Deep River-Portage Burns Waterway Watershed

1 Watershed Community Initiative

A watershed is the land area that drains to a common point such a location on a stream or even a lake. Within this watershed, human land use practices and activities can dramatically influence the health of its waterbodies. As rain or snowmelt moves over and through the ground it can pick up harmful pollutants from the watershed's various land uses and deliver them to nearby lakes and streams. This type of pollution is known as nonpoint source pollution and it is one of the greatest threats to water quality in Northwest Indiana.

Our particular watershed of interest is the Deep River-Portage Burns Waterway watershed (Figure 1). It is the largest of six watersheds located within the Little Calumet-Galien sub-basin, draining an area of approximately 180 mi² in north central Lake and Porter Counties. Some its major tributaries include portions of the West Branch Little Calumet River, Deep River, Main Beaver Dam Ditch and Turkey Creek. This watershed community initiative was begun to help address and restore the nearly 125 miles of impaired stream within its boundaries.

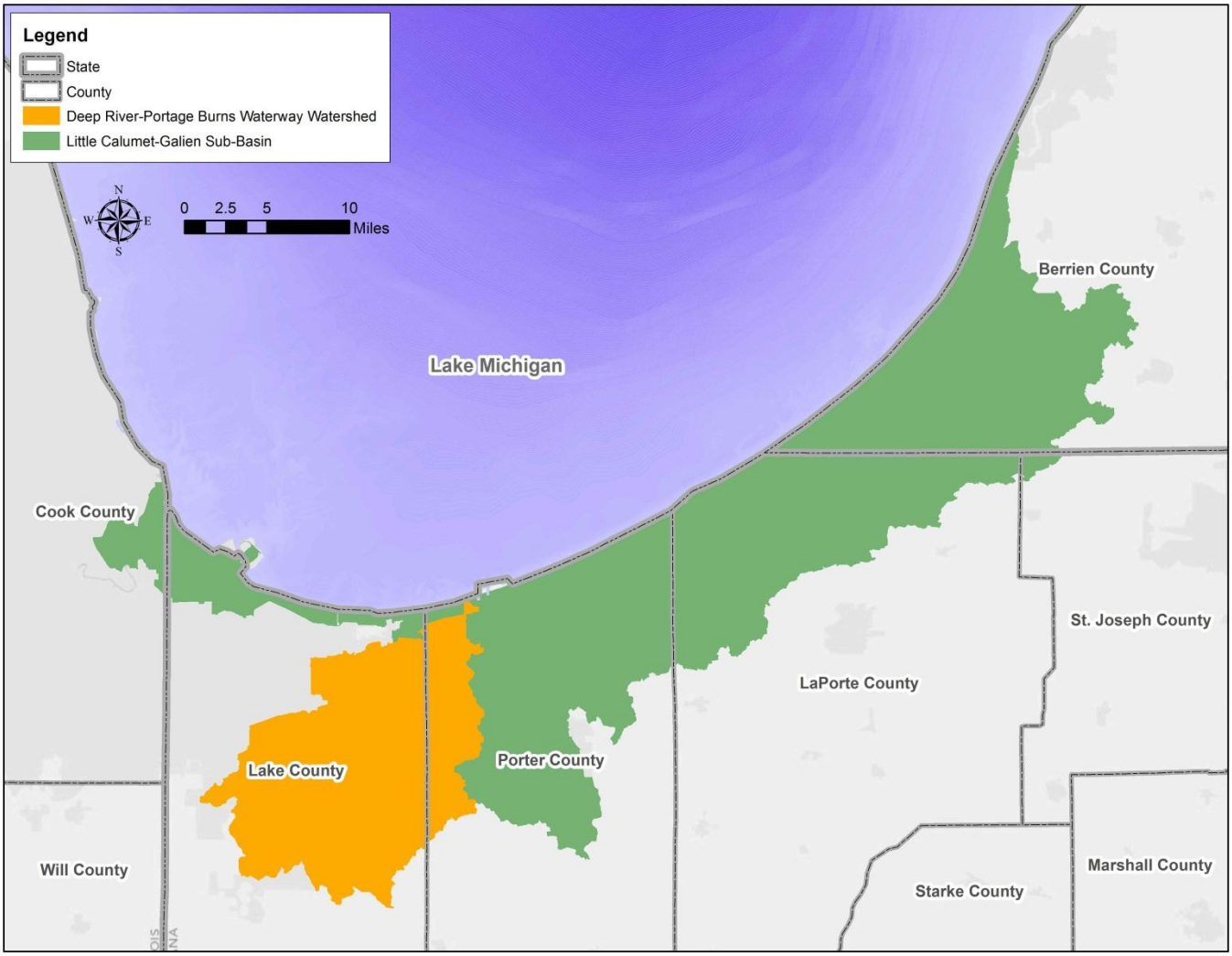

Figure 1 Little Calumet-Galien Sub-Basin & Deep River-Portage Burns Waterway Watershed Project Area

Using a watershed approach provides a flexible framework for managing water quality and quantity within specific drainage areas. The watershed planning process works within this framework by using a series of iterative steps to characterize existing watershed conditions, identify and prioritize problems, define management objects, develop protection or restoration strategies, and implement selected actions as necessary through a collaborative stakeholder process. The following sections detail this process for the Deep River-Portage Burns Waterway watershed.

1.1 Project History

Stakeholders intending to use this template to develop a watershed management plan (WMP) that meets IDEM's current WMP checklist should include a brief explanation of the initial concerns that led local groups or individuals to gather enough support to initiate this project. Also explain who the local groups or individuals are and how/why they decided to work tighter.

1.2 Stakeholder Involvement

Stakeholders intending to use this template to develop a watershed management plan (WMP) that meets IDEM's current WMP checklist should explain here how stakeholder involvement in the project was generated and how additional stakeholder concerns, beyond the initial concerns listed above, were gathered. In a figure, list the steering committee members and their affiliation. Briefly describe any public meetings or outreach efforts that were used to generate stakeholder involvement. Insert mission or vision statement in this section if one was created by the group.

1.3 Resident Attitudes and Knowledge on Water Quality

Understanding public attitudes, knowledge, and willingness to participate in actions that protect or improve water quality is essential for a successful watershed management program. In 2010, the Northwestern Indiana Regional Planning Commission initiated a survey to gauge the effectiveness of regional and local public outreach campaigns on water quality issues in the region. While not specific to our watershed of interest, over 600 residents located in or adjacent to the Little Calumet-Galien sub-basin were interviewed via telephone. A few key takeaway points from the survey were: 1) a majority of those surveyed value clean water for a variety of reasons, 2) most either do not know where stormwater runoff goes or think that it goes to a treatment plant, and 3) 42% of residents do not know what to do around the home to conserve/protect water.

The following provide a summary of the resident survey responses. More in-depth analysis, such as mapping and factors that drive specific attitudes and behaviors can be found in the survey.

1.3.1 Attitudes

Three in five residents (61%) value having clean streams lakes and rivers in their communities "a tremendous amount." Seven in ten residents (70%) say it's very important to look at clean water bodies. Nine in ten residents agree that the quality of local water bodies affects the quality of drinking water (90%), the quality of local water bodies affects enjoyment of water recreation activities (91%), and the quality of local rivers and stream affects whether or not local beaches remain open (90%). Nearly three in four residents (73%) disagree that there will be plenty of fresh water no matter what they do. More than three in four residents (77%) say their personal actions have a definite impact on water quality/quantity.

The following percentages of NIRPC residents think that local rivers, streams, lakes, or Lake Michigan are clean enough to:

- 42% - Boat in
- 40% - Look at
- 39% - Run or hike next to
- 38% - Picnic by
- 37% - Fish in
- 34% - Swim in

1.3.2 Knowledge

Nearly three in ten residents (28%) think that storm water goes directly into water bodies untreated, while nearly three in ten residents (28%) think that storm water goes to wastewater treatment plants. One in three residents (33%) does not know where storm water goes. Two in five residents (42%) do not know what to do around the home to conserve/protect water.

The following percentages of residents think that the following items had a great impact on the quality of water bodies:

- 79% - Motor oil, paint, and batteries
- 63% - Household water conservation
- 59% - Septic tank problems
- 56% - Lawn fertilizer
- 52% - Type of fertilizer
- 45% - Dog waster
- 37% - Lawn watering

1.3.3 Actions

Regarding use and interaction with water bodies (percentage of residents who say water bodies are clean enough for actions such as fishing, swimming, etc. are in parentheses):

- 41% of residents walked, ran, or biked trails through woods or parks near water bodies (39%)
- 37% of residents walked, sat, or ran by water bodies (40%)
- 25% of residents fished or hunted in or near water bodies (37%)
- 24% of resident swam in water bodies (34%)
- 23% of residents went boating, canoeing, or kayaking in water bodies (42%)
- 11% of residents gave money or took actions to help conserve and preserve water bodies

Three in four residents (75%) say they take actions most days that preserve water quality/quantity. Nearly two in three residents (63%) say they do more than others to preserve water quality/quantity. Of the 30% of residents who have a dog, nearly one in three (31%) use a pooper scooper while nearly one in five (18%) leave it. Of the 89% of residents who have a lawn, more than two in five (42%) fertilize more than once a year.

The following percentages of residents report engaging in the following actions around the home:

- 86% - wash only full loads of clothes/dishes
- 70% - try to reduce shower length
- 24% - water their lawn less when rainfall levels are low

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- 18% - use low phosphate and slow release fertilizer
- 15% - use native landscaping
- 13% - have a water timer
- 8% - test their soil before fertilizing
- 66% (of the 11% of residents that have a septic tank) - service their septic tanks at least every 5 years
- 7% - dispose of leaves/grass clipping improperly
- 4% - dispose of motor oil improperly

1.3.4 Motivation to Do the Right Thing

In order to motivate residents to do the right thing when it comes to conserve/preserve water quality/quantity, the following percentages of residents recommend:

- 91% - teach the right actions in school
- 90% - advertise
- 74% - develop neighborhood councils
- 57% - utilize a hotline to report offenders
- 55% - fine offenders
- 34% - publish the names of offenders
- 30% - levy an environmental tax on all households

Half of residents (50%) support stricter development ordinances even if prices go up.

1.4 Stakeholder Concerns

Stakeholders intending to use this template to develop a watershed management plan (WMP) that meets IDEM's current WMP checklist should list in a figure the concerns of the steering committee and those collected from stakeholders at public meeting or outreach events. List every concern. You may want to group the concerns by similarity (Ex. agricultural, education, urban). Stakeholder surveys conducted as part of the project may be discussed here or elsewhere in the WMP as deemed appropriate.

2 Watershed Inventory- Part I

2.1 Watershed Location

The Deep River-Portage Burns Waterway watershed (HUC 0404000105) drains approximately 180 mi^2 (115,138 ac.) of north central Lake and Porter Counties to Lake Michigan through Burns Ditch. The watershed is comprised of nine smaller HUC-12 subwatersheds (Figure 2 and Table 1) ranging in size from 15.8 to 26.3 mi^2. Several municipalities are located within the watershed including the entirety of Hobart and Merrillville and portions of Cedar Lake, Crown Point, Gary, Griffith, Lake Station, New Chicago, St. John, Schererville, Winfield, Portage, Lakes of the Four Seasons, and Ogden Dunes.

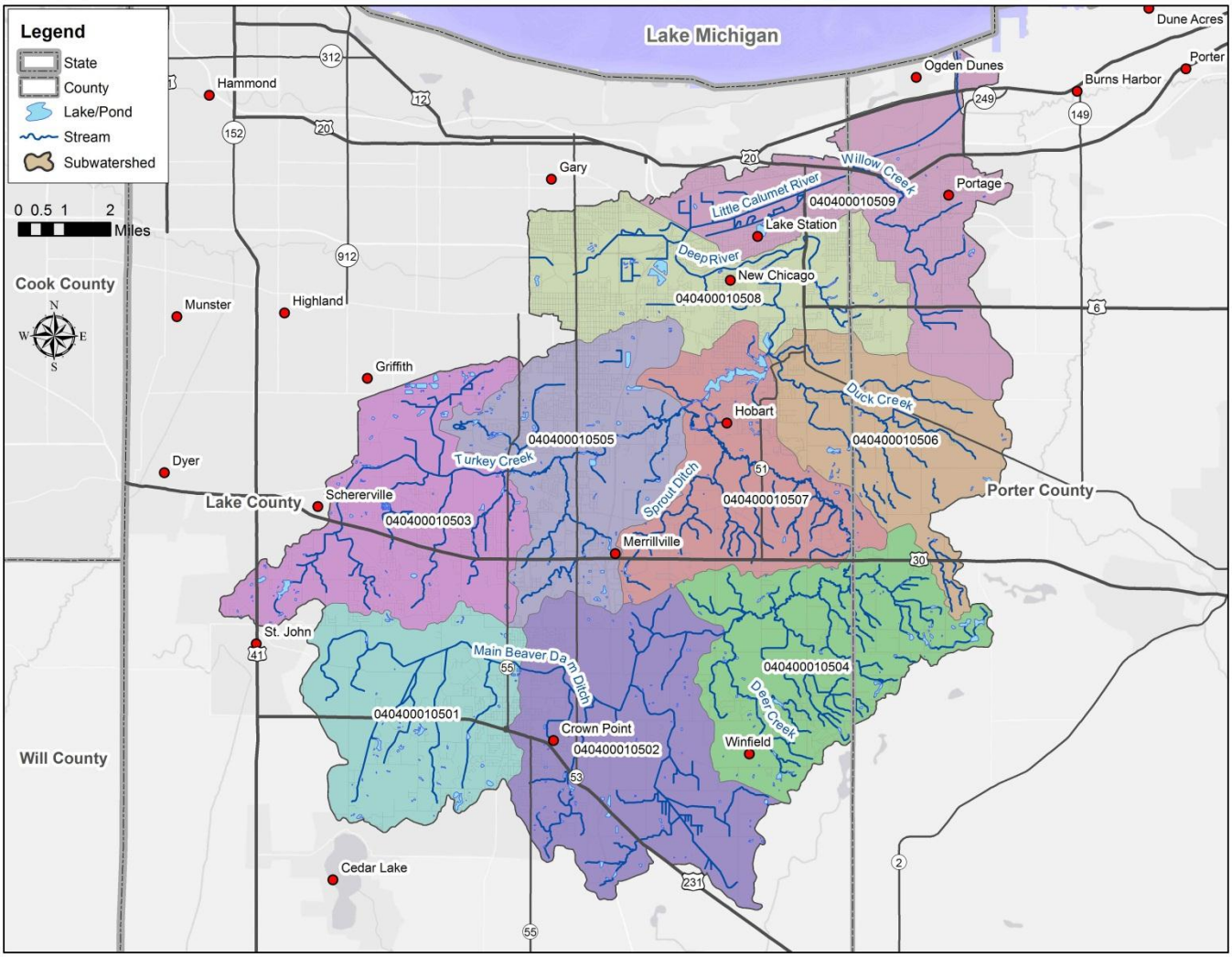

Figure 2 Subwatersheds within the Deep River-Portage Burns Waterway Watershed

Name	HUC-12	Area (ac.)	Area (mi²)	County
Headwaters Main Beaver Dam Ditch	040400010501	11,709	18.3	Lake
Main Beaver Dam Ditch-Deep River	040400010502	16,821	26.3	Lake
Headwaters Turkey Creek	040400010503	13,595	21.2	Lake
Deer Creek-Deep River	040400010504	13,745	21.5	Lake, Porter
City of Merrillville-Turkey Creek	040400010505	12,493	19.5	Lake
Duck Creek	040400010506	10,140	15.8	Lake, Porter
Lake George-Deep River	040400010507	11,081	17.3	Lake, Porter
Little Calumet River-Deep River	040400010508	12,148	19.0	Lake, Porter
Willow Creek-Burns Ditch	040400010509	13,406	20.9	Lake, Porter
Watershed Total		115,138	179.9	

Table 1 Subwatershed Drainage Area and Location

2.2 Climate

Water availability and use in the Lake Michigan region is directly linked to the regional climate, which is the long-term combination of daily weather events. Climate within Deep River-Portage Burns Waterway watershed is classified as temperate continental and is characterized by warm summers, cool winters, and the absence of a prolonged dry season. Normal monthly maximum temperatures measure 83° F in July, while minimum temperatures measure 18° F in January. The presence of Lake Michigan has a pronounced effect on climatic conditions in parts of Northwest Indiana. The most pronounced generally occur 1-2 miles inland however they can extend as fare inland as 25 miles. In general, the region experiences warmer falls, cooler springs, higher humidity, and greater amounts of snow compared to nearby regions due to differences in Lake Michigan surface water temperature relative to land surface temperature. On average, 39.5 inches of precipitation occur throughout much of the watershed. Normal monthly climate data is presented below in Table 2 based on information from the Valparaiso Waterworks Cooperative weather station for the period of 1975 to 2005.

Period	Precipitation (in.)	Maximum Temperature (° F)	Mean Temperature (° F)	Minimum Temperature (° F)
January	2.37	32	24	18
February	1.99	37	29	21
March	2.66	48	38	29
April	3.56	61	50	39
May	4.11	71	60	49
June	4.31	80	69	58
July	4.36	83	73	63
August	3.90	81	72	62
September	3.49	75	64	54
October	3.60	63	53	43
November	3.67	49	42	34
December	2.76	35	28	22

Table 2 Normal Monthly Climate Data for the Valparaiso Waterworks Station (1974-2010)

2.3 Geology and Topography

2.3.1 Surficial Geology

Surficial geology refers to the study of landforms and the unconsolidated sediments that lie beneath them. Surficial geology greatly influences topography and soil development, which, in turn, control runoff and infiltration of precipitation. This influences groundwater resources and surface water quality. The majority of the unconsolidated sediments found at the land surface in the region were deposited during the late Wisconsin glaciation, 21,000 to 13,600 years ago. These deposits range in thickness from 100 to more than 350 feet. Figure 3 shows that a large portion of the watershed's surficial deposits are comprised of clay-loam to silt-loam. Clay-loams typically have very high runoff potential

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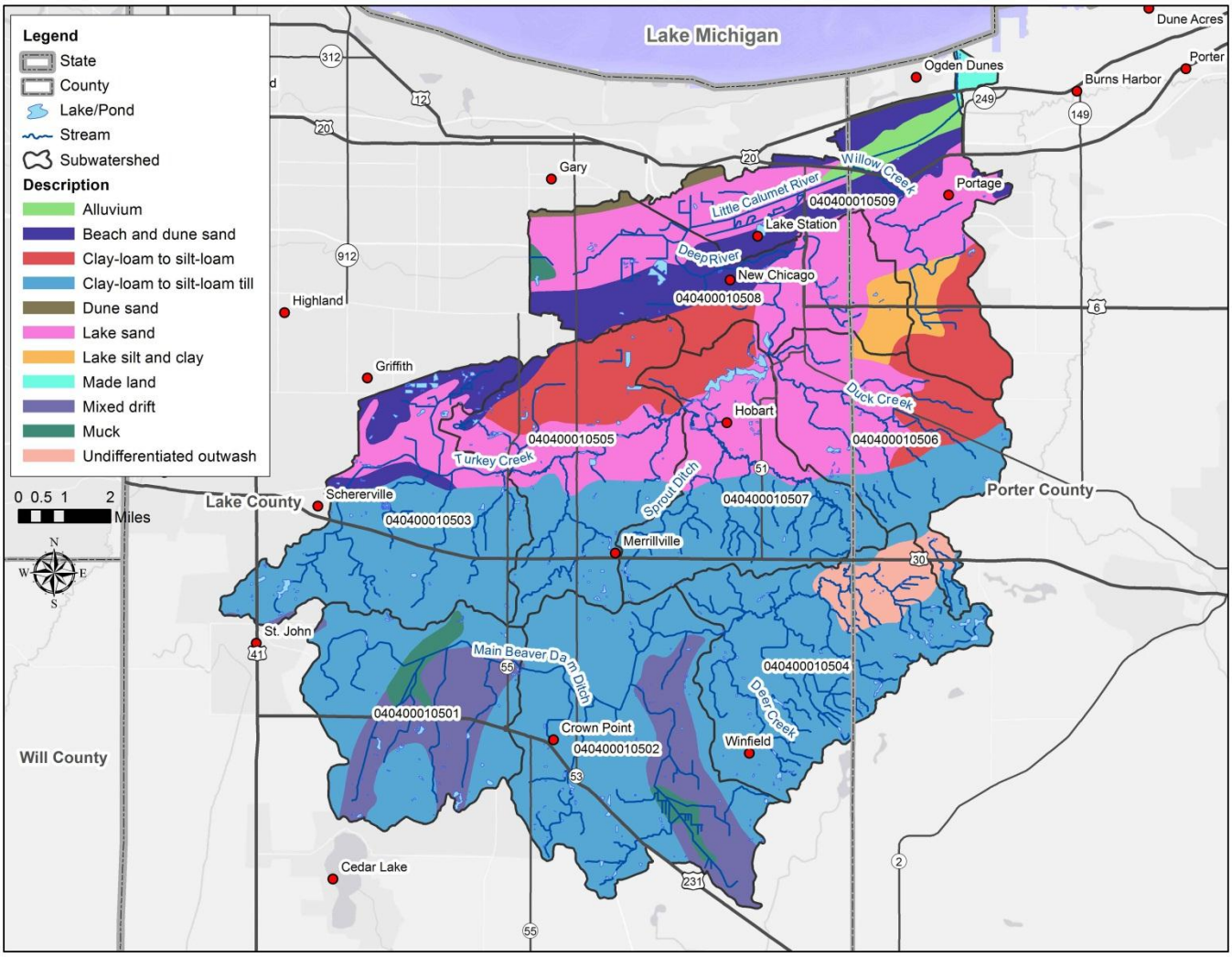

Figure 3 Surficial Geology

2.3.2 Physiography

The Deep River-Portage Burns Waterway watershed is located in what is known as the Northern Moraine and Lake Region. The topography of this region has been created almost entirely by the erosional and depositional action of the latest glaciation event, the Wisconsin. It is dominated by moraines, which are accumulations of unconsolidated glacial debris, and includes almost all of Indiana's natural lakes. The Northern Moraine and Lake Region is divided into several smaller physiographic sections. The Deep River-Portage Burns Waterway watershed is situated across two of these sections, the Lake Michigan Border and the Valparaiso Morainal Complex (Figure 4).

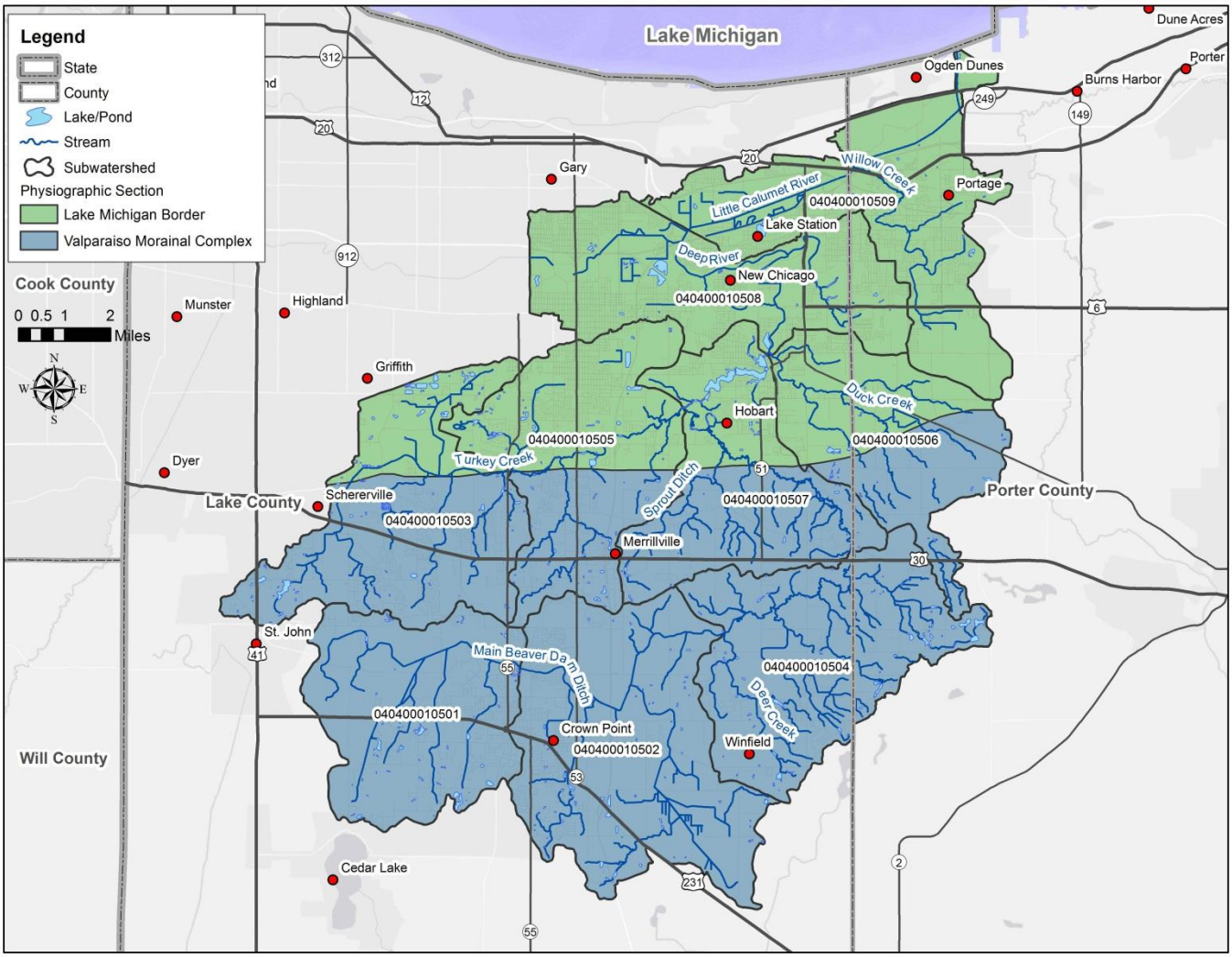

Figure 4 Physiography

The Lake Michigan Border forms a 4-11 mile wide band along the southern shore of Lake Michigan which includes a complex of beach ridges, dunes, moraines, lake floor deposits and related washed surfaces. The Valparaiso Morainal Complex forms a 13-20 mile wide band that is roughly concentric with the Lake Michigan shoreline. Its most dominate land forms include moraines and alluvial fans that grade to the southeast towards the Kankakee Drainageways. Lakes can be found in depressions of till areas and tunnel valleys of the moraines.

2.3.3 Elevation

The highest point in the watershed, at 823 feet (251 meters), is located north of County Road 100 West near Norman Olson Lake in Porter County, Indiana. In general the lowest elevations (574 feet or 175 meters) occur along a corridor adjacent to the West Branch of the Little Calumet River west of State Road 51.

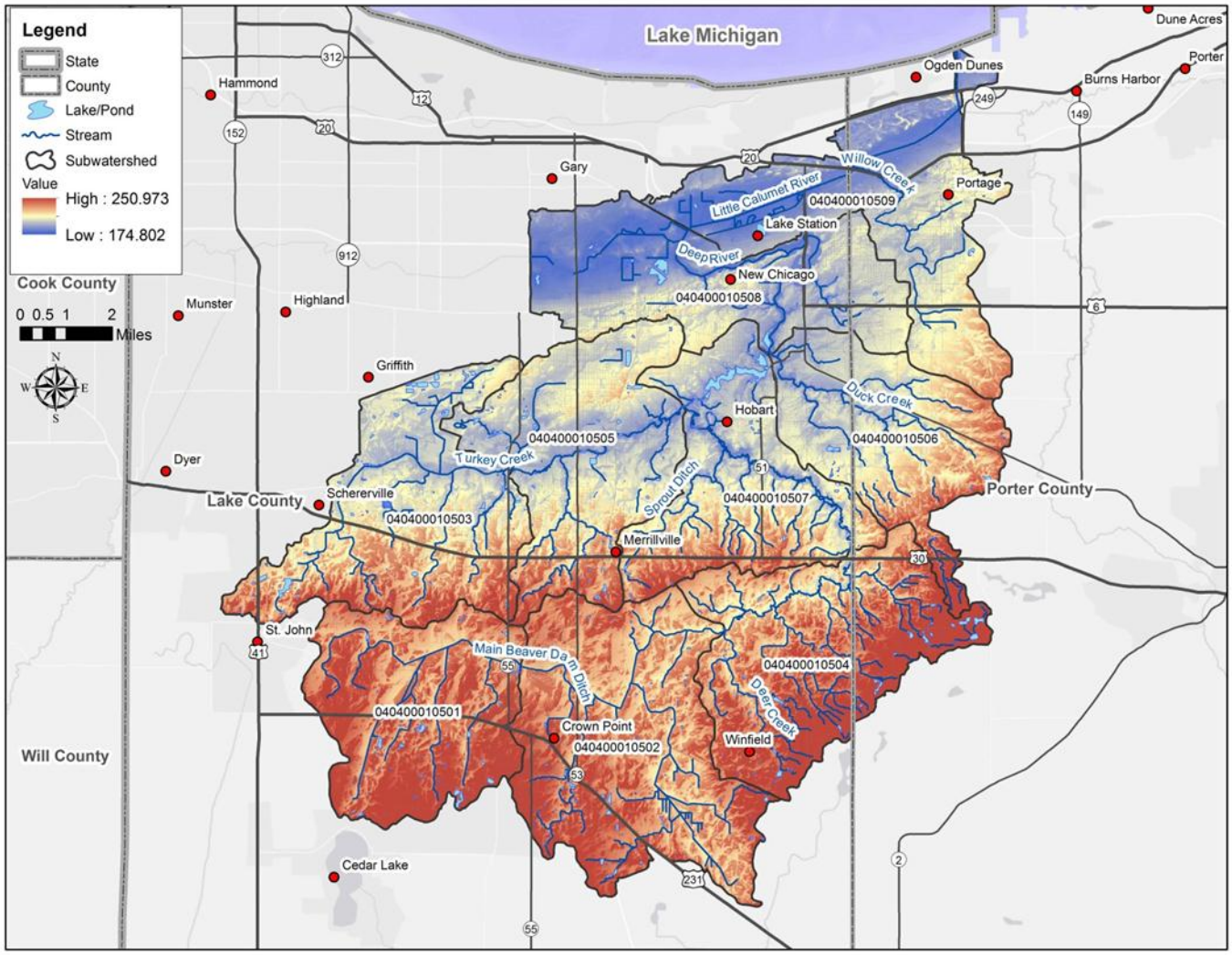

Figure 5 Elevation

2.3.4 Slope

Slope within the Deep River-Portage Burns Waterway watershed ranges from 0 to 71.5% with a mean of 2% (Figure 6). However most of the watershed can best be described as flat to gently rolling with the greatest topographic relief occurring in the headwater areas of the Valparaiso Moraine and along Deep River. Slopes exceeding 10% can be found along Lake George, the river valley edges of Duck Creek, Deep River one of its small, unnamed tributaries located south of U.S. Highway 30 in Porter County. Other areas with slopes exceeding 10% can be observed in the headwaters of Main Beaver Dam Ditch and Turkey Creek near St. John. In 2007, IDEM published the Indiana Storm Water Quality Manual (IDEM, 2007) which defines “steep” slopes as those exceeding 15%. The manual recommends prohibiting development on these slopes because of the high potential for soil erosion and degradation of surface water. Several areas within the watershed exceed this target.

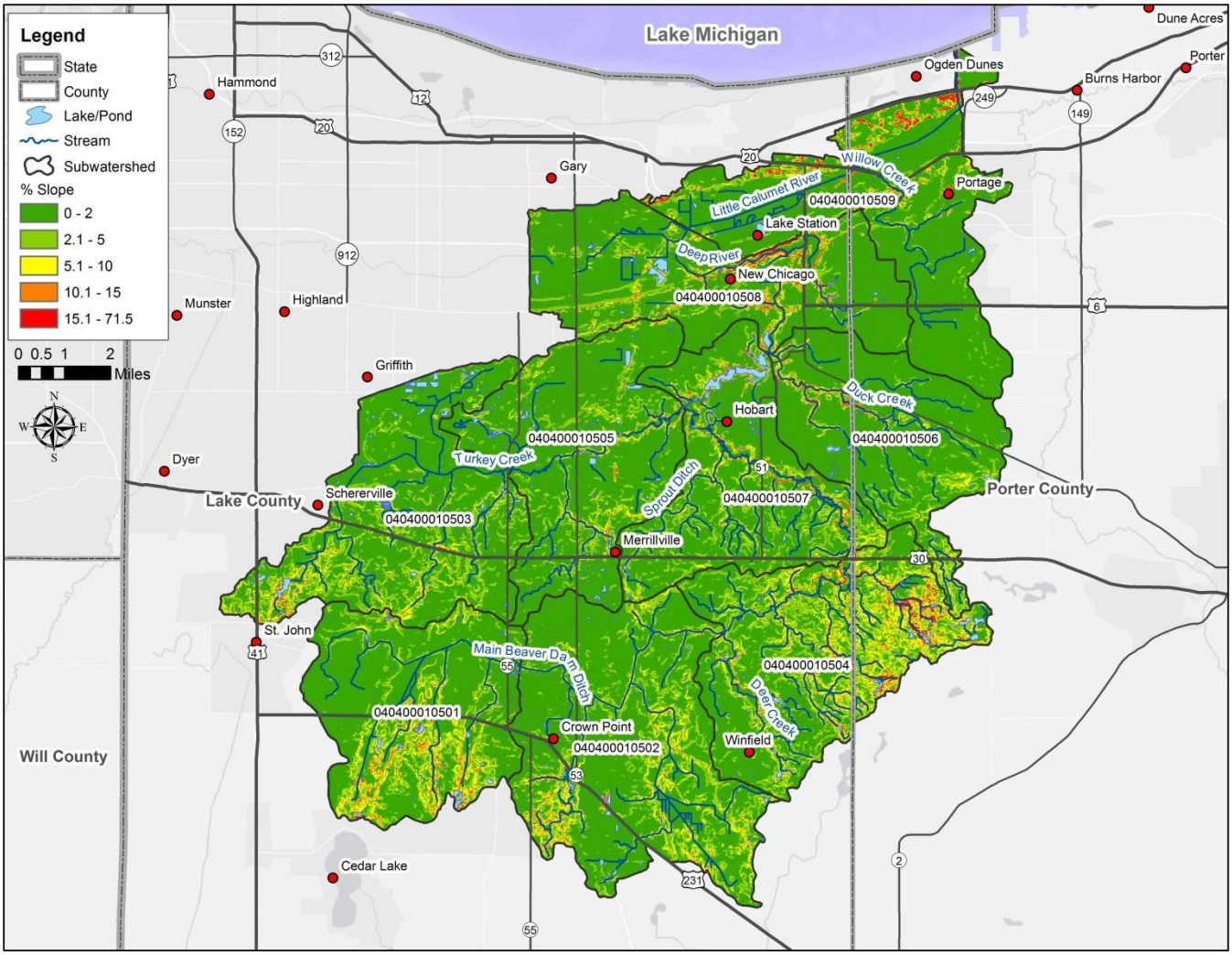

Figure 6 Watershed Slope

2.4 Soil Characteristics

Understanding the types of soils that exist within a watershed and their characteristics can be useful in identifying areas that are prone to erosion, are likely to experience runoff, or can affect water quality in some other way. Additionally soils information can be useful for identifying and prioritizing future restoration projects. Soil development is the product of the interaction of parent material, topography, climate, organisms and time.

In the Lake Michigan region the distribution of major soil types is closely related to the physiographic terrains of the region. Clayey or loamy soils are typical of the Valparaiso Morainal Complex while sandy soils are more typical in the Lake Michigan Border.

2.4.1 Hydrologic Soil Groups

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), then the first letter is for drained areas and the

second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes. The groups are defined as follows:

- **Group A:** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- **Group B:** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- **Group C:** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- **Group D:** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

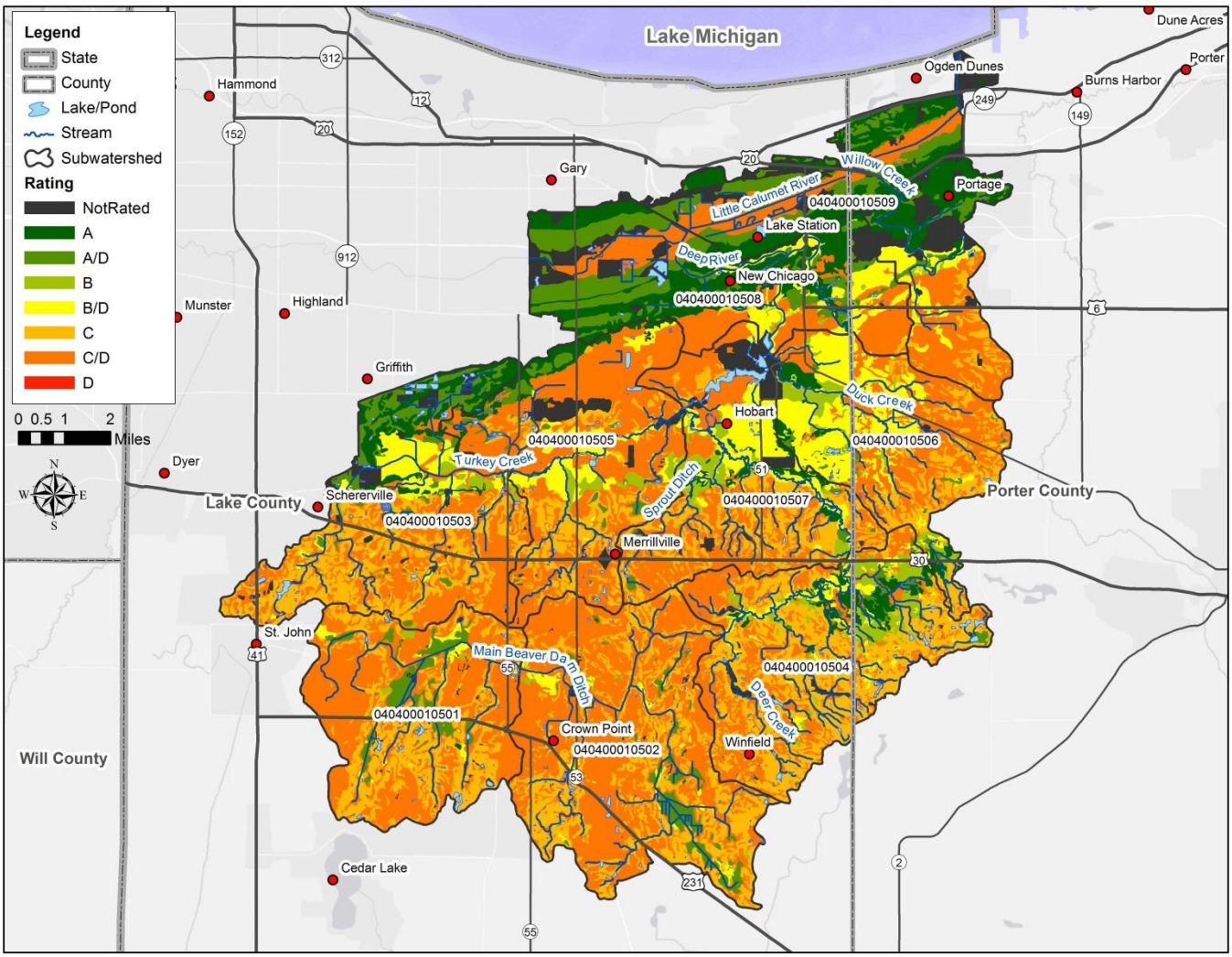

Figure 7 Hydrologic Soil Groups

Table 3 provides a breakdown of the hydrologic soil group data for each subwatershed and the watershed as a whole. Group C/D soils are the most common hydrologic soil group accounting for 43% of the watershed area. In drained areas these soils are classified as Group C and have a slow infiltration rate when thoroughly wet. In undrained areas they are classified as Group D and have a very slow infiltration rate (high runoff potential) when thoroughly wet. The second most common hydrologic soil group within the watershed is Group C. Areas either classified as Group C, C/D or D tend to strongly correspond with soil surface textures that are silty. In general, silty soils also tend to be more erodible than sandy or clayey soils.

A large band of Group A, A/D, and B soils is found in the northern portion of the watershed running parallel to the Little Calumet River (Figure 7). Soil surface texture in this area is typically sandy to loamy and less prone to erosion.

Given the prevalence of Group C and C/D soils throughout the watershed, there is generally a moderate to high potential of runoff being generated during precipitation events. Between 80-90% of the soils in the Headwaters Main Beaver Dam Ditch (HUC 040400010501), Main Beaver Dam Ditch-Deep River (HUC 040400010502) and City of Merrillville-Turkey Creek (HUC 040400010505) subwatersheds have low or very low infiltration rates.

Subwatershed	A (ac.)	%	A/D (ac.)	%	B (ac.)	%	B/D (ac.)	%	C (ac.)	%	C/D (ac.)	%	D (ac.)	%	NR (ac.)	%
040400010501	12	0	959	8	95	1	331	3	3,386	29	6,737	58	0	0	189	2
040400010502	10	0	889	5	80	0	384	2	4,918	29	10,427	62	0	0	113	1
040400010503	1,344	10	1,231	9	260	2	1,137	8	3,790	28	5,108	38	0	0	724	5
040400010504	677	5	311	2	1,061	8	855	6	5,963	43	4,547	33	0	0	331	2
040400010505	570	5	534	4	350	3	1,250	10	1,998	16	7,064	57	0	0	726	6
040400010506	386	4	216	2	646	6	3,138	31	1,788	18	3,830	38	0	0	136	1
040400010507	364	3	108	1	514	5	1,826	16	2,647	24	4,669	42	0	0	953	9
040400010508	3,345	28	3,067	25	87	1	1,201	10	82	1	2,922	24	0	0	1,444	12
040400010509	3,605	27	2,409	18	38	0	685	5	491	4	3,764	28	0	0	2,413	18
Total	10,313	9	9,724	8	3,132	3	10,808	9	25,063	22	49,067	43	0	0	7,031	6

Table 3 Subwatershed Hydrologic Soil Groups Data

2.4.2 Highly Erodible Land

Highly erodible land (HEL) is a classification used by the NRCS to identify land that is very susceptible to erosion for agricultural purposes. To be eligible for USDA benefits, farmers that produce annually tilled agricultural commodity crops must use an approved conservation system on all HEL. The basis that NRCS uses for identifying highly erodible land is the erodibility index of a soil map unit. The erodibility index of a soil is determined by dividing the potential erodibility for each soil by the soil loss tolerance (T) value established for the soil. The T-value represents the maximum annual rate of soil erosion that could take place without causing a decline in long-term productivity.

Analysis of HEL soils was done using a soils database query provided by the NRCS for Indiana. Table 4 provides a breakdown of HEL soils data for each subwatershed and the watershed as a whole. Overall, 53% of the soils in the watershed are classified as HEL. A majority of HEL soils are located in the southern ¾'s of the watershed (Figure 8). A wide band of soils classified as non-HEL runs southwest to northeast parallel to the Little Calumet River. The Main Beaver Dam Ditch-Deep River (HUC 040400010502) and Deer Creek-Deep River (HUC 040400010504) subwatersheds have the highest percentage of HEL soils. These subwatersheds also have two of the highest percentages of cultivated land within the watershed.

Subwatershed	Non-HEL (ac.)	%	HEL (ac.)	%	Not Rated (ac.)	%
040400010501	4,124	35	7,396	63	191	2
040400010502	5,131	31	11,576	69	115	1
040400010503	5,942	44	6,928	51	718	5
040400010504	2,993	22	10,421	76	333	2
040400010505	5,029	40	6,737	54	727	6
040400010506	3,826	38	6,178	61	142	1
040400010507	3,382	31	6,746	61	953	9
040400010508	8,588	71	2,310	19	1,237	10
040400010509	8,794	66	2,903	22	1,713	13
Watershed Total	47,809	42	61,196	53	6,128	5

Table 4 Subwatershed Highly Erodible Land Soils Data

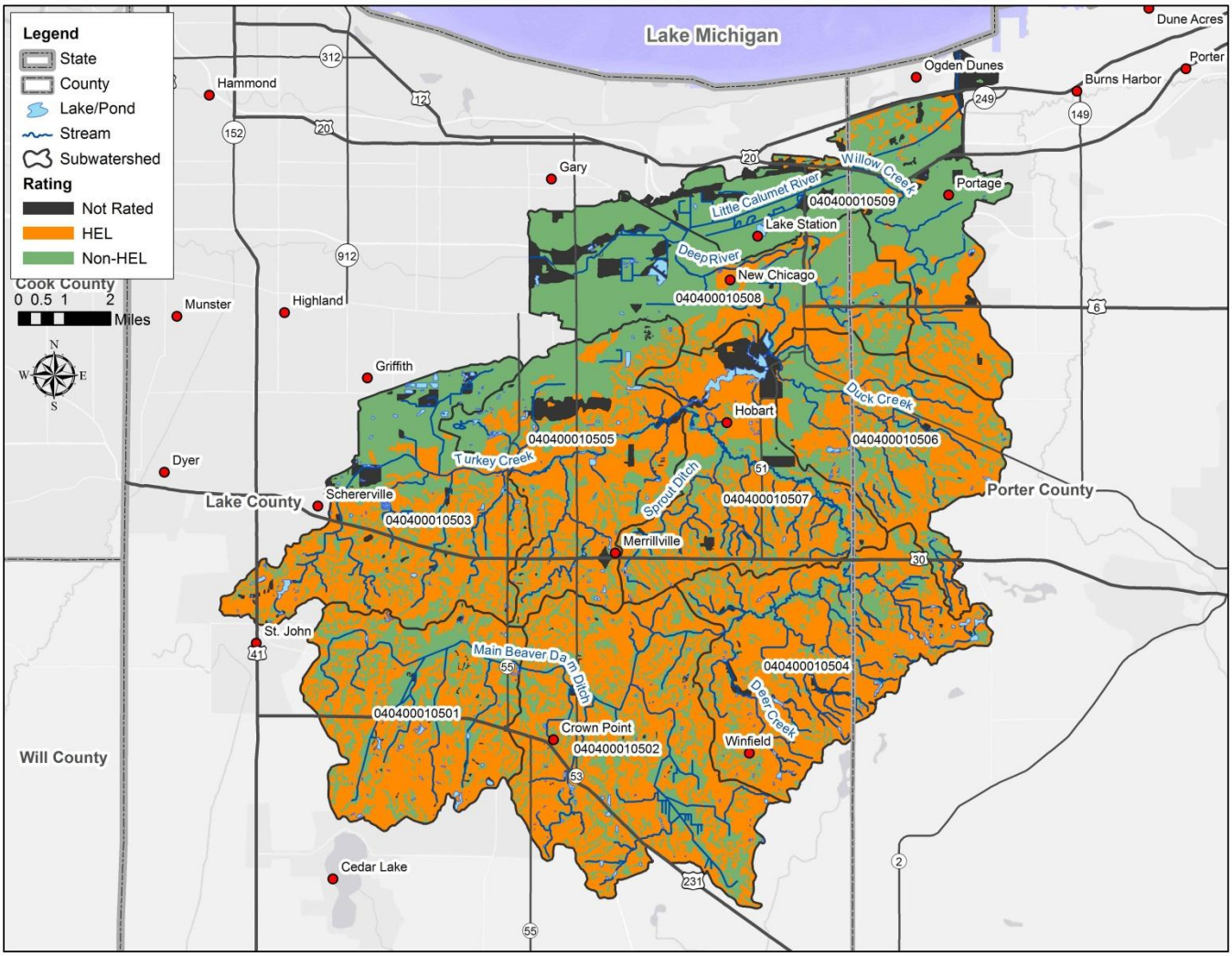

Figure 8 Highly Erodible Land Soils

2.4.3 Hydric Soils

Hydric soils are one of three characteristics used to identify wetlands. The National Technical Committee for Hydric Soils (NTCHS) defines "hydric soils" as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic (water-loving) vegetation. Areas where hydric soils are present but wetlands no longer exist can be useful in identifying potential wetland restoration opportunities.

Table 5 provides a breakdown of hydric soils data for each subwatershed and the watershed as a whole while Figure 9 provides us with a sense of the approximate historic distribution and location of wetlands based on this data. In total there are approximately 37,233 acres of hydric soil within the watershed. This represents about 32% of the land area. Hydric soils are relatively equally distributed throughout the watershed and its subwatersheds. Many hydric soils can be found adjacent to tributaries. Wetlands associated with streams store floodwaters by spreading water out over a large flat area. This temporary storage of water decreases runoff velocity, reduces flood peaks, and distributes storm flows over longer time periods, causing tributary and main channels to peak at different times (Carter).

Subwatershed	All Hydric (ac.)	%	Partially Hydric (ac.)	%	Not Hydric (ac.)	%	Unranked (ac.)	%
040400010501	4,540	39	0	0	7,146	61	24	0
040400010502	5,665	34	0	0	11,137	66	21	0
040400010503	4,922	36	0	0	8,236	61	430	3
040400010504	3,588	26	0	0	10,159	74	0	0
040400010505	4,278	34	25	0	7,690	62	500	4
040400010506	2,781	27	0	0	7,282	72	82	1
040400010507	2,808	25	0	0	7,650	69	623	6
040400010508	4,025	33	61	1	7,359	61	689	6
040400010509	4,626	34	24	0	8,038	60	721	5
Watershed Total	37,233	32	111	0	74,698	65	3,091	3

Table 5 Subwatershed Hydric Soils Data

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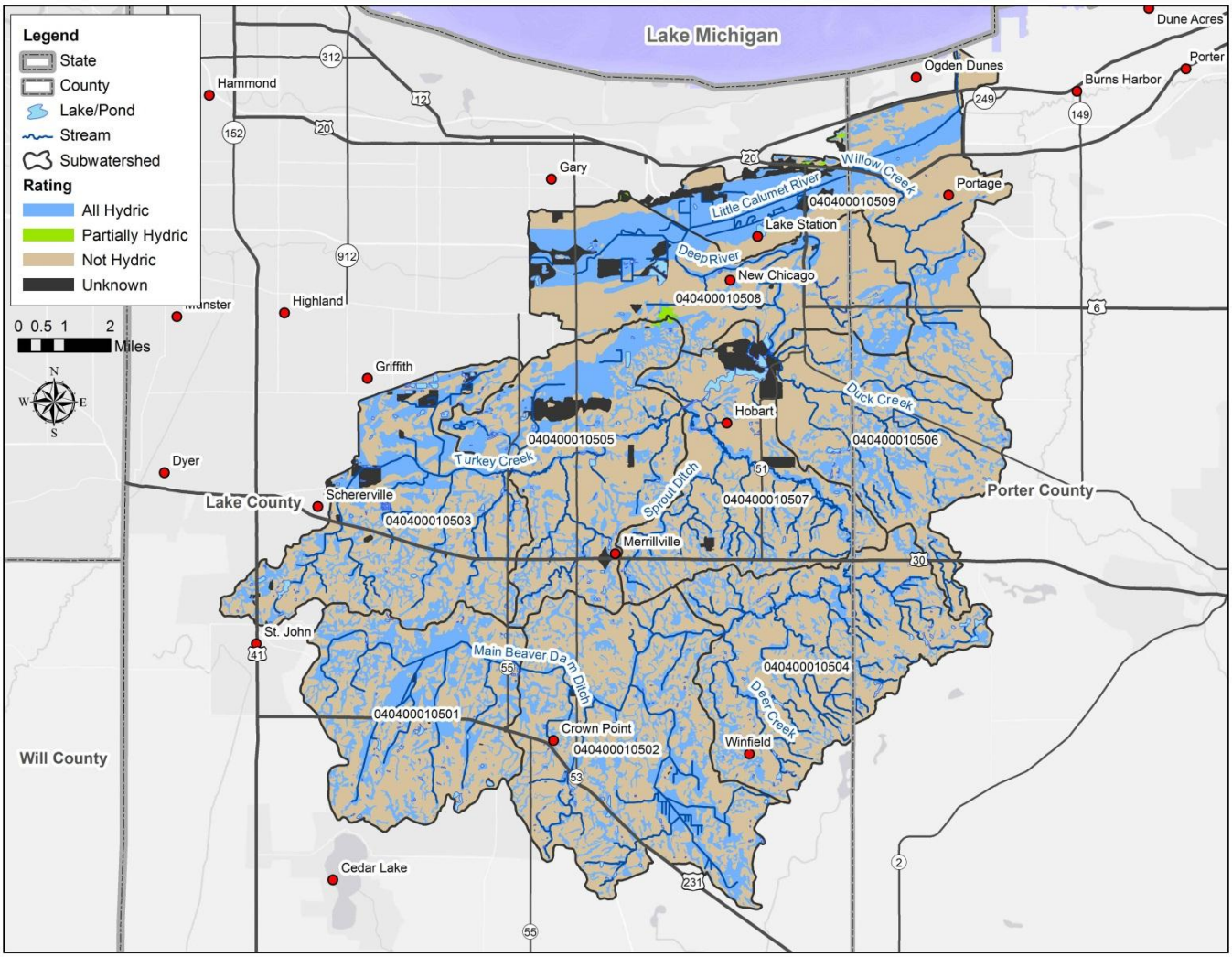

Figure 9 Hydric Soil Rating

2.4.4 Soils Drainage Class

Soil drainage classes identify the natural drainage condition of the soil and refer to the frequency and duration of periods when the soil is free of saturation. This information can be of value when trying to identify where field drain tiles may exist in agricultural lands or areas that might be prone to flooding.

The rating classes are described as follows:

- "Excessively drained"- Water is removed very rapidly. The occurrence of internal free water commonly is very rare or very deep. The soils are commonly coarse-textured and have very high hydraulic conductivity or are very shallow.
- "Somewhat excessively drained"- Water is removed from the soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured and have high saturated hydraulic conductivity or are very shallow.
- "Well drained"- Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout

most of the growing season in humid regions. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of features that are related to wetness.

- "Moderately well drained"- Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1 meter, periodically receive high rainfall, or both.
- "Somewhat poorly drained"- Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall.
- "Poorly drained"- Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.
- "Very poorly drained"- Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater.
- "Not rated"- Soils have characteristics that show extreme variability from one location to another. Often these areas are urban land complexes or miscellaneous areas. An on-site investigation is required to determine soil conditions present at the site.

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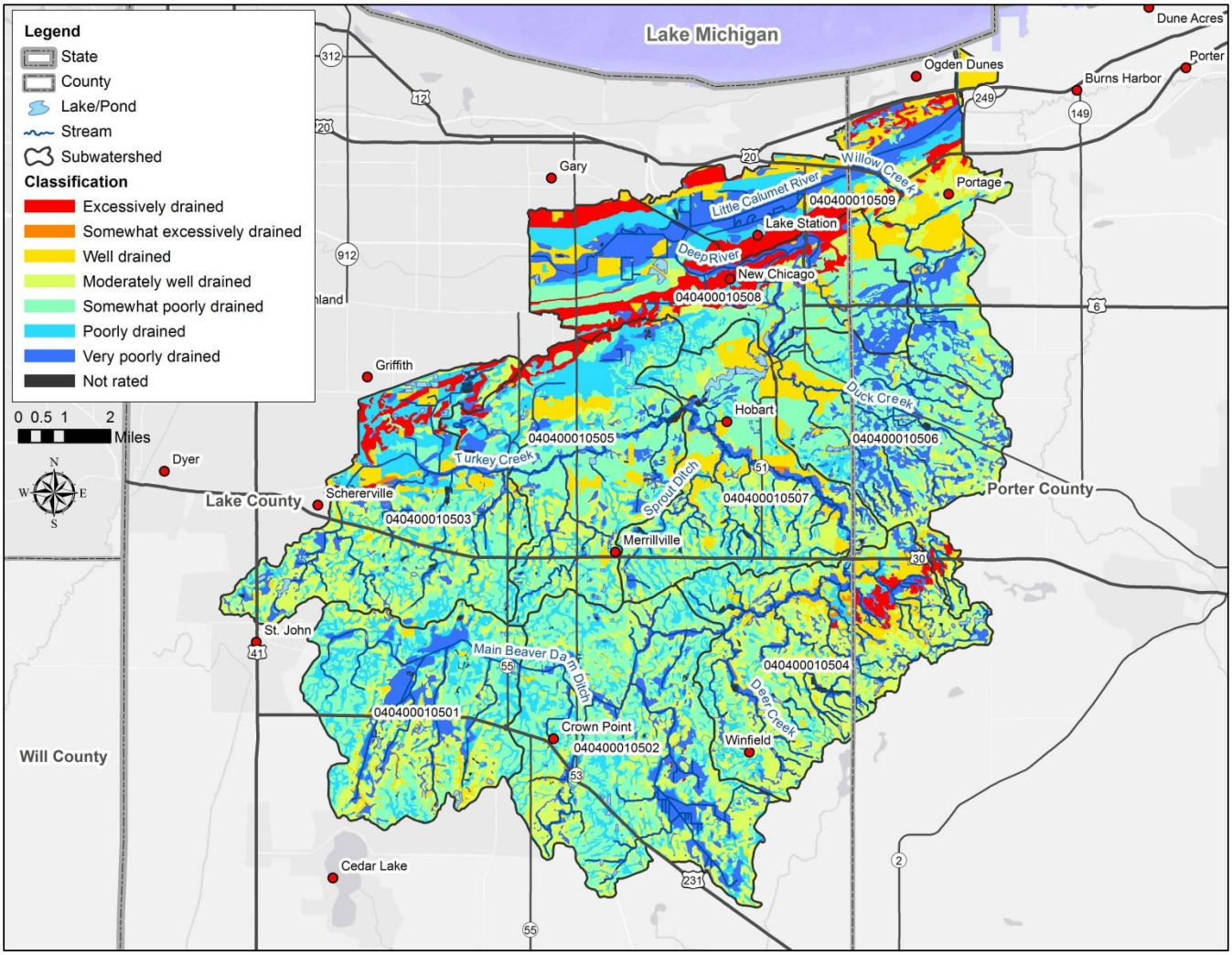

Figure 10 Soil Drainage Class

Table 6 provides a breakdown of soil drainage class data for each subwatershed and the watershed as a whole. A majority (61%) of the watershed's soils are classified somewhere between somewhat poorly drained to very poorly drained. In agricultural areas, the wetness of these soils markedly restricts the production of most crops unless artificial drainage is provided. Additionally, as referenced in the discussion about hydrologic soils groups, dual soil ratings are influenced by whether the soil is artificially drained or not. If they are not drained there is high runoff potential when the soils are thoroughly wet which can contribute to erosion, and phosphorus and pesticide transport. However, nitrate flow from subsurface drains in agricultural areas is one of the leading sources of nitrate in Midwest streams. Nitrate concentration in tile drains can be as high as 10-40 mg/l (Fankenberger & Kladivko).

Subwatershed	Excessively Drained	%	Somewhat Excessively Drained	%	Well Drained	%	Moderately Well Drained	%	Somewhat Poorly Drained	%	Poorly Drained	%	Very Poorly Drained	%	Not Rated	%
040400010501	0	0	0	0	484	4	3,033	26	3,497	30	2,886	25	1,654	14	155	1
040400010502	7	0	2	0	186	1	4,830	29	6,035	36	3,454	21	2,211	13	95	1
040400010503	860	6	72	1	788	6	4,052	30	2,574	19	3,734	27	1,188	9	327	2
040400010504	395	3	48	0	1,480	11	5,783	42	2,203	16	1,505	11	2,084	15	247	2
040400010505	475	4	8	0	898	7	2,038	16	4,598	37	2,946	24	1,332	11	198	2
040400010506	90	1	0	0	1,038	10	1,778	18	4,403	43	407	4	2,374	23	50	0
040400010507	0	0	21	0	1,511	14	2,615	24	3,803	34	1,735	16	1,073	10	322	3
040400010508	2,655	22	7	0	1,253	10	499	4	3,427	28	1,514	12	2,511	21	281	2
040400010509	1,398	10	0	0	3,301	25	1,542	12	2,323	17	1,336	10	3,290	25	216	2
Watershed Total	5,880	5	159	0	10,939	10	26,170	23	32,864	29	19,516	17	17,717	15	1,892	2

Table 6 Subwatershed Drainage Class Data

2.4.5 Septic System Soil Limitations

Conventional onsite sewage disposal systems (a.k.a. septic systems), while common, are not suitable for all areas. Among the limitations which might preclude installation of a conventional system are: high groundwater tables; shallow limiting layers of bedrock or fragipan; very slowly or rapidly permeable soils; topography; and lot size.

Soil limitations within the watershed for conventional septic systems that use absorption fields for treatment are displayed in Figure 11. Only that part of the soil between depths of 24 and 60 inches is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Figure 11 is a general reference of likely field conditions. A soil scientist is necessary to determine actual site conditions which may vary greatly than what is shown in the figure. The rating class terms include:

- “Not rated”- Soils are highly disturbed such as in urban areas.
- “Not limited”- Soils have features that are very favorable for the specified use. Good performance and very low maintenance can be expected.
- "Somewhat limited" - Soils have features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

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- "Very limited" - Soils have one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Slightly more than 92% of the watershed's land area is rated as "very limited" for conventional systems that use absorption fields for treatment. This rating indicates that there are significant challenges and costs to assure functionality of the system. Furthermore poor performance and high maintenance can be expected which particularly problematic since there is no operation and maintenance program in place for existing systems within this region of Indiana.

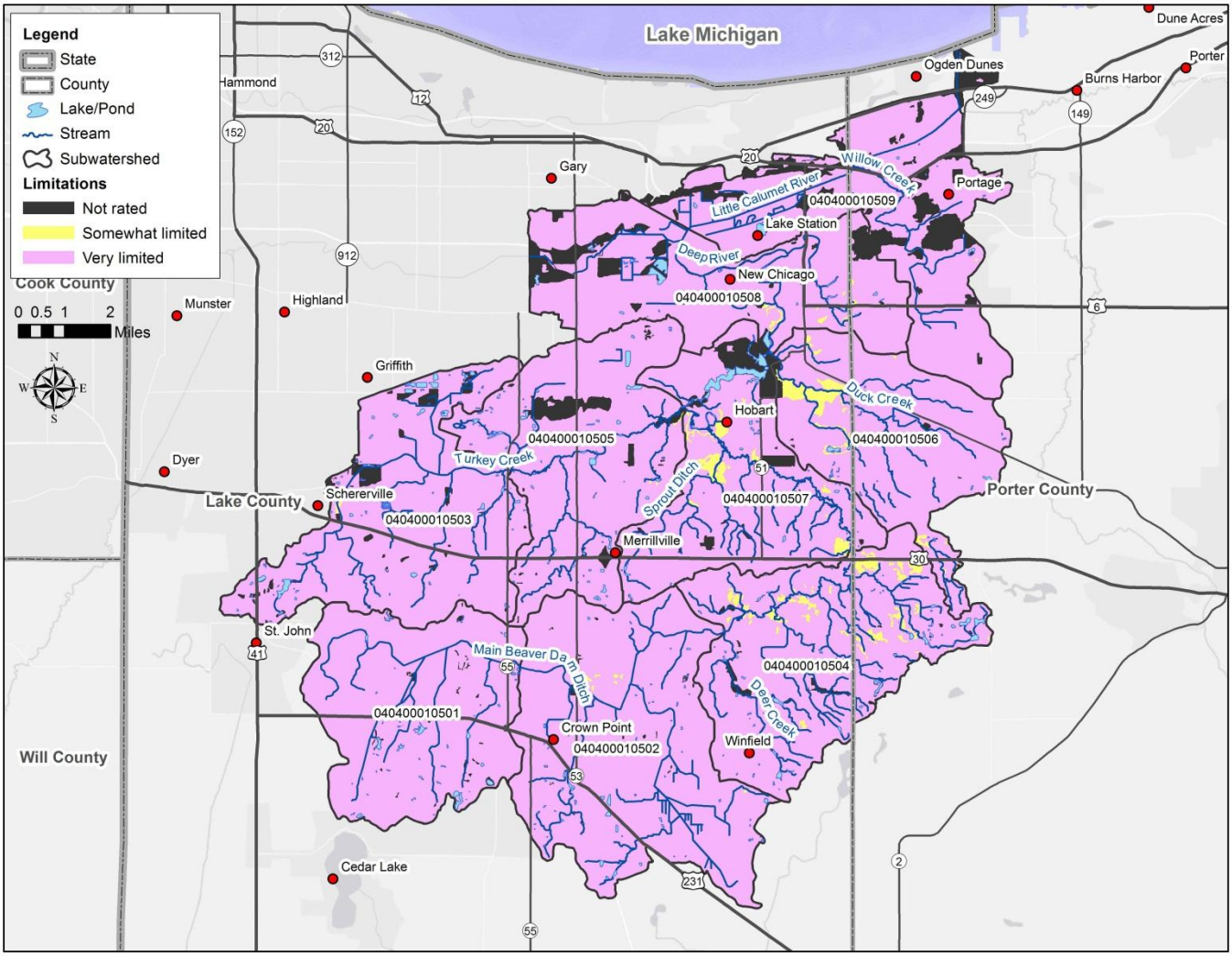

Figure 11 Soil Limitation Ratings for Conventional Septic Systems

2.5 Hydrology

Hydrology in the Little Calumet-Galien sub-basin and its watersheds is markedly different than what once existed prior to urbanization and industrialization of the region during the 1800's and 1900's. Historically the Little Calumet River and the Grand Calumet River were part of a single river called the Calumet. Its headwaters were located in LaPorte County in what is present-day Red Mill County Park. From here the river flowed sluggishly to the west through the Calumet Lacustrine Plain before making a hairpin back east near present-day Blue Island in Illinois and

eventually emptying into Lake Michigan near the Marquette Park Lagoon in Gary. Sometime around 1926 Burns Ditch was constructed between Deep River in Lake County and Salt Creek in Porter County to improve local drainage. Around this same time period, Burns Waterway was excavated connecting Burns Ditch to Lake Michigan thereby diverting the eastern part of the Little Calumet River directly into Lake Michigan. Following the construction of harbors and canals, industries moved lakeward filling nearshore areas with slag and marshes and swamps with sand from nearby dunes and beaches. A series of levees and flood control projects were completed to protect low lying, flood prone urban areas along the mainstem of the Little Calumet River and its tributaries in northern Lake County. Drainage improvement projects have altered surface hydrology to such an extent that land areas that once drained to Lake Michigan now empty into the Gulf of Mexico. Figure 12 highlights flow directions for the Little Calumet River as well as some other nearby tributaries. Under certain conditions flows can reverse along the West Branch of the Little Calumet River due to control structures and changes in Lake Michigan water levels.

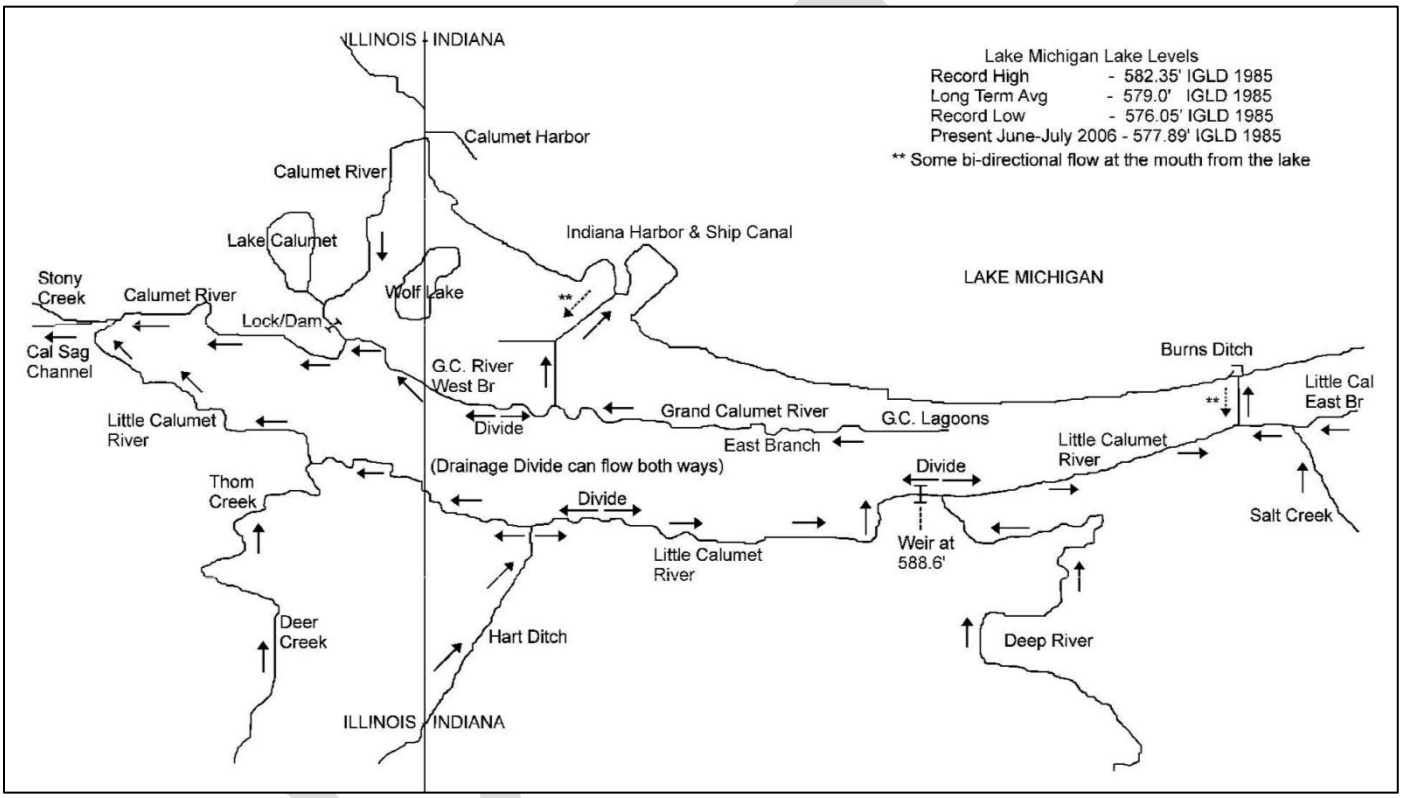

Figure 12 Little Calumet River & Adjacent Tributaries Flow Directions

2.5.1 Surface Waterbody Features

2.5.1.1 Streams

Today nearly 290 miles of stream and ditch drain the landscape of the Deep River-Portage Burns Waterway watershed (Figure 13). Approximately 41 miles of flowing water in the watershed are classified as “canal/ditch” and another 32 miles as “artificial path” according to the National Hydrography Dataset which is maintained by the U.S. Geological Survey.

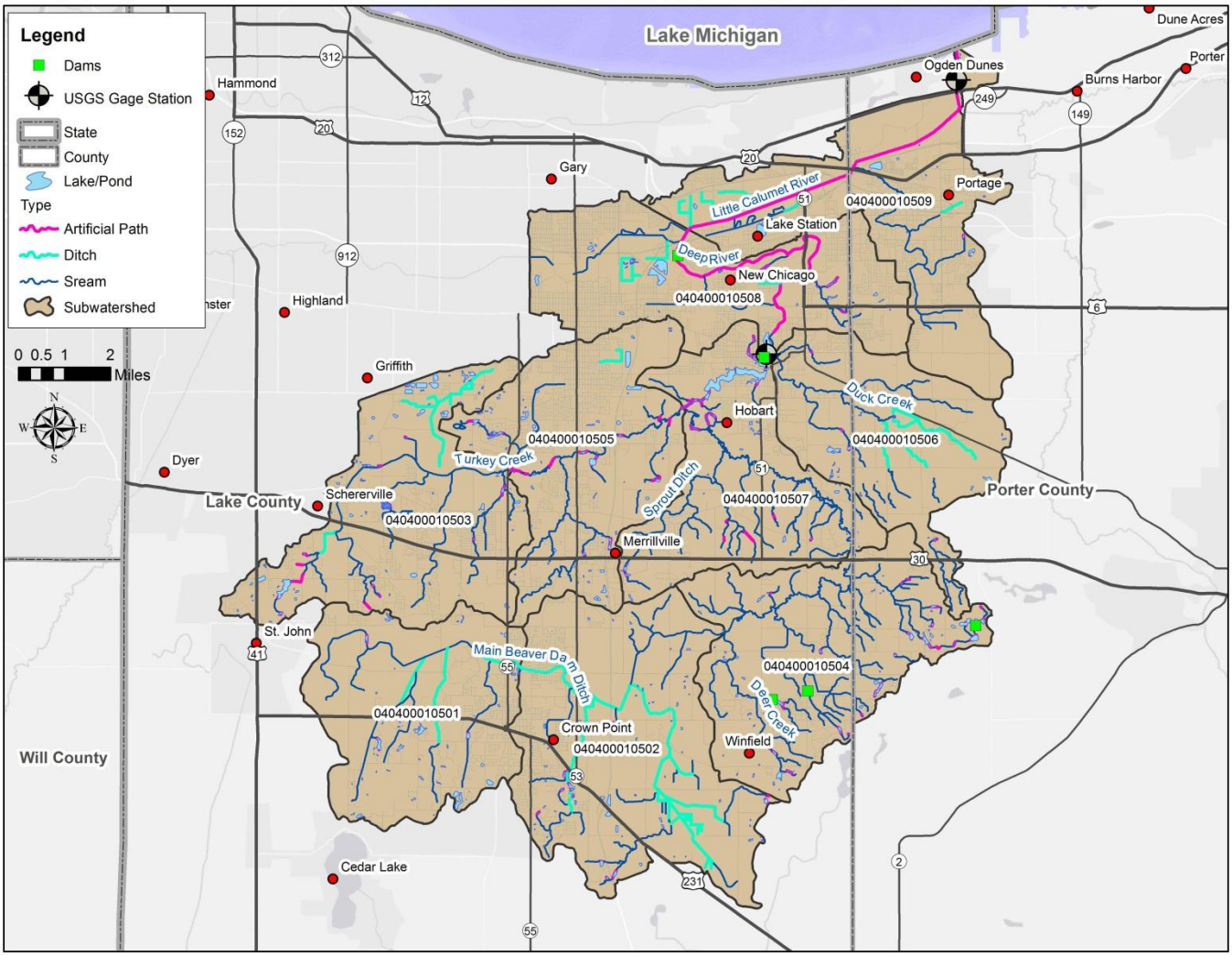

Figure 13 Surface Waterbody Features

Some of the major tributaries within the watershed include the Little Calumet River (a.k.a. Burns Ditch east of Deep River confluence), Deep River, and Turkey Creek. Tributaries feeding into Deep River include Main Beaver Dam Ditch, Deer Creek, Duck Creek, and Turkey Creek. The confluence of Deep River and the Little Calumet River (Burns Ditch) is approximately ½ mile east of Interstate 65 and just north of Interstate 80-94. The East and West Branch of the Little Calumet River join approximately 1/3 mile south of U.S. Highway 20 near State Road 249 in Portage where they empty into Lake Michigan through the Burns Waterway. Turkey Creek joins Deep River approximately ½ mile southwest of Lake George in Hobart.

Burns Waterway is designated by the DNR as a salmonid (trout and salmon) stream. While no other stream segments are designated as salmonid streams within the watershed, trout and salmon are known to migrate up Deep River as far as the Lake George dam. They are also known to migrate up Willow Creek and the length of the West Branch Little Calumet River and its tributaries. Additionally 21.6 miles of Deep River, from one mile south of U.S. 30 to the Little Calumet River, is included on the "Outstanding Rivers List for Indiana" by the Natural Resources Commission. Rivers and streams included on this list have a particular environmental, recreational, or aesthetic interest.

2.5.1.2 Stream Discharge

Flooding, stream geomorphology, and aquatic life support are all directly influenced by stream flow. Additionally stream flow and runoff drive the generation, transport, and delivery of many nonpoint source pollutants. Surface water flow is simply the continuous movement of water in streams. It is often quantified as discharge which is defined as the volume or rate of water that passes through a channel cross section in a specific time period. The USGS maintains and operates a stream gaging station (ID # 04093000) on Deep River at the outlet of Lake George in Hobart. The drainage area at this station is approximately 124 mi² and includes the entirety of the Headwaters Main Beaver Dam Ditch, Main Beaver Dam Ditch-Deep River, Headwaters Turkey Creek, Deer Creek-Deep River, City of Merrillville-Turkey Creek, and Lake George-Deep River subwatersheds.

Annual peak stream discharge for the period of record (1947-2009) at this station along with annual total precipitation is displayed in Figure 14. The figure shows increasing trends for both peak discharge and annual precipitation. However, peak discharge has increased approximately 57% while total precipitation has only increased approximately 11% over this time period. Peak discharge is influenced by many factors, including the intensity and duration of storms and snowmelt, the topography and geology of stream basins, vegetation, and the hydrologic conditions preceding storm and snowmelt events. Land use and other human activities also influence the peak discharge by modifying how rainfall and snowmelt are stored on and run off the land surface into streams.

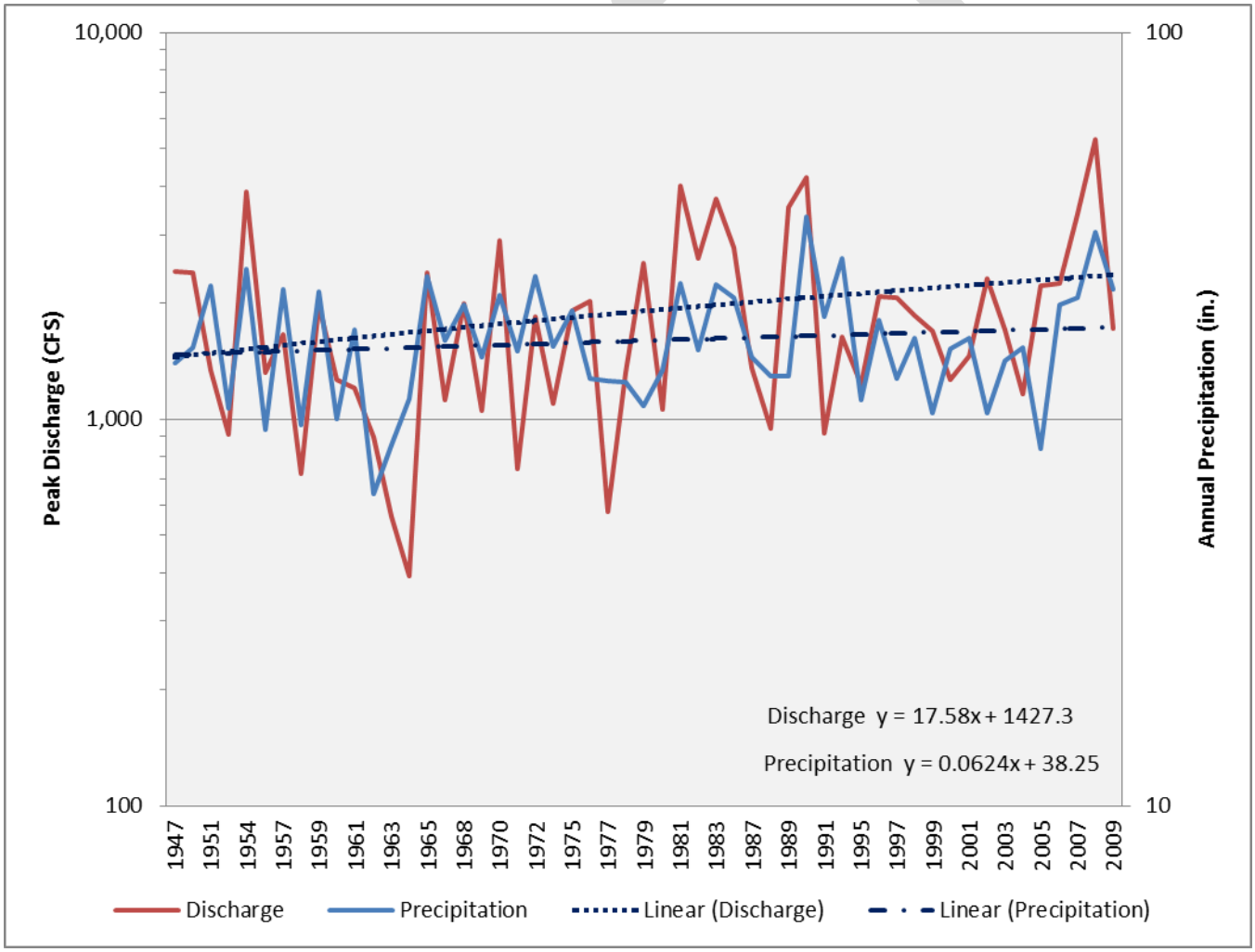

Figure 14 Annual Peak Stream Discharge & Total Precipitation

2.5.2 Floodplains & Flooding

Floodplains play an important role in the health and function of streams. Development and alteration of floodplains can eliminate or degrade the services they provide. The following table, adapted from the Ohio DNR Division of Soil & Water Resources, outlines some of these services.

Water Resources	
• reduce flood velocities • reduce flood peaks • reduce erosion potential and impacts • stabilize soils • accommodate stream meander • provide a broad area for streams to spread out and for temporary storage of floodwater	• reduce sediment loads and amount of sediments • filter nutrients and impurities • process organic and chemical wastes • moderate water temperature • protect the physical, biological, and chemical integrity of water
Maintain Groundwater Supply and Balance	
• promote infiltration and aquifer recharge • reduce frequency and duration of low flow by increasing\enhancing base flow	
Biological Resources	
Support Flora	*Provide Fish and Wildlife Habitat*
• maintain high biological productivity of floodplain and wetland vegetation • maintain productivity of natural forests • maintain natural crops • maintain natural genetic diversity	• maintain breeding and feeding grounds • create and enhance waterfowl habitat • protect rare and endangered species habitat • maintain natural genetic diversity
Cultural Resources	
Maintain Harvest of Natural and Agricultural Products	*Provide Recreational Opportunities*
• create and enhance agricultural lands • provide areas for cultivation of fish and shellfish • protect and enhance silvaculture • provide harvest for fur resources	• provide areas for active and consumptive uses • provide areas for passive activities • provide open space values • provide aesthetic values
Provide Scientific Study and Outdoor Education Areas	*Improve Economic Base of Community*
• provide opportunities for ecological studies • provide historical and archaeological sites	• increase tourist activity • stimulate natural-resource businesses • improve property values

Table 7 Natural and Cultural Benefits of Floodplains

The general location of floodplains in the Deep River-Portage Burns Waterway watershed is shown below in Figure 15. Floodplain resources, including wetlands, have seen and continue to see increasing pressure from development in the watershed. Riparian forests have been cleared in areas for development and agriculture. Expanding urbanization continues to increase the amount of surface runoff to receiving streams. Additionally streams have been straightened or channelized to move water more quickly downstream.

Most of the critical flooding in the Lake Michigan region of Northwest Indiana occurs along the mainstem and tributaries of the Little Calumet River in Lake County. Extensive development, poorly drained soils, inadequate

channel capacity and high water table all contribute to prolonged floods (Indiana Department of Natural Resources, 1994). Channelization and ditching add a further level of complexity to regional flooding. Floods are typically aggravated by the accumulation of debris, sediment, and ices at bridges and culverts because of backwater effects. The largest and most damaging floods usually occur during early spring when the ground is still frozen or saturated. Major flood can and do occur during other the other seasons given the right conditions.

In the tributary areas of Deep River and Turkey Creek, poorly drained depressions allow considerable floodwater storage. As a result, the 10-year and 100-year flood flows are among the lowest for a given drainage area in Northwest Indiana's Lake Michigan region. Along the mainstem valley of Deep River, alluvial silt, sand and gravel serve as temporary storage features during periods of flooding. Alluvium in the Turkey Creek valley does not extend far from the channel resulting in little back storage during floods (Indiana Department of Natural Resources, 1994).

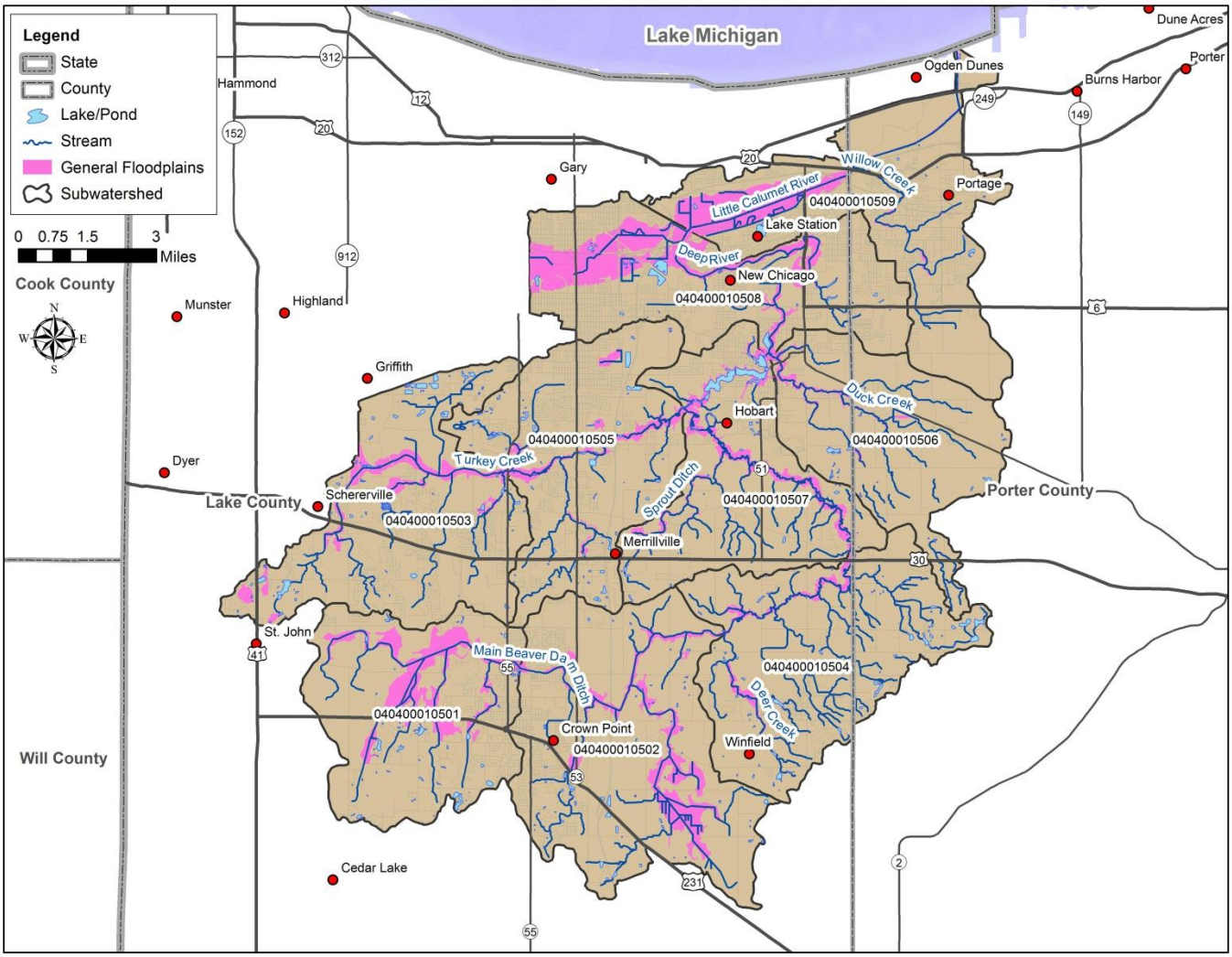

Figure 15 General Floodplains

Floodplain management regulations in Indiana are governed by statutory laws at both the state and federal levels. The state establishes minimum standards governing the delineation and regulation of flood hazard areas. The Department of Natural Resources, Division of Water administers the state flood control law and also serves as the state coordinator of the National Flood Insurance Program which helps regulate development on flood-prone lands.

Construction, excavation or placement of fill in the floodplain is also regulated by the Department of Natural Resources.

2.5.2.1 Lakes

Many of the Little Calumet-Galien sub-basin's lakes are located in the urban and industrialized regions of Lake County and along the Valparaiso Moraine. An unknown number of lakes have been destroyed or greatly reduced in size due to drainage or filling for development purposes. Today there are approximately 518 lakes/ponds covering a combined surface area of 1,217 acres within the Deep River-Portage Burns Waterway watershed. Most are relatively small, unnamed lakes with a mean size of 2.3 acres. Some of these lakes were formed as a result of past glacial activity others are man-made. Most of the artificial lakes consist of old gravel and borrow pits or impoundments of rivers and streams. Lake George in Hobart is the largest lake in the watershed at approximately 175 acres in size. Lake George was created by the damming of Deep River sometime around 1840 by George Earle to power a gristmill and provide a community water supply.

2.5.2.2 Water-Based Recreational Opportunities

The lakes and streams of the watershed provide many recreational opportunities including boating, fishing, swimming and nature watching. There are approximately 30 recreational facilities that have a lake, pond or stream on site (Figure 16). These facilities include parks, fish & wildlife areas, nature preserves, marinas, and golf courses. The greatest concentration of facilities exists around Deep River, Turkey Creek and Lake George. The Indiana Dunes National Lakeshore's Portage Lakefront and Riverwalk is located at Burns Ditch's outlet to Lake Michigan. This park is quickly becoming one of the region's most popular and visited. Potential water trails have been identified along Deep River, Turkey Creek and the Little Calumet River.

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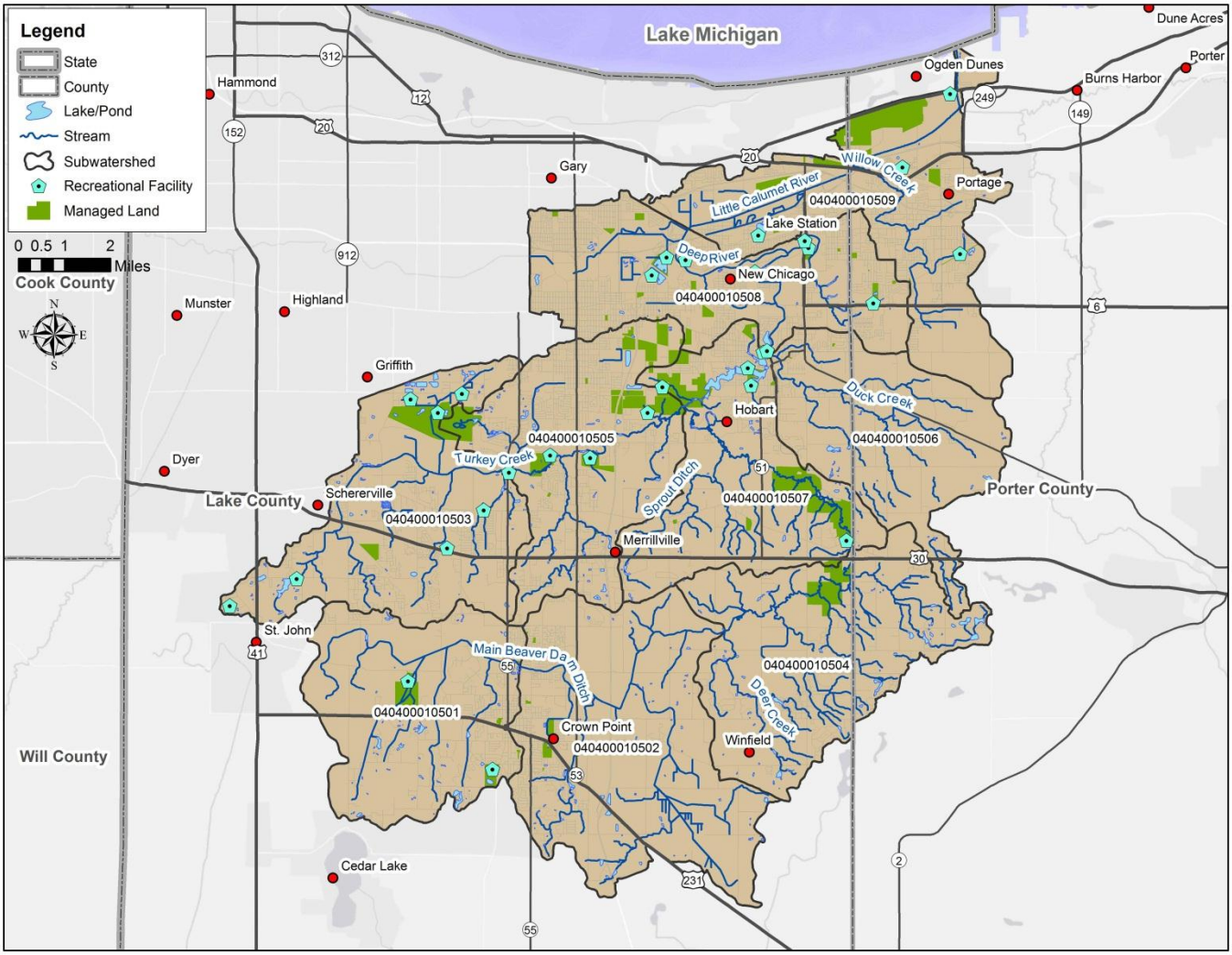

Figure 16 Recreational Facilities with Lakes or Streams Onsite and Managed Lands

2.5.3 Wetlands

Wetlands are an important feature in the landscape providing beneficial services for both people and fish and wildlife. They function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and flood waters. More than one-third of the United States' threatened and endangered species live only in wetlands, and nearly half use wetlands at some point in their lives. Within the watershed, 214 State Endangered, Threatened or Rare (ETR) species element occurrences (observations) have been documented in or directly adjacent to wetland habitats. Additionally many breeding bird populations including ducks and wading birds feed, nest, and raise their young in wetlands.

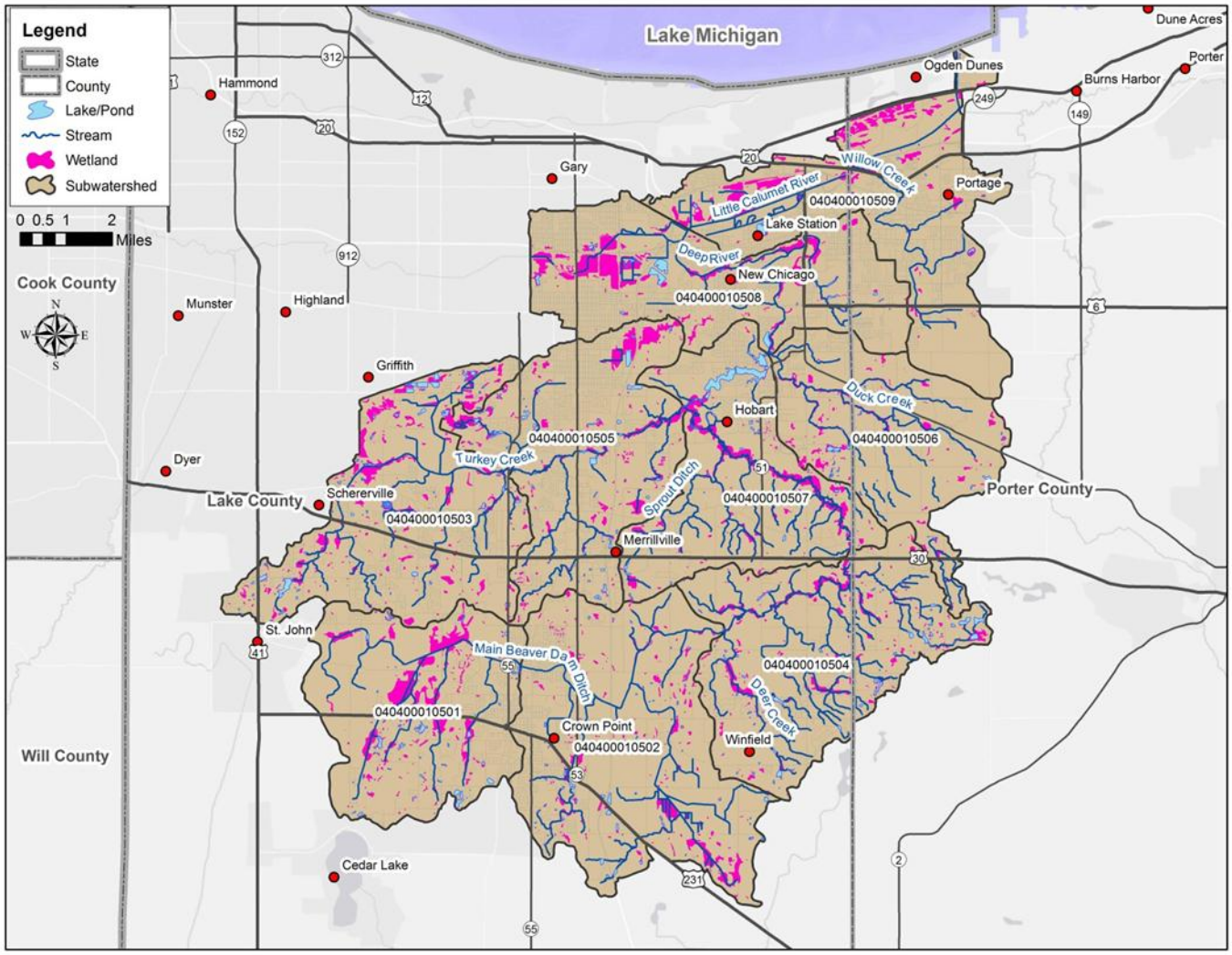

Figure 17 Wetlands

Approximately 9,247 acres of wetland exist today within the Deep River-Portage Burns Waterway watershed (Table 8). Wetlands account for 8% of the watershed's drainage area. Historically, this number would have been closer to 37,354 acres or 32% of the watershed's drainage area based on hydrologic soils data. Large contiguous tracts of wetland exist along stream corridors such as Deep River, the Little Calumet River, and Main Beaver Dam Ditch (Figure 17). Subwatershed percent wetland area ranges from 4.7-10.3%. The Little Calumet River-Deep River subwatershed (HUC 040400010508) has the greatest concentration of wetlands with slightly more than 1,246 acres representing 10.3% of the land cover.

Subwatershed	Emergent (ac)	Forested/ Shrub (ac)	Lake (ac)	Pond (ac)	Riverine (ac)	Total	% Wetland
040400010501	547	363	23	213	0	1,146	9.8
040400010502	516	134	0	146	0	797	4.7
040400010503	438	396	56	299	0	1,189	8.7
040400010504	293	438	55	237	0	1,024	7.4
040400010505	296	463	67	182	8	1,016	8.1
040400010506	183	262	0	74	0	520	5.1

Subwatershed	Emergent (ac)	Forested/ Shrub (ac)	Lake (ac)	Pond (ac)	Riverine (ac)	Total	% Wetland
040400010507	188	570	218	108	3	1,086	9.8
040400010508	446	470	88	138	104	1,246	10.3
040400010509	465	535	60	57	106	1,223	9.1
Watershed Total	3,374	3,631	567	1,454	221	9,247	8.0

Table 8 Subwatershed Wetland Data

The most common wetland type by total acreage in the watershed is forested/shrub wetland (3,572 acres) followed by emergent wetland (3,377 acres) (Table 9). Mean forested/shrub wetland size is 8.4 acres while mean emergent wetland size is 4 acres. There is a total of 243 acres of riverine wetland located in the watershed. The largest contiguous tract is located on Deep River downstream of Lake George, continuing along Burns Ditch and Burns Waterway where it empties to Lake Michigan.

Wetland Type	Count	Minimum (ac)	Maximum (ac)	Sum	Mean	S.D.
Emergent	848	<0.1	76.3	3,377.1	4.0	8.1
Forested/ Shrub	448	0.2	157.7	3,752.4	8.4	17.5
Lake	11	20.4	262.2	562.3	51.1	67.5
Pond	824	<0.1	20.7	1,456.0	1.8	2.8
Riverine	12	0.2	133.2	243.1	20.3	42.2

Table 9 Watershed Wetland Type Statistics

Northwest Indiana, one of the most rapidly developing areas in the State, has several wetlands that are critical to controlling storm water and reducing water pollution, that provide good wildlife and plant habitat, and some of which are globally and regionally rare systems. The Northwest Indiana Advance Identification (ADID) study, completed in 2002, was designed to provide landscape-level information on critical wetlands in advance of development pressure so that planners, regulators, developers, landowners, and others would consider the information when making land-use decisions. The study was designed by a diverse group of partners to identify which area wetlands provide important wetland functions. Area wetlands were assessed, characterized, and mapped for their plant and animal habitat and their capacity for storing storm water and filtering pollutants. The overall purpose of the study was to further the protection of wetlands in the region.

Because of the large size of the project area, not all wetlands were included for assessment in the study. Wetlands smaller than five acres and that were not contiguous with other waterbodies were screened from potential field assessment. An exception was made in the portion of Lake County north of the I-80/I-94 where one acre was the screening threshold. Wetlands included in the study were placed into one of three categories by the Northwest Indiana ADID working group (Figure 18).

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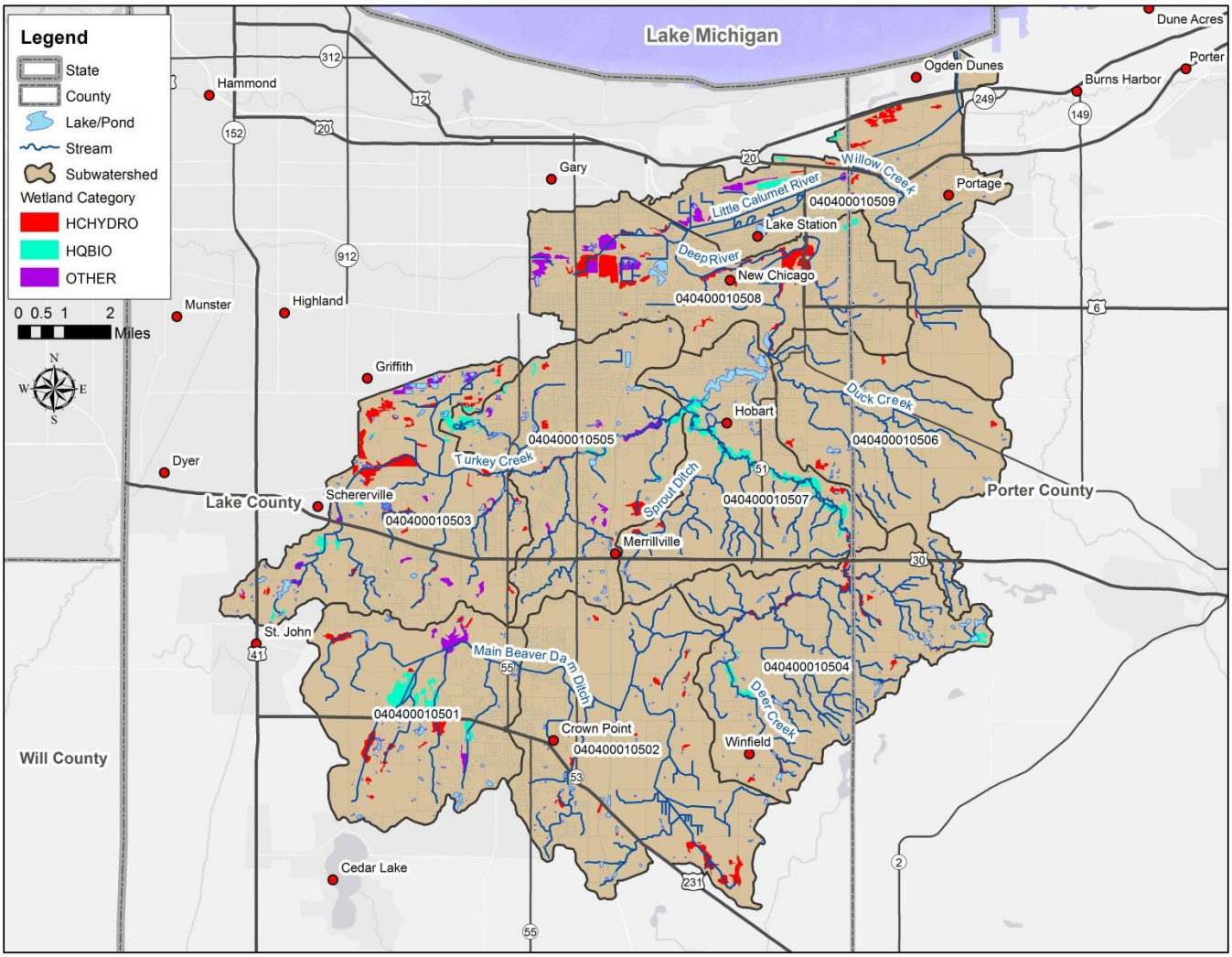

Figure 18 ADID Wetlands

The wetland categories include and are described as follows:

- **High Capacity Hydrologic Function Wetlands** (HCHYDRO). These wetlands provide good storm water retention or pollutant removal functions. Wetlands serve as natural water storage areas during periods of high runoff and stream flow. Riparian or reducing peak stream flows. Depressional wetlands may hold runoff for longer periods of time, reducing the volume of storm runoff and potentially supplementing base flow as the depressions slowly drain. Wetlands that are in the headwaters of a sub-watershed or that are located in a flood-prone area meet the criteria for this category. Wetlands that intercept sediment-laden flow, are vegetated, and are upstream of high quality wetlands and other water bodies meet the criteria for being effective at pollutant removal.
- **High Biological Function Wetland** (HQBIO). The wetlands in this category represent wetlands and wetland complexes of five acres or greater and are the least impacted by ditching, filling, draining, excavating, intensive surrounding land use, or other anthropogenic disturbances. These wetlands include native vegetative communities and/or provide good habitat for waterfowl, songbirds, aquatic mammals, and amphibians. Some smaller wetlands were included in this assessment - wetlands within the Grand Calumet Area of Concern (AOC), and the rare systems of dune and swale, and panne.
- **Other** (OTHER). Other Wetlands with ADID Data. These are wetlands that have a variety of associated data obtained from field visits or from the files of natural resource organizations.

Additionally the Northwest Indiana ADID study provided information on wetland restoration potential, recommend management activities, and threats. Recommended management strategies for these wetlands most often included invasive species control, runoff control and restoring hydrology. The most common threats were encroaching development, invasive species, runoff, altered hydrology, and some instances of grazing. Figure 19 shows wetland restoration potential based upon ADID findings and recommendations.

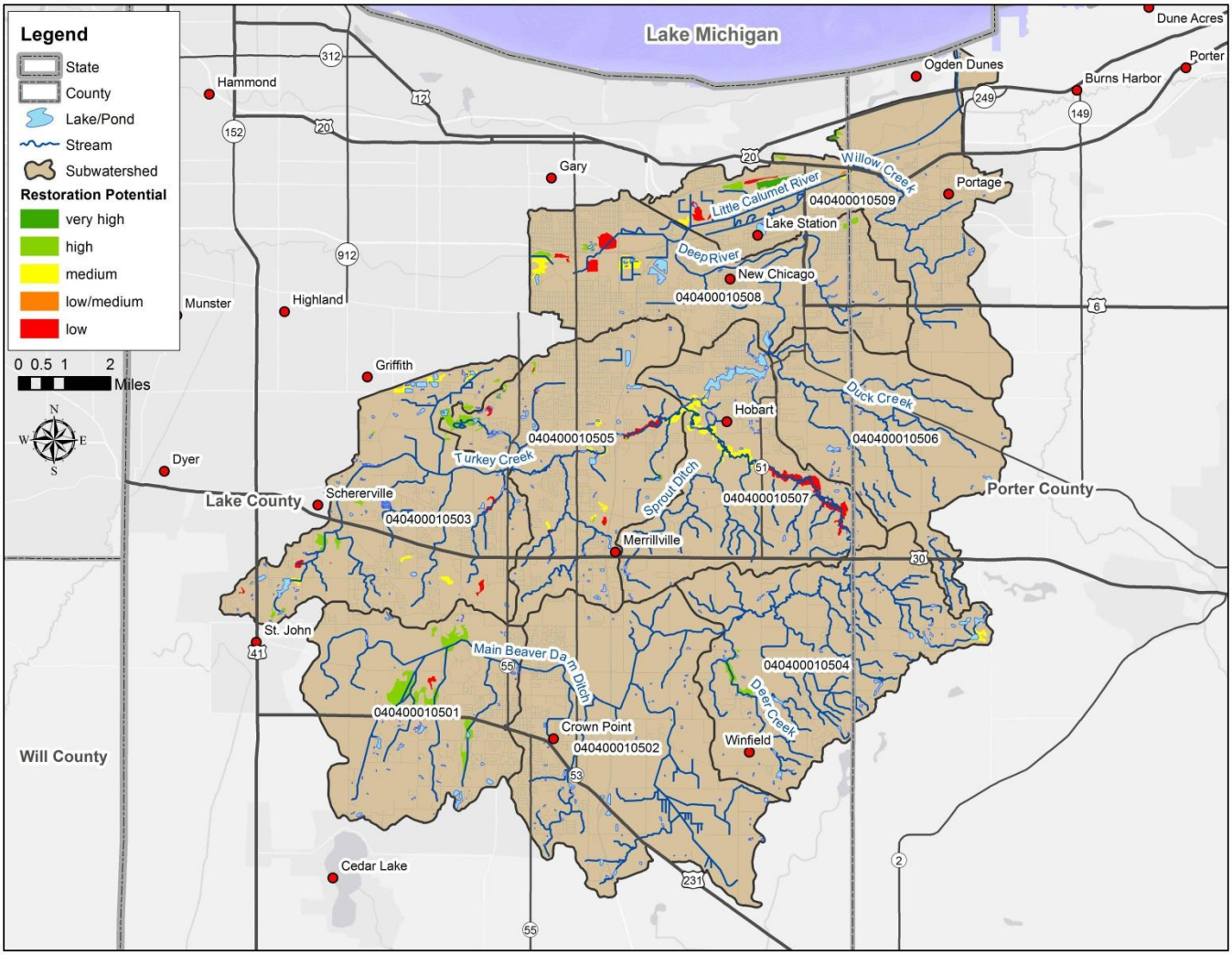

Figure 19 ADID Wetland Restoration Potential

2.5.4 Hydromodification

Hydromodification is defined as alteration of the hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources. According to the EPA, hydromodification is one of the leading sources of impairment in streams, lakes and other waterbodies in the United States. Examples include dredging, straightening, stream relocation, construction along or in streams, dams, and land reclamation. The EPA has grouped hydromodification into three major types of hydromodification categories including (1) channelization and channel modification, (2) dams, and (3) streambank and shoreline erosion.

Historically, channelization occurred to reduce the risk of flooding and to drain wet areas for agriculture and development. Channelization can affect the timing and delivery of pollutants to downstream areas. Additionally

during storm events, channelization can lead to higher flows which increase the risk of flooding and streambank erosion. In some cases the stream may no longer be able to access its floodplain to dissipated energy and deposit sediment loads carried by flood waters. In recent years regulatory requirements, primarily through the Clean Water Act, have limited traditional hydromodification activities within stream channels and waterbodies.

In both urban and rural areas, streambank and shoreline erosion is often associated with changes in watershed land use characteristics such as increased impervious surface cover (ex. streets, parking lots and rooftops). Because streambanks and shorelines erosion is often closely related to upland activities that occur outside riparian areas, it is often necessary to consider solutions to these issues as a component of overall watershed protection and restoration objectives.

Dams are artificial barriers that control the flow of water. They are built for a variety of purposes such as flood control, power generation, irrigation, or to create recreational lakes and ponds. While dams can have societal benefits, they can also have detrimental impacts to aquatic resources. In some cases the original purpose for the dams construction may no longer be present (ex. provide mechanical power for grist mills). Cost benefit analysis of dams have been conducted by communities, environmental agencies and organizations across the U.S. and the results often show that the benefits of dam removal outweigh the benefits of continuing to maintain and operate the dam.

In general some effects of channel modification activities and dams include:

- Changes in sediment supply
- Accelerated delivery of pollutants
- Floodplains disconnected from their streams
- Loss of instream and riparian habitats
- Impede or block fish migration routes
- Alter water temperature and chemistry

2.5.4.1 Regulated Drains

A regulated drain (a.k.a. legal drain) is an open channel or closed tile/sewer that is subject to the provisions of the Indiana drainage code, I.C.-36-9-27. Under this code, a drainage board has the authority to construct, maintain, reconstruct or vacate a regulated drain. The board can maintain the regulated drain by dredging, clearing, tile repair, obstruction removal, erosional control or other work necessary to keep the drain in proper working order based on its original specifications. In total there are 112.4 miles of regulated drain within the watershed. This includes 88.4 miles of regulated drain in Lake County and approximately 24 miles in Porter County. The locations of these regulated drains are shown in Figure 20.

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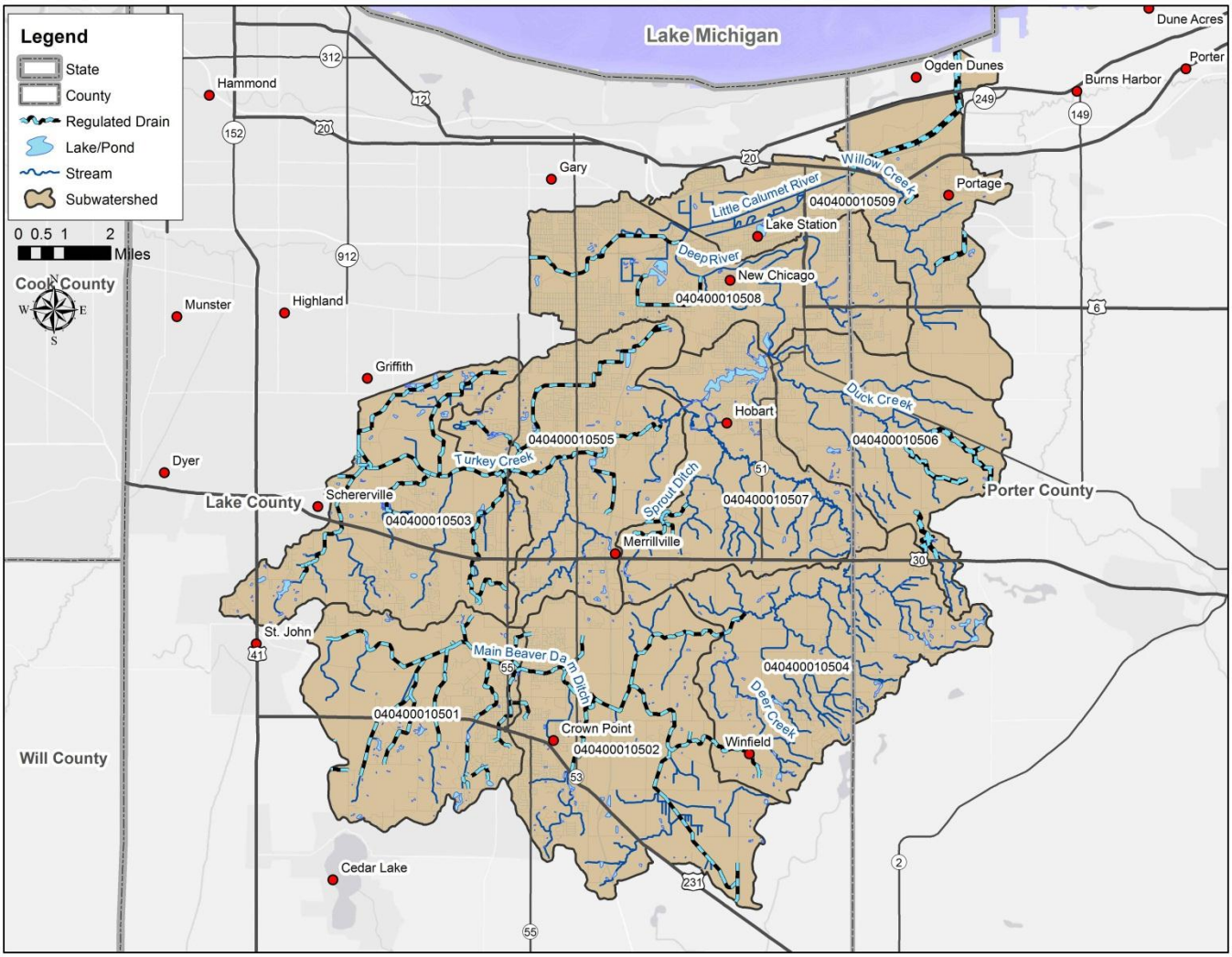


Figure 20 Regulated Drains

2.5.4.2 Dams

Dams are another common form of hydromodification in the watershed. Many dams in the region were built to either store and provide water for mechanical power generation (e.g., waterwheels to mill grain) or provide recreational opportunities (e.g., boating and fishing). However, dams can also be associated with a number of negative impacts including changes to hydrology, water quality, habitat, and river morphology. Human activities, such as agricultural and urban land uses, can contribute to contaminant and sediment loads to the impoundments created by these dams.

There are a total of 5 dams located within the watershed (Figure 21). General location, drainage area, associated lake surface area, and storage information is included in Table 10. Lakes with large drainage areas and small surface areas, such as Lake George, tend to be prone to nonpoint source pollution impacts.

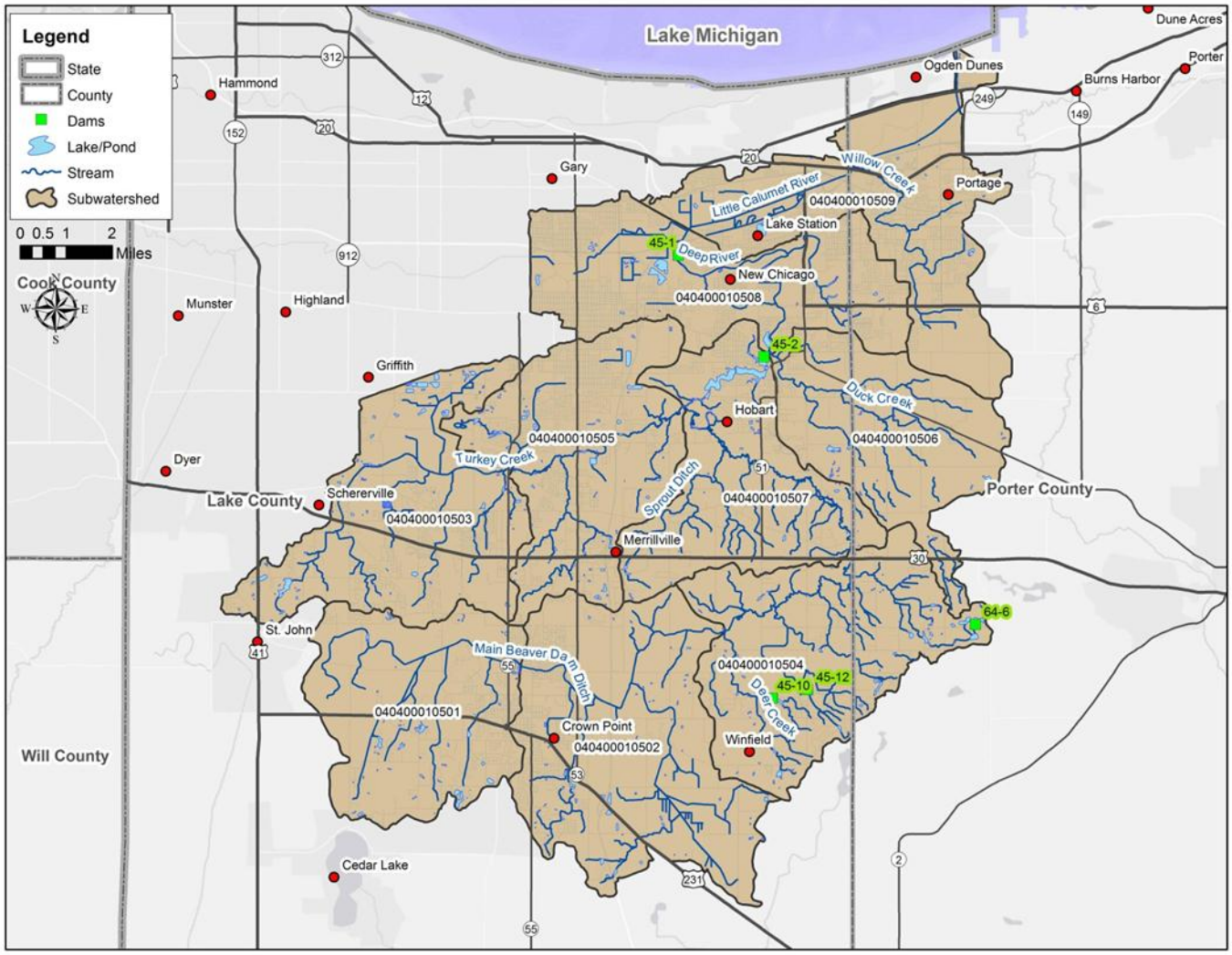


Figure 21 Dams

Name	State ID	County	Drainage Area (mi^2)	Lake Surface Area (ac.)	DA:LSA	Max Storage (ac.-ft.)	Height (ft.)
Doubletree Lake Estates Dam	45-12	Lake	0			270	6
Hobart Deep River Dam	45-1	Lake	141			0	14
Hooseline & Molchan Lake Dam	45-10	Lake	0.65			147	21
Lake George Dam	45-2	Lake	124			3,450	22
Norman Olson Lake Dam	64-6	Porter	0.23			172	20

Table 10 Dams

In 1995 the U.S. Army Corps of Engineers (USACE), Chicago District, published a report investigating the feasibility of dredging Lake George. As noted previously Lake George was created by the damming of Deep River sometime around 1840. The USACE concluded in the study that Lake George had "trapped large quantities of fine sediment

from upstream agricultural areas, reducing water depths, making the lake bottom softer and the water murkier." Additionally, the report noted that "lake residents are not happy with these conditions, as they interfere with boating, swimming, fishing and clarity of the lake". More than 590,000 cubic yards of sediment were dredged from Lake George by 2000 at a cost of more than $2 million.

Another dam of particular interest in the watershed is the Hobart Deep River Dam (State ID # 45-1). This dam is located in Lake Station approximately 1/3 mile downstream from where Deep River joins the West Branch of the Little Calumet River (Figure 22). This 14-foot high, in-channel dam was constructed some time prior to 1945 out of timber and sheet piling. Some safety concerns have been expressed recently due the structure's deteriorated state.

Sometime around 2006, the Wildlife Habitat Council (WHC) approached the Gary Community School Corporation to discuss potential habitat restoration at the Deep River Outdoor Education Center where the dam is located. One of the potential restoration activities identified was dam removal. In 2009 several key stakeholder groups including staff from the Deep River Outdoor Education Center, the WHC, USACE, USFWS, DNR, and Shirley Heinze Land Trust met onsite to discuss this possibility further. Since this time the City of Lake Station has purchased the former Riverside Mobile Home Park which is located on the opposite streambank. The trailer park had flooded several times in recent years including the severe September 2008 flood. Lake Station was awarded a grant from the Indiana Department of Homeland Security to purchase the land, demolish abandoned trailers, and turn the property into recreational green space. A significant opportunity exists to restore hydrology, habitat, and fish migration within this reach of Deep River by removing the dam.

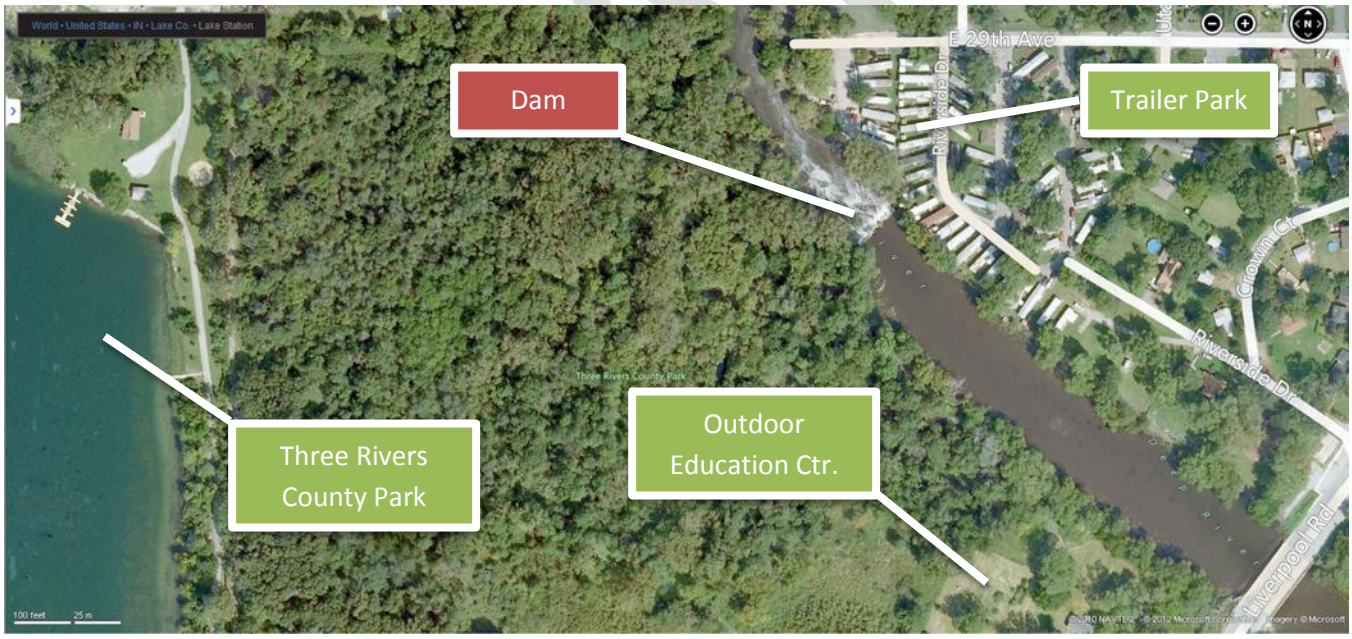


Figure 22 Hobart Deep River Dam Site

2.5.4.3 Levees

The Little Calumet River Basin Development Commission was created in 1980 by the Indiana General Assembly to serve as the required local sponsor for the Little Calumet River, Indiana Flood Control and Recreation Project. The Federal project, which was authorized for construction in the 1986 Water Resources Development Act, is designed to provide structural flood protection up to the 200-year level along the main channel of the Little Calumet River from the Illinois State Line to Martin Luther King Drive in Gary, Indiana.

The flood control project features include:

- Construction of over 9.7 miles of set-back levees in Gary and Griffith.
- Construction of 12.2 miles of levees and floodwalls in Hammond, Highland, and Munster.
- Installation of a flow diversion structure at the Hart Ditch confluence in Hammond/Munster.
- Modification of four major highway bridges along the river corridor to permit better flow.
- Creation of 16.8 miles of hiking/biking trails connecting recreational developments.

Figure 23 shows the Little Calumet River flood control project area. The hatched lines represent levee and floodwall locations. The levees end upstream of the confluence of Deep River and the West Branch Little Calumet River. During high flow conditions the diversion structure located immediately west of Hart Ditch on the Little Calumet River redirects water eastward towards the Burn Waterway and out to Lake Michigan.

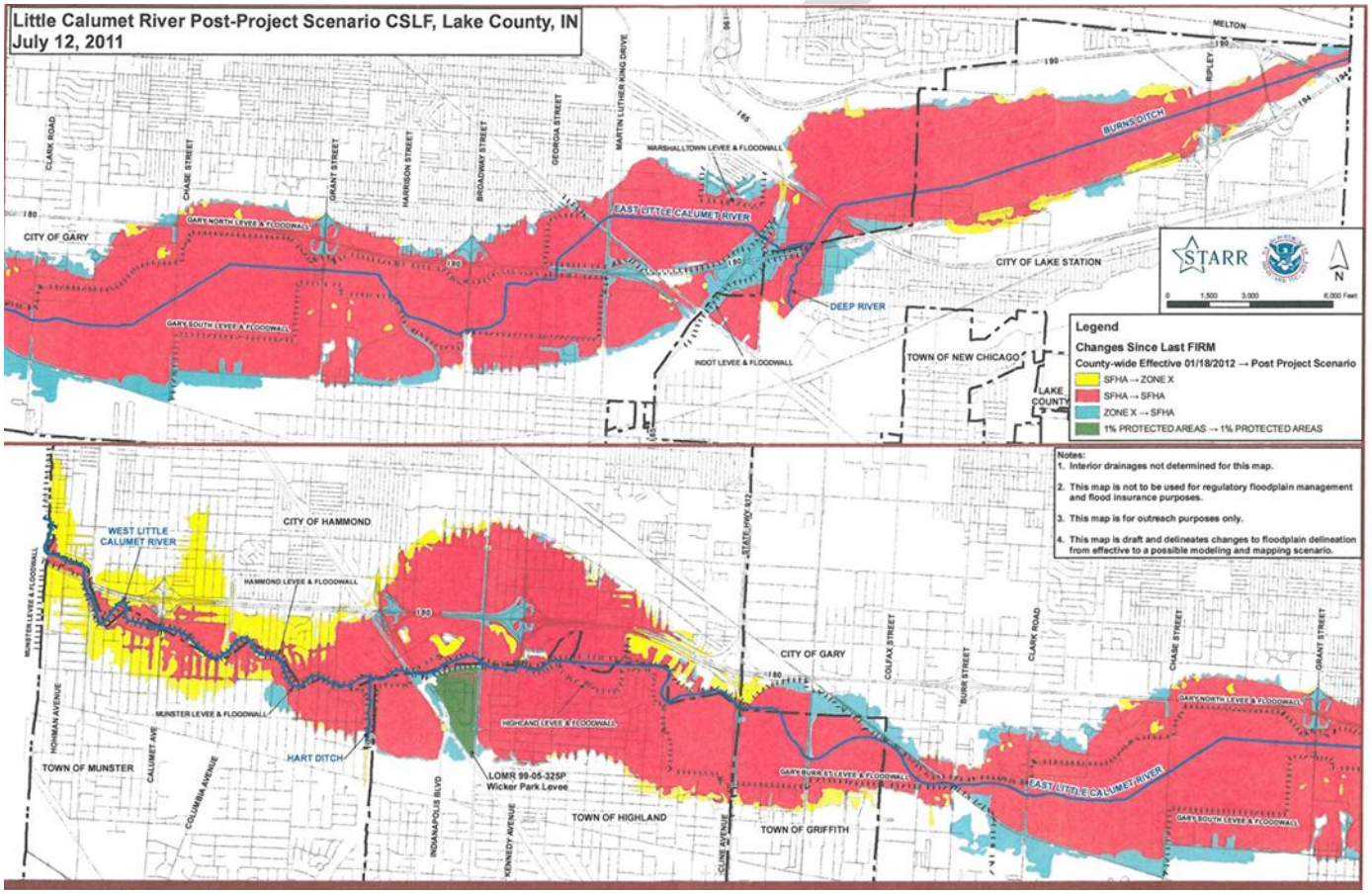


Figure 23 Little Calumet River Flood Control Project Area

2.5.5 Impaired Waterbodies

The Indiana Department of Environmental Management (IDEM) prepares the 303d List of Impaired Waters on a biannual basis. The 303d list identifies where water quality problems exist and the nature of those impairments. The primary purpose of the 303d List, in accordance with the Clean Water Act, is to identify impairments for which a Total Maximum Daily Load (TMDL) study is needed. A TMDL identifies the maximum amount of pollutant that a waterbody can receive and still meet state water quality standards, and allocates pollutant loadings among point and nonpoint sources. A TMDL also provides information that can be used to guide restoration activities in the watershed aimed at mitigating the impairment(s). Once a TMDL has been completed for the impairment, it may be

removed from the 303d list, and placed under Category 4 on the consolidated list. An example would be the Little Calumet River for the *E. coli*. Being placed under Category 4 in this case simply means that the waterbody is still impaired or threatened but a TMDL has been completed.

Within Deep River-Portage Burns Waterway watershed, there are eight different stream segments included on the 2012 303d List. These segments have been grouped into what are known as assessment units by IDEM. Assessment units are typically determined by significant breakpoints in the stream network (large lakes, major tributaries, coldwater/warmwater fishery designations, etc.). The types and locations of impairments within the watershed are presented below in Table 11 and Figure 24.

Segment Name	Assessment Unit ID	Subwatershed	DO	*E. coli*	Free Cyanide	IBC	Siltation	PCB-FT
Deep River	INC0154_01	040400010504		X		X		
Deep River	INC0158_01	040400010508			X	X		
Deep River Tributary Merrillville	INC0154_T1003	040400010504				X	X	
Deer Creek	INC0154_T1001	040400010504		X				
Little Calumet River	INC0158_T1005	040400010508	X			X		X
Little Calumet River	INC0159_01	040400010509	X					X
Little Calumet River	INC0159_02	040400010509				X		X
Main Beaver Dam Ditch	INC0151_01	040400010501				X		
Main Beaver Dam Ditch	INC0152_04	040400010502				X		
Niles Ditch	INC0152_T1009	040400010502				X		
Turkey Creek	INC0153_01	040400010503		X		X		
Turkey Creek	INC0155_01	040400010505		X				
Willow Creek	INC0159_T1001	040400010509		X		X		X

Table 11 Category 5 Impaired Waterbodies- 2012

The impairments identified within the watershed include dissolved oxygen (DO), *E. coli*, free cyanide, impaired biotic communities (IBC), siltation, and PCBs in fish tissue (PCB-FT). A total of 15.4 miles stream are listed for dissolved oxygen, 36.4 miles for *E. coli*, 9 miles for free cyanide, 91.5 miles for impaired biotic communities, 34 miles for PCB's in fish tissue, and 12.3 miles for siltation. Approximately 75.2 miles of stream are listed for multiple impairments (example Willow Creek- E. coli, IBC, PCB-FT). The most common impairment by far is for biotic communities.

Biological impairments differ from some traditional water quality impairments in that the impaired biotic communities are indicators of disturbance rather than causes of disturbance. The composition of aquatic communities found in streams and rivers is determined by the interaction of numerous physical, chemical, and biological processes. As a result, biological impairments can be driven by natural or unnatural changes to one or many components of these systems. Biological impairments are commonly caused by stressors that are not considered conventional pollutants within our water quality rules (ex. altered flow regimes or deposited and bedded sediment). One of the most challenging aspects of developing TMDLs for impaired biotic communities is identifying the dominant stressors and developing load allocations for them.

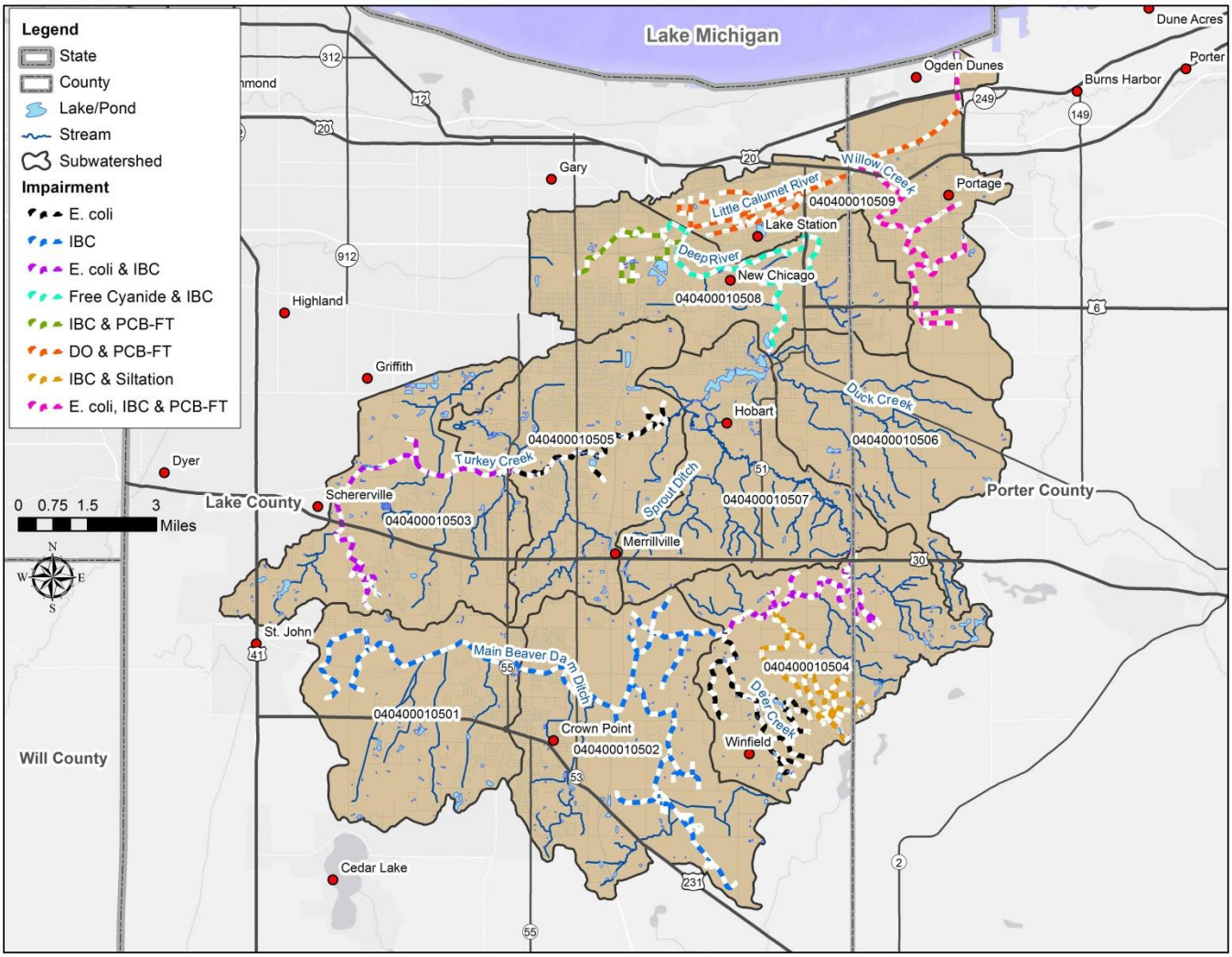


Figure 24 Impaired Streams- 2012

2.6 Land Cover & Land Use

Land cover and land use within a watershed can have a profound impact on both water quality and habitat. Natural land cover such as forests, wetlands, and grasslands help protect water quality and aquatic habitats by filtering pollutants from runoff, maintaining hydrologic functions, and supporting fish and wildlife needs. Alteration of natural land cover for human use almost inevitably leads to increased runoff which can carry associated pollutants to nearby waterbodies. The pollutants generated are dependent on the land uses within the given drainage area. Some of the common pollutants generated in urbanized areas include excess nutrients, sediment, metals, pathogens, and toxins. In agricultural areas common pollutants can include excess nutrients, sediment, pathogens, herbicides and pesticides. For this reason having an understanding of what land uses are present in a watershed can help determine what factors may be contributing to water quality problems and potential sources.

Based upon 2006 land cover data, development is the dominate land cover type within the watershed followed by agriculture (Table 12, Figure 25, and Figure 26). However, distinct differences in percent land cover are readily apparent at the subwatershed scale. Subwatersheds located in the southeastern portion of the watershed including Main Beaver Dam Ditch-Deep River (HUC 040400010502), Deer Creek-Deep River (HUC 040400010504), and Duck Creek (HUC 040400010506) are predominately agricultural (46-53% by land area). The Headwaters Turkey Creek

(HUC 040400010503), City of Merrillville-Turkey Creek (HUC040400010505), Little Calumet River-Deep River (HUC 040400010508), and Willow Creek- Burns Ditch (HUC 040400010509) subwatersheds are predominately developed (48-69% by land area). The remaining subwatersheds are more balanced in the percent distribution of agricultural and developed land uses.

Natural land cover within the watershed, including forest, grassland, scrub/shrub, water and wetland account for 30% of the land area. The Lake George-Deep River (HUC 040400010507) subwatershed has the highest percentage of natural land cover within the watershed at 38%. Forestland covers approximately 9% of the watershed with subwatershed coverage ranging between 7-11%. Grassland covers 7% of the watershed with subwatershed coverage ranging from 4-11%. Wetland covers 8% of the watershed with subwatershed coverage ranging from 5-9%.

Subwatershed	Agriculture (ac.)	%	Bare Land (ac.)	%	Developed (ac.)	%	Forest (ac.)	%	Grassland (ac.)	%	Scrub/ Shrub (ac.)	%	Water (ac.)	%	Wetland (ac.)	%
040400010501	3,660	31	239	2	3,817	33	1,197	10	976	8	629	5	87	1	1,088	9
040400010502	8,222	49	181	1	4,623	28	1,121	7	1,198	7	516	3	55	0	890	5
040400010503	2,453	18	34	0	6,554	48	1,350	10	1,059	8	860	6	132	1	1,135	8
040400010504	6,269	46	59	0	2,008	15	1,973	14	1,250	9	904	7	124	1	1,146	8
040400010505	1,784	14	13	0	7,205	58	956	8	974	8	467	4	125	1	966	8
040400010506	5,414	53	35	0	1,833	18	971	10	820	8	313	3	32	0	713	7
040400010507	3,460	31	113	1	3,253	29	1,208	11	1,224	11	552	5	226	2	1,046	9
040400010508	684	6	8	0	8,416	69	843	7	445	4	502	4	133	1	1,109	9
040400010509	2,873	21	11	0	6,975	52	1,157	9	469	4	537	4	119	1	1,231	9
Watershed Total	34,818	30	691	1	44,685	39	10,777	9	8,415	7	5,280	5	1,033	1	9,322	8

Table 12 Subwatershed Land Cover Data (2006)

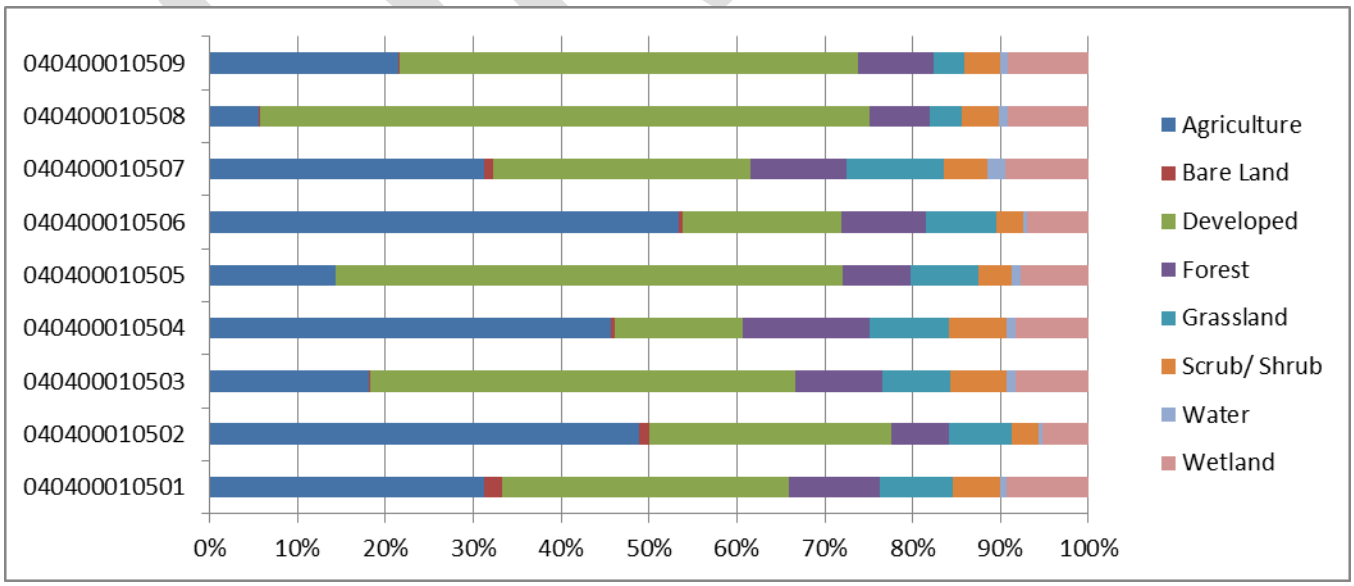


Figure 25 Subwatershed Percent Land Cover (2006)

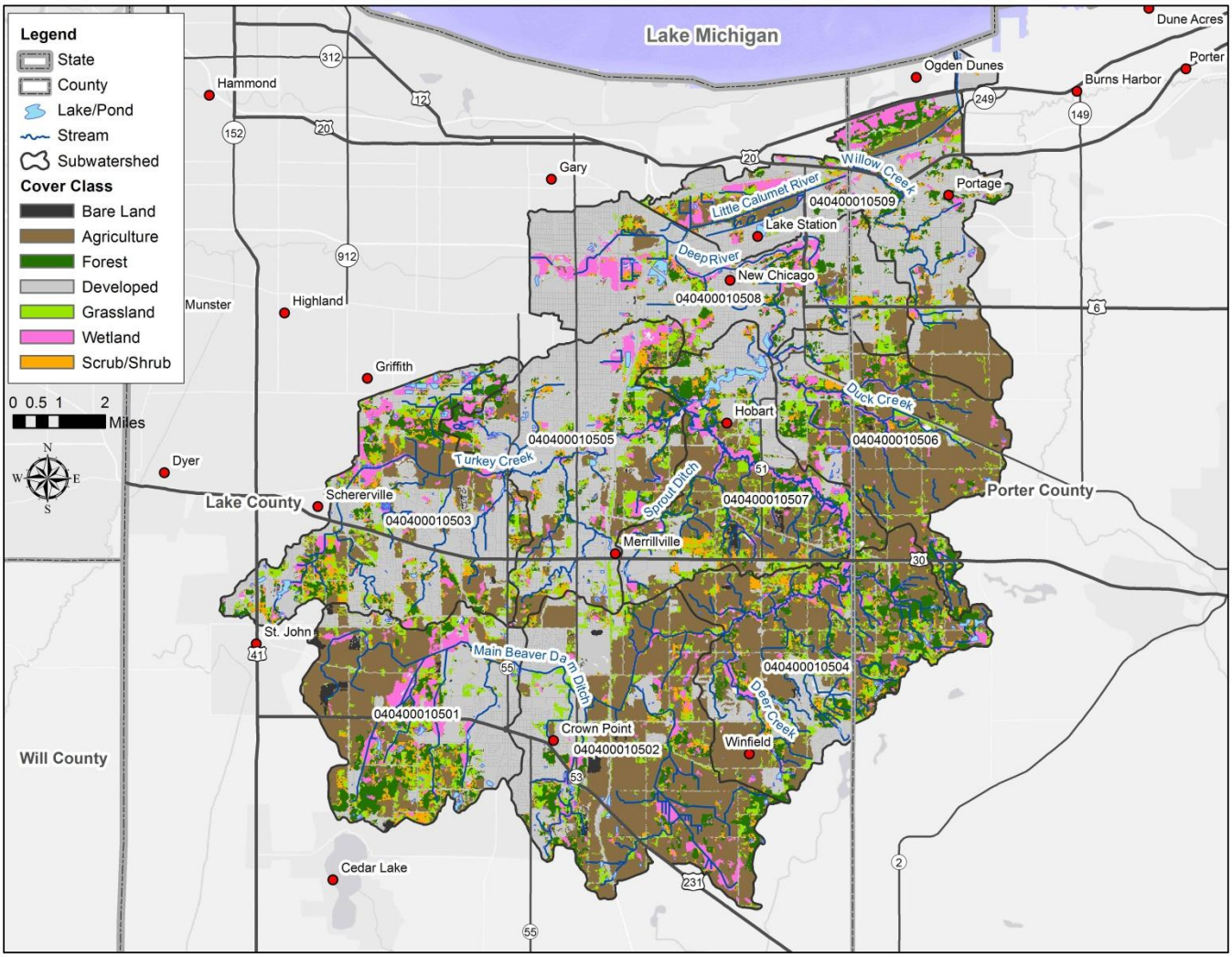


Figure 26 Land Cover (2006)

2.6.1 Agriculture Lands

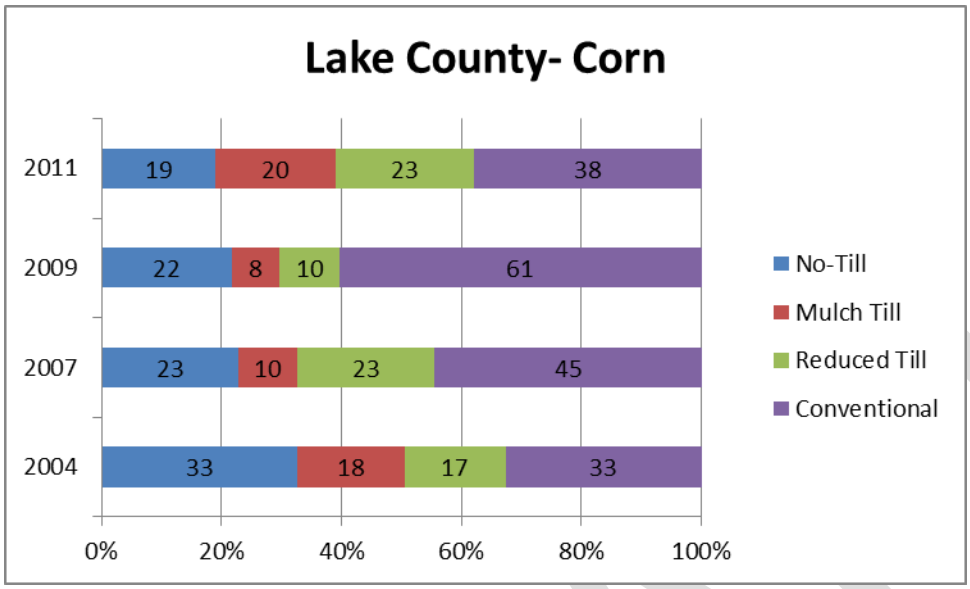
Agriculture remains a prominent land use within portions of the watershed. In 2006, approximately 34,818 acres (30%) of the land was devoted to agriculture. Cultivated land accounted for 80% of agricultural use with corn and soybeans being the predominant crops. Pasture/hay accounted for the remaining 20% of agricultural land use. The percentage of agricultural land cover for each subwatershed is presented above in Table 12.

2.6.1.1 Cropland Conservation Tillage Practices

In cultivated areas, tillage practices can have a major effect on water quality. Conventional tillage leaves the soil surface bare and loosens soils particles making them susceptible to wind and water erosion. Conservation tillage reduces erosion by leaving at least 30% of the soil surface covered with crop residue after planting. Residues protect the soil surface from the impact of raindrops and act like a dam to slow water movement. Rainfall stays in the crop field allowing the soil to absorb it. With conservation tillage less soil and water leave a field.

While there is no data specifically available for conservation tillage practices by watershed, the Indiana State Department of Agriculture does provide data by county. Cropland tillage data for 2004-2011 for both corn and soybean are displayed in Figure 27 and Figure 28. After a decreasing trend in the use of conservation tillage practices for corn production in Lake County between 2004 and 2009, the percentage rose over 20% in 2011. In

Porter County there has been a decreasing trend in the use of conservation tillage practices for corn production since 2007. Comparison between the two counties shows that farmers are more apt to use conservation tillage practices for corn production in Lake County by a fairly large margin. A high percentage of conservation tillage practices for soybean production can be seen in both counties although Porter County did have an 18% drop in 2011.



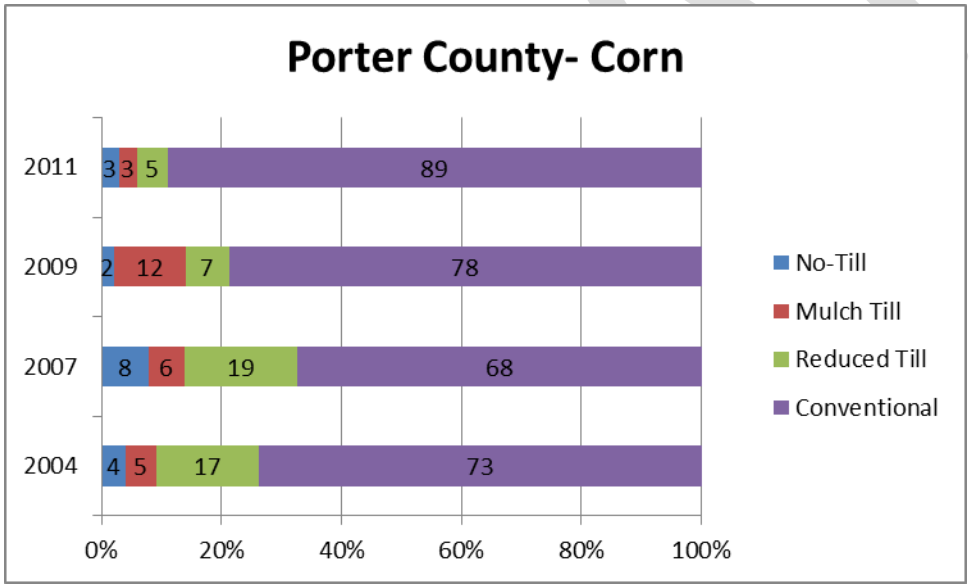
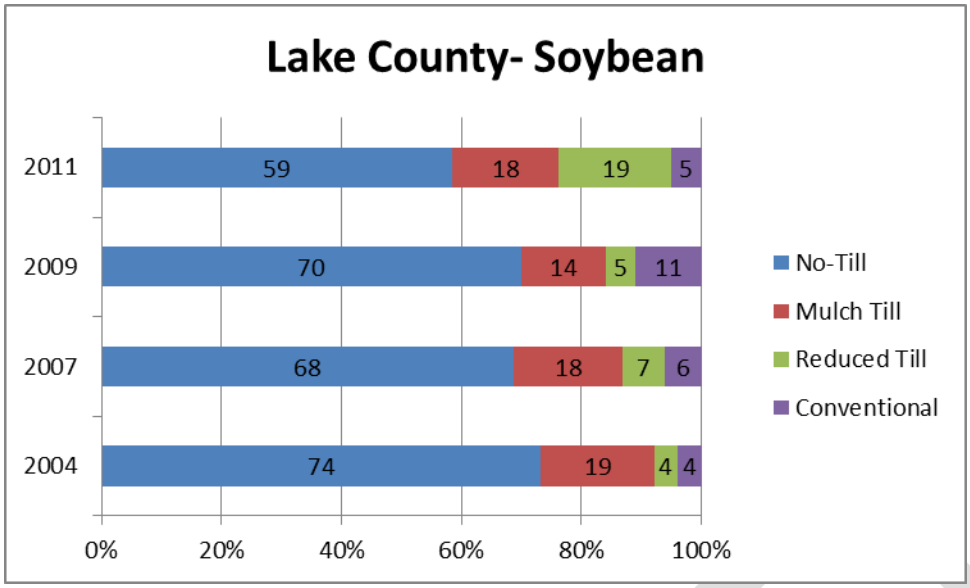


Figure 27 Corn Production Conservation Tillage



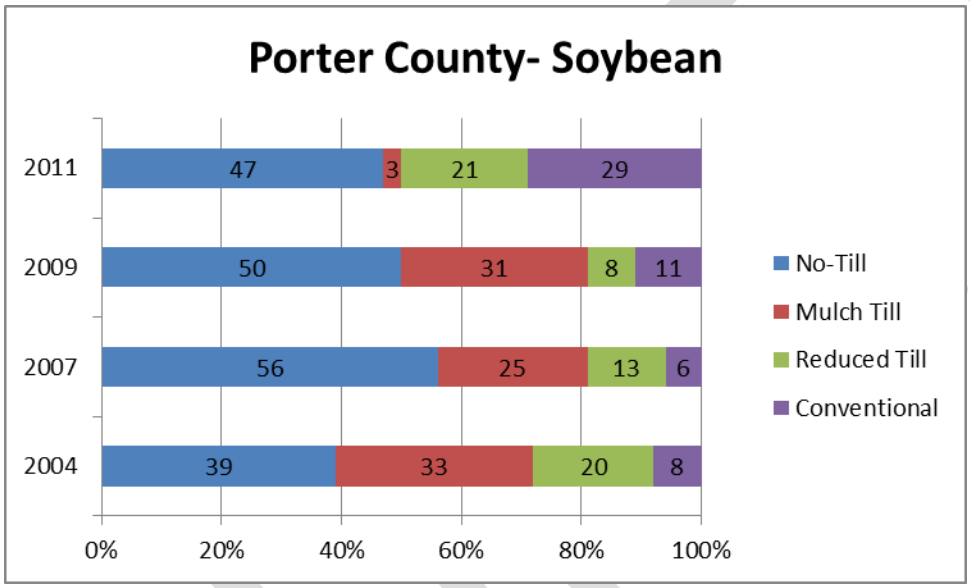


Figure 28 Soybean Production Conservation Tillage

2.6.1.2 Confined Feeding Operation Facilities

Indiana's Confined Feeding Control Law (IC-13-18-10) defines a confined feeding operation (CFO) as any animal feeding operation engaged in the confined feeding of at least 300 cattle, or 500 horses, or 600 swine or sheep, or 30,000 fowl, such as chickens and turkeys. Animals raised in CFOs produce manure and wastewater which is collected and stored in pits, tanks, lagoons and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial reuse provides a natural source of nutrients for crop production. It also lessens the need for fuel and other resources that are used in the production of commercial fertilizer.

Confined feeding operations, however, can also pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons or tanks
- Improper application of manure to the land can impair surface or ground water quality

The IDEM regulates CFO facilities, as well as smaller operations which have violated water pollution rules or laws under the Confined Feeding Control Law. Due to size or historical compliance issues some confined feeding operations are defined as concentrated animal feeding operations (CAFOs). The CAFO regulation contains more stringent operational requirements and slightly different application requirements. The focus of the regulations is to protect water quality. The program is intended to provide an oversight process to assure that waste storage structures are designed, constructed and maintained to be structurally sound and that manure is handled and land applied in an environmentally acceptable manner.

A review of CFO facility GIS point data shows that there is one facility located off of East 121st Avenue in the Main Beaver Dam Ditch-Deep River subwatershed (HUC 040400010502) (Figure 29). IDEM records show that the facility houses dairy cattle. Manure is managed in an earthen waste treatment lagoon system and dry manure storage shed. Land application of waste is periodically applied to 200 acres of cropland. In May of 2011 the facility was granted a "Request for Approval Voidance" by IDEM since they no longer operated as a CFO having less than 300 cattle. The facility is still required to meet spill rule requirements and therefore cannot discharge any manure. Therefore manure management structures should be monitored and maintained to reduce the risk of spills.

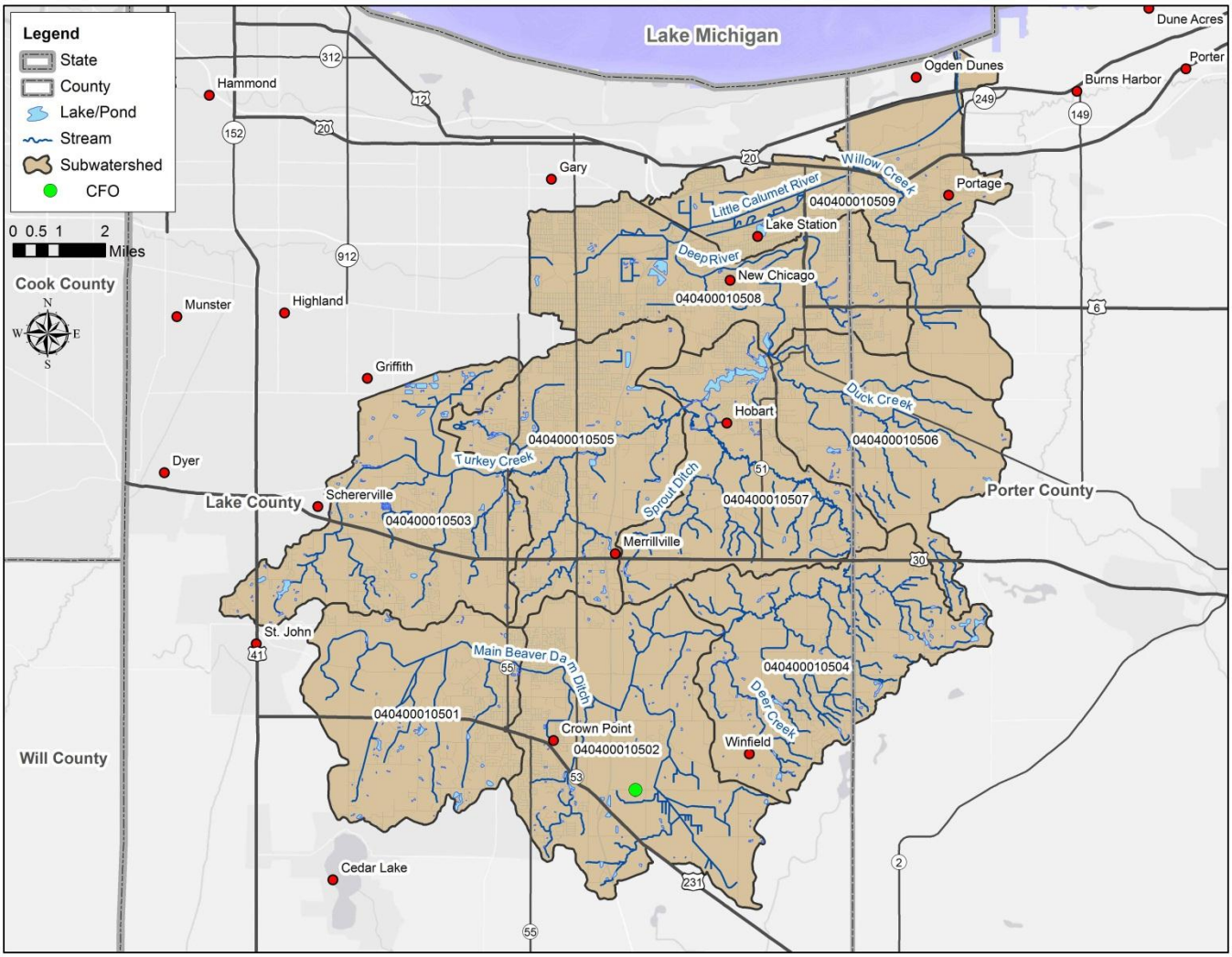


Figure 29 Confined Feeding Operation Facilities

2.6.2 Agricultural Animals

The table below presents the approximate types and number agricultural animals located in the watershed and its subwatersheds. This data was obtained by querying the EPA's STEPL Data Server. The agricultural animals' data was gathered from the USDA 2007 Census of Agriculture. Animal wastes can be a potential source of nutrient and pathogen loading to adjacent waterbodies if appropriate pollution prevention practices are not implemented. Additionally unrestricted livestock access to streams can lead to streambank erosion and sedimentation.

Subwatershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck
40400010501	19	50	0	5	36	12	0	12
40400010502	27	72	0	8	54	20	0	14
40400010503	22	57	0	8	44	15	0	13
40400010504	25	42	200	9	36	10	0	6
40400010505	21	53	0	8	39	13	0	12
40400010506	29	20	324	13	25	9	0	2
40400010507	17	44	17	4	32	12	0	9
40400010508	23	45	86	8	36	13	0	10
40400010509	36	29	427	19	37	16	1	6
Watershed Total	219	412	1054	82	339	120	1	84

Table 13 Agricultural Animals

2.6.3 Developed Lands

Poor development practices and planning can have detrimental impacts to streams. The following table, adapted from the Ohio DNR Division of Soil & Water Resources, shows some of the impacts that can occur to stream hydrology, geomorphology, water quality, habitat and ecology.

Changes in Hydrology	Changes in Geomorphology
▪ increase in magnitude and frequency of severe floods ▪ increased frequency of erosive bankfull floods ▪ increase in annual volume of surface runoff ▪ more rapid stream velocities ▪ decrease in dry weather stream baseflow	▪ stream channel widening and downcutting ▪ increased streambank erosion ▪ shifting bars of course-grained sediments ▪ elimination of pool\riffle structure ▪ imbedding of stream sediments ▪ stream relocation\enclosure or channelization ▪ stream crossings form fish barriers
Changes in Water Quality	**Changes in Aquatic & Terrestrial Habitat, and Ecology**
▪ sedimentation ▪ nutrient enrichment ▪ bacterial contamination during dry and wet weather ▪ higher toxic levels, trace metals, and hydrocarbons ▪ increased water temperatures	▪ shift from external to internal stream energy production ▪ reduction in diversity of aquatic and terrestrial species ▪ destruction of wetlands, riparian buffers, and springs

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▪ trash\debris jams	

Table 14 Development Impacts on Streams

Overall, developed land is the dominant land cover type within the watershed. In 2006 approximately 44,685 acres or 39% of the watershed was classified as developed. Between 1996 and 2006 developed land area in the watershed increased by 9%. Much of this occurred at the loss of agricultural lands and to a lesser extent natural areas. The percentage of developed land cover for each subwatershed is presented above in Table 12.

Subwatersheds located in the northern and western portions of the watershed are more urban in character compared to those subwatersheds in the southeast. Municipalities within the watershed include are presented below in Figure 30 and Table 15 which also includes population change data.

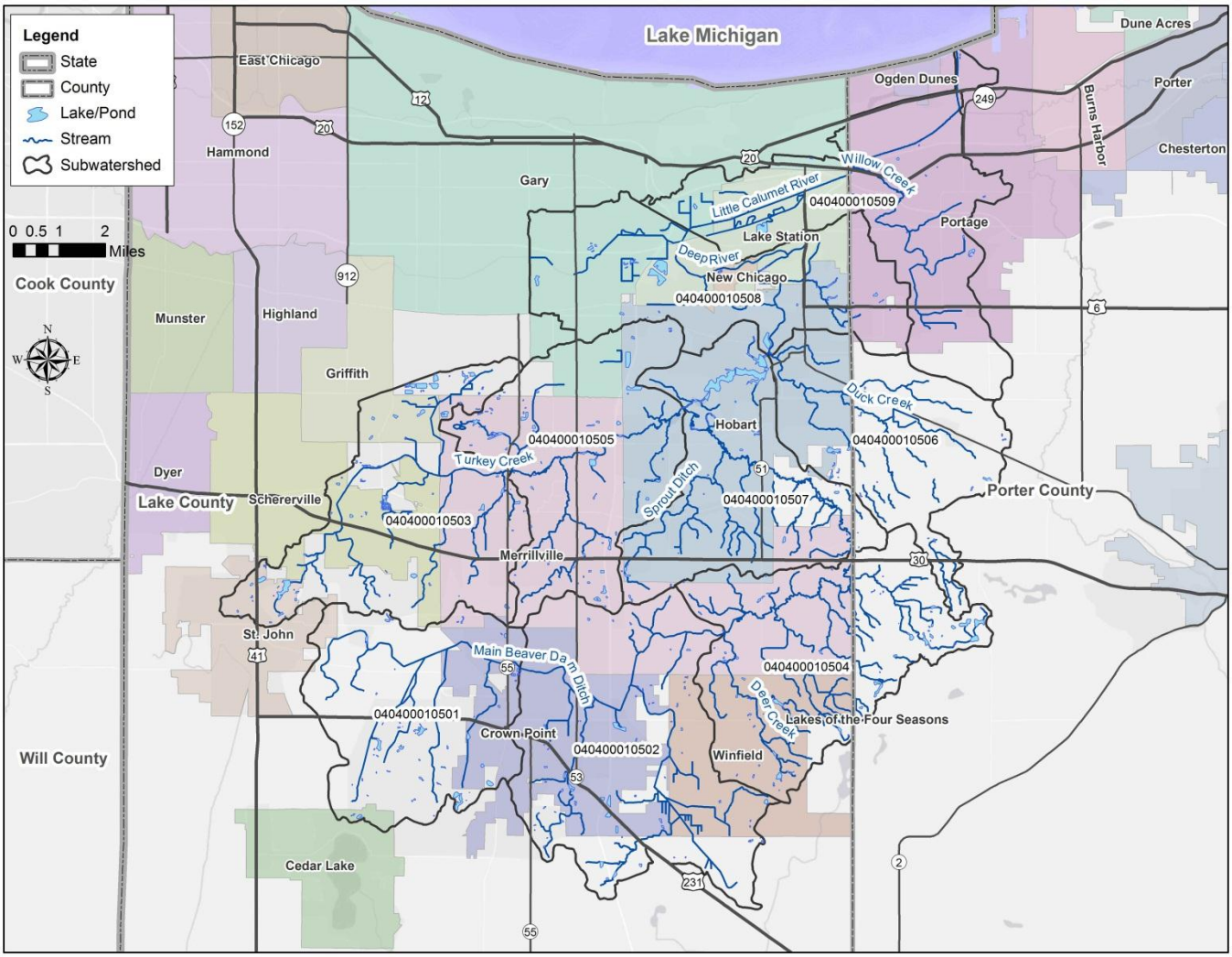

Figure 30 Municipal Boundaries

2.6.3.1 Population Growth

Over the past 30 years development in the region of Northwest Indiana has been expanding southward. In the 2040 Comprehensive Regional Plan for Northwest Indiana, NIRPC showed a decreasing trend in urban core community populations with populations shifting towards the suburbs and unincorporated areas to the south. Table 15 below

shows population change between 1980 and 2010 for the municipalities located within the watershed. Several municipalities are showing a positive trend in population growth. Between 1980 and 2010 the population of Crown Point increased by nearly 11,000 people. Winfield's population went from 0 to 4,383 over this same time period. According to NIRPC new housing units were built at a pace of more than double that of population growth in the region between 1990 and 2009. This means more land is being consumed for development than needed for housing with surplus housing being vacant. Areas of recent development were presented earlier in Figure 36 and Figure 37.

	Population				Change by Decade			% Change by Decade		
Community	1980	1990	2000	2010	1980-1990	1990-2000	2000-2010	1980-1990	1990-2000	2000-2010
Cedar Lake	8,754	8,885	9,279	11,560	131	394	2,281	0.015	0.044	0.246
Crown Point	16,455	17,728	19,806	27,317	1,273	2,078	7,511	0.077	0.117	0.379
Gary	151,953	116,646	102,746	80,294	-35,307	-13,900	-22452	-0.232	-0.119	-0.219
Griffith	17,026	17,914	17,334	16,893	888	-580	-441	0.052	-0.032	-0.025
Hobart	22,987	24,440	25,363	29,059	1,453	923	3,696	0.063	0.038	0.146
Lake Station	15,083	13,899	13,948	12,572	-1,184	49	-1,376	-0.078	0.004	-0.099
Lakes of the Four Seasons	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Merrillville	27,677	27,257	30,560	35,246	-420	3,303	4,686	-0.015	0.121	0.153
New Chicago	2,585	2,066	2,063	2,035	-519	-3	-28	-0.201	-0.001	-0.014
Ogden Dunes	1,489	1,499	1,313	1,110	10	-186	-203	0.007	-0.124	-0.155
Portage	27,409	29,060	33,496	36,828	1,651	4,436	3,332	0.060	0.153	0.099
Schererville	13,209	20,155	24,851	29,243	6,946	4,696	4,392	0.526	0.233	0.177
St. John	3,974	4,921	8,382	14,850	947	3,461	6,468	0.238	0.703	0.772
Winfield	0	0	2,298	4,383	NA	2,298	2,085	NA	2.563	0.907

Table 15 Population Change by Municipality

2.6.3.2 Impervious Cover

A considerable amount of research has been done to evaluate the direct impact of urbanization on streams. Much of this research has focused on hydrologic, physical and biological indicators. In recent years, impervious cover (IC) has emerged as a way to explain and sometimes predict how severely these indicators change in response to varying levels of watershed development. Impervious cover includes surfaces that are impenetrable to water such as rooftops, roads and parking lots. The Center for Watershed Protection (CWP) has integrated research findings into a general watershed planning model, known as the Impervious Cover Model (ICM). The ICM predicts that most stream quality indicators decline when watershed IC exceeds 10%, with severe degradation expected beyond 25% IC (CWP, 2003).

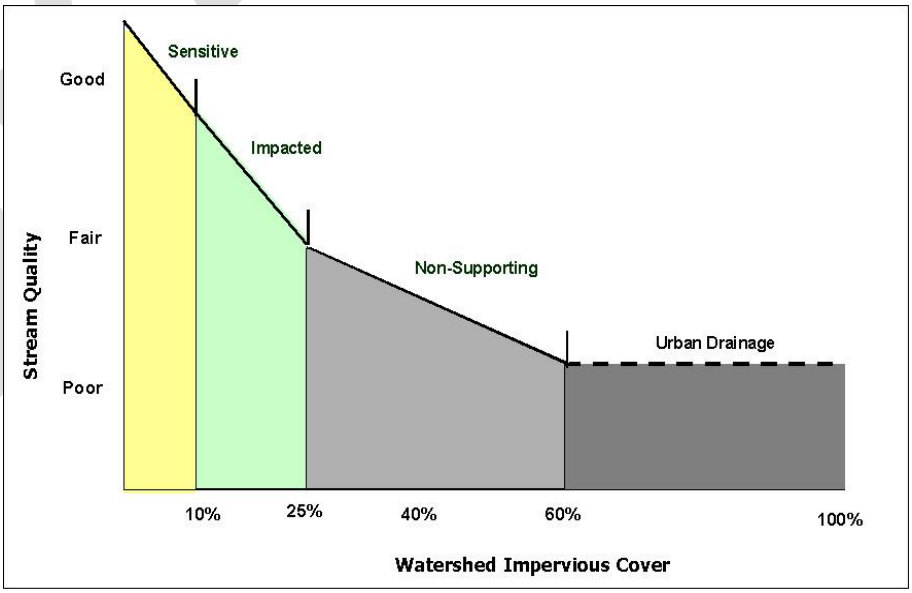

Figure 31 Relationship between Impervious Cover & Stream Quality

Figure 32 shows the impervious cover that existed in the watershed in 2006. An analysis of percent impervious surface was done for each subwatershed (Table 16). Results of this analysis show that seven of the nine subwatersheds exceed the 10% threshold classification for a sensitive stream. The Little Calumet River-Deep River subwatershed (HUC040400010508) had the highest percentage of impervious cover in the watershed at nearly 28%. Both the Deer Creek-Deep River (HUC 040400010504) and Duck Creek (HUC 040400010506) subwatersheds are classified as sensitive streams with less than 10% impervious cover. The remaining subwatersheds are classified as impacted having 10-25% impervious cover. Both the City of Merrillville-Portage Burns Waterway (HUC 040400010505) and Willow Creek-Burns Ditch (HUC 040400010508) subwatersheds were very near 25% impervious surface cover in 2006.

While the percent impervious cover presented above is substantially less than what was presented in the Little Calumet River and Portage Burns Watershed TMDL for *E. coli* for the Deep River watershed, the TMDL does indicate a correlation between impervious surface cover and bacterial concentrations (Earth Tech, 2004).

Subwatershed	% Impervious Cover	ICM Classification	Downstream Subwatershed
40400010501	12.1	Impacted	040400010502
40400010502	11.9	Impacted	040400010504
40400010503	18.6	Impacted	040400010505
40400010504	4.9	Sensitive	040400010507
40400010505	24.9	Impacted	040400010507
40400010506	6.3	Sensitive	040400010508
40400010507	13.4	Impacted	040400010508
40400010508	27.6	Non-Supporting	040400010509
40400010509	23.7	Impacted	Outlets to Lake Michigan

Table 16 Subwatershed Percent Impervious Cover

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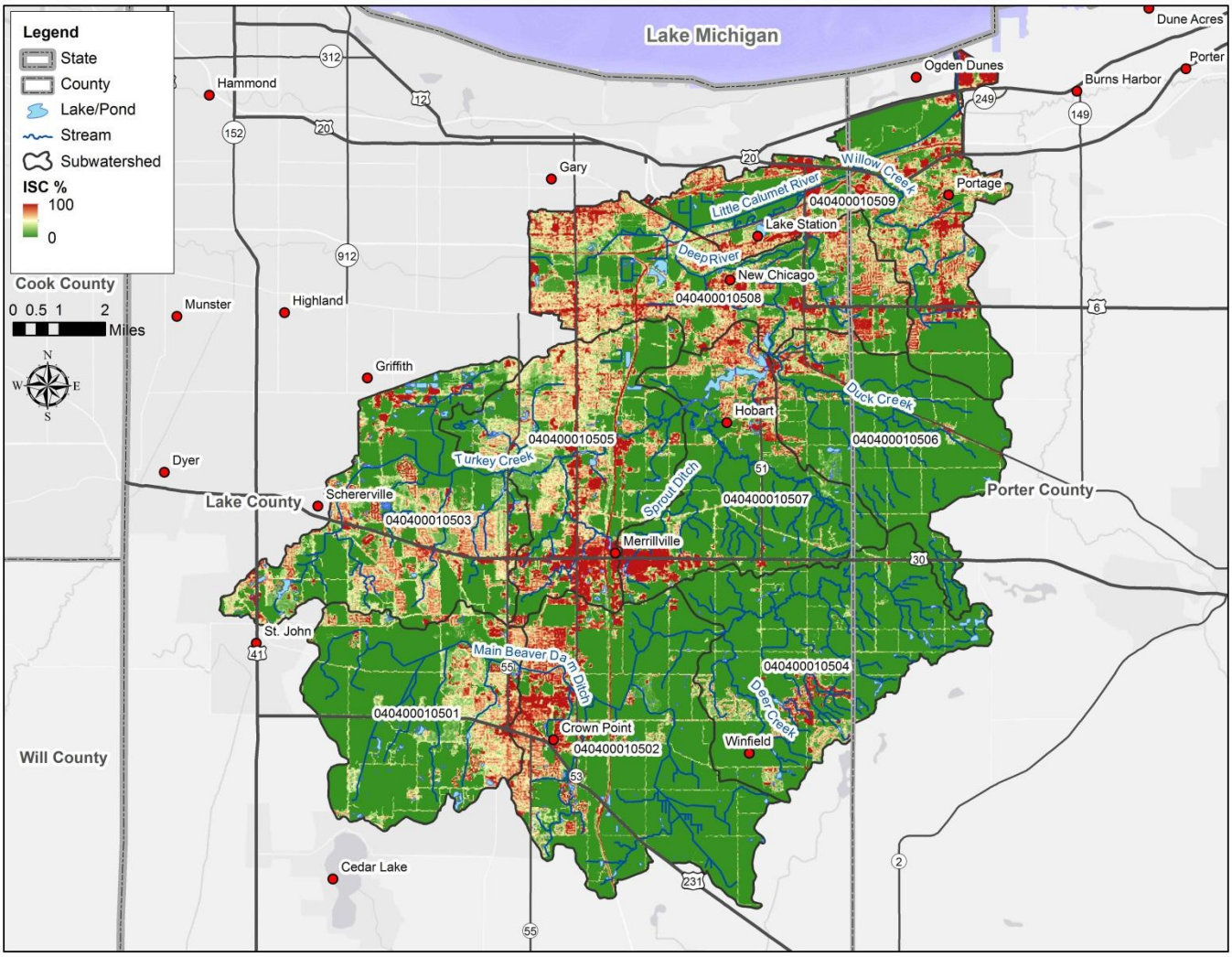

Figure 32 Impervious Cover 2006

Much of the recent growth within the watershed has occurred near Crown Point, Merrillville, and Winfield. Given that these areas are located further up in the watershed's drainage area this has future implications on runoff volume and water quality. Post construction stormwater practices that address both volume and quality for new development will need to be considered and incorporated to protect downstream areas.

2.6.4 Forest

Forests play a critical role in the health of a watershed. Forest cover reduces stormwater runoff and flooding by intercepting rainfall and promoting infiltration into the ground. Trees growing along streams help prevent erosion by stabilizing the soil with their root systems. They help improve water quality by filtering sediment and associated pollutants from runoff and they provide cover for both terrestrial and aquatic life. Forests also reduce summer air and water temperatures and improve regional air quality.

In 2006 there was approximately 10,777 acres of forestland within the watershed. Overall this accounts for 9% of the land area. Forest cover by subwatershed ranged from a low of 7% in the Main Beaver Dam Ditch-Deep River subwatershed (HUC 040400010502) to a high of 14% in the Deer Creek-Deep River subwatershed (HUC 040400010504).

While it is important to have a general understanding of how much forest cover exists in a watershed, it is also at least equally as important to understand the quality and location of that forest cover. Forest fragmentation occurs when large, contiguous stands of mature forest are divided into smaller isolated patches known as "forest fragments." Forest fragmentation is caused by human activities, such as road construction, agricultural clearing, and urbanization, or by natural processes that include fire and climate change. Forest fragmentation is considered a useful indicator of forest ecosystem health. The degradation of core forest into fragments can cause loss of native flora and fauna species, alterations to water cycles, and adverse impacts on air and water quality. Forests weakened by fragmentation become more susceptible to damage from insects and diseases, and this stress often degenerates into a condition of chronic ill health.

Forest fragmentation data for the watershed is displayed below in Figure 34. The data is classified into four different categories: patch, edge, perforated, and core. These categories have been identified as indicators of forest ecosystem quality and can be used to assess the amount of fragmentation present in a landscape and potential habitat impacts. Core forest area decreased approximately 219 acres or 2.8% between 1996 and 2006 while patch forest area increased nearly 70 acres or 4.2% over the same time period. The figure shows a subtle yet increasing trend in forest habitat fragmentation.

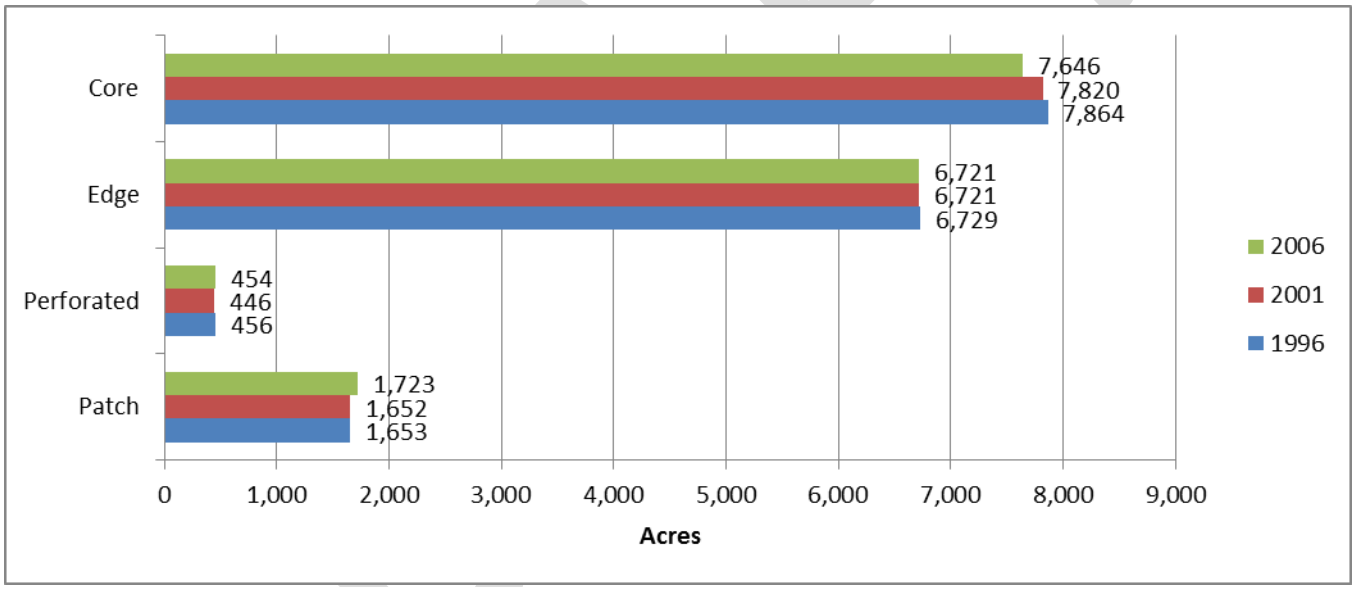

Figure 33 Forest Fragmentation Change (1996-2006)

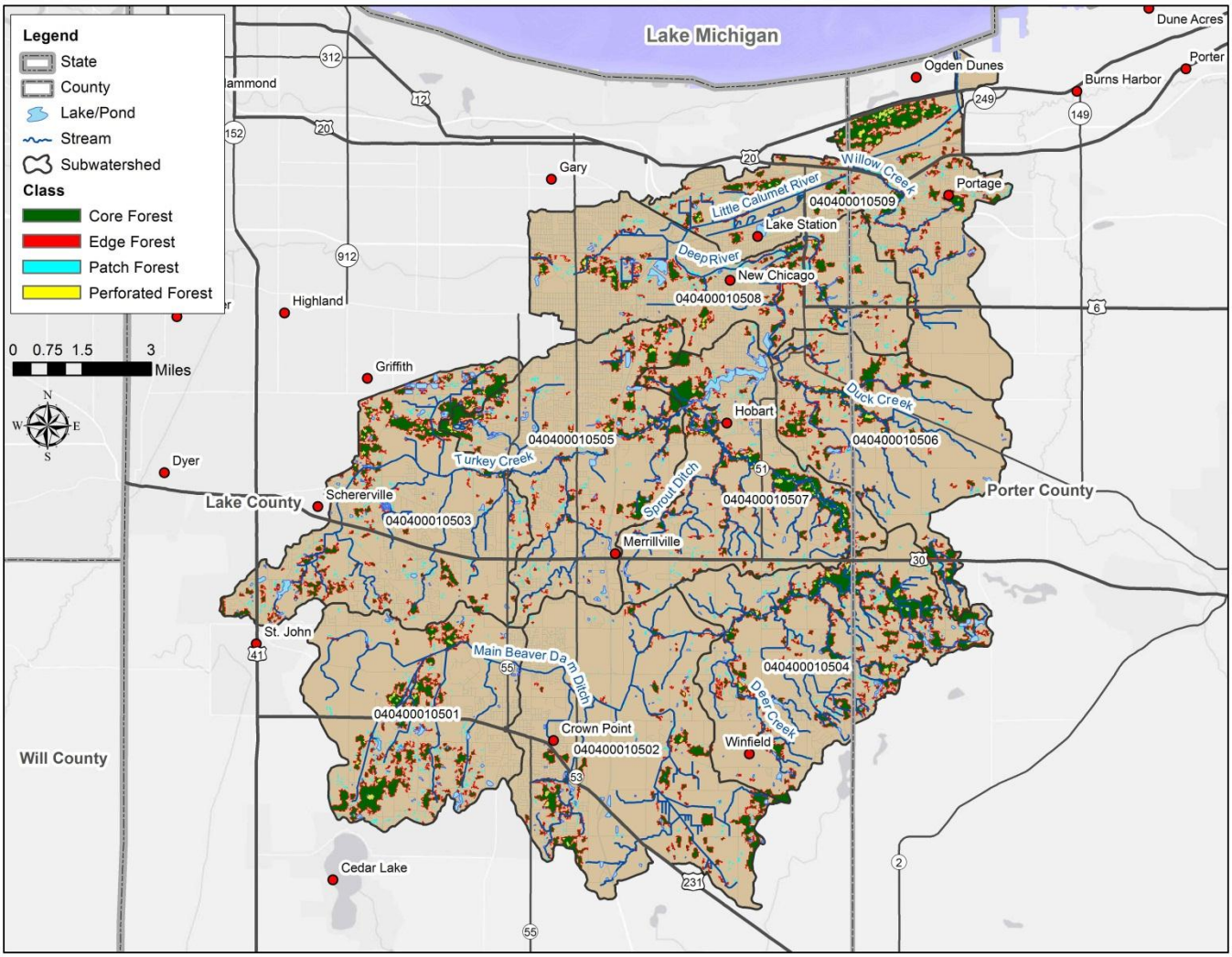

Figure 34 Forest Fragmentation

2.6.5 Land Cover Trends

A review of land cover data from 1996 to 2006 shows a steady decline in agricultural land and an increase in development within the watershed. Between 1996 and 2006, nearly 4,000 acres of agricultural land (-10%) was converted to other uses while development expanded by nearly 3,700 acres (9%) Decreases in natural land cover were also observed over this time period: 209 acres of forest (-2%), 97 acres of scrub/shrub (-2%), 57 acres of grassland (-1%), and 38 acres of wetland (- 0.5%).

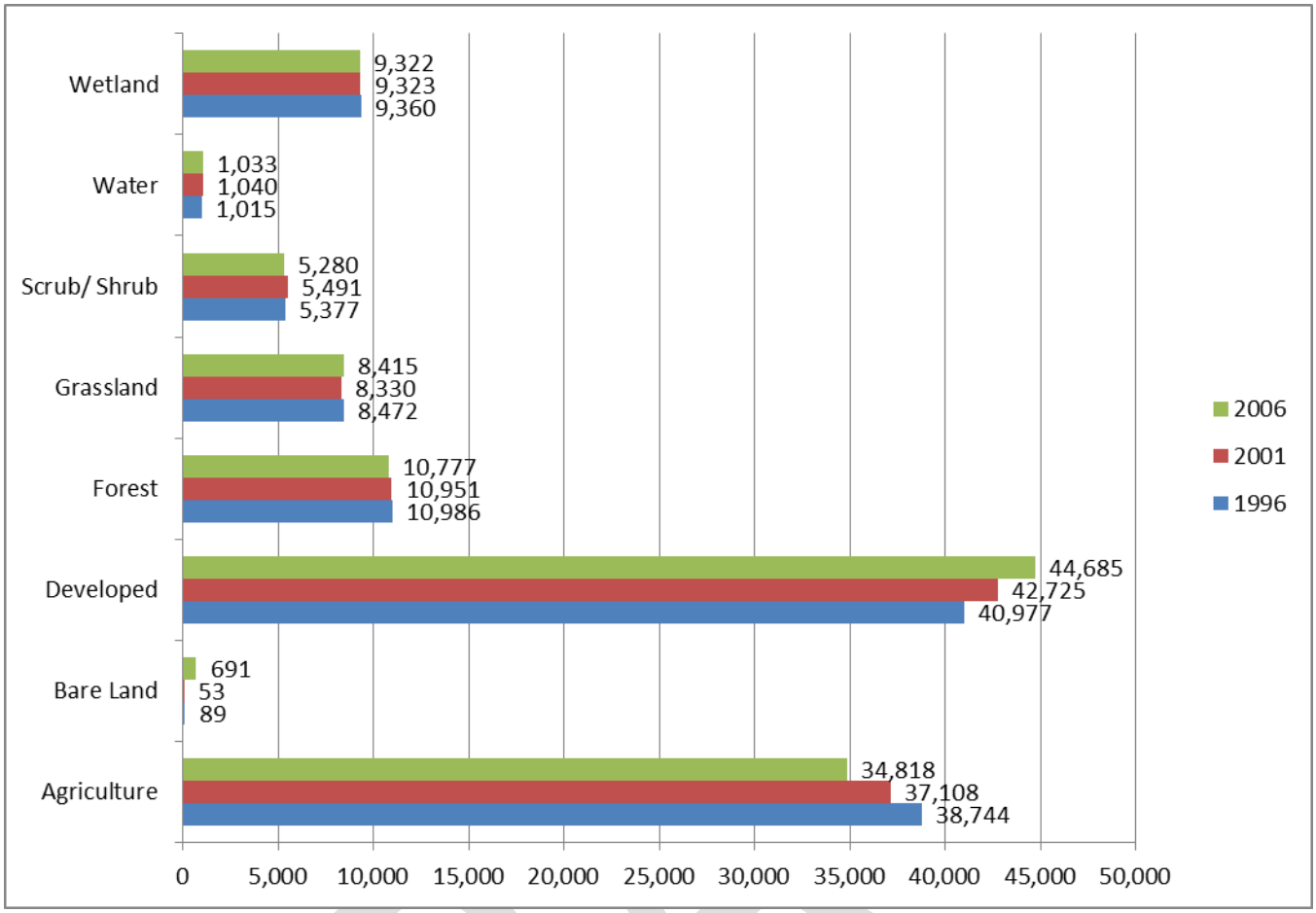

Figure 35 Changes in Land Cover Type Distribution (1996-2006)

Figure 36 displays areas in which land was converted to development between 1996 and 2006. A majority of the converted land had previously been in agricultural use. The figure shows that the greatest concentration of development occurred south of U.S. 30 near Crown Point and Merrillville within the Headwaters Main Beaver Dam Ditch (HUC 040400010501) and Main Beaver Dam Ditch-Deep River (HUC 040400010502) subwatersheds. Winfield also experienced substantial development during this time period in the Deer Creek-Deep River subwatershed (HUC 040400010504). Much of the development appears to have occurred within municipal boundaries and not in unincorporated areas. However, this observation does not take into account any annexation that may have occurred.

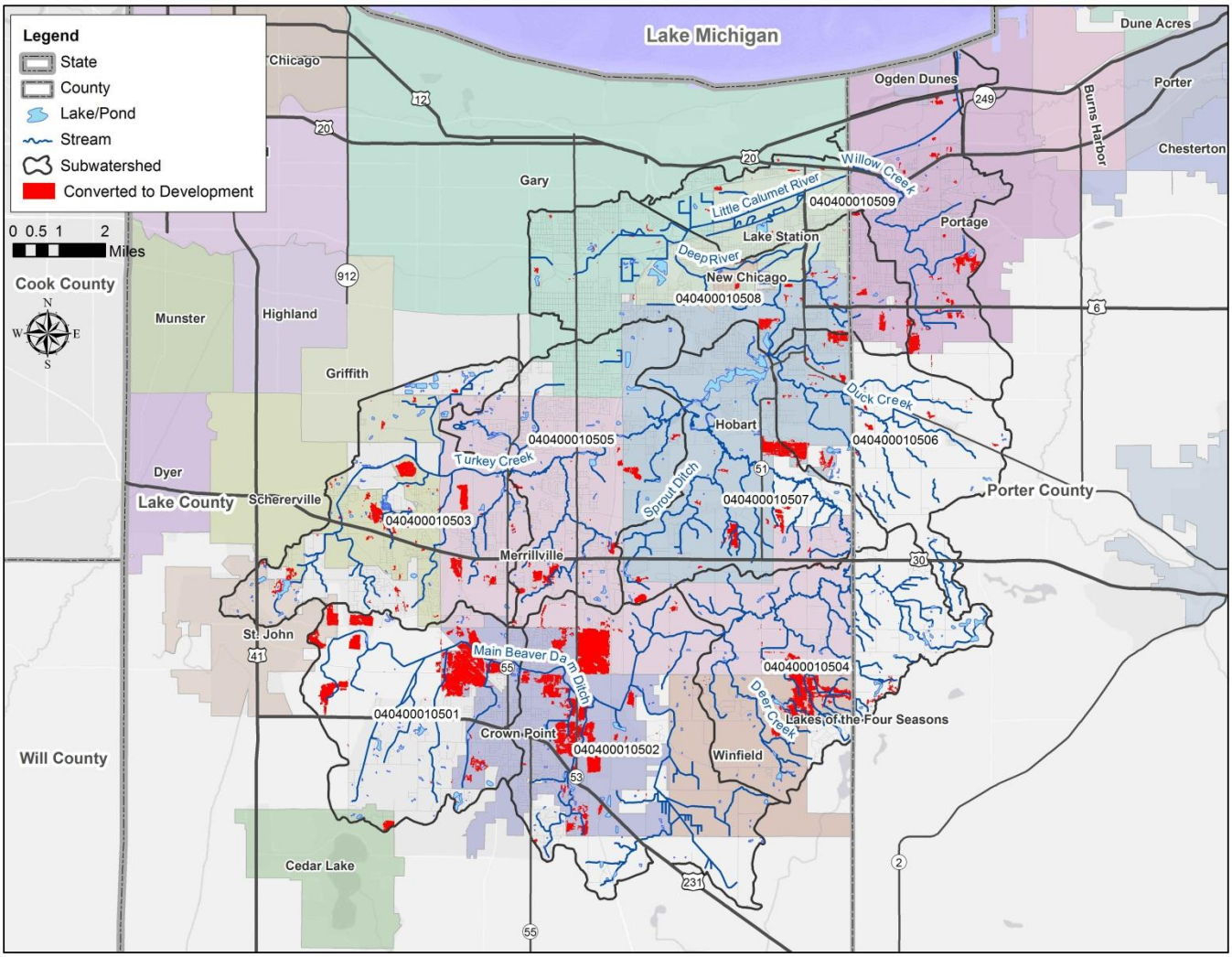

Figure 36 Areas Converted to Development between 1996 and 2006

Figure 37 shows a comparison of areas that were developed in 1996 and 2006. A substantial amount of new development occurred in the area between Crown Point and Merrillville over this time period. Winfield, which was incorporated in 1993, saw a significant amount of new development between 1996 and 2006.

Some of the commonly observed effects of urban development on physical, chemical, and biological characteristics of stream ecosystems include increased flashiness (more rapid rise and fall of stream levels during and after storms), higher and more frequent peak flows, increased concentrations of chemicals, and changes in aquatic communities. These effects can be attributed to increases in impervious surface area, stormwater conveyance infrastructure and loss of natural habitats (forests, wetlands, and grasslands) that can help moderate runoff volume and rates.

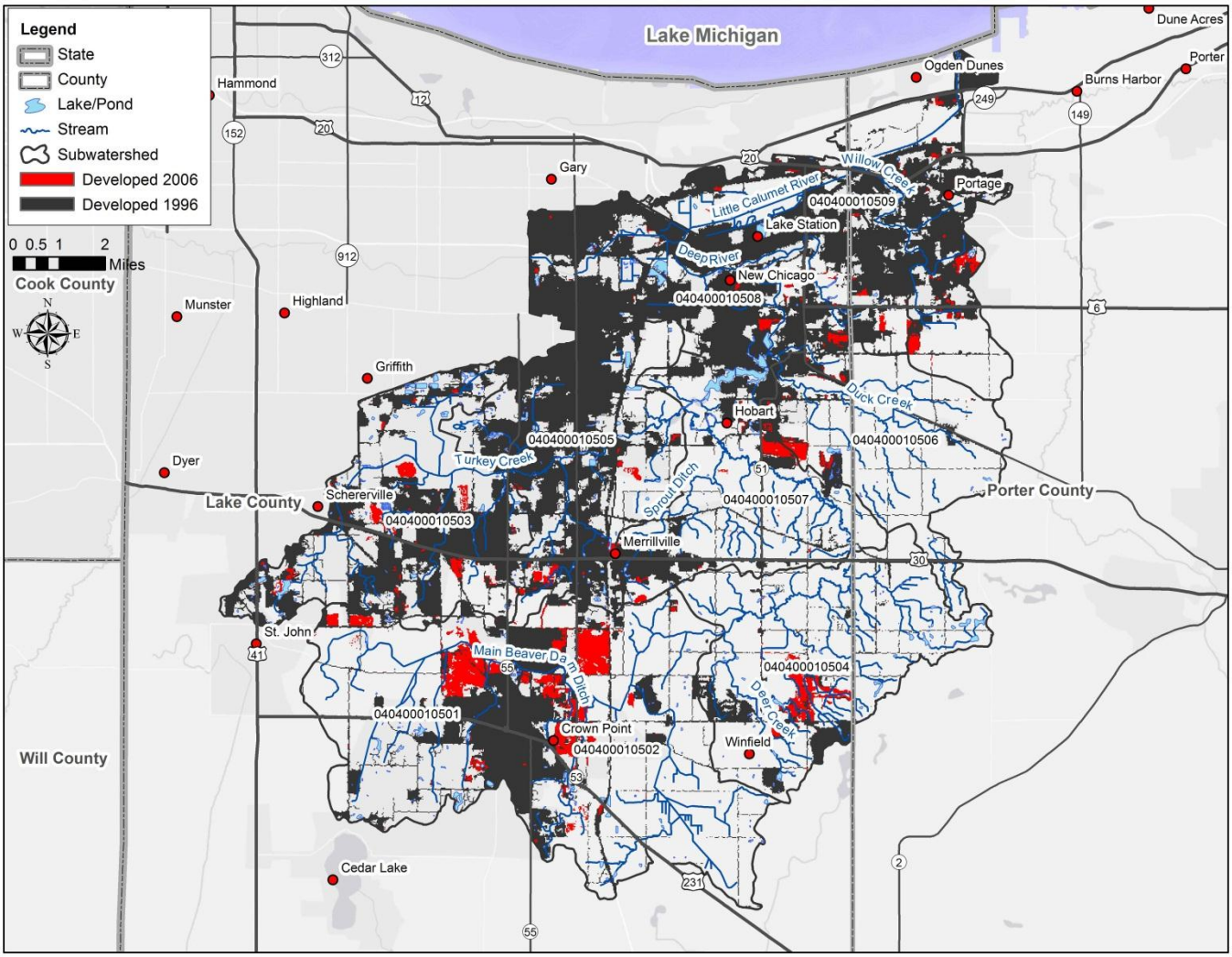

Figure 37 Comