCUA outfall, the Lower Rouge has been transformed from being a very low baseflow system to a mid-sized river with moderate baseflow yields (Wiley et.al., 1998). The YCUA discharge has also caused a marked improvement in DO levels. This new hydrologic configuration creates a potential fishery opportunity in the Lower 1 Subwatershed of up to 29 species with angling opportunities for seven species including smallmouth bass, walleye, and northern pike. Similar rivers in Lower Michigan contain 23 species including six sport fish species. Future temperature monitoring is needed to clarify the fisheries potential of this reach. Within the past couple of years, local representatives have also cited trout in this section of the river. Thus, continued attention to rehabilitation of this branch will produce significant improvements to both habitat and aquatic community diversity.

Rock bass

Impairments

The excessive flow variation and lack of appropriate spawning habitat have been the main factors negatively impacting the Lower 1 Subwatershed fish community. The YCUA base flow enhancement has dramatically increased the fishery potential of the Lower 1 Subwatershed. In low base flow systems like the Rouge River, base flow enhancement may be a particularly useful tool to enhance sport fish populations.

Recent urbanization of land surrounding headwater tributaries has increased point and non-point storm water inputs which continue to impair water quality and hydrology. Increased flashiness contributes to streambank erosion and sedimentation which results in myriad negative impacts on the biota. High flows carry away small woody and other debris from the stream channel, eliminating flow refugia and hard substrates upon which many macroinvertebrates forage and endemic fish species lay eggs. Excessive sedimentation covers and embeds critical habitat leaving a relatively flat channel configuration. Elimination of terrestrial components necessary for moderating the intensity of storm water flows has also resulted in a decrease in ground water flow and loss of riparian canopy that may result in increased in-stream temperatures and lower retention of dissolved oxygen.

The natural geology of the Lower 1 Subwatershed also restricts high rates of groundwater contribution to streams, therefore negative impacts caused by poor storm water management and removal of riparian buffer zones are magnified. Increases in extreme peak flow and low base flow and increases of temperature are likely to occur as continued development of the headwaters occurs.


Bug hunt volunteer

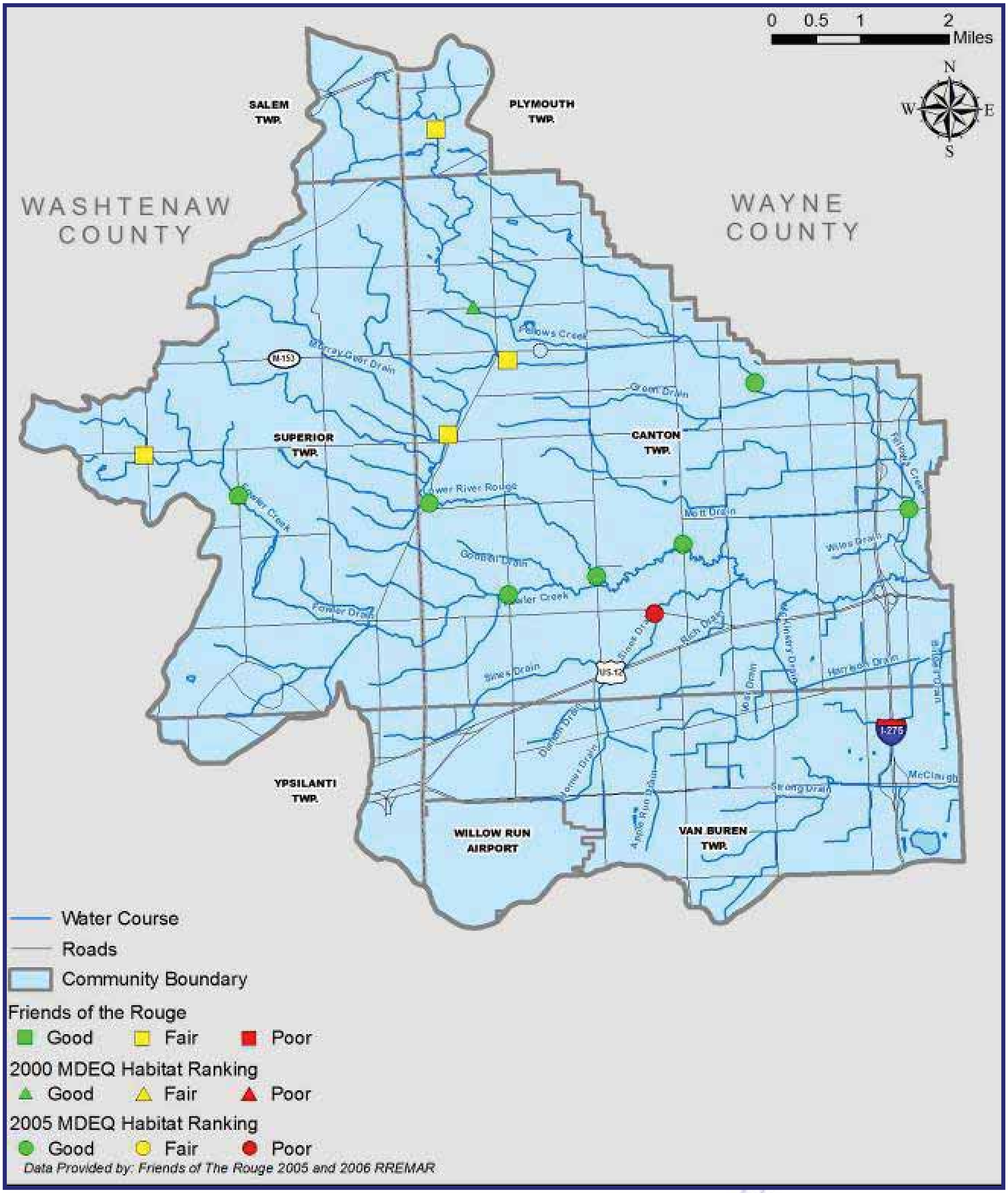
Macroinvertebrate Communities

As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed, is also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decades. Below is a description and summary of these results within the Lower 1 subwatershed.

FOTR began sampling in the Lower 1 Subwatershed in 2002 and has nine spring sampling sites, eight fall sampling sites and six winter stonefly sampling sites. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation. Figure 3-23 shows the FOTR sampling locations. Specific information about what sites have been sampled when, the rating, quality of macroinvertebrates and number of taxa, may be reviewed in the current RREMAR or on the FOTR website (www.therouge.org).

Figure 3-23: Lower 1 Macroinvertebrate Assessments



The data generally indicates the quality of the various sites throughout the Lower 1 Subwatershed have remained relatively similar over time. The FOTR Winter Stonefly data also indicates the headwaters of both Fowler and Fellows Creeks are consistently rated Good to Excellent.

Bug survey in Flodin Park in Canton Township

Stoneflies have been found at Fowler Creek in Superior Township at the Cherry Hill and Prospect Road site six years in a row. In addition, stoneflies have been found the last two years at the newly surveyed Lower Branch site in Canton Township at the Cherry Hill and Ridge roads site. Various sites along Fellows Creek have also had stoneflies during the last six years. During the survey of 2007, two of the three sites in the upper headwater sections of Fellows Creek had stoneflies.

Notable Areas

The headwaters of Fowler Creek at Prospect and Cherry Hill roads in Superior Township and the Lower Rouge River at Cherry Hill and Ridge roads in Canton Township contain a diverse assemblage of aquatic macroinvertebrates including sensitive species. In fact, caddisflies were actually found in this area.

Impairments

Lack of habitat variability, especially pools and riffles, and in-stream cover have been identified as the causes of impairment. Streams that exhibit this type of impairment typically experience frequent occurrences of extreme peak and low flows. In addition, increased imperviousness across the subwatershed has been demonstrated to have impacts on many stream characteristics. Channel incisions caused by flow variability also reduces pool and riffle habitat and recruitment of organic materials and woody debris necessary for the development of a diverse macroinvertebrate community.

American Toad

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed, however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

In 1999 and 2000 the MDNR completed a voluntary Frog and Toad Survey for the Rouge River Watershed. Results of MDNR surveys for the Lower 1 Subwatershed are shown in Table 3-13 (MDNR, 2006).

Table 3-13: MDNR Frog and Toad Survey - Percent of sections in which species were heard in Lower 1 Subwatershed

Species	1999	2000
Wood Frog	25	0
Western Chorus Frog	0	50
Spring Peeper	100	25
American Toad	100	0
Northern Leopard Frog	0	0
Gray Tree Frog	25	75
Green Frog	50	25
Bullfrog	0	25
Total Sections Surveyed	4	4

Similar to the MDNR, the FOTR began a Frog and Toad Survey in 2000. Based on the FOTR information, all eight species of native frog and toads are present in this subwatershed (See Figure 3-24). Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time. There were no notable trend differences between these two years and the previous ones. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area. Table 3-14 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 2000 through 2007.

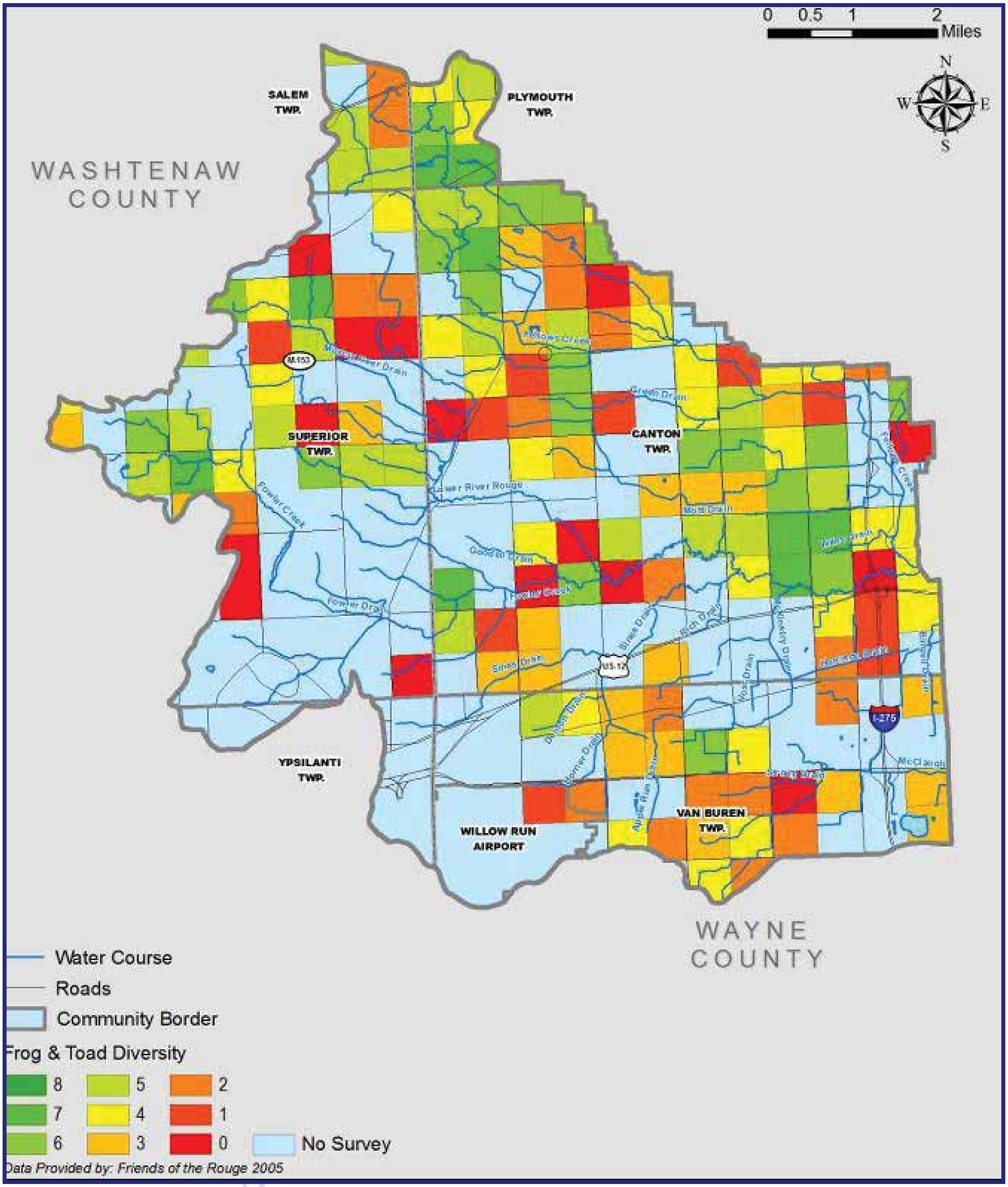
Table 3-14: FOTR Frog and Toad Survey Percent of blocks in which species were heard in Lower 1 Subwatershed

Species	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	6	6	17	29	41	35	33	28
Western Chorus Frog	82	84	78	76	87	89	82	83
Spring Peeper	61	61	65	46	54	69	59	67
American Toad	73	71	76	54	64	72	76	92
Northern Leopard Frog	3	3	9	20	30	26	20	25
Gray Tree Frog	70	71	50	46	67	93	67	81
Green Frog	18	16	33	34	56	75	71	64
Bullfrog	0	0	4	5	11	18	0	11
Total Blocks Surveyed	33	31	46	41	47	37	22	36

Notable Areas

All eight species were heard within the Lower 1 Subwatershed. In general, species of wood frogs were more prevalent in the headwater areas of the subwatershed, however, they were also heard in both the newly constructed Flodin Park and in other areas of Fellows Creek. This can generally be attributed to prevalence of a diversity of aquatic and semi-aquatic habitats found in the upstream reaches of

Figure 3-24: Lower 1 Frog and Toad Diversity



the Lower 1 Subwatershed. The Northern Leopard Frog and Bullfrog were heard in the fewest survey blocks.

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease or differences in temperature and precipitation from year to year. Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man-made wetlands can be appropriate substitutes; provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Stream Habitat

Stream habitat in the Lower 1 Subwatershed varies in conditions due to flow rate variability, excess storm water volume and water quality. The extreme headwater areas have abundant populations of macroinvertebrates, thus the stream habitat is good in these areas. Where macroinvertebrate populations are not abundant, generally stream habitat conditions are also poor.

Quality stream habitat includes:

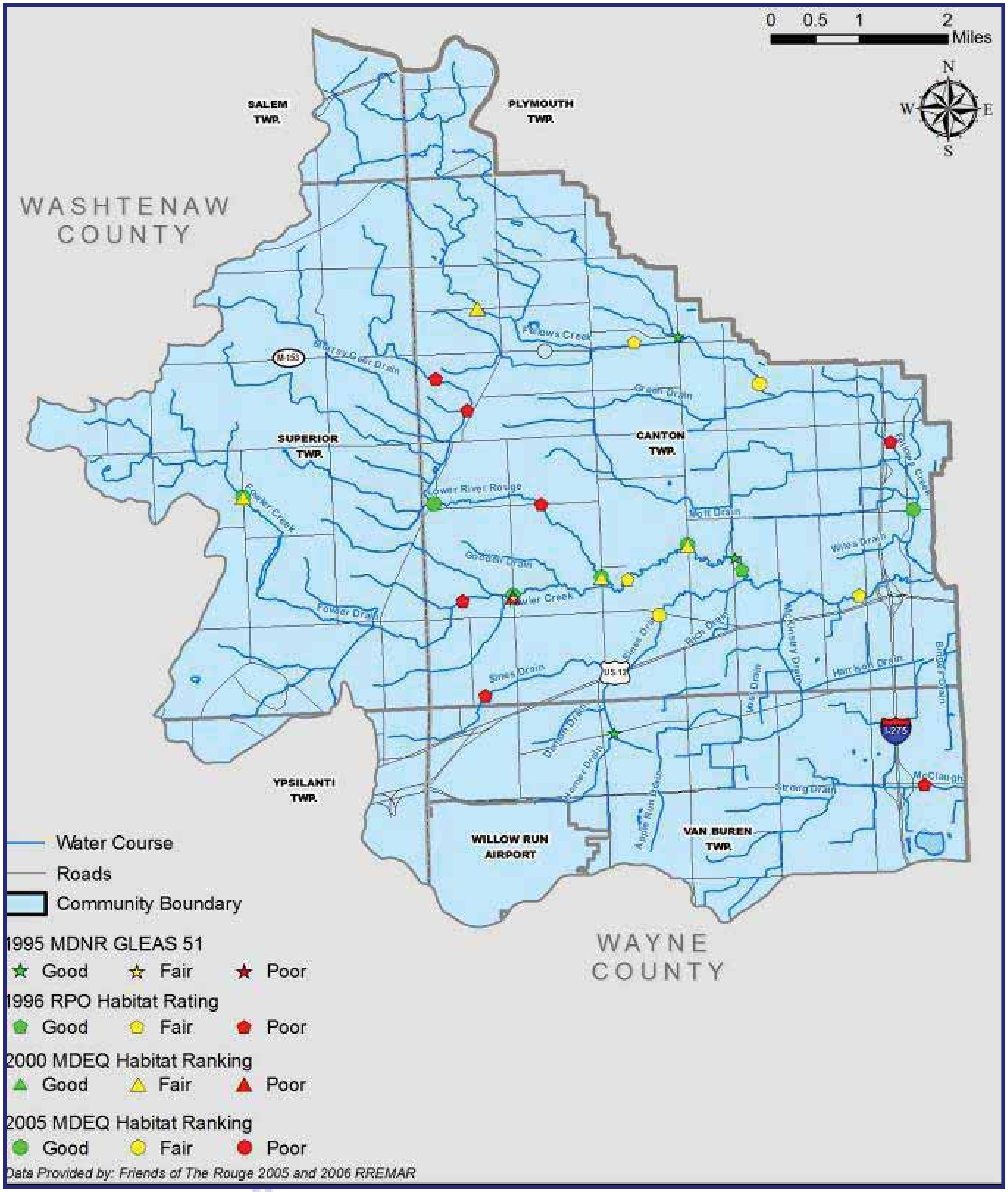
- ***diversity (pools, riffles, and woody debris)***
- ***suitable substrate types***
- ***available cover***
- ***flow stability***
- ***depth variability***
- ***low sedimentation***
- ***stable streambanks***
- ***stable water temperatures***

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in the Stream Hydrology section above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels; and decline in undercut banks.

Evaluations of stream habitat were conducted by the MDNR in 1995 and again by the MDEQ in 2000 and 2005. Figure 3-25 shows the locations and results sampled in 1995, 2000 and 2005. In addition, the Rouge Project conducted an aquatic habitat survey during the summer of 1996. The Rouge Project findings were consistent with those identified by MDNR. All referenced studies used the MDEQ GLEAS 51 protocol previously described.

Both the 1995 MDNR and the 1996 Rouge Project studies rated the Lower 1 Subwatershed on average as Poor. The 2000 MDEQ study ranked the subwatershed on average as Fair. The 2005 MDEQ study rated all of the Lower 1 stream habitat stations as Good. Overall stream habitat in the Lower 1 Subwatershed is showing improvement. As with most parts of the Rouge River, the major cause of degraded habitats in the Lower 1 Branch is excessive flow instability and accompanying erosion and sedimentation.

Figure 3-25: Lower 1 Stream Habitat Assessment



Notable Areas

The Lower Rouge River through Canton has an extensive forested wetland which should be preserved, although many invasive shrub species have become established and limit the potential for native ground flora to become established. The tributaries upstream of Beck Road, including both Fowler Creek and Sines Drain also exhibit some impacts due to recent development, but opportunities exist to enhance these corridors since streambank erosion is not a significant issue. Fellows Creek upstream of Canton Center Road exhibits opportunities to enhance the riparian corridors for habitat and aquatic community diversity, however, it also exhibits severe streambank erosion downstream of Canton Center Road. The Flodin Park Fellows Creek wetland has established a natural stream system that effectively manages flow variability and has significantly increased both habitat and aquatic community diversity.

Forested wetland

Impairments

The Lower 1 Subwatershed exhibits an underlying geology that predisposes its streams to extremes in both flow and temperature. Fragmented areas of streambank erosion combined with sedimentation in the stream channel are located throughout the watershed. In addition, areas where riparian vegetation has been removed have also resulted in additional impairments and challenges across the subwatershed. Since a good portion of this watershed is agricultural land, vegetated buffer strips or other agricultural BMPs may be needed in order reduce overland transport of soil to the streams, which would improve stream habitat.

Lower Rouge Trail in Canton Township

Stream Corridor

The Lower 1 Subwatershed has a variety of stream corridor conditions, including extensive forested areas along the Lower Rouge River, emergent wetland areas along tributary streams, mowed turf grass in urban neighborhoods and naturally established grow zones within the Canton Township Pheasant Run Golf Course. The forested areas are significant due to the presence of large historic trees, including oak, poplar and sycamore, some exceeding five feet in diameter. The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River. Trees, grow zones and native vegetation all contribute to reducing storm water runoff volume.

Riparian Corridor

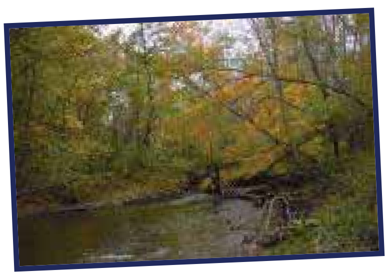
The Lower 1 Subwatershed encompasses 120 miles of river and creeks. A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms, and a buffer for pollutants and sediments from surface runoff. The corridor is used by many birds and mammals as well as providing habitat for aquatic organisms. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

Created wetland in Canton Township

Wetlands and Woodlands

Figure 3-26 shows the existing wetlands within the Lower 1 Subwatershed. This figure depicts forested wetlands as the highest percentage of remaining wetlands in the subwatershed, with smaller areas of both scrub-shrub and emergent wetlands. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-27. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.



Lower Rouge Trail in Canton Township

Historical Storm Water Projects in the Lower 1 Subwatershed

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are a few project watershed stewards have completed in the past 10 years:

- Canton Township has completed at least ten (10) detention basin enhancements that have converted dry/nonfunctional basins into wetland basins that also serve as a recreational amenity to their respective developments.
- The first phase of the Lower Rouge River Recreational Trails has been constructed with an additional phase anticipated in the next year. This trail winds through the Lower Rouge Riparian corridor and offers opportunities to experience historic vegetative features.
- The Fellows Creek Regional Wetland system was constructed in Flodin Park serves to minimize the flow variability associated with Fellows Creek and Green Drain while also creating a recreational wetland within a local park.
- Van Buren Township in partnership with Visteon Corporation constructed a wetland fringe for an existing 36-acre lake that improves water quality and habitat while also serving as a passive recreational amenity to Visteon employees. In addition, a recreational trail was constructed through the wooded area on Visteon property that highlights various ecological features.
- Superior Township adopted a growth management plan to preserve and manage nature features; protect the quality of surface and groundwater, woodlands, open space, steep slopes and to permanently protect strategic open space and agricultural lands from development.

Fellows Creek Regional Wetland

Figure 3-26: Lower 1 Existing Wetlands

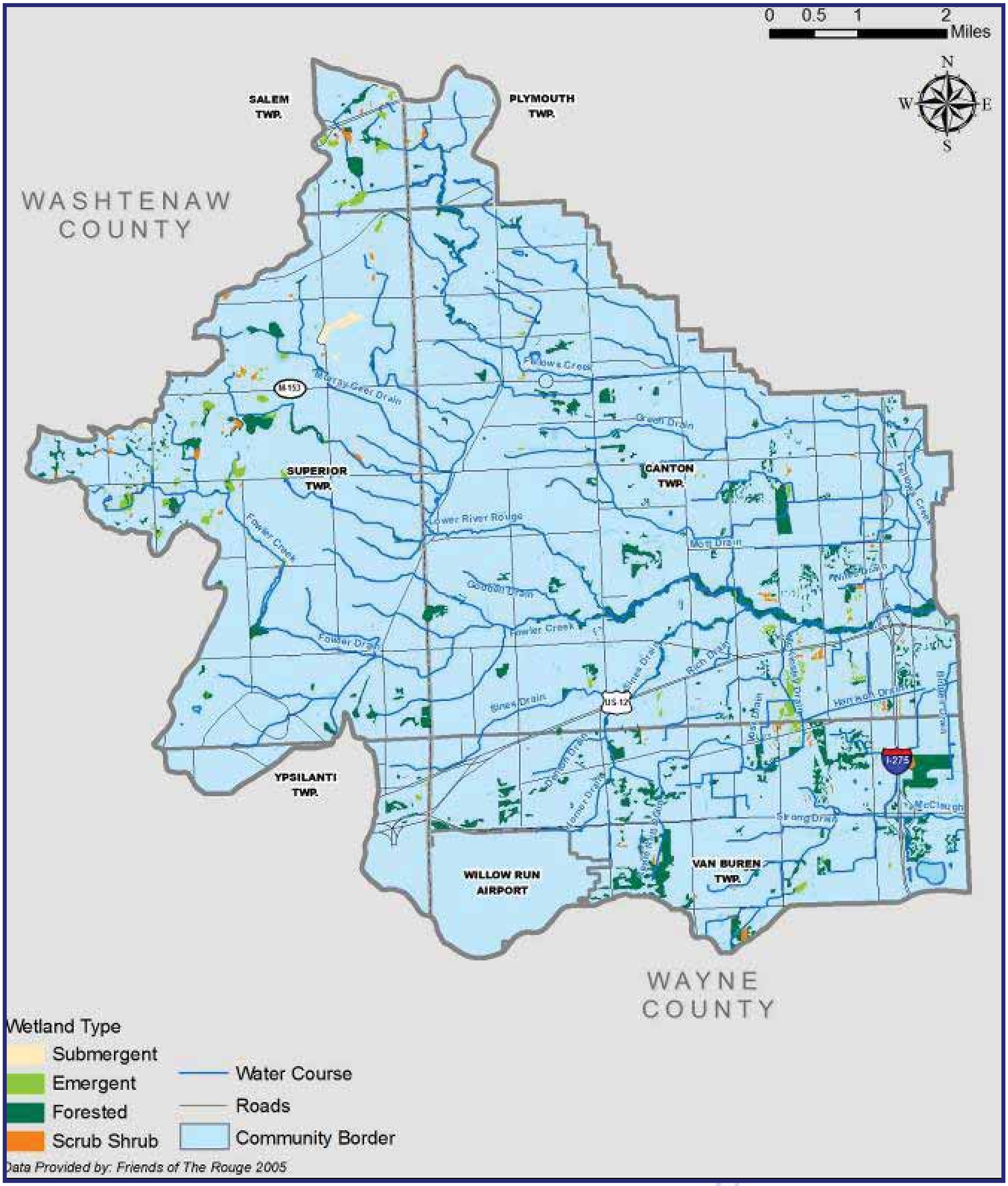
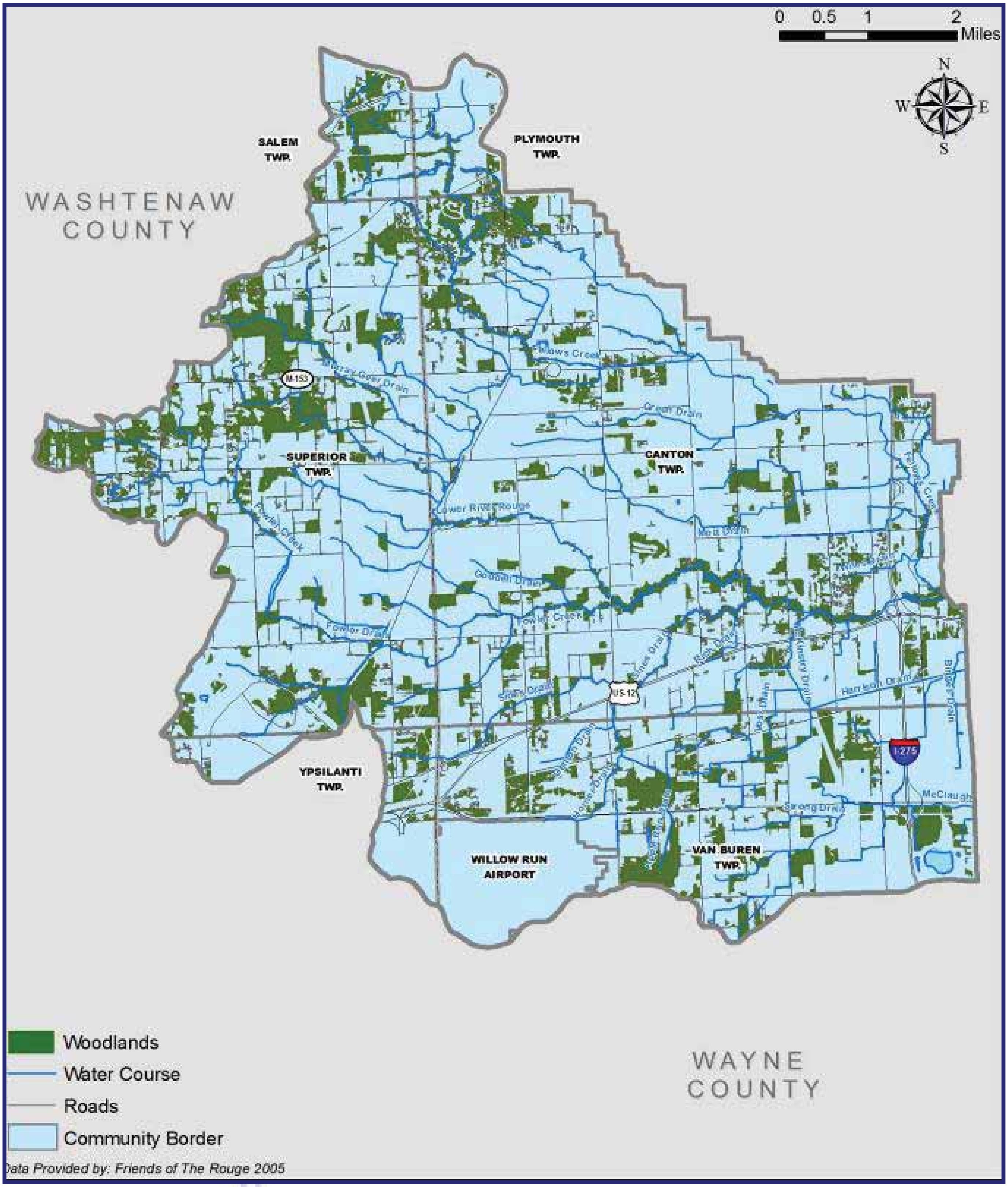


Figure 3-27: Lower 1 Existing Woodlands



- Plymouth Township educates citizens by publishing "Watershed Wisdom" tips in their newsletter. They have also been active in implementing streambank stabilization techniques within their community.
- Ypsilanti Township worked with local Boy Scouts to install 100 native plants and install grow zone signs.

Lower 2 Subwatershed (Storm Water Management Area) Conditions

The Lower 2 communities are older, urban areas that are faced with the tremendous financial burden of repairing and replacing their aging infrastructure. Much of the existing infrastructure was designed at a time when frequent discharges of sewage into the river were an acceptable practice. While the overall water quality of the Lower 2 has improved, there continues to be challenges associated with wet weather.

The characteristics and conditions of this subwatershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Lower 2 Subwatershed Management Plan. While the stream indicators of water quality, stream hydrology, aquatic diversity, stream habitat and physical conditions of the stream corridor are all indicative of urban stream conditions, the general trends show improvement. Challenges exist with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in wet weather conditions.

Lower 2 highlights:

- ***The Lower 2 is almost completely built out, with only 3% urban open space left in the watershed.***
- ***The Lower 2 cities have invested a great deal of money to control and/or eliminate Combined Sewer Overflows (CSOs).***
- ***Stream habitat conditions in the Lower 2 have improved since initial sampling evaluations in 1996.***

Subwatershed Demographics

The Lower 2 Subwatershed is located in the middle of Wayne County, as shown in Figure 3-28. This subwatershed covers about 7% of the watershed's area or approximately 21,024 acres (approximately 33 square miles). The Perrin Drain is a main tributary that flows into the Lower Rouge River in the Lower 2 Subwatershed.

The Lower Branch of the Rouge River flows through the Lower 2 communities of Westland, Wayne, Romulus, Garden City, Inkster, Dearborn Heights and Dearborn before joining the Main Branch of the Rouge River.

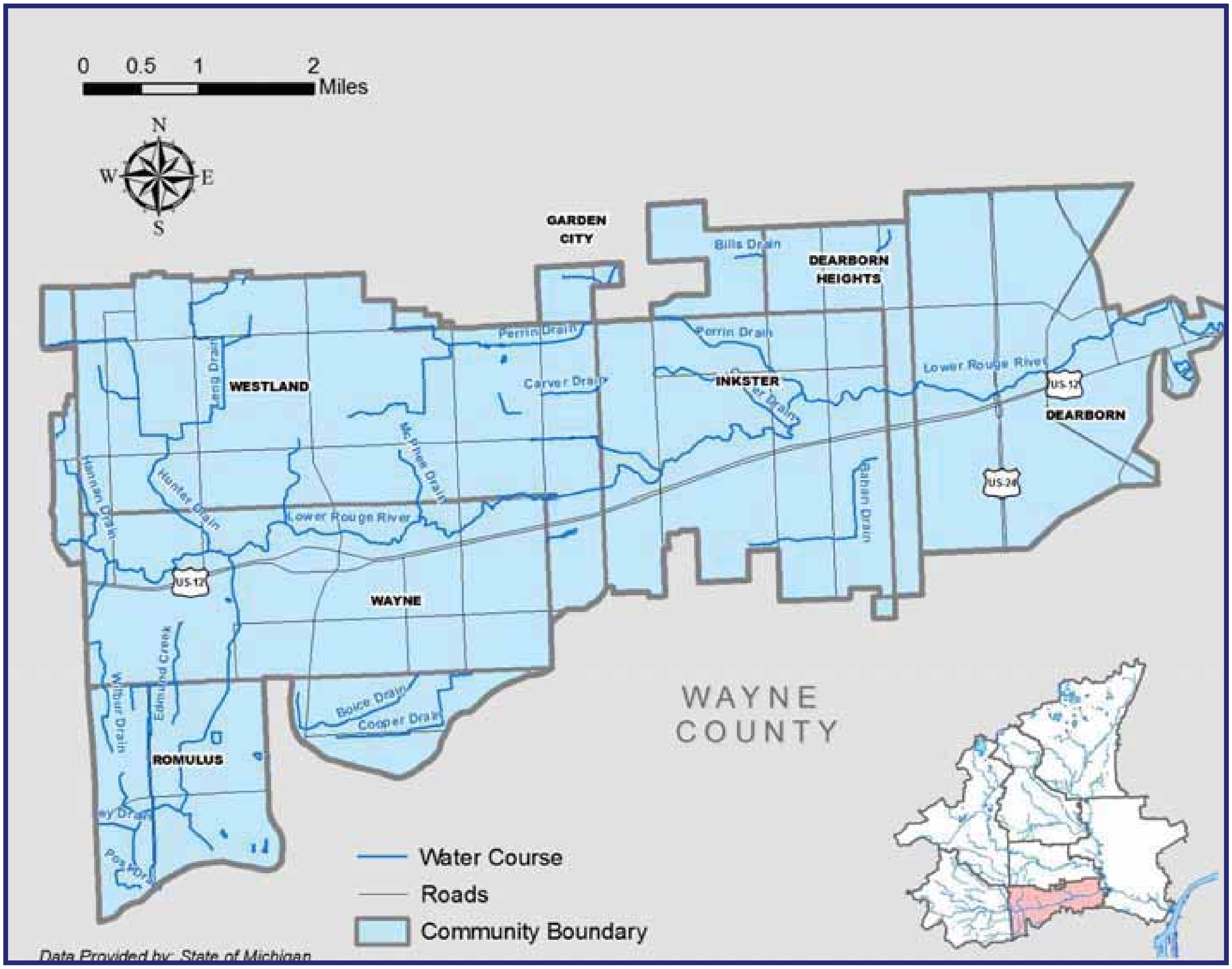
Table 3-15 lists the member communities that make up the Lower 2 Subwatershed and summarizes the area for each community.

Ford Field Park in Dearborn

Table 3-15: Lower 2 Subwatershed Community Area within the Rouge Watershed

City/Township	Acres in Subwatershed (square miles)	Percent of Community in Subwatershed
Dearborn	6	18%
Dearborn Heights	1.6	5%
Garden City	1.1	3%
Inkster	5.8	18%
Romulus	3.8	12%
Wayne	6.0	18%
Westland	8.6	26%
Totals	32.9	100%
Counties		
Wayne County	32.9	

Figure 3-28: Lower 2 Subwatershed Location



Canoeing in the City of Wayne

This subwatershed is almost completely built out, with only 3% urban open space left in the watershed. The largest category of land use is residential housing. Recreation areas in the Lower 2 Subwatershed include Wayne County's Lower Rouge Parkway, Goudy Park in Wayne, Inkster Valley Golf Course, Dearborn Hills Golf Course, Ford Field in Dearborn and smaller city parks in Romulus, Westland, Garden City, Wayne, Dearborn and Dearborn Heights.

Impervious Cover

Significant changes in land use and land cover have occurred across this subwatershed between 1991 and 2002. Table 3-16 highlights the changes in land cover between 1991 and 2002. In addition, Figure 3-29 graphically depicts the current impervious cover across this subwatershed.

Table 3-16: Changes in Land Cover 1991-2002

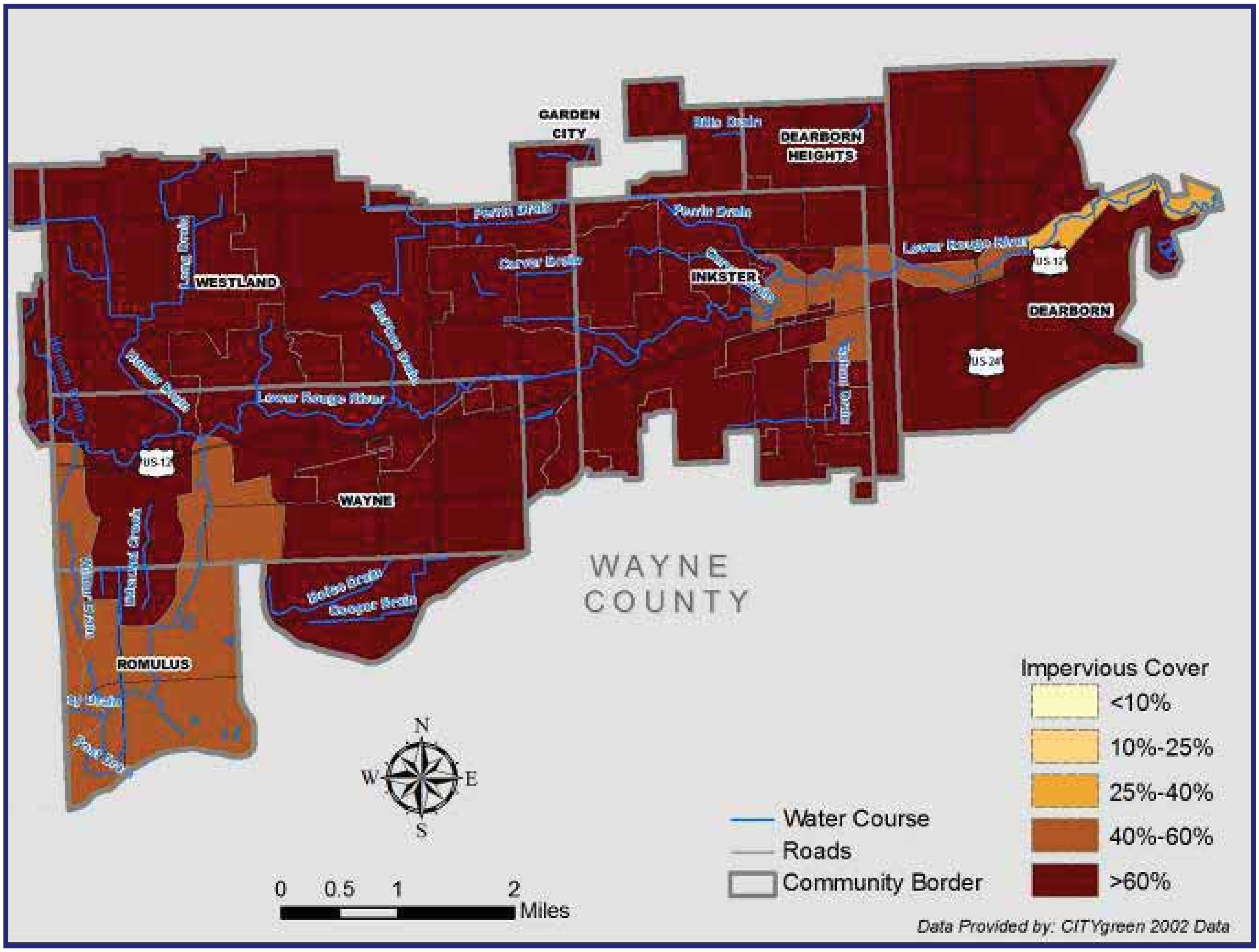
Lower 2 SWMA Land Cover	1991	2002
Open Space - Grass	18%	11%
Trees	18%	16%
Grow Zones	0%	0%
Green Roofs	0%	0%
Sub-total: Green Infrastructure	36%	27%
Urban: Impervious	60%	71%
Urban: Bare	4%	2%
Water	0%	0%
Total	100%	100%

City of Inkster CSO basin

Water Quality

The cities in the Lower 2 Subwatershed have invested a great deal of money to control and/or eliminate Combined Sewer Overflows (CSOs). CSO areas in Wayne and Westland were controlled by sewer separation projects that addressed 288-acres and 409-acres respectively. Four miles of new sewers and storm drains were installed in Wayne and eight miles in Westland. The City of Inkster CSO retention treatment basin began operation in 1997 and eliminates uncontrolled CSOs serving 833 acres. The City of Wayne's project also included a 2.3 million gallon retention basin and CSO control projects in the City of Dearborn continue. As a result, average DO concentrations have increased from 3.7 mg/L in 1994 to 7.3 mg/L in 2006 and most notably since YCUA began discharging in 1996. In 2006, the majority of DO values were greater than 5 mg/L.

Figure 3-29: Lower 2 Imperviousness



The Lower 2 Subwatershed Advisory Group established targets for water quality as part of the 2001 Lower 2 Subwatershed Management Plan. These targets are summarized in Table 3-17.

Table 3-17: Lower 2 Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Water Temperature, Warmwater Fishery (°C)	≤ 29.4 (by 2005)
Dissolved Oxygen, Warmwater Fishery (mg/L)	Daily average >5 (by 2015)
Total Phosphorus (mg/L)	Annual average ≤ 0.05 (dry weather) by 2015
Total Suspended Solids (mg/L)	Decrease in dry and wet weather
E. coli (cfu/100 ml)	Partial body contact standard by 2015 (dry weather)

The Ypsilanti Community Utilities Authority (YCUA) provides water and wastewater services to communities in portions of both Washtenaw and Wayne Counties. It contracts with the Western Townships Utilities Authority (WTUA) to provide wastewater treatment services for the Townships of Canton, Northville, and Plymouth. Annually, YCUA processes over eight billion gallons of wastewater at their plant located at McGregor and State Streets near Willow Run Airport. Once treated, this water is discharged into the Lower Rouge River at Beck Road (www.ycua.org)

Based on dry weather sampling results, it is clear that progress has been made towards improving water quality conditions based on almost all parameters (see Table 3-18). Water quality trends are indicated below, if enough data was available for a trend assessment. The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. Details on sampling results may be found in the most recent RREMAR. The Lower 2 monitoring sites are depicted in Figure 3-30.

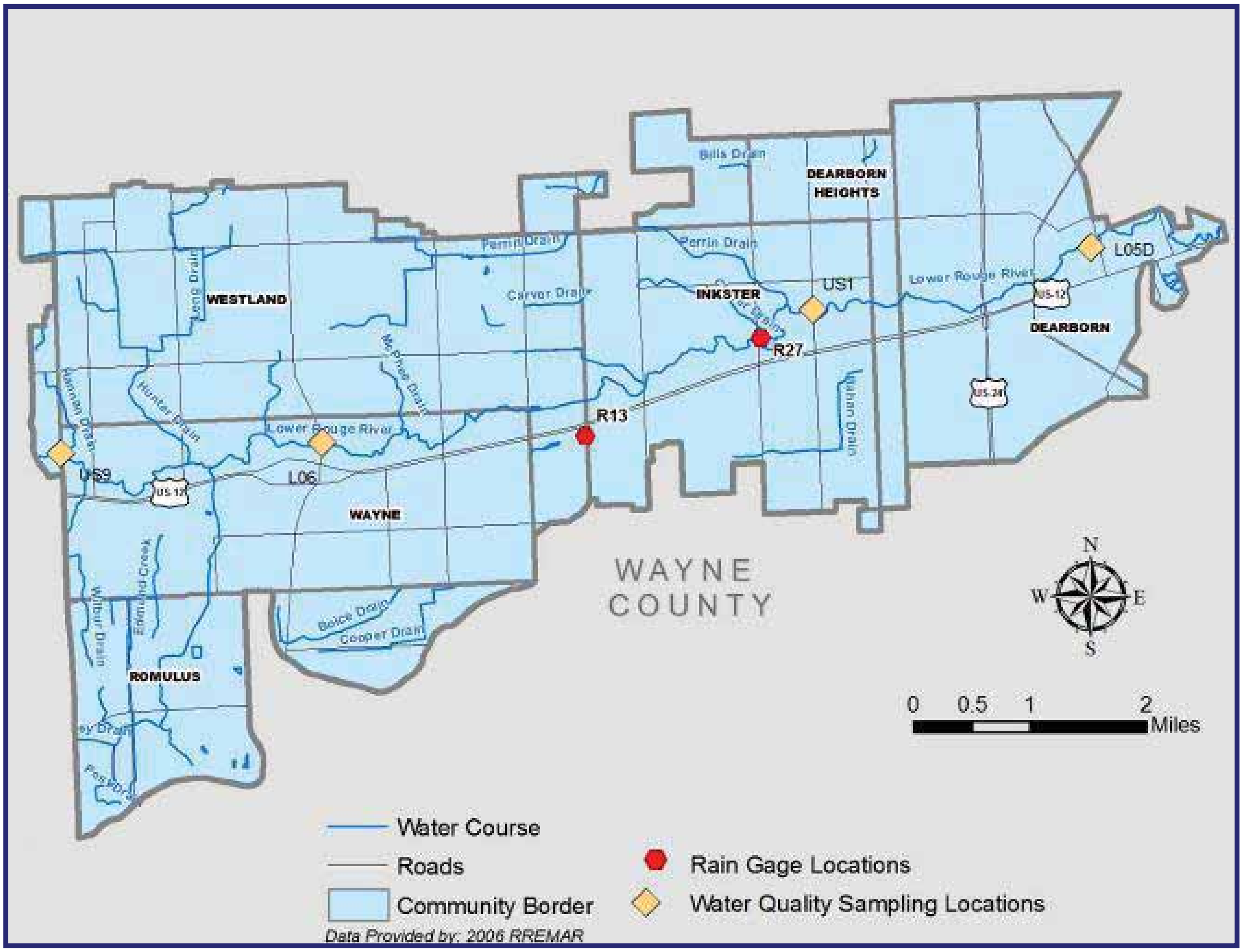
Table 3-18: Lower 2 Dry Weather Conditions – Summary

Parameter	Wayne Road L06	John Daly Road G98/US1	Military Road L05D
Water Temperature	Good	Good	Good
Dissolved Oxygen (DO)	Good ↑	Good ↑	Good ↑
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Good ↑	Good ↑	Good ↑
Ammonia (NH_3-N)	Good ↑	Good ↑	Good ↑
Total Phosphorus (TP)	Poor ↑	Poor ↑	Poor ↑
Total Suspended Solids (TSS)	Fair ↑	Good ×	Good ×
E. coli	Fair ↑	Poor ↑	Poor ×

↑ indicates an improving trend ↓ indicates a declining trend × indicates no trend

It is clear that both the Lower 2 Subwatershed targets for DO and water temperature have been achieved when looking at the results, which were monitored continuously in 2006 at the downstream end of the Lower 2 Branch at Military Road (L05D). Average DO concentrations have increased from 3.7 mg/L in 1994 to 7.3 mg/L in 2006 and most notably since Ypsilanti Community Utility Authority Wastewater Treatment Plant (YCUA). YCUA began discharging in 2006. In 2006, the majority of DO values were greater than 5 mg/L. The maximum temperature recorded in 2006 was 27.5°C which is greater than the Rouge Project

Figure 3-30: Lower 2 Water Quality Sampling and Rain Gage Locations



temperature criteria of 27°C; however, this exceedance occurred less than one percent of the time (RRNWWDP, RREMAR, 2006).

In 2006, the majority of the dry weather sampling show TSS concentrations were less than 50 mg/L. However, higher concentrations were found at the upper end of the subwatershed at Wayne Road (L06).

The original total phosphorus target was set at 0.05 mg/L prior to the MDEQ permit issuance for YCUA. YCUA t was issued a permit with a 0.7 mg/L effluent discharge limit for Total Phosphorus (TP) and is the likely reason behind the higher TP levels in the Lower Branch of the river. The YCUA discharges into the main stem of the Lower Rouge River just downstream of the Beck Road (L01) monitoring location. The overall TP watershed plan target for the Lower Rouge River should be reconsidered in light of the YCUA discharge limit. *E. coli* sampling results indicated that the total body contact state standard was not met, however partial body contact recreation was met 60% of the time at Wayne Road.

E. coli Results

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

The *E. coli* data collected in the Lower 2 indicates that pathogens continue to be a problem in this subwatershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human) sources . Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

The 2005 *E. coli* data indicated that the Lower 2 almost always exceeded total body contact water quality standards and it frequently exceeded partial body contact standards (see Figure 3-31). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum and farm animals. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), aging sanitary sewers and failing septic systems, also known as on-site sewage disposal systems (OSDS).

The BST sampling showed human sources of *E. coli* are suspected at one site during dry weather and two sites during wet conditions (Figure 3-32). The dry weather *E. coli* source could be from illicit connections to storm drains. The wet weather *E. coli* sources could potentially be from CSOs, illicit connections to storm drains, aging sanitary sewers and failing septic systems.

Water Quality in Wet Weather Conditions

While the overall water quality of the Lower 2 has improved, there continues to be challenges associated with wet weather. To document these challenges, the

Figure 3-31: Lower 2 E. coli Sampling Results

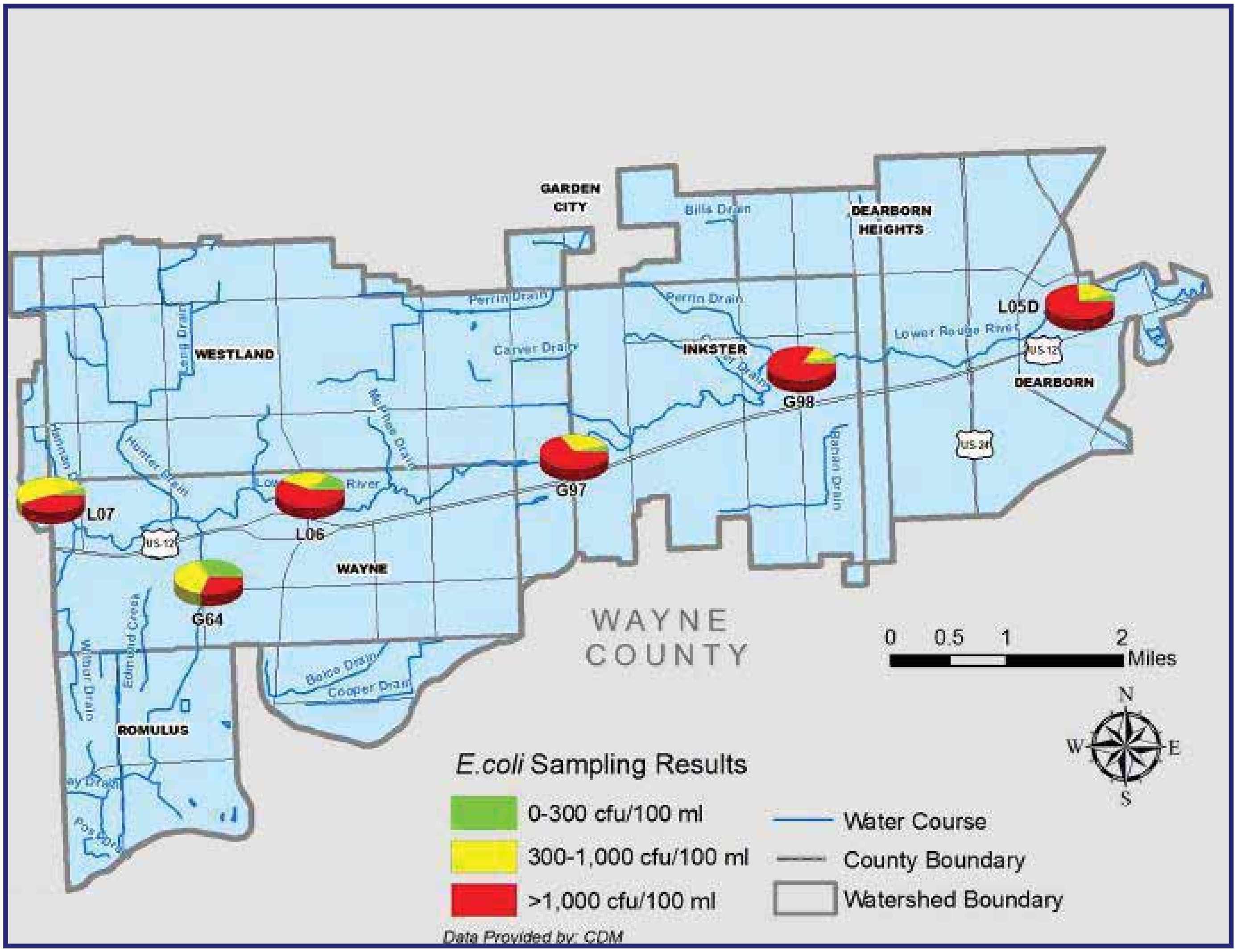
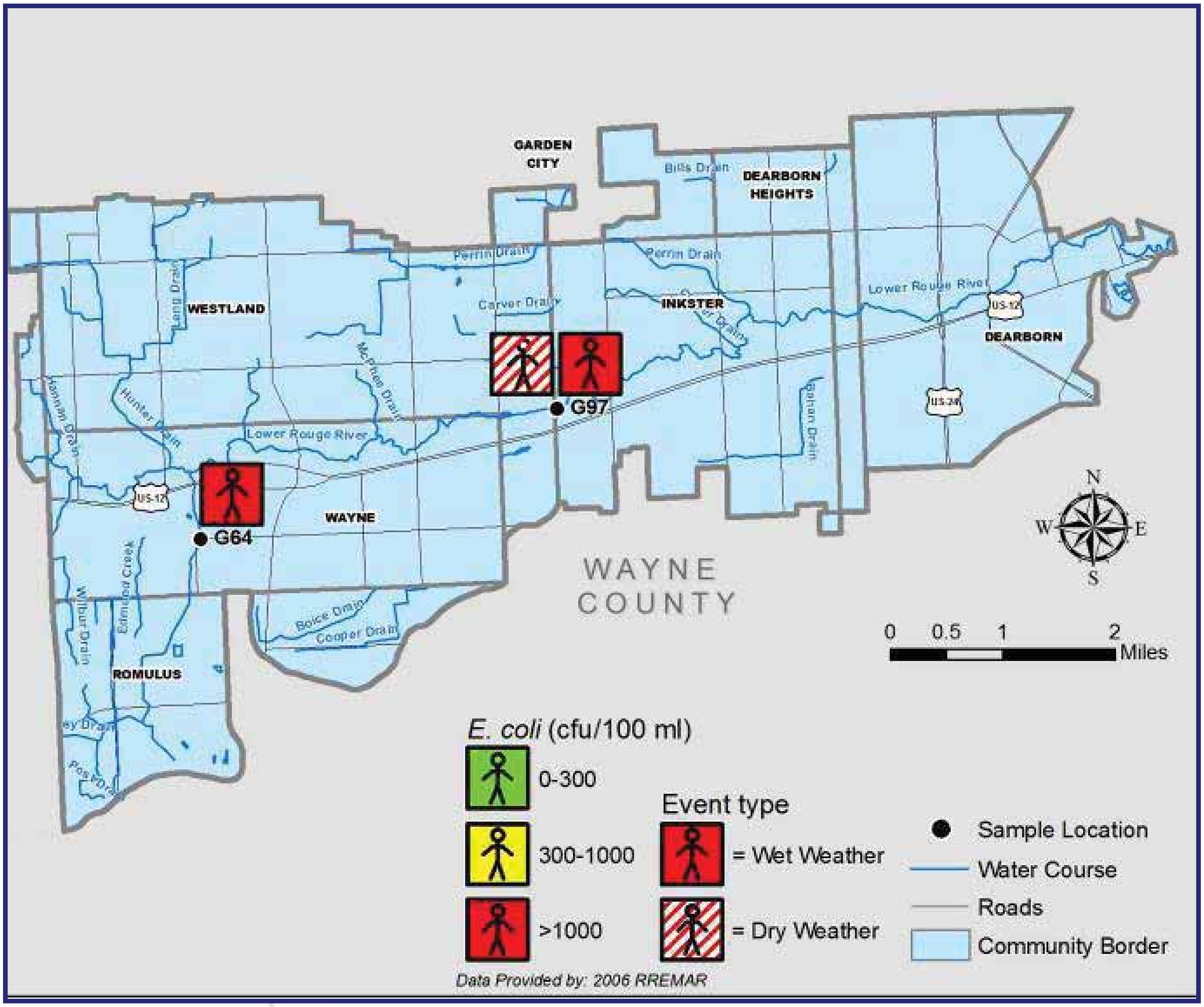


Figure 3-32: Lower 2 Bacterial Source Tracking Results



site at Military Road (L05) was sampled during wet weather conditions for $CBOD_5$, NH_3-N, TSS, TP and *E. coli* in 2006. The following observations were made:

- All five of the *E. coli* daily geometric means exceeding the State's partial body contact standard of 1,000 cfu/100mL.
- The *E. coli* and TSS concentrations were seven and three and one-half times higher than the dry weather values, respectively.
- The $CBOD_5$, NH_3-N and TP concentrations were one and one-half to two times higher than the corresponding dry weather values.

Trend analysis of the wet weather data showed a slight improvement in all parameters, except *E. coli*, which showed no significant change.

Garden City sewer separation project

The Lower 2 communities are older, urban areas that are faced with the tremendous financial burden of repairing and replacing their aging infrastructure. Much of the existing infrastructure was designed at a time when frequent discharges of sewage into the river were an acceptable practice. This is no longer the case. This change in professional practice substantially increases the cost of upgrading the system. CSO control and sanitary sewer overflow (SSO) control has lead to some of the largest public works projects in the history of these municipalities. Below are a few of the main projects completed in these communities to protect public health.

- The cities of Wayne, Westland, and Garden City completed construction of sewer separation projects to eliminate CSOs to the Rouge River, costing approximately $32 million dollars, which was partially funded by the Rouge Project.
- The City of Westland conducted inspections of 480 sanitary sewer manholes to identify repairs necessary for elimination of storm water infiltration and reduction of SSOs.
- The City of Inkster identified and eliminated illicit connections by dye testing residences and businesses in areas where water quality sampling indicated potential problems.
- The Wayne County Department of Environment conducted illicit discharge investigations in 821 facilities along the Lower Branch of the Rouge River. The investigation found 68 illicit connections in 26 facilities. Eliminating those illicit connections is preventing 9,171 pounds of pollutants from entering the river each year.
- The City of Romulus conducted a field survey and inspection of the City's sanitary sewer system and conducted a pilot footing drain removal and manhole rehabilitation program in order to reduce SSOs.

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water runoff contributes significant pollutant loading to the Rouge River in the Lower 2 subwatershed.

Total pollutant loading considering baseflow, point sources, CSOs and non-point sources was estimated for the Rouge River using the WMM model. The estimated existing pollutant loads for the Lower 2 subwatershed are summarized in Table 3-19. The complete study details from the NPS Loading Report may be found at www.allianceofrougecommunities.com.

Table 3-19: Existing Pollutant Loads for the Lower 2 Subwatershed

Pollutant	Units	Source (%)				Total Load
		Base Flow	Storm water	Point Sources	CSO	
BOD	lbs/yr	6%	58%	0%	36%	1,160,000
DP	lbs/yr	13%	61%	0%	26%	7600
Fecal Coliform	counts/yr	0	5%	0%	95%	3.0×10^{16}
NO_2 & NO_3	lbs/yr	32%	60%	0%	8%	67,400
TKN	lbs/yr	23%	59%	1%	17%	102,000
TP	lbs/yr	12%	49%	0%	38%	19,400
TSS	lbs/yr	23%	42%	0%	35%	4,920,000

Pollutant Abbreviations:

BOD: *Biochemical Oxygen Demand*
DP: *Dissolved Phosphorus*
NO_2: *Nitrite*
NO_3: *Nitrate*
TKN: *Total Kjeldahl Nitrogen*
TP: *Total Phosphorus*
TSS: *Total Suspended Solids*

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the Rouge River. The bacteria loading from CSOs is nearly twice the loading from non-point sources. However, when considering TSS and phosphorus, the contribution from non-point sources is similar to that from CSOs. The loading from point sources is relatively insignificant. For the purposes of prioritizing storm water BMPs, the remainder of the analysis within this section focuses on pollutant loads associated with non-point sources.

The Lower 2 Subwatershed was subdivided into 40 subbasins as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, total phosphorus and total suspended solids within each subarea are shown in Figures 3-33, 3-34 and 3-35. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

All three figures demonstrate the highest pollutant loadings come from the upstream areas of this subwatershed. The *E. coli* storm water loading estimates are consistent with the Poor *E. coli* concentrations found throughout the Subwatershed, while the TSS loads are consistent with the Poor TSS conditions found at the upstream area of the subwatershed. The subbasins with the highest phosphorus correspond to the areas of highest TSS. These figures are used as a relative measure of critical area identification.

The primary non-point sources of phosphorus in the critical Lower 2 subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, runoff containing pet waste and illegal sewer connections. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils for construction sites without

Figure 3-33: Lower 2 Fecal Coliform Estimated Non-Point Source Load

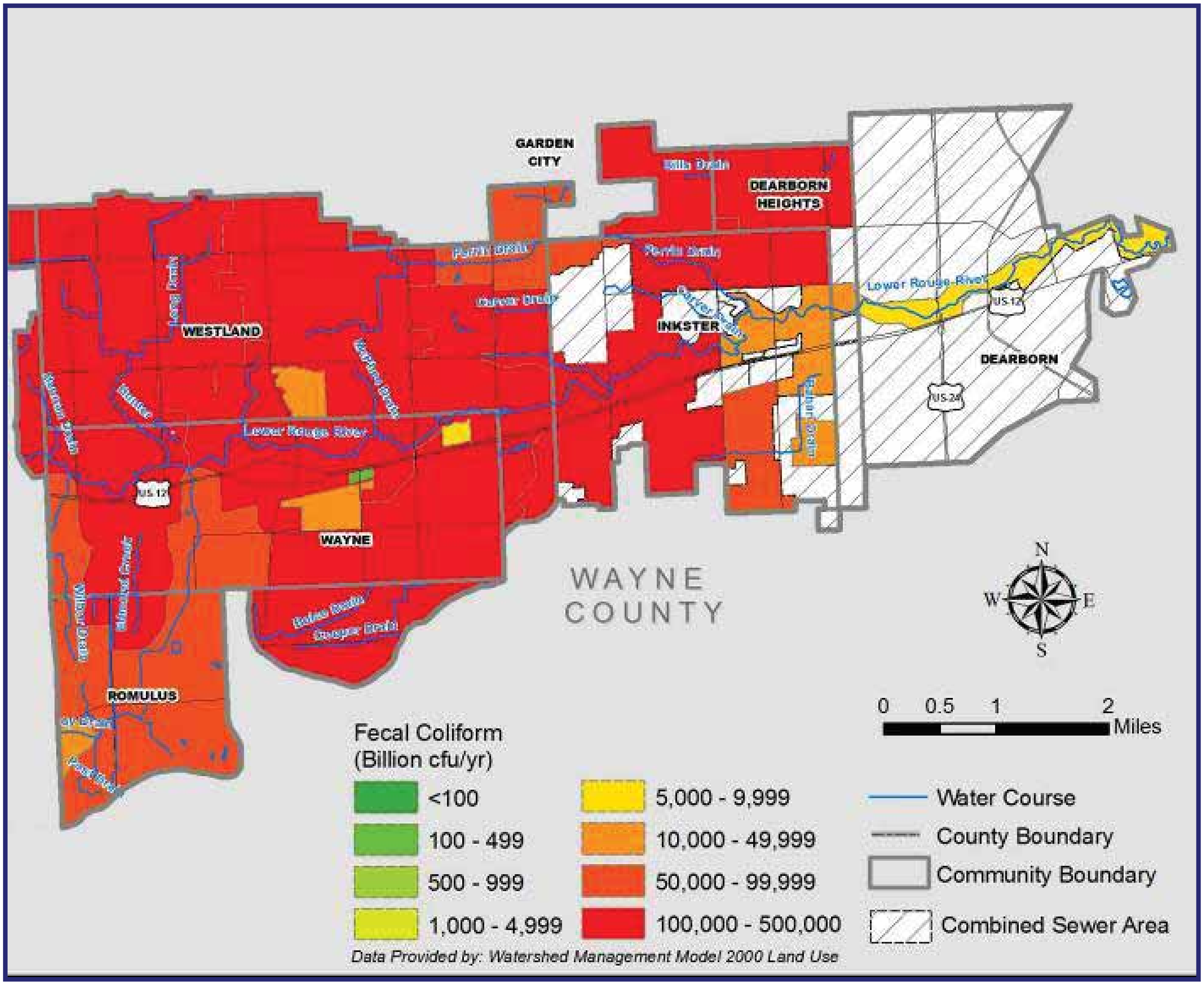


Figure 3-34: Lower 2 Total Phosphorus Estimated Non-Point Source Load

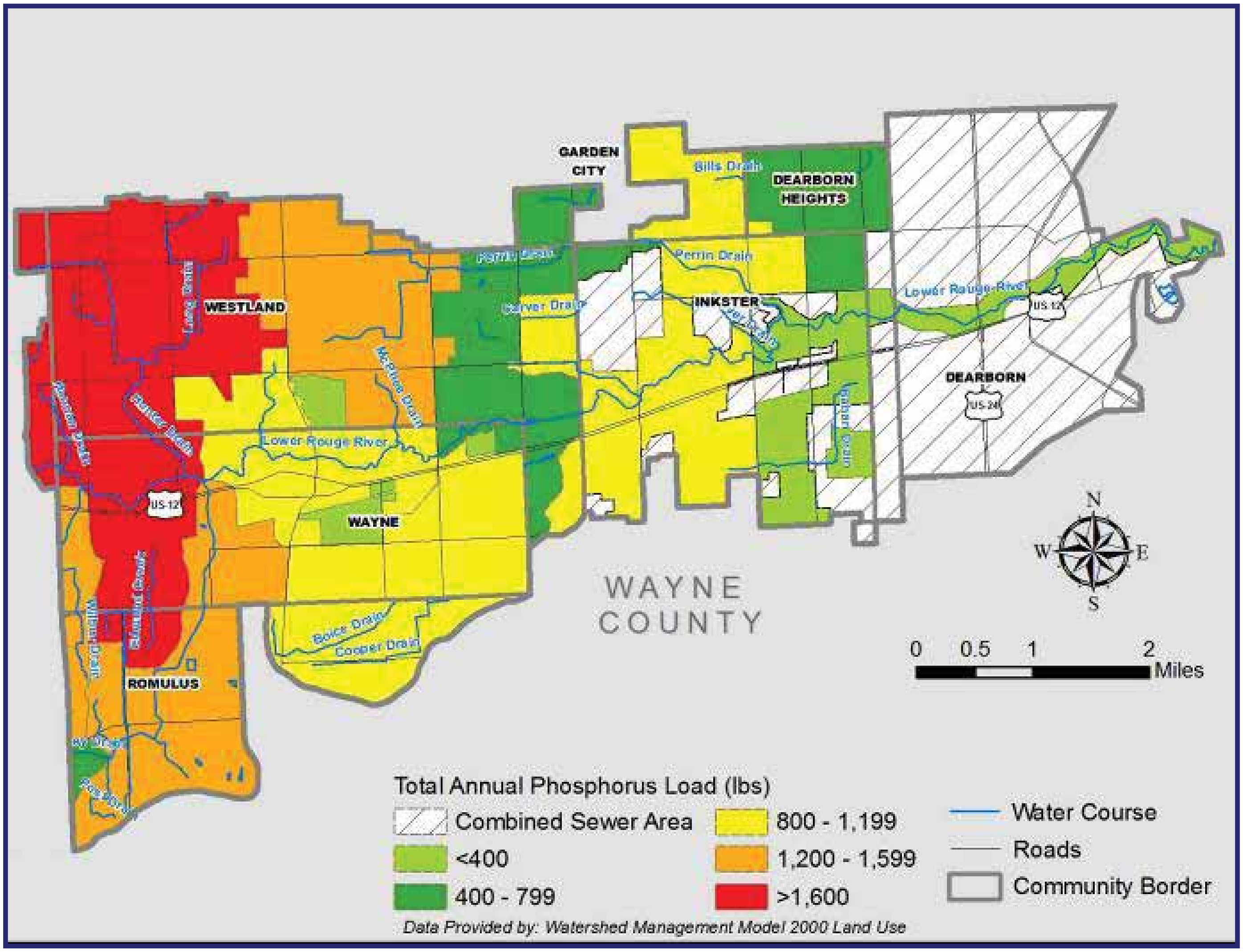
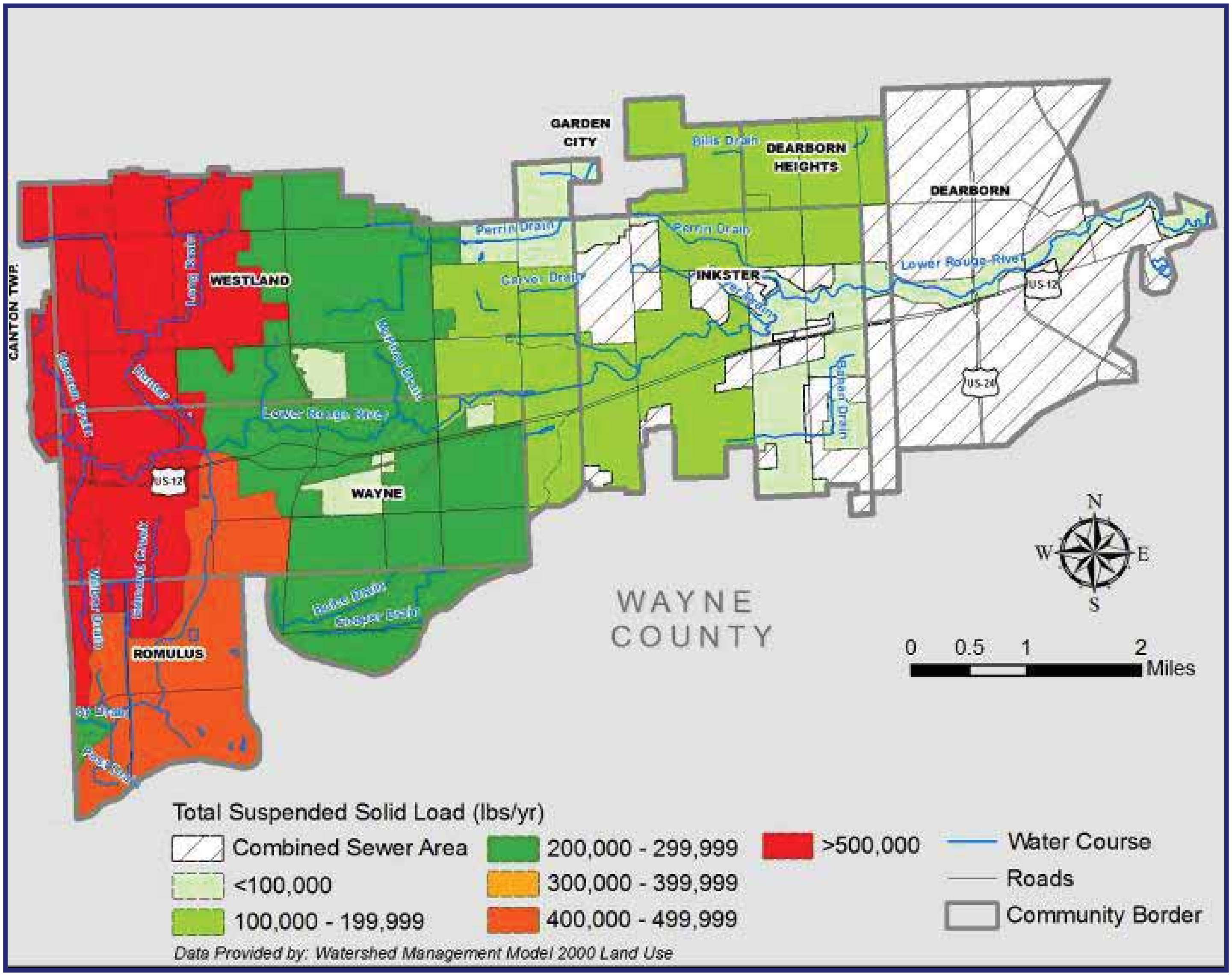


Figure 3-35: Lower 2 Total Suspended Solids Estimated Non-Point Source Load



proper soil erosion control practices. Some of TSS sources are likely supplying phosphorus to the Lower Branch, since soils contain high levels of phosphorus.

Stream Hydrology

The hydrologic trends along the Lower Rouge River continue to cause excessive erosion and habitat destruction. The 2001 Lower 2 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under two inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed.

While the bankfull, or overbank flood event, occurs on the order of every two years in stable river systems, this study evaluation determines that it occurs on the order of every one to two months in this subwatershed.

USGS gage, Lower Rouge at Inkster

A hydraulic analysis was completed to help identify Best Management Practice (BMP) measures that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

Figure 3-29 on page 3-65 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04168000), Lower Rouge at Inkster (US1), provides appropriate flow information for identifying goals for the Lower 2 Subwatershed. Figure 3-36 shows the area in the subwatershed that contributes to the flow conditions for this gage.

Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events. Table 3-20 shows the Lower Subwatershed Flow Rate Trends at Site US1 (Lower Rouge River at Inkster Road).

Figure 3-36: Lower 2 USGS Gage at Inkster Drainage Area

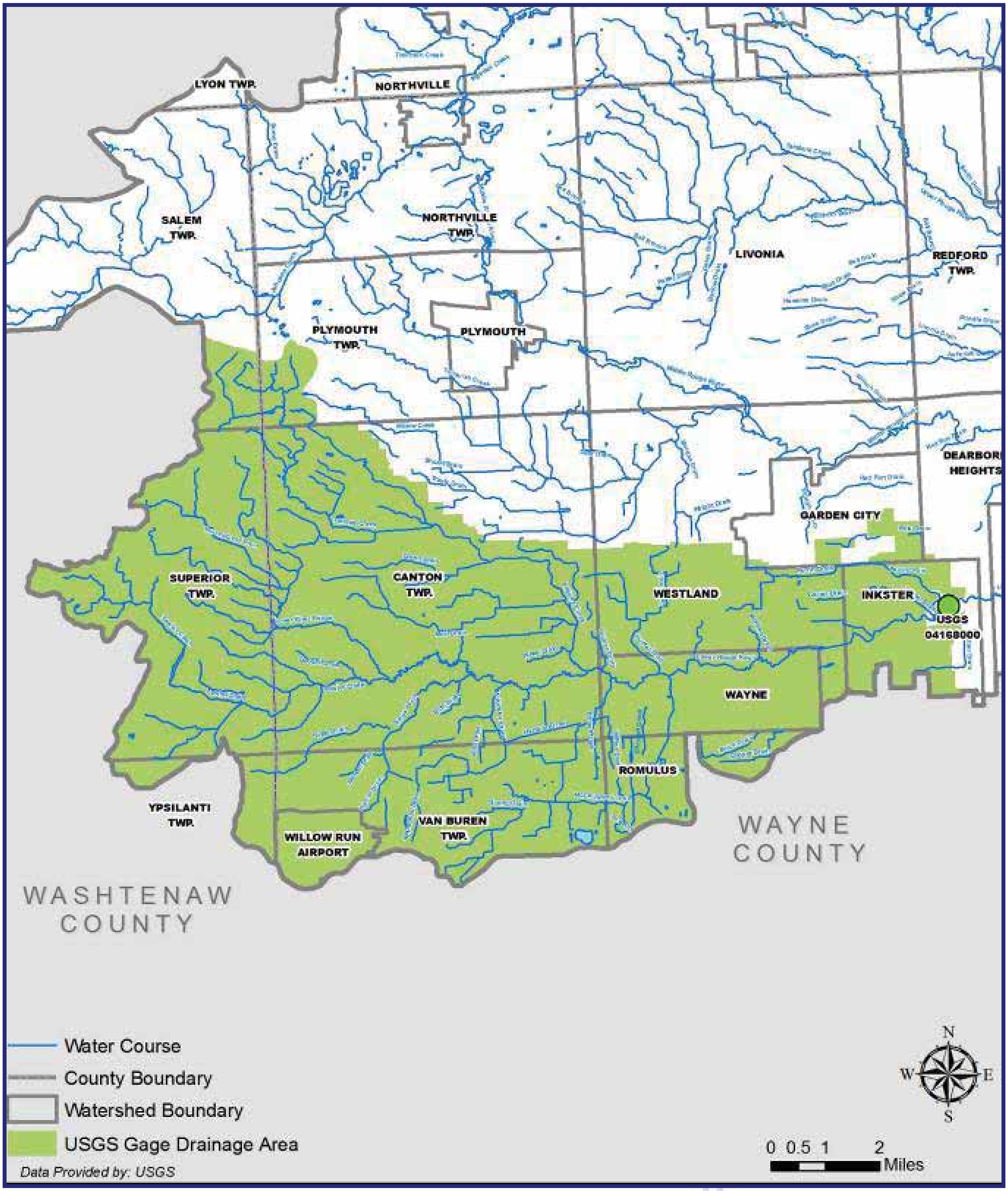


Table 3-20: Lower Subwatershed Flow Rate Trends at US1

Bankfull Flow Rate	1,047 cfs with return period of 7.2 months
15-day	171 cfs
30-day	352 cfs

Figure 3-37 also represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

Inkster Valley Wetland

The combination of the gage analysis, impervious cover and annual storm water runoff volume across the subwatershed provides important information for focusing efforts on reducing storm water runoff volume. Reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 21,900,000 cubic feet of storm water (0.284 inches of water over the subwatershed) is needed to help reduce the effect of these small storms. It is important to note that the water needs to be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

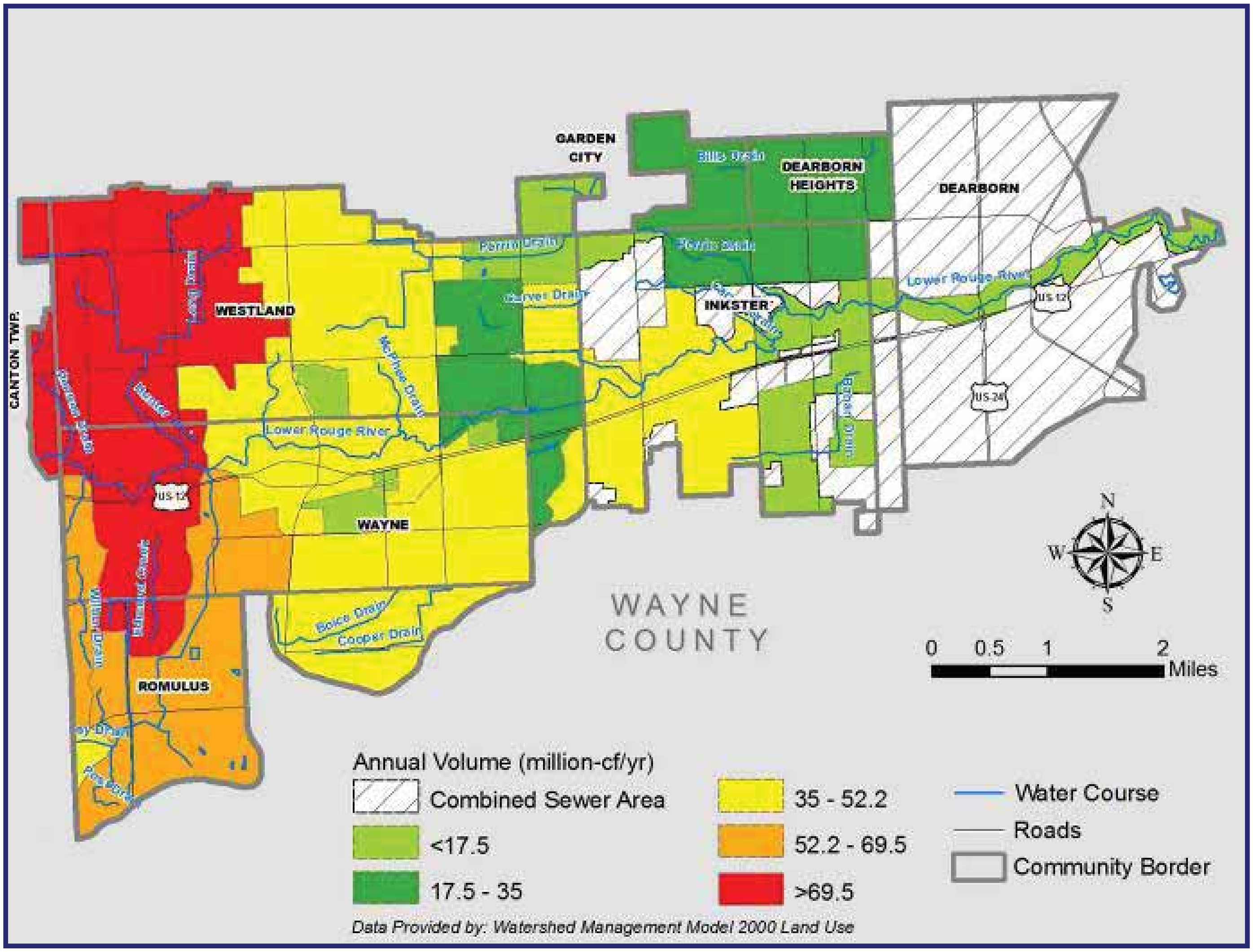
A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands, such as those constructed at the Inkster Valley Golf Course, might be more appropriate for addressing storm water runoff from highly urbanized areas. Small-scale best management practices (BMPs), including rain barrels, bio-retention basins or rain gardens, and porous pavements can be installed on individual properties.

Green Infrastructure projects such as Rooting for the Rouge, a tree planting initiative in Lower 2 schools will also provide storm water retention.

Over the past several years various projects have been completed in the Lower 2 Subwatershed to help control flow in the rivers. These include:

- The cities of Wayne, Inkster and Dearborn have a downspout disconnection program. Disconnected downspouts reduce flow in the Lower Rouge River during storm events.
- The City of Wayne installed a rain garden in its municipal parking lot.
- Wayne County planted a grow zone along the Lower Rouge River behind its Commerce Court office location.
- The Inkster Valley Wetland, which was constructed by Wayne County and the Rouge Project, helps minimize flow variation.
- The City of Dearborn and Ford Motor Co. volunteers planted buffers along the river in Ford Field.

Figure 3-37: Lower 2 Storm Water Runoff Non-Point Source Annual Volume



Ecosystems

Ecosystems encompass three main criteria, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Lower 2 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, and lack of appropriate spawning habitat. The lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Aquatic Diversity

Fish Communities

Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

Limited recreational fishing opportunities exist in this subwatershed with the Chinook salmon and steelhead that migrate up the river each fall. The dam at Wayne Road has been identified as a hindrance to further migration. Modification of the dam has been identified as a restoration project which would help delist the Loss of Fish and Wildlife Communities beneficial use impairment of the Rouge River (AOC document, get name). Potential angling opportunities include such fish species as Northern Pike, Rock Bass and Smallmouth Bass (Wiley, 2005).

Trout caught in the city of Wayne

Photo credit: Frank Walker

The main factors negatively affecting fish community integrity in the Lower 2 Subwatershed are excessive flow variation and lack of appropriate spawning habitat. Stream quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities.

Four sites located in the Lower 2 Subwatershed were surveyed as a part of the 1995 MDNR fish assessment. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a “balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region” (Karr & Dudley, 1981).

The MDEQ completed additional surveys in 2000 and 2005 using the GLEAS 51 procedure (MDEQ, 2005). The 2000 MDEQ biological assessment surveyed one site in the Lower 2 Subwatershed, and none in 2005. Unfortunately, direct correlation and trends between the 1995, 2000, and 2005 surveys are not available as the survey points were not the same for any of the studies. Figure 3-38 shows the overall fish community rating for the above referenced surveys.

While the rankings may indicate poor conditions, the opportunities for restoration are great. In fact, limited numbers of Chinook salmon (a.k.a. king salmon) and steelhead migrate up the Rouge River's Lower Branch every fall. Both species are native to the Pacific Coast, and have been stocked in the Great Lakes states since the 1970s. These fish were probably stocked in Lake Erie, and are not likely to breed successfully in the Lower Branch due to warm summer water temperatures, excessively variable water flows, and inappropriate bottom substrate which is sand rather than the preferred large gravel. However, they do provide a small recreational fishery.

No new surveys or studies have been conducted since 2005. It is assumed that existing conditions are reflective of the most recent studies. Prior to the YCUA flow enhancements, base flows at these sites were very low. The YCUA enhancements present a unique scenario for our modeling comparisons- a high base flow stream without the accompanying cold temperatures that groundwater supply typically brings. The additional discharge of cool, oxygenated water contributed by the outfall is providing unique and positive changes in the ecology that will require additional studies to thoroughly describe its impact on the Lower 2 Subwatershed. The YCUA flow also contributes additional phosphorus to the stream which contributes to the high levels of phosphorus in the Lower 2 Subwatershed.

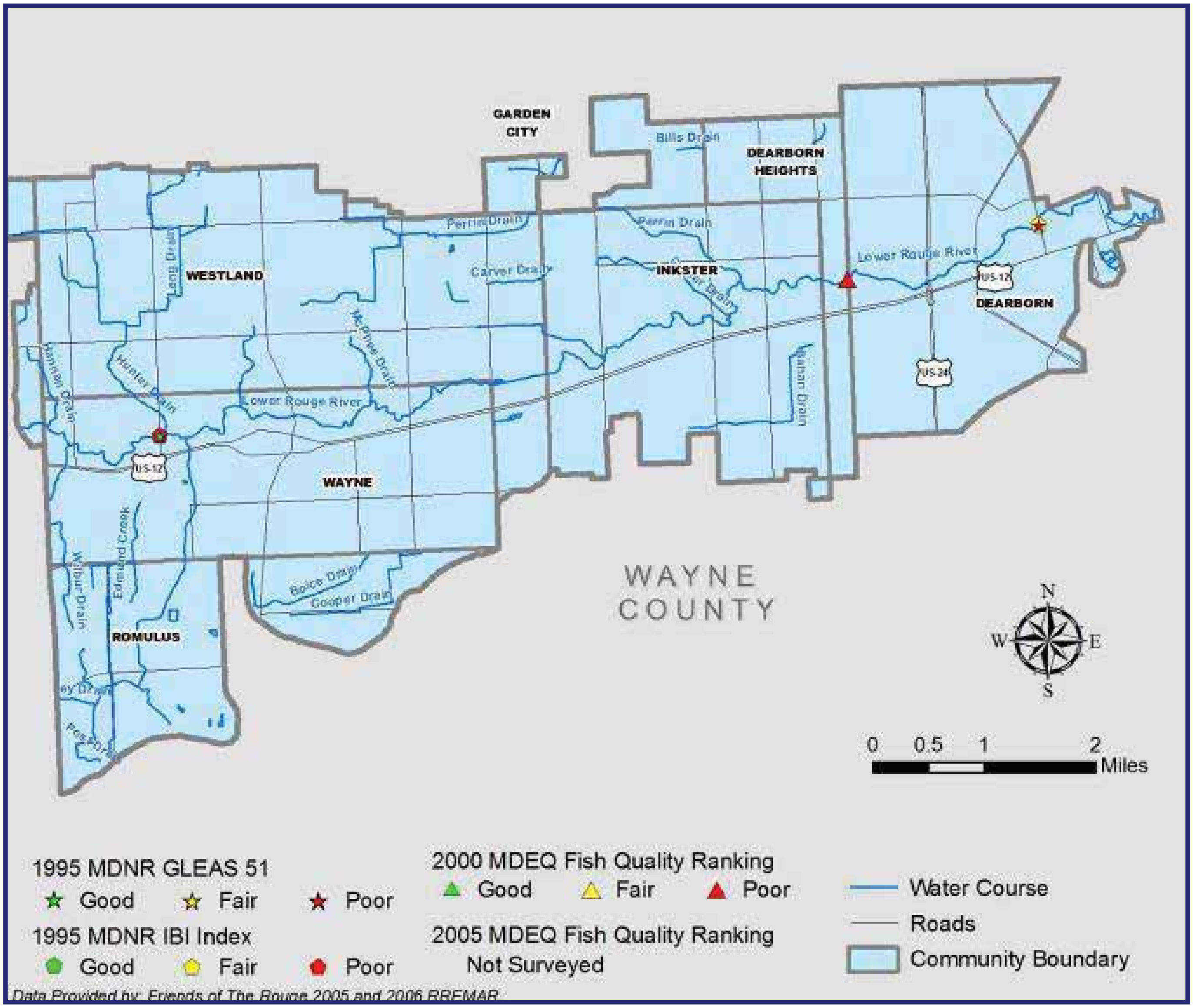
Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Lower 2 Subwatershed. These fish and their associated advisories were last updated in 2007 by the MDCH, as shown in Table 3-21. As with previous advisories, PCBs are the major contaminant influencing the consumption of fish in the Lower 2 Subwatershed.

Table 3-21: 2007 Fish Consumption Advisories for the Lower 2 Subwatershed

Location	Fish Species	Contaminant	General Population	Women and Children
Lower Branch	Carp, < 26 inches	PCBs	Unlimited Consumption	6 Meals/year
	Carp, > 26 inches	PCBs	Do not eat	Do not eat
	Suckers, <14 inches	PCBs	Unlimited Consumption	6 Meals/year
	Suckers, > 14 inches	PCBs	Do not eat	Do not eat

Figure 3-38: Lower 2 Fish Community Assessments



Notable Areas

The addition of increased base flow from the YCUA outfall has transformed the Lower Rouge within the Lower 2 Subwatershed. With the YCUA flow enhancements, the Lower Rouge has changed from being a very low base flow system to a mid-sized river with moderate base flow yields. This new hydrologic configuration has the potential for up to 29 species with angling opportunities for seven species including smallmouth bass, walleye, and northern pike. Similar rivers in Lower Michigan contained 23 species with six sport fish species. Future temperature monitoring is needed to clarify the fishery potential of this reach. There have been confirmed reports of a developing fishery for brown and rainbow trout immediately downstream of the outfall.

Impairments

Historically, excessive flow variation and lack of appropriate spawning habitat have been the main factors negatively impacting the Lower 2 Subwatershed fish community. Base flow enhancement has dramatically increased the fishery potential of the Lower 2 Subwatershed. Continued attention to rehabilitation of this branch will be well worth the effort. In low base flow systems like the Rouge River, artificial base flow enhancement may be a particularly useful tool to enhance sport fish populations (Wichert, 1995).

In 1986 30,000m^3 of Zinc contaminated sediment was removed from the Lower Rouge branch by mechanical dredging

Recent urbanization of land surrounding headwater tributaries has increased point and non-point storm water inputs which continue to impair water quality and hydrology. Increased stream flashiness contributes to streambank erosion and sedimentation, which results in a myriad of negative impacts on the biota. High flows carry away small woody and other debris from the stream channel, eliminating flow refugia and hard substrates upon which many macroinvertebrates forage and endemic fish species lay eggs. Excessive sedimentation covers and embeds critical habitat leaving a relatively flat channel configuration.

Elimination of terrestrial components necessary for moderating the intensity of storm water inputs has also resulted in a decrease in groundwater flow and loss of riparian canopy that may result in increased in-stream temperatures and lower retention of dissolved oxygen. The natural geology of the Lower 2 Subwatershed prohibits high rates of groundwater contribution to streams, therefore negative impacts caused by poor storm water management and removal of riparian buffer zones are magnified. Increases in extreme peak flow and low base flow and increases of temperature are likely to occur as headwaters become more urbanized.

Dearborn CSO control project

Uncontrolled CSOs are located in the stream section that would support the highest diversity and abundance of fish species, however current CSO projects, such as the West Dearborn CSO control project at Military Road in Dearborn will correct this. Several sediment samples exceeded the NOAA ER-M sediment quality values for PCBs, lead, nickel, and zinc, especially between Beech Daly Road and Outer Drive, and for zinc at two stations between Middlebelt Road and Inkster Road. In general, surficial sediments in the downstream portion of the Lower 2

Subwatershed are moderately contaminated and more contaminated on average than sediments upstream in the Lower 1 Subwatershed.

Wayne Road Dam

The size and diversity of the fish community in this subwatershed is constrained by the dams at Wayne Road in the City of Wayne and Henry Ford Estate in Dearborn in the Main 3-4 Subwatershed which prevent fish passage within the subwatershed and from Lake Erie.

The MDNR 1998 Fisheries Assessment identified the Wayne Road Dam in the City of Wayne as an impediment to the Lower Rouge fishery. Removing or providing fish passage at this site would be extremely helpful in enhancing fish communities in the Lower Rouge River by reconnecting it to the Detroit River and Lake Erie ecosystem.

Macroinvertebrate Communities

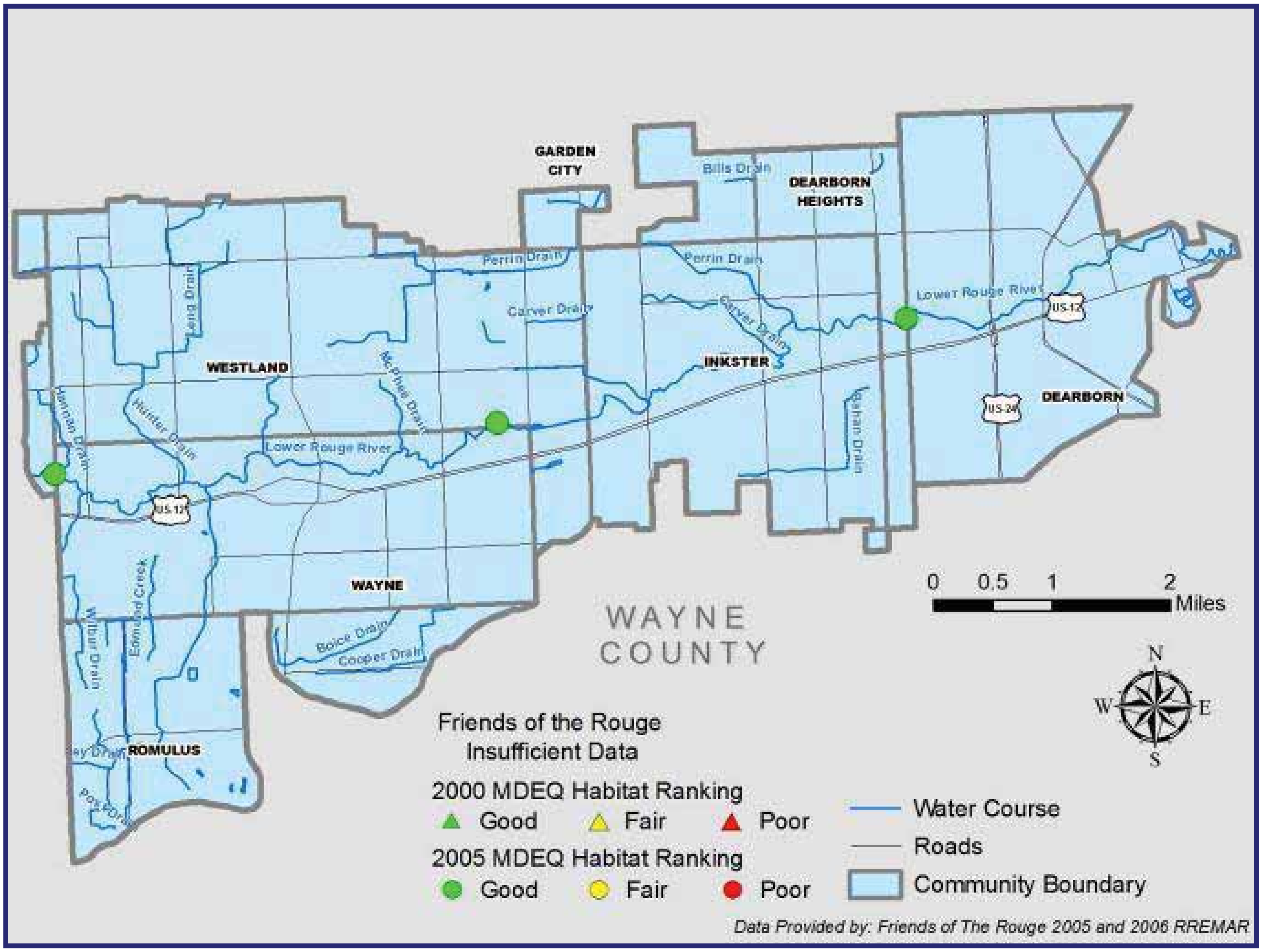
Macroinvertebrate survey results show improving trends in communities over time. As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed are also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Dragonfly

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decades. Below is a description and summary of these results within the Lower 2 Subwatershed.

In 1986, the MDNR conducted aquatic macroinvertebrate surveys at three sites in the Lower 2 Subwatershed. In 2000 and 2005 the MDEQ conducted a Rouge River biological assessment survey (Goodwin, 2002). Macroinvertebrate communities were sampled at three locations and one location in the Lower 2 Subwatershed, respectively. FOTR began sampling in the Lower 2 Subwatershed in 2005 and have two spring sampling sites, and three fall sampling sites. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation. Specific information about what sites have been sampled when, the rating, quality of macroinvertebrates and number of taxa, may be reviewed in the current RREMAR or on the FOTR website (www.therouge.org). Figure 3-39 shows the locations sampled by the MDEQ in 2000 and 2005.

Figure 3-39 Macroinvertebrate Assessments



Streambank stabilization at Ford Field in Dearborn

Notable Areas

The Lower Rouge at Goudy Park in the City of Wayne contains a diverse assemblage of aquatic macroinvertebrates including sensitive species. Enhancing this area and associated subarea may improve results of macroinvertebrate surveys.

Impairments

Lack of habitat variability (especially pools and riffles) and in-stream cover have been identified as causes of impairment. Streams that exhibit this type of impairment typically experience frequent occurrences of extreme peak and low flows. There are many controlled and several uncontrolled CSOs discharging into this subwatershed, and numerous storm sewer discharges. Water quality and quantity is an issue throughout the area. Land use is primarily urban, which results in increased imperviousness resulting in extreme stream patterns. Historically, erosion and sedimentation, along with lack of hard substrates, have prevented the establishment of suitable habitat for a diverse and abundant community of benthic macroinvertebrates within the most downstream reaches of the Lower 2 Rouge Subwatershed. Extensive streambank stabilization has occurred in Ford Field in the City of Dearborn to improve these conditions.

Western chorus frog

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed, however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

In 1999 and 2000 the MDNR completed a voluntary Frog and Toad Survey for the Rouge River Watershed. Results of MDNR surveys for the Lower 2 Subwatershed are shown in Table 3-22 (MDNR, 2006).

Table 3-22: MDNR Frog and Toad Survey - Percent of sections in which species were heard in the Lower 2 Subwatershed

Species	1999	2000
Wood Frog	25	0
Western Chorus Frog	0	50
Spring Peeper	100	25
American Toad	100	0
Northern Leopard Frog	0	0
Gray Treefrog	25	75
Green Frog	50	25
Bullfrog	0	25
Total Sections Surveyed	4	4

Similar to the MDNR, the FOTR began a Frog and Toad Survey in 2000. Based on the FOTR information, all eight species of native frog and toads are present in this subwatershed (Figure 3-40). Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species presence or absence over time. There were no notable trend differences between these two years and the previous ones. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area. Table 3-23 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 2000 through 2007 (FOTR). The number of blocks surveyed in the Lower 2 Subwatershed peaked in 2004 and 2005 with 34 blocks each year and then fell to five and seven blocks respectively in 2006 and 2007.

Gray treefrog

Notable Areas

Within this highly urbanized watershed, a diverse amount of frogs and toads have been heard along the Lower Rouge, specifically at the Inkster Wetlands and Dearborn Hills Golf Course. Green corridors give these species opportunity to flourish.

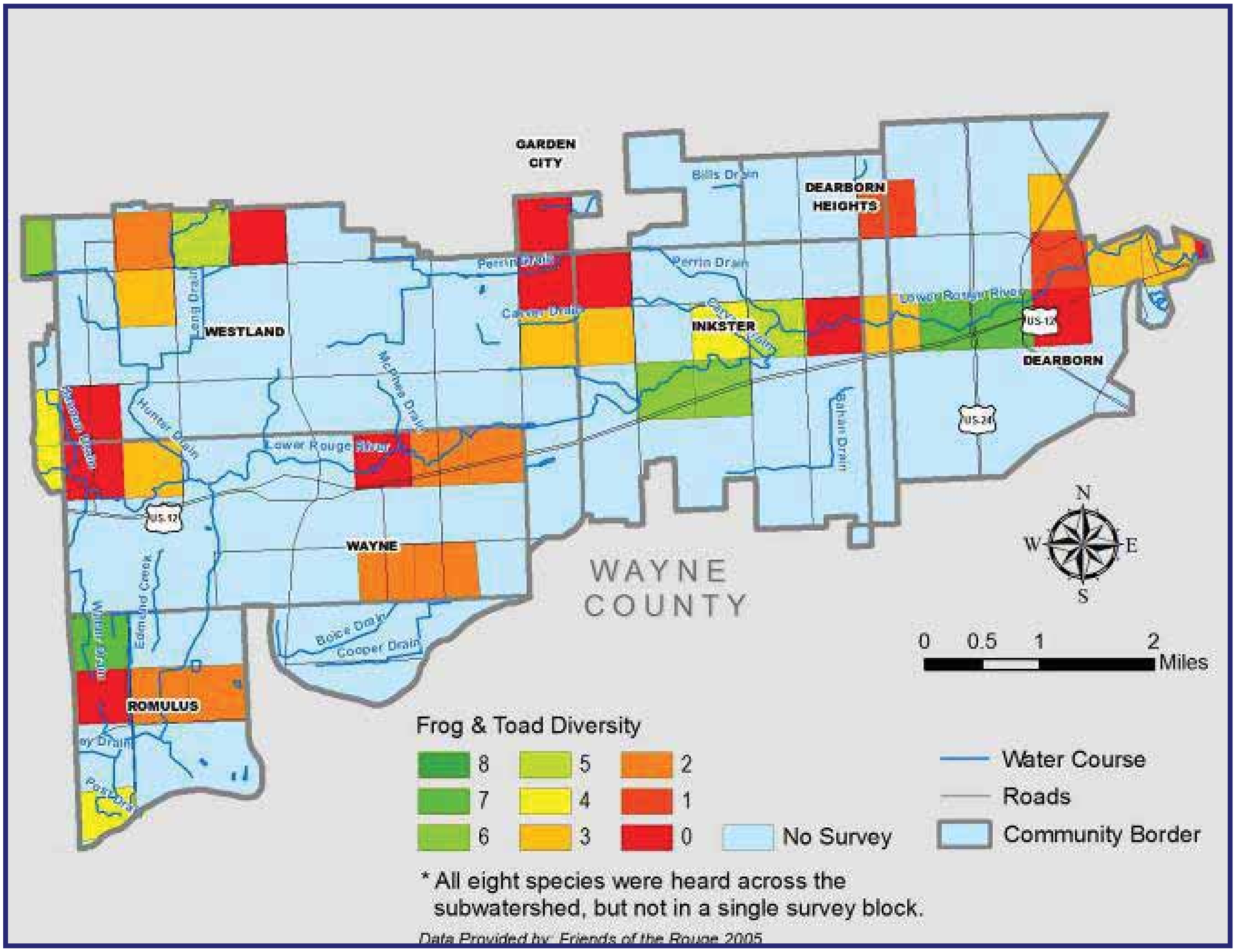
Table 3-23: FOTR Frog and Toad Survey - Percent of blocks in which species were heard in the Lower 2 Subwatershed

Species	2002	2003	2004	2005	2006	2007
Wood Frog	0	10	9	23	17	33
Western Chorus Frog	67	50	42	92	50	56
Spring Peeper	0	20	21	50	50	11
American Toad	100	70	73	100	100	67
Northern Leopard Frog	0	15	15	0	17	11
Gray Tree Frog	0	0	0	44	33	0
Green Frog	0	50	44	44	100	56
Bullfrog	0	15	12	22	50	44
Total Blocks Surveyed	3	20	34	17	6	7

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease or differences in temperature and precipitation from year to year. Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine emergent, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man-made wetlands, like the Inkster Valley Constructed Wetlands created in 1998, can be appropriate substitutes provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Figure 3-40: Lower 2 Frog and Toad Diversity



Stream Habitat

Stream habitat conditions in the Lower 2 Subwatershed have improved since initial sampling evaluations in 1996. One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in the Stream Hydrology section earlier in this section, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels, and decline in undercut banks.

Evaluations of stream habitat were conducted by the MDNR in 1995 and again by the MDEQ in 2000 and 2005. Figure 3-41 shows the locations and results sampled in 1995, 2000 and 2005. In addition, the Rouge Project conducted an aquatic habitat survey during the summer of 1996. The Rouge Project findings were consistent with those identified by MDNR. All referenced studies used the MDEQ GLEAS 51 protocol previously described.

Woody debris management, City of Wayne

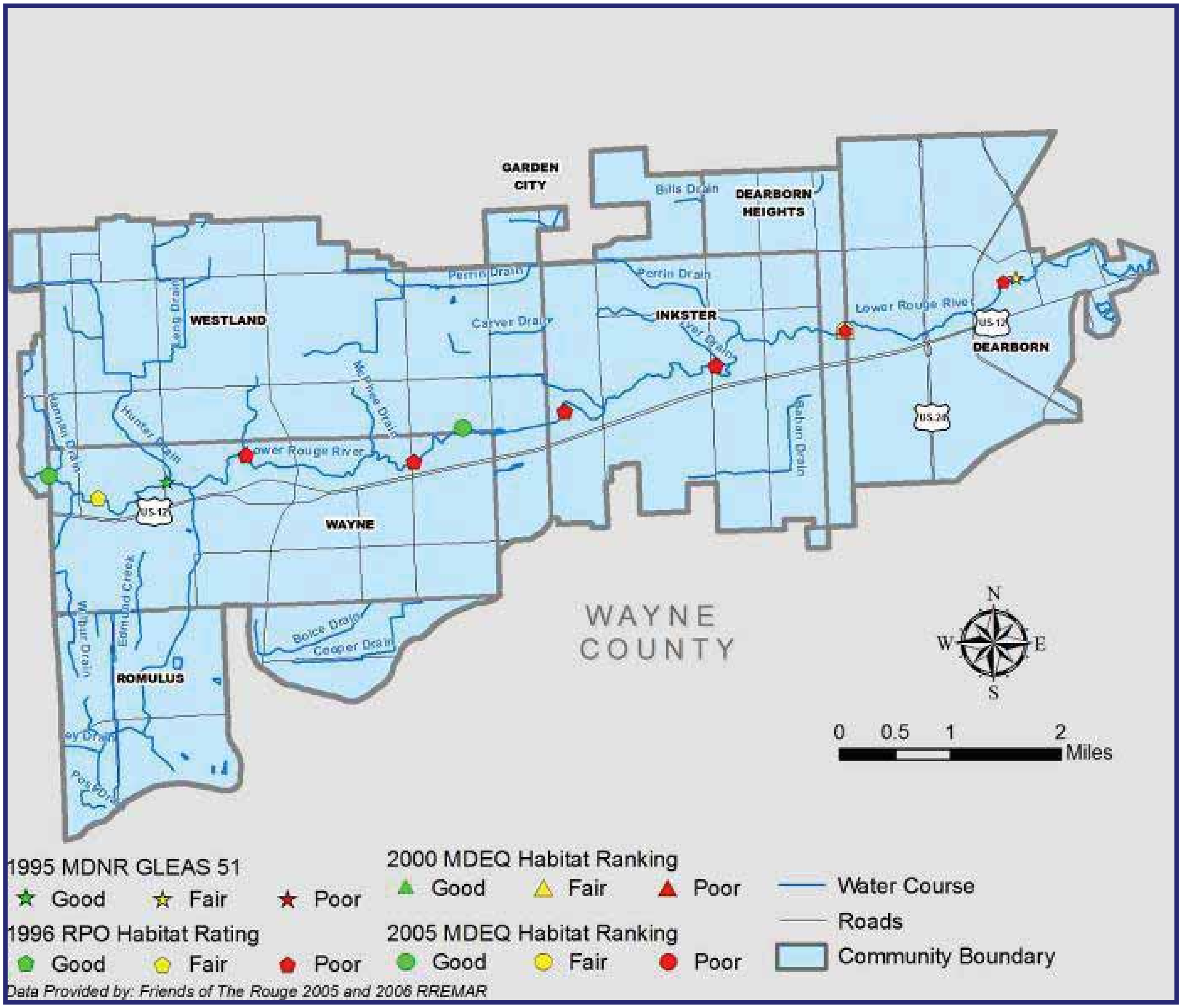
Impairments

The Lower 2 Subwatershed should support a fairly diverse aquatic community. The habitat in the Lower 2 Subwatershed, like much of the Rouge River Watershed, suffers from excessive flow variation, which results in unstable banks, lack of streamside cover, riffles and pools. The primary cause of degraded stream habitat is the excessive flow instability, which in turn causes erosion, sedimentation and lack of habitat complexity. Eroded streambanks and sedimentation negatively impacts the bottom substrates. High flows displace small woody and other debris from the channel, eliminating flow refuges provided by hard substrates. Removal of log jams within the stream negatively impacts habitat availability. The remaining uncontrolled CSOs in the watershed negatively impact water quality. Plans are underway to correct these CSOs. Negative impacts from unmitigated storm water flow continue to impair the stream habitat. The dam at Wayne Road in the City of Wayne in the Lower 2 Subwatershed fragments aquatic habitats and renders them unavailable for some fish species.

Stream Corridor

The Lower 2 Subwatershed, while heavily developed, contains forested river corridor areas through the communities. The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and

Figure 3-41: Lower 2 Stream Habitat Assessments



wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River Watershed.

Riparian Corridor

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms; and a buffer for pollutants and sediments from surface runoff. In addition to providing habitat for aquatic organisms, the corridor is used by many birds and mammals. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

The Lower 2 Subwatershed is heavily developed, however it still retains a moderately intact riparian corridor in the cities of Wayne, Inkster and Dearborn. This riparian corridor is seasonally flooded, providing an important connection with the river. This dynamic is readily observed in the vicinity of the Inkster Valley Wetlands. This area is also important as it demonstrates the use of natural and constructed wetlands to treat non-point source pollution.

Wetlands and Woodlands

Figure 3-42 shows the existing wetlands within the Lower 2 Subwatershed. This figure depicts forested wetlands as the highest percentage of remaining wetlands in the subwatershed, with smaller areas of both scrub-shrub and emergent wetlands. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-43. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Edison Elementary School in Westland participate in "Rooting for the Rouge"

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Figure 3-42: Lower 2 Existing Wetlands

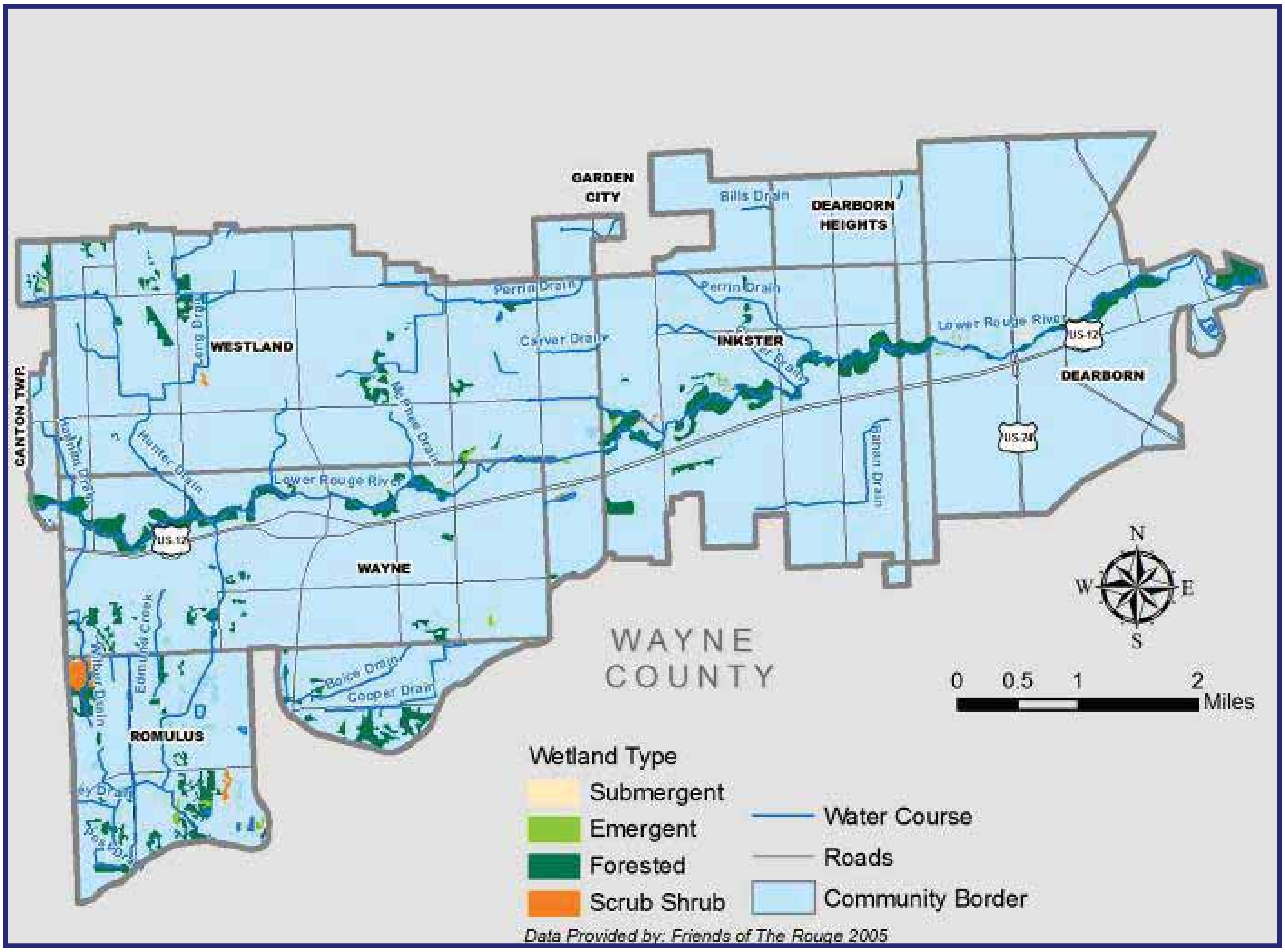
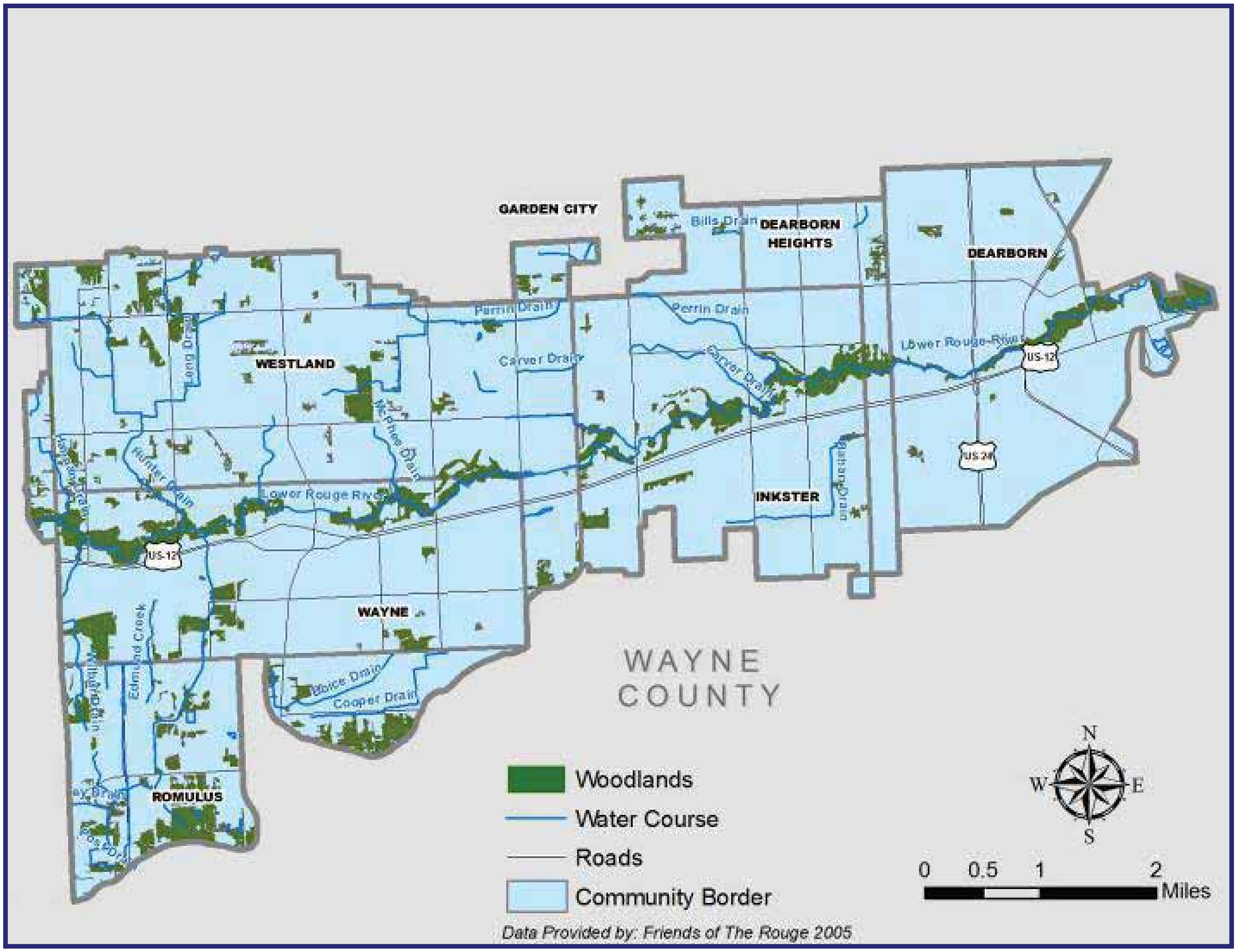


Figure 3-43: Lower 2 Existing Woodlands



Historical Storm Water Projects in the Lower 2 Subwatershed

All storm water best management practices have an effect on the river's water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are some projects subwatershed stakeholders have completed:

- The City of Dearborn sponsors an annual Household Hazardous Waste drop-off day.
- The cities of Romulus, Dearborn, Inkster, Dearborn Heights and Wayne perform regular street-sweeping activities which reduce the amount of oils, greases and debris that go into storm drains and eventually into the Rouge River.
- The City of Westland partnered with schools in Wayne, Inkster and Canton Township to present "Rooting for the Rouge," a tree-planting project which teaches fourth-grade students about land and water issues.
- "Ours to Protect" signage has been installed at numerous tributary crossings throughout the Lower 2 Subwatershed.
- The City of Dearborn continues to work with volunteers from Ford Motor Company who perform river stewardship activities at Ford Field park, including streambank stabilization, woody debris management and native plantings.
- In 2006, Friends of the Rouge and 21 volunteers added a buffer of native plants to Attwood Park in the City of Wayne.
- A storm water pond created in the City of Dearborn's Ford Field and is now home to a variety of fish like bluegills, large mouth bass, small mouth bass and Yellow Bullhead. Snapping turtles and mud, map, red-eared slider, painted, and soft-shell turtles also call the pond home. Belted Kingfisher, Blue Heron and egrets are frequent visitors.
- The City of Wayne installed rain gardens in its municipal parking lot to retain and treat storm water onsite, thus reducing the amount of polluted storm water going into the Rouge River.

City of Wayne rain garden

Main 1-2 Subwatershed (Storm Water Management Area) Conditions

The Main 1-2 Subwatershed continues to face heavy development pressure and has lost habitat due to development. Overall, the Main 1-2 has been experiencing improving trends in a number of water quality parameters. The characteristics and conditions of this subwatershed and the associated stream indicators described in this subchapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Main 1-2 Subwatershed Management Plan. While the stream indicators of water quality, stream hydrology, aquatic diversity, stream habitat and physical conditions of the stream corridor are all indicative of urban stream conditions, the general trends show improvement. Stream habitat conditions vary across the entire subwatershed. Clear trends show numerous poor ratings in 1996 leading to frequent good habitat conditions in 2005. This is quite promising and is indicative of the significant improvement efforts that have been completed are continue throughout this subwatershed. Challenges remain with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in wet weather conditions.

The communities, non-profit organizations and educational institutions of the Main 1-2 Subwatershed have accomplished a great deal of storm water pollution control in the past ten years through individual and collaborative projects, some of which will be noted throughout this section.

Main 1-2 highlights:

- ***The Main 1-2 continues to face heavy development pressure and has lost habitat due to development.***
- ***Overall, the Main 1-2 has been experiencing improving trends in a number of water quality parameters.***
- ***The Main 1-2, notably between Troy and Southfield, has some of the highest populations and diversity of mussels in the entire watershed due largely to the intact riparian corridor.***

Subwatershed Demographics

The Main 1-2 Subwatershed is located entirely in Oakland County and has a drainage area of approximately 103 square miles. Tributaries that drain to the Main Rouge River in this Subwatershed include Evans Ditch, Pebble Creek, and the Franklin Branch.

The Main 1-2 Subwatershed includes all or portions of Auburn Hills, Beverly Hills, Bingham Farms, Birmingham, Bloomfield Hills, Bloomfield Township, Farmington, Farmington Hills, Franklin, Lathrup Village, Oak Park, Orchard Lake Village, Pontiac, Rochester Hills, Southfield, Southfield Township, Troy and West Bloomfield Township (See Figure 3-44).

Valley Woods Nature Preserve in Southfield

Figure 3-44: Main 1-2 Subwatershed Location

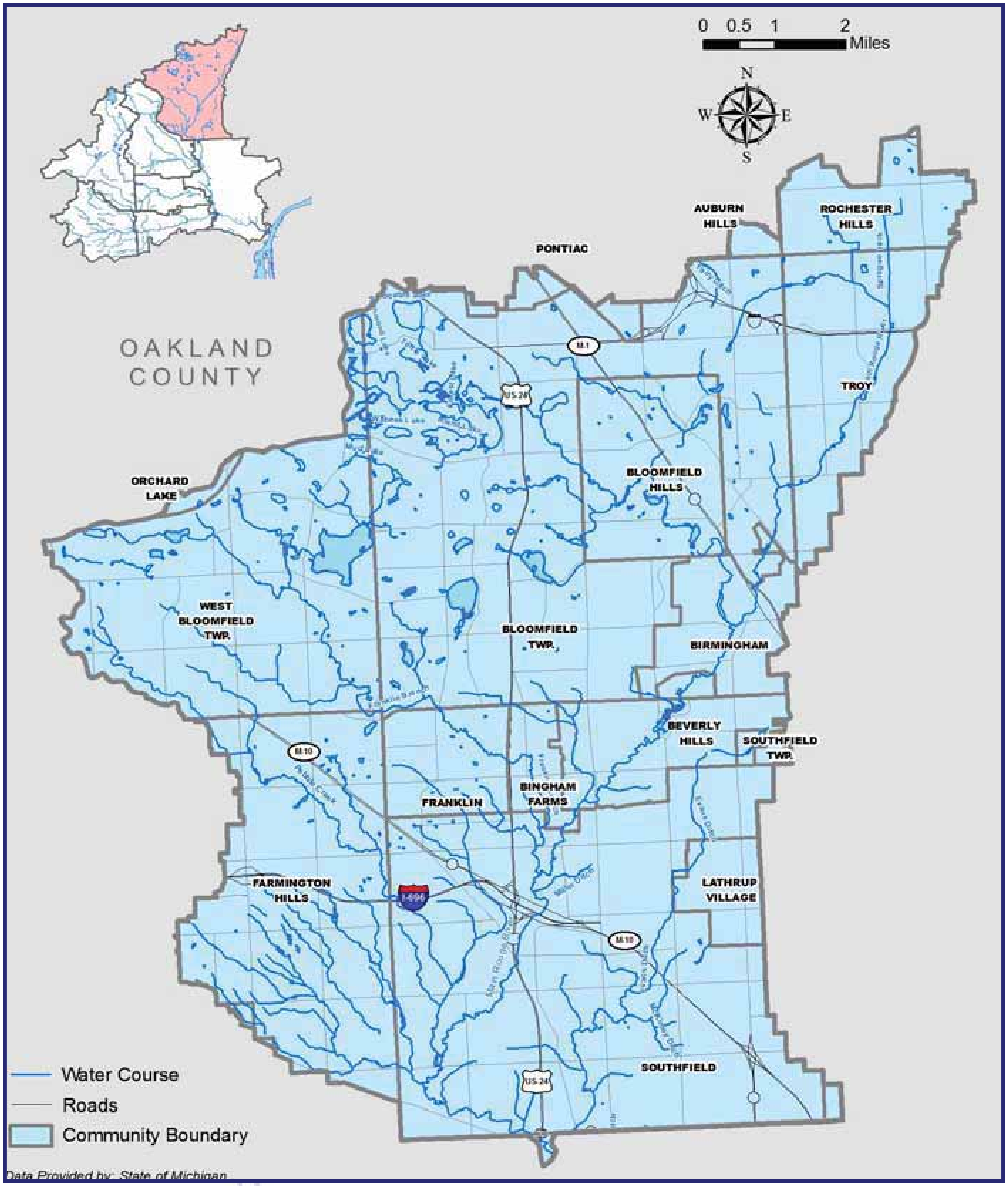


Table 3-24 lists the member communities that make up the Main 1-2 Subwatershed and summarizes the area for each community.

Table 3-24: Main 1-2 Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Auburn Hills	0.3	1.8
Beverly Hills	3.7	100
Bingham Farms	1.2	100
Birmingham	3.1	100
Bloomfield Hills	5	100
Bloomfield Township	25.5	98.8
Farmington	0.2	3.8
Farmington Hills	12	36.1
Franklin	2.6	100
Lathrup Village	1.5	100
Oak Park	0.2	2.5
Orchard Lake Village	0.3	6
Pontiac	0.7	3.5
Rochester Hills	3.1	9.4
Southfield	23.4	89.2
Southfield Township	0.2	2
Troy	6	17.9
West Bloomfield	14	44.9
Totals	**103**	**NA**
Counties		
Oakland County	103	

This subwatershed continues to face heavy development pressure and has lost habitat due to development. Additional development could exacerbate the problems associated with flow variability of the river. This subwatershed also has many parks and nature centers including: Carpenter Lake and the Valley Woods Nature Trail in Southfield which traverses wetland and meadow habitat; the Douglas-Evans Nature Preserve in Beverly Hills; the E.L. Johnson Nature Center in Bloomfield Township; the Cranbrook Gardens in Bloomfield Hills; Firefighters Park and Lloyd A. Stage Outdoor Education Center in Troy, West Bloomfield Woods Nature Preserve, and Booth Park in Birmingham. These open spaces can be managed to provide recreation and improve water quality.

Firefighters Park in Troy

Impervious Cover

Significant changes in land use and land cover have occurred across this subwatershed over the last ten years. Figure 3-45 graphically depicts the current impervious cover across this subwatershed. In addition, Table 3-25 highlights the changes in land cover between 1991 and 2002.

Figure 3-45: Main 1-2 Imperviousness

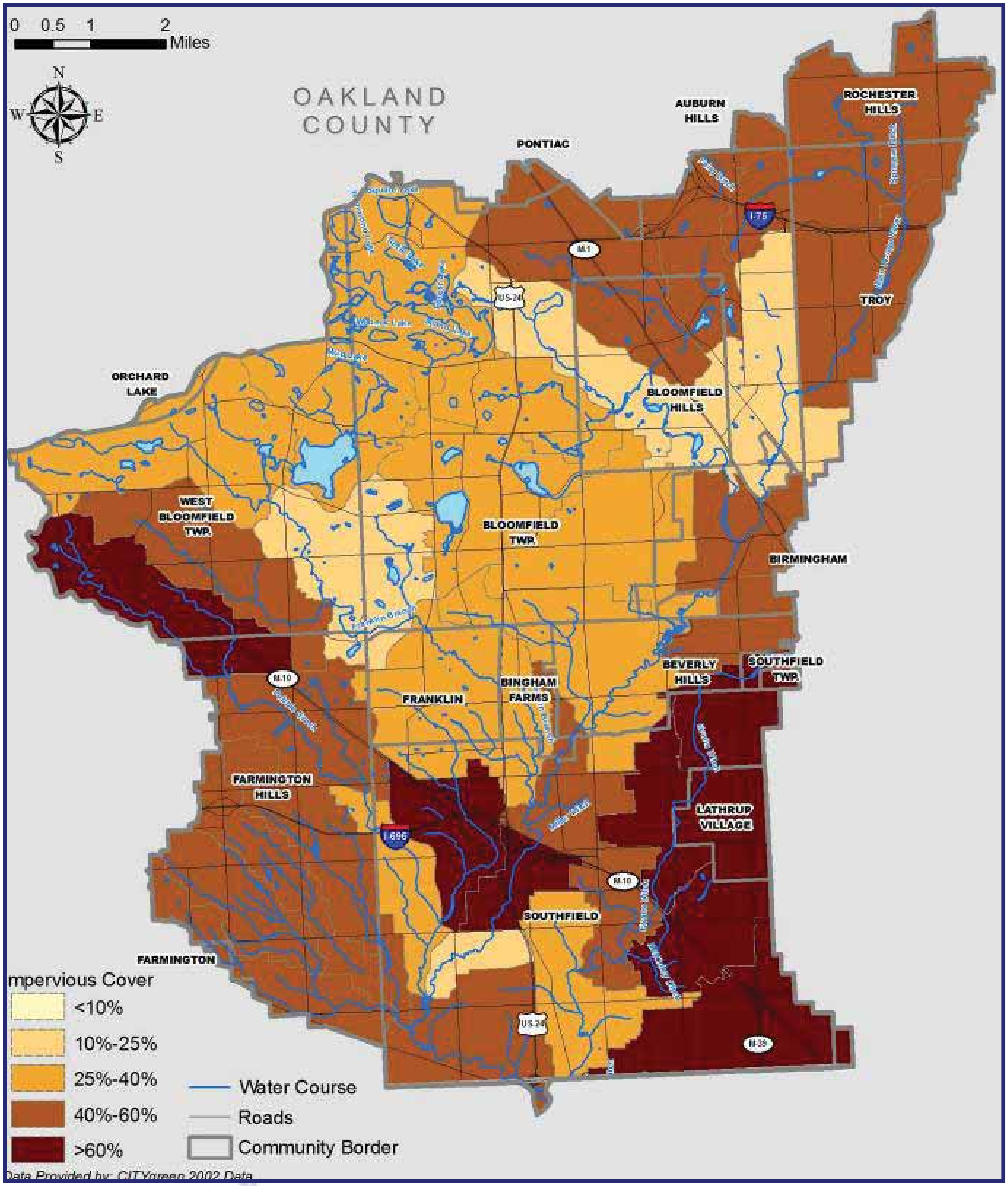


Table 3-25: Changes in Land Cover 1991-2002

Main 1-2 SWMA Land Cover	1991	2002
Open Space - Grass	21%	12%
Trees	40%	40%
Grow Zones	0%	0%
Green Roofs	0%	0%
Subtotal: Green Infrastructure	61%	52%
Urban: Impervious	34%	45%
Urban: Bare	3%	1%
Water	2%	3%
Total	100%	100%

Water Quality

Trends in water quality are improving which demonstrates that projects and activities implemented over the past ten years have been successful. The CSO control program in this subwatershed has included both CSO Retention Treatment Basins (RTBs) and sewer separation. Three CSO RTBs operating in this subwatershed include Birmingham, Bloomfield Village and Acacia Park. Bloomfield Hills completed a sewer separation project in 1998. Collectively, these projects control all known CSOs in the subwatershed.

Linden Park CSO in Birmingham

Overall, the Main 1-2 has been experiencing improving trends in a number of water quality parameters, including temperature, dissolved oxygen (DO) and *E. coli.* DO concentrations improved significantly since the completion of the CSO control projects and have remained consistent since that time. Since 1997 DO concentrations have rarely been lower than the State water quality standard of 5 mg/L. In fact, during the 2005 sampling events, 99.8% of the measured DO concentrations met the State standard.

The Main 1-2 Subwatershed Advisory Group established targets for water quality as part of the 2001 Main 1-2 Subwatershed Management Plan. These targets are summarized in Table 3-26.

Table 3-26: Main 1-2 Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Total Phosphorus (mg/L)	Annual average ≤ 0.05 (dry weather)
Total Suspended Solids (mg/L)	< 80 by 2015 (dry weather)
E. coli (cfu/100 ml)	Partial body contact standard by 2015 (dry weather)

Water sampling

Based on the dry weather sampling results, it is clear that progress has been made towards improving water quality conditions based on some parameters (see Table 3-27). The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. Water quality trends are indicated in Table 3-27, where sufficient data was available for a trend assessment. More detailed information is available in the most recent RREMAR. The Main 1-2 monitoring sites are depicted in Figure 3-46.

Table 3-27: Main 1-2 Dry Weather Conditions - Summary

Parameter	Maple Road G45	Lahser Road M03	Beech Road US5
Water Temperature	Good	Good	Good
Dissolved Oxygen (DO)	Good ↑	Good ↑	Good ↑
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Good	Good	Good
Ammonia (NH_3-N)	Good	Good	Good
Total Phosphorus (TP)	Poor	Poor	Poor
Total Suspended Solids (TSS)	Good	Fair	Fair
E. coli	Fair ↑	Fair ↑	Fair ×

↑ indicates an improving trend ↓ indicates a declining trend ×indicates no trend

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

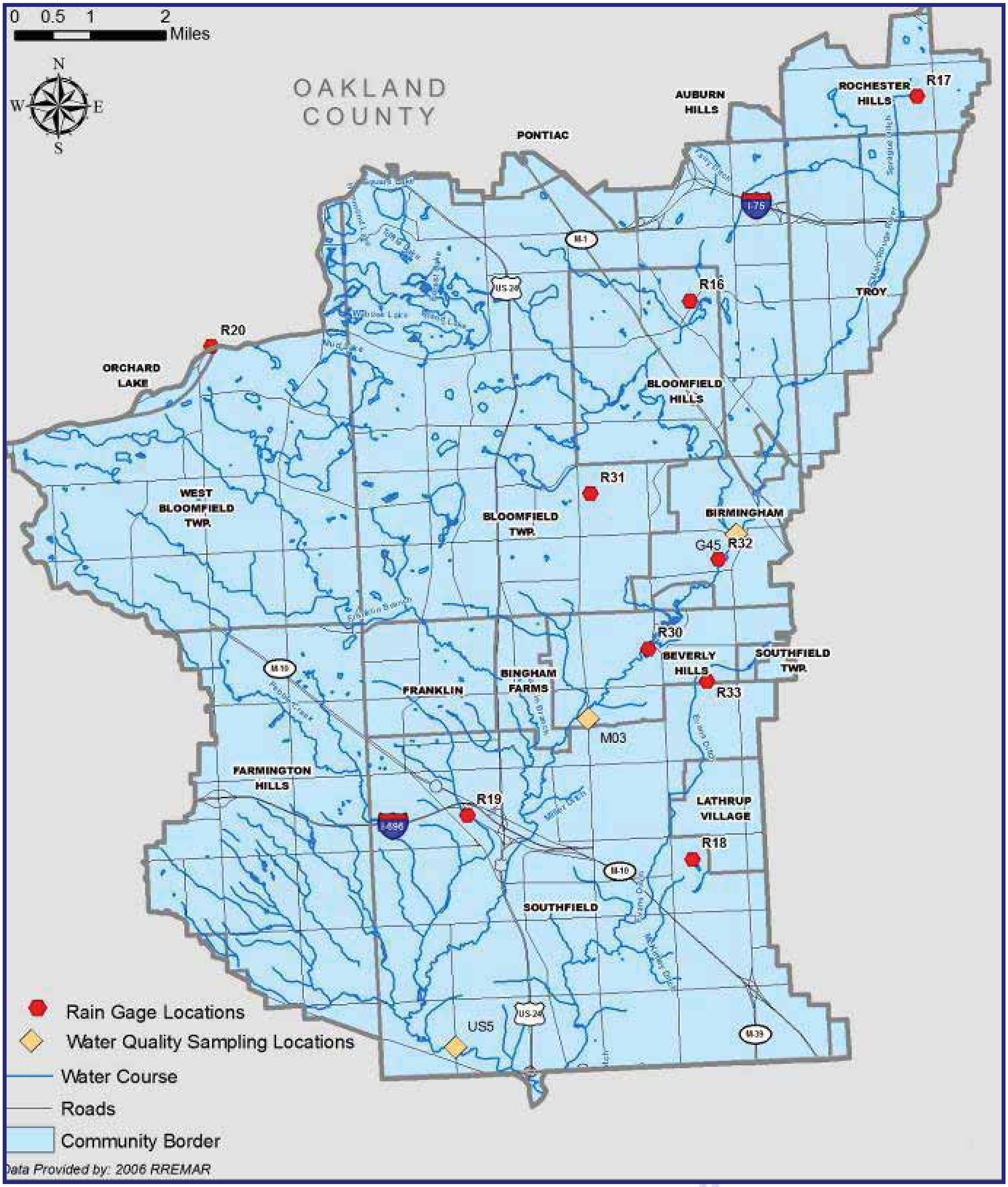
http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

Average DO concentrations have improved and remained consistent from 1994 through 2005 at approximately 8.4 mg/L. Dry weather sampling was performed in 2004. During this time, all sites met the 80 mg/L TSS target previously mentioned. Total phosphorus sampling resulted in a poor rating; however, slight improvements would raise this rating. While samples tested for *E. coli* were rated fair, the State standard for both total body contact and partial body contact was not met in any of the surveys conducted in 2004.

E. coli Results

The *E. coli* information collected in the Main 1-2 indicates that pathogens continue to be a problem in this watershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human (sewage) sources. Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

Figure 3-46: Main 1-2 Water Quality Sampling & Rain Gage Locations



The 2005 *E. coli* data indicated that the Main 1-2 frequently exceeded total body contact water quality standards and often exceeded partial body contact standards (see Figure 3-47). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum to and farm animals. . Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), aging sanitary sewers and failing septic systems which are also called on-site sewage disposal systems (OSDSs).

The BST sampling showed human sources of *E. coli* are suspected at two sites during dry weather and five sites during wet conditions (see Figure 3-48). The dry weather hits were noted in two locations, including the Franklin Branch at Middlebelt Road between 14 Mile and Maple Road and Pebble Creek at Franklin Road south of 11 Mile Road. The dry weather human *E. coli* sources are most probably associated with illicit connections, while the wet weather sources could be any of the human sources mentioned previously including sanitary sewer overflows (SSOs).

Failing septic field

Water Quality in Wet Weather Conditions

While the overall water quality of this subwatershed continues to improve, challenges still exist with wet weather conditions. Wet weather sampling at Beech Road (US5) has not been performed consistently from 1994 through 2004. Five wet weather surveys were performed at Beech Road (US5) from May through October in 2004. The most notable results follow.

- In 2004 mean concentrations for $CBOD_5$, TSS, NH_3, and TP were only slightly lower in dry weather than wet weather.
- The 2004 *E. coli* wet weather geometric mean was approximately eight times the dry weather geometric mean.
- The 2004 *E. coli* wet weather event geometric means at Beech Road (US5) all exceed the State partial body contact standard of 1,000 cfu/100ml for *E. coli*.

Beginning in the mid-1990s, under the direction of the Oakland County Water Resource Commissioner's Office, CSO retention treatment basins were constructed in the Lincoln Hills Golf Club in Bloomfield Township, the Douglas-Evans Nature Preserve in Beverly Hills and Linden Park in Birmingham. Although these CSOs are controlled, some may still discharge to the Rouge River during very large rain events. However, this discharge receives screening, primary treatment, and disinfection and should have low *E. coli* concentrations.

There are two major reasons for the occurrences of SSOs: legally connected footing drains and sump pump connections. There is also the potential for surface waters to enter manholes in flood prone areas and contribute inflow to the system. Footing drain disconnection projects have been successful in a number of Main 1-2 communities. In 2004, the City of Farmington Hills, the Village of Beverly

Figure 3-47: Main 1-2 2005 E. coli Sampling Results

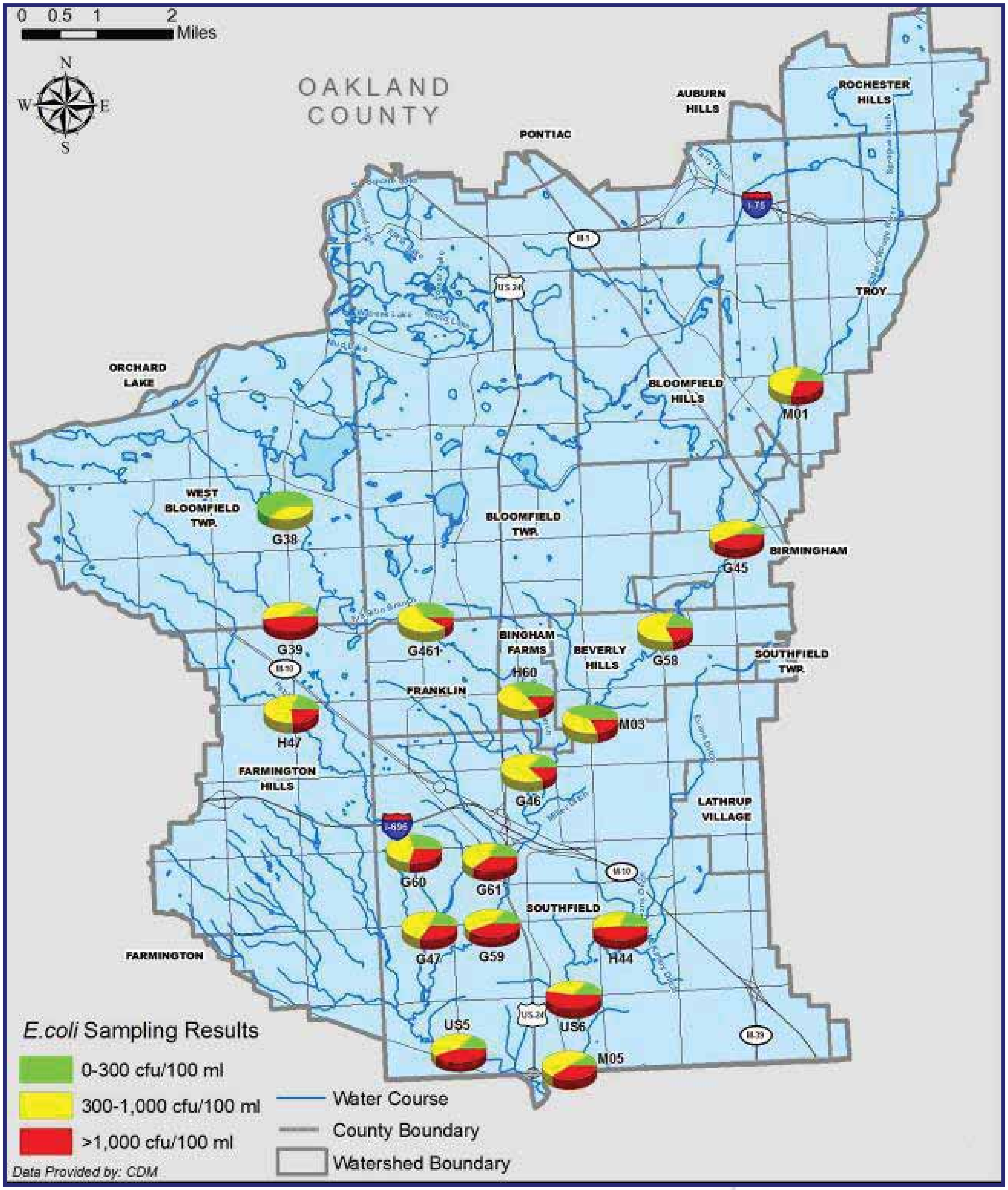
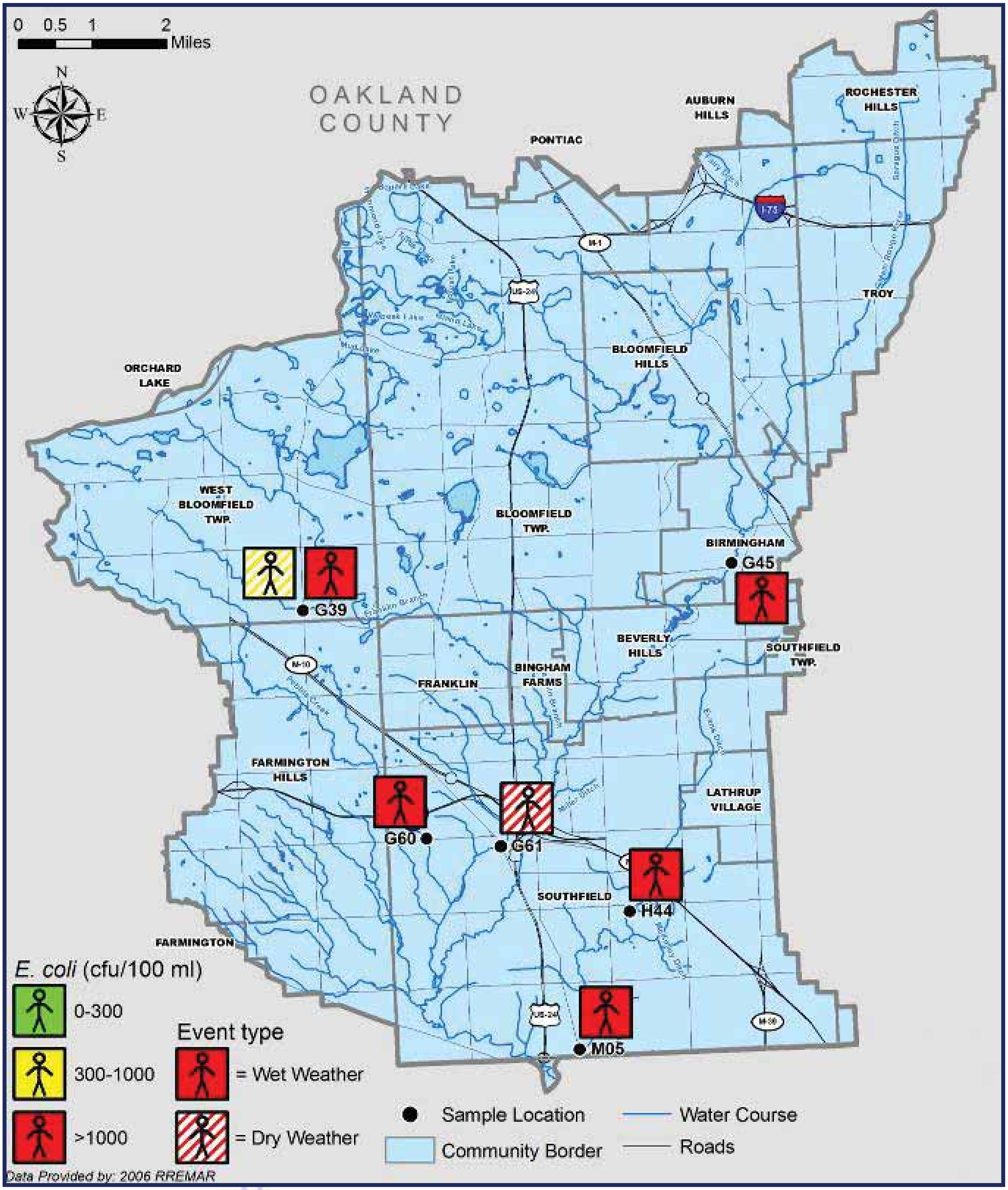


Figure 3-48: Main 1-2 Bacterial Source Tracking Results



Hills, the City of Auburn Hills, West Bloomfield Township, the City of Troy and Oakland County successfully applied for $2.7 million in Rouge Project Round VI grant funding to correct their SSOs. In addition, the reconstruction of Walnut Lake Pump Station No. 1 in the Oakland County Evergreen Farmington Sewage Disposal System also worked to eliminate SSOs.

While CSOs and SSOs discharge during wet weather events and, therefore, when storm water dilution occurs, failing septic systems, illicit connections and aging sanitary sewers can discharge continuously.

Since a typical house is expected to discharge wastewater in excess of 50,000 gal./yr., failing septic systems can be a significant source of *E. coli*. There is an estimated 10,000 septic systems in the Main 1-2 Subwatershed. Based on studies done in the Rouge watershed and across Michigan, the expected failure rate for these systems is 25% to 40%.

The City of Southfield and Bloomfield Township hosted septic system maintenance workshops in 2006 and 2007 to educate homeowners about the proper care of septic systems. In addition, the City of Southfield requires homes with septic systems to hook-up to a city sewer at time-of-sale.

The animal sources of *E. coli,* including wildlife, pets and farm animals, are much more challenging to locate within a storm drain system, and it is difficult to quantify their impacts.

Pollutant Abbreviations:

BOD:	*Biochemical Oxygen Demand*
DP:	*Dissolved Phosphorus*
NO_2:	*Nitrite*
NO_3:	*Nitrate*
TKN:	*Total Kjeldahl Nitrogen*
TP:	*Total Phosphorus*
TSS:	*Total Suspended Solids*

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water runoff contributes significant pollutant loading to the Main Rouge River and Evans Ditch in this subwatershed. In the Main 1-2 Subwatershed, storm water contributes high bacterial and total suspended solids loading. The loading from point sources is relatively insignificant.

Total pollutant loading incorporating base flow, point sources, combined sewer overflows (CSOs) and non-point sources was estimated for the entire Rouge River Watershed using the WMM model. The estimated existing pollutant loads for the Main 1-2 Subwatershed are summarized in Table 3-28. Specific study details from the ARC NPS Loading Report may be found at www.allianceofrougecommuni-ties.com.

Table 3-28: Existing Pollutant Loads for the Main 1-2 Subwatershed

Pollutant	Units	Source				Total Load
		Base Flow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	19%	70%	0%	11%	685,000
DP	lbs/yr	51%	42%	0%	7%	5,400
Fecal Coliform	counts/yr	0%	99%	0%	1%	3.3×10^{16}
NO_2 & NO_3	lbs/yr	84%	13%	0%	3%	44,000
TKN	lbs/yr	80%	17%	0%	3%	113,000
TP	lbs/yr	36%	55%	0%	9%	15,400
TSS	lbs/yr	62%	33%	0	5%	5.8×10^{6}

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the Rouge River. The bacteria loading from CSOs are nearly twice the loading from non-point sources. However, when considering TSS and phosphorus, the contribution from non-point sources is similar to that from CSOs. The loading from point sources is relatively insignificant. For the purposes of prioritizing storm water BMPs, the remainder of the analysis within this section focuses on pollutant loads associated with non-point sources.

The Main 1-2 Subwatershed was subdivided into 38 subbasins as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, phosphorus and total suspended solids (TSS) within each subarea are shown in Figures 3-49, 3-50 and 3-51. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

The primary non-point sources of phosphorus in the critical Main 1-2 subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, runoff containing pet and livestock waste, illegal sewer connections and failing septic systems. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils from construction sites without proper soil erosion control practices.

Rain gage

Stream Hydrology

The hydrologic trends along the Main Rouge River continue to cause excessive erosion and habitat degradation. The 2001 Main 1-2 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under two-inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed. The target for long-term volume reduction for the Main 1-2 Subwatershed is approximately 80 million cubic feet. Volume reduction can be achieved through interception, infiltration, evapo-transpiration and reuse.

River and stream flow data were also collected at the USGS site north of Maple Road (US4), Beech Road (US5) and at Evans Ditch at 9 Mile Road (US6). Overall, an increasing trend in low flows, average annual flow rates and instantaneous peak flow rates have shown an increasing trend through the 1990's, but a decreasing trend at Beech Road and Evans Ditch since that time. (RRNWWDP, RREMAR, 2006).

A hydraulic analysis was completed to help identify Best Management Practice (BMP) measures that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the

Figure 3-49: Main 1-2 Fecal Coliform Estimated Non-Point Source Load

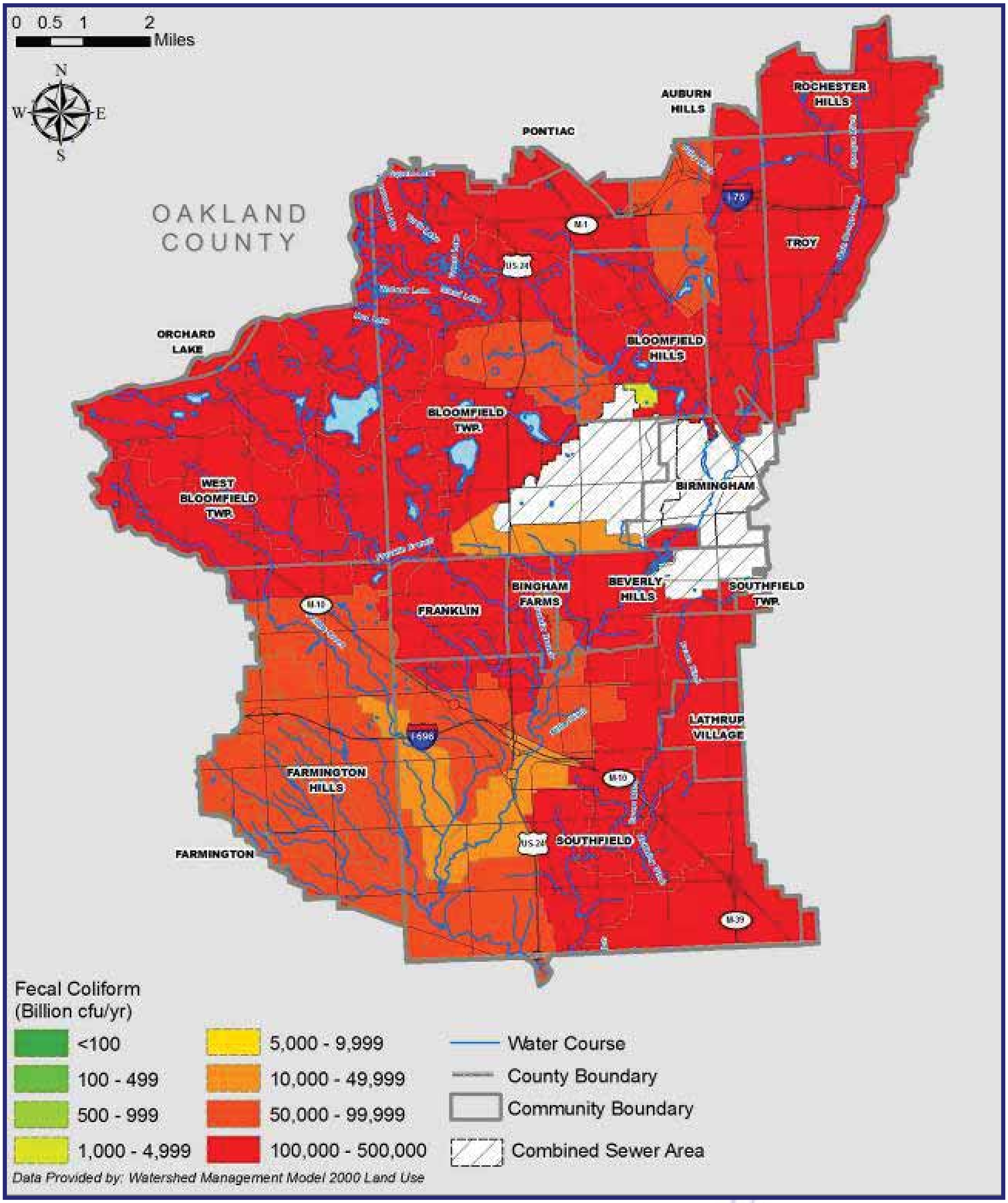


Figure 3-50: Main 1-2 Total Phosphorus Estimated Non-Point Source Load

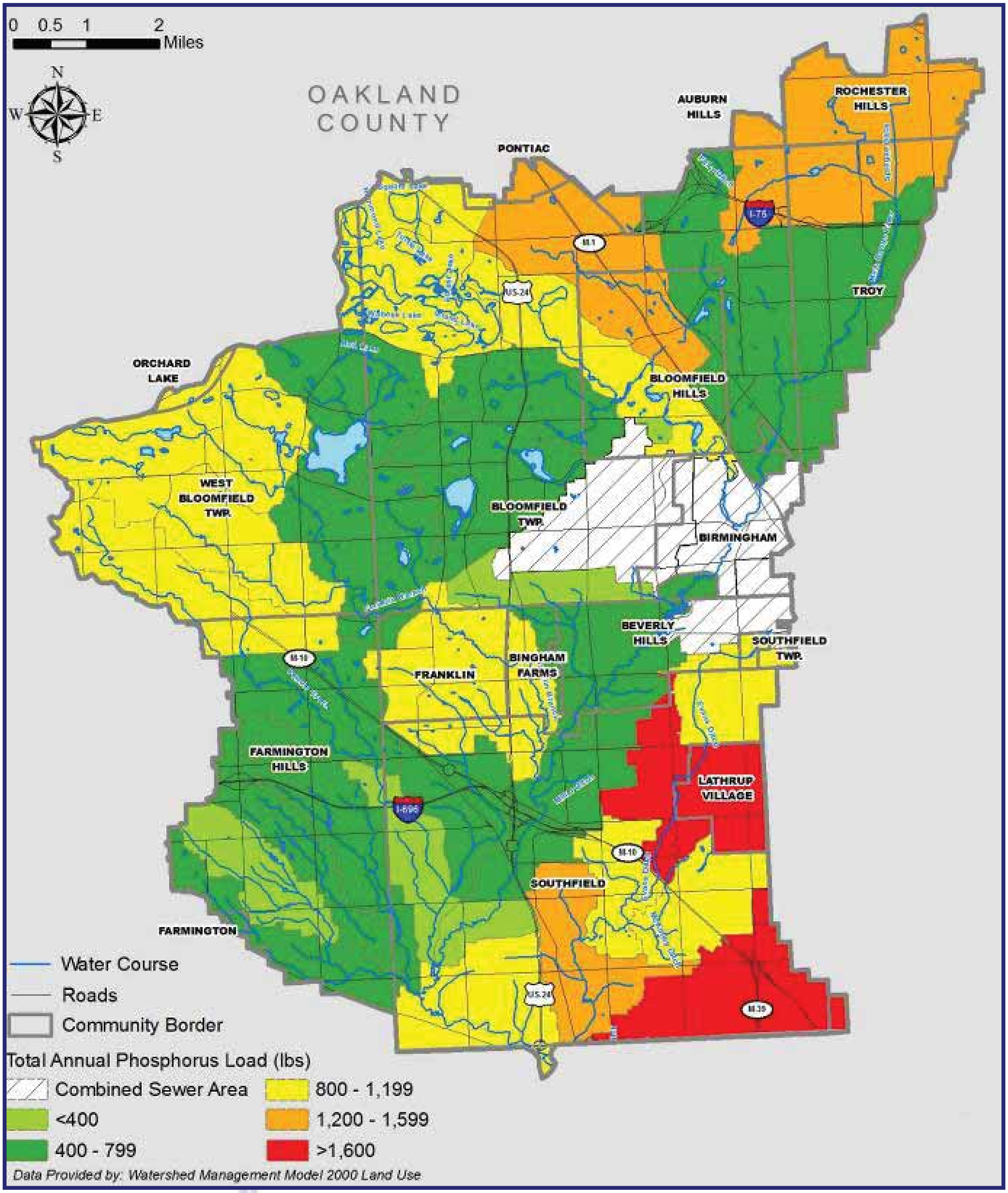
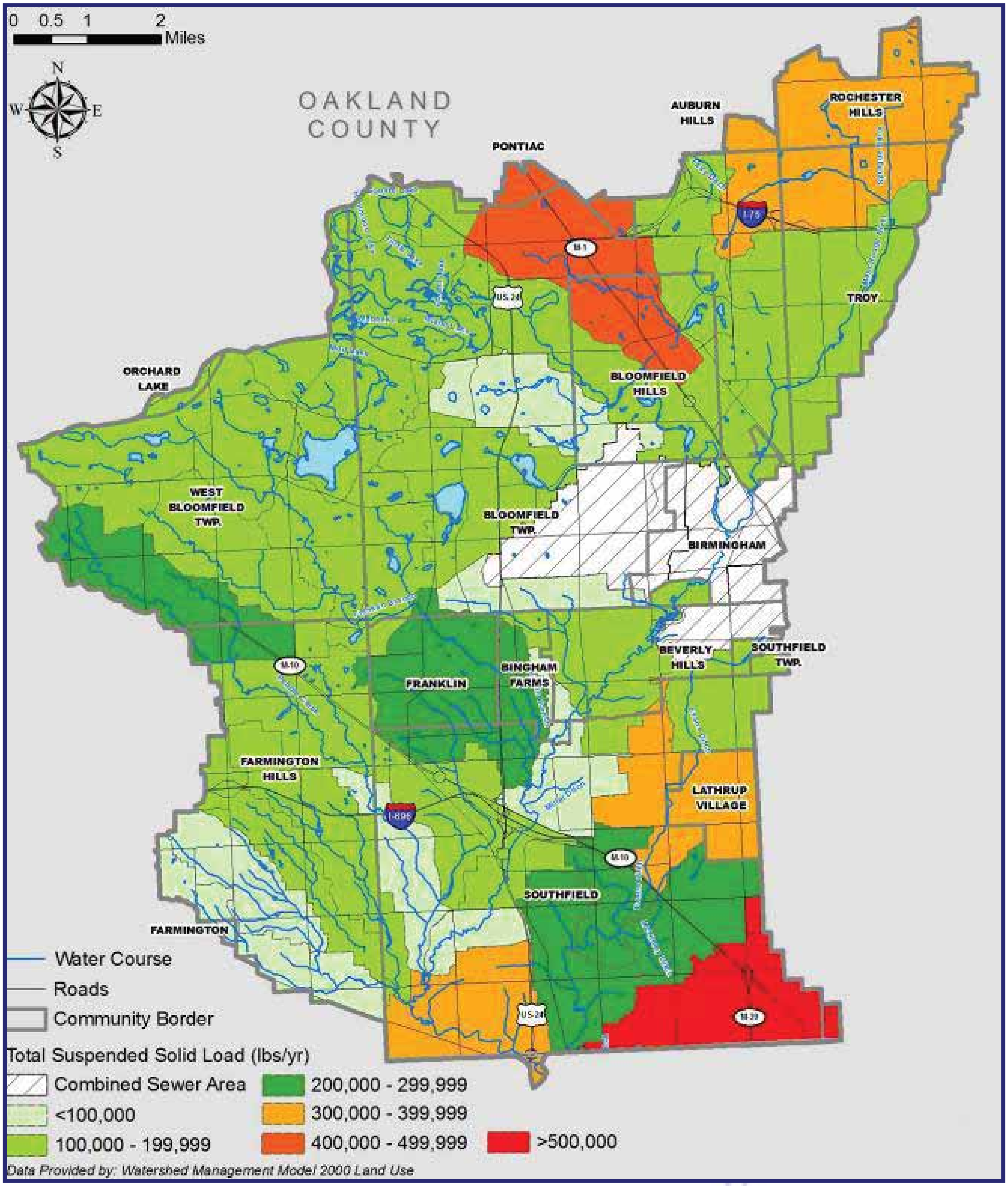


Figure 3-51: Main 1-2 Total Suspended Solids Estimated Non-Point Source Load



largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

US4 gage in Birmingham

Figure 3-45 on page 3-98 previously mentioned shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. Three USGS gages within this subwatershed (04166000, 04166100, 04166200), US4 in Birmingham, US5 in Southfield and US6 for Evans Ditch in Southfield, provide appropriate flow information for identifying goals for the Main1-2 subwatershed. Figure 3-52 shows the areas in the subwatershed that contribute to the flow conditions for these gage.

Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events. These results are shown in Tables 3-29, 3-30 and 3-31.

Table 3-29: Main 1-2 Subwatershed Flow Rate Trends at Site US4 (Birmingham)

Bankfull Flow Rate	495 cfs with a return period of 8.6 months
15-day Flood Flow Rate	52 cfs
1-month Flood Flow Rate	110 cfs

US6 gage for Evans Ditch in Southfield

Table 3-30: Main 1-2 Subwatershed Flow Rate Trends at Site US5 (Southfield)

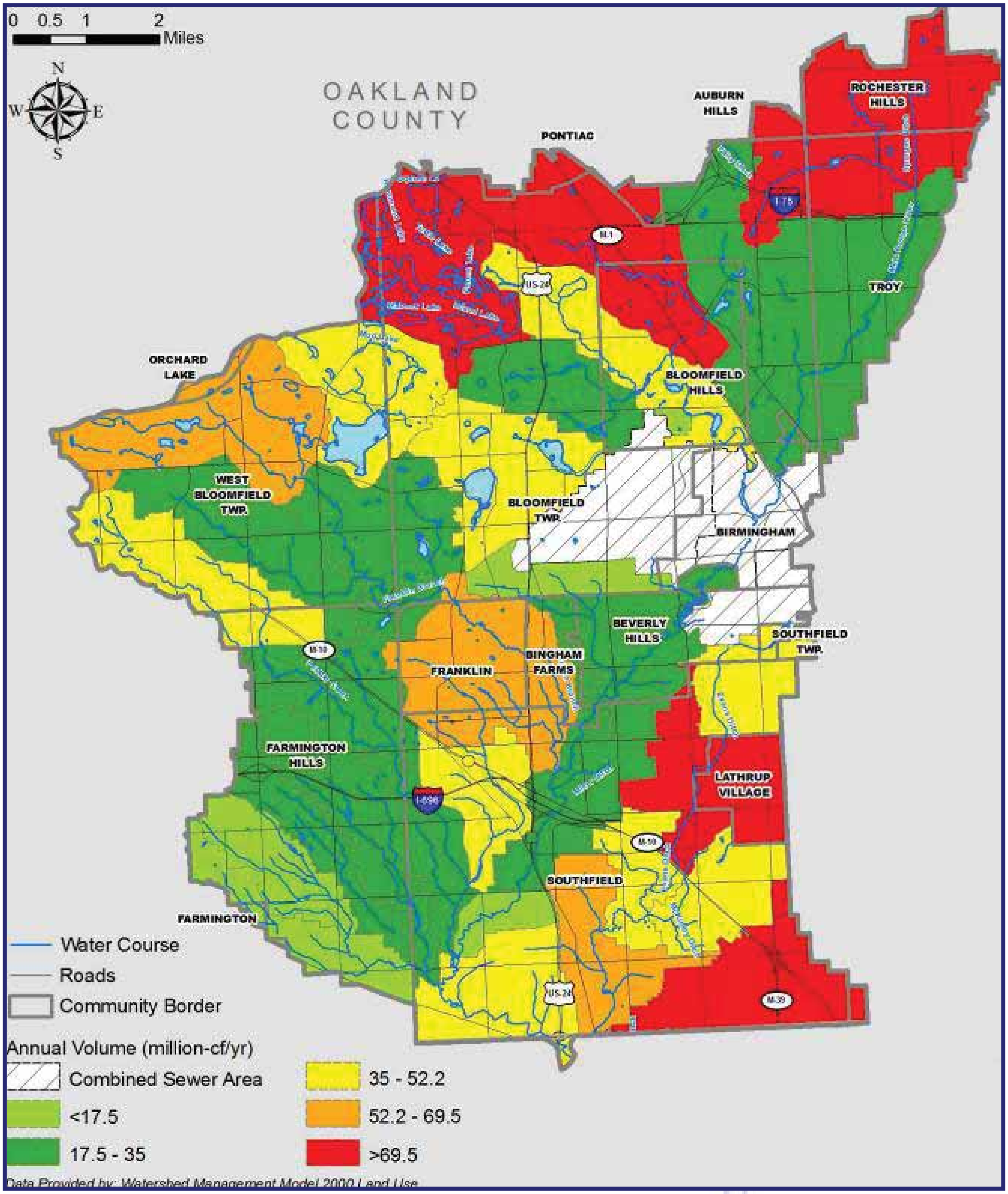
Bankfull Flow Rate	664 cfs with a return period of 2.2 months
15-day Flood Flow Rate	190 cfs
1-month Flood Flow Rate	357 cfs

Table 3-31: Main 1-2 Subwatershed Flow Rate Trends at Site US6 (Evans Ditch at Southfield)

Bankfull Flow Rate	357 cfs with a return period of 2.8 months
15-day Flood Flow Rate	86 cfs
1-month Flood Flow Rate	190 cfs

Figure 3-52 also represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

Figure 3-52: Storm Water Run-Off Non-point Source Annual Volume



The combination of the gage analysis, impervious cover and annual storm water runoff volume across the subwatershed provide important information for focusing efforts on reducing storm water runoff volume.

The USGS gage, Main Rouge at Southfield, provides appropriate flow information for identifying storm water volume reduction goals for the Main 1-2 Subwatershed. A trend analysis review determined that reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 80,300,000 cubic feet of storm water (0.336 inches of water over the subwatershed) would help reduce the effect of these small storms. It is important to note that the water needs to be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing roadside ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bio-retention basins or rain gardens, and porous pavements can be installed on individual properties. Additional trees and grow zones within the subwatershed will also provide storm water retention.

Rain garden in the City of Troy

Over the past several years various projects have been completed in the Main 1-2 Subwatershed to help control flow in the tributaries and the Rouge River. Examples of these projects include the following:

- The City of Southfield Vegetated Swale in a Residential Neighborhood;
- Lathrup Village and Southeastern Oakland County Water Authority rain garden installation program;
- Municipal property rain gardens and school yard habitat projects in the City of Troy, Farmington Hills, Birmingham and Southfield;
- Streambank stabilization and natural buffer installation at Firefighters Park in Troy, Fairway Park in Birmingham and the Streamwood area of Southfield.
- Bloomfield Township converted a 600 foot grass ditch into a bioswale to treat storm water prior to discharge into Meadow Lake.

In addition to these projects, the Rouge Main 1-2 Subwatershed Detention Basin Inventory was completed in November 2004. This report identifies potential retrofitting and enhancement opportunities for over 370 detention basins. Of the 370 detention basins, at least twenty (20) were identified for potential infiltration retrofits and two (2) were identified for potential functionality as regional basins. These details are further outlined in the report and should be utilized to further refine volume-control priorities.

Ecosystems

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Main 1-2 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Holy Sepulchre Cemetery in the City of Southfield

Aquatic Diversity

Fish Communities

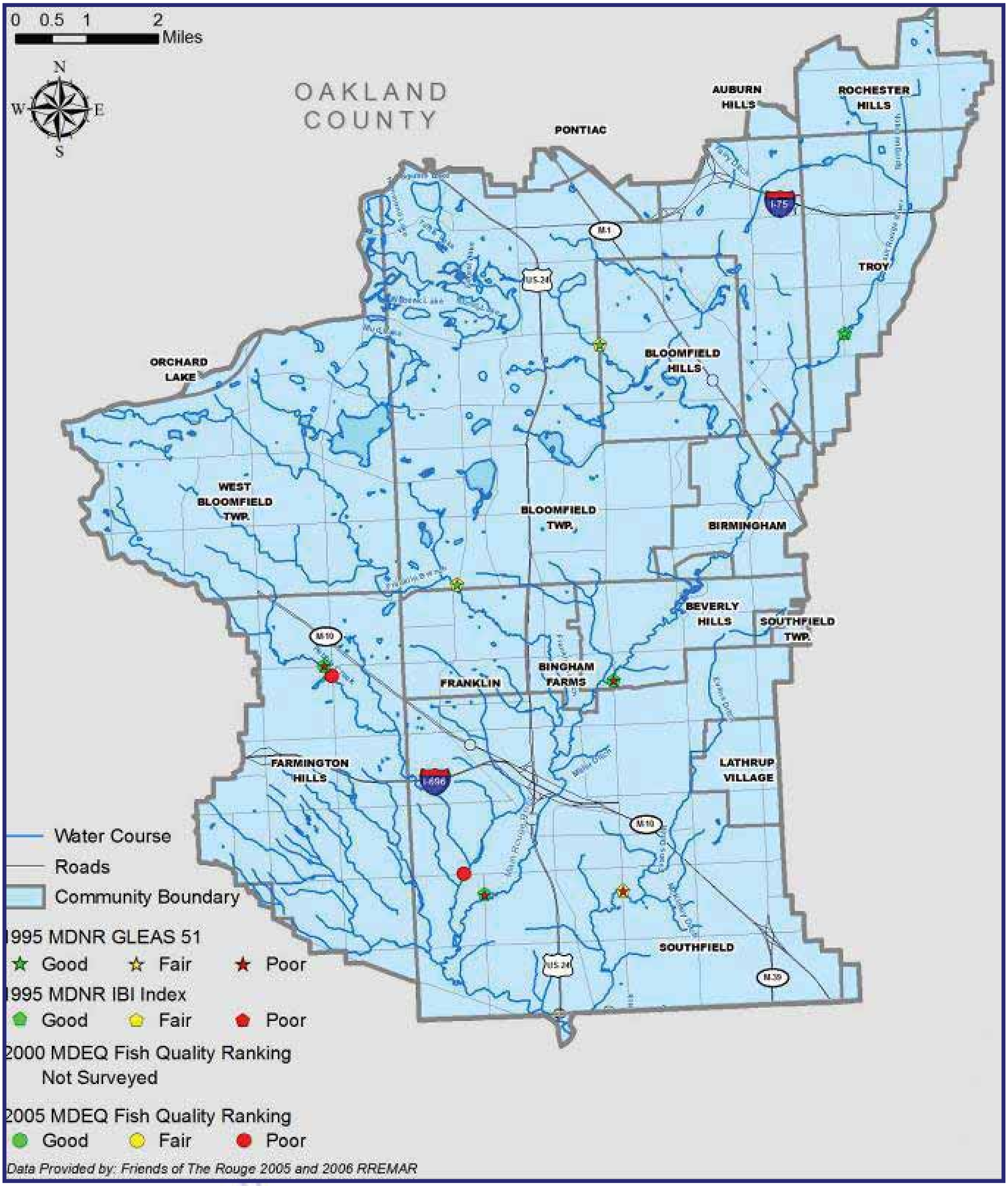
The 1996 fish community assessment noted that the healthiest fish communities were located along Cranbrook Creek, Franklin Branch and in the Main Branch at Beach Road in Troy. Overall, excessive flow variations and lack of spawning habitat in this subwatershed still present significant challenges to establishing and maintaining fish communities. The most recent fish community assessment demonstrates that Pebble Creek has does not support a healthy fish population.

Seven sites located in the Main 1-2 Subwatershed were surveyed as part of the 1995 MDNR fish assessment. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981).

The MDEQ completed additional surveys in 2005 of which two sites were surveyed. Figure 3-53 shows the overall fish community rating for the above referenced surveys. Six of the seven stations surveyed in 1995 were rated *Good* using the GLEAS 51 procedure with one site rating *Fair*. The IBI scores were consistently lower with the average being *Poor*. Comparatively speaking, the average GLEAS score was *Good*. Unfortunately, direct correlation and trends between the 1995, and 2005 surveys cannot be completed as the survey points were not the same for any of the studies. Only two (2) survey points were evaluated in 2005. Both survey points were located in Pebble Creek and rated *Poor*.

In 1998, Wiley-Seelbach-Bowler used the MDNR/U-M model to determine if the 1995 MDNR fish survey supported the potential fish species predicted by the model for the Rouge River. While the observed species of fish was less than the expected number of species as predicted by the model, it's important to recognize that opportunities for fish community enhancements will be evident as progress is made towards addressing the flow variability and stream habitat in the river.

Figure 3-53: Main 1-2 Fish Community Assessments



Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Main 1-2 Subwatershed. These advisories were last updated in April 2007, as shown in Table 3-32.

Table 3-32: 2007 Fish Consumption Advisories for the Main 1-2 Subwatershed

Location	Fish Species	Contaminant	General Population	Women and Children
Main Branch	Suckers	PCBs	Unlimited consumption	One meal per week
Lakes/ Impoundments	Rock Bass, Yellow Perch or Crappie	Mercury	No more than one meal per week of fish over 9 inches	No more than one meal per month
Lakes/ Impoundments	Bass, Walleye, Northern Pike or Muskellunge	Mercury	No more than one meal per week of fish any size	No more than one meal per month

Notes:
Men and boys over the age of 15 and women who are beyond child bearing years.
Women of child bearing years and children under the age of 15.

Notable Areas

In 1995, the highest quality fish communities were found in Franklin Branch, Cranbrook Creek, and on the main stem at Beach Road in Troy. Due to cool temperatures and moderate base flow Franklin Branch may be capable of supporting brown trout if extreme flow variations are controlled (MDNR, 1995).

Carpenter Lake in Southfield

Several impoundments of the Main 1-2 Subwatershed have experienced fishery restoration. In 2007, the City of Southfield, in partnership with the MDNR, released more than 14,000 native game fish species into Carpenter Lake, an impoundment of the Ravines Branch. The fish planting was one component of the lake restoration project that began in 2004. The goal of the project was to restore the lake to a sustainable fish and wildlife habitat with improved water quality and storm water management. The released fish included largemouth bass, channel catfish, bluegill, sunfish and minnows. Nuisance and exotic fish species were removed due to their tendency to overpopulate and negatively impact the game fish population. A fish stocking plan was developed to limit the re-establishment of nuisance and exotic fish and to provide a unique recreational fishery in an urban setting. Access for people with disabilities and fishing piers were installed to provide additional public recreation opportunities.

Quarton Lake in Birmingham

Quarton Lake, an impoundment of the Quarton Branch in the City of Birmingham, was dredged and fishery habitat, including woody structure and spawning habitat, was installed. Nuisance and exotic fish species were also removed as a part of this project.

Impairments

The main factors negatively impacting fish community integrity in the Main 1-2 Subwatershed are excessive flow variation and lack of appropriate spawning habitat. Other factors include the removal of riparian vegetation and excessive sedimentation. Removal of riparian vegetation is increasing the rate at which poor quality storm water reaches streams. Additionally, excessive sedimentation within impoundments is the result of poor soil and erosion control on lands adjacent the stream resulting in eroding streambanks. Dams are also impairments within the Main 1-2 Subwatershed. Although the dams create opportunities for development of recreational fish communities, through the impoundment of water and a variety of habitat, they are also a source of habitat fragmentation preventing upstream and downstream movements of fish species (Beam and Braunscheidel, 1998).

E. L. Johnson Nature Center in Bloomfield Township

Macroinvertebrate Communities

As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed is also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decades.

In 1999, Rouge Project staff evaluated macroinvertebrate communities at six sites within the vicinity of the Oakland County CSO basins in order to assess the effects of basin discharges on the river (Rathbun & Frederick, 2000). The results of the study concluded that all macroinvertebrate communities, both upstream and downstream of the basin, were neither numerous nor diverse, but the discharges from the basin had no affect on those macroinvertebrate communities immediately downstream of the basin.

During MDEQ's Rouge River biological assessment survey of 2000 (Goodwin, 2002), macroinvertebrate communities were sampled at seven locations in the Main 1-2 Subwatershed with all sites earning a rating of *Acceptable*. In 2005 another biological assessment was performed by the MDEQ at nine stations in the Main 1-2 Subwatershed and its tributaries. Eight stations received an *Acceptable* rating. The Main Rouge River at Wattles Road received a *Poor* rating. (MDEQ, 2005). Figure 3-54 shows the locations sampled by the MDEQ in 2000 and 2005.

Friends of the Rouge (FOTR) began sampling in the Main 1-2 Subwatershed in 2001 and have 12 spring sampling sites, 12 fall sampling sites and eight winter stonefly sampling sites. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation. Results from these surveys are also depicted on Figure 3-54. Specific information about what sites have been sampled when, the rating, quality of macroinvertebrates and number of taxa, may be reviewed in the current RREMAR or on the FOTR website (www.therouge.org). No stoneflies were found during the FOTR Winter Stonefly Search at eight sites surveyed in the Main 1-2 Subwatershed over the past several years.

The Main 1-2 Subwatershed has the largest and most diverse population of freshwater mussels in the watershed.

Separate evaluations have been conducted on mussel populations. The Main 1-2 Subwatershed, notably between Troy and Southfield, has some of the highest populations and diversity of mussels in the entire watershed due largely to the absence of zebra mussels and the relatively low flow flashiness.

Notable Areas

The Main Branch in Troy consistently exhibits the highest quality macroinvertebrate population found during surveys within the Main 1-2 Subwatershed. FOTR fall surveys indicate good populations of aquatic macroinvertebrates in Pebble Creek in the City of Southfield and Fairway Park in the City of Birmingham.

Impairments

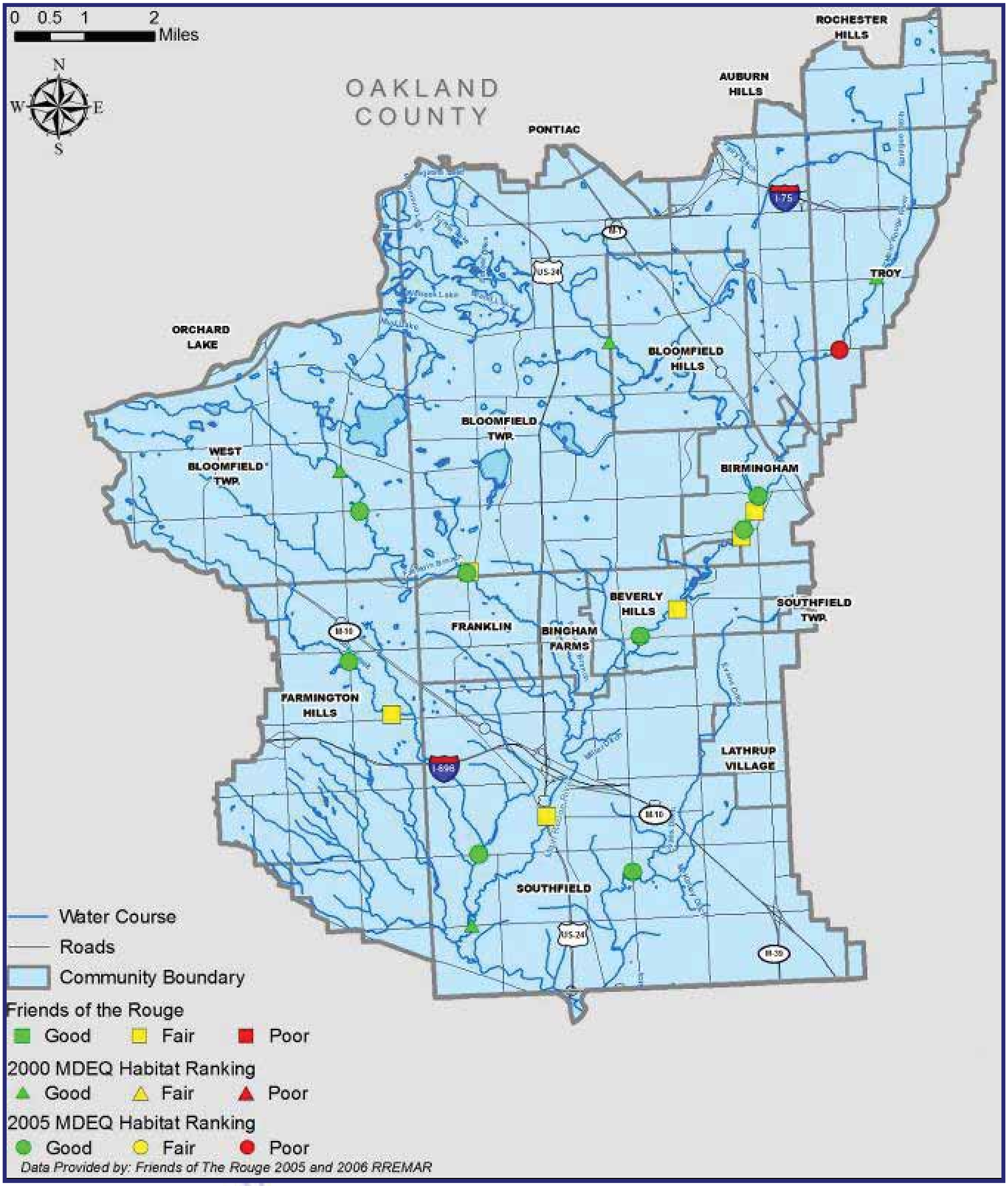
Increased impervious surfaces, non-point storm water discharges, streambank erosion and sedimentation, and increasingly extreme hydrologic fluctuation continue to impair the quality of suitable habitat for benthic macroinvertebrates. These effects are being transferred downstream and are reflected in the lack of sensitive aquatic macroinvertebrates in downstream monitoring sites. The subwatershed's land use is primarily urban, which results in increased imperviousness causing frequent occurrences of extreme flow.

Wood frog

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed; however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

Figure 3-54: Main 1-2 Macroinvertebrate Assessments



The MDNR completed a voluntary frog and toad survey for the Main 1-2 Subwatershed from 1996-2003 and 2006-2007. Results of MDNR surveys are shown in Table 3-33 (MDNR, 2006).

Table 3-33: MDNR Frog and Toad Survey - Percent of sections in which species was heard in Main 1-2 Subwatershed

Species	1996	1997	1998	1999	2000	2001	2002	2003	2006	2007
Wood Frog	100	5	13	4	10	15	0	0	6	0
Western Chorus Frog	37	47	40	39	20	0	0	11	6	10
Spring Peeper	37	79	53	43	70	31	100	0	6	10
American Toad	68	74	53	43	40	38	100	33	25	60
Northern Leopard Frog	5	5	0	9	10	0	0	0	0	0
Gray Tree Frog	42	53	47	35	40	8	0	22	13	30
Green Frog	47	63	67	65	70	23	100	33	13	20
Bullfrog	16	11	7	17	20	15	50	0	0	10
Total Sections Surveyed	19	19	15	23	10	13	4	9	16	10

Note: No frog and toad data were collected in 2004 and 2005 by the MDNR in the Main 1-2 Subwatershed.

Similar to the MDNR Frog and Toad Survey, the FOTR began a Frog and Toad Survey in 2000 and found eight species of native frog and toads present in the Main 1-2 Subwatershed (Figure 3-55). Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area. Table 3-34 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 2000 through 2006 (FOTR, 2006).

Vernal pool

Table 3-34: FOTR Frog and Toad Survey - Percent of blocks in which species was heard in Main 1-2 Subwatershed

Species	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	22	24	19	9	18	13	14	13
Western Chorus Frog	44	47	42	32	38	87	27	28
Spring Peeper	33	35	53	34	40	38	43	59
American Toad	22	24	70	57	71	73	74	77
Northern Leopard Frog	6	6	7	7	10	16	7	10
Gray Tree Frog	11	12	28	18	48	26	32	51
Green Frog	28	29	56	45	67	67	76	70
Bullfrog	0	0	14	16	21	11	14	13
Total Blocks Surveyed	18	17	43	44	50	63	31	38

Notable Areas

In 2007, seven of eight frog and toad species were identified in Firefighters Park in Troy. This area supports diverse habitat suitable for a variety of frogs and toads. There were also improvements in the frog and toad diversity across the subwatershed. As shown in Figure 3-55 more areas are documenting the presence of increased diversity within this subwatershed.

Rouge River in Birmingham

Impairments

The reduction in frogs and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease or differences in temperature and precipitation from year to year. Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine emergent, shrub scrub and forested wetlands will also result in decreased frog and toad breeding areas. Mitigated and man-made wetlands can be appropriate substitutes provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Stream Habitat

Stream habitat conditions vary across the entire subwatershed. Clear trends show numerous poor ratings in 1996 leading to frequent good habitat conditions in 2005. This is quite promising and is indicative of the significant improvement efforts that have been completed are continue throughout this subwatershed.

Rouge River in Farmington

One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in Stream Hydrology above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure, sedimentation of the low-flow channel, reduction in woody debris, straightening of channels, and decline in undercut banks.

An evaluation of stream habitat was undertaken during four separate occasions, all using MDEQ's GLEAS 51 protocol. Study results are shown in Figure 3-56.

Both the 1995 MDNR and the 1996 Rouge Project studies rated the Main 1-2 Subwatershed on average as *Poor*. The 2000 and 2005 MDEQ studies ranked the subwatershed on average as *Good*. The 2005 survey included an evaluation of stream habitat in the Main Rouge River, Ashcroft Drain, Evan's Ditch, Pebble Creek and the Franklin Branch.

Figure 3-55: Main 1-2 Frog & Toad Diversity

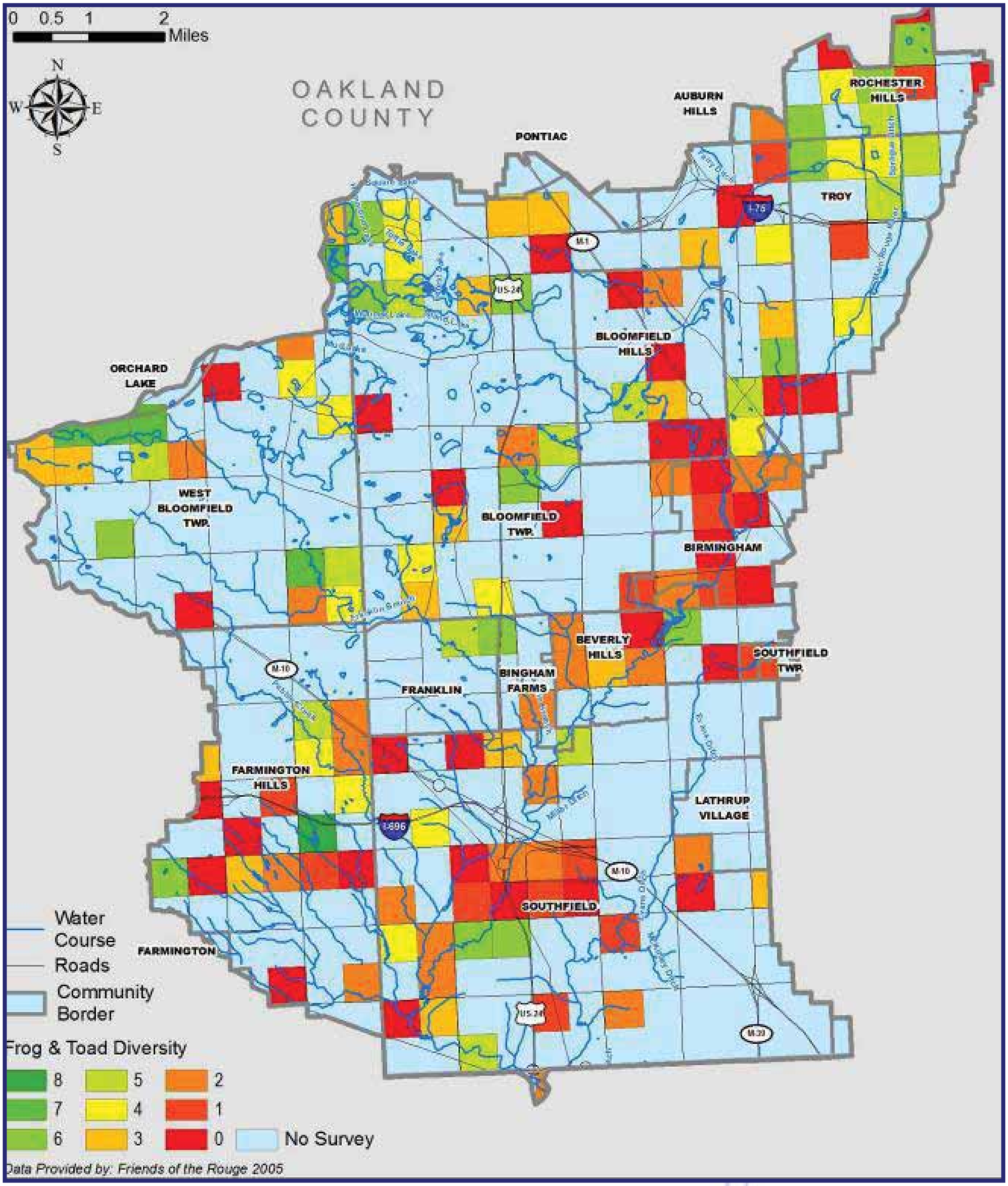
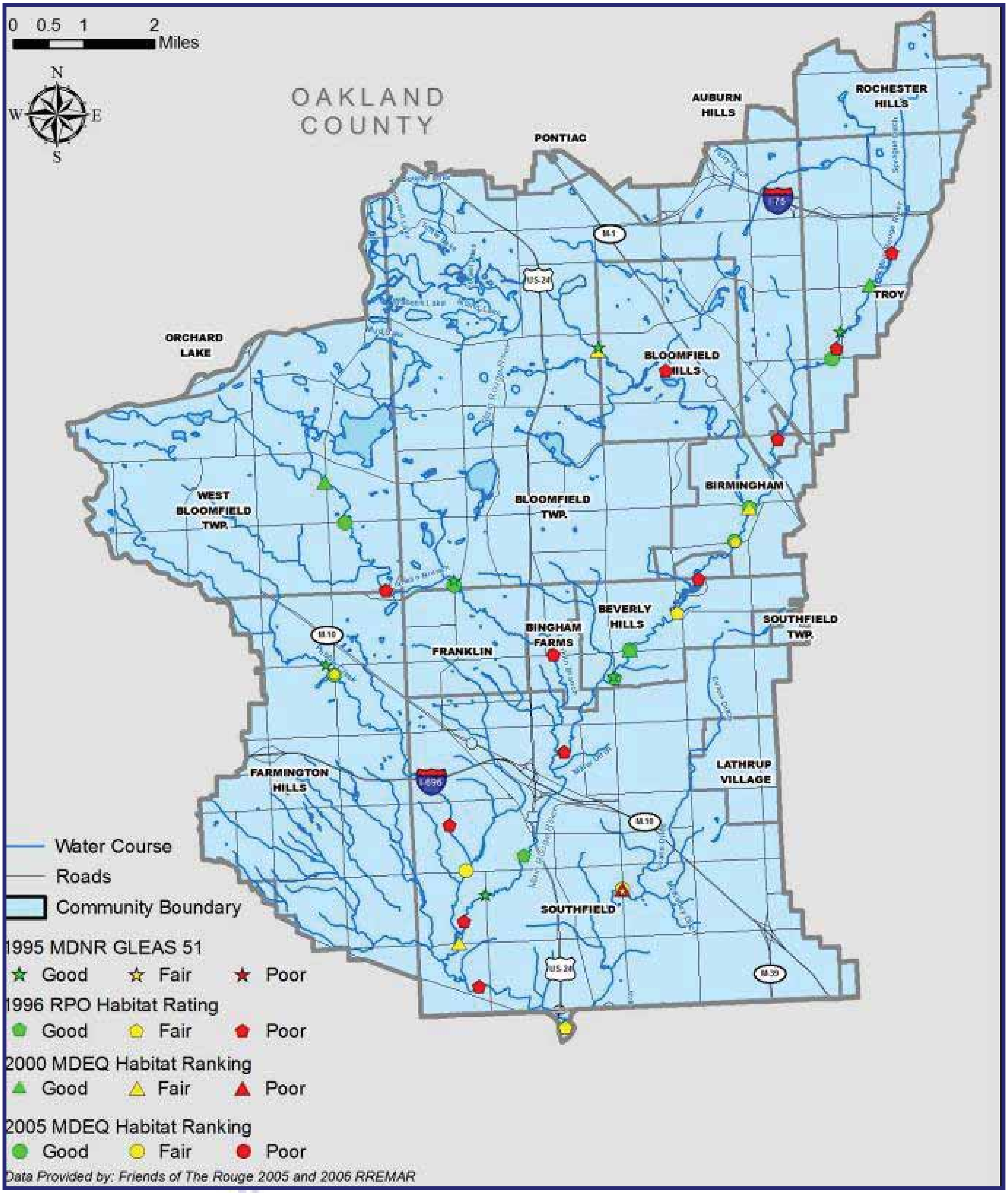


Figure 3-56: Main 1-2 Stream Habitat Assessment Results



Notable Areas

In general, habitat quality was slightly better along the Main Branch of the Rouge River in the Main 1-2 Subwatershed, than in its tributaries. Good quality aquatic habitat was found in the Franklin Branch, Pebble Creek and the Main Branch of the Rouge in 2005. A large number of streams within the Main 1-2 SMWA are flanked by riparian buffer zones that protect the aquatic habitat. These "green corridors" are found along the Quarton Branch, Franklin Branch, Main Branch and a portion of the Ravines Branch in Farmington and the City of Southfield adjacent to Carpenter Lake.

Impairments

The main factors impacting stream habitat in the Main 1-2 Subwatershed include excessive flow instability and accompanying erosion, sedimentation and lack of riffles and pools. Point and non-point storm water inputs continue to impair water quality and hydrology. Increased flashiness contributes to streambank erosion and sedimentation, which results in a myriad of negative impacts on the biota. High flows carry away small woody and other debris from the stream channel, eliminating flow refugia and hard substrates upon which many macroinvertebrates forage and endemic fish species lay eggs. Excessive sedimentation covers and embeds critical habitat leaving a relatively flat channel configuration. Elimination of terrestrial components necessary for moderating the intensity of storm water inputs has also resulted in a decrease in ground water flow and loss of riparian canopy that may result in increased instream temperatures and lower retention of dissolved oxygen.

The stream corridor within this subwatershed also has challenges associated with streambank erosion. The Rouge Main 1-2 Subwatershed Streambank Erosion Inventory and Site Prioritization Report was completed in December 2004. This report identifies priority erosion sites for future restoration. While the report identifies at least 177 "severe" streambank erosion locations, 12 sites are identified for priority restoration. These sites are as follows (Limno-Tech, 2004):

- Evans Drain, Southfield
- Rouge River, immediately downstream from a grade control structure, Troy
- Rouge River, several hundred feet upstream from Beach Road, Troy
- Pebble Creek, immediately east of Danvers Drive and north of Twelve Mile Road, Farmington Hills
- Trib. A – Main Ravines Drain, Farmington Hills
- Main Ravines Drain, Farmington Hills (a)
- Main Ravines Drain, Farmington Hills (b)
- Unnamed Tributary near Bingham Lane, Bingham Farms
- Unnamed Tributary immediately west of Bell Road, Southfield
- Pebble Creek meander adjacent to Holy Sepulchre Cemetery, Southfield
- Upstream of Nine Mile Road Bridge, Southfield
- Broad meander, downstream of the confluence of Pernick Creek, Southfield.

Stream Corridor

The Main 1-2 Subwatershed contains some of the highest quality riparian forests in the entire Rouge River Watershed. The headwater areas also have recreational lakes and impoundments, some of which include Walnut Lake, Gilbert Lake, Upper and Lower Long Lake, Wing Lake and Square Lake.

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River Watershed.

Rouge Green Corridor signage

Riparian Corridor

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms; and a buffer for pollutants and sediments from surface runoff. As well as providing habitat for aquatic organisms, the corridor is used by many birds and mammals. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

Some of the high-quality native vegetation present along the riparian corridor includes tree species such as red oak, American beech, sugar maple, bitternut hickory and ironwood and plants including trillium and jack-in-the-pulpit. (http://www.oakgov.com/peds/assets/docs/es_docs/rgc_natresource.pdf).

Trillium

The Rouge Green Corridor (RGC) is the riparian corridor that stretches from the cities of Birmingham through Beverly Hills to Southfield. These communities began working together in 2000 to preserve and protect the RGC. From 2004-2006, with a grant from the Rouge Program Office, Oakland County Planning and Economic Development Services worked with the RGC communities, the Southeast Oakland County Water Authority (SOCWA), the Office of the Oakland County Water Resources Commissioner (OCWRC), Friends of the Rouge (FOTR) and Oakland Land Conservancy (now Six Rivers Land Conservancy) to identify and facilitate the promotion, protection and enhancement of the RGC as a unique community asset in the Rouge River Watershed. By establishing goals and promoting a unique identity to this corridor, communities can more effectively plan greenways initiative projects and raise awareness amongst subwatershed stakeholders.

The current phase of the Rouge Green Corridor project is funded in part by a grant from the National Fish and Wildlife Foundation to the Six Rivers Land Conservancy and has the following goals:

- Prepare a plan to manage habitat along the Rouge Green Corridor.
- Create a landscape-scale green infrastructure plan.
- Create a river corridor-scale detailed natural resource inventory and management plan for the terrestrial and aquatic resources.

- Conduct four habitat improvement demonstration projects to be used for public outreach initiatives communicating the habitat inventory, habitat plan, green infrastructure plan, and the role of active stewardship of river corridors in urban areas.
- Conduct a workshop to educate private riparian landowners on ways to manage habitat on their land.

Wetlands and Woodlands

Figure 3-57 shows the existing wetlands within the Main 1-2 Subwatershed. This figure depicts forested wetlands along the riparian corridor as the highest percentage of remaining wetlands in the subwatershed, with smaller areas of both scrub-shrub and emergent wetlands. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-58. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Dirt Doctors

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Household hazardous waste day in Bloomfield Township

Historical Storm Water Projects in the Main 1-2 Subwatershed

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are some projects completed by the Main 1-2 Subwatershed stakeholders:

- The Dirt Doctors, sponsored by the Oakland County Water Resource Commissioner's Office, teach school groups about soil erosion and sedimentation throughout the subwatershed.
- The Cranbrook Institute of Science sponsors the Oakland County Rouge River Water Festival every September.
- E.L. Johnson Nature Center, a Bloomfield Hills Schools facility located in Bloomfield Township, provides educational programs and sponsors Rouge Rescue activities annually in June. A 5000-square foot Visitor Center and lab facility was built in 2006 with partial funding by state and federal grants, including one from the Rouge Program Office. The 32-acre site is one of the last remaining tracts of undeveloped land in Bloomfield Township.
- Hundreds of informational signs have been installed in the Main 1-2 Subwatershed for streambank stabilization projects, the Rouge Green Corridor, grow zones and stream crossings.
- Household hazardous waste days are sponsored by various Main 1-2 Subwatershed communities.

Figure 3-57: Main 1-2 Existing Wetlands

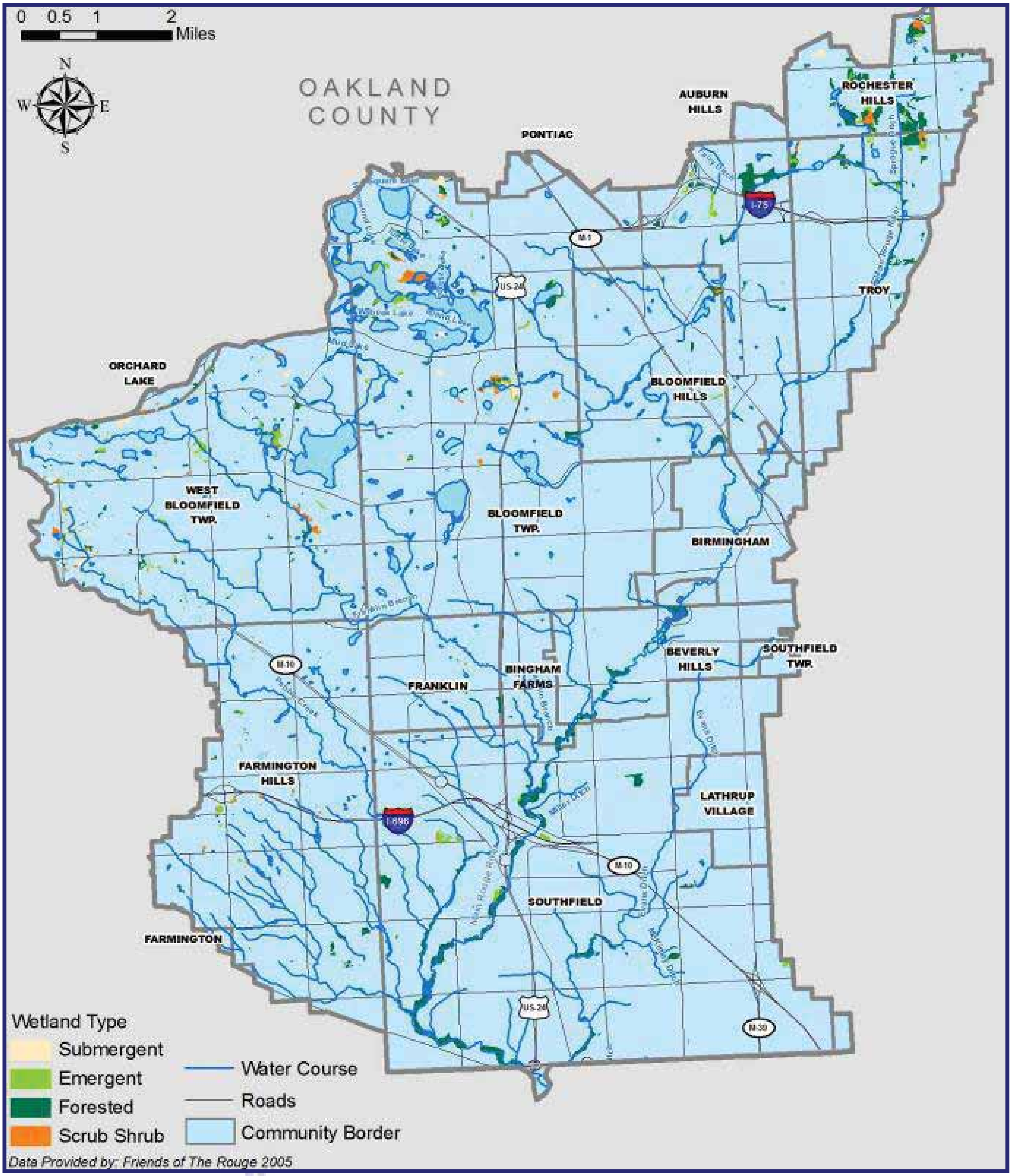
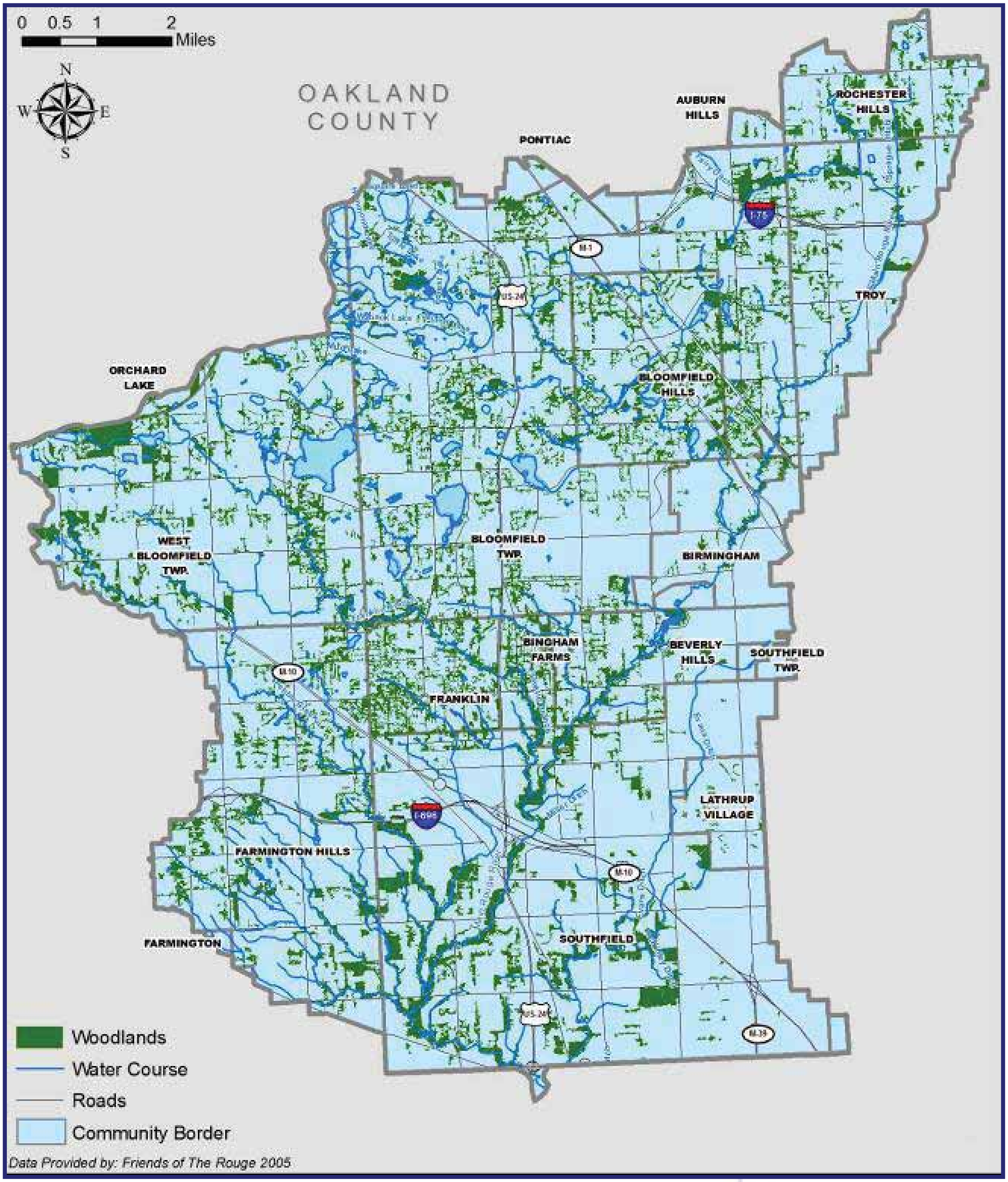


Figure 3-58: Main 1-2 Existing Woodlands



- West Bloomfield Township and Farmington Hills completed the Pebble Creek Sediment Removal and Stream Improvement Project.
- The Oakland County Water Resource Commissioner's Office (OCWRC) conducted the Edwards Relief Drain Streambank Stabilization Project.
- Lawrence Technological University installed a green roof on its new student services building.
- The City of Southfield restored Carpenter Lake and installed buffers, and habitat and restocked it with game fish.

Main 3-4 Subwatershed (Storm Water Management Area) Conditions

The Main 3-4 Subwatershed is the most urban of all the Rouge River subwatersheds. It is completely developed with residential housing as its largest land use.   A portion of the Rouge River in this subwatershed has been channelized to control flooding, and natural features on the streambank have been eliminated.

Although the Main 3-4 Subwatershed is heavily developed it still retains a moderately intact riparian corridor in the northern reaches, mostly due to excessive flooding. This riparian corridor is seasonally flooded, providing an important connection with the river. Eliza Howell Park and Rouge Park in Detroit and a restored oxbow adjacent to the river in Dearborn provides an opportunity for future habitat development.

As a part of the continuing effort to improve the recreational opportunities and wildlife habitat within the Main 3-4, the Rouge River Gateway Partnership was formed in 1999 from a diverse leadership group including Wayne County, five municipalities, cultural institutions, and private businesses in the Main 3-4 Subwatershed, and a master plan was completed. This project focuses on restoring the Rouge River's final eight miles in the Rouge River's Main Branch. Under the guidance of the Gateway Partnership, the master plan encourages people, ecology, and economy to co-exist equitably and sustainably in the landscape. The plan includes a number of projects that restores the relationship between the Rouge River and its natural and social systems. More information about the Gateway Partnership is discussed later in this subchapter.

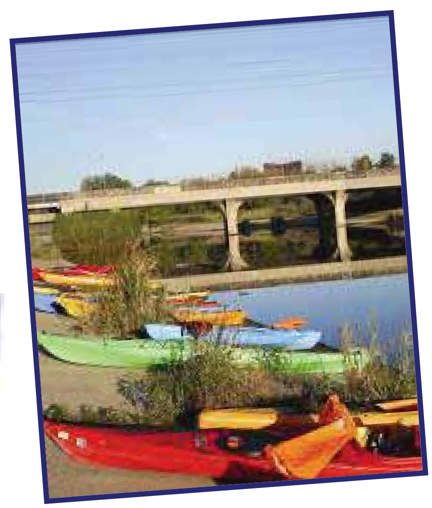
The characteristics and conditions of this subwatershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Main 3-4 Subwatershed Management Plan. While the stream indicators of water quality, stream hydrology, aquatic diversity, stream habitat and physical conditions of the stream corridor are all indicative of urban stream conditions, the general trends show improvement. Challenges exist with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in wet weather conditions.

Subwatershed Demographics

The Upper, Middle, and Lower branches of the Rouge River all join the Main Branch in the Main 3-4 Subwatershed before it empties into the Detroit River. The Main Branch of the Rouge River flows through the Main 3-4 Subwatershed which has a drainage area of 91 square miles. This subwatershed includes portions of the cities of Detroit, Highland Park, Dearborn, Dearborn Heights, Redford Township, Melvindale, Allen Park and River Rouge (Figure 3-59). Table 3-35 lists the member communities that make up the Main 1-2 Subwatershed and summarizes the area for each community.

Main 3-4 highlights:

- ***The Main 3-4 is completely developed with residential housing as its largest land use.***
- ***The hydrologic trends along the Main Rouge continue to cause excessive erosion and habitat destruction.***
- ***Eliza Howell Park and Rouge Park in Detroit and a restored oxbow adjacent to the river in Dearborn provides an opportunity for future habitat development.***
- ***The Rouge River Gateway Partnership is working to improve recreational opportunities and wildlife habitat in the Main 3-4.***



Friends of the Rouge 2007 Kayak Tour, Melvindale Boat Launch
Photo credit: Philip Crookshank

Figure 3-59: Main 3-4 Subwatershed Location

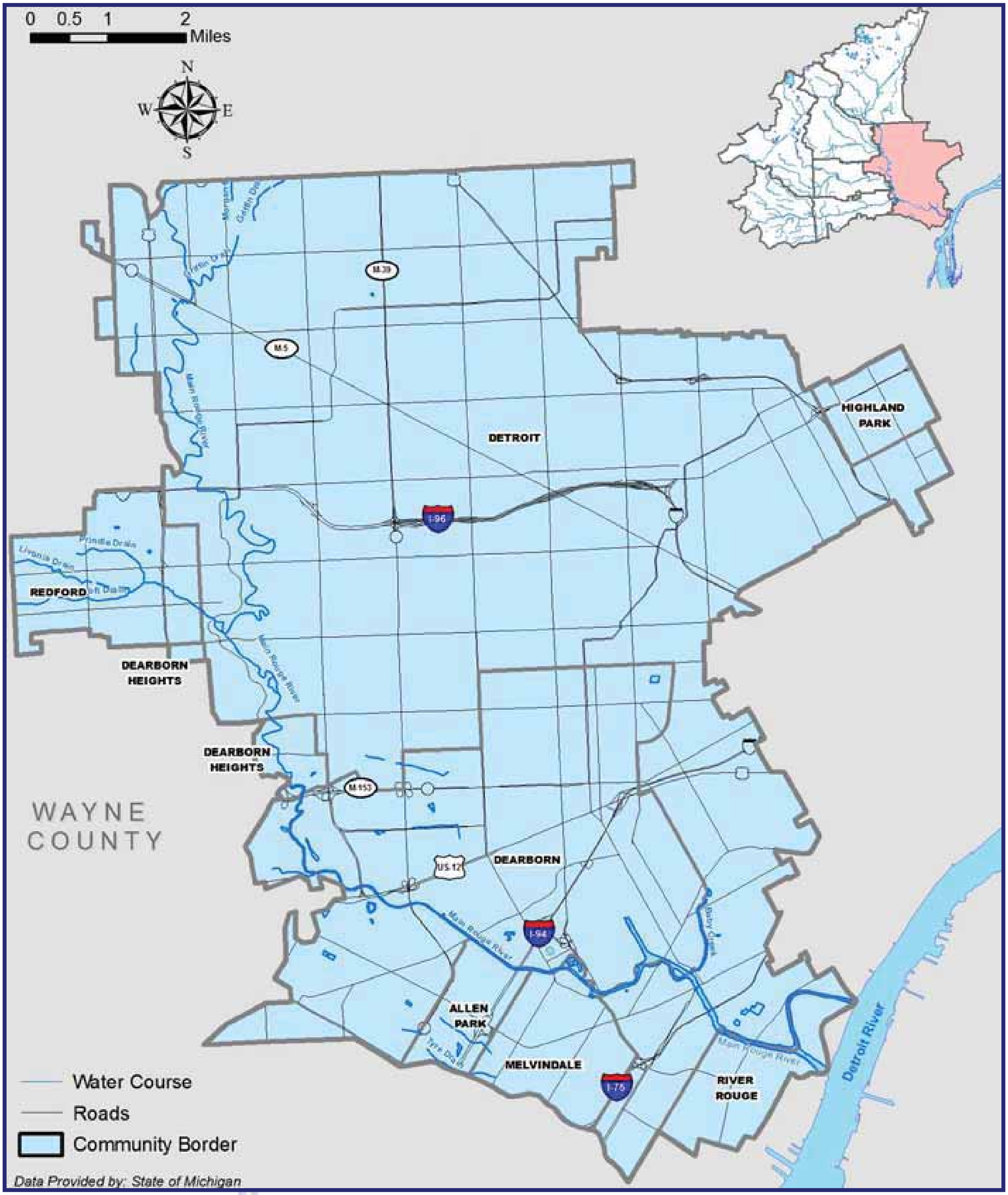


Table 3-35: Main 3-4 Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Allen Park	1.3	19.9
Dearborn	18.4	75.6
Dearborn Heights	0.8	7.3
Detroit	60.2	43.8
Highland Park	1.3	46.5
Melvindale	2.6	97.4
Redford Township	4.2	36.9
River Rouge	2.2	77.2
Totals	**91**	**NA**
Counties		
Wayne County	91	

Current land use indicates that the subwatershed is completely developed with residential housing as its largest land use. There is little to no open space remaining in the subwatershed. Parkland in the Main 3-4 Subwatershed includes the City of Detroit's largest park, Rouge Park and Eliza Howell and Patton parks in Detroit, and the U of M-Dearborn Environmental Study Area and the Henry Ford Estate in Dearborn.

Impervious Cover

Slight changes in land use and land cover have occurred across this subwatershed over the last ten years. Table 3-36 highlights the changes in land cover between 1991 and 2002. In addition, Figure 3-60 graphically depicts impervious cover across this subwatershed.

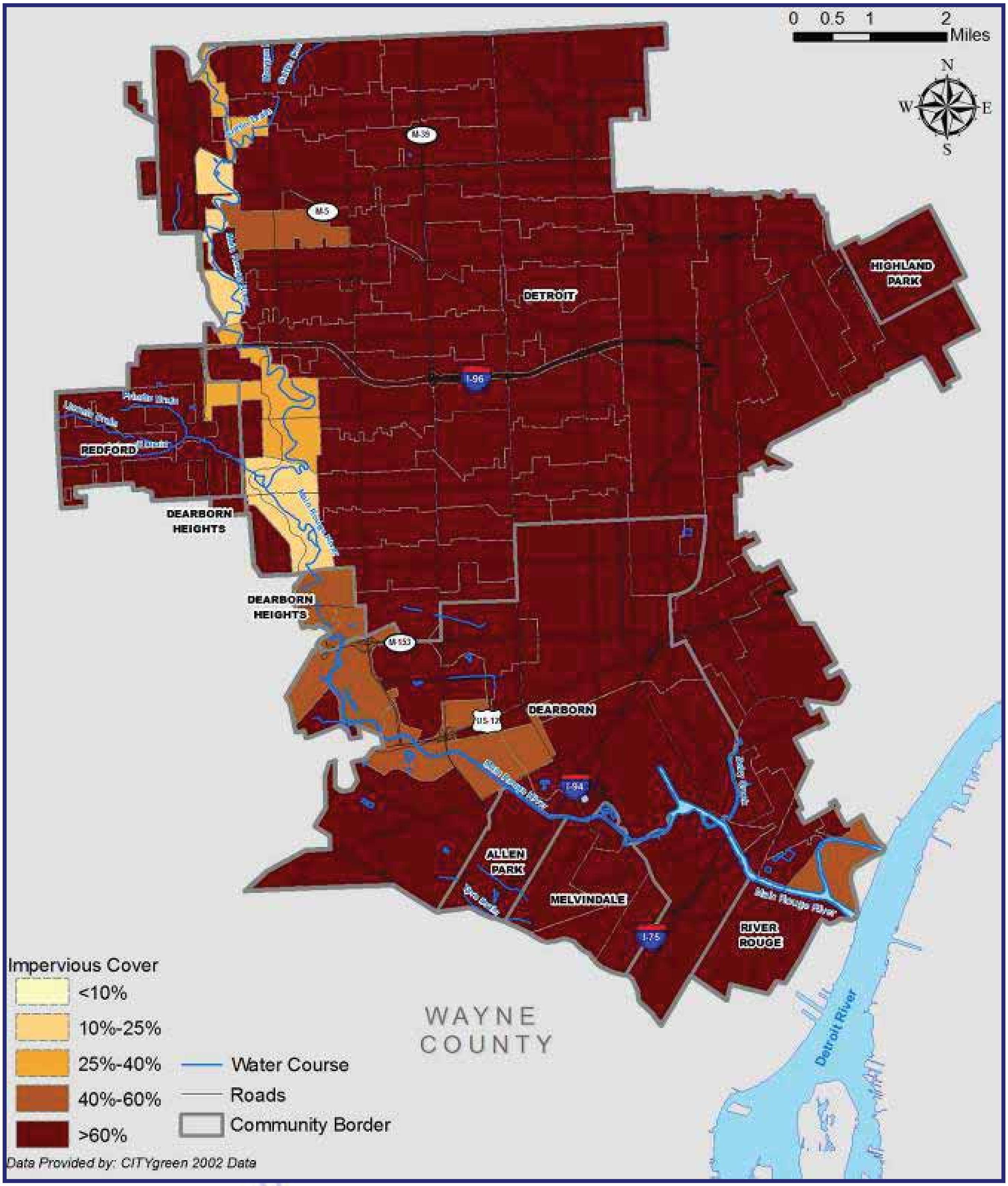
Table 3-36: Changes in Land Cover between 1991 and 2002

Main 3-4 SWMA Land Cover	1991	2002
Open Space - Grass	9%	6%
Trees	7%	8%
Grow Zones	0%	0%
Green Roofs	0%	0%
Sub Total: Green Infrastructure	16%	14%
Urban: Impervious	80%	84%
Urban: Bare	3%	1%
Water	1%	1%
Total	100%	100%


Concrete channel in the Main 3-4 Subwatershed

This subwatershed is typical of an urban setting and contains numerous impervious surfaces such as roofs, parking lots, roadways and sidewalks. Land use has resulted in a high proportion of the land being covered by impervious surfaces, which allows rainfall and snow melt to rapidly reach the river through street runoff and enclosed storm drains. A portion of the Rouge River in this subwatershed has been channelized to control flooding, and natural features on the streambank have been eliminated.

Figure 3-60: Main 3-4 Imperviousness



Water Quality

DO concentrations in the Main 3-4 SWMA have typically been poor since 1994 with the DO frequently dropping below the State water quality standard of 5 mg/L, particularly during the warm summer months. Trend analysis indicates that DO conditions in the Main Rouge River are steadily improving at Plymouth Road (US7) during both wet and dry weather conditions.

Kayaking on the Main 3-4 in Melvindale

The Main 3-4 Subwatershed Advisory Group established targets for water quality as part of the 2001 Main 3-4 Subwatershed Management Plan. These targets are summarized in Table 3-37.

Table 3-37: Main 3-4 Subwatershed Advisory Group Targets

Parameter	2001 Target
Dissolved Oxygen, Warmwater Fishery (°C)	Daily average ≥5 (by 2015)
Total Phosphorus (mg/L)	Decrease by 2015 (dry weather)
Total Suspended Solids (mg/L)	Decrease in dry weather
E. *coli* (cfu/100 ml)	Partial body contact standard by 2010 (dry weather)

Based on the dry weather sampling results, it is clear that some progress has been made towards improving water quality conditions based on some parameters (see Table 3-38). The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. Water quality trends are indicated in Table 3-38, where sufficient data was available for a trend assessment. More detailed information is available in the most recent RREMAR. The Main 3-4 monitoring sites are depicted in Figure 3-61.

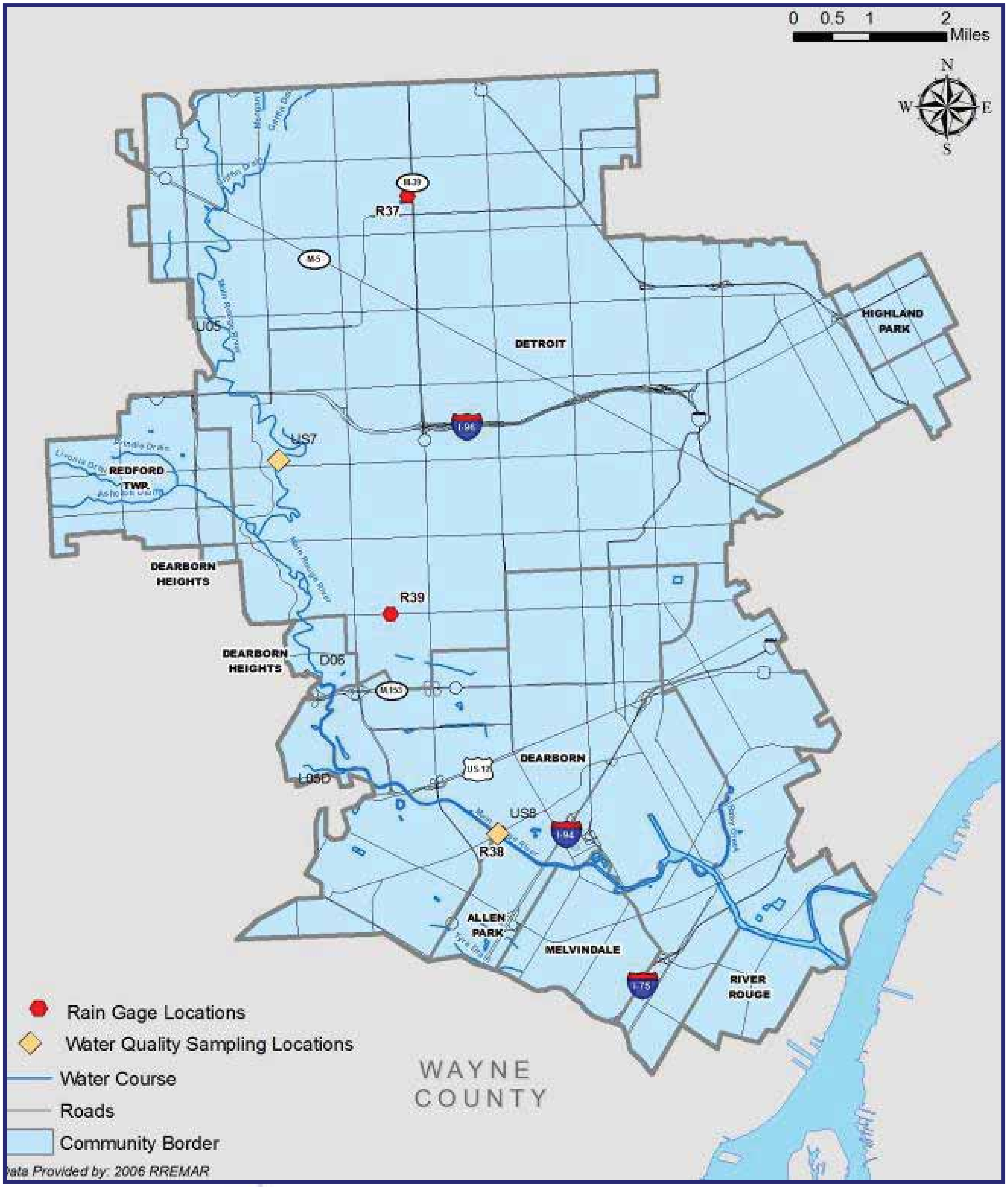
Table 3-38: Main 3-4 Dry Weather Conditions - Summary

Parameter	Plymouth Road US7	Rotunda Drive US8	Fenkell Road (5 Mile) G43
Water Temperature	Good	Good	Good
Dissolved Oxygen (DO)	Fair ↑	Good ×	Fair ×
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Fair ↑	Good ↑	Good ↑
Ammonia (NH_3-N)	Good ↑	Good ↑	Good ↑
Total Phosphorus (TP)	Poor ↑	Poor ×	Poor ×
Total Suspended Solids (TSS)	Good ×	Good ×	Fair ×
E. coli	Poor ↑	Poor ×	Poor ↑

↑indicates an improving trend ↓indicates a declining trend × indicates no trend

Intermittent grab sampling during dry and wet weather was conducted in the Main 3-4 SWMA in 2007. $CBOD_5$ and NH_3-N levels have also been improving at all sites. TP levels are poor, as in most of the watershed, but slight improvements

Figure 3-61: Main 3-4 Water Quality Monitoring and Rain Gage Locations



are seen at Plymouth Road (US7). Overall the TSS concentrations are at fair to good levels with no signs of significant change.

Although *E. coli* values are still poor, a 5% and 13% improvement has been seen at Plymouth Road (US7) and 5 Mile Road (G43), respectively. Much of the Main 3-4 Subwatershed is still influenced by uncontrolled CSOs. The bacteria levels in 2007 were routinely higher than the State water quality standard of 1,000 cfu/100 ml for partial body contact recreation.

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

E. coli Results

The *E. coli* information collected in the Main 3-4 indicates that pathogens continue to be a problem in this watershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human (sewage) sources. Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

The 2005 *E. coli* data indicated that the Main 3-4 exceeded total body contact water quality standards about 80% of the time and it exceeded partial body contact standards about 50% of the time (see Figure 3-62). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum to and agricultural animals like horses, cows or pigs. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), aging sanitary sewers and failing septic systems which are also called on-site sewage disposal systems (OSDSs). The BST data shows that *E. coli* associated with human sources are suspected (see Figure 3-63).

Water Quality in Wet Weather Conditions

While the overall water quality of the Main 3-4 Subwatershed has improved, there continues to be challenges associated with wet weather. To document these challenges, $CBOD_5$, TSS, NH_3-N and TP concentrations were measured in 2007. Previous monitoring of these parameters took place intermittently from 1994 – 1998. *E. coli* was monitored from 1998 – 2001 and again in 2007 at Fenkell Road (5 Mile) (G43) and Plymouth Road (US7). Before 2007, *E. coli* was only monitored during 1994 at Rotunda Drive (US8). The following observations can be made based on the wet weather data:

- At Fenkell Road (5 Mile) (G43), there have been improvements in all parameters, most notably the *E. coli* concentrations have improved 11% based on trend analysis. Despite this improvement, wet weather concentrations were still 30 times higher than dry weather values at this

Figure 3-62: Main 3-4 2005 E. coli Sampling Results

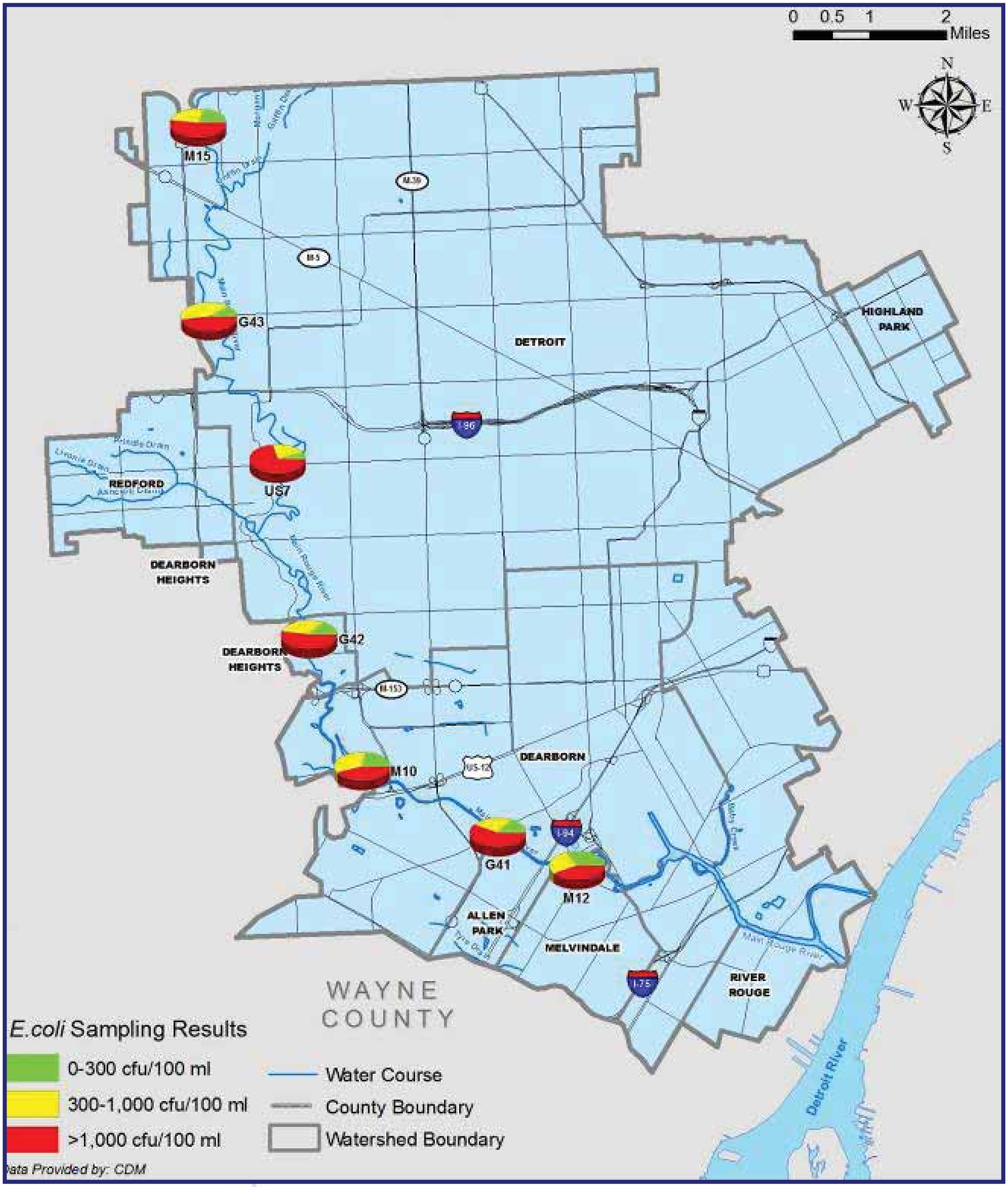
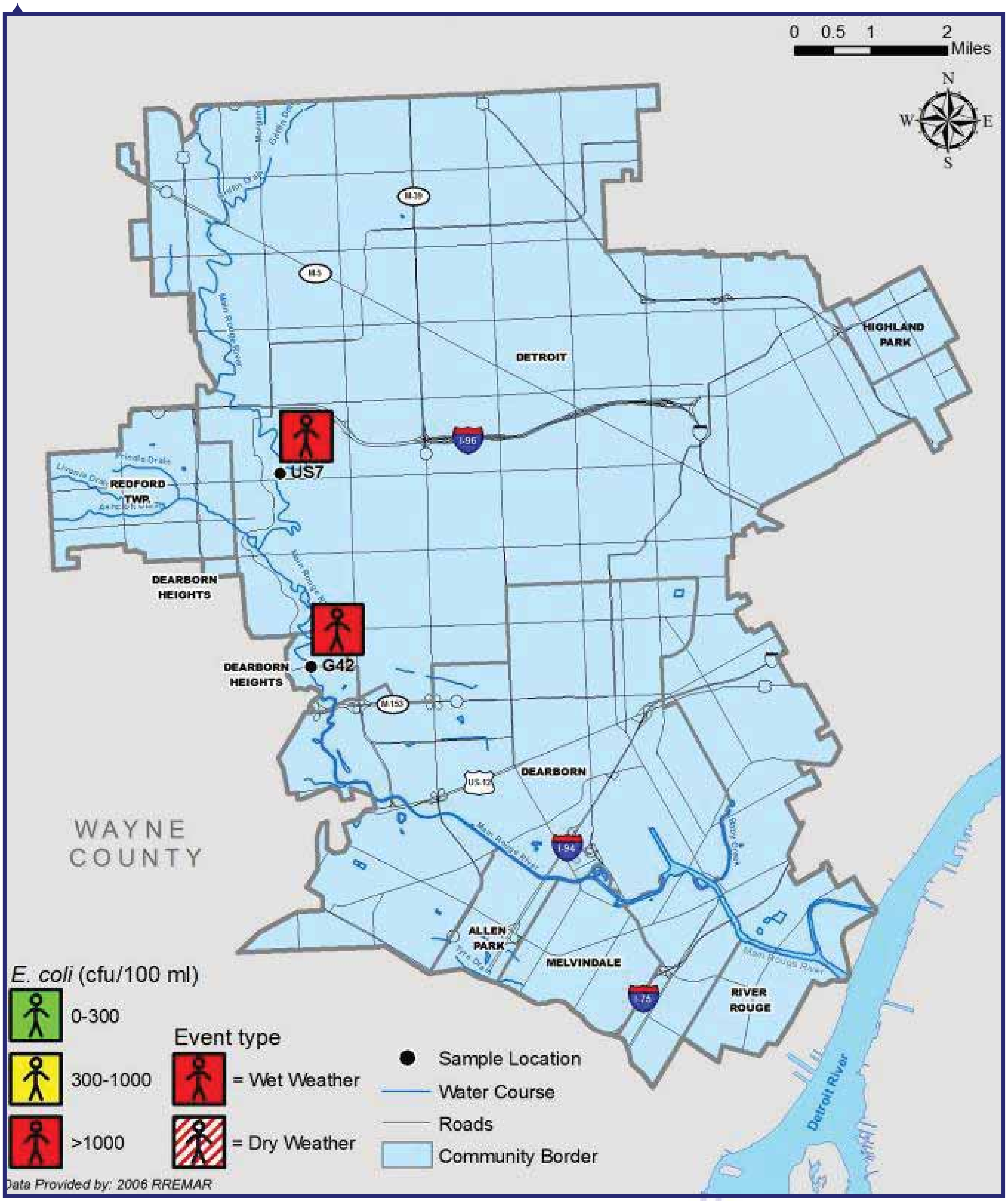


Figure 3-63: Main 3-4 Bacterial Source Tracking Results



site. Wet weather concentrations were nine times higher than dry weather values at Plymouth Road (US7) and Rotunda Drive (US8), as well.

- TSS concentrations have improved from 3 to 5 mg/L per year at all three sites and are three times higher than those found in dry conditions.
- $CBOD_5$, NH_3-N and TP concentrations are one and one-half to two and one-half times higher than the corresponding dry weather values.

Projects completed in the subwatershed to address bacteria include:

- The construction of four CSO Retention Treatment Basins (RTBs): Seven Mile, Puritan-Fenkell, Hubbell-Southfield, and River Rouge. The CSO RTBs now control many of the previously uncontrolled CSOs in the Main 3-4 Subwatershed. Together, the four basins alone serve an area over 16,000 acres. An added benefit is, that the areas surrounding the basins have been enhanced with tennis courts, basketball courts, play areas, native plants, trees, and landscaping.
- An illicit discharge investigation and a sanitary sewer evaluation conducted by the City of Melvindale using Rouge Program Office grant funding in 2002.
- The construction of a $1 Million sanitary sewer overflow tank by the City of Melvindale in 2006 that is 25-feet high and 90 feet in diameter and holds about one million gallons.

River Rouge CSO basin

While uncontrolled CSOs still exist in the Main 3-4 Subwatershed, all known CSOs are being corrected under MDEQ guidance. Those discharges include:

- The East Dearborn CSO project in the City of Dearborn.
- The construction of the $500 million Upper Rouge Tunnel being spearheaded by the Detroit Water and Sewerage Department, which will divert overflow during heavy rains and snow melts and direct it away from the Rouge River to Detroit's wastewater treatment plant. Once completed, the seven-mile tunnel, which will run along the Rouge River from Warren Avenue to north of Seven Mile Road, will reduce the number of combined sewer overflows to the Rouge River from 55 to one a year.

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water runoff contributes significant pollutant loading to the Main Rouge River in this subwatershed. Total pollutant loading considering baseflow, point sources, CSOs and non-point sources was estimated for the Rouge River using the WMM model. The estimated existing pollutant loads for the Main 3-4 subwatershed are summarized in Table 3-39.

Table 3-39: Existing Pollutant Loads for the Main 3-4 Subwatershed

Pollutant	Units	Source				Total Load
		Base Flow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	2%	12%	19%	67%	7.3×10^6
DP	lbs/yr	3%	8%	57%	32%	74,000
Fecal Coliform	counts/yr	0%	0%	0%	100%	2.7×10^{17}
NO_2 & NO_3	lbs/yr	1%	2%	95%	2%	3.2×10^6
TKN	lbs/yr	7%	7%	67%	19%	1,080,000
TP	lbs/yr	3%	8%	34%	55%	161,000
TSS	lbs/yr	5%	7%	58%	30%	6.5×10^7

Pollutant Abbreviations:

BOD: *Biochemical Oxygen Demand*
DP: *Dissolved Phosphorus*
NO_2: *Nitrite*
NO_3: *Nitrate*
TKN: *Total Kjeldahl Nitrogen*
TP: *Total Phosphorus*
TSS: *Total Suspended Solids*

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the Rouge River. Point sources, for example industrial facilities with NPDES permits, and combined sewer overflows (CSOs) are bigger contributors to pollutant loadings than non-point sources for each of the modeled parameters. For the purposes of prioritizing storm water BMPs, the remainder of the analysis within this section focuses on pollutant loading associated with non-point sources, especially in the non-CSO areas of Allen Park, Dearborn, and Melvindale.

The Main 3-4 Subwatershed was subdivided into 106 subbasins as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, phosphorus and TSS within each subarea are shown in Figures 3-64, 3-65 and 3-66. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

The primary non-point sources of phosphorus in the critical Main 3-4 subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, runoff impacted by pet waste and agricultural practices, and illegal sewer connections. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots.

Stream Hydrology

The hydrologic trends along the Main Rouge continue to cause excessive erosion and habitat destruction. The 2001 Main 3-4 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under 2-inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed.

Figure 3-64: Main 3-4 Fecal Coliform Estimated Non-Point Source Load

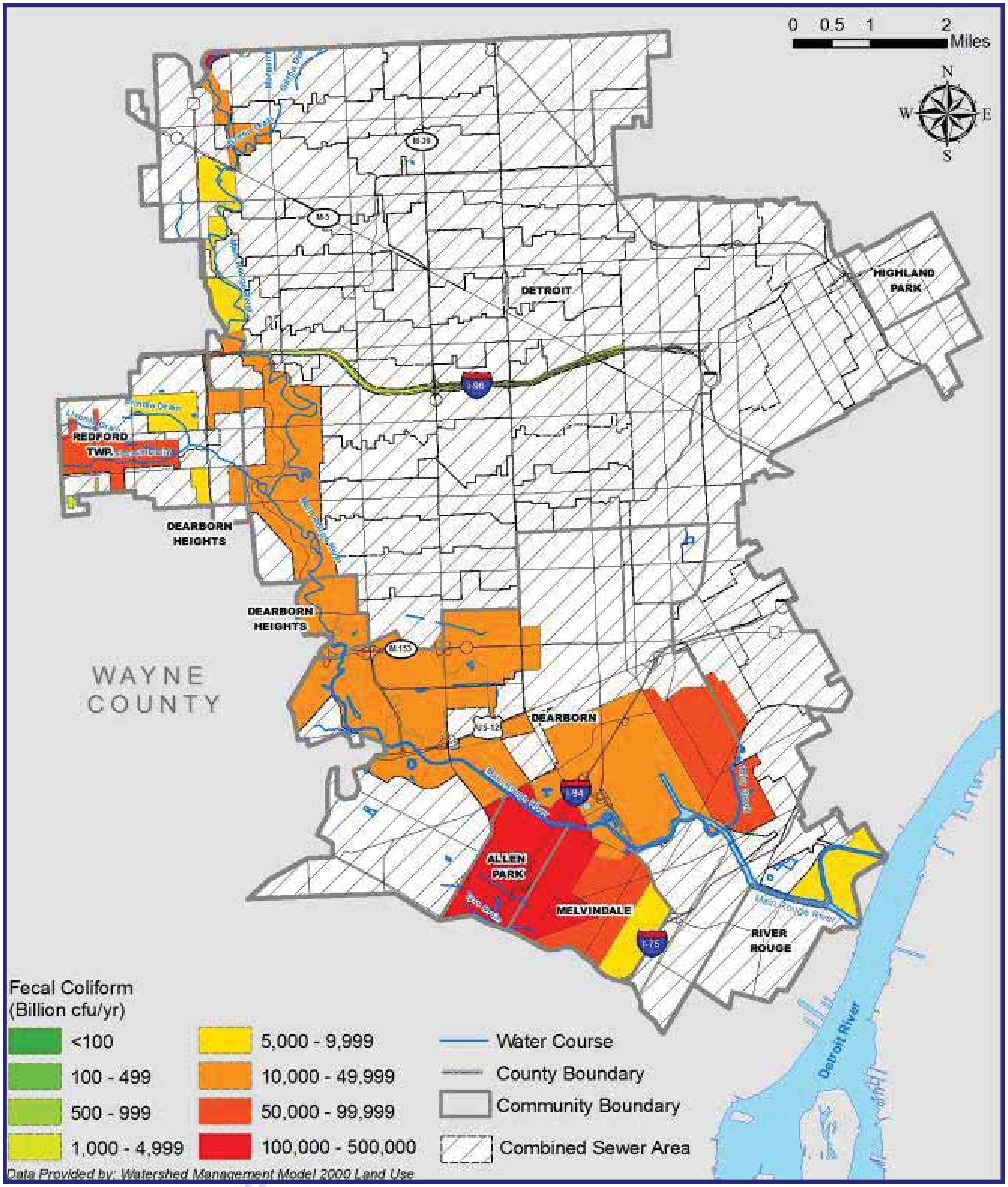


Figure 3-65: Main 3-4 Total Phosphorus Estimated Non-Point Source Load

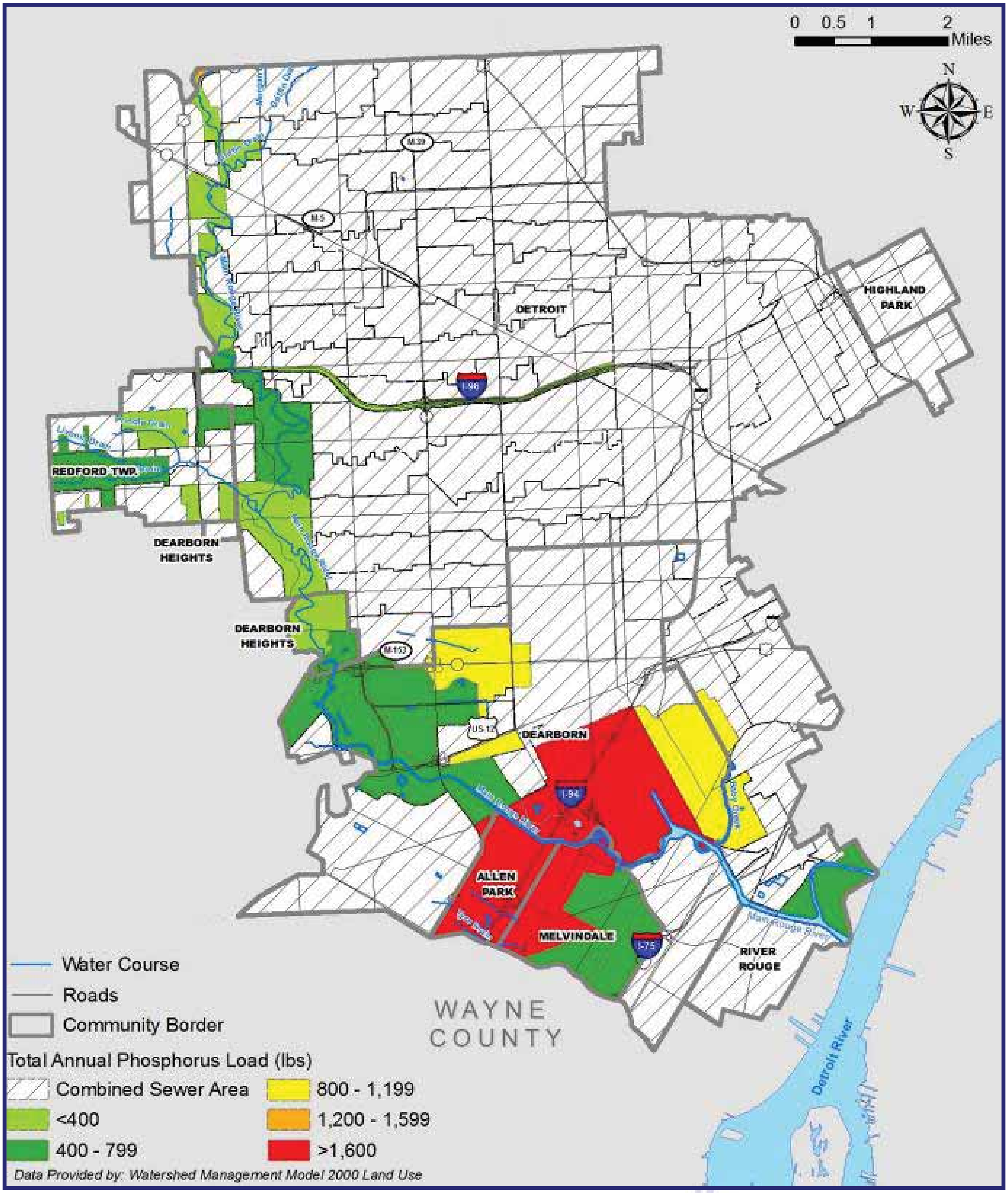
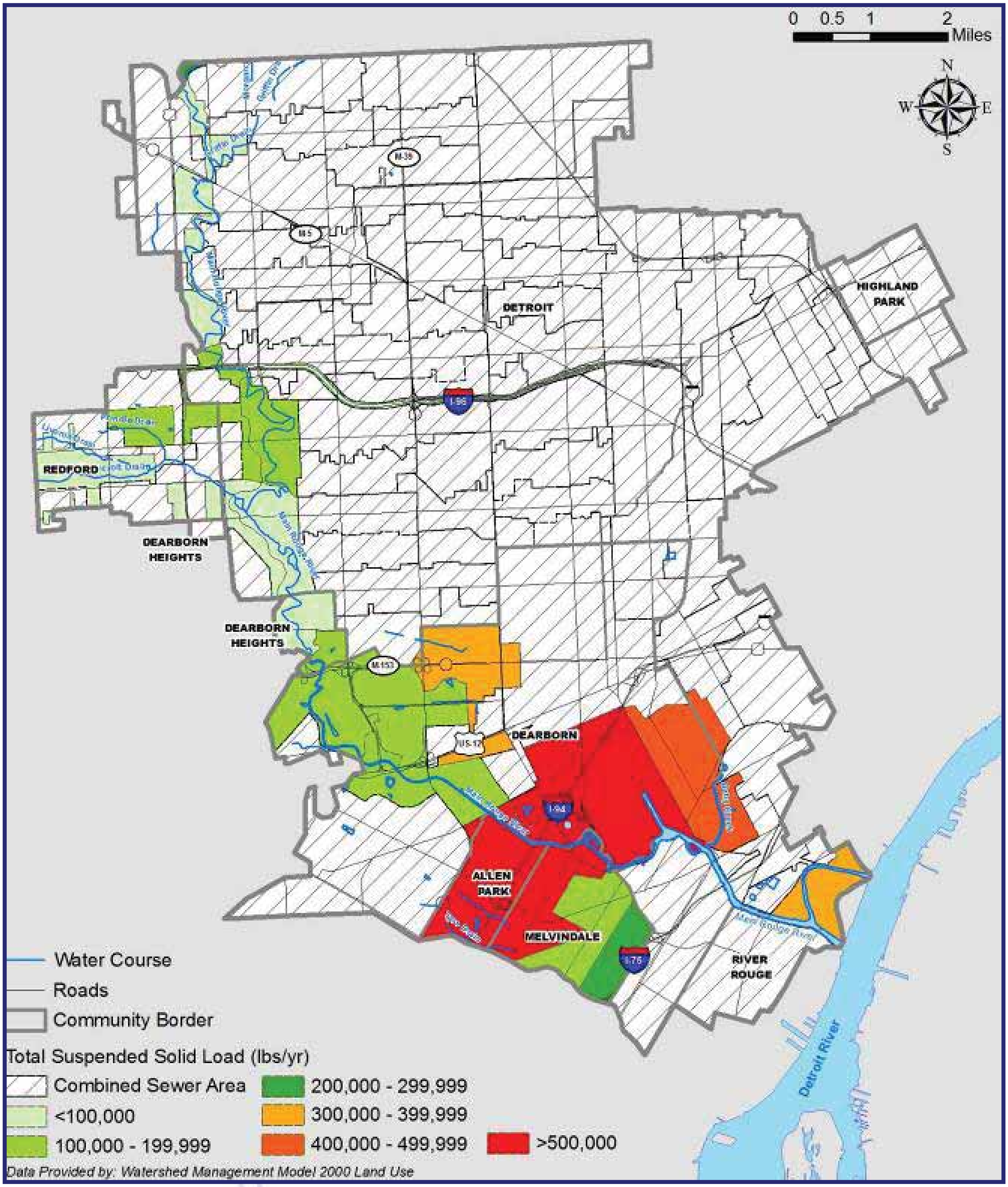


Figure 3-66: Main 3-4 Total Suspended Solids Estimated Non-Point Source Load



While the bankfull, or overbank flood event, occurs on the order of every two years in stable river systems, this study evaluation determines that it occurs on the order of every three to four months in this subwatershed.

A hydraulic analysis was completed to help identify Best Management Practices (BMPs) that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

Figure 3-60 on page 3-132 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04166500), Main Rouge at Detroit (US7), is the most accurate gage within this watershed because of the back water conditions caused by the Detroit River. Although most of this watershed flow is not accounted for, in our opinion, it is provides sufficient flow information for identifying goals for the Main 3-4 subwatershed, as such, identified BMPs should be implemented throughout the watershed. Figure 3-67 shows the area in the subwatershed that contributes to the flow conditions for this gage.

Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events. These results are shown in Table 3-40.

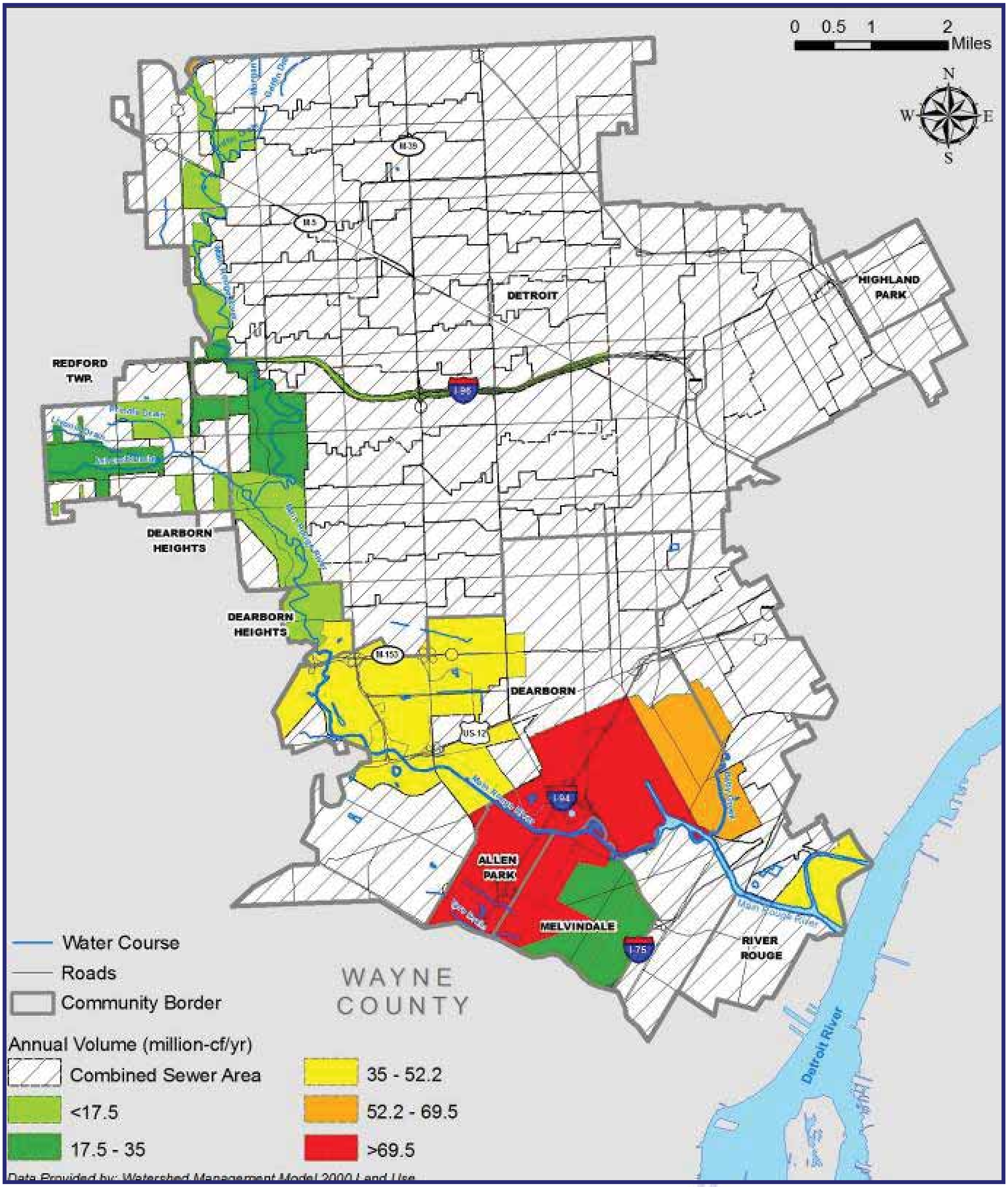
Table 3-40: Main 3-4 Subwatershed Flow Rate Trends at Detroit

Bankfull Flow Rate	1,309 cfs with return period of 3.5 months
15-day	363 cfs
30-day	650 cfs

Figure 3-68 also represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

Figure 3-67: Main 3-4 USGS Gage at Detroit Drainage Area

Figure 3-68: Main 3-4 Storm Water Runoff Non-Point Source Annual Volume



The hydrologic trends along the Main Rouge continue to cause excessive erosion and habitat destruction. The analysis suggests that reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 71,300,000 cubic feet of storm water (0.209 inches of water over the subwatershed) is needed to help reduce the effect of the small storms. This is an extremely difficult task. It is important to note that the water needs to be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

Rain garden at UM-D Environmental Interpretive Center

A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins and constructed wetlands might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing road-side ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bioretention basins or rain gardens, and porous pavements can be installed on individual properties.

Over the past several years various projects have been completed in the Main 3-4 to help control flow in the rivers. In addition to the Rouge Gateway Partnership projects, other activities include:

- A rain garden was created in 2006 to control on-site storm water runoff at the UM-D Environmental Interpretive Center in Dearborn.
- The City of Melvindale conducted a downspout disconnection program which reduced the known connected downspouts from 359 to 37 in 2005 and from 37 to 10 in 2006. The remaining connected downspouts are assessed a $2 per day storm water impact fee as a disincentive to remain connected.
- The City of Dearborn has installed wetland detention, rain gardens and swirl concentrators to reduce flow and treat storm water runoff in its public works yard.

City of Dearborn DPW rain gardens

Ecosystems

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Main 3-4 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Aquatic Diversity

Fish Communities

The Main Branch of the Rouge River presents significant opportunities for improving fish communities provided the poor water quality, lack of appropriate spawning habitat and riparian habitat conditions are improved. In addition, lack of fish passage to upstream river branches also inhibits enhancing Great Lakes fish communities in those areas. Significant efforts have been undertaken to determine the level of work associated with creating fish passage opportunities in the concrete channel and around the Henry Ford Estate dam.

Henry Ford Estate dam

Additionally, river quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities. Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

As a part of the 1995 MDNR fish study two sites located in the Main 3-4 Subwatershed were surveyed and the assessment documented that this reach of the river was rated *Poor* to *Very Poor* using the Index of Biotic Integrity (IBI) (Karr, 1981) and *Fair* to *Moderately* impaired using the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies.

Potanadromous fish are fish that breed in rivers and live their adult life in open waters (i.e. brown trout, lake trout, rainbow trout or steelhead, Chinook salmon, and coho salmon)

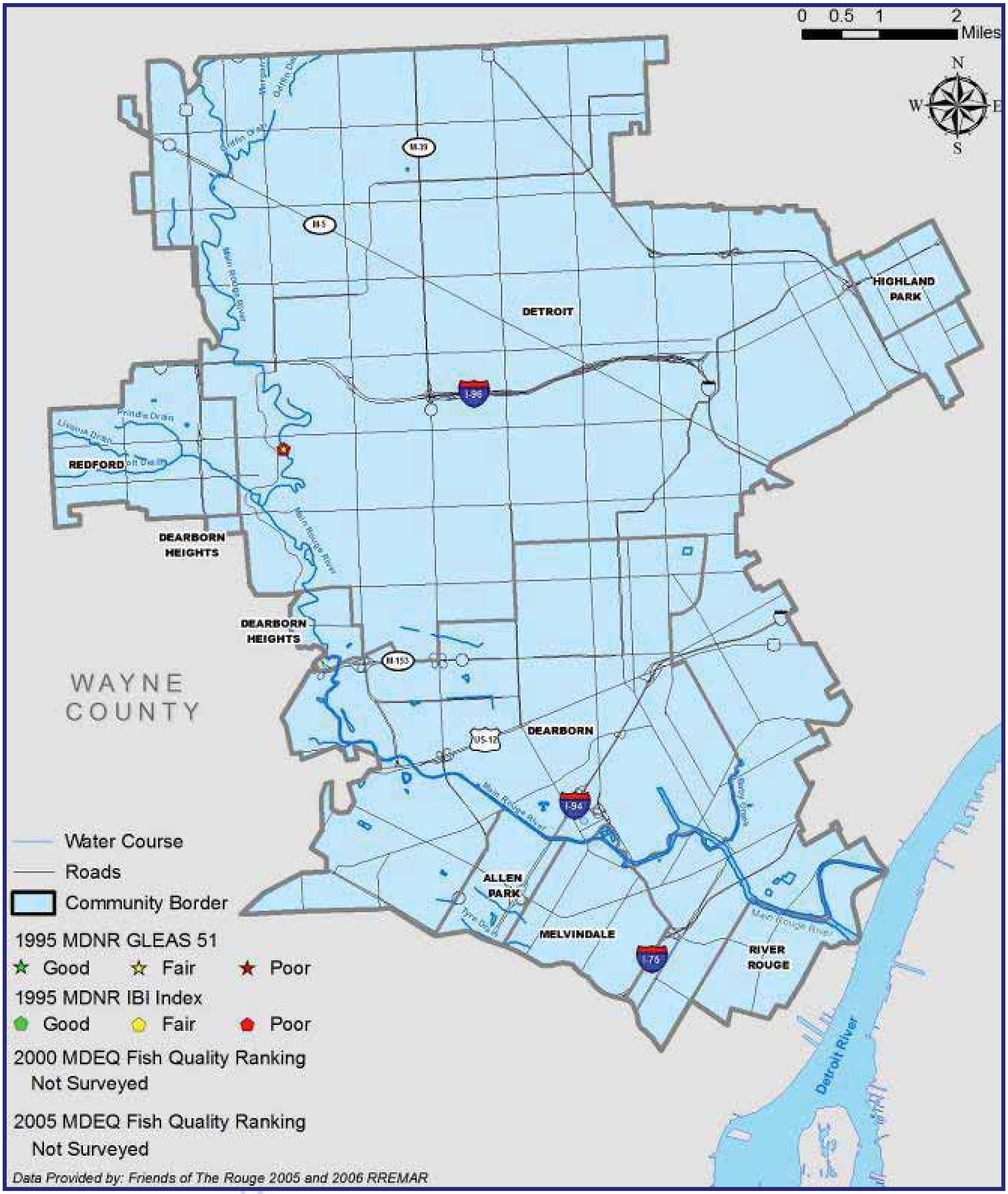
The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981). The results of the 1995 survey are shown in Figure 3-69. IBI and GLEAS 51 use similar metrics, however, it was felt that the IBI results proved a more reliable indicator of fish population integrity. Only one of the two sites was rated for fish species composition, which was on the Main Branch at Spinoza Road in Rouge Park. This site was rated Poor to Very Poor using IBI and Fair to Moderately Impaired using GLEAS 51. No data was collected for the Main 3-4 Subwatershed during the 2000 and 2005 MDEQ biological assessments. Therefore, there have been no assessments of the fish community since 1995, which makes it difficult to predict the current conditions.

The stretch of the river below the dam at the Henry Ford Estate is accessible to Potanadramous fish species, like brown trout and steelhead salmon. Of the 34 species documented at this site in 1995, 20 species are only found at this site and nowhere else in the Rouge River Watershed. The species composition at this location is greatly influenced by the Detroit River and Lake Erie.

Chinook salmon

Limited numbers of Chinook salmon migrate up the Main Branch every fall and limited numbers of steelhead, also known as rainbow trout, have also been documented. Both species are native to the Pacific Coast, and have been stocked in the Great Lakes states since the 1970s. These fish were probably stocked in Lake Erie, and are not likely to breed successfully in the Main Branch due to warm summer water temperatures, excessively variable water flows, and inappropriate

Figure 3-69: Main 3-4 Fish Community Assessments



bottom substrate. They could provide a small recreational fishery each year; however poor water quality, lack of suitable spawning habitat and the dam at the Henry Ford Estate are primary sources of impairment.

Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Main 3-4 Subwatershed. These fish and their associated advisory were last updated in 2007, as shown in Table 3-41. As with previous advisories, polychlorinated biphenyls (PCBs) are the major contaminant influencing the consumption of fish in the Main 3-4 Subwatershed.

Table 3-41: 2007 Fish Consumption Advisories for the Main 3-4 Subwatershed

Location	Fish Species	Contaminant	General Population	Women and Children
Main Branch, Upstream of Ford Rd. (M-153)	Suckers	PCBs	Unlimited Consumption	1 meal/week
	Carp, <30 inches	PCBs	Unlimited Consumption	6 meals/year
	Carp, >30 inches	PCBs	Do not eat	Do not eat
	Catfish	PCBs	Do not eat	Do not eat
Main Branch between Ford Rd. and Ford Dam	Largemouth & Smallmouth Bass	PCBs	Do not eat	Do not eat
	Northern Pike >22 inches	PCBs	Do not eat	Do not eat
	Suckers, <14 inches	PCBs	Unlimited Consumption	1 meal/month
	Suckers, >14 inches	PCBs	Unlimited Consumption	6 meals/year
	Carp, <26 inches	PCBs	Unlimited Consumption	6 meals/year
Main Branch, below Ford Dam	Carp, >26 inches	PCBs	Do not eat	Do not eat
	Suckers, <14 inches	PCBs	Unlimited Consumption	6 meals/year
	Suckers, >14 inches	PCBs	Do not eat	Do not eat

Notable Areas

The section of the Main 3-4 Subwatershed accessible to the waters of the Great Lakes is of extreme significance. This section could be home to a thriving community of game fish. At present, there are species found here that are found nowhere else in the watershed. The flat, low valley itself provides the conditions necessary for extensive flooding and floodplain development. Indeed most of the riparian land in this district is in public ownership due to its propensity for flooding. The restoration of an oxbow at The Henry Ford provides habitat for fish and wildlife and will also contribute to the fishery in this subwatershed.

Impairments

Severe water quality degradation from CSO discharges, excessive flow variation, separation of river segments by the presence of a high head (12-foot) dam at the Henry Ford Estate, and lack of appropriate habitat have been the main factors negatively impacting the Main 3-4 fish community. Pavement lining the channel south of Michigan Avenue in the lowest reaches acts as a barrier to movement of fish and other aquatic life. The impoundment at the Ford Estate, and the degraded condition of the lower river district's physical channel and water quality present serious impediments to the normal functioning of the Rouge River system. (Seelbach, et. al, 1998)

Concrete channel in Dearborn

Increases in flashiness contribute to streambank erosion and sedimentation, which results in a myriad of negative impacts on the biota. High flows carry away small woody and other debris from the stream channel, eliminating flow refugia and hard substrates upon which many macroinvertebrates forage and endemic fish species lay eggs. Excessive sedimentation covers and embeds critical habitat leaving a relatively flat channel configuration. Elimination of terrestrial components necessary for moderating the intensity of storm water inputs has also resulted in a decrease in ground water flow and loss of riparian canopy that may result in increased in-stream temperatures and lower retention of dissolved oxygen. The natural geology and hardening of surfaces through urban land use prohibits high rates of groundwater contribution to streams, therefore negative impacts caused by poor storm water management and removal of riparian buffer zones are magnified.

Bloodworm

Macroinvertebrate Communities

As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed, is also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decades. Below is a description and summary of these results within the Main 3-4 subwatershed.

In 1986 the MDNR conducted aquatic macroinvertebrate surveys at two sites in the Main 3-4 Subwatershed. Evans Ditch at 8 Mile Road was rated *Poor-Very Poor* and the Main Branch between Joy and Plymouth roads was rated *Poor.*

During MDEQ's Rouge River biological assessment survey of 2000, macroinvertebrate communities were sampled at Seven Mile Road along the Main 3-4, earning a rating of *Acceptable* (Goodwin, 2002). A 2005 biological assessment was performed by the MDEQ at two stations in the Main 3-4 (MDEQ, 2005). An *Acceptable* rating was assessed at the Spinoza Rd. location, but the tributary Ashcroft Drain received a *Poor* rating. Figure 3-70 shows the MDEQ locations sampled in 2000 and 2005.

Rouge Education Project students conducting water quality sampling in the City of Melvindale

The Main 3-4 has only been sampled twice since 2003. Friends of the Rouge sampled the Main 3-4 at Henry Ford Academy in Greenfield Village after completion of the oxbow restoration and at Eliza Howell Park in 2004. These sites were rated *Poor*. There was insufficient data to come to an overall rating.

Impairments

Lack of habitat variability, especially pools and riffles, and in-stream cover has been indicated as the primary impairment. Streams that exhibit this type of impairment typically experience frequent occurrences of extreme peak and low flows. There are many controlled and several uncontrolled CSOs discharging into this subwatershed, and numerous storm sewer discharges. Water quality and quantity is an issue throughout the area. Land use is primarily urban and exhibits high rates of imperviousness resulting in extreme stream flow patterns. Erosion and sedimentation, along with lack of hard substrates prevent the establishment of suitable habitat for a diverse and abundant community of benthic macroinvertebrates within most reaches of the Main 3-4 Rouge Subwatershed. The channelized section of this subwatershed, while hard, does not have a diverse substrate needed to provide enough break from the current for macroinvertebrates to colonize.

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed; however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

Green frog

Similar to the MDNR Frog and Toad Survey, the FOTR began a Frog and Toad Survey in 2000 and eight species of native frog and toads are present in the Main 3-4 Subwatershed (Figure 3-71). Even though all eight species of native frog and toads are present in this subwatershed, their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools, while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time.

Figure 3-70: Main 3-4 Macroinvertebrate Assessments

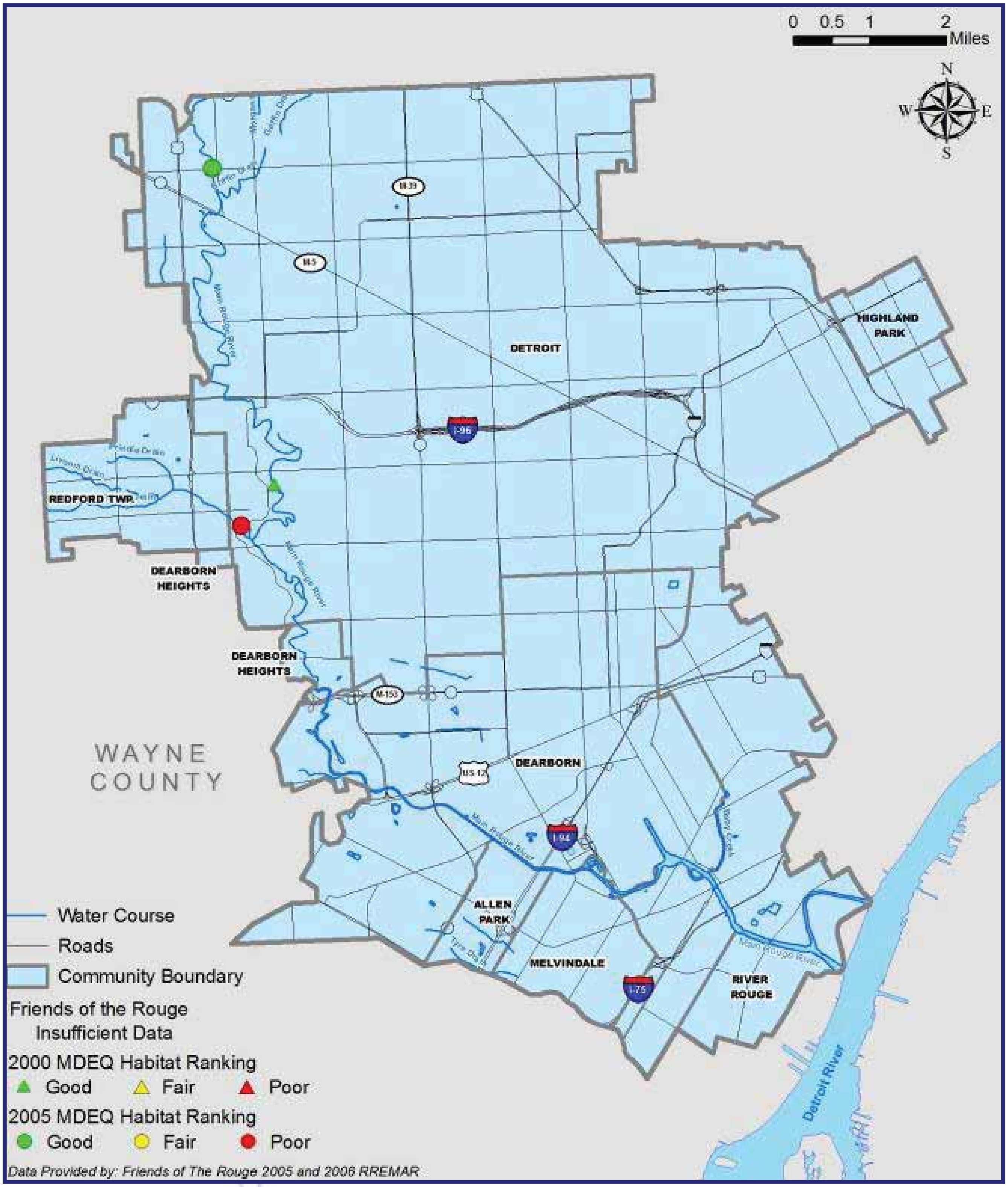
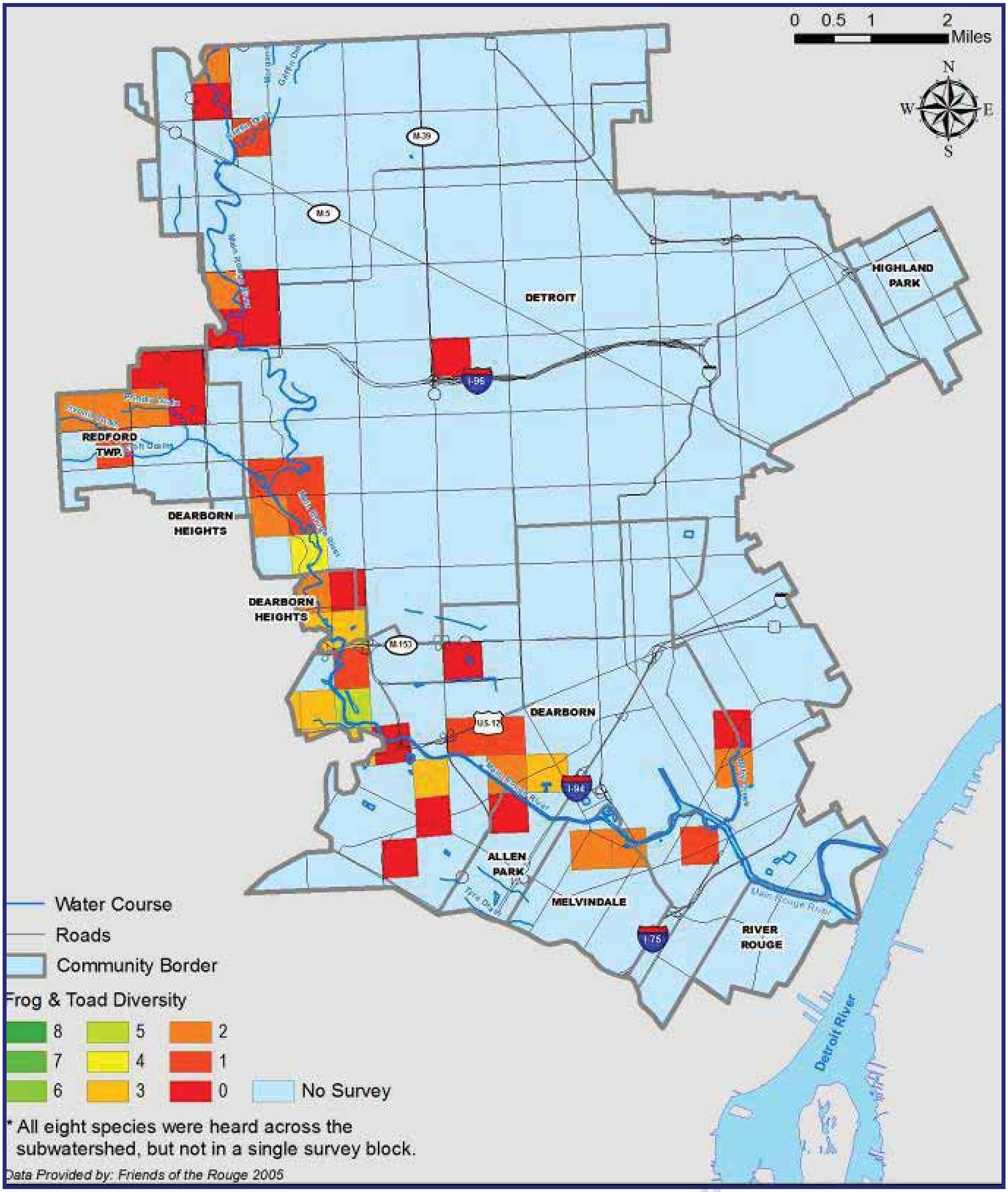


Figure 3-71: Main 3-4 Frog and Toad Diversity



There were no notable trend differences between the years. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area.

Table 3-42 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 2000 through 2007 (FOTR, 2007). The number of blocks surveyed in the Main 3-4 Subwatershed peaked in 2002 and 2003 with 34 blocks each year and then fell to between five and eight blocks in the years since. One must be careful in comparing survey results year to year because survey blocks are not consistent due to the fact that the extent of coverage is determined by volunteer interest.

Table 3-42: FOTR Frog and Toad Survey - Percent of blocks in which species were heard in the Main 3-4 Subwatershed

Species	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	7	7	9	14	0	13	0	20
Western Chorus Frog	21	21	18	29	13	40	0	0
Spring Peeper	14	14	0	7	4	14	25	20
American Toad	50	50	45	79	48	42	88	60
Northern Leopard Frog	0	0	0	0	0	11	0	0
Gray Tree Frog	0	0	0	0	4	0	0	0
Green Frog	7	7	18	57	43	44	43	40
Bullfrog	0	0	0	14	13	33	25	40
Total Blocks Surveyed	14	14	11	14	25	15	8	7

Oakwood Commons Retirement Community in the City of Dearborn

Notable Areas

Data collection methodologies do not allow determination of the exact location of suitable habitat. However areas exist within public parkland that would provide habitat for native frog and toads.

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as diseases or differences in temperature and precipitation from year to year. Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man-made wetlands can be appropriate substitutes provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Stream Habitat

One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in Stream Hydrology above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels; and decline in undercut banks.

Rouge Rescue volunteers at Rouge Park

An evaluation of stream habitat was undertaken during four separate occasions, all using MDEQ's GLEAS 51 protocol. Study results are shown in Figure 3-72.

Both the 1995 MDNR and the 1996 Rouge Project studies rated the Main 3-4 on average as *Poor.* The 2000 MDEQ study however ranked the watershed on average as *Fair.* In 2005, the stream habitat in the Rouge River and selected tributaries was re-evaluated, however no sites were located within the Main 3-4 Subwatershed (MDEQ, 2005). The habitat in the Main 3-4, like much of the Rouge River, suffers from excessive flow variation, which is manifested in unstable banks, lack of streamside cover, and high sediment load.

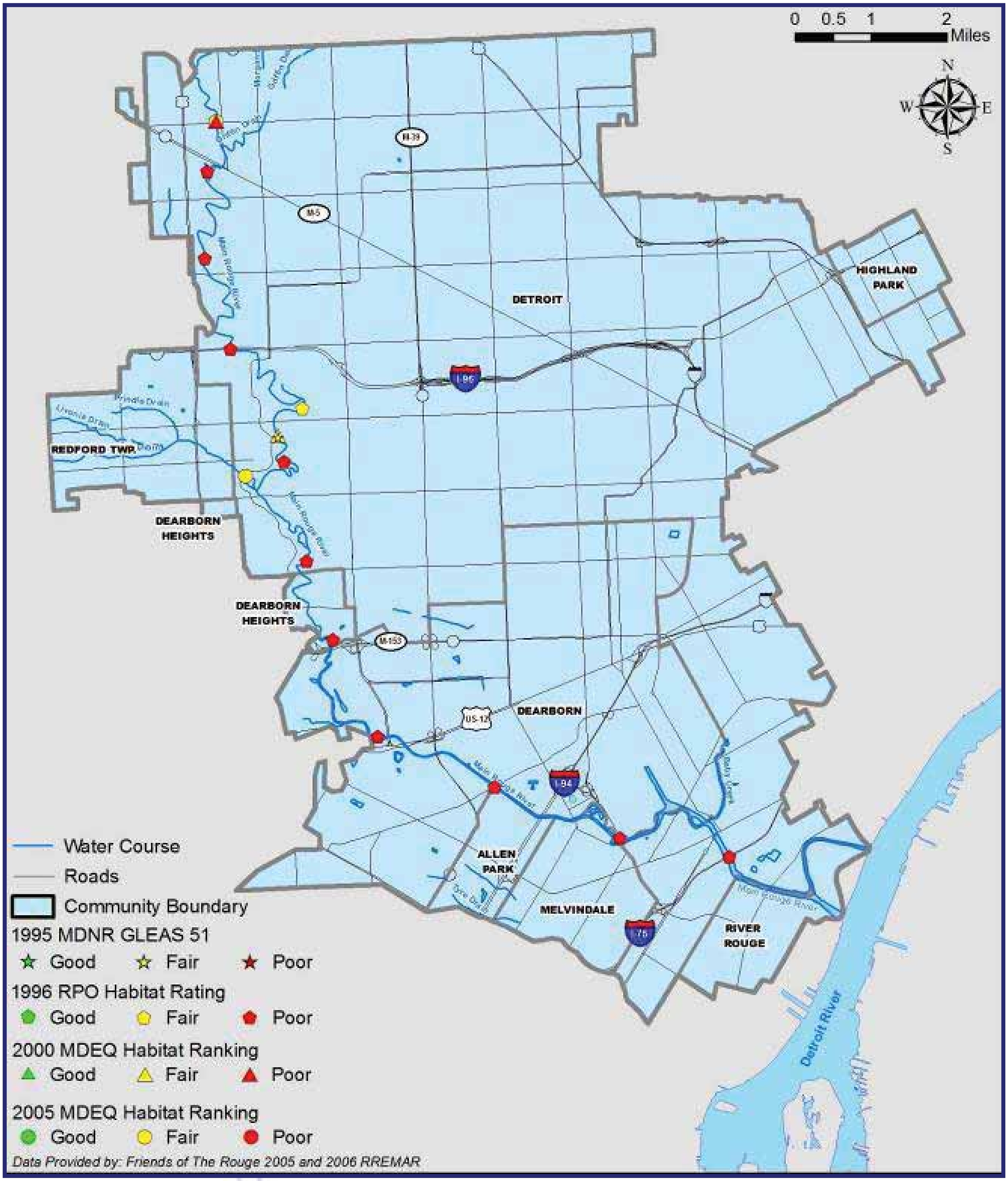
Notable Areas

The Main 3-4 Subwatershed is heavily developed, however it still retains a moderately intact riparian corridor in the northern reaches, mostly due to excessive flooding. This riparian corridor is seasonally flooded, providing an important connection with the river. Eliza Howell Park and Rouge Park in Detroit and a restored oxbow adjacent to the river in Dearborn provides an opportunity for future habitat development.

Impairments

The Main 3-4 Subwatershed should support a fairly diverse aquatic community. The habitat in this reach suffers from excessive flow variation, which is manifested in unstable banks, lack of streamside cover, riffles and pools. The primary cause of degraded stream habitat is the excessive flow instability and accompanying erosion and sedimentation and a lack of habitat complexity. Extremes in flow result in erosion of streambanks and sedimentation that negatively impacts the bottom substrates. High flows displace small woody debris from the channel, eliminating flow refuges provided by hard substrates. Removal of log jams within the stream negatively impacts habitat availability. The remaining uncontrolled CSOs in the subwatershed negatively impact water quality, however, plans are underway to correct these CSOs, which will lead to considerable improvements in water quality. Negative impacts from unmitigated storm water inputs continue to impair the stream habitat. The dam at the Henry Ford Estate in

Figure 3-72: Main 3-4 Stream Habitat Assessments



Dearborn fragments aquatic habitats and render them unavailable for some fish species. The channelization and paving of four miles of river from Michigan Avenue to the Turning Basin has impaired a valuable connection between the watershed and the waters of the Detroit River.

Stream Corridor

Existing remaining natural features along the Main 3-4 corridor of the Rouge River should be prioritized for preservation. Parklands create opportunities for native planting establishments.

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes the actual vegetation along the streambanks including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River.

Riparian Corridor

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms; and a buffer for pollutants and sediments from surface runoff. As well as providing habitat for aquatic organisms, the corridor is used by many birds and mammals. Over 250 species of birds have been recorded in the Natural Area at the University of Michigan-Dearborn, including many rarities and several first state records. The area around Fair Lane Lake is especially good for warblers and other brightly colored songbirds in spring. In the fall, many fruiting trees and shrubs attract numerous migrants. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment. Educational opportunities are provided by the Rouge River Bird Observatory and the Environmental Interpretive Center, both at the University of Michigan-Dearborn, as well as The Henry Ford.

Fair Lane Lake in the City of Dearborn

Wetlands and Woodlands

Figure 3-73 shows the existing wetlands within the Main 3-4 Subwatershed. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-74. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Trails at the oxbow located at The Henry Ford

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and

Figure 3-73: Main 3-4 Existing Wetlands

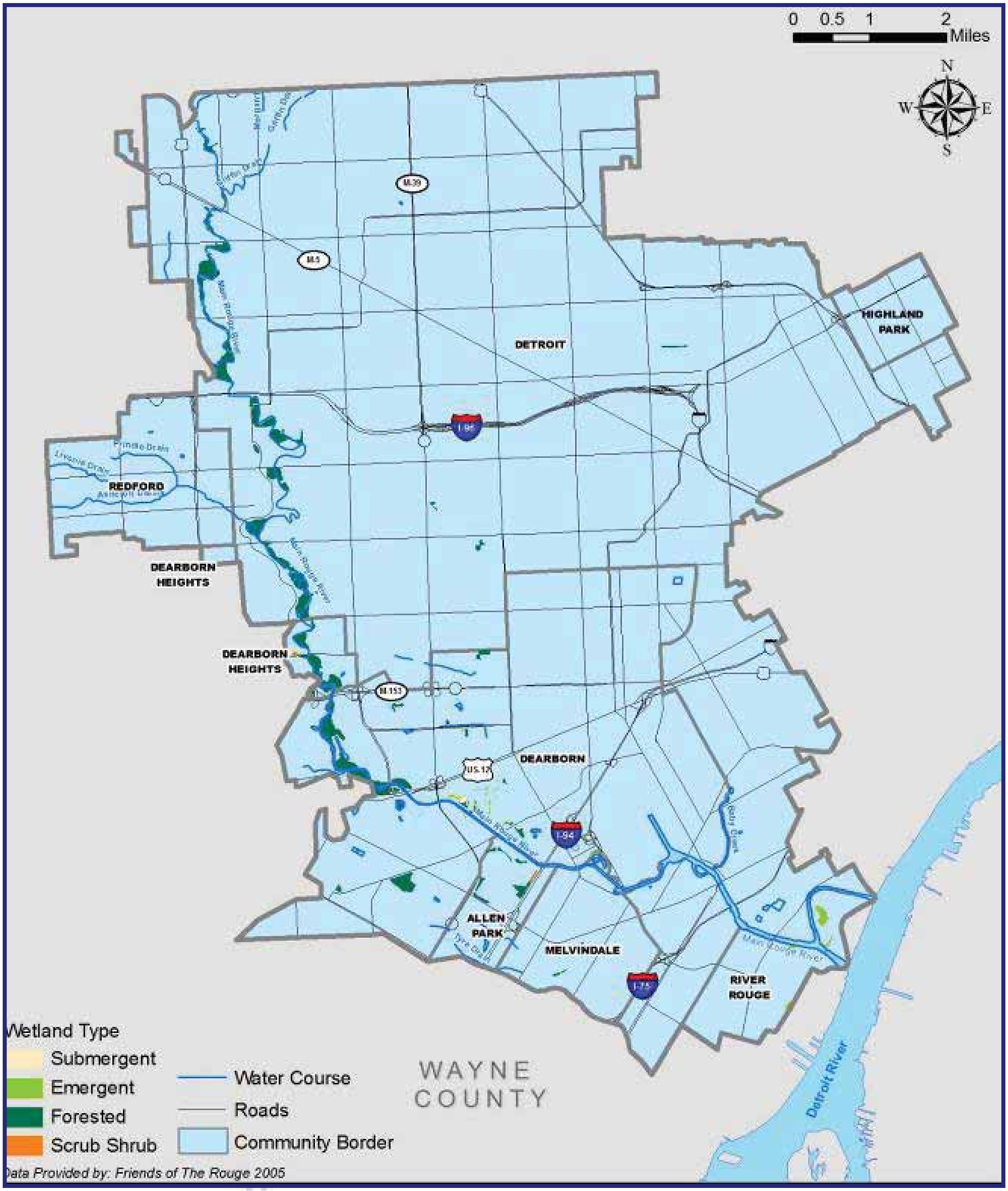
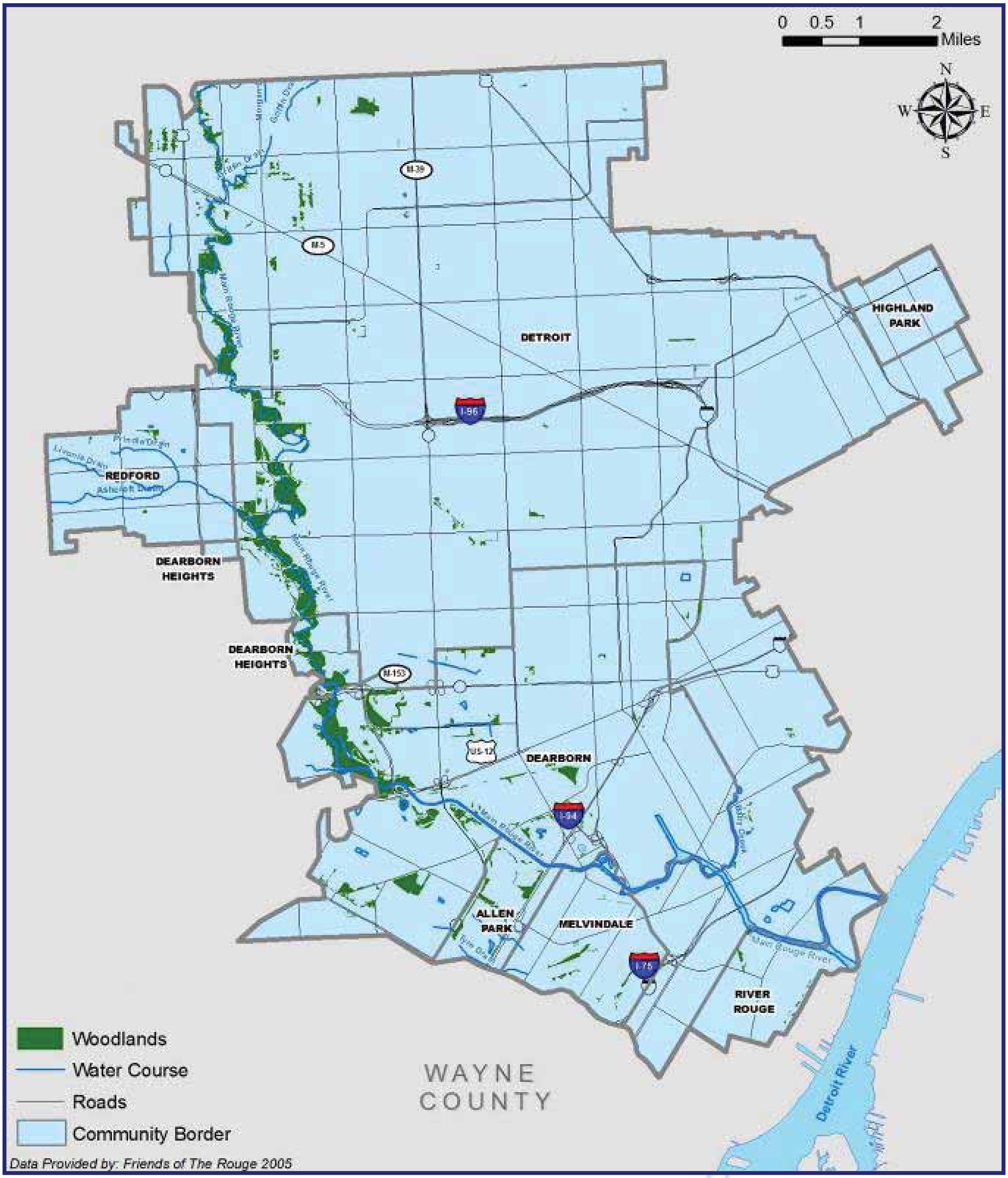


Figure 3-74: Main 3-4 Existing Woodlands



increasing infiltration of storm water with root systems and often more permeable soils.

Miller Road by Ford Motor Company in Dearborn

Historical Storm Water Project in the Main 3-4 Subwatershed

As a part of the continuing effort to improve the recreational opportunities and wildlife habitat within the Rouge River Watershed, the Rouge River Gateway Partnership was formed in 1999 from a diverse leadership group including Wayne County, five municipalities, cultural institutions, and private businesses in the Main 3-4 Subwatershed, and a master plan was completed. This project focuses on restoring the Rouge River's final eight miles in the Rouge River's Main Branch. Under the guidance of the Partnership, the master plan encourages people, ecology, and economy to co-exist equitably and sustainably in the landscape. The plan includes a number of projects that restores the relationship between the Rouge River and its natural and social systems. Thus far, these projects have been completed:

- The restored oxbow at the Henry Ford provides educational opportunities for hundreds of thousands of people who visit the Henry Ford each year. Funding for the oxbow restoration was provided by Clean Michigan Initiative and the Rouge Program Office.
- The Environmental Interpretive Center at the University of Michigan-Dearborn was opened in 2001 to provide environmental education to school children, teachers and university students. The UM-D is also host to the Rouge River Water Festival which attracts up to 3,000 fifth-graders annually in May to learn about the Rouge River.
- In 2002, Ford Motor Company in Dearborn conducted "green" activities at the Ford Motor Rouge Plant by installing a green roof on the manufacturing plant, using porous pavement at new car storage areas and creating mass plantings of native plants. Ford also partnered with Wayne County Roads to reconstruct Miller Road to include storm water detention.
- A bike path that connects UM-D and Henry Ford Community College to Hines Parkway

Prairie planning at Henry Ford Community College in Dearborn

Future projects include a proposed fish passage around the historic dam at the Henry Ford Estate on the University of Michigan - Dearborn campus and the Army Corps of Engineers is studying models for partial removal of the concrete channel to create new fish habitat and natural riverbanks.

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are other projects Main 3-4 subwatershed stakeholders have completed:

- The City of Dearborn is implementing BMPs in its Department of Public Works Yard to treat storm water that runs off the yard into the Rouge River. Improvements include a swirl concentrator to remove solids; a wetland detention area to treat storm water as it leaves the yard and rain gardens to treat storm water from the parking lot.
- Henry Ford Community College maintains a prairie planting on its Dearborn campus to recreate the mix of plants typically found in the prairies of southeast Michigan up until a century ago.

- In 1999, the City of Detroit used a Rouge Program Office (Rouge Project) grant to create natural areas at Eliza Howell Park, Rouge Park and Rogell Golf Course. Nearly three acres of native plants were planted at Eliza Howell Park; 15 acres of prairie grasses and native flowers were planted at Rouge Park, and streambank was stabilized and native buffers planted at Rogell Golf Course.

Grow zone at Rouge Park in Detroit

Middle 1 Subwatershed (Storm Water Management Area) Conditions

The Middle 1 Subwatershed begins at Walled Lake and encompasses 150 miles of rivers and creeks and includes several impoundments along the Middle Branch of the river. These impoundments include Meadowbrook Lake, Phoenix Lake and Wilcox Lake. The Middle 1 Subwatershed is currently home to some of the best water quality and wildlife habitat in the Rouge River Watershed, although these water resources have been affected by land uses changes. The Johnson Creek is the only designated cold-water trout stream within the Rouge River Watershed and also is home to the endangered redside dace.

Middle 1 highlights:

- ***The Middle 1 land uses vary from small rural horse farms in the west to urban residential and commercial areas in the east and north.***
- ***The Middle 1 is home to the Rouge River's only designated cold water trout stream***
- ***Walled Lake is the largest waterbody in the watershed and contains a healthy population of warm water fish species***

Significant changes in land use and land cover have occurred across this subwatershed over the last ten years as development continues to expand away from the urban core of Detroit. Although the water quality in the Middle 1 is improving in portions of the watershed, there is also stress as a result of the continuing urbanization of the watershed.

The characteristics and conditions of this subwatershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Middle 1 Subwatershed Management Plan. While the stream indicators of water quality, stream hydrology, aquatic diversity, stream habitat and physical conditions of the stream corridor are all indicative of urban stream conditions, the general trends show improvement. Challenges exist with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in wet weather conditions.

Subwatershed Demographics

The Middle 1 Subwatershed is situated in the western portion of the watershed and makes up about 20% or approximately 80 square miles (51,457 acres) of the entire Rouge River Watershed (Figure 3-75). The Middle 1 Subwatershed is comprised of portions of Canton Township, Commerce Township, Farmington Hills, Livonia, Lyon Township, City of Northville, Northville Township, City of Novi, City of Plymouth, Plymouth Township, Salem Township, Walled Lake, Wixom, western Wayne County, eastern Washtenaw County and southern Oakland County. It also has a diverse set of land uses varying from small rural horse farms in the west to urban residential and commercial areas in the east and north. Table 3-43 lists the member communities that make up the Middle 1 and summarizes the area for each community.

Bennett Arboretum, Wayne County Hines Park in Northville Township

Figure 3-75: Middle 1 Subwatershed Location

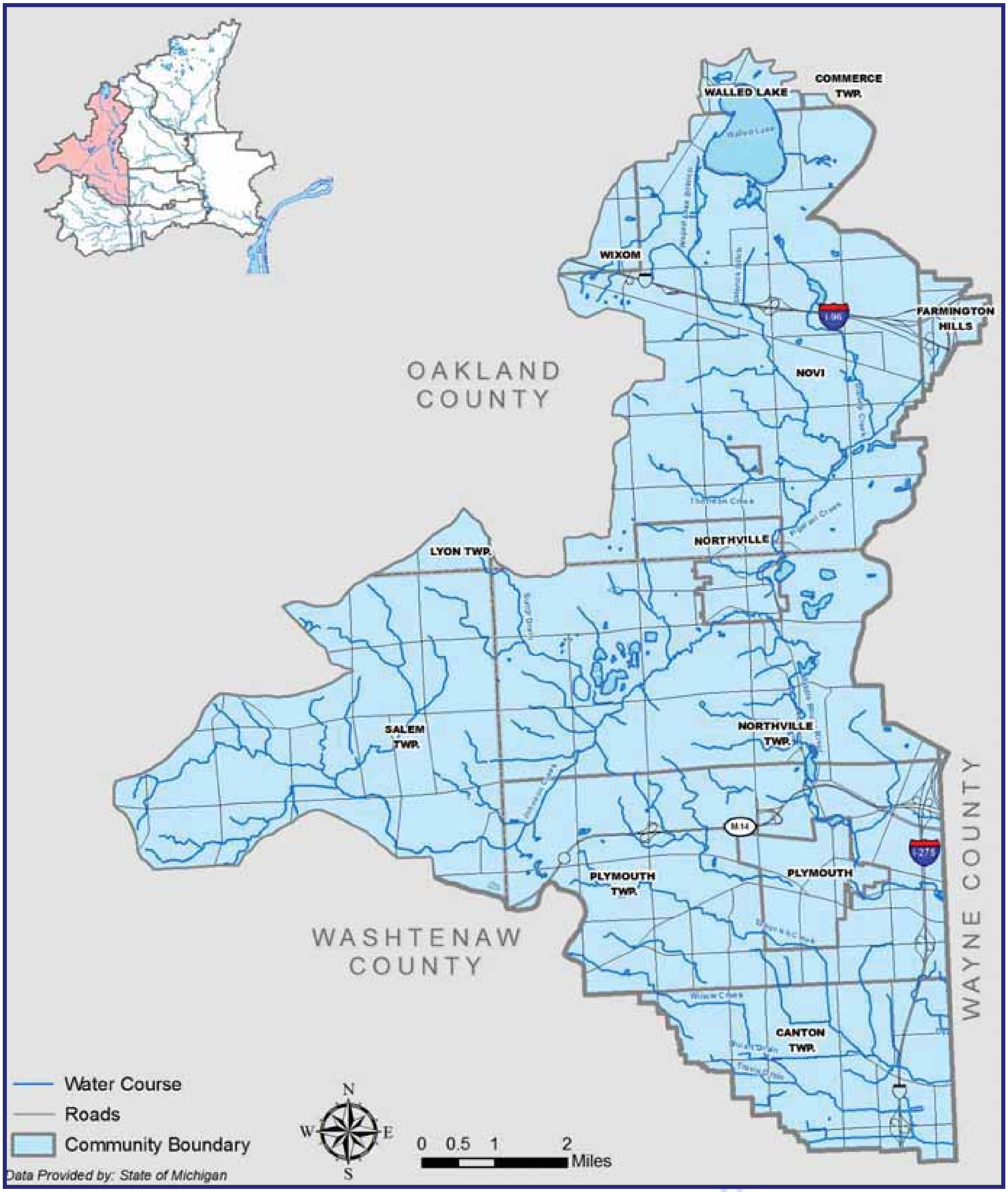


Table 3-43: Middle 1 Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Canton Township	7.50	20.8
Commerce Township	0.1	0.3
Farmington Hills	0.9	2.8
Livonia	0.03	0.1
Lyon Township	0.7	2.3
Northville	2	100
Northville Township	14.3	86.3
Novi	21.5	68.8
Novi Twp	0.1	83.4
Plymouth	2.2	100
Plymouth Township	14.7	92.1
Salem Township	14.5	42.1
Walled Lake	0.9	37.1
Wixom	0.9	9
Counties		
Oakland County	25.1	
Washtenaw County	14.6	
Wayne County	40.8	

Phoenix Lake

The Middle 1 Subwatershed is currently home to some of the best water quality and wildlife habitat in the Rouge River Watershed (although these water resources have been affected by land uses changes). The Johnson Creek is the only designated cold-water trout stream within the Rouge River Watershed and also is home to the endangered redside dace.

The Middle 1 Subwatershed begins at Walled Lake and encompasses 150 miles of rivers and creeks and includes several impoundments along the Middle Branch of the river. These impoundments include Meadowbrook Lake, Phoenix Lake and Wilcox Lake. Newburgh Lake, directly downstream of the Middle 1 Subwatershed is heavily impacted by upstream actions of the Middle 1 and is of major interest due to the 1998 sediment remediation project in the lake. Johnson, Tonquish and Bishop Creeks are a few of the Middle 1 Subwatershed tributaries to the Middle Branch of the Rouge River.

Impervious Cover

Significant changes in land use and land cover have occurred across this subwatershed over the last ten years as development continues to expand away from the urban core of Detroit. Figure 3-76 graphically depicts the current impervious cover across this subwatershed. In addition, Table 3-44 highlights the differences in land use classifications between 1991 and 2002.

Figure 3-76: Middle 1 Imperviousness

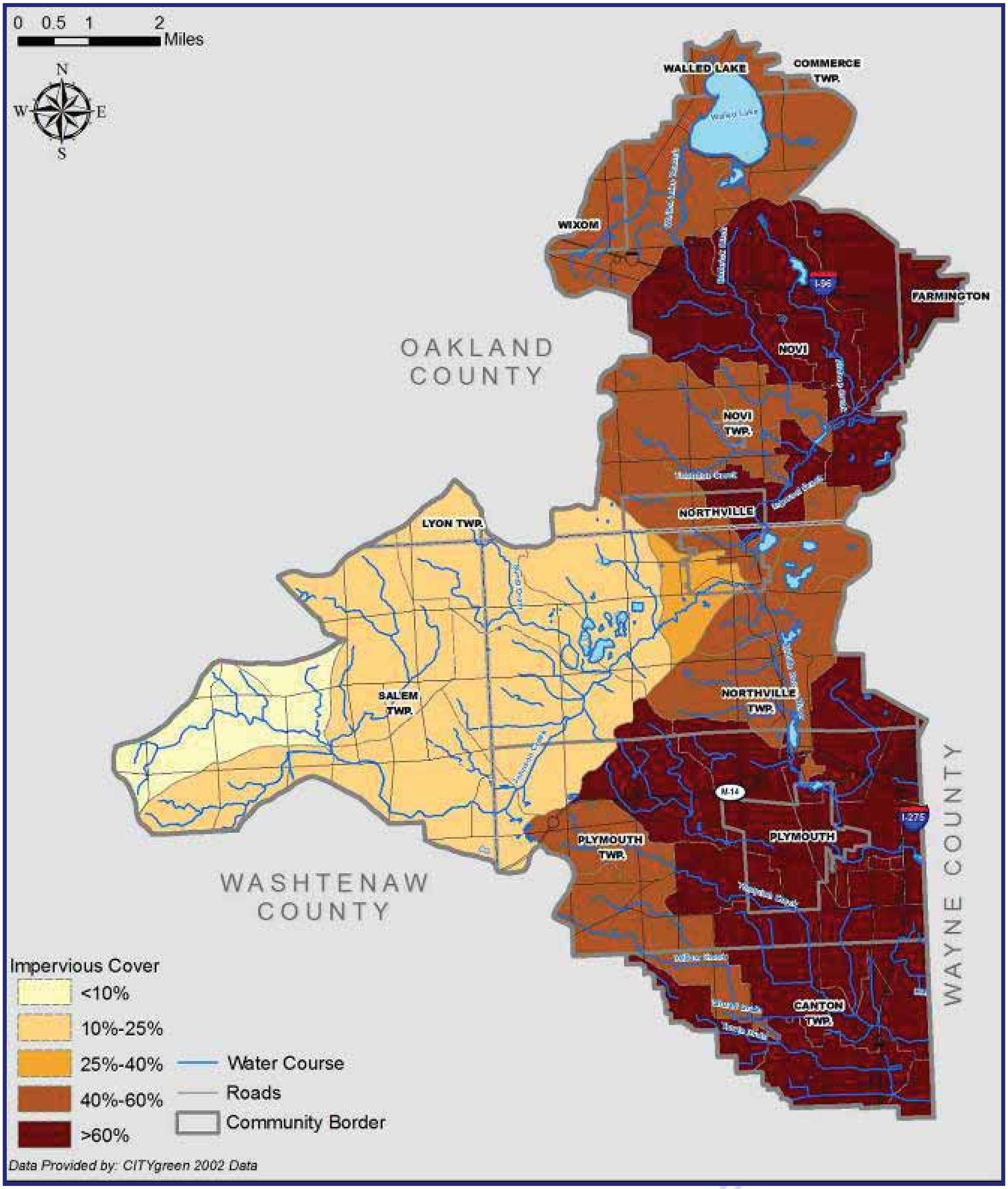


Table 3-44: Changes in Land Cover 1991-2002

Lower 1 SWMA Land Cover	1991	2002	Change
Green Infrastructure			
Open Space - Grass	36%	23%	
Trees	27%	23%	
Grow Zones	0%	0%	
Green Roofs	0%	0%	
Subtotal: Green Infrastructure	**63%**	**47%**	- 16%
Urban			
Impervious	31%	47%	+ 16%
Bare	4%	4%	
Water	2%	2%	

Water sampling

Water Quality

The water quality in the Middle 1 is improving in portions of the watershed but also display stress as a result of the continuing urbanization of the watershed. This change in water quality has been documented by monitoring activities.

The Middle 1 Subwatershed Advisory Group established targets for water quality as part of the 2001 Lower 1 Subwatershed Management Plan. These targets are summarized in Table 3-45.

Table 3-45: Middle 1 Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Water Temperature, Warmwater Fishery (°C)	≤ 29.4 (by 2005)
Water Temperature, Coldwater Fishery (°C)	≤20.0 (by 2005)
Dissolved Oxygen, Warmwater Fishery (mg/L)	Daily average >5 (by 2005)
Dissolved Oxygen, Coldwater Fishery (mg/L)	Daily average > 7 (by 2005)
Total Phosphorus (mg/L)	Annual average ≤ 0.05 (dry weather)
Total Suspended Solids (mg/L)	< 80 by 2006 (dry weather)
E. *coli* (cfu/100 ml)	Partial body contact standard by 2010 when flow is > 2 cfs (dry weather)

Based on the dry weather sampling results, it is clear that progress has been made towards improving water quality conditions for some parameters. Table 3-46 provides a summary of the Middle 1 data with monitoring locations identified in Figure 3-77. Water quality trends are indicated where sufficient data was available for a trend assessment. The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. More detailed information, including site specific ratings are available in the most recent RREMAR.

Figure 3-77: Middle 1 Water Quality Sampling and Rain Gage Locations

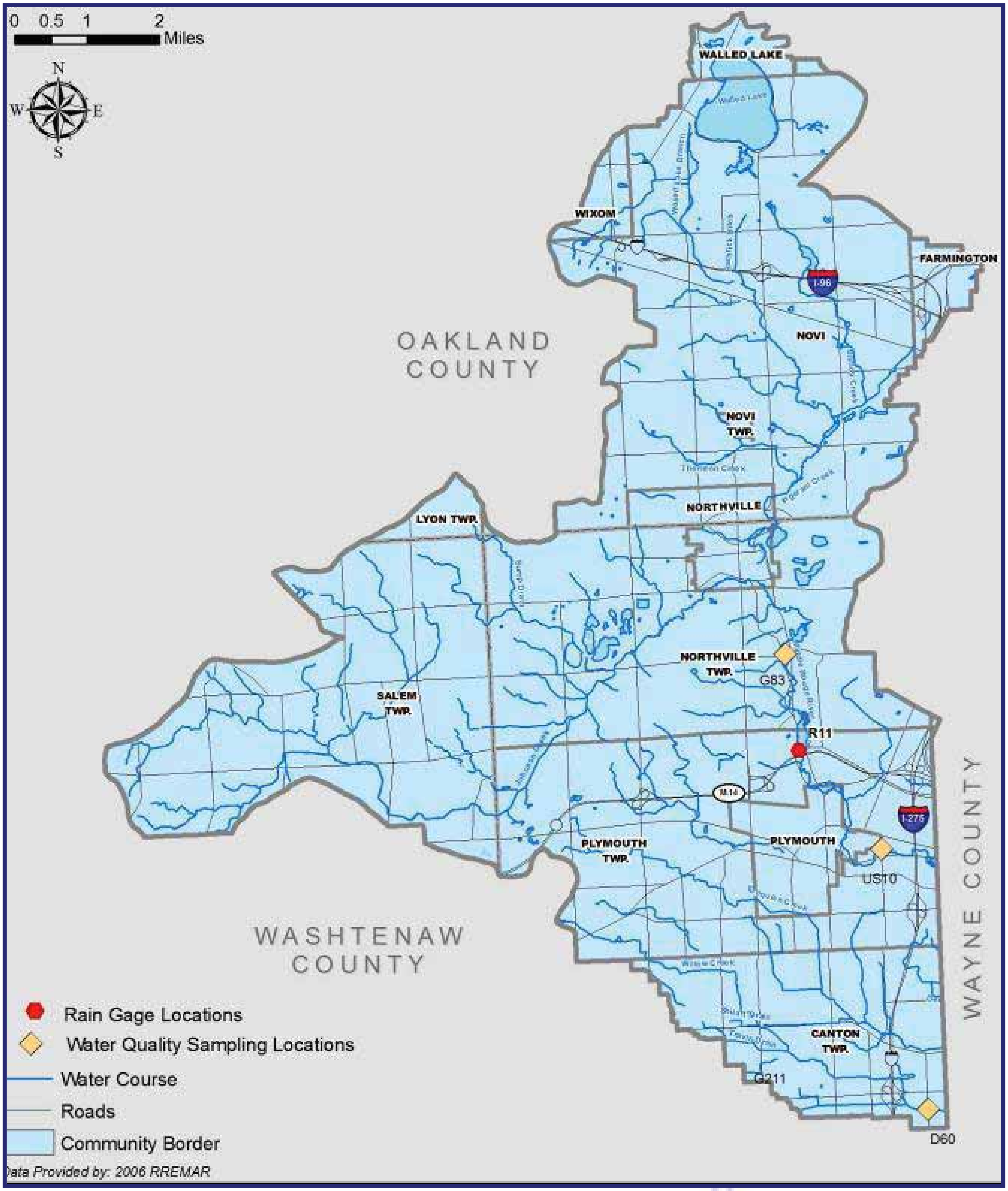


Table 3-46: Middle 1 Dry Weather Conditions - Summary

Parameter	Six Mile Road G83	Haggerty Road US10	Lotz Road D60
Water Temperature	Good	Good	Good
Dissolved Oxygen (DO)	Good ↓	Good ×	Poor
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Good ↑	Good ↑	Fair ↑
Ammonia (NH_3-N)	Good ×	Good ×	Good ×
Total Phosphorus (TP)	Fair ×	Poor ×	Poor ↑
Total Suspended Solids	Good ×	Good ×	Poor ↑
E. coli	Fair ×	Fair ×	Poor ↑

↑ indicates an improving trend ↓ indicates a declining trend × indicates no trend

Since DO and temperature data began in 2002, measured DO concentrations on the Middle branch met the target of 5 mg/L almost 100% of the time at Haggerty Road (US10). The mean DO concentration has been approximately 8.0 mg/L since monitoring began. The maximum water temperature at US10 was 28.3°C which did not exceed the Middle 1 temperature target. The dry weather target for TSS was met 98% of the time with two of the three sampling locations rated *Good* while the Lotz Road location was rated *Poor.*

Johnson Creek TMDL

Johnson Creek is impaired for DO from the confluence with the Walled Lake Branch up to Five Mile Road. Due to low stream flows in the upper portion of the drainage area, the current TMDL only addresses Johnson Creek from the confluence upstream to Six Mile Road. The MDEQ monitored DO concentrations in 2000 in both dry and wet weather conditions in comparison to the 7 mg/L State standard for coldwater fish. The continuous data collected at Seven Mile Road demonstrated compliance for all but one sample between 1994 and 1996. Between 1998 and 2001, the RRNWWDP collected 50 grab samples, of which 22 were less than 7 mg/L, with the minimum observed being 2.6 mg/L at Currie Road in the upper part of the subwatershed.

The MDEQ identified high sediment oxygen demand as the cause of the low DO levels in the Creek. MDEQ set a target of reducing the suspended solids loads in storm water from municipal and agricultural sources by 15 percent and 85 percent, respectively. Due to the low flow in the upper portions of the Creek, the MDEQ is reconsidering the Creek designation as a coldwater fishery.

Water Quality in Wet Weather Conditions

While the overall water quality of the Middle 1 has improved, there continues to be challenges associated with wet weather. Wet weather sampling at Haggerty Road (US10) has not been performed consistently from 1994 to 2005. Five wet weather surveys were conducted at Haggerty Road (US10) from May through October, 2005. The following observations can be made from the data:

- In 2005 mean concentrations for NH_3-N, and TP were only slightly lower in dry weather than wet weather. $CBOD_5$ mean concentrations in wet weather were approximately one and one-half times those in dry weather and TSS mean concentrations were approximately three times those in dry weather.
- The 2005 *E. coli* wet weather geometric mean was approximately four and one-half times the dry weather geometric mean.
- The 2005 *E. coli* wet weather event daily geometric means all exceed the partial body contact standard of 1,000 cfu/100ml for *E. coli.*

E. coli Results

The *E. coli* information collected in the Middle 1 Rouge River indicates that pathogens continue to be a problem in this subwatershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human (sewage) sources. Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

The 2005 *E. coli* data indicated that the Middle 1 routinely exceeded total body contact water quality standards and often exceeded partial body contact standards (see Figure 3-78). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). The best *E. coli* conditions were found near the outlet of Johnson Creek (D03), while the worst conditions were found on Tonquish Creek at Joy Road (D62). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum and farm animals. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), dilapidated sanitary sewers and failing septic systems which are also called on-site sewage disposal systems (OSDSs).

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

The BST data showed human sources of *E. coli* are suspected at six sites during wet conditions and one site during dry weather (Figure 3-79). The dry weather human *E. coli* sources are most probably associated with illicit connections, while the wet weather sources could be any of the human sources mentioned previously.

Figure 3-78: Middle 1 2005 E. coli Sampling Results

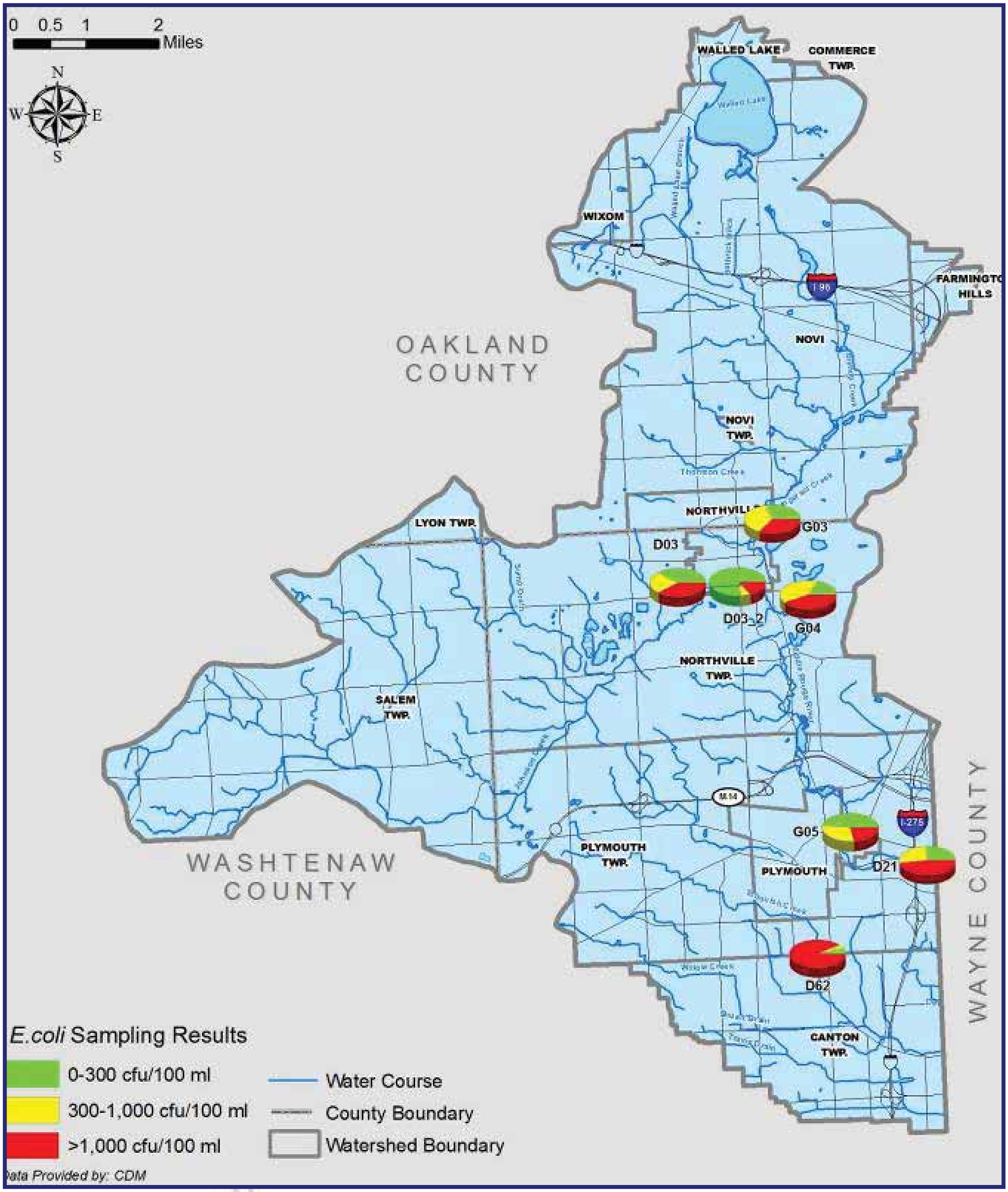
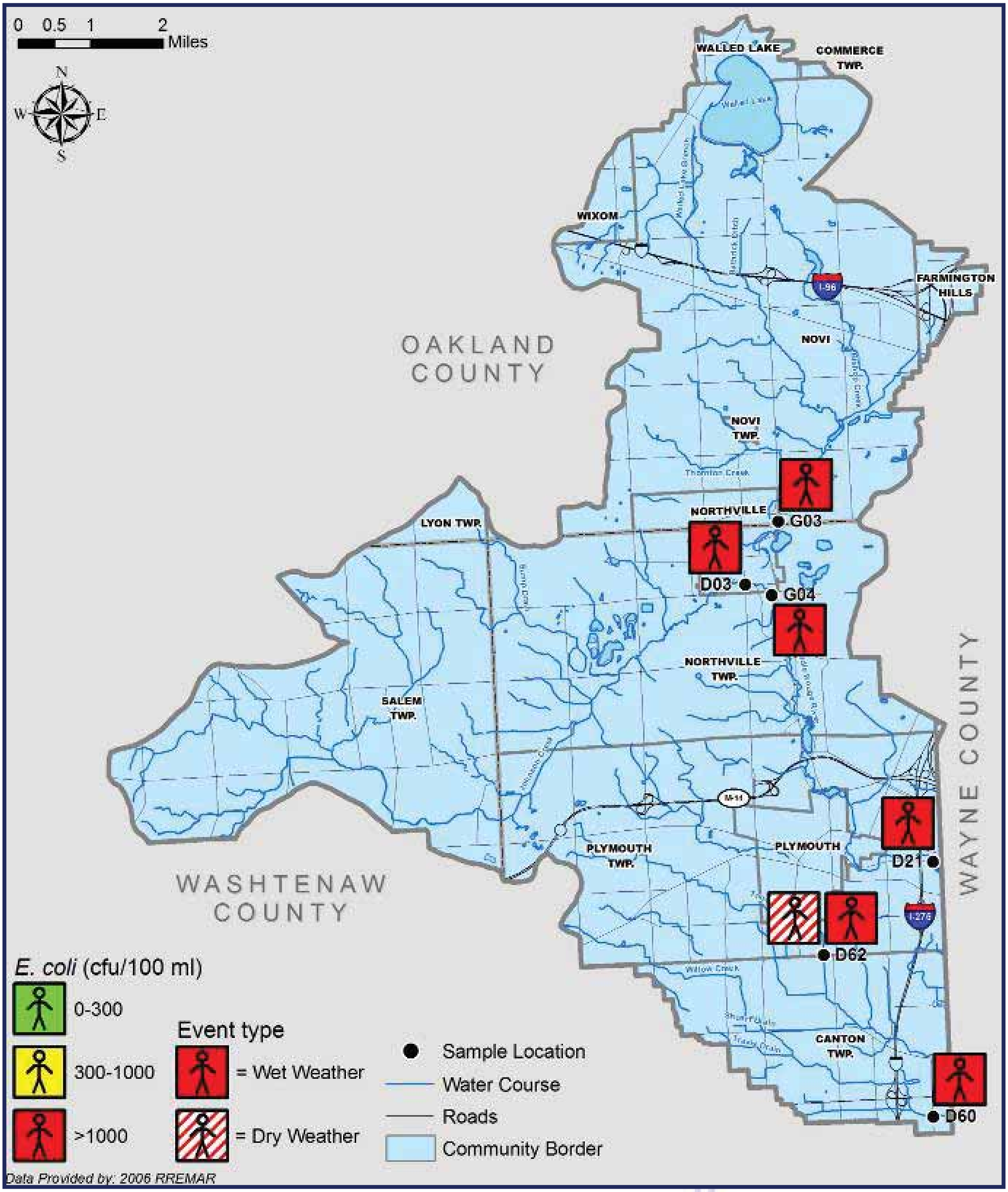


Figure 3-79: Middle 1 Bacterial Source Tracking Results



The use of OSDSs occurs in rural and low-density areas of Salem Township, with some OSDS areas in Northville Township, the City of Northville, Plymouth Township and the City of Novi. The more urbanized areas of the subwatershed are generally serviced by sanitary sewers that carry wastewater to a wastewater treatment plant. Both systems are effective in properly treating wastewater and sewage if sited, installed and maintained correctly. However, if either of these systems is not constructed or maintained properly, they can be the source of pollution to receiving surface waters and cause a significant threat to public health.

In addition to threatening human health, high counts of bacteria from these sources can impair fish, wildlife, and benthos populations and habitats, by accelerating aquatic plant growth or eutrophication, which can cause a decrease in oxygen levels, restrict water-related recreation, and degrade aesthetic values. Septic systems can be improperly sited on clay soils that cannot percolate properly, or are not maintained properly, and begin to fail or leak. Because of this potential problem, most county health departments regulate the installation and repair of septic systems. Some counties, such as Washtenaw County, require the installation and maintenance of both a main and reserve septic field for alternating use, thereby decreasing the possibility of overuse or leaking of either field. Both Washtenaw and Wayne County require time-of-sale inspection of OSDS, which require correction of leaking or improperly sited septic fields when real estate is sold. Furthermore, sanitary sewer systems can also be improperly constructed and poorly maintained. For example, a sanitary sewer pipe can be mistakenly connected to a storm water system that creates an illicit discharge, conveying the wastewater directly and untreated into our creeks and rivers. Additionally, sanitary sewer pipes can break and leak, or can be overloaded beyond capacity, both creating environmental and public health hazards, as well as high repair costs.

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water continues to stress the Middle 1 Rouge River. Thus the communities are required to estimate this portion of the pollutant load and affect management practices to reduce the impact.

Computer models that simulate pollutant loading, based on existing land use classifications, provide a mechanism with which to guide decision-making for implementation of BMPs. Total pollutant loading incorporating base flow, point sources, combined sewer overflows (CSOs) and non-point sources was estimated for the entire Rouge River Watershed using the WMM model. The estimated existing pollutant loads for the Middle 1 Subwatershed are summarized in Table 3-47. Specific study details from the ARC NPS Loading Report may be found at www.allianceofrougecommunities.com.

Table 3-47: Existing Pollutant Loads for the Middle 1 Subwatershed

Pollutant	Units	Source				Total Load
		Base Flow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	31%	66%	3%	0%	2.0×10^6
DP	lbs/yr	15%	81%	4%	0%	11,500
Fecal Coliform	counts/yr	0%	100%	0%	0%	2.7×10^{15}
NO_2 & NO_3	lbs/yr	16%	43%	42%	0%	234,000
TKN	lbs/yr	58%	40%	3%	0%	326,000
TP	lbs/yr	16%	75%	9%	0%	27,400
TSS	lbs/yr	12%	86%	2%	0%	6.0×10^6

Pollutant Abbreviations:

BOD: *Biochemical Oxygen Demand*
DP: *Dissolved Phosphorus*
NO_2: *Nitrite*
NO_3: *Nitrate*
TKN: *Total Kjeldahl Nitrogen*
TP: *Total Phosphorus*
TSS: *Total Suspended Solids*

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the Rouge River. When considering bacteria, TSS and phosphorus, pollutant loadings from storm water runoff are most significant. For the purposes of prioritizing storm water BMPs, the remainder of the analysis within this section focuses on pollutant loading associated with non-point sources.

The Middle 1 Subwatershed was subdivided into 42 subareas as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, phosphorus and total suspended solids (TSS) within each subarea are shown in Figures 3-80, 3-81 and 3-82. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

These figures clearly show that the higher non-point source pollutant loadings are generated from the more heavily developed areas of the subwatershed. Areas ultimately draining to Tonquish Creek exhibit the highest loadings for fecal coliform, total phosphorus and total suspended solids. Areas in the vicinity of the I-275 corridor also exhibit high pollutant loadings.

The primary sources of phosphorus in the critical Middle 1 subareas are likely fertilizer runoff from residential, commercial and golf course lawns, agricultural crop runoff and feedlots, pet and livestock wastes, illegal sewer connections and failing septic systems. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils from agricultural fields without buffer strips and from construction sites without proper soil erosion control practices.

Stream Hydrology

The hydrologic trends along the Middle Rouge continue to cause excessive erosion and habitat destruction. The 2001 Middle 1 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management

Figure 3-80: Middle 1 Total Fecal Coliform Estimated Non-Point Source Load

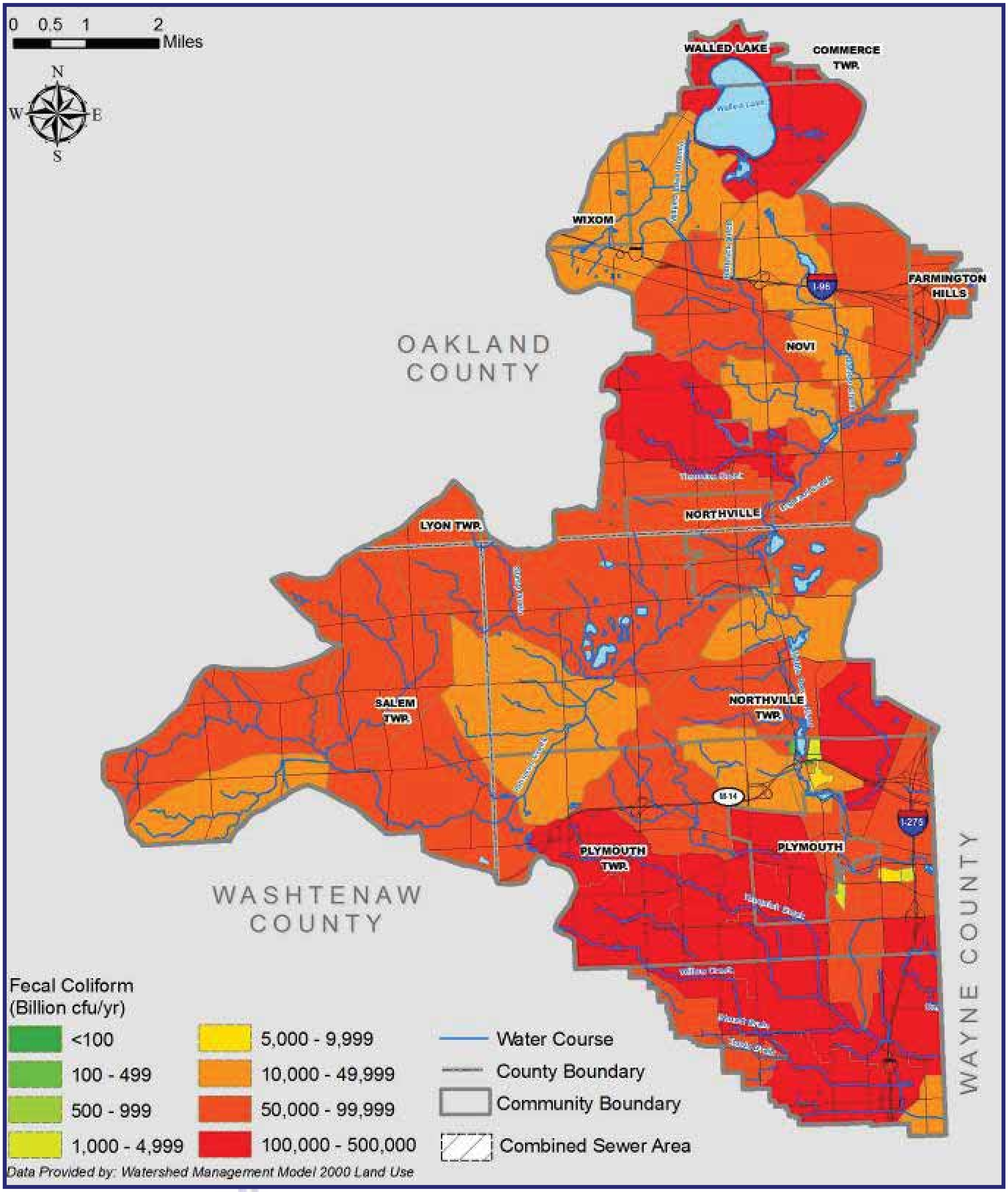


Figure 3-81: Middle 1 Total Phosphorus Estimated Non-Point Source Load

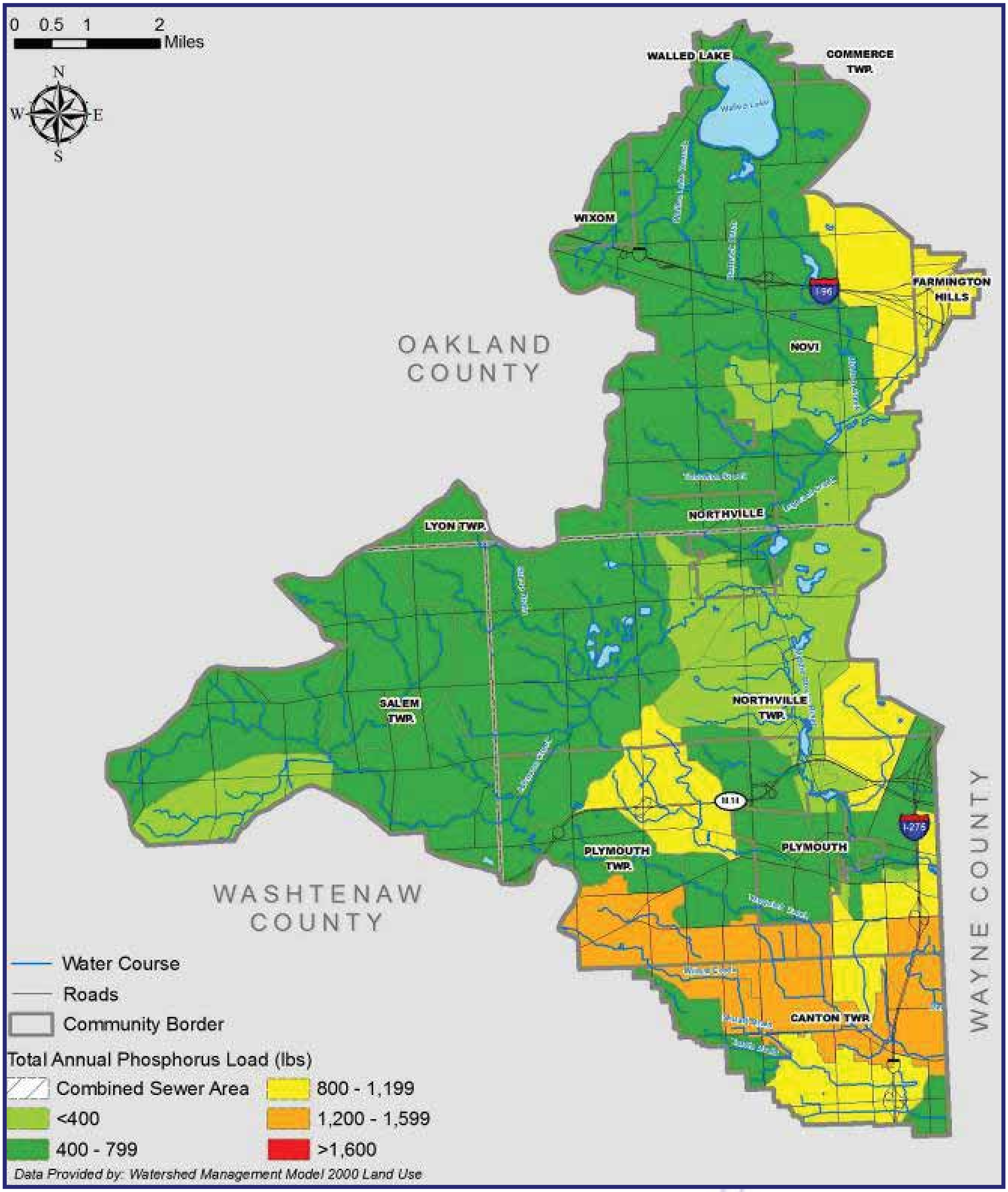
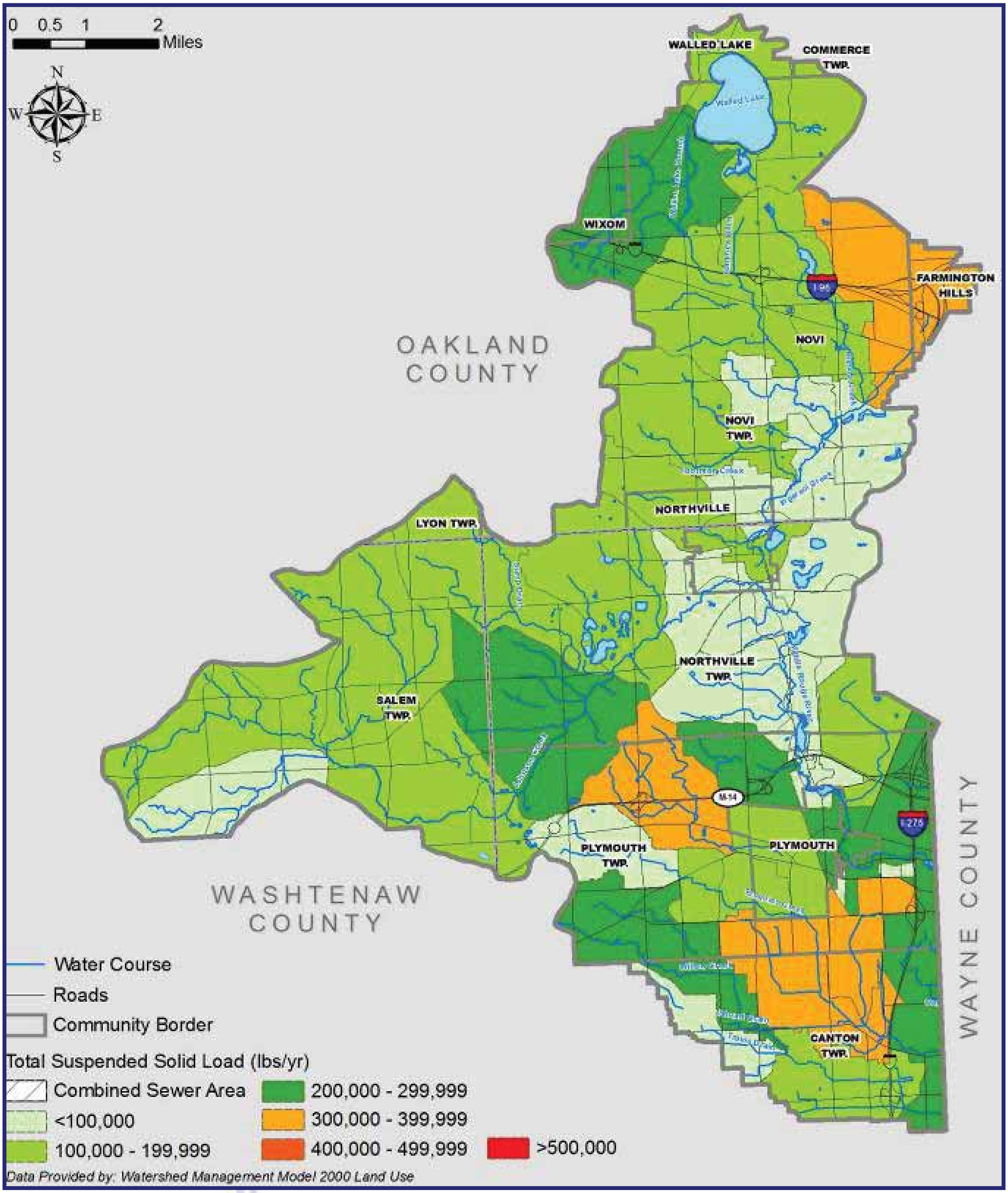


Figure 3-82: Middle 1 Total Suspended Solids Estimated Non-Point Source Load



Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under 2-inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed. While the bankfull, or overbank flood event, occurs on the order of every two years in stable river systems, this study evaluation determines that it occurs on the order of every one to two months in this subwatershed.

A hydraulic analysis was completed to help identify Best Management Practices (BMPs) that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of two to two and a half years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.


USGS rain gage location in Garden City

Figure 3-76 on page 3-165 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04167000), Middle Rouge at Garden City (US2), provides the most accurate flow information for this subwatershed and helps identify goals for the Middle 1 subwatershed. Figure 3-83 shows the area in the subwatershed that contributes to the flow conditions for this gage.

Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events (see Table 3-48).

Table 3-48: Middle Subwatershed Flow Trends at Garden City (US2)

Bankfull Flow Rate	525 cfs with return period of 2.2 months
15-day	173 cfs
30-day	315 cfs

Figure 3-84 represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

Figure 3-83: Middle 1 USGS Gage at Garden City Drainage Area

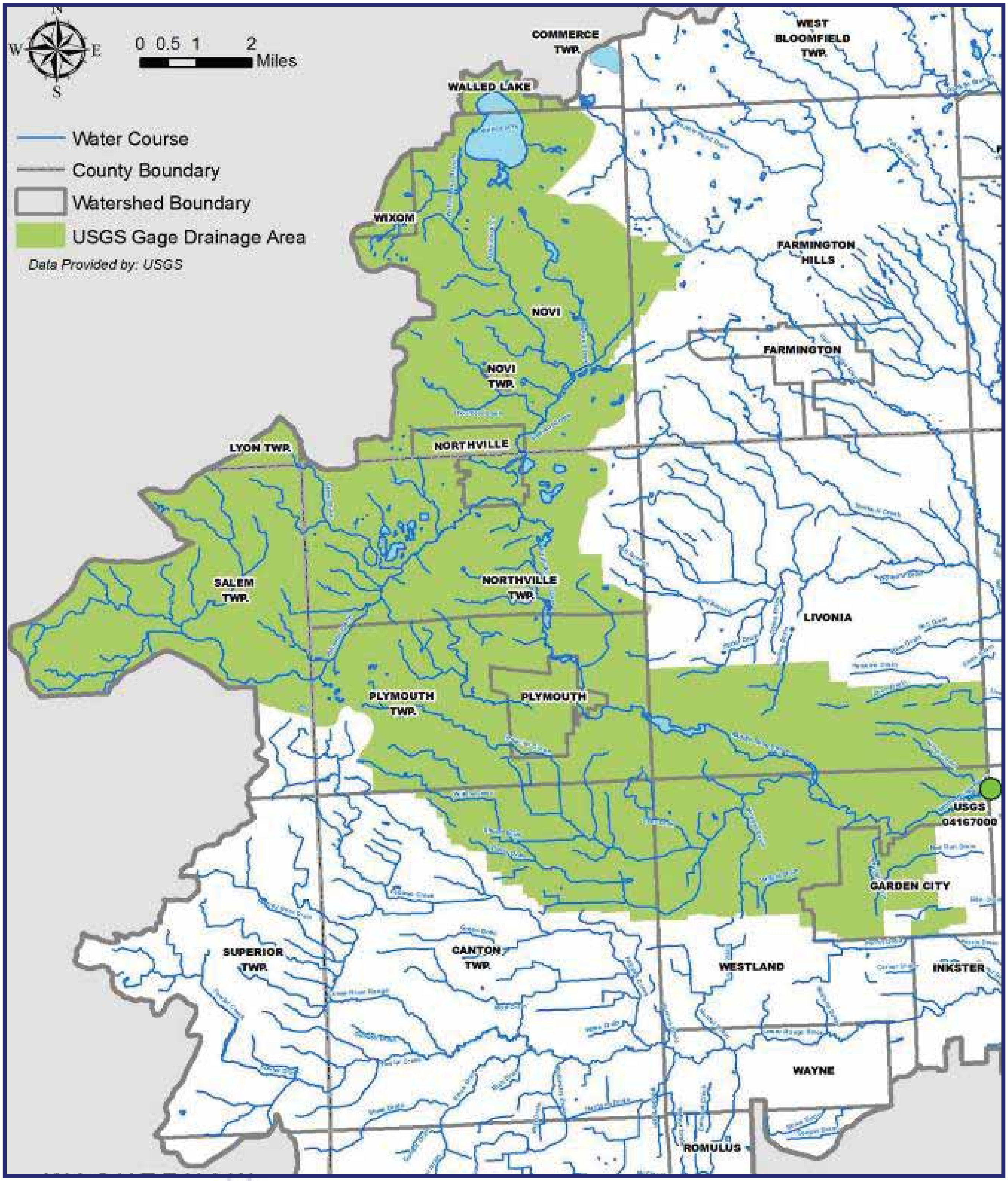
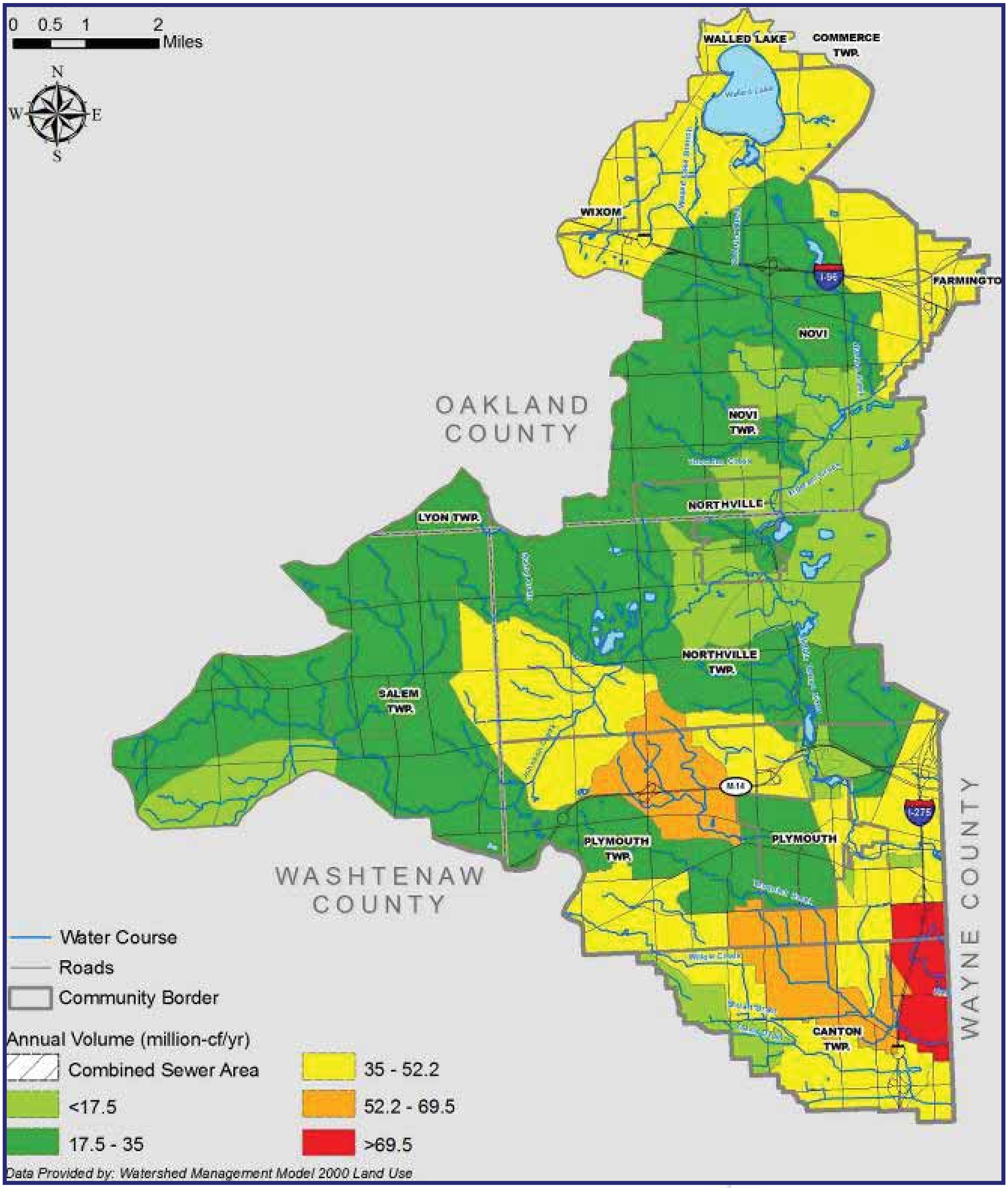


Figure 3-84: Middle 1 Storm Water Runoff Non-point Source Annual Volume



The hydrologic trends along the Middle 1 Rouge River continue to cause excessive erosion and habitat destruction. The annual storm water runoff volume and the extent of impervious cover, an estimate of storm water runoff volume management was ascertained. It was determined that reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of 40,500,000 cubic feet of storm water (0.216 inches of water over the subwatershed) is needed to help reduce the effect of these small storms. It is important to note that the water needs to be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing road-side ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bio-retention basins or rain gardens, and porous pavements can be installed on individual properties. Additional trees and grow zones within the subwatershed will also provide storm water retention/infiltration. Additional agricultural BMPs, such as buffer strips, drain tile minimization and no till drill techniques would also help reduce the amount of water flowing into the waterways.

Bennett Arboretum along Hines Parkway

Over the past several years various projects have been completed in the Middle 1 to help control flow in the rivers. These include:

- The City of Novi Haggerty Regional Detention Basin and Dunbarton Detention Pond was designed to minimize flow variability, improve water quality, and enhance habitat, and wildlife.
- A Grow Zone Strategy initiated by Wayne County within Hines Park to increase infiltration, reduce flooding impacts and restore habitat.
- A Master Plan created by Wayne County for Bennett Arboretum along Hines Parkway.
- The Northville Township detention basin maintenance program which works with privately-owned detention basins to insure proper function.

Ecosystems

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Middle 1 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Aquatic Diversity

Fish Communities

The Middle 1 Subwatershed is home to the only cold-water designated trout stream in the Rouge River Watershed. Also, because the Middle 1 has the headwaters of the Rouge River many of the tributaries are home to redside dace, darters and mottled sculpin.

Redside Dace

The main factors negatively affecting fish community integrity in the Middle 1 Subwatershed are believed to be excessive flow variation and lack of appropriate spawning habitat. Stream quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities. Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

Seven sites located in the Middle 1 Subwatershed were surveyed as a part of the 1995 MDNR fish assessment. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981).

The MDEQ completed additional surveys in 2000 and 2005 using the GLEAS 51 procedure (MDEQ, 2005). One site in the Middle 1 Subwatershed was surveyed during the 2000 and 2005 MDEQ biological assessments. Johnson Creek was the only stream in the Middle 1 Subwatershed that received a fish community assessment. Unfortunately, direct correlation and trends between the 1995, 2000, and 2005 surveys are not possible because the survey points were different in each study. Figure 3-85 shows the overall fish community rating for the above-referenced surveys.

Biotic integrity – a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"

(Karr & Dudley, 1981)

Fish Consumption Advisories

The MDNR and the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Middle 1 Subwatershed. The advisories for these fish were last updated in 2007(See Table 3-49).

Figure 3-85: Middle 1 Fish Community Assessment Results

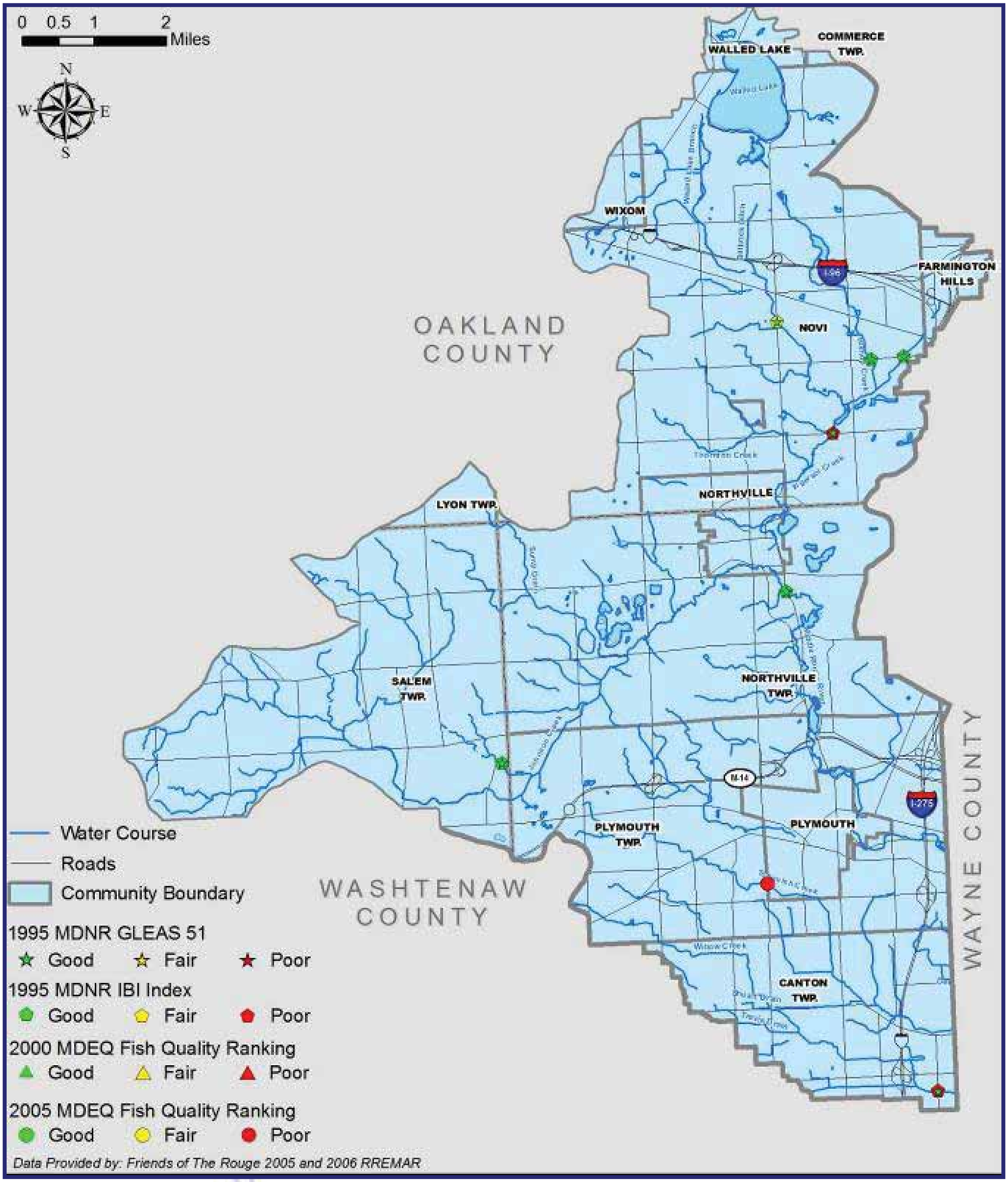


Table 3-49: 2007 Fish Consumption Advisories for the Middle 1 Subwatershed

Water body	Fish Species	Contaminant	General Population	Women/Children
Phoenix Lake	Bluegill	PCBs	Unlimited consumption	No more than one meal/week of fish up to 14 inches.
	Suckers	PCBs	Unlimited consumption	No more than one meal/week of fish over 14 inches.
	Carp	PCBs	Unlimited consumption	No more than one meal per month of fish over 18 inches.
	Northern Pike	PCBs	Unlimited consumption	No more than one meal per month of fish over 30 inches.

Notes: Men and boys over the age of 15 and women who are beyond child bearing years.
Women of childbearing years and children under the age of 15.

Notable Areas

Johnson Creek is a designated cold water stream that supports a viable population of cold and cool water species including brown trout, redside dace, darters and mottled sculpin. Walled Lake is the largest waterbody in the watershed and contains a healthy population of warmwater fish species, however the lake does not provide public access. There are numerous impoundments within the Middle 1 Subwatershed, however public access is limited or restricted. Phoenix Lake in Northville Township and Wilcox Lake in Plymouth Township provide the best opportunities for recreational fishing for warm water fish species.

Impairments

Researchers have noted both physical and chemical impairments to aquatic habitat such as sedimentation, erosion, lack of cover, etc. and chemical ones such as TSS, *E.coli,* dissolved oxygen, etc. (Beam & Braunscheidel, 1998, Leonardi, 1996, Goodwin, 2002, Crawford & Denison, 1997). Hydrologic irregularity caused by channelization and agricultural and urban land use impacts continue to be indicated as a factor in impairments to spawning and refuge habitats. These habitat impairments are mostly due to point and non-point sources resulting from conversion of forest and open space to agricultural and urban land uses. Contaminants such as PCBs prohibit consumption of game fish species within impoundments (see fish consumption advisory below). Phoenix Lake, at the downstream end of the Middle 1 Subwatershed in Northville Township, falls well short of ecological targets with 32 species predicted but only 16 species identified in surveys. Higher than average peak flows and lower than desirable summer flows are thought to be the major cause of the lack of diversity (Wiley, et al., 1998).

Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others.

Macroinvertebrate Communities

As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed, is also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Mayfly

The Middle 1 Subwatershed was studied, with respect to aquatic invertebrate assemblages (Jackson 1975) as far back as 1973. The earliest data indicates *Fair* to *Poor* ratings in the Middle Rouge River itself, with the highest rated stream reaches (*Good*) located in Johnson Creek.

During MDEQ's Rouge River biological assessment survey of 2000 (Goodwin, 2002), macroinvertebrate communities were sampled at 13 locations in the Middle 1 Subwatershed with all sites earning a rating of *Acceptable* except two, which were rated *Poor.* In 2005 another biological assessment was performed by the MDEQ at 15 stations in the Middle 1 Subwatershed and its tributaries (MDEQ, 2005). Eleven stations were rated *Acceptable* and four stations were rated *Poor*: one in Finley Drain, two in Bishop Creek and one in Tonquish Creek (See Figure 3-86).

Bug hunt volunteers

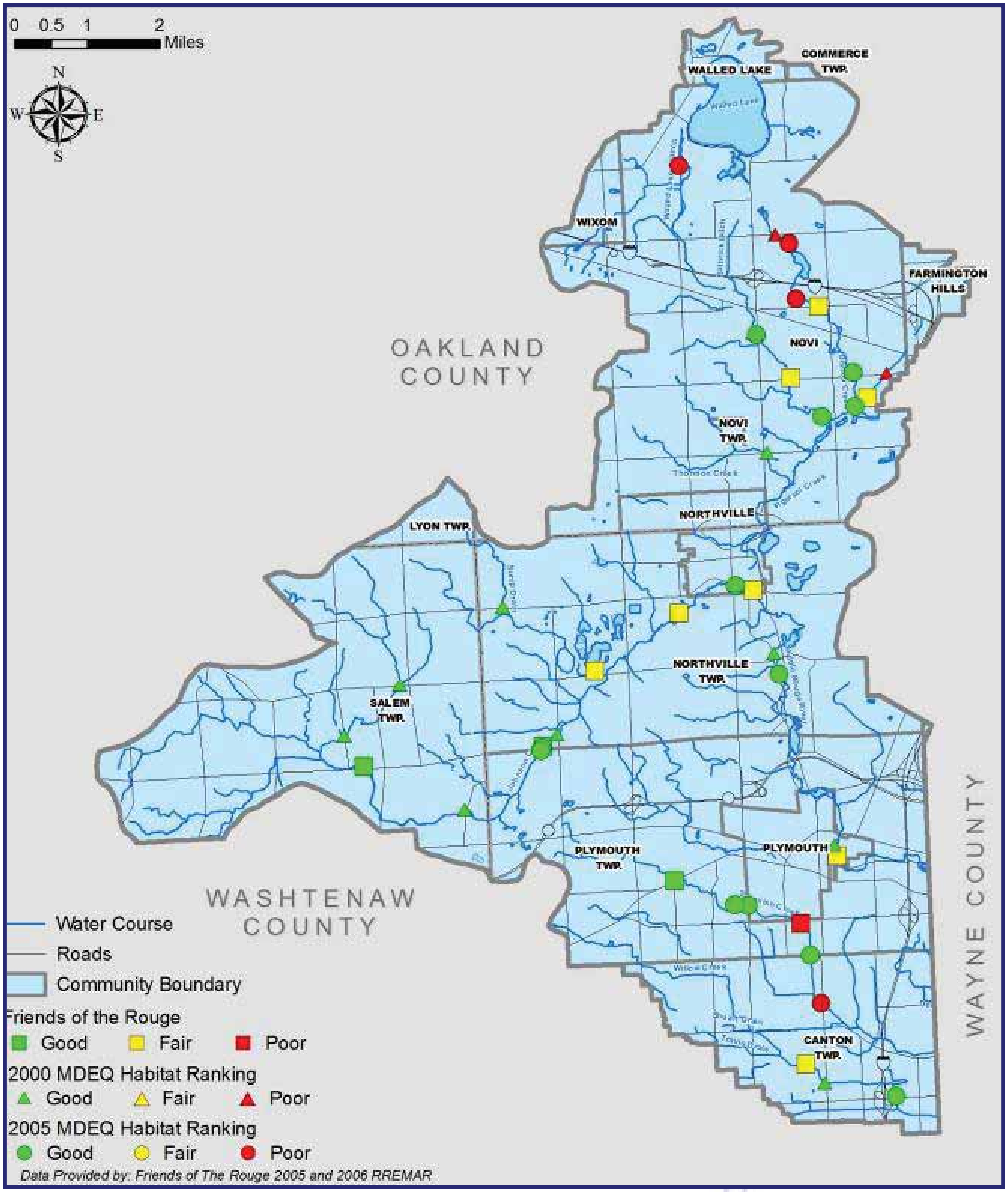
Friends of the Rouge (FOTR) started sampling for benthic macroinvertebrates in the Middle 1 Subwatershed in 2002 and have 23 spring sampling sites, 20 fall sampling sites and 16 winter stonefly sampling sites. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation (See Figure 3-86).

Stoneflies have been found at nine of the 16 stations surveyed within the Middle 1 Subwatershed. Stoneflies have been found at every station during each survey conducted within Johnson Creek. Stoneflies have been found with fewer numbers and less regularity in other stations within the Middle 1 Subwatershed. Overall, stonefly data correlates well with the quality ratings of the macroinvertebrate communities as a whole.

Notable Areas

Johnson Creek consistently supports the highest quality aquatic macroinvertebrate communities including a thriving stonefly population in the Middle 1 Subwatershed. The stream reach near the sampling station at Ridge Road stands out as exhibiting the highest quality aquatic macroinvertebrates communities within Johnson Creek. The geology of its subwatershed allows for the contribution of ecologically significant amounts of groundwater that attenuate low flow conditions and moderate in-stream temperatures.

Figure 3-86: Middle 1 Macroinvertebrate Assesssments



This supports the high oxygen retention and benefiting the sensitive aquatic macroinvertebrates. The Middle Branch between Newburgh Lake and Nankin Lake, which is associated with some of the most intact riparian zones remaining in the Rouge River Watershed, exhibited an abundant and diverse mussel population (Rathbun, unpublished report 2008).

Impairments

The changes in impervious cover, combined with the non-point source pollutant loading have had a marked increase in the flow variability. This continues to impair the quality of suitable habitat for benthic macroinvertebrates.

Wood frog

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed; however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

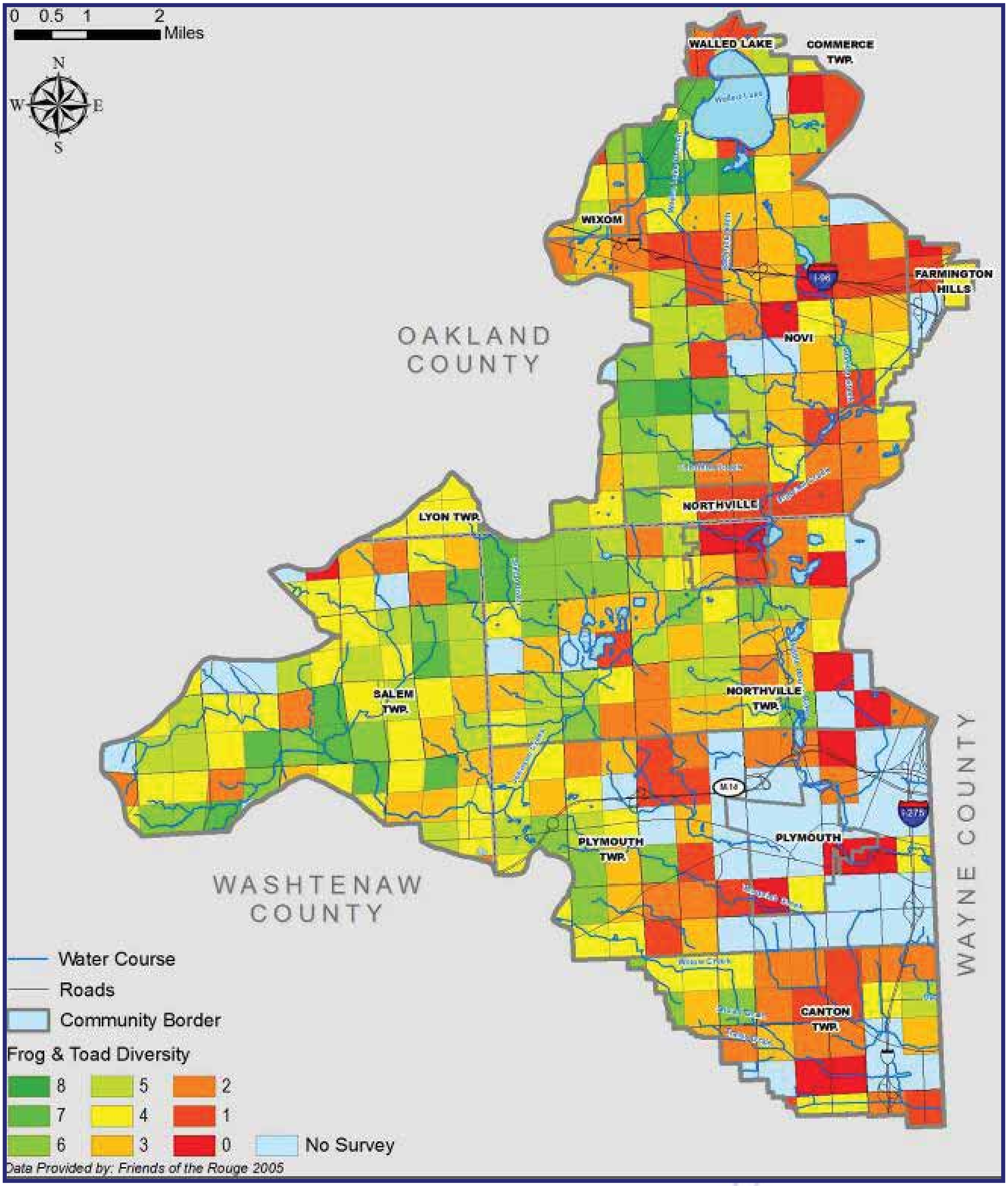
The MDNR completed a volunteer frog and toad survey for the Middle 1 Subwatershed in 1996, 1997, 2005 and 2006. Results of MDNR surveys are shown in Table 3-50 (MDNR, 2006).

Table 3-50: MDNR Michigan Frog and Toad Survey - Percent of sections in which species was heard in the Middle 1 Subwatershed

Species	1996	1997	2005	2006
Wood Frog	100	0	11	25
Western Chorus Frog	25	25	22	25
Spring Peeper	100	50	11	25
American Toad	0	0	0	0
Northern Leopard Frog	25	0	0	13
Gray Tree Frog	75	50	0	13
Green Frog	50	50	55	75
Bullfrog	0	0	0	25
Total Sections Surveyed	4	3	9	8

Similar to the MDNR Frog and Toad Survey, the FOTR began a Frog and Toad Survey in 1998 and eight species of native frog and toads are present in the Middle 1 Subwatershed (Figure 3-87). Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time. There were no notable trend differences between the 1996 and 1998 surveys.

Figure 3-87: Middle 1 Frog & Toad Diversity



Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area. Table 3-51 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 1998 through 2007 (Catalfio, et al., 2007).

Table 3-51: FOTR Frog and Toad Survey – Percent of Blocks in which species were heard in the Middle 1 Subwatershed

Species	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	44	37	25	25	26	38	23	46	22	43
Western Chorus Frog	78	61	60	60	59	55	59	72	63	69
Spring Peeper	83	70	68	68	70	66	64	78	69	74
American Toad	50	50	58	58	65	61	49	78	80	95
Northern Leopard Frog	--	7	8	8	13	20	23	30	12	24
Gray Tree Frog	--	37	63	63	39	50	75	81	69	69
Green Frog	--	31	15	15	35	39	64	70	72	71
Bullfrog	--	2	0	0	2	7	7	7	7	10
Total Blocks Surveyed	208	123	60	60	54	56	86	74	59	42

Notable Areas

In general, all species of identified frog and toads (except the bullfrog) was more prevalent in the headwater areas of the subwatershed. This can generally be attributed to lack of habitat ponds and sluggish stream courses in the more upstream reaches that would support the bullfrog populations.

Johnson Creek

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease and differences in temperature and precipitation from year to year. Changes in water chemistry and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man-made wetlands can be appropriate substitutes; provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Stream Habitat

Stream habitat in the Middle 1 subwatershed varies in conditions, primarily due to the flow variability, excess storm water volume and water quality. One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in Stream Hydrology above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels, and decline in undercut banks.

An evaluation of stream habitat was undertaken during four separate occasions, all using MDEQ's GLEAS 51 protocol. Study results are shown in Figure 3-88.

Both the 1995 MDNR and the 1996 Rouge Project studies rated the Middle 1 Subwatershed on average as *Poor.* The 2000 MDEQ study rated the watershed on as *Fair* and in 2005 most sites were rated *Good*. Bishop Creek and Willow Creek were rated in 2005. The most recent habitat surveys show a trend towards improvement in habitat quality (MDEQ, 2005).

Notable Areas

Johnson Creek is a headwater stream that supports a high quality fish and biotic community. The stream reach between Six Mile Road and Beck Road (Northville Township), and the section approximately 1,000 feet upstream of Pickford Avenue to Edenberry Road (Salem Township) exhibits high quality aquatic habitat and flow characteristics worthy of preservation (RPO-WMGT-TPM44.00, 1997). Bishop Creek was found to have marginal habitat per GLEAS 51 ratings in 2005. The watershed of Bishop Creek is being developed on a rapid basis, and the intensity of storm water inputs can overcome rehabilitative efforts and further degrade this stream.

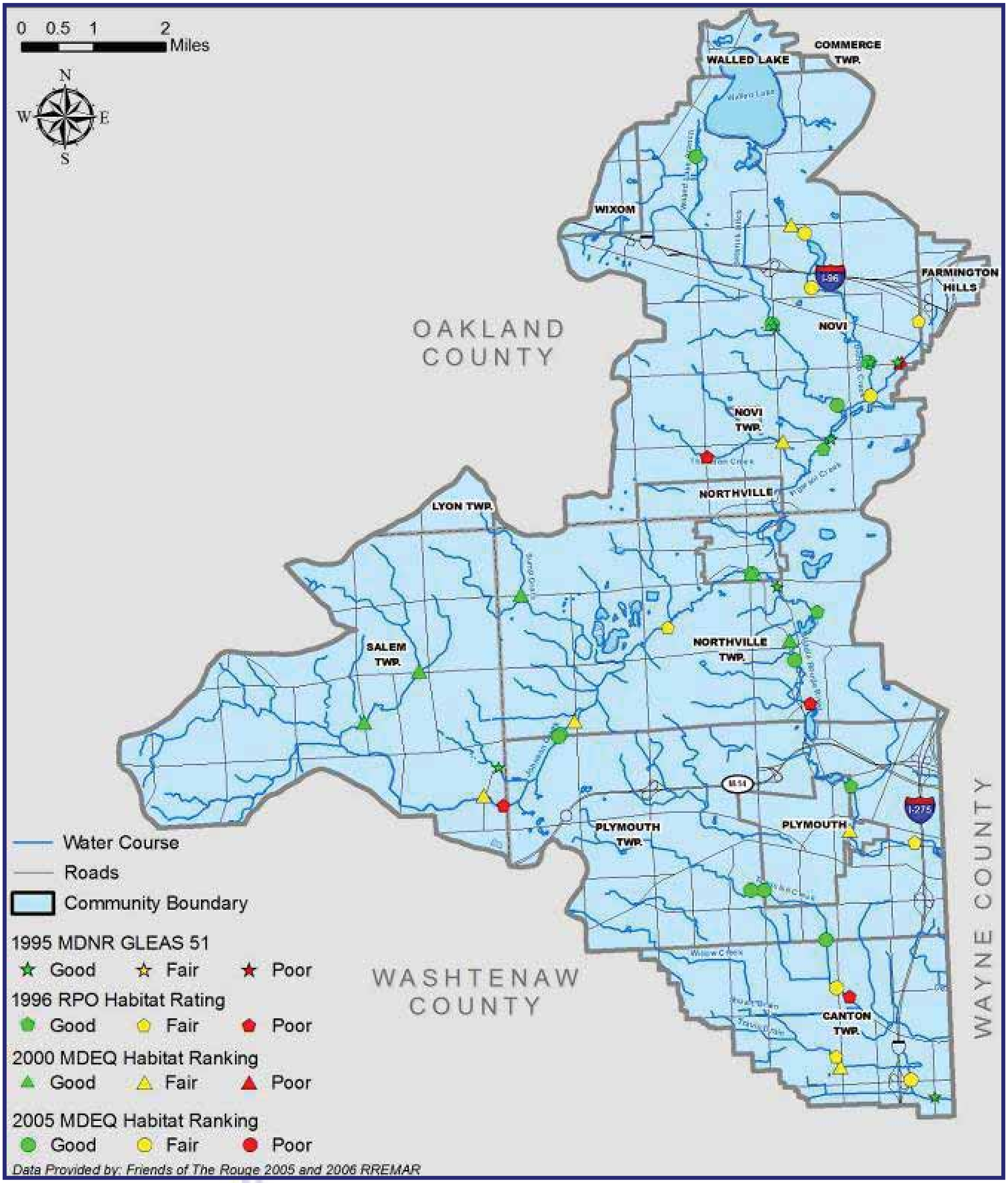
Impairments

The Middle 1 Subwatershed of the Rouge River exhibits an underlying geology that should support a viable population of aquatic habitat suitable for cool and coldwater aquatic organisms. Both point and non-point storm water inputs continue to impair water quality and hydrology. With a good portion of this watershed being agricultural, vegetated buffer strips or other agricultural BMPs may be needed in order reduce overland transport of soil to the streams, which would improve stream habitat.

Woody debris management

Increased flashiness contributes to streambank erosion and sedimentation, which results in a myriad of negative impacts on the biota. High flows carry away small woody and other debris from the stream channel, eliminating flow refugia and hard substrates upon which many macroinvertebrates forage and endemic fish species lay eggs. Excessive sedimentation covers and embeds critical habitat leaving a relatively flat channel configuration. Elimination of terrestrial components necessary for moderating the intensity of storm water inputs has also resulted in a decrease in ground water flow and loss of riparian canopy that may result in increased in-stream temperatures and lower retention of dissolved oxygen.

Figure 3-88: Middle 1 Stream Habitat Assessments



Stream Corridor

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River Watershed.

Riparian Corridor

The Middle 1 Subwatershed encompasses 150 miles of river and creeks. A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms, and a buffer for pollutants and sediments from surface runoff. As well as providing habitat for aquatic organisms, the corridor is used by many birds and mammals. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

The riparian corridor in the Middle 1 Subwatershed is in fair condition in many areas along the river with woodlands and wetlands lining the banks, but has become mowed lawn in many of the urban areas. Protecting this corridor is especially critical to protect the cold water temperature regime of the Johnson Creek.

Forested wetland

Wetlands and Woodlands

Figure 3-89 shows the existing wetlands within the Middle 1 Subwatershed. This figure depicts forested and emergent wetlands as the highest percentage of remaining wetlands in the subwatershed. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-90. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Woodlands, forests and heavily treed areas provide many benefits to water quality, water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Figure 3-89: Middle 1 Existing Wetlands

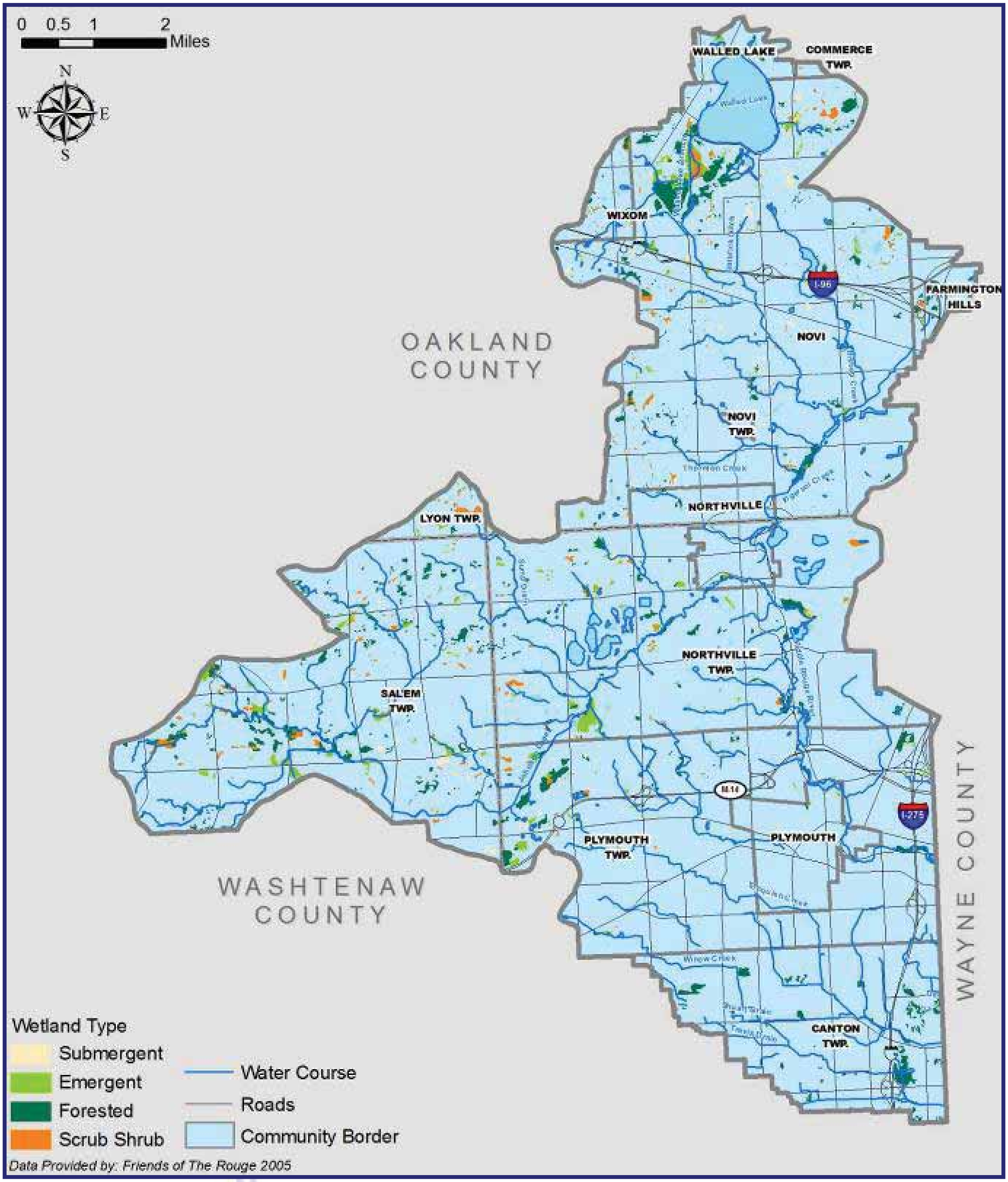
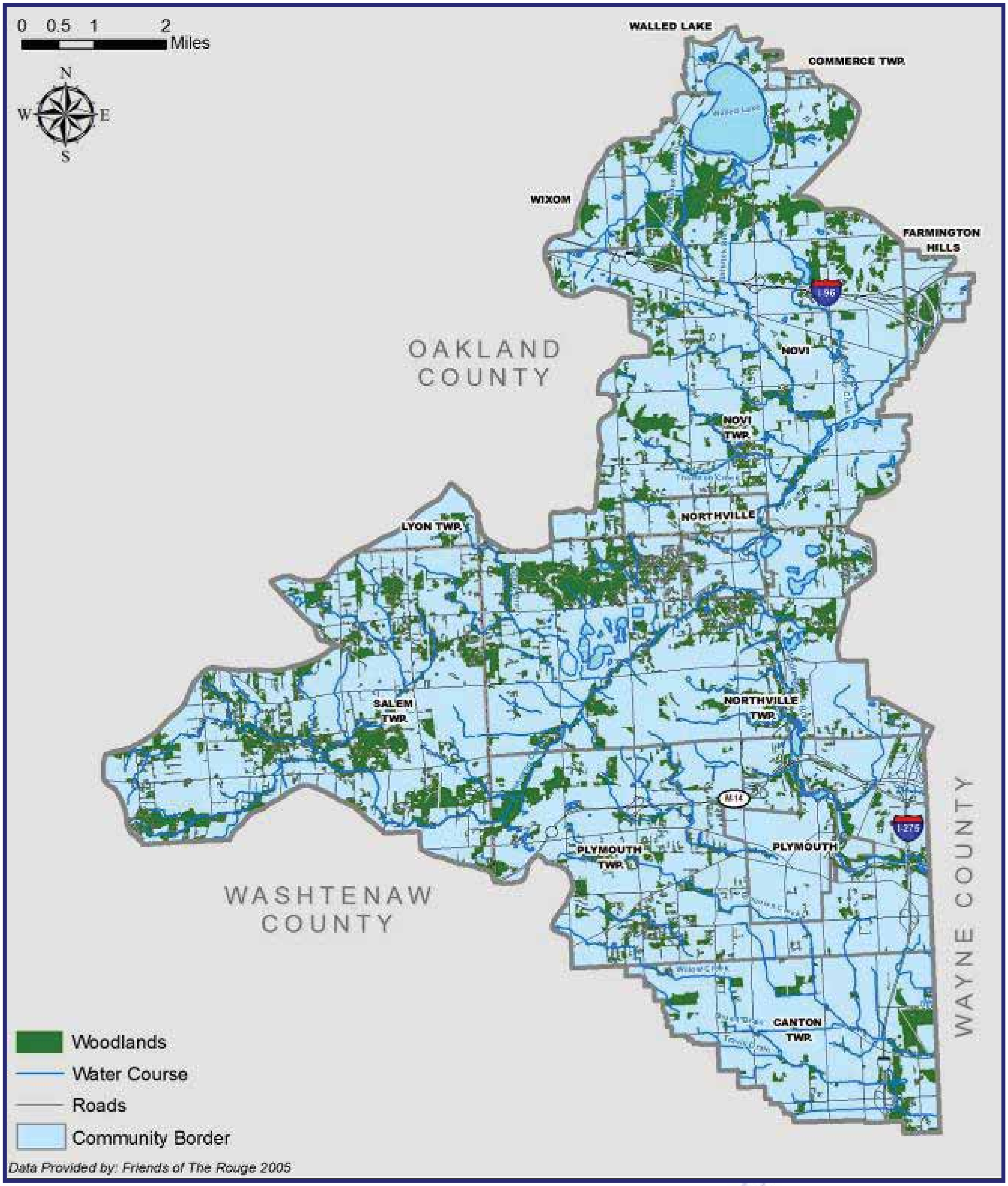


Figure 3-90: Middle 1 Existing Woodlands



Lake and Impoundments

The Middle 1 Subwatershed begins at Walled Lake and has several impoundments including Meadowbrook Lake in Novi, Phoenix Lake in Northville Township and Wilcox Lake in Plymouth Township. Newburgh Lake in Livonia, which is downstream of the Middle 1, is heavily impacted by upstream actions of the Middle 1 and is of major interest due to the 1996 sediment remediation project in the lake. All of these lakes are of major importance to the subwatershed due to their visibility to the public, their recreation potential, and their fish and wildlife habitat. A limnological study completed in 1996 found that of the lakes that were studied (Walled Lake, Meadowbrook Lake, Phoenix Lake and Newburgh Lake), all lakes were moderately to highly eutrophic, meaning that they have excessive plant and algae growth that impedes aesthetic and recreational potential as well as degrades wildlife habitat. Overall, Walled Lake was the least eutrophic and Meadowbrook Lake was the most eutrophic. This study recommends a subwatershed-wide reduction of nutrients and solids inputs, controlling storm water inputs, controlling streambank erosion, preventing further destruction of riparian habitat, and possibly deepening selected areas of one or more impoundments to improve fish habitat. The Newburgh Lake Restoration Project, completed in 1998, deepened parts of the lake and created fish habitat.

Native landscape be in Northville Township

Historical Storm Water Projects in the Middle 1 Subwatershed

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are a few projects completed by the Middle 1 communities and other stakeholders.

- Wayne County completed construction of 10 streambank stabilization projects along the Middle Rouge River.
- The City of Northville restored Mill Pond to treat storm water and increased its educational, recreational, environmental and neighborhood aesthetic potential.
- Northville Township and City of Novi improved Quail Ridge Drain through bioengineered streambank stabilization techniques and natural channel and compound channel design.
- Toll Brothers donated the design and construction of two demonstration native landscape beds to Northville Township.
- Canton Township developed a detention pond maintenance video that provides background on storm water management.
- The City of Wixom conducted a commercial lawn maintenance workshop.
- Plymouth Township created an interpretive and education system along Tonquish Creek.
- The cities of Northville, Livonia, Plymouth and Novi and the Plymouth, Canton and Northville townships regularly host Household Hazardous Waste collection days.

Canton detention pond maintenance

Middle 3 Subwatershed (Storm Water Management Area) Conditions

The Middle 3 Subwatershed is the smallest of the seven Rouge River subwatersheds and is located in the north central portion of Wayne County. A unique feature of the Middle 3 Subwatershed is the extensive parkland and open space along eight miles of river corridor along Hines Drive. However, urban storm water continues to stress the Middle Rouge River.

There are many controlled and several uncontrolled CSOs discharging into this subwatershed and numerous storm sewer discharges. Water quality and quantity is an issue throughout the area. Land use is primarily urban, which results in increased imperviousness resulting in unpredictable stream patterns. The primary cause of degraded stream habitat in the Middle 3 Subwatershed is the excessive flow instability and accompanying erosion and sedimentation and a lack of habitat complexity.

With streambank erosion control and habitat improvements, the Middle 3 should support a fairly diverse aquatic community.

The characteristics and conditions of this subwatershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Middle 3 Subwatershed Management Plan.

While the stream indicators of water quality, stream hydrology, aquatic diversity, stream habitat and physical conditions of the stream corridor are all indicative of urban stream conditions, the general trends show improvement

Middle 3 highlights:

- ***The most significant improvements in fish communities in the Middle 3 can be attributed to the 1998 Newburgh Lake restoration.***
- ***Tonquish Creek is a headwater stream that supports above average stream habitat.***
- ***The Middle 3 contains very diverse stream corridor conditions, including tributary areas in the Holliday Nature Preserve to the entire Wayne County Parks system along Hines Drive.***

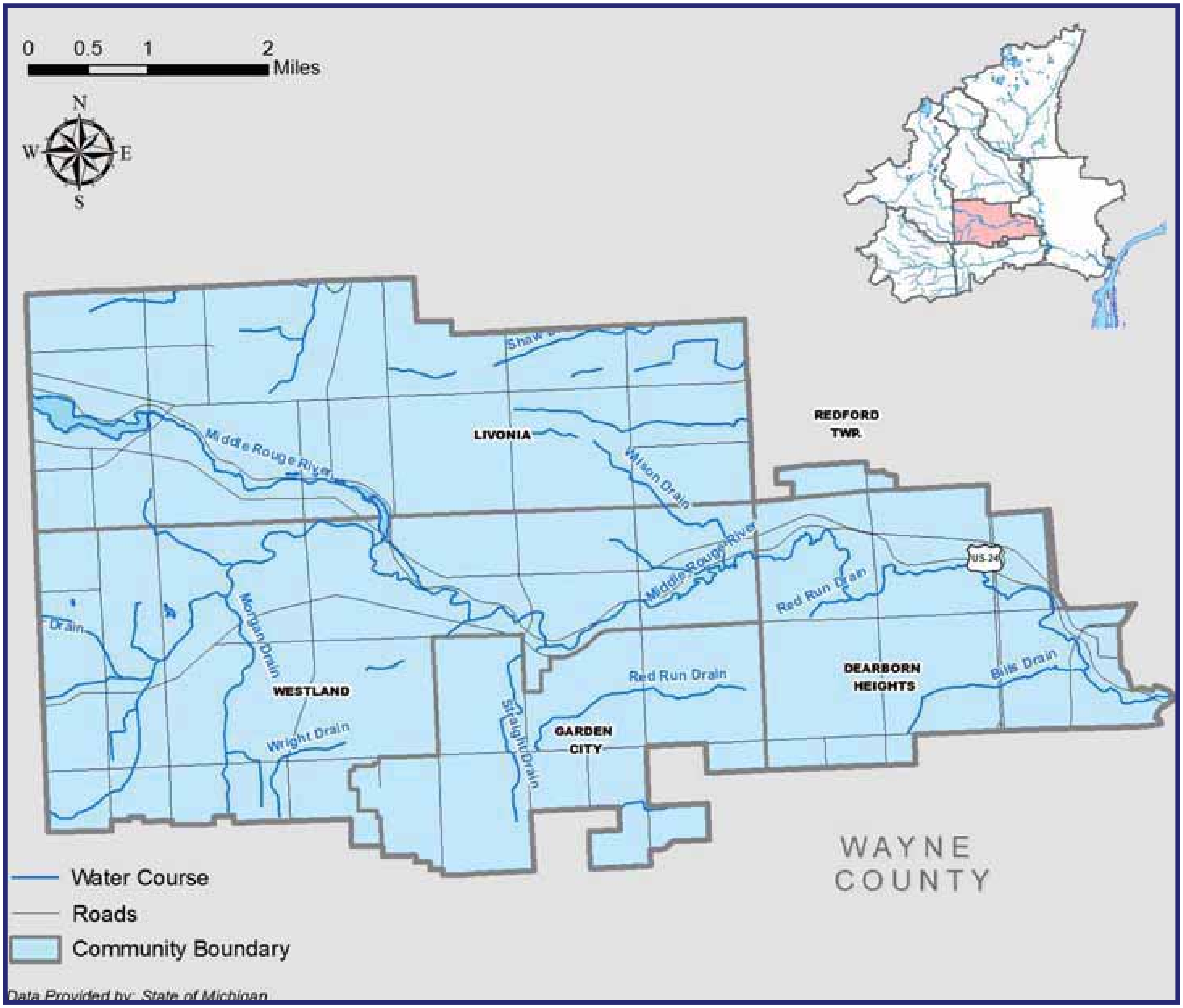
Subwatershed Demographics

The Middle 3 Subwatershed is the smallest of the seven Rouge River subwatersheds, containing about 32.4 square miles (Figure 3-91). The Middle 3 Subwatershed begins at I-96 and I-275 and ends at the point where the Middle Branch of the Rouge River enters the Main Branch of the Rouge River near Ford Road in Dearborn Heights. The Middle 3 Subwatershed includes Tonquish Creek, a small stream that flows into the Middle Rouge below Nankin Dam. Newburgh Lake and Nankin Lake are located in the Middle 3 Subwatershed.

The Middle 3 Subwatershed is located in the north central portion of Wayne County and contains portions of the cities of Dearborn Heights, Garden City,

Nankin Mills in Livonia

Figure 3-91: Middle 3 Subwatershed Location



Livonia, Westland and a small section of Redford Township. Table 3-52 lists the member communities that make up the Middle 3 Subwatershed and summarizes the area for each community.

Table 3-52: Middle 3 Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Dearborn Heights	5.9	50%
Garden City	4.8	82%
Livonia	10.7	30%
Redford Twp	0.2	2%
Westland	10.8	53%
Totals	**32.4**	**NA**
Wayne County	**32.4**	

A unique feature of the Middle 3 Subwatershed is the extensive parkland and open space along eight miles of river corridor along Hines Drive. Newburgh Lake and Nankin Lake are two significant impoundments along Hines Drive in the Middle 3 Subwatershed. From 1996-98 Newburgh Lake in Livonia was restored by removing contaminated sediment, eradicating PCB-contaminated fish and establishing fish habitat. After remediation, the lake was re-vegetated and restocked with native fish species.

From 1996-98 Newburgh Lake in Livonia was restored by removing PCB-contaminated sediment and fish and establishing fish habitat. After remediation, the lake was re-vegetated and restocked for future use.

The parkland (see Figure 3-92) along the river provides a variety of recreational activities, like paddleboating and fishing. In addition, this area includes the William P. Holliday Nature Preserve, located in the City of Westland. The Preserve is part of the Wayne County's Parks system and consists of 500-plus acres of forests and wetlands along the tributaries of the Middle Rouge River.

Impervious Cover

Significant changes in land use and land cover have occurred across this subwatershed over the last ten years. Table 3-53 highlights the changes in land cover between 1991 and 2002. In addition, Figure 3-93 graphically depicts the current impervious cover across this subwatershed.

Table 3-53: Changes in Land Cover 1991-2002

Middle 3 SWMA Land Cover	1991	2002	Change
Green Infrastructure			
Open Space - Grass	12%	7%	
Trees	16%	14%	
Grow Zones	0%	0%	
Green Roofs	0%	0%	
Subtotal: Green Infrastructure	**28%**	**21%**	- 7%
Urban			
Impervious	69%	78%	+ 9%
Bare	3%	1%	- 2%
Water	1%	1%	

Figure 3-92: Middle 3 Recreational Locations

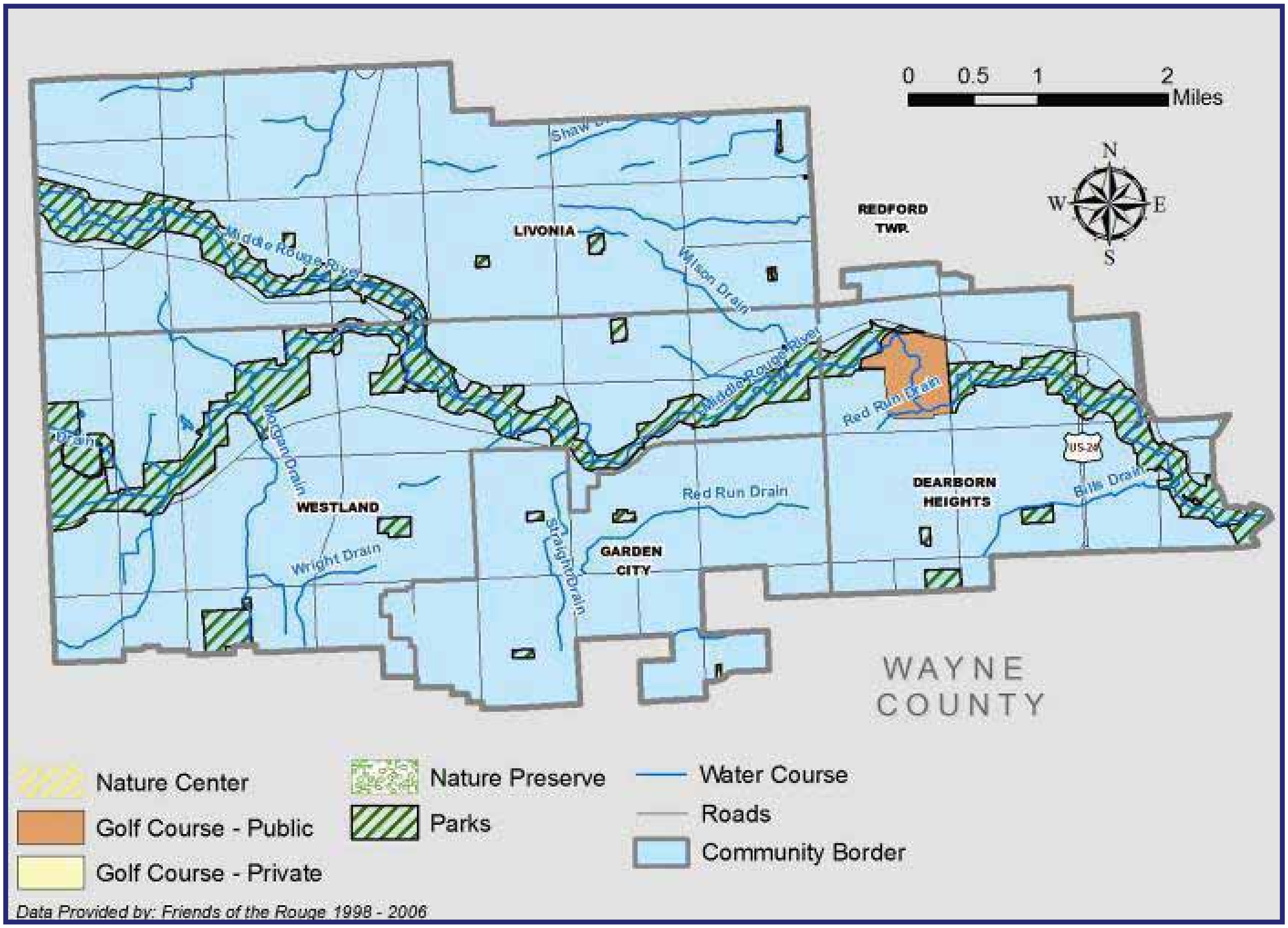
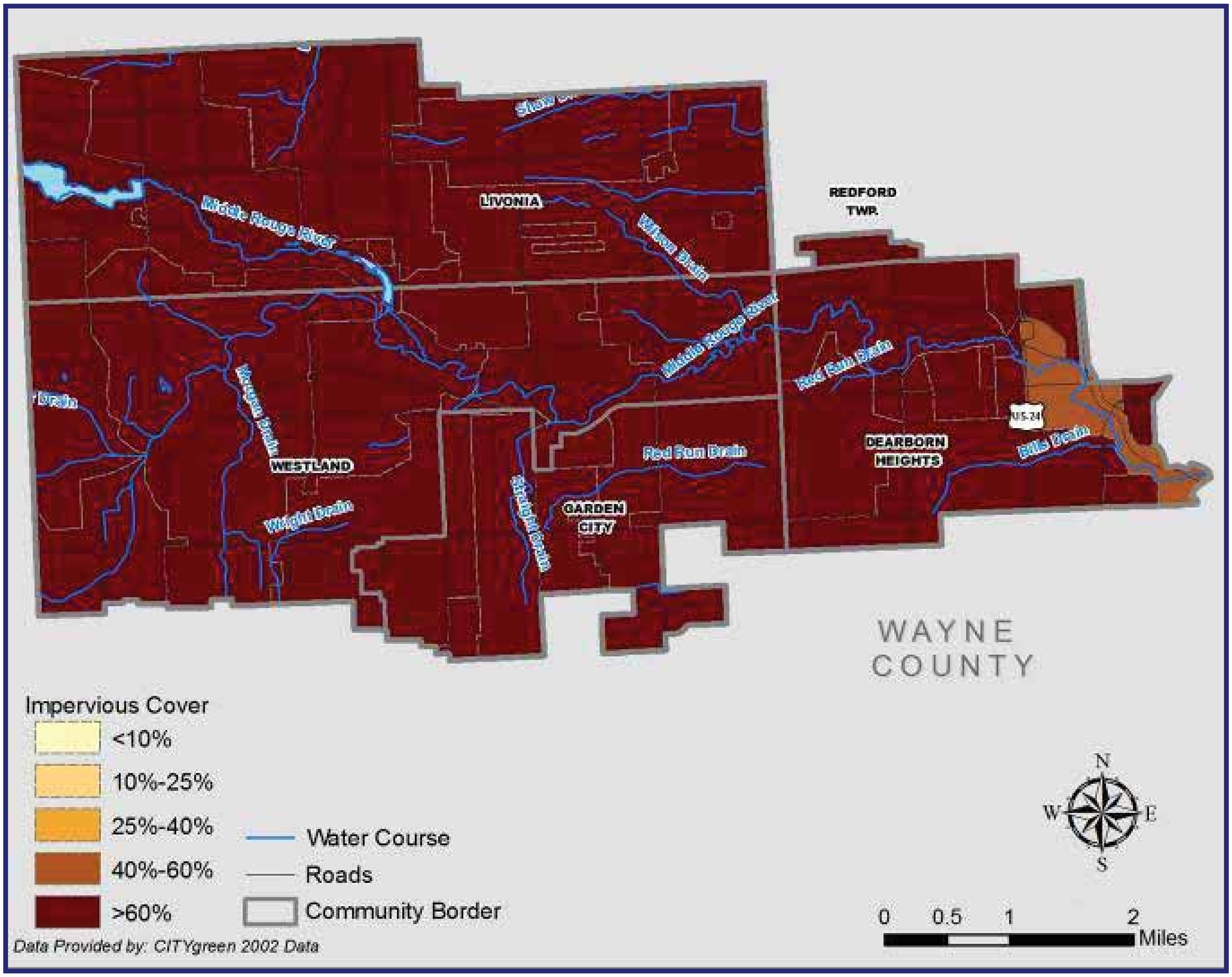


Figure 3-93: Middle 3 Impervious Surfaces



Water Quality

The Middle 3 Subwatershed has experienced an improving trend for dissolved oxygen and temperature, most notably since 2002. The dissolved oxygen concentration has met the state standard of 5 mg/L more than 96% of the time. The Rouge Project temperature criterion of 27°C was met almost 100% of the time.

Dry weather and wet weather sampling results demonstrated that additional work is necessary in addressing sources of pollution, particularly for *E. coli* and total phosphorus in specific areas. Both the partial body contact and total body contact criteria were exceeded across the subwatershed, but most notably in the Tonquish Creek and locations downstream of the confluence of Tonquish Creek in the Middle Rouge River. The Good *E. coli* water quality rating at Newburgh Road demonstrates that progress is being made in this part of the subwatershed.

The Middle 3 Subwatershed Advisory Group established targets for water quality as part of the 2001 Middle 3 Subwatershed Management Plan. These targets are summarized in Table 3-54.

Table 3-54: Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Dissolved Oxygen, Warmwater Fishery (°C)	Daily average ≥5 (by 2005)
Total Phosphorus (mg/L)	Annual average ≤ 0.05 (dry weather)
Total Suspended Solids (mg/L)	Decrease in dry and wet weather
E. *coli* (cfu/100 ml)	Total body contact standard by 2005 upstream of Nankin Lake and by 2010 downstream of Nankin Lake (dry weather)

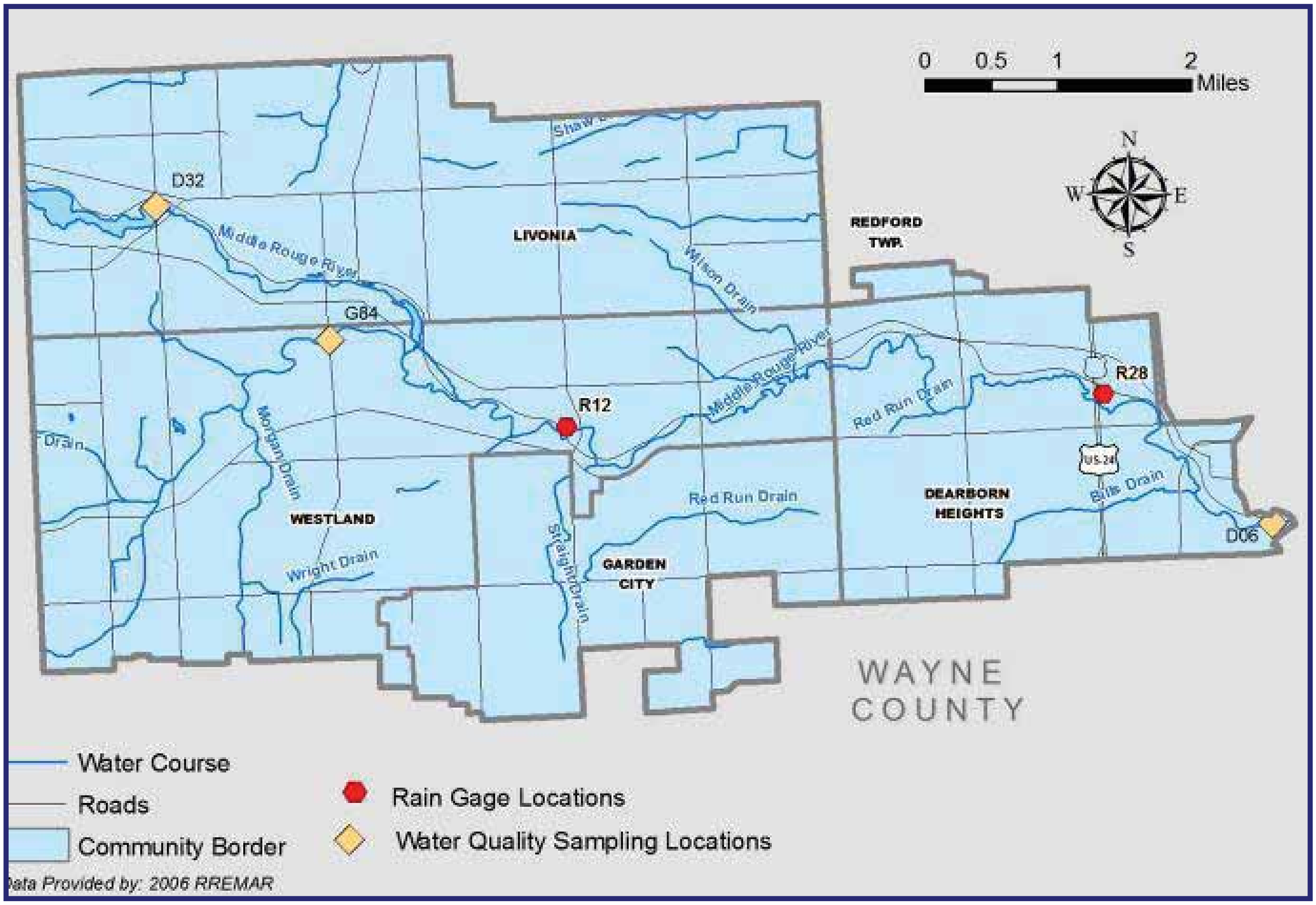
Based on the dry weather sampling results, progress has been made towards improving water quality conditions for a few parameters. Table 3-55 provides a summary of the Middle 3 data with monitoring locations identified in Figure 3-94. Water quality trends are indicated where sufficient data was available for a trend assessment. The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. More detailed information, including site specific ratings are available in the most recent RREMAR.

Table 3-55: Middle 3 Dry Weather Conditions - Summary

Parameter	Newburgh Road D32	Tonquish Creek, Wayne Road - G84	Hines Drive/ Ford Road D06
Water Temperature	Fair	Good	Good
Dissolved Oxygen (DO)	Good ↓	Good ↓	Good ↑
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	Good ↑	Good ↑	Fair ×
Ammonia (NH_3-N)	Good ×	Good ×	Good ×
Total Phosphorus (TP)	Good ×	Poor ×	Poor ×
Total Suspended Solids (TSS)	Fair ×	Good ×	Fair ×
E. coli	Good ↑	Fair ×	Poor ↑

↑ Indicates an improving trend ↓ indicates a declining trend × indicates no trend

Figure 3-94: Middle 3 Water Quality Sampling and Rain Gage Locations



Continuous DO and water temperature monitoring has been performed in the Middle 3 Subwatershed at Hines Drive near Ford Road (D06) since 1994. DO concentrations during this period frequently dropped below the State water quality standard of 5 mg/L particularly during wet weather conditions. Trend analysis results show an improving trend for both wet and dry weather conditions with substantial improvement beginning in 2002. The percent of values greater than the State standard of 5 mg/L has been 96 percent or greater since 2002.

The intermittent dry weather sampling performed in 2005 resulted in varying ratings for most of the water quality parameters, indicating that more work remains in addressing some pollution sources, particularly those contributing to ratings of *Poor* and *Fair* for *E. coli* and TP at Wayne Road (G84) and Hines Drive/Ford Road (D06). Worth noting is the rating of *Good* for *E. coli* at Newburgh Road (D32). Overall $CBOD_5$ and NH_3-N concentrations were rated *Good.*

E. coli Results

The *E. coli* information collected in the Middle 3 Subwatershed indicates that pathogens continue to be a problem in this watershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human (sewage) sources. Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

The 2005 *E. coli* data indicated that the Middle 3 routinely exceeded total and partial body contact water quality standards (see Figure 3-95). These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum and farm animals. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), dilapidated sanitary sewers and failing septic systems which are also called on-site sewage disposal systems (OSDSs).

The BST sampling showed human sources of *E. coli* are suspected at two sites during wet conditions (see Figure 3-96). CSOs still exist upstream from the Hines Drive/Ford Road sampling location and three of these CSOs were controlled at the end of the monitoring season in 2005. Even with CSO controls in place, the 2006 data demonstrates challenges with compliance with the state's *E. coli* standards.

Figure 3-95: Middle 3 E. coli Sampling Results

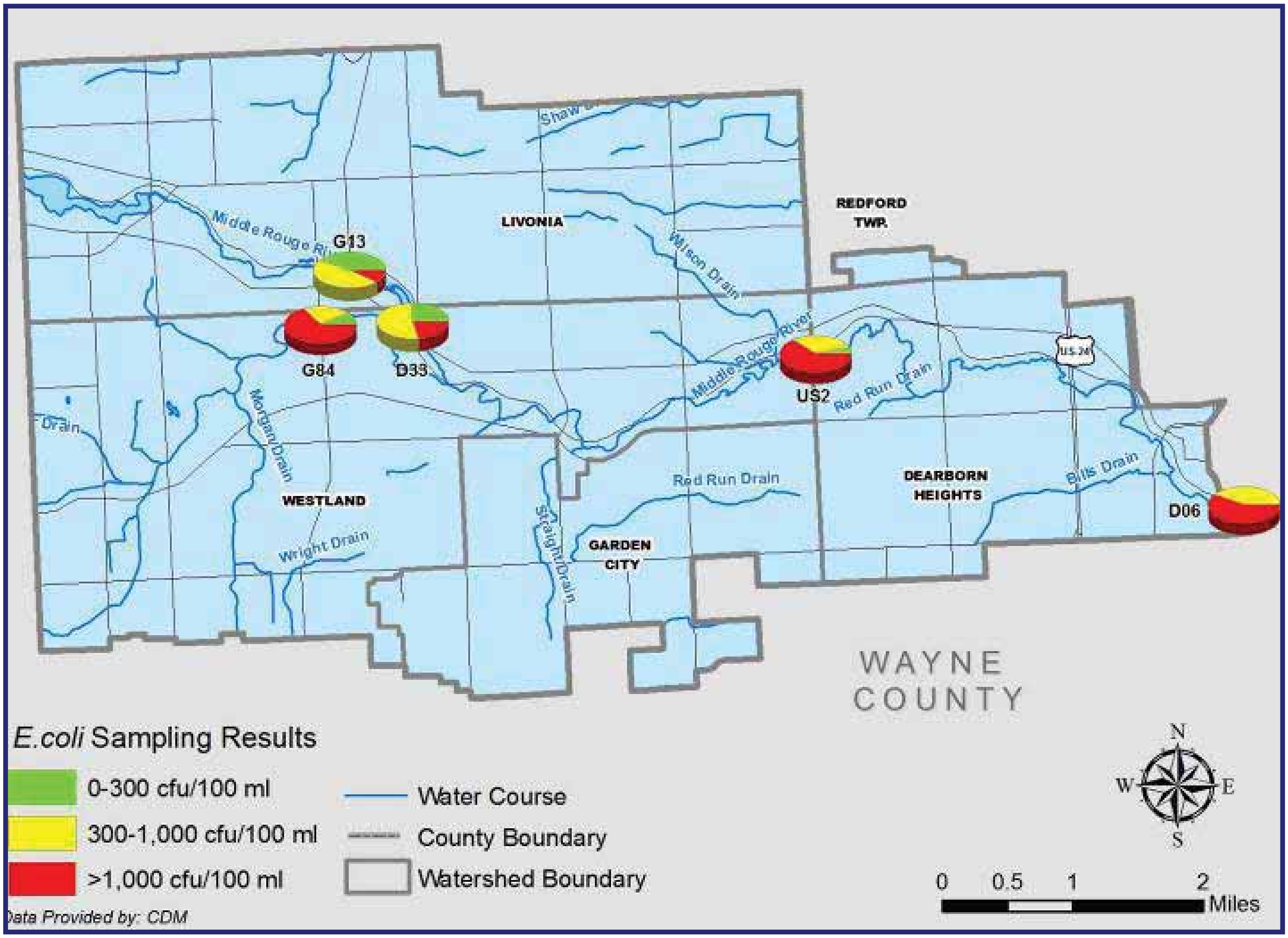
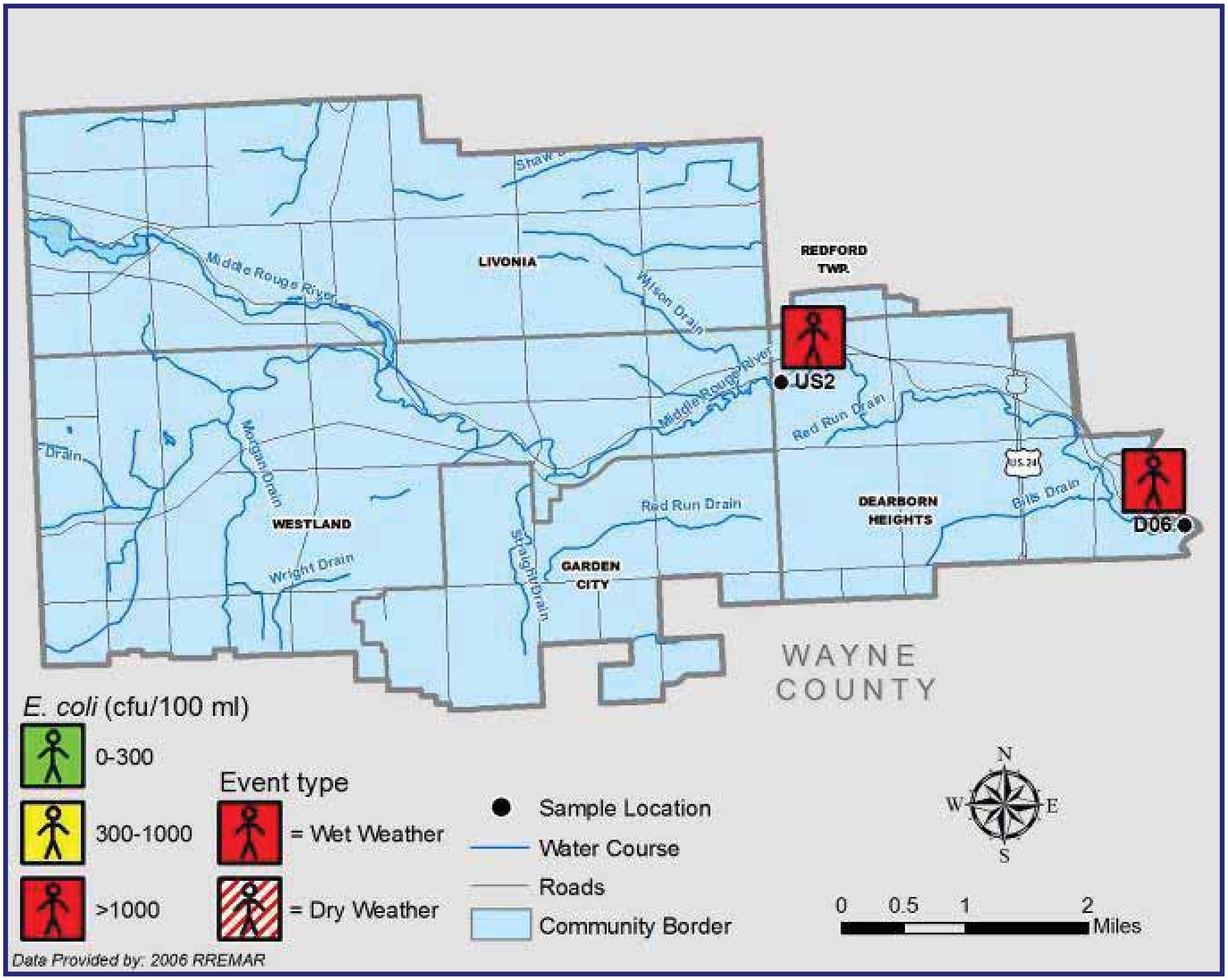


Figure 3-96: Middle 3 Bacterial Source Tracking Results



Water Quality in Wet Weather Conditions

While the overall water quality of the Middle Rouge has improved, there continues to be challenges associated with wet weather. Wet weather sampling at Hines/Ford Road (D06) has not been performed consistently from 1994 through 2005. Five wet weather surveys were performed at this site in 2005. The 2005 data do not reflect the CSOs which were controlled at the end of the monitoring season upstream from the wet weather monitoring location.

Pollutant Abbreviations:

BOD:	*Biochemical Oxygen Demand*
DP:	*Dissolved Phosphorus*
NO2:	*Nitrite*
NO3:	*Nitrate*
TKN:	*Total Kjeldahl Nitrogen*
TP:	*Total Phosphorus*
TSS:	*Total Suspended Solids*

The following observations can be made from the data:

- In 2005 mean concentrations for NH_3-N, and TP were only slightly lower in dry weather than wet weather. $CBOD_5$ mean concentrations in wet weather were approximately twice those in dry weather and TSS mean concentrations were approximately two and one-half times those in dry weather.
- The 2005 *E. coli* wet weather geometric mean was approximately six and one-half times the dry weather geometric mean.
- The 2005 *E. coli* wet weather daily geometric means all exceeded the partial body contact standard of 1,000 cfu/100ml for *E. coli.*
- Trend analyses indicate a slight improvement in TSS, NH_3-N, and TP, in wet weather, but no significant change in $CBOD_5$, and *E. coli.*

Over the past several years there have been many projects in the Middle 3 Subwatershed to control human waste from entering the River. Projects completed in the subwatershed that address bacteria include:

- Garden City conducted a SSO control project to reduce excess peak flows through evaluation and modification of in-line storage.
- The City of Westland implemented a Rear Yard Catch Basin Disconnection Program to the sanitary sewers re ducing potentials SSOs.
- Wayne County constructed a new pump station to alleviate surcharge conditions and significantly reduced the number and volume of SSOs from the Middle 3 communities.
- The City of Dearborn Heights completed a new sanitary flow system to take excess sanitary flows and divert them into their retention/treatment basin.
- Dearborn Heights and Redford Township are working with the City of Detroit to enlarge a CSO tunnel to capture several remaining untreated CSO outfalls in their communities.

Dearborn Heights CSO

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water continues to stress the Middle Rouge River. Thus the communities are required to estimate this portion of the pollutant load and adopt management practices to reduce the impact. Computer models that simulate pollutant loading, based on existing land use classifications, provide a mechanism with which to guide decision-making for implementation of BMPs. In the Middle 3 Subwatershed, CSOs contribute significant bacterial loading, however, the loading from storm water is nearly twice that from CSOs. When considering TSS and phosphorus, the contribution from non-point sources is most prominent. The loading from point sources is relatively insignificant.

Total pollutant loading incorporating base flow, point sources, combined sewer overflows (CSOs) and non-point sources was estimated for the entire Rouge River Watershed using the WMM model. The estimated existing pollutant loads for the Middle 3 Subwatershed are summarized in Table 3-56. Specific study details from the ARC NPS Loading Report may be found at www.allianceofrouge-communities.com.

Table 3-56: Existing Pollutant Loads for the Middle 3 Subwatershed

Pollutant	Units	Source				Total Load
		Baseflow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	16%	82%	0%	2%	1.5×10^6
DP	lbs/yr	7%	92%	0%	1%	8,800
Fecal Coliform	counts/yr	0%	67%	0%	33%	3.5×10^{15}
NO_2 & NO_3	lbs/yr	16%	84%	0%	0%	91,000
TKN	lbs/yr	40%	60%	0%	2%	176,000
TP	lbs/yr	8%	90%	0%	2%	19,100
TSS	lbs/yr	6%	92%	0%	2%	4.5×10^6

The Middle 3 Subwatershed was subdivided into 37 subareas as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, phosphorus and TSS within each subarea are shown in Figures 3-97, 3-98, and 3-99. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

The results in these demonstrate that higher levels of impervious cover generate higher pollutant loadings in non-point source runoff. These areas are consistently located in the more commercial/industrialized sections of Westland. These figures are used as a relative measure of critical area identification. It has been demonstrated that land cover provides an improved measure of non-point source pollutant loadings as opposed to land use.

Based on a review of land uses, the primary sources of phosphorus in the critical Middle 3 subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, runoff impacted by pet waste and agricultural practices, and illegal sewer connections. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils on construction sites without proper soil erosion control practices.

Stream Hydrology

The hydrologic trends along the Middle Rouge continue to cause excessive erosion and habitat destruction. The 2001 Middle 3 Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain

Figure 3-97: Middle 3 Fecal Coliform Estimated Non-Point Source Load

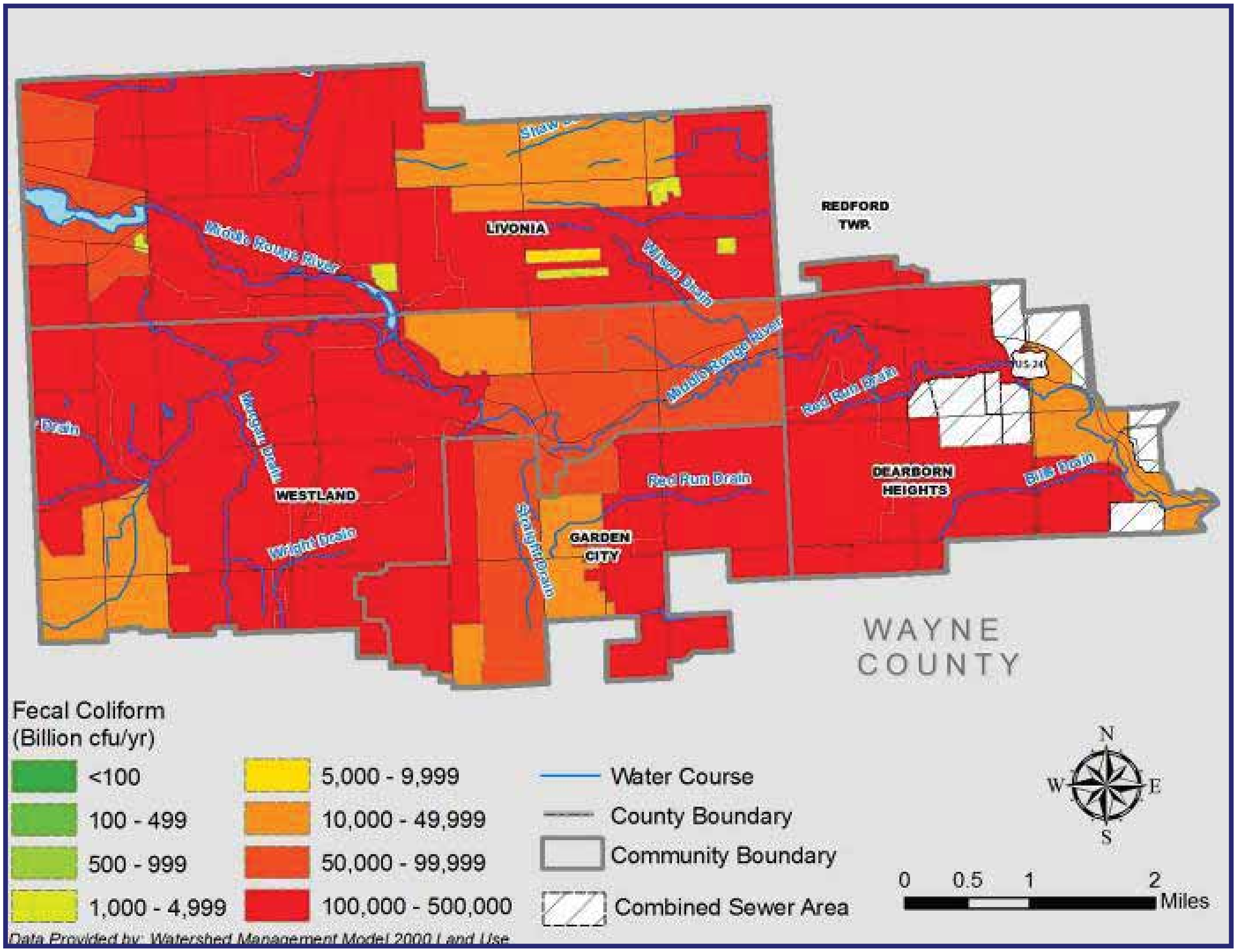


Figure 3-98: Middle 3 Total Phosphorus Estimated Non-Point Source Load

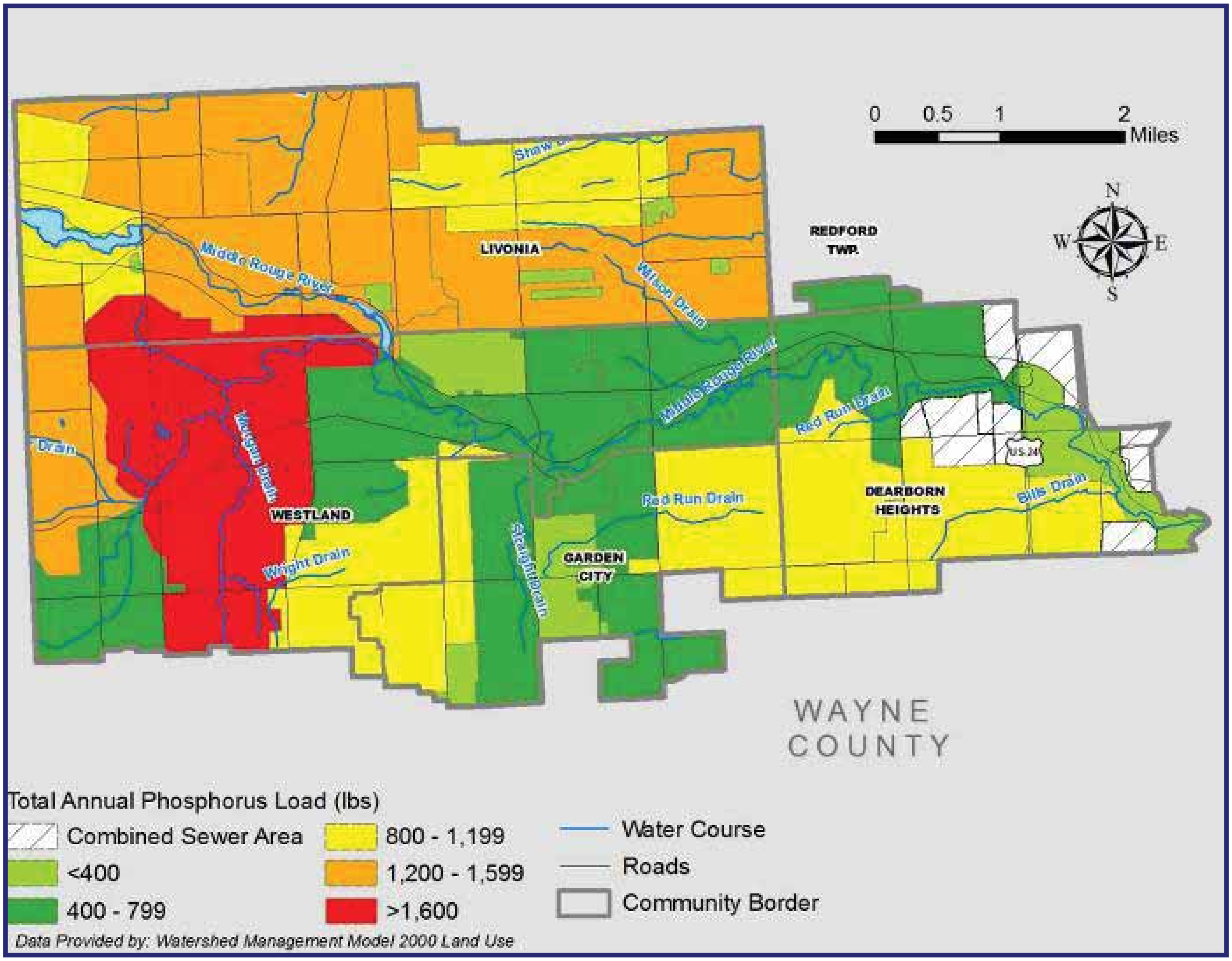
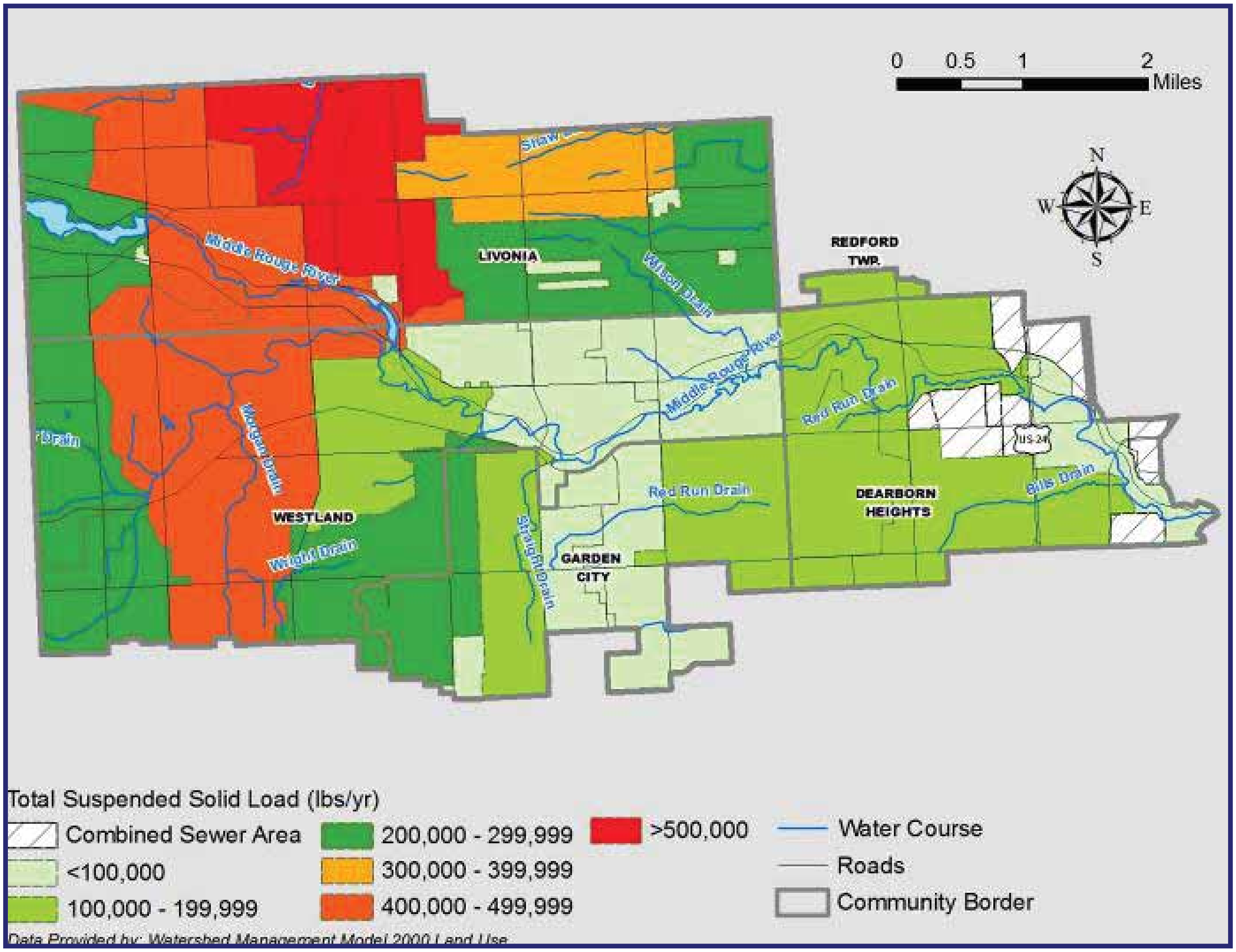


Figure 3-99: Middle 3 Total Suspended Solids Estimated Non-Point Source Load



events, such as those under two-inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed.

While the bankfull, or overbank flood event, occurs on the order of every two years in stable river systems, this study evaluation determines that it occurs on the order of every two to three months in this subwatershed.

A hydraulic analysis was completed to help identify Best Management Practice (BMP) measures that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

USGS gage, Middle Rouge at Inkster (US2)

Figure 3-93 on page 3-199 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04167150), Middle Rouge at Dearborn Heights (D06), provides appropriate flow information for identifying goals for the Middle 3 subwatershed. Figure 3-100 shows the area in the subwatershed that contributes to the flow conditions for this gage.

Table 3-57 shows the results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events.

Table 3-57: Middle 3 Flow Rate Trends at Site D06 (Middle Rouge at Dearborn Heights)

Bankfull Flow Rate	550 cfs with return period of 2.4 months
15-day	175 cfs
30-day	339 cfs

Figure 3-101 represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

The combination of the gage analysis, impervious cover and annual storm water runoff volume across the subwatershed provide important information for focusing efforts on reducing storm water runoff volume. Reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 16,300,000 cubic feet of storm water (0.227 inches of water over the subwatershed would reduce the effect of the small storms. Holding the storm water onsite will provide the necessary volume reduction to reduce flow rates of small storm events.

Figure 3-100: Middle 3 USGS Gage at Dearborn Heights Drainage Area

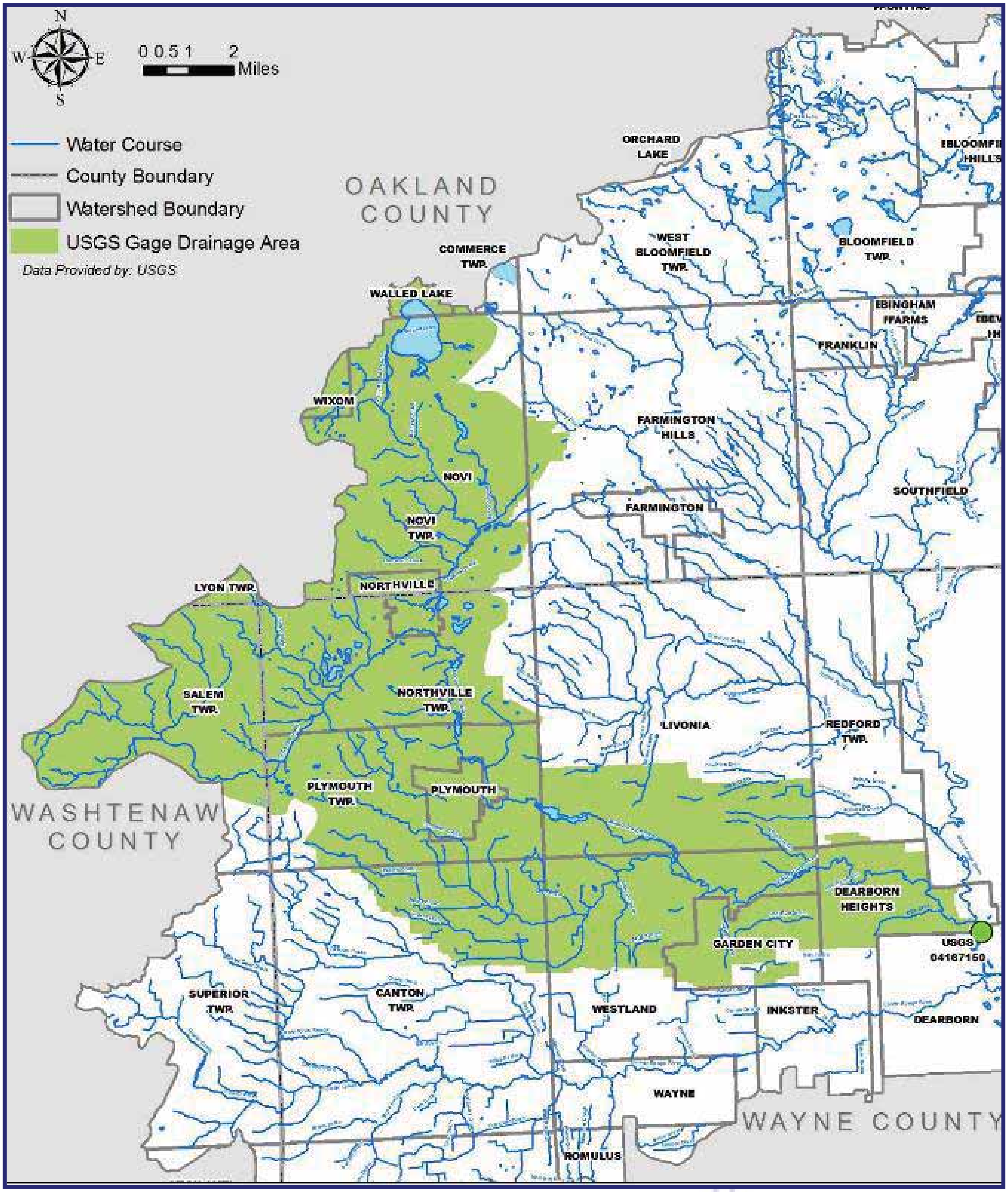
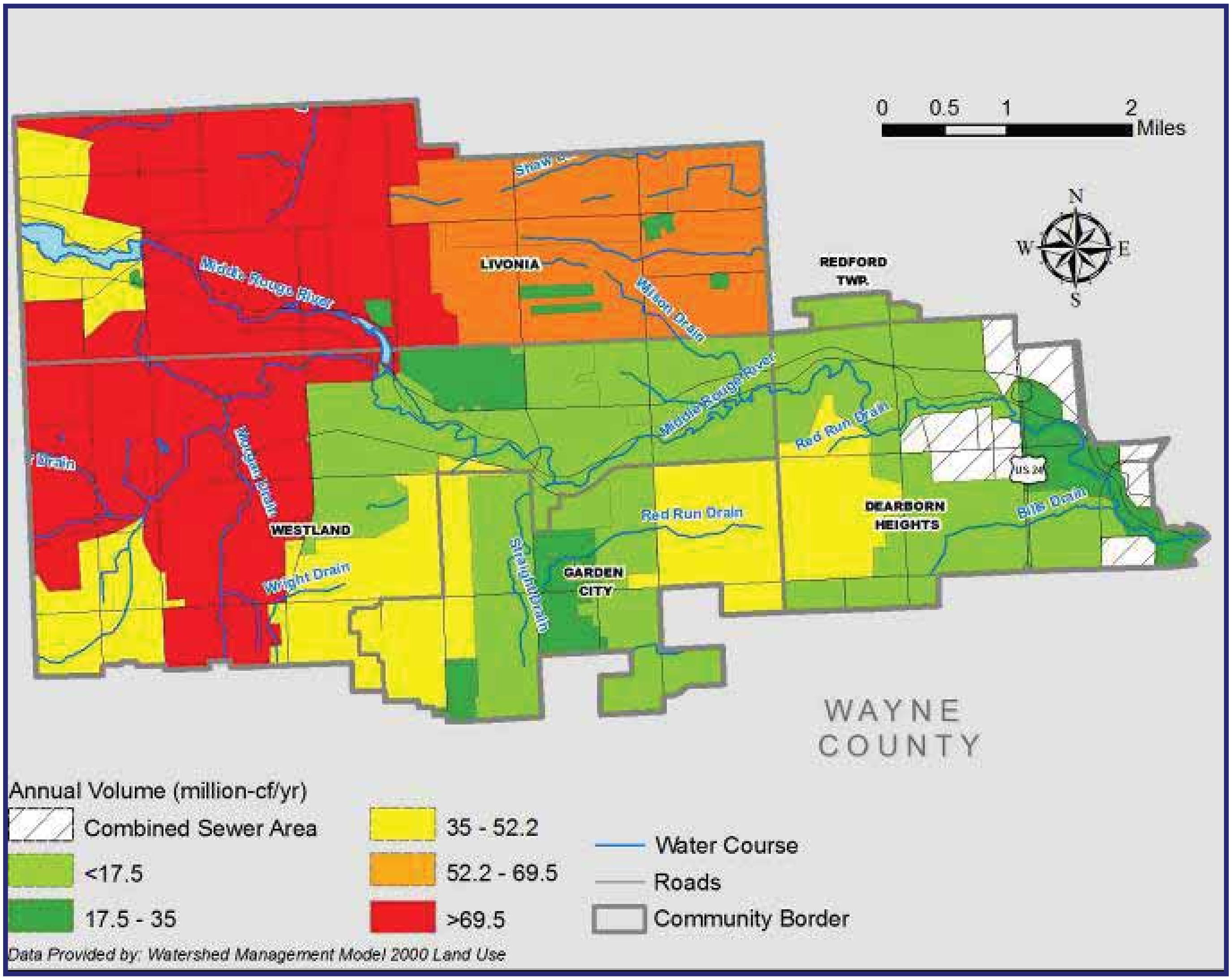


Figure 3-101: Middle 3 Storm Water Runoff Non-Point Source Annual Volume



A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing road-side ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bioretention basins or rain gardens, and porous pavement can be installed on individual properties.

Bioengineering

Over the past several years various projects have been completed in the Middle 3 Subwatershed to help control flow in the rivers. These include:

- Wayne County's storm water ordinance, instituted in 2002, to help minimize flooding problems, streambank erosion and other impacts to natural resources downstream of development projects.
- Rooting for the Rouge, a school tree planting program presented by the City of Westland, Wayne-Westland Schools and other school districts, that teaches fourth grade students about land and water issues.
- The construction of 10 streambank stabilization projects completed by Wayne County along the Middle Rouge River in 2004. The projects were implemented using bioengineering and biotechnical methods, including live stakes, geogrid, riparian buffer expansions and crib walls.
- A $766,000 SSO control project, conducted by Garden City in 2003, to reduce excess peak flows through evaluation and modification of in-line storage.

Sediment removal at Newburgh Lake in Livonia

Ecosystem

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands. In our opinion, the two primary challenges negatively impacting the Middle 3 Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.

Aquatic Diversity

Fish Communities

The most significant improvements in fish communities in this subwatershed can be attributed to the Newburgh Lake restoration, completed in 1998. Newburgh Lake has served as a recreational resource for the surrounding area since the early 1900s. Excessive nutrients contributed to excessive aquatic plant growth and other toxic pollutants, including PCBs, accumulated in the sediment. PCBs entered the food chain making most fish unfit for human consumption. The restoration project removed nearly 560,000 tons of sediment and over 28,000 pounds of PCB-contaminated fish. The lake was deepened and over seven acres of fish spawning beds and habitat structures were constructed. The lake was then restocked with over 30,000 fish of various species including bluegills, largemouth bass, catfish and walleyes. This complete restoration resulted in the State of Michigan lifting the fish consumption bans for the general population (men and boys over the age of 15 and women who are beyond child bearing years) for carp, channel catfish, largemouth bass and northern pike caught in Newburgh Lake.

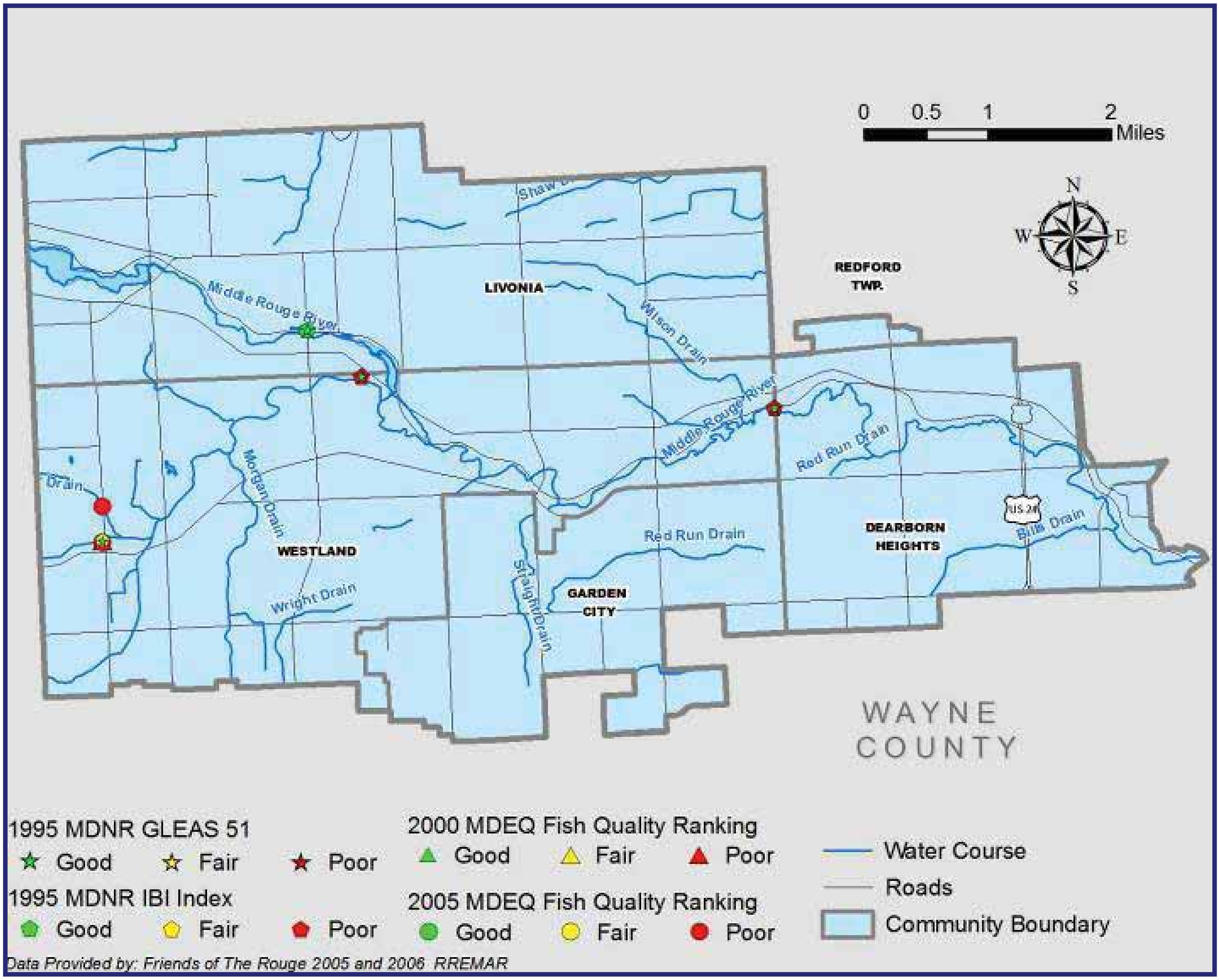
The main factors that still negatively affect fish community integrity in the Middle 3 Subwatershed are excessive flow variation and lack of appropriate spawning habitat. Stream quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities. In addition, the dams at both Nankin and Newburgh Lakes also prevent travel and spawning of the fish community (RREMAR, 2006). Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

Four sites located in the Middle 3 Subwatershed were surveyed during the 1995 MDNR fish study. During the 2000 MDEQ biological assessment one site was surveyed for the Middle 3 Subwatershed, and two sites were surveyed in 2005. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981). Figure 3-102 shows the overall fish community rating for the above referenced surveys.

Recent assessments of the fish communities in the Middle 3 Subwatershed found mostly species tolerant of water quality and aquatic habitat impairment. An attempt was made to sample fish in Tonquish Creek at John Hix Road during MDEQ's 2000 survey, however, no fish were observed. As a result, the site was rated *Poor*. Fish sampling was successfully performed at this station in 2005 and one additional station. The GLEAS 51 Ratings for the two sites sampled in 2005 were *Poor*.

The Merriman Road/Wayne Road and Inkster Road sites were found to have small numbers of several game fish species such as rock bass, largemouth bass, suckers, and carp in 1995. The Newburgh Lake site, for which a target community of 18 to 32 fish species was identified, is actually located in the river just downstream of the dam, while the location sampled by MDNR in 1995 was in the lake itself. This makes comparison of the predicted and actual fish communities difficult. It might be noted that the three groups of predicted game fish (bullheads, sunfishes, and northern pike) were all found in the lake.

Figure 3-102: Middle 3 Fish Community Assessments



Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Middle 3 Subwatershed. These fish and their associated advisories were last updated in 2007, as shown in *Table 3-58.*

Table 3-58: 2007 Fish Consumption Advisories for the Middle 3 Subwatershed

Water Body	Fish Species	Contaminant	General Population[1]	Women/Children[2]
Newburgh Lake	Largemouth Bass	PCBs	Unlimited consumption	No more than one meal/week of fish over 14 inches.
	Suckers	PCBs	Unlimited consumption	No more than one meal/week of fish up to 14 inches. No more than one meal/month of fish over 14 inches.
	Carp	PCBs	Unlimited consumption	No more than one meal per month of fish of any size.
	Channel Catfish	PCBs	Unlimited consumption	No more than one meal per month of fish over 12 inches.
	Northern Pike	PCBs	Unlimited consumption	No more than one meal per month of fish over 22 inches.
Middle Branch downstream of Newburgh Lake	Suckers	PCBs	Unlimited consumption	No more than one meal per month of fish up to 14 inches. No more than 6 meals/year of fish 14 inches and over.
	Carp	PCBs	Do not eat any fish over 30 inches.	No more than 6 meals/year of fish up to 30 inches. Do not eat any fish over 30 inches.
	Largemouth and Smallmouth Bass	PCBs	Do not eat any fish over 14 inches.	Do not eat any fish over 14 inches.
	Northern Pike	PCBs	Do not eat any fish over 22 inches.	Do not eat any fish over 22 inches.
	Catfish	PCBs	Do not eat fish of any size.	Do not eat fish of any size.
	All other species	PCBs	No more than one meal/week of fish of any size.	Do not eat fish of any size.

[1] Men and boys over the age of 15 and women who are beyond child bearing years.

[2] Women of childbearing years and children under the age of 15.

Notable Areas

Notable areas within this subwatershed include Newburgh Lake and the recreational areas along Hines Drive. With Wayne County as the largest riparian land owner in this subwatershed, additional opportunities exist for construction of grow zones and low-impact BMPs. Focusing on reduction of storm water volume will work towards improving river conditions for fish habitat.

Impairments

The size and diversity of the fish community in this subwatershed is constrained by the dams at Newburgh Lake and Nankin Lake in the Middle 3 Subwatershed and the Henry Ford Estate in the Main 3-4 Subwatershed which prevent fish passage within the subwatershed and from Lake Erie. Additional impairments include sedimentation, flow variability, streambank erosion, total suspended solids pollutant loads, *E. coli,* low dissolved oxygen (MDNR, 1998). Habitat limitations arise from point and non-point sources. CSOs in the Middle 3 Subwatershed continue to create challenges to water quality improvements.

Macroinvertebrate Communities

As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed are excellent long-term indicators of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence or absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to water quality impairments. Generally, a natural, unpolluted stream reach supports a variety of macroinvertebrates. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of air-breathing or pollution-tolerant species of worms or midges.

Caddisfly have a large range of pollution tolerance

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past two decades. Below is a description and summary of these results within the Middle 3 Subwatershed.

A high number of Oligochaetes indicate poor water quality

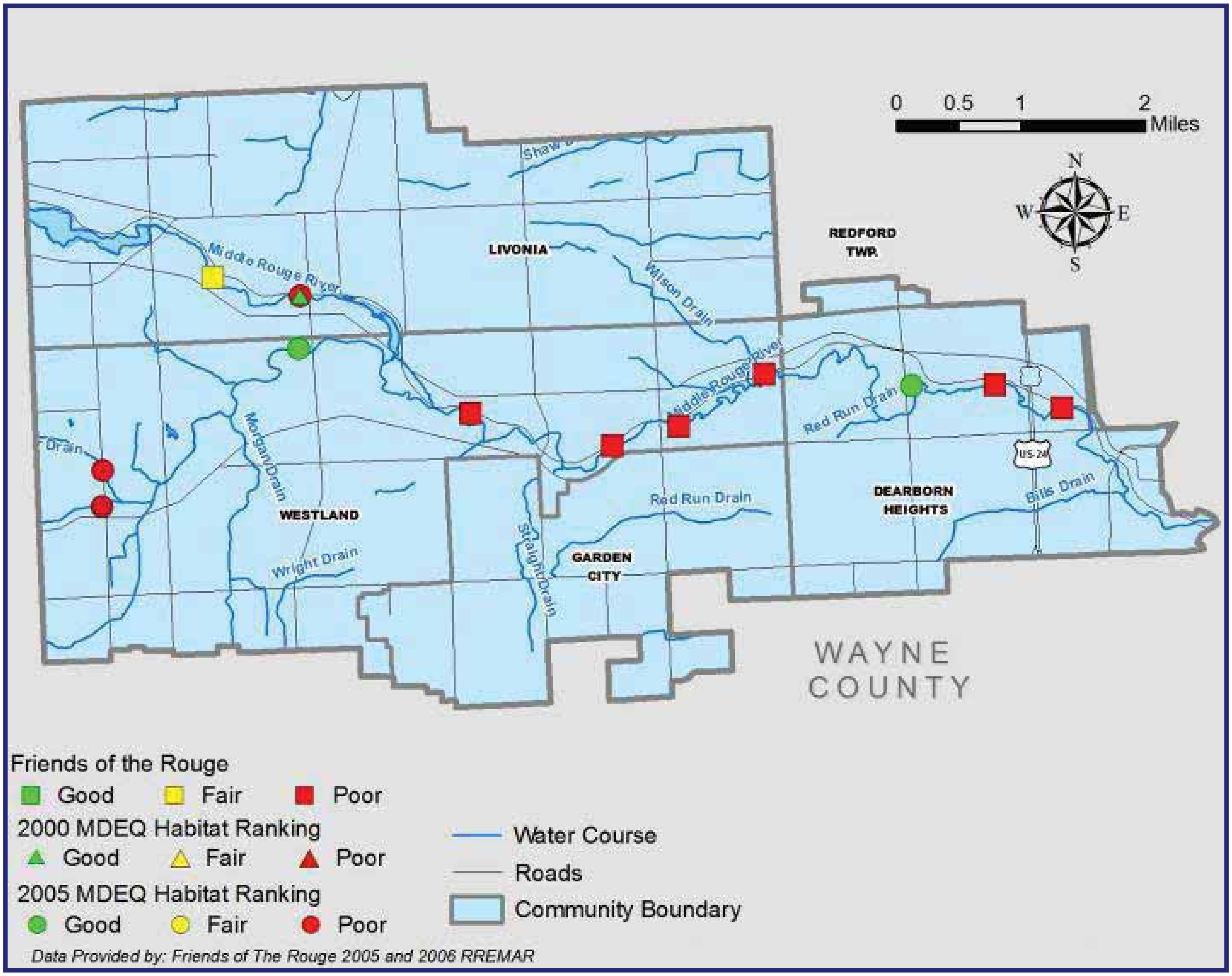
In 1986, the MDNR conducted aquatic macroinvertebrate surveys at four sites in the Middle 3 Subwatershed. In 1999, Rouge Project staff collected macroinvertebrates from seven locations in the vicinity of separated and combined sewer areas adjacent to the Middle 3 and rated them using GLEAS 51 procedures (Rathbun & Frederick, 2000). In 2000 and 2005, the MDEQ conducted a Rouge River biological assessment survey (Goodwin, 2002), and sampled macroinvertebrate communities at two locations and six locations in the Middle 3 Subwatershed, respectively (Figure 3-103).

FOTR started sampling aquatic macroinvertebrates in the Middle 3 Subwatershed in 2004 and have 12 spring sampling sites and 12 fall sampling sites. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation. Specific information about what sites have been sampled when, the rating, quality of macroinvertebrates and number of taxa, may be reviewed in the current RREMAR or on the FOTR website (www.therouge.org).

Notable Areas

Aquatic macroinvertebrate communities along Hines Parkway in the Middle 3 Subwatershed have consistently rated *Fair*. Potential for improvement exists due to streambank stabilization projects underway to minimize erosion and excessive sedimentation. A population of native mussels exist downstream of the dam at Newburgh Lake. Native mussel populations are an indicator of good water quality

Figure 3-103: Middle 3 Macroinvertebrate Assessment Results



and stream flow stability. In addition, as mentioned previously, Wayne County has installed a number of grow zones and natural buffers along the riparian corridor in the Middle 3 Subwatershed.

Impairments

There are many controlled and several uncontrolled CSOs discharging into this subwatershed and numerous storm sewer discharges. Water quality and quantity is an issue throughout the area. Land use is primarily urban, which results in increased imperviousness resulting in unpredictable stream patterns. Erosion and sedimentation, along with lack of hard substrates prevent the establishment of suitable habitat for a diverse and abundant community of benthic macroinvertebrates.

Spring peeper

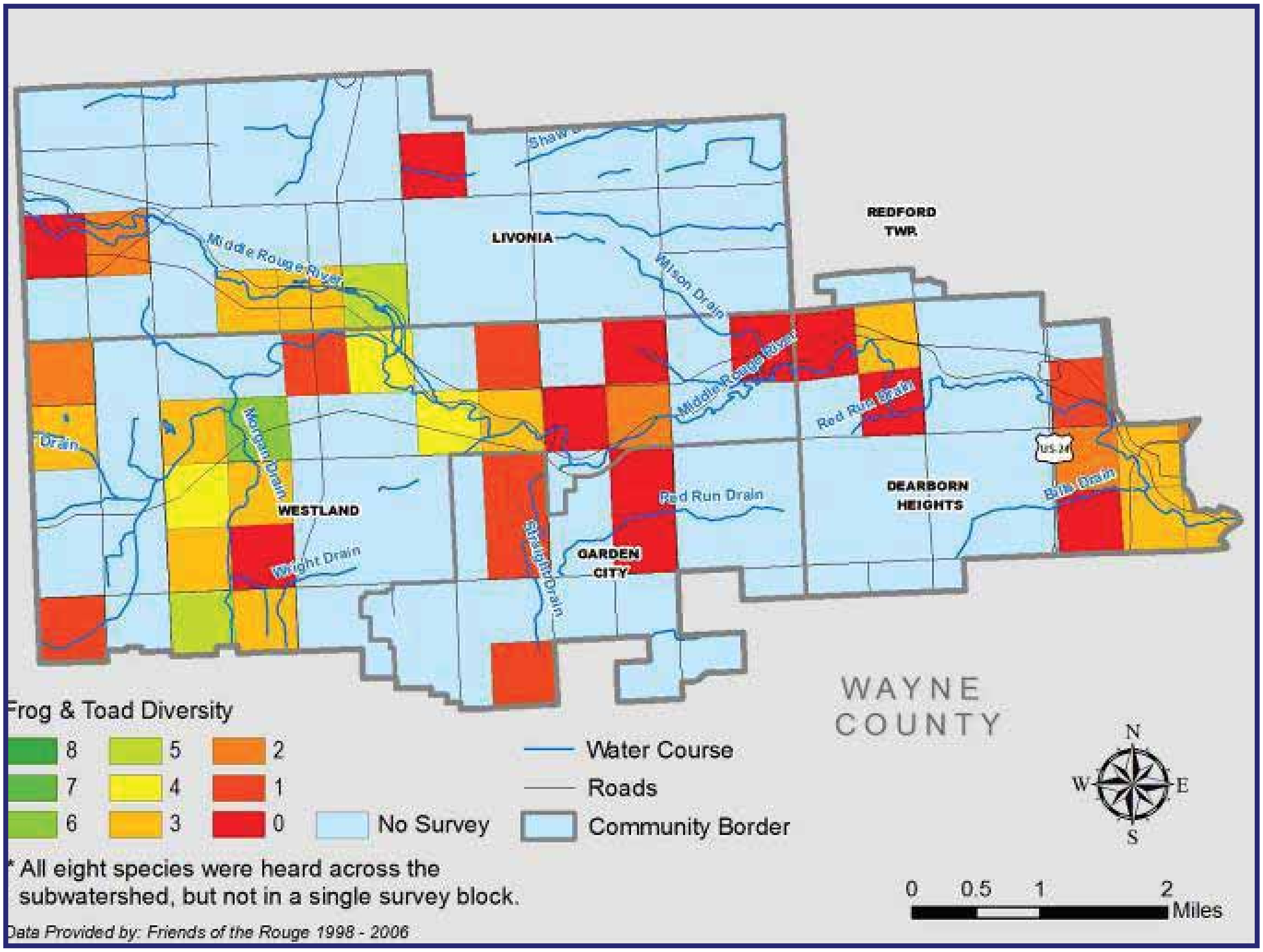
Frog & Toad Diversity

FOTR began a volunteer-based Frog and Toad Survey in 2000. Based on the FOTR information, five of the eight species of native frog and toads present in the Rouge River Watershed are present in the Middle 3 Subwatershed (Figure 3-104). Table 3-59 shows the total number of blocks surveyed and the percentage of blocks in which species were heard from 2000 through 2007 (Catalfio, et al., 2007). Annual data is dependent on where volunteers choose to listen for frogs. Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area.

Table 3-59: FOTR Frog and Toad Survey - Percent of blocks in which species was heard in the Middle 3 Subwatershed

Species	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	0	0	27	7	8	14	17	17
Western Chorus Frog	20	20	27	14	9	29	17	50
Spring Peeper	10	10	27	14	11	29	0	67
American Toad	10	10	55	50	57	86	100	83
Northern Leopard Frog	0	0	0	0	3	0	0	0
Gray Tree Frog	0	0	0	0	6	0	0	50
Green Frog	0	0	0	0	23	57	67	17
Bullfrog	0	0	0	0	0	0	0	17
Total Blocks Surveyed	10	10	11	14	37	7	6	5

Figure 3-104: Middle 3 Frog and Toad Diversity



Notable Areas

In general, all species of identified frog and toads would be more prevalent in isolated, fishless, ponds, wetlands along the shore of impoundments in the flood plain and wetlands associated with the river valley. Golf course ponds would also be a place where frog and toads are found. Areas such as Hines Parkway, including Holliday Nature Preserve would be expected to contain habitats that support frog and toads. Gray tree frogs were heard along Hines Drive just west of Beech Daly.

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease or differences in temperature and precipitation from year to year. Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man-made wetlands can be appropriate substitutes, provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

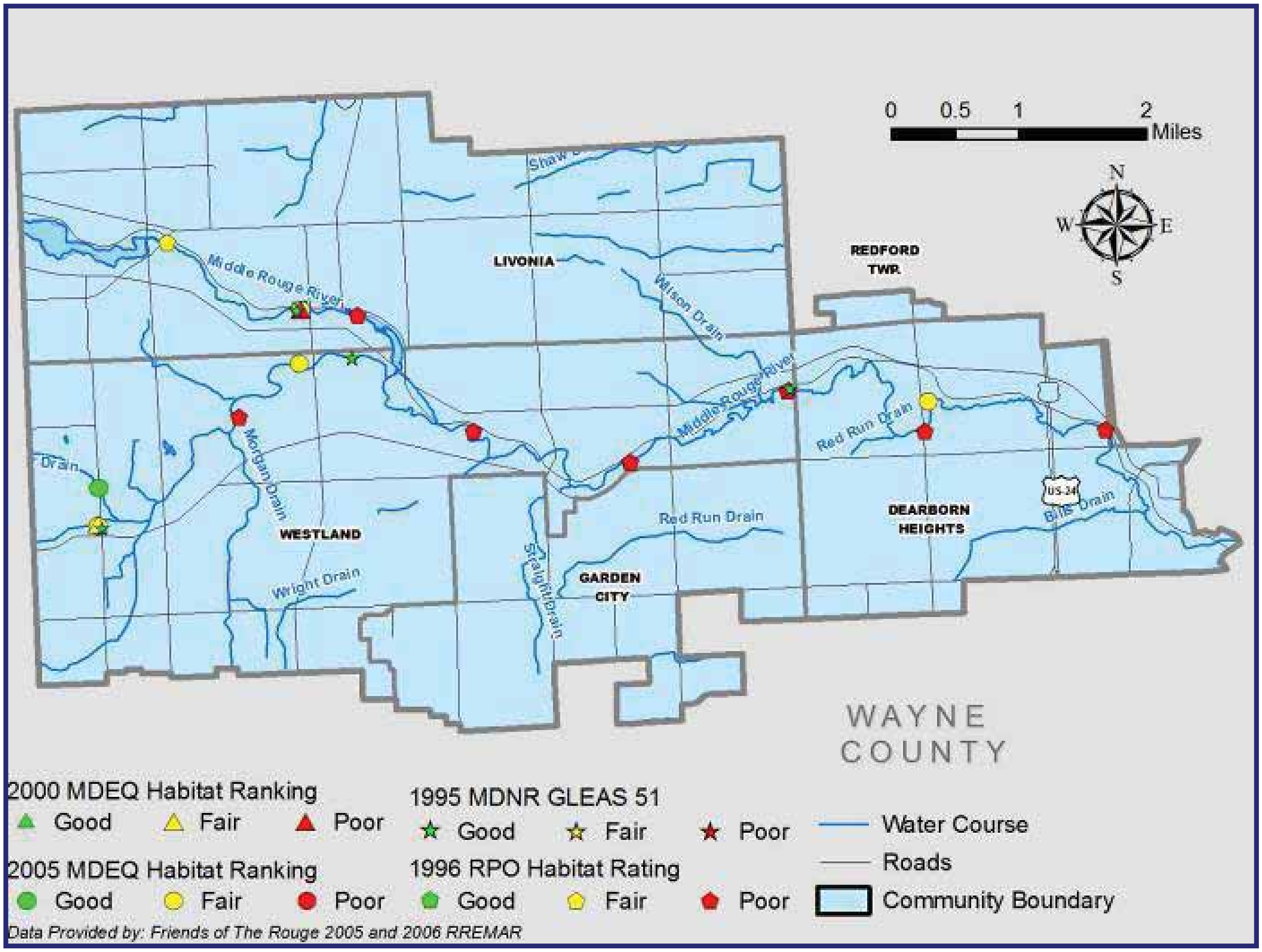
Stream Habitat

Stream habitat in the Middle 3 Subwatershed varies in conditions, primarily due to the flow variability, excess storm water volume and water quality. One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in Stream Hydrology above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure, sedimentation of the low-flow channel, reduction in woody debris, straightening of channels, and decline in undercut banks.

Evaluations of stream habitat were conducted by the MDNR in 1995 and again by the MDEQ in 2000 and 2005. Figure 3-105 shows the locations and results sampled in 1995, 2000 and 2005. In addition, the Rouge Project conducted an aquatic habitat survey during the summer of 1996. The Rouge Project findings were consistent with those identified by MDNR. All referenced studies used the MDEQ GLEAS 51 protocol previously described.

Figure 3-105: Middle 3 Stream Habitat Assessment Results



The 1995 MDNR and the 1996 Rouge Project studies rated the Middle 3 Subwatershed on average as *Poor*. Lack of habitat variability (especially pools and riffles), lack of in-stream cover, inadequate spawning habitat, and low dissolved oxygen concentrations were identified as sources of habitat impairment.

The impairments to stream habitat found in previous assessments were primarily attributed to flow instability and impaired water quality. Several CSOs that were historically impacting water quality are being controlled. The 2000 MDEQ study assessed two sites and ranked one *Fair* and the other *Poor*. The 2005 study rated sites as either *Marginal* or *Good*. The *Marginal* ratings were observed at some stations in Tonquish Creek, the Middle Rouge at Beech Daly Road, and at Wayne Road/Hines Drive. The Middle Rouge at 6 Mile/Waterford Park, Tonquish Creek at Joy Road, and Tonquish Creek at Hix Road were rated *Good*.

Hines Drive flooding

Notable Areas

Tonquish Creek is a headwater stream that supports above average stream habitat. Streambank erosion control and habitat improvements can help to minimize the negative impacts associated with extreme flow pattern. The watershed feeding this stream is becoming increasingly developed and unmitigated storm water inputs continue to degrade the stream. Each new hard surface constructed in this watershed can result in potential degradation of stream quality by decreasing base flow and increasing peak flows. Areas that will benefit in stream habitat conditions from improvements in managing storm water runoff include the Middle Rouge River along Hines Drive.

Impairments

The Middle 3 Subwatershed of the Rouge River should support a fairly diverse aquatic community. The primary cause of degraded stream habitat in the Middle 3 Subwatershed is the excessive flow instability and accompanying erosion and sedimentation and a lack of habitat complexity. Extremes in flow result in erosion of streambanks and sedimentation that negatively impacts the bottom substrates. High flows displace small woody and other debris from the channel, eliminating flow refuges provided by hard substrates. The impoundments upstream and within this stretch capture woody debris and prevent its recruitment into downstream reaches. Removal of log jams within the parkland bordering the stream negatively impacts habitat availability. The remaining uncontrolled CSOs in the watershed negatively impact water quality. Plans are underway to rehabilitate these CSOs, which will help. Negative impacts from unmitigated storm water inputs continue to impair the stream habitat.

Stream Corridor

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River Watershed.

Riparian Corridor

The Middle 3 Subwatershed contains very diverse stream corridor conditions, including tributary areas in the Holliday Nature Preserve to the entire Wayne County Parks system including the Middle Rouge River floodplain along Hines Drive. Conditions range from heavily forested with interspersed wetland areas to mowed turf adjacent to the river.

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water, organic debris to feed aquatic organisms, bank stabilization with its root structure, cover, perching and nesting areas for aquatic organisms, and a buffer for pollutants and sediments from surface runoff. While providing habitat for aquatic organisms, the corridor is also used by many birds and mammals. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

Wetlands and Woodlands

Figure 3-106 shows the existing wetlands within the Middle 3 Subwatershed. This figure depicts wetlands as the highest percentage of remaining wetlands in the subwatershed, with smaller areas of both scrub-shrub and emergent wetlands. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-107. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Nankin Mills Interpretive Center

Historical Storm Water Projects in the Middle 3 Subwatershed

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are some of the projects completed by subwatershed stakeholders:

- In 2000, the City of Westland passed an ordinance prohibiting the feeding of pigeons, doves, gulls and waterfowl on private or public property.
- The Nankin Mills Interpretive Center was opened to the public in 2001. It was created to foster awareness and appreciation of the natural and cultural resources of the Rouge River Watershed through exhibits and interpretive programming and to promote stewardship of these resources.

Figure 3-106: Middle 3 Existing Wetlands

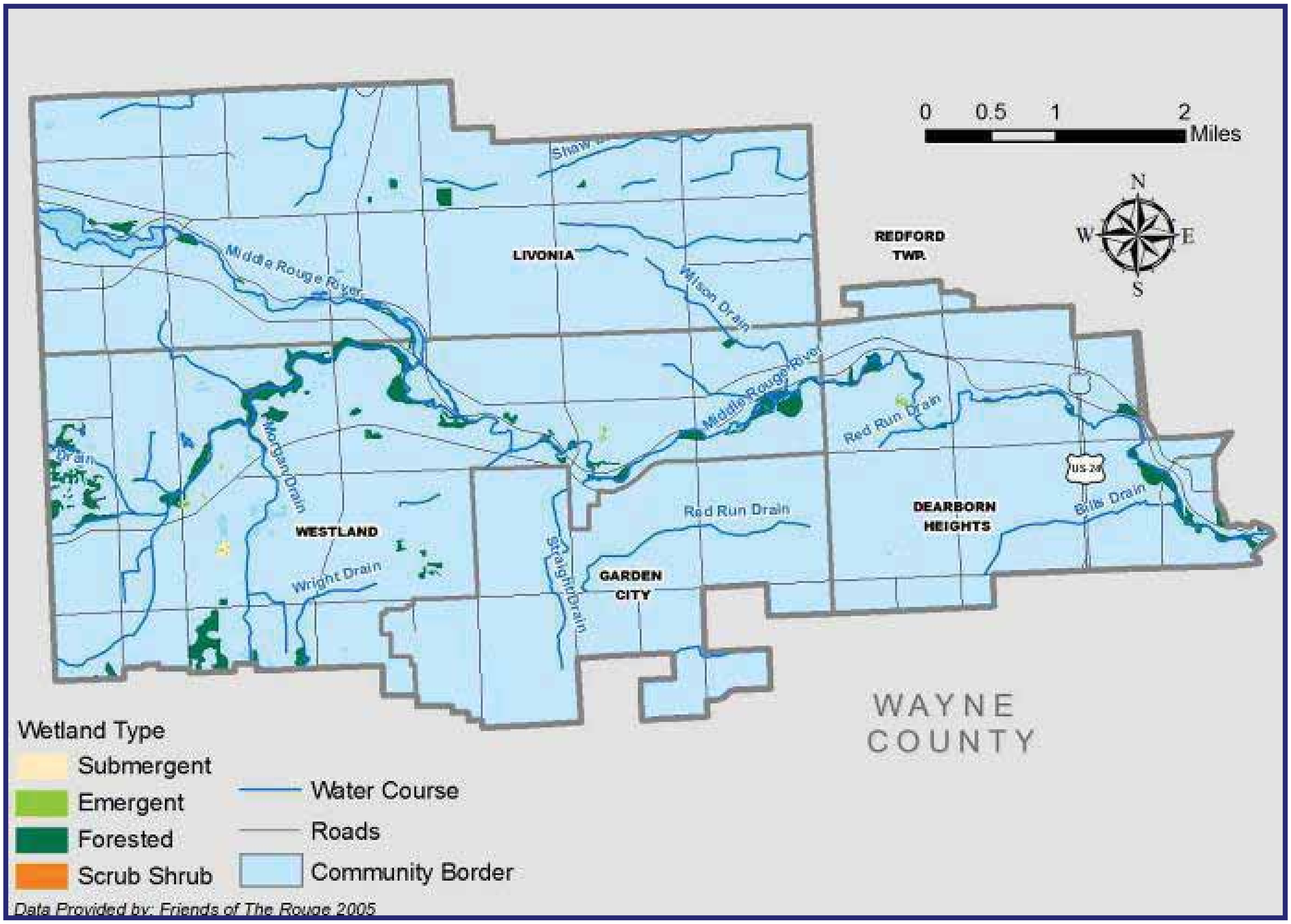
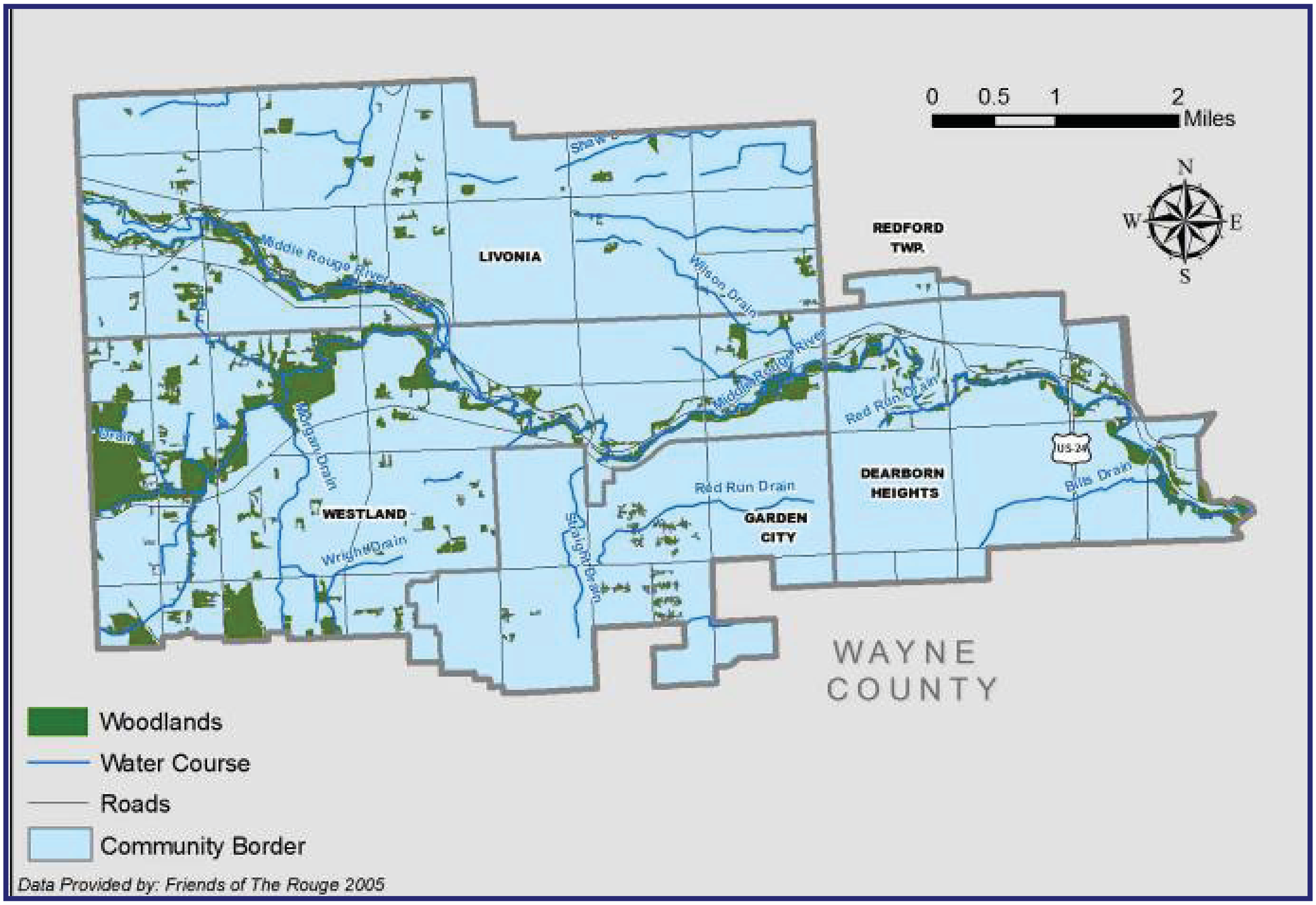


Figure 3-107: Middle 3 Existing Woodlands



- The Nankin Mills Streambank Stabilization Project was completed by Wayne County utilizing a variety of streambank stabilization methods to improve the aesthetics, recreational desirability and water quality of the Nankin Mill Race.
- The City of Westland implemented a Rear Yard Catch Basin Disconnect Program, documented existing sewer system conditions and conducted a pilot footing drain removal program.
- Cities of Livonia and Westland hosted a Detention Pond Maintenance Workshop for residents in 2005.

Upper Subwatershed (Storm Water Management Area) Conditions

The Upper Subwatershed is the most stable major branch in the watershed, however, the hydrologic trends along the Upper continue to cause excessive erosion and habitat destruction. The wet weather water quality in the Upper has improved, due in part to CSO control program projects over the past several years, including the Redford Township Retention Treatment Basin. A unique feature of the Upper is the river gradient or the change in its elevation from the northern portion of the subwatershed to its southern end just prior to entering the Main Rouge River.

The characteristics and conditions of this subwatershed and the associated stream indicators described in this chapter demonstrate that much progress has been made in improving the quality of the water and natural resources since the completion of the 2001 Upper Subwatershed Management Plan. Challenges exist with managing flow variability, including both flow rates and storm water runoff volume, along with bacterial loading in wet weather conditions. This subchapter provides a synopsis of the conditions of each of the above stream indicators with associated challenges for restoration.

Upper highlights:

- ***The Minnow Pond Drain and Seeley Drain contain sensitive fish species like redside dace and mottled sculpin, and the most diverse aquatic habitat.***
- ***Tarabusi Creek and the Minnow Pond Drain consistently exhibit the higher quality populations of aquatic macroinvertebrates.***
- ***The Upper Subwatershed is the most stable major branch in the watershed***

Subwatershed Demographics

The Upper Subwatershed (Figure 3-108) is situated in the northern central portion of the Rouge Watershed and is approximately 63 square miles. In addition to the upstream half of the Upper Branch of the Rouge River, the Upper Subwatershed's water resources include the tributaries of both the Bell Branch and Tarabusi Creek.

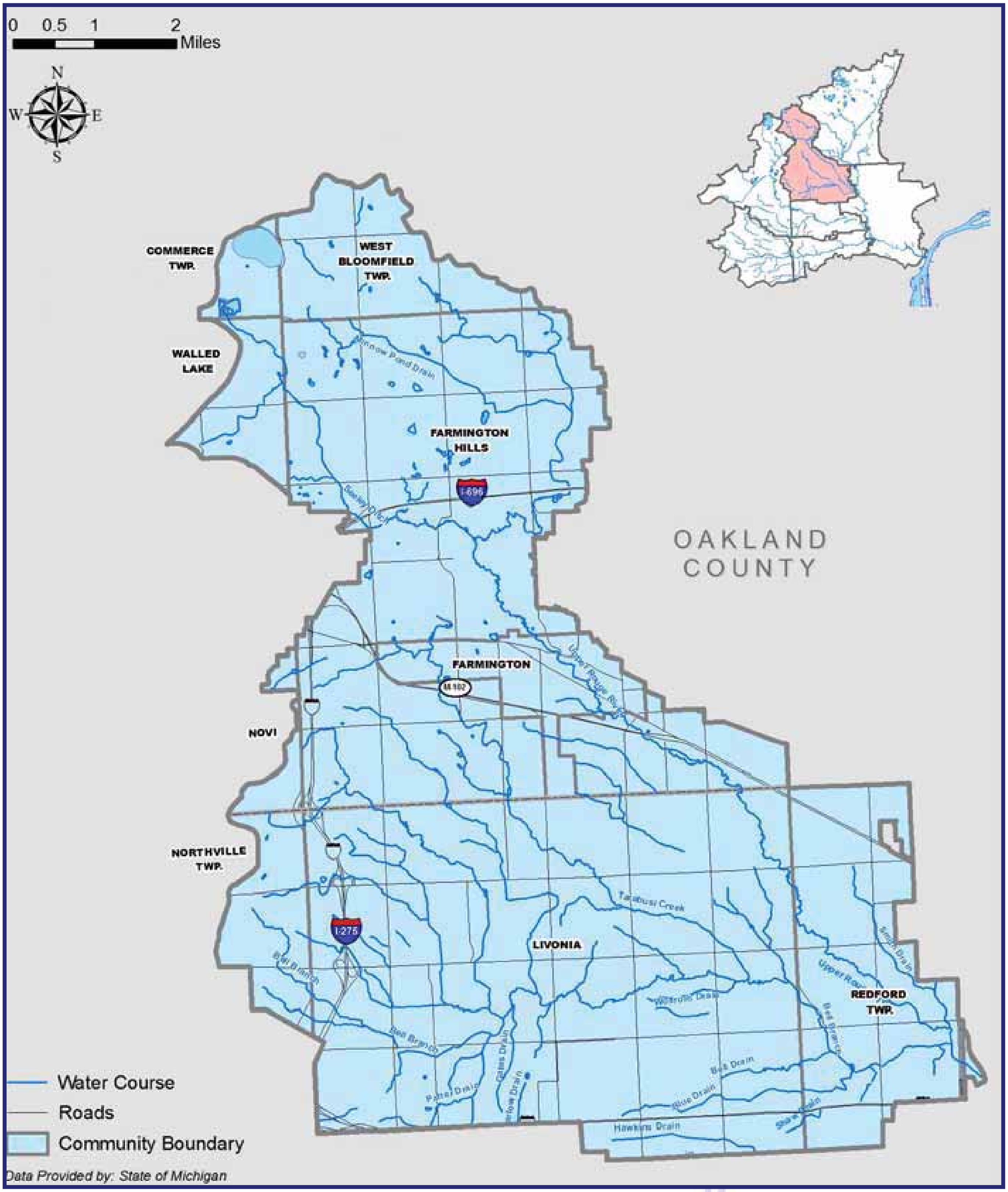
The Upper Subwatershed is located in Oakland and Wayne counties encompassing portions of Commerce, West Bloomfield, Northville, and Redford townships and the cities of Novi, Farmington, Farmington Hills, and Livonia. Table 3-60 lists the member communities that make up the Upper subwatershed and summarizes the area for each community.

Table 3-60: Upper Subwatershed Community Area within the Rouge Watershed

City/Township	Square Miles in Subwatershed	Percent of Community in Subwatershed
Commerce Township	0.9	2.9
City of Farmington	2.6	96.2
City of Farmington Hills	20.4	61.2
City of Livonia	24.9	69.7
Northville Township	2.1	12.9
City of Novi	2.2	7.2
Redford Township	6.9	61.3
West Bloomfield Township	3.3	10.7
Totals	**63.3**	**NA**
Counties		
Oakland County	29.4	
Wayne County	33.9	

Bell Creek in Redford Township

Figure 3-108: Upper Subwatershed Location



The significant land use classifications in the Upper Subwatershed include residential, industrial and commercial comprising 75% of the subwatershed area. A unique feature of the Upper Subwatershed is the river gradient or the change in its elevation from the northern portion of the subwatershed to its southern end just prior to entering the Main Rouge River. The majority of the stream gradients across the watershed average approximately five-feet per river mile; however, the gradient in the Upper Subwatershed averages twenty-one feet per mile, the highest gradient in the watershed. This unique feature generally exhibits regular riffle/pool sequences that support aquatic communities.

The Center for Watershed Protection developed the Impervious Cover Model for Urban Stream Classifications. The model is based on percentage of impervious cover (IC)

Impacted Stream: 10 – 25% IC

Non-Supporting Stream: 25 – 60% IC

Urban Drainage: > 60% IC

Impervious Cover

Significant changes in land use and land cover have occurred across this subwatershed over the last ten years. Table 3-61 highlights the changes in land cover between 1991 and 2002. In addition, Figure 3-109 graphically depicts the impervious cover across this subwatershed.

Table 3-61: Land Cover Changes between 1991 and 2002

Upper Subwatershed Land Cover	1991	2002
Open Space - Grass	23%	11%
Trees	28%	25%
Grow Zones	0%	0%
Green Roofs	0%	0%
SubTotal: Green Infrastructure	**51%**	**36%**
Urban:Impervious	47%	62%
Urban:Bare	2%	1%
Water	0%	1%
Total	**100%**	**100%**

Water Quality

The water quality in the Upper is improving and has been documented by recent watershed monitoring. Average DO concentrations have improved over the last decade with the number of days in which measured DO was lower than the 5 mg/L state standard significantly reduced between 2003 and 2004.

Automatic sampler

The Upper Subwatershed Advisory Group established targets for water quality as part of the 2001 Upper Subwatershed Management Plan. These targets are summarized in Table 3-62.

Table 3-62: Upper Subwatershed 2001 Water Quality Targets

Parameter	2001 Target
Water Temperature, Warmwater Fishery (°C)	Reduce no. of days < 5mg/L (by 2005, June-September)
E. *coli* (cfu/100 ml)	Partial body contact standard where public contact expected (dry weather)

Figure 3-109: Upper Imperviousness

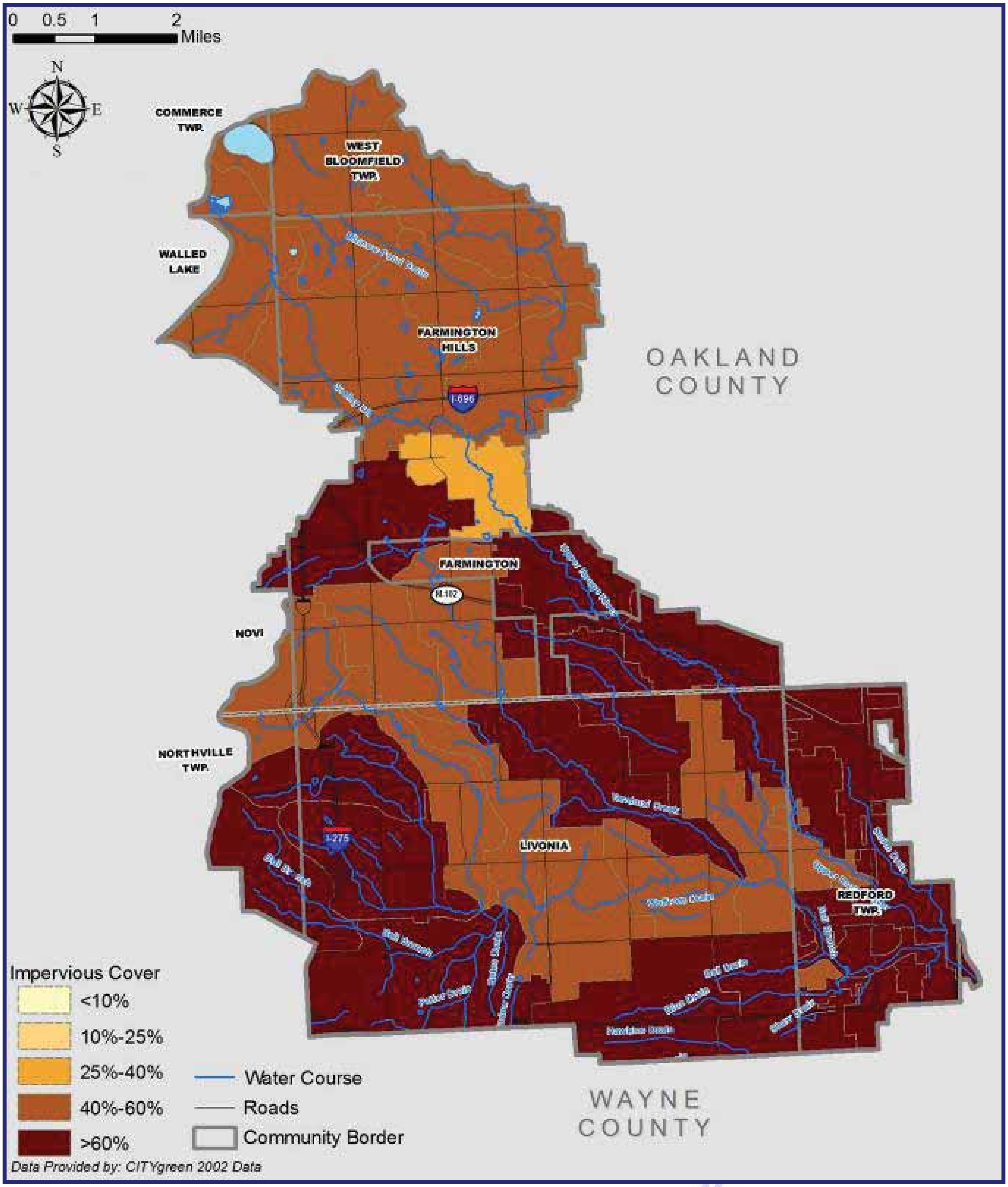


Table 3-63 provides a summary of the Upper Subwatershed data with monitoring locations identified in Figure 3-110. Water quality trends are indicated where sufficient data was available for a trend assessment. The criteria associated with this dry weather rating scale were previously outlined in Table 3-3 on page 3-13. More detailed information, including site specific ratings are available in the most recent RREMAR.

Table 3-63: Upper Dry Weather Conditions - Summary

Parameter	Telegraph Road U05	Inkster Road G71	Farmington Road U16	Six Mile Road U19
Water Temperature	Good	Good	Good	Good
Dissolved Oxygen (DO)	Fair ↑	Good ↓	Good ×	Good ×
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	NA	Good	Good	Good
Ammonia (NH_3-N)	NA	Good	Good	Good
Total Phosphorus (TP)	NA	Poor	Poor	Poor
Total Suspended Solids (TSS)	NA	Fair	Good	Good
E. coli	NA	Poor ×	Poor ×	Poor ↓

↑ indicates an improving trend ↓ indicates a declining trend × indicates no trend

300 E. coli per 100 ml (daily geometric mean) or 130 E. coli/100 ml (30-day geometric mean for total body contact (swimming)

1,000 E. coli per 100 ml (daily geometric mean) for partial body contact (boating, etc.)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3713-10416--,00.html

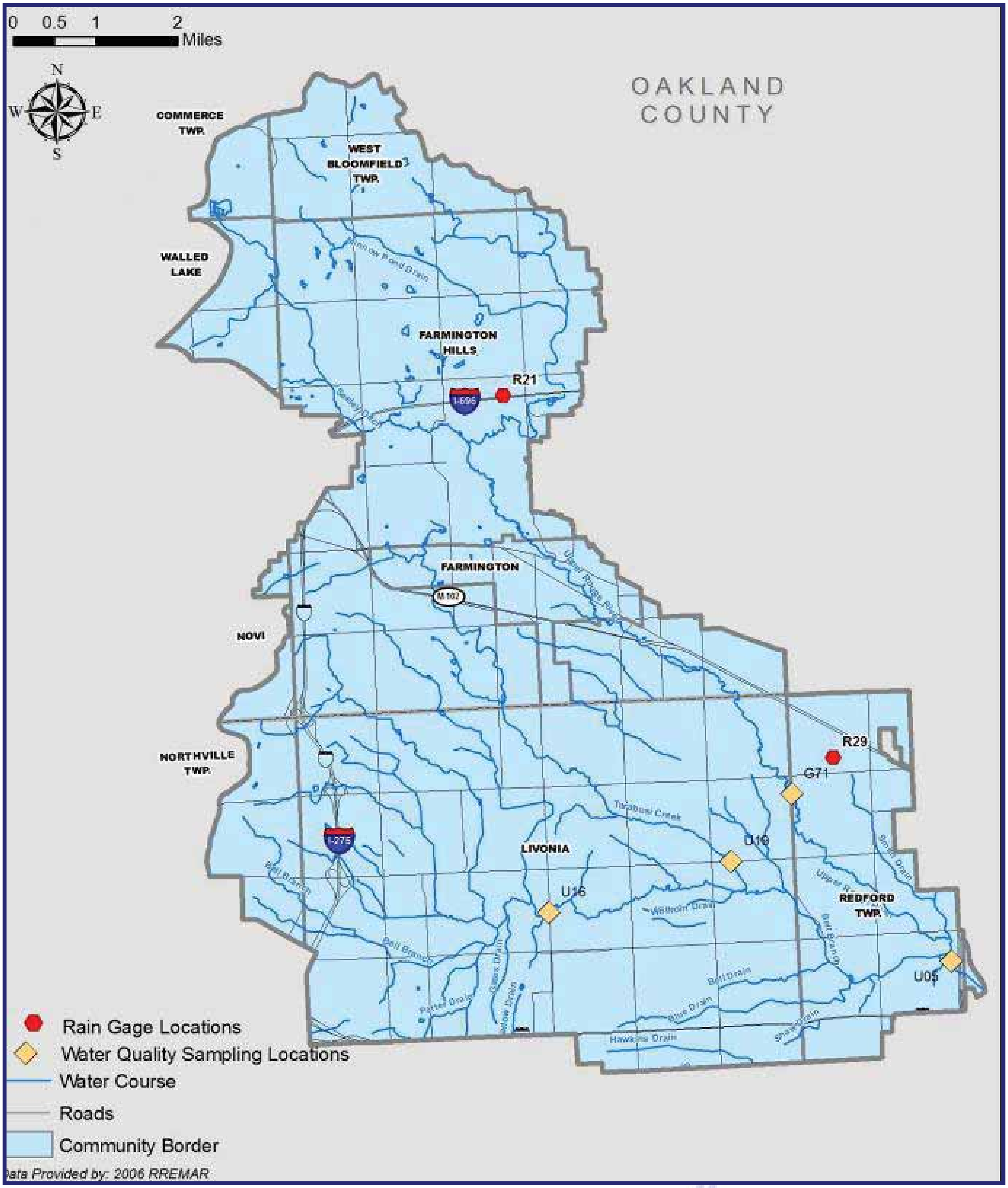
Samples analyzed for total phosphorus in 2004 indicated that they are approaching the general rating criteria of 0.05 mg/L and although a target was not established for TSS, dry weather sampling indicates both fair and good conditions.

Dry weather sampling results also indicated that the partial body contact target was met for two of the fifteen sampling events in 2004. Overall, based on the *E. coli* rating scale, the subwatershed rated poor.

E. coli Results

The *E. coli* information collected in the Upper Subwatershed indicates that pathogens continue to be a problem in this watershed. It is assumed that untreated sewage (and other sources) continues to enter this reach of the river. Water quality sampling for *E. coli* was completed by the MDEQ in 2005 for the development of the TMDL. Limited bacterial source tracking (BST) analysis was conducted as part of the MDEQ's effort to determine if areas with elevated *E. coli* were associated with human (sewage) sources. Continuing the efforts of the MDEQ, in 2006 the ARC completed a more comprehensive BST assessment to help identify areas where untreated sewage is entering the river. Specific sampling information may be found in the Rouge River *E. coli* TMDL and the RREMAR at www.allianceofrougecommunities.com.

Figure 3-110: Upper Water Quality Sampling and Rain Gage Locations



The 2005 *E. coli* data indicated that the Upper Branch and its tributaries rarely met the state's total body contact water quality standards and frequently exceeded the partial body contact standards (see Figure 3-111). In fact, the Upper Subwatershed had the highest *E. coli* concentrations of all the Rouge subwatersheds. These exceedences occurred during both dry and wet weather conditions (MDEQ, 2007c). Sources of *E. coli* include storm water runoff contaminated with feces from pets, urban wildlife like raccoons, deer and possum to and agricultural animals like horses, cows or pigs. Human sources of *E. coli* include untreated sewage from illicit connections, untreated combined sewer overflows (CSOs), aging sanitary sewers and failing septic systems which are also called on-site sewage disposal systems (OSDSs).

The BST data showed human sources of *E. coli* are suspected at seven sites during wet conditions and two sites during dry weather (Figure 3-112). The dry weather human *E. coli* sources are most probably associated with illicit connections, while the wet weather sources could be any of the human sources mentioned previously.

Water Quality in Wet Weather Conditions

The wet weather water quality in the Upper Rouge has improved. Multiple wet weather samples were collected at Telegraph Road (U05) in 1994, 1997, 1998, and in 2004. Trend analyses were performed on the $CBOD_5$, TSS, NH_3-N, TP, and *E. coli* data that have been collected since 1994. The following observations can be made from the data:

- TSS concentrations are improving,
- *E. coli* concentrations are also improving, and
- The 2004 *E. coli* wet weather daily geometric means all exceeded the partial body contract standard.

Over the past several years there have been CSO control program projects in the Upper Subwatershed including the Redford Township Retention Treatment Basin.

CSO basin in Redford

There are two major sources of Sanitary Sewer Overflows (SSOs) and these are increased volumes from legally connected gravity footing drains or illegal sump connections. There is also the potential for surface waters to enter manholes in flood prone areas which contribute to inflow to the system. In 2002, the City of Livonia constructed the Sunset Hills Sanitary Sewer to eliminate SSOs; the City of Farmington conducted a footing drain disconnection program in Chatham Hills Subdivision, and West Bloomfield Township completed a Sanitary Sewer System Evaluation to determine priority projects to reduce/eliminate potential SSOs.

Figure 3-111: Upper E. coli Sampling Results

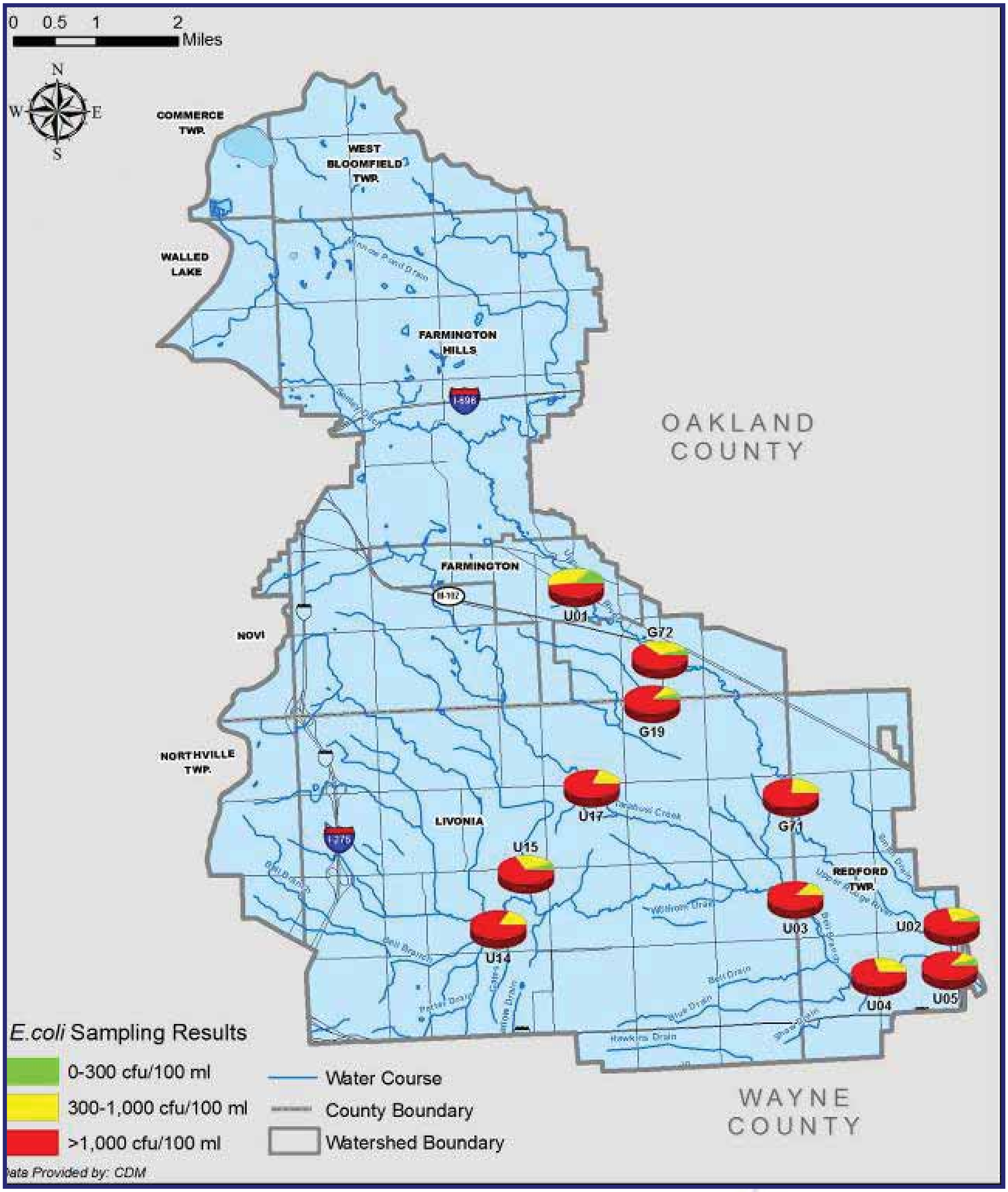
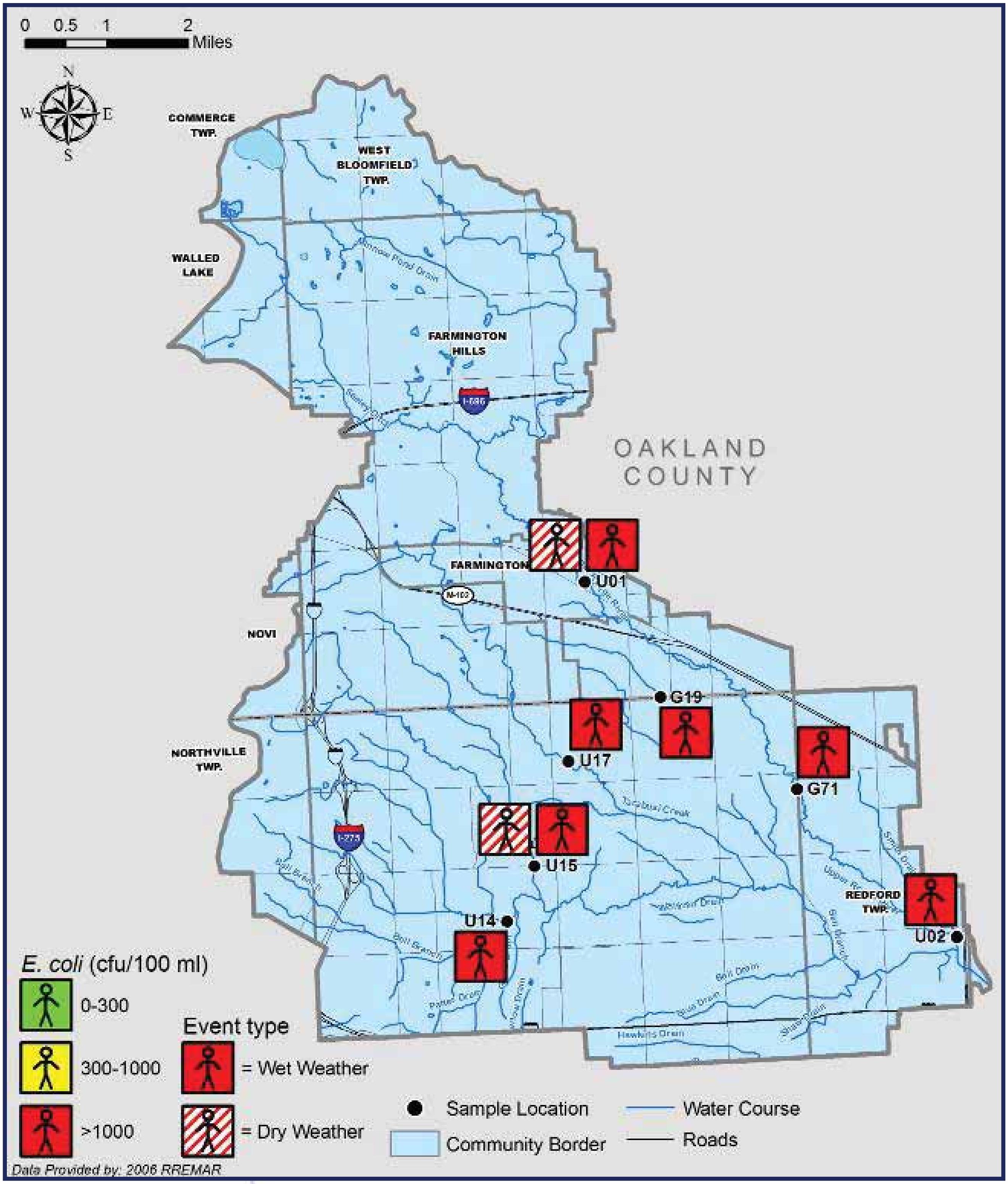


Figure 3-112: Upper Bacterial Source Tracking Results



While CSOs and SSOs discharge during wet weather events and, therefore, when storm water dilution occurs, failing septic systems can discharge continuously. Since a typical house is expected to discharge wastewater in excess of 50,000 gal/yr, failing septic systems can be a significant source of *E. coli* to the river. Based on studies done in the Rouge River Watershed and across Michigan, the expected failure rate for these systems is 25% to 40%.

Urban Storm Water and Non-Point Source Pollutant Loading

Urban storm water continues to stress the Upper Rouge River. Thus the communities are required to estimate this portion of the pollutant load and affect management practices to reduce the impact.

Total pollutant loading considering base flow, point sources, CSOs and non-point sources was estimated for the Rouge River using the WMM model. The estimated existing pollutant loads for the Upper Subwatershed are summarized in Table 3-64.

Pollutant Abbreviations:

BOD: Biochemical Oxygen Demand
DP: Dissolved Phosphorus
NO_2: Nitrite
NO_3: Nitrate
TKN: Total Kjeldahl Nitrogen
TP: Total Phosphorus
TSS: Total Suspended Solids

Table 3-64: Existing Pollutant Loads for the Upper Subwatershed

Pollutant	Units	Source				Total Load
		Base Flow	Storm Water	Point Sources	CSO	
BOD	lbs/yr	6%	90%	1%	3%	2,620,000
DP	lbs/yr	9%	88%	1%	2%	19,000
Fecal Coliform	counts/yr	0%	58%	0%	42%	9.9×10^{15}
NO_2 & NO_3	lbs/yr	11%	85%	3%	1%	158,000
TKN	lbs/yr	14%	84%	1%	1%	248,000
TP	lbs/yr	7%	87%	2%	4%	38,700
TSS	lbs/yr	8%	87%	1%	4%	7,490,000

Comparing the pollutant loadings from various sources provides a mechanism for subwatersheds to prioritize efforts aimed at reducing the pollutants within the Rouge River. The most significant contributor to pollutant loading are non-point sources. For purposes of prioritizing storm water BMPs, the remainder of the analysis within this section focuses on pollutant loading associated with non-point sources.

The Upper Subwatershed was subdivided into 53 subareas as a part of the modeling effort. The total pollutant loads associated with non-point sources for fecal coliform, phosphorus and total suspended solids (TSS) within each subarea are shown in Figures 3-113, 3-114 and 3-115. Locating storm water BMPs in areas with higher pollutant loadings can provide a more significant improvement to the water quality within the Rouge River.

These figures demonstrate that higher levels of impervious cover generate higher pollutant loadings in non-point source runoff. These areas are consistently located in the upper headwater areas such as Seeley and Minnow Creek and along Smith Drain. These figures are used as a relative measure of critical area identification.

Figure 3-113: Upper Fecal Coliform Estimated Non-Point Source Load

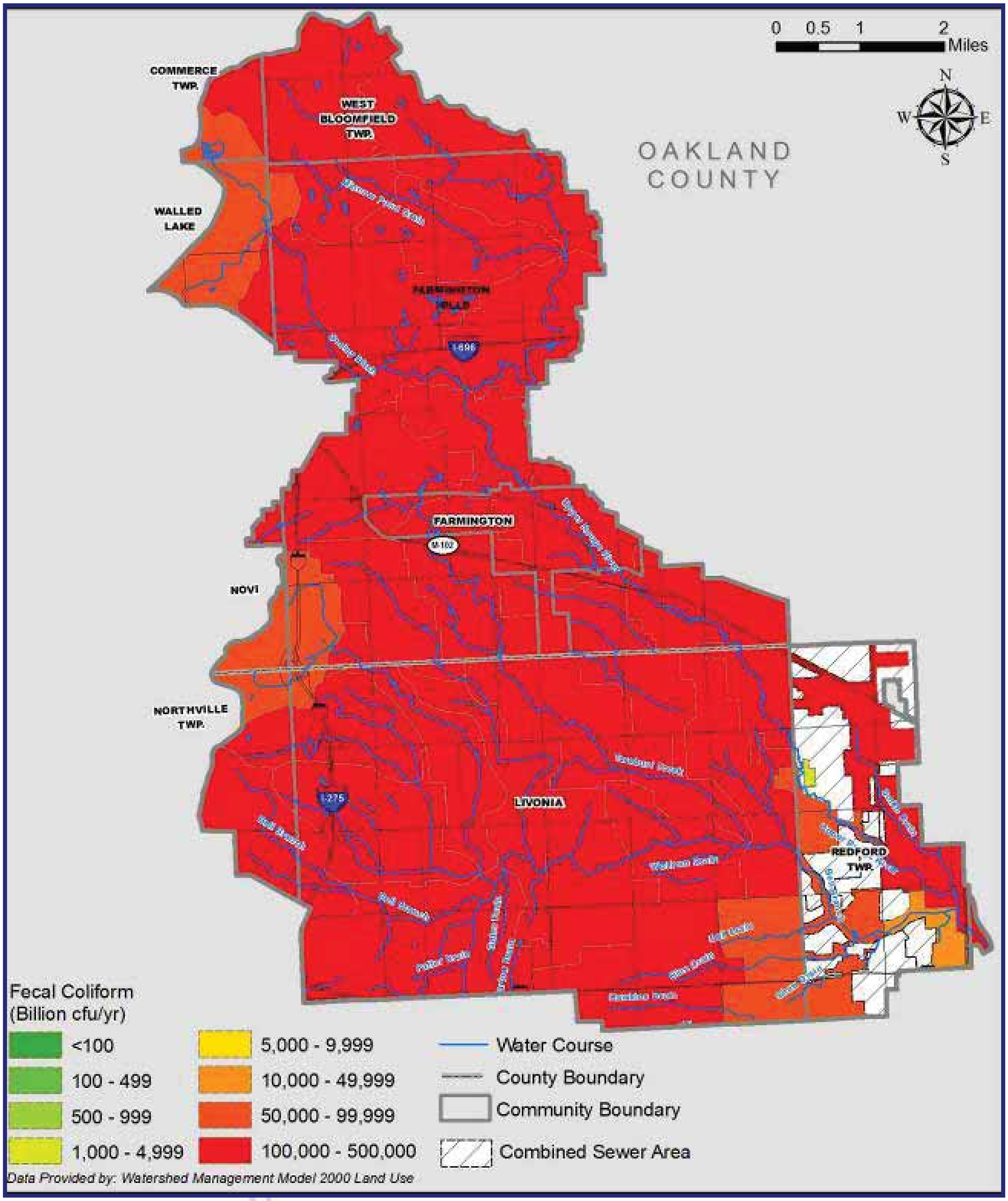


Figure 3-114: Upper Total Phosphorus Estimated Non-Point Source Load

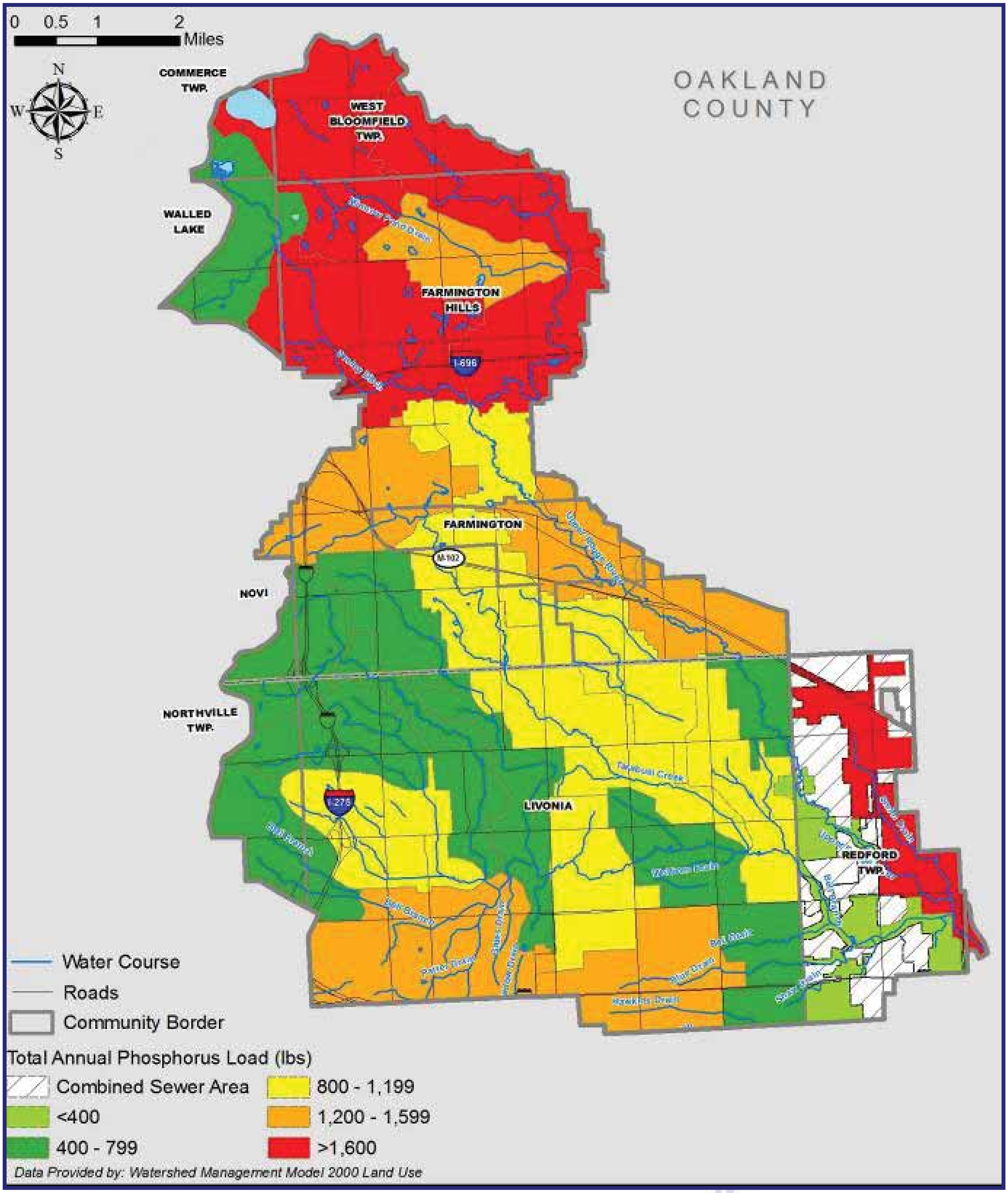
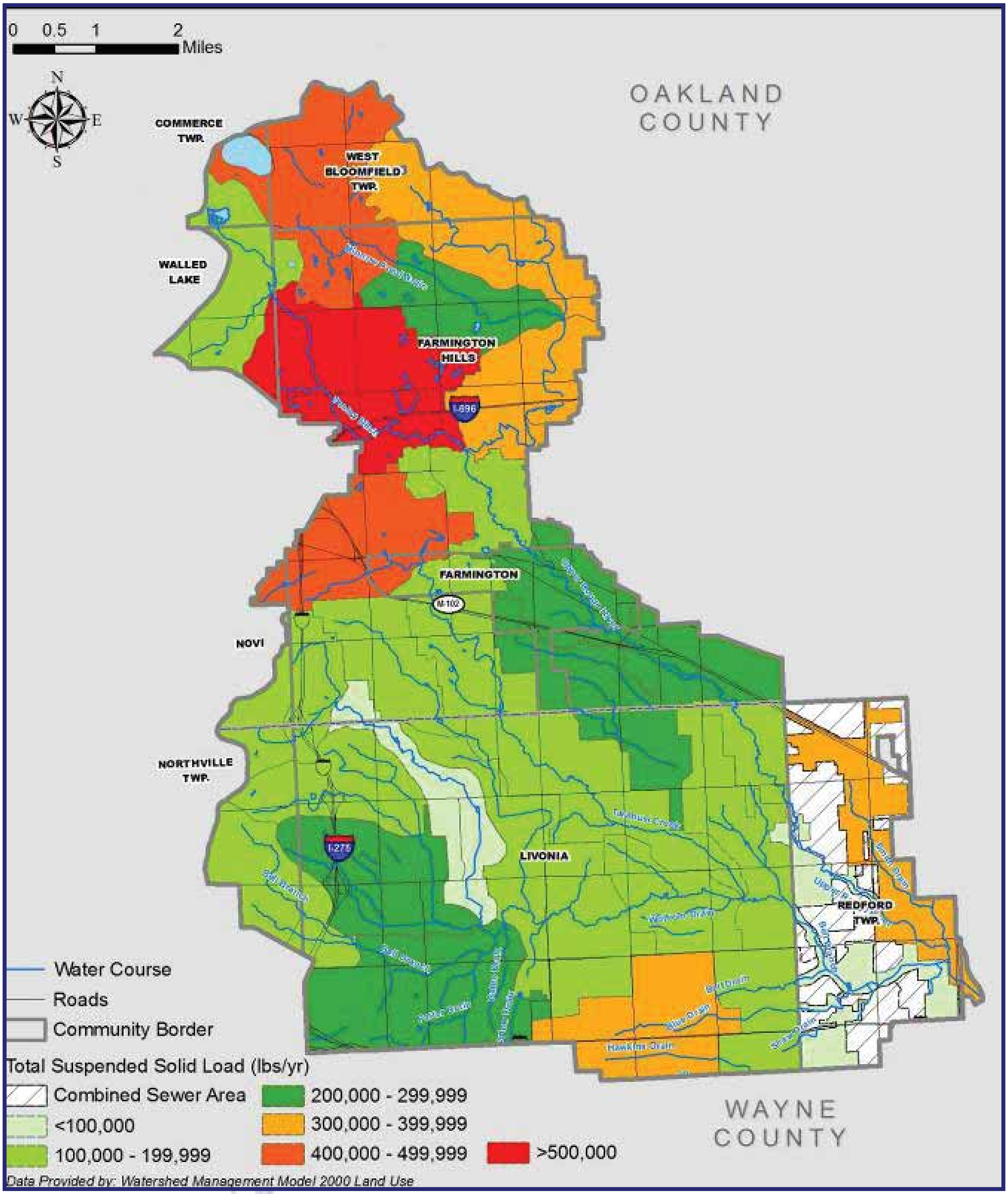


Figure 3-115: Upper Total Suspended Solids Estimated Non-Point Source Load



The primary sources of phosphorus in the critical Upper subbasins are likely fertilizer runoff from residential, commercial and golf course lawns, runoff impacted by pet waste, and illegal sewer connections. Possible sources of TSS include runoff from paved surfaces, such as large commercial and industrial parking lots, streambank erosion due to high river velocities and lack of vegetation, and overland erosion of exposed soils on construction sites without proper soil erosion control practices.

Stream Hydrology

The hydrologic trends along the Upper Rouge continue to cause excessive erosion and habitat destruction. The 2001 Upper Subwatershed Management Plan identified goals for addressing flow variability. While these goals focused primarily on addressing the rate of runoff, the excess storm water volume still poses challenges to further restoration opportunities. Best Management Practices (BMPs) that address the storm water runoff volume from smaller rain events, such as those under 2-inches in a 24-hour period, are critical to reducing the impacts from the stream and river flow variability. Background data and model evaluations are further discussed.

Minnow Pond Creek in Farmington Hills

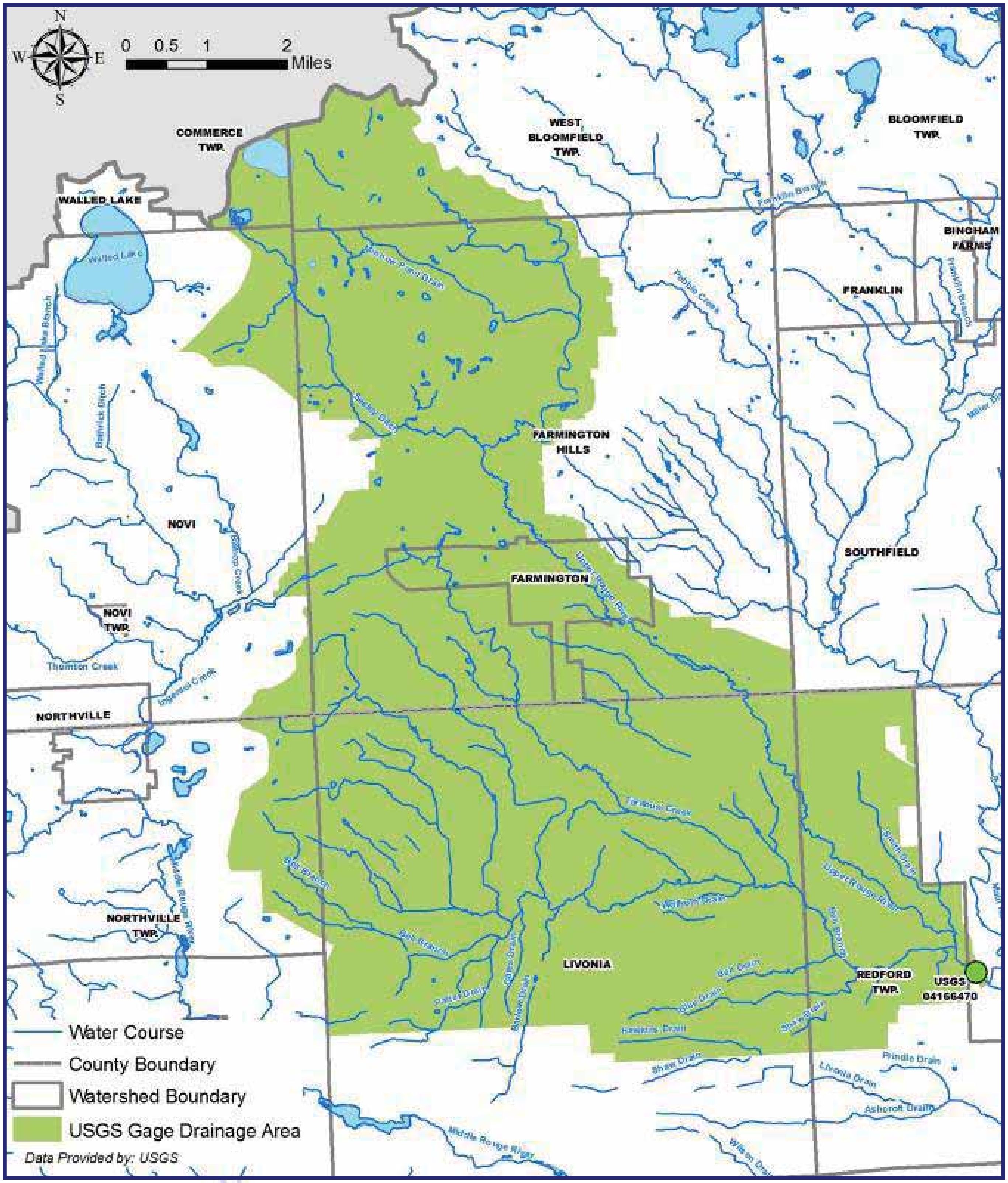
The Upper Subwatershed is the most stable major branch in the watershed with the bankfull, or overbank flood event, occurring on the order of every two years at the location of the USGS gage. However, this stream is considered impacted because of its flashiness based on 15 day and 1 month flows.

A hydraulic analysis was completed to help identify Best Management Practice (BMP) measures that may be implemented to reduce the flashiness of the river (see Appendix C). The bankfull flow rate is generally considered to be the largest flow that can be completely contained within the low flow channel of a river. In stable river systems, the bankfull flow corresponds to a return period of one to two years. More frequent occurrences of the bankfull flow generally result in increased streambank erosion due to high flow velocities. In order to address streambank erosion problems, it is important to understand the frequency of the erosive small storm events and take actions to reduce the frequency of these events.

USGS gage location in Farmington

Figure 3-109 on page 3-231 shows the ranges of impervious cover across the subwatershed. The increased imperviousness heightens the effect of smaller storm events which generate highly erosive velocities within the low flow channel. As mentioned, it is critical to reduce the frequency of these events in order to minimize flow variability in the stream channels. The USGS gage (04166300), Upper Rouge River at Farmington (US3), provides appropriate flow information for identifying goals for the Upper subwatershed. Figure 3-116 shows the area in the subwatershed that contributes to the flow conditions for this gage.

Figure 3-116: Upper USGS Gage at Detroit Drainage Area



Results of the hydraulic analysis indicate an increasing trend of the flow rates of the 15-day and 30-day storm events (see Table 3-65).

Table 3-65: Upper Subwatershed Flow Rate Trends at Site US3 (Upper Rouge River at Farmington)

Bankfull Flow Rate	478 cfs with return period of 21.1 months
15-day	46 cfs
30-day	81 cfs

Figure 3-117 represents the locations of the highest annual storm water runoff volume subareas based on the WMM model.

Idyl Wyld golf course in Livonia

The combination of the gage analysis, impervious cover and annual storm water runoff volume across the subwatershed provide important information for focusing efforts on reducing storm water runoff volume. Based on the trend analysis, it was determined that reducing the frequency of the 30-day storm event by half or capturing, retaining and/or reusing a total of approximately 47,000,000 cubic feet of storm water (0.318 inches of water over the subwatershed) is needed to help reduce the effect of these small storms. It is important to note that the water needs to be retained rather than detained. While detention basins reduce peak flows, they do not provide the necessary volume reduction to reduce flow rates of small storm events.

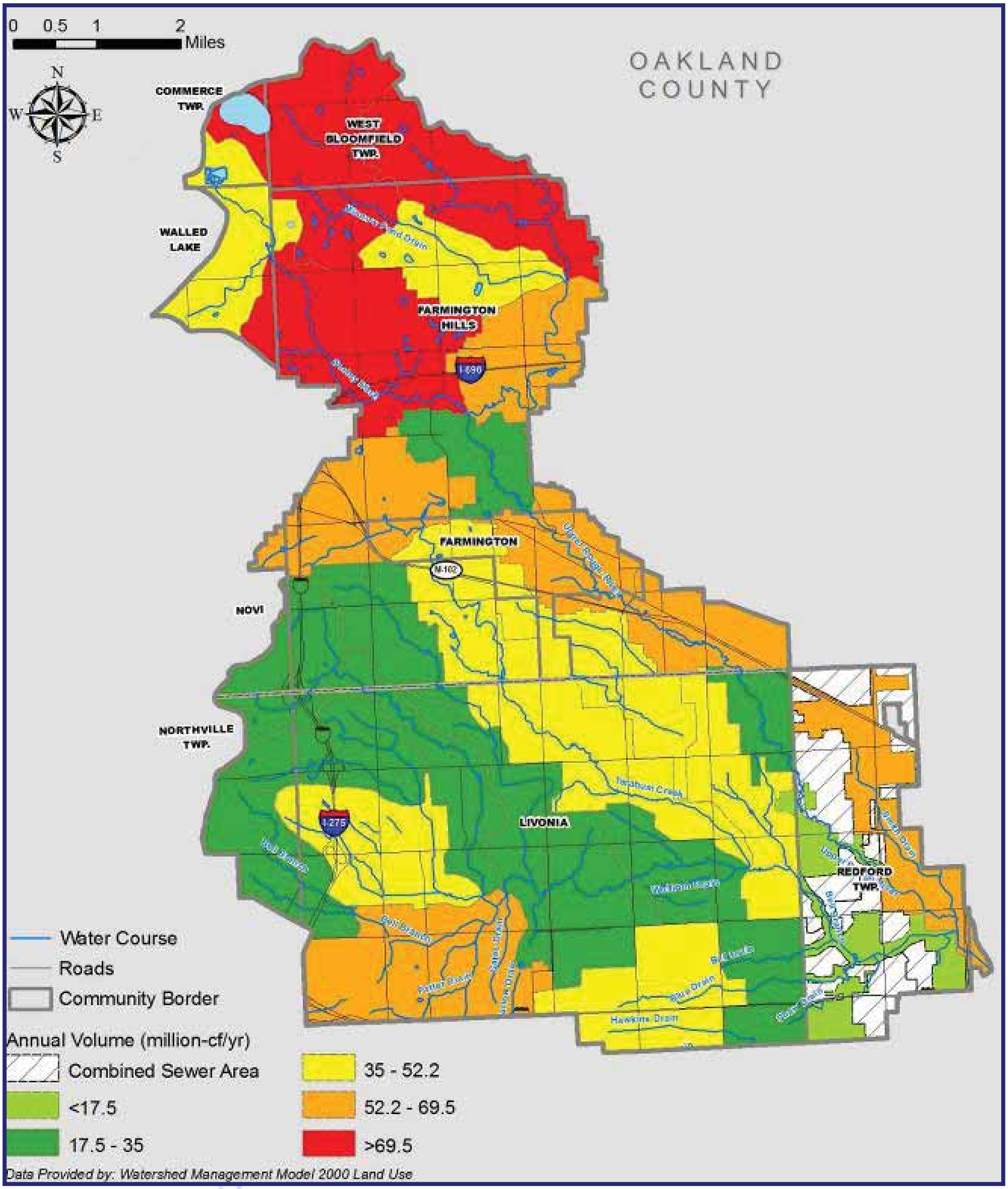
A number of techniques can be utilized to meet the volume reduction goal. Large-scale or regional improvements, including regional in-line and off-line infiltration basins, and constructed wetlands might be more appropriate for addressing storm water runoff from highly urbanized areas. Improvements to existing road-side ditches and swales, including installation of check dams can provide retention volume. Small-scale BMPs, including rain barrels, bio-retention basins or rain gardens, and porous pavements can be installed on individual properties. Additional trees and grow zones within the subwatershed will also provide storm water retention.

Caddell Drain in Farmington Hills

Over the past several years various projects have been completed in the Upper Subwatershed to help control flow in the river. These include:

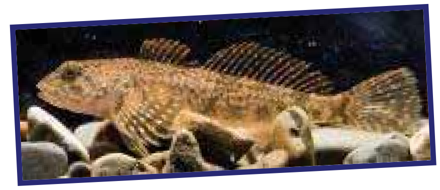
- An off-line regional storm water management facility at Idyl Wyld golf course to manage storm water from a 2,700 acre area completed by the City of Livonia.
- A new outlet to increase detention in an existing, large, in-line regional upstream pond at the Caddell Drain Storage Facility constructed by the Oakland County Water Resource Commissioner's Office .
- A rain garden to treat runoff from the roof of the Heritage Park Nature Center installed by the City of Farmington Hills.

Figure 3-117: Upper Storm Water Runoff Non-point Source Annual Volume



Ecosystems

Ecosystems encompass three main topics, including aquatic diversity (fish, benthics and frog & toad), stream habitat and the physical stream corridor (riparian, wetlands and woodlands). In our opinion, the two primary challenges negatively impacting the Upper Subwatershed ecosystems are excessive flow variability, in terms of both flow rates and storm water runoff volume, along with lack of appropriate spawning habitat. Even this lack of spawning habitat can be attributed to the excessive flow variability. It is for this reason that improvements in biological communities and their respective habitats is dependent on implementation of management measures designed to reduce the impacts of flow variability.



Mottled sculpin

Aquatic Diversity

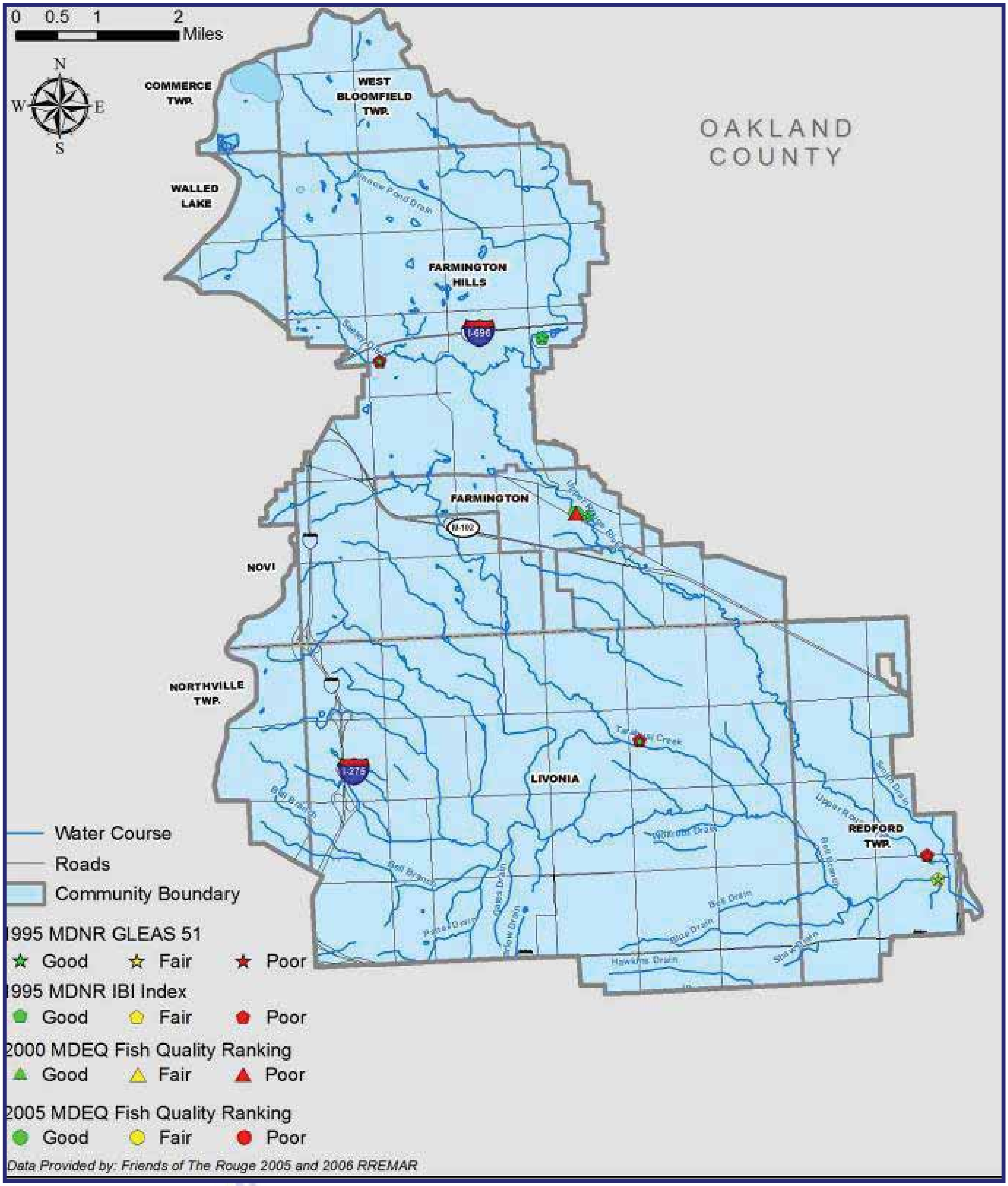
Fish Communities

The Minnow Pond Drain, near Farmington Road, and Seeley Drain, Halstead Road, contained sensitive fish species like redside dace and mottled sculpin, and the most diverse aquatic habitat. The main factors negatively affecting fish community integrity in the Upper Subwatershed are believed to be excessive flow variation and lack of appropriate spawning habitat. Stream quality habitat including diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation and stable streambanks all contribute to the quality of fish communities. Since the inception of the Rouge Project, a number of studies and assessments have been completed to describe the status of the fish populations throughout the watershed.

Six sites located in the Upper Subwatershed were surveyed as a part of the 1995 MDNR fish assessment. Assessments were made using both the Index of Biotic Integrity (IBI) (Karr, 1981) and the Michigan Department of Environmental Quality, Surface Water Quality Division, Great Lakes Environmental Assessment Section, Procedure 51 (GLEAS 51) methodologies. The IBI and GLEAS 51 methodologies measure the biotic integrity of a fish population. This is defined as a *"balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region"* (Karr & Dudley, 1981).

The MDEQ completed additional surveys in at one location in the 2000 and 2005 using the GLEAS 51 procedure (MDEQ, 2005). Unfortunately, direct correlation and trends between the 1995, 2000, and 2005 surveys are not possible because the survey points were different in each study. Figure 3-118 shows the overall fish community rating for the above-referenced surveys.

Figure 3-118: Upper Fish Community Assessments



Fish Consumption Advisories

The MDNR along with the Michigan Department of Community Health (MDCH) have established fish consumption advisories for selected fish in the Upper Subwatershed (MDCH, 2007). These fish and their associated advisory were last updated in April 2007, as shown in Table 3-66.

Table 3-66: 2007 Fish Consumption Advisories for the Upper Subwatershed

Location	Fish Species	Contaminant	General Population[1]	Women and Children[2]
Upper Branch	Suckers	PCBs	Unlimited consumption	One meal per week
Lakes/Impoundments	Rock Bass, Yellow Perch or Crappie	Mercury	No more than one meal per week of fish over 9 inches	No more than one meal per month
	Bass, Walleye, Northern Pike or Muskellunge	Mercury	No more than one meal per week of fish any size	No more than one meal per month

Notes: [1] Men and boys over the age of 15 and women who are beyond child bearing years.
[2] Women of child bearing years and children under the age of 15

Notable Areas

Of the four locations sampled, Minnow Pond Drain near Farmington Road and Seeley Drain at Halstead Road contained sensitive fish species like redside dace and mottled sculpin, and the most diverse aquatic habitat. Adult rainbow trout have been stocked near Powers Road to support short-term fishing derbies. There is no evidence of the establishment of a permanent population.

Impairments

Low dissolved oxygen levels, siltation in spawning and feeding areas, degradation of physical habitat due to the bank erosion and streambed scouring associated with frequent high flood flows are the most significant factors limiting the abundance of fish species in the Upper Subwatershed. Biotic integrity quickly diminishes from headwaters to the main branch of the Upper Rouge River. Tarabusi Creek at Orchard Lake Road and the Bell Branch, between Beech-Daly and Telegraph roads, exhibit unstable, eroded streambanks due to extreme flow patterns. Physical impacts to tributaries including channelization, relocation and enclosure have resulted in negative cumulative impacts on fish communities. Uncontrolled CSOs still exist downstream of the Bell Branch where DO was monitored continuously at Telegraph Road (U05) from 1994 through 2005. DO concentrations at this site continue to drop below the State water quality standard of 5 mg/L.

Slender winter stoneflies (Capniidae) were found in the Upper Subwatershed at Heritage Park in Farmington Hills

Macroinvertebrate Communities

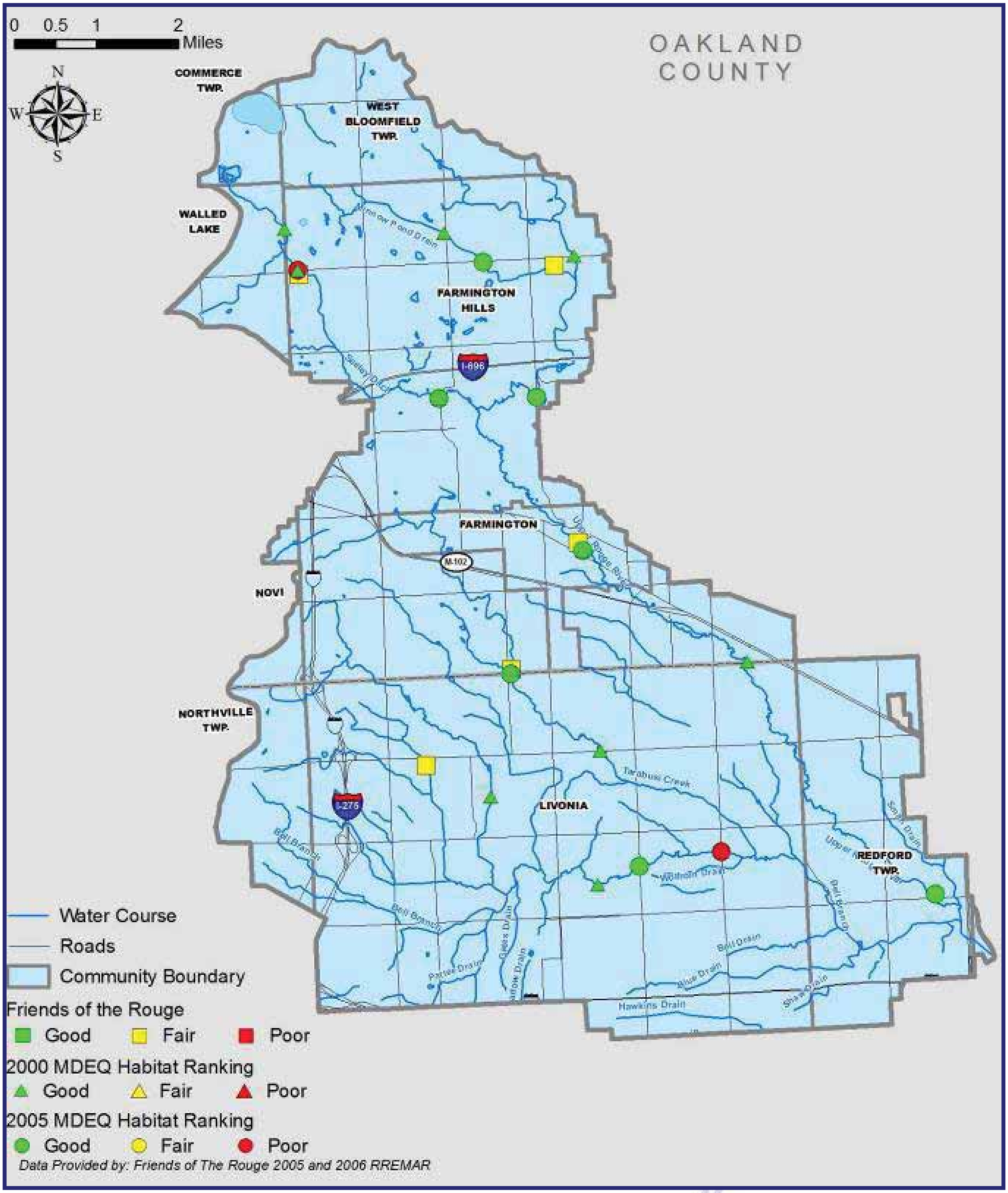
As previously described, the presence, abundance and diversity of certain macroinvertebrates in the streambed, is also an excellent long-term indicator of water quality. Aquatic macroinvertebrates live in or on the bottom of streams, and include species of insects, clams, snails, worms, scuds, sow bugs, crayfish, dragonflies and many others. Since macroinvertebrates are relatively immobile, the presence and absence of a family or genera of organisms can indicate long-term changes in water quality. Furthermore, different groups of macroinvertebrates respond differently to different types of water quality impairments. Generally, a natural, unpolluted stream reach supports many different kinds of macroinvertebrates with relatively few individuals of any given species. In high quality streams, insects of the stonefly, mayfly and caddisfly groups usually constitute a large portion of the aquatic macroinvertebrate community. In a degraded stream, however, few of these pollution-intolerant macroinvertebrate groups exist, while there may be an abundance of worms and air-breathing or pollution-tolerant species of worms or midges.

Several studies have been undertaken to assess the macroinvertebrate population in the Rouge River Watershed over the past decades. Below is a description and summary of these results within the Upper subwatershed. In 1999, the Rouge Project collected macroinvertebrates from five locations both upstream and downstream of the Redford CSO basin in an effort to assess the effects of basin discharges on the river (Rathbun & Frederick, 2000). The study results concluded that macroinvertebrate communities at all five sites were neither numerous nor diverse, and while the populations approximately 200 feet downstream of the basin outfall may have been negatively impacted by the basin's discharge, they recovered within another quarter-mile downstream.

Monitoring in Farmington Hills

During MDEQ's Rouge River biological assessment surveys of 2000 (Goodwin, 2002), macroinvertebrate communities were sampled at nine locations in the Upper Subwatershed with all sites earning a rating of Acceptable. In 2005 another biological assessment was performed by the MDEQ at nine stations in the Upper Rouge River and its tributaries (MDEQ, 2005). Seven of the stations were assessed an Acceptable rating and two of the stations were assessed a Poor rating. FOTR began sampling in the Upper Subwatershed in 2002 and have 12 sites located for spring sampling, 14 for fall sampling and six sites for winter stonefly sampling. The number of sites sampled per event varies from year to year depending on the number of volunteers who participate, however, the site locations have not changed for long-term evaluation. Stoneflies have only been observed in 2003 at the Upper Branch site at Shiawassee Park in Farmington. Figure 3-119 shows the location sampled and overall rating by the MDEQ and FOTR.

Figure 3-119: Upper Macroinvertebrate Assessments



Notable Areas

Overall aquatic macroinvertebrate populations in the Upper Rouge Subwatershed are of fair quality. Assessments of Tarabusi Creek at Eight Mile Road in Farmington Hills and the Minnow Pond Drain near Farmington Road consistently exhibit the higher quality populations of aquatic macroinvertebrates.

Impairments

Impervious cover, non-point storm water discharges, streambank erosion and sedimentation, and increasingly extreme hydrologic fluctuation continue to impair the quality of suitable habitat for benthic macroinvertebrates. These effects are being transferred downstream and are reflected in the lack of sensitive aquatic macroinvertebrates in downstream monitoring sites. Uncontrolled CSOs and SSOs continue to impair water quality at locations in the downstream portions of the subwatershed. Land use is primarily urban with a high percentage of impervious cover causing extreme stream hydrologic patterns.

Gray tree frog

Frog & Toad Diversity

Like many aquatic organisms, frogs and toads are sensitive to changes in water quality and to alterations in their habitat resulting from changes in impervious cover. This sensitivity makes frogs and toads good indicators of environmental conditions in the stream. Up to ten species of frogs and toads are possible in this watershed, however, pickerel frogs are seldom heard and Cope's gray treefrogs are difficult to distinguish from gray treefrogs so they are generally not included in volunteer survey activities.

The MDNR completed a frog and toad survey using volunteers in the Upper Subwatershed from 1996-2001, 2003 and 2006-2007. Results of MDNR surveys for the Upper Subwatershed are shown in Table 3-67 (MDNR, 2006).

Table 3-67: MDNR Frog and Toad Survey - Percent of sections in which species was heard in the Upper Subwatershed

Species	1996	1997	1998	1999	2000	2001	2003	2006	2007
Wood Frog	100	0	0	0	0	0	0	0	0
Western Chorus Frog	0	10	0	17	0	0	0	0	0
Spring Peeper	70	70	67	33	100	0	0	0	25
American Toad	30	30	50	83	33	67	33	25	25
Northern Leopard Frog	40	10	0	0	33	0	0	0	0
Gray Tree Frog	60	50	67	50	33	33	33	8	50
Green Frog	40	40	50	0	33	0	33	17	0
Bullfrog	0	0	0	67	0	0	0	0	0
Total Sections Surveyed	10	10	6	6	3	3	3	12	4

Similar to the MDNR Frog and Toad Survey, the FOTR began a Frog and Toad Survey in 2000 and all eight species of native frog and toads are present in the Upper Subwatershed (Figure 3-120). Their distribution is not uniform and is dependent upon habitat availability. The species require varied habitat types. For instance, wood frogs require forested wetlands with vernal pools while bullfrogs and green frogs prefer permanent water bodies like ponds and streams. The data is best suited for determination of trends in species present or absent over time. Annual populations tend to fluctuate as a whole, based on precipitation and temperature characteristics, but the prevalence of species remains consistent throughout the area. Chorus frogs were heard for the very first time in three blocks that had been surveyed before including Franklin & 14 Mile roads, Farmington and 13 Mile roads, and Drake and 13 Mile roads (FOTR 2007).

Table 3-68 shows the total number of blocks surveyed and the percent of blocks in which species were heard from 2000 –2006 (FOTR, 2006).

Table 3-68: FOTR Frog and Toad Survey - Percent of blocks in which species was heard in the Upper Subwatershed

Species	2000	2001	2002	2003	2004	2005	2006	2007
Wood Frog	9	9	25	0	19	22	11	35
Western Chorus Frog	22	22	15	22	30	22	26	35
Spring Peeper	26	26	20	41	52	42	47	59
American Toad	30	30	60	52	77	77	74	71
Northern Leopard Frog	4	4	5	0	5	10	16	35
Gray Tree Frog	0	0	5	7	32	39	26	59
Green Frog	0	0	15	22	52	48	53	59
Bullfrog	0	0	0	4	10	14	11	24
Total Blocks Surveyed	23	23	20	27	27	28	19	20

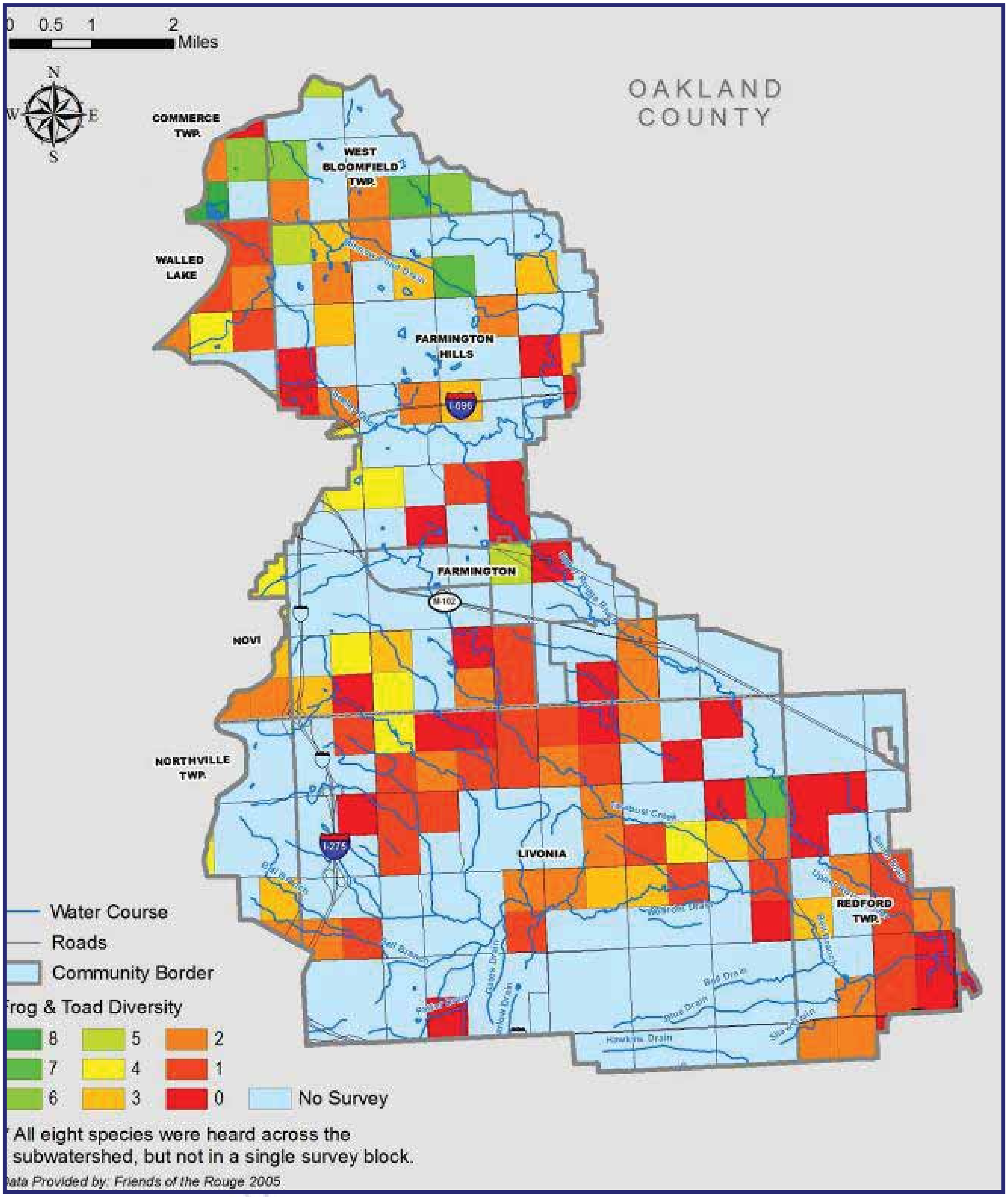
Notable Areas

In general, all species of identified frog and toads would be more prevalent in isolated, fishless, ponds, wetlands along the shore of impoundments in the floodplain or wetlands associated with the river valley. Golf course ponds are also places where frogs and toads can be found.

Impairments

Changes in populations of frog and toads can be attributed to habitat impairments. Some of these are unpredictable and out of human control, such as disease or differences in temperature and precipitation from year to year.

Figure 3-120: Upper Frog and Toad Diversity



Changes in water chemistry from storm water runoff and degradation of aquatic breeding areas can also negatively impact these species. Filling and draining of palustrine emergent, shrub scrub and forested wetlands will result in decreased frog and toads breeding areas. Mitigated and man made wetlands can be appropriate substitutes; provided the quality and quantity of water and vegetation within these wetlands approximates what would be found naturally.

Stream Habitat

Stream habitat in the Upper Subwatershed varies in conditions due to flow rate variability, excess storm water volume and water quality. One of the factors contributing to the success of a diverse and robust fish community is the existence of quality stream habitat. Characteristics of quality habitat include: diversity (pools, riffles, and woody debris), suitable substrate types, available cover, flow stability, depth variability, low sedimentation, stable streambanks and stable water temperatures.

Bell Branch in Livonia

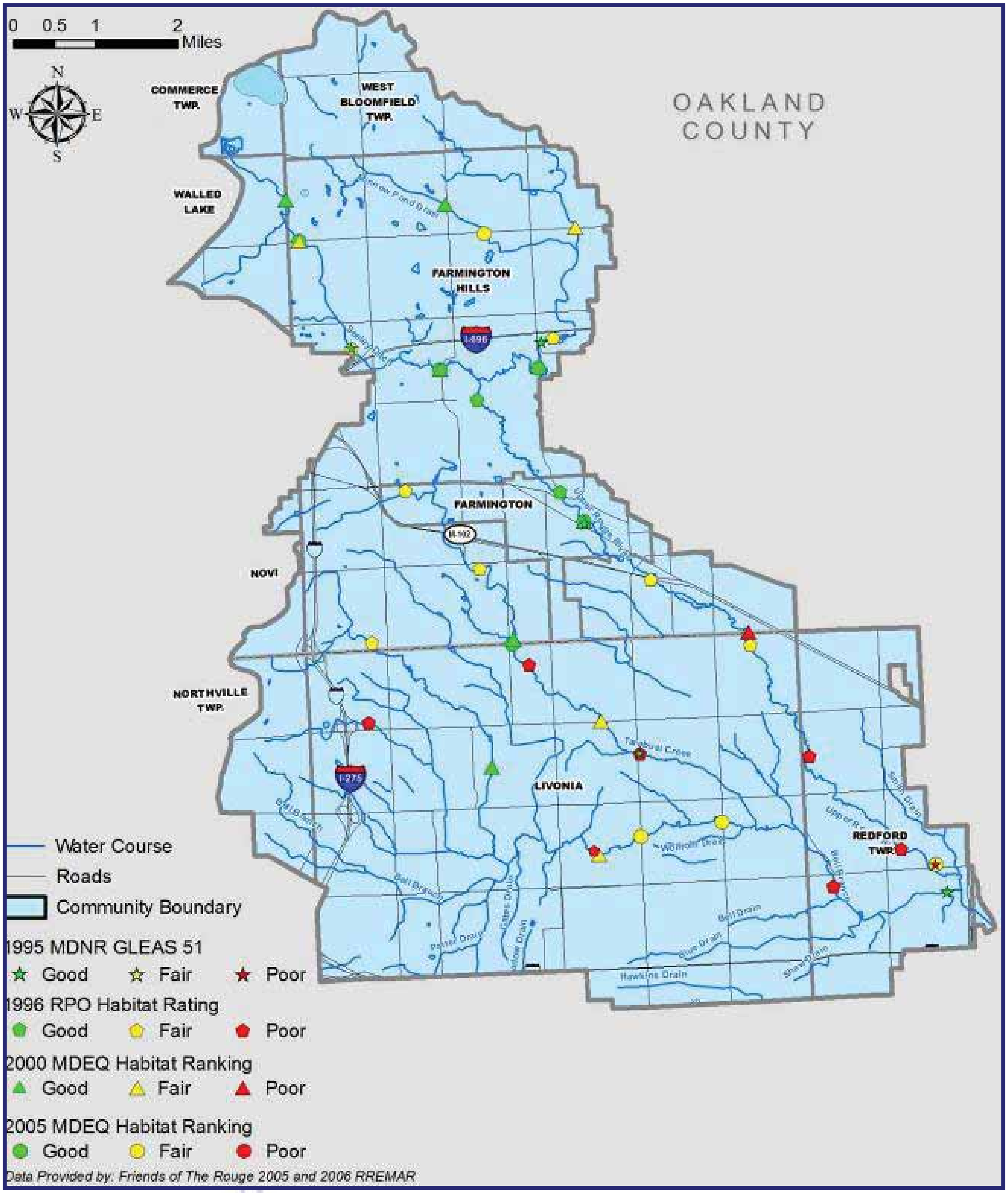
Stream habitat is significantly altered by changes in both the frequency and magnitude of storm events. As described in the Stream Hydrology section above, the smaller, more frequent storms have a large impact on stream habitat. In urban streams, these more frequent storms cause changes in channel geometry to accommodate the increased flows. This also results in more streambank erosion and sediment deposition in the stream. Urban streams commonly transport two to ten times more sediment than rural streams (CWP, 2005). Observed habitat changes resulting from these hydrology changes include reduction in pool/riffle structure; sedimentation of the low-flow channel; reduction in woody debris; straightening of channels; and decline in undercut banks.

Streambank erosion

Evaluations of stream habitat were conducted by the MDNR in 1995 and again by the MDEQ in 2000 and 2005. Figure 3-121 shows the locations and results sampled in 1995, 2000 and 2005. In addition, the Rouge Project conducted an aquatic habitat survey during the summer of 1996. The Rouge Project findings were consistent with those identified by MDNR. All referenced studies used the MDEQ GLEAS 51 protocol previously described. Study results are also shown in Figure 3-121.

Both the 1995 MDNR and the 1996 Rouge Project studies rated the Upper Subwatershed on average as Poor. The 2000 MDEQ study however ranked the subwatershed on average as Fair. In 2005, five sites in the Upper Branch and its tributaries (Bishop Creek, Minnow Pond, Seeley Drain, Tarabusi Creek, and the

Figure 3-121: Upper Stream Habitat Assessments



Bell Branch) were rated Marginal and four sites were rated Good. The factors identified as negatively affecting habitat in the Upper Branch include excessive flow variation and lack of pool and riffle habitat areas.

Bell Branch at Beech Daly

Notable Areas

The Upper Rouge River at Powers Road, and the Seeley Drain, Minnow Pond drains and Drake Road were rated Good in the 1995, 2000 and 2005 assessments using GLEAS 51 protocols. Minnow Pond and Seeley Drains contain aquatic habitat that supports both sensitive fish and aquatic macroinvertebrate species.

Impairments

The primary cause of degraded stream habitat in the Upper Subwatershed is the excessive flow instability, accompanying erosion and sedimentation and a lack of habitat complexity. Extremes in flow result in erosion of streambanks and sedimentation that negatively impacts the bottom substrates. High flows displace small woody and other debris from the channel, eliminating flow refuges provided by hard substrates. The remaining uncontrolled CSOs in the watershed negatively impact water quality, however there are plans to correct these CSOs, which will improve water quality. Negative impacts from unchecked storm water inputs continue to impair the stream habitat.

Stream Corridor

The stream corridor generally describes the riparian corridor that includes floodplains and uplands, woodlands and wetland areas. It also includes that actual vegetation along the streambanks, including tree canopy. These natural features in the landscape are crucial to restoring and protecting the quality of the Rouge River Watershed.

Wetland in West Bloomfield

Riparian Corridor

A vegetated riparian corridor, or all the land adjacent to the river and creeks, can provide shading and cooling for water; organic debris to feed aquatic organisms; bank stabilization with its root structure; cover, perching and nesting areas for aquatic organisms, and a buffer for pollutants and sediments from surface runoff. The corridor is used by many birds and mammals as well as providing habitat for aquatic organisms. In many urbanized areas, riparian corridors have been converted to lawn, but significant strides have occurred to enhance these corridors and educate the public about their important role in the environment.

Wetlands and Woodlands

Figure 3-122 shows the existing wetlands within the Upper Subwatershed. This figure depicts forested wetlands as the highest percentage of remaining wetlands in the subwatershed, with smaller areas of both scrub-shrub and emergent wetlands. The forested wetland areas are generally located in stream floodplain areas and are connected to upland woodlands. The current woodlands are shown in Figure 3-123. General wetland protection guidelines include maintaining connection between the waterways, not mowing or disturbing native vegetation around wetlands, removing invasive species and creating buffer zones around wetlands.

Figure 3-122: Upper Existing Wetlands

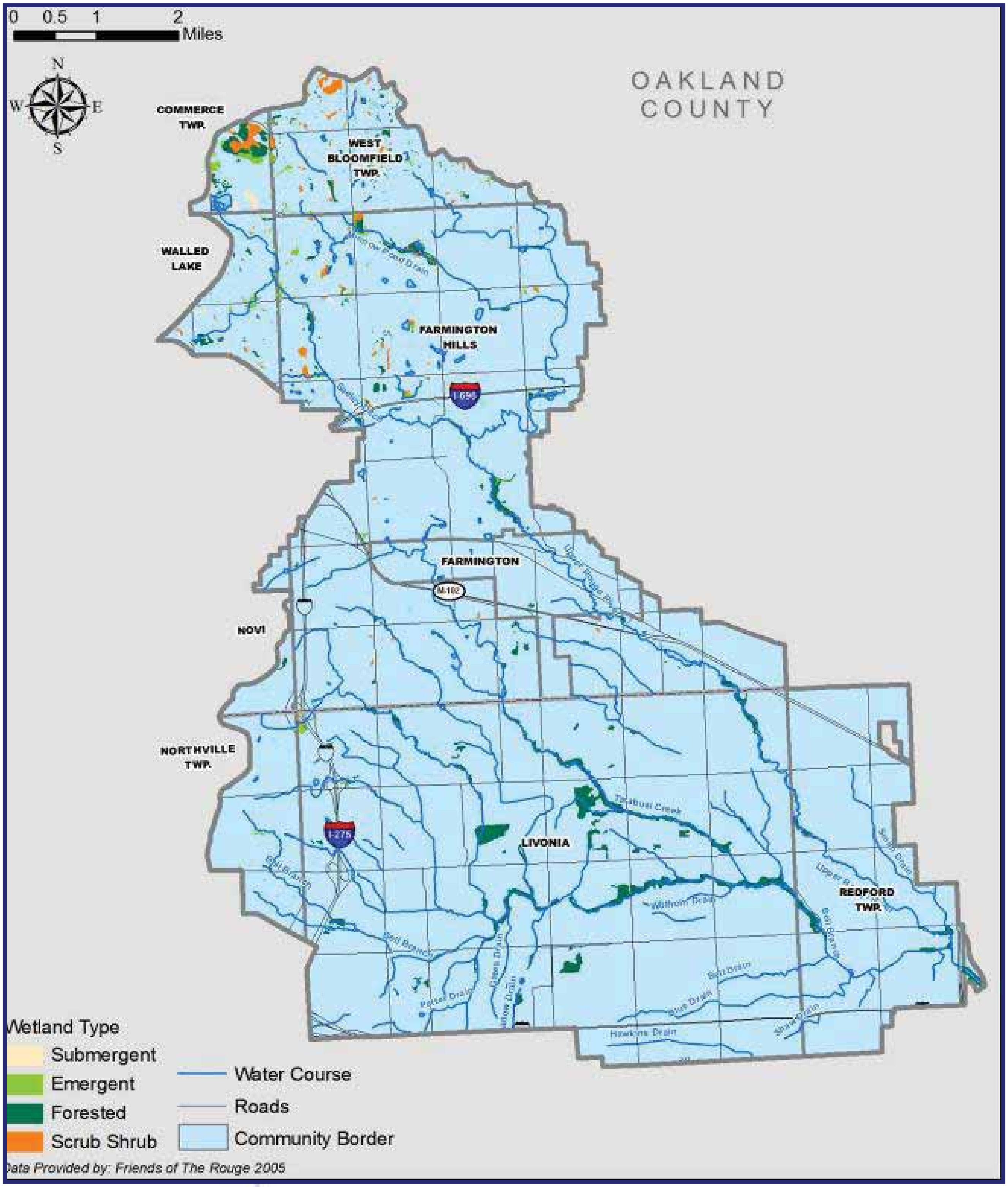
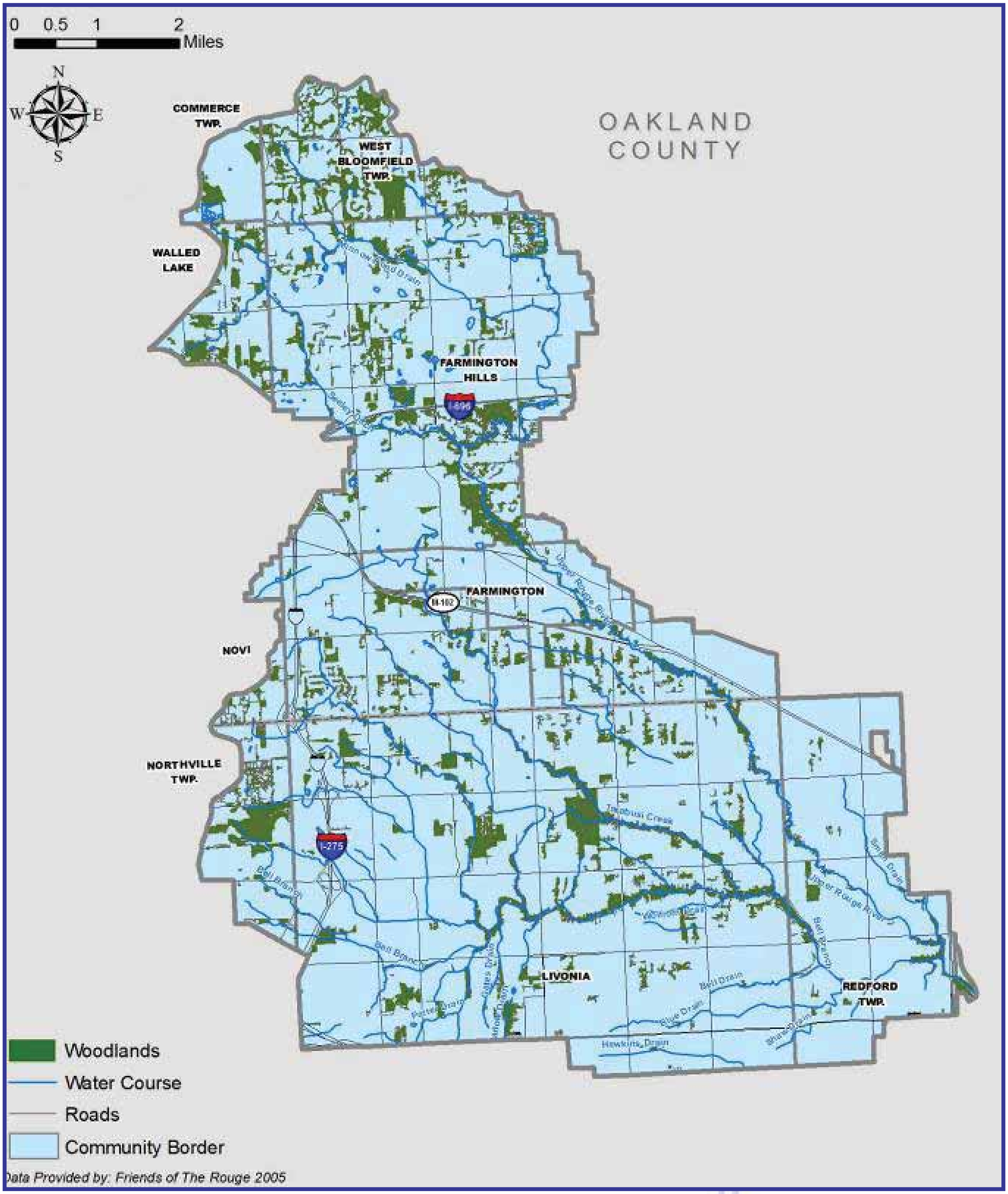


Figure 3-123: Upper Existing Woodlands



Shiawassee Park planting in Farmington

Woodlands, forests and heavily treed areas provide many benefits to water quality water quantity and wildlife habitat. Wooded areas provide nesting, perching, feeding and cover for birds and mammals. Wildlife commonly found in the area include grey fox, deer, song birds, wood ducks, weasels, skunks, flying squirrels, chipmunks, opossum, and others. Wooded areas also provide water quality and quantity benefits by cooling and shading storm water, intercepting storm water as it falls with leaf and trunk surface area and leaf litter, and increasing infiltration of storm water with root systems and often more permeable soils.

Historical Storm Water Projects in the Upper Subwatershed

All storm water best management practices have an effect on the water quality, fisheries, habitat, macroinvertebrates and the overall ecosystem. Below are a few projects Upper Subwatershed stakeholders have completed:

- Friends of the Rouge and the City of Farmington performed woody debris management and planted a native buffer along the riparian corridor in Shiawassee Park.
- Northville Township has initiated a detention basin maintenance program that includes maintenance agreements which grant the township a license to inspect all privately-owned detention basins and require that maintenance is performed.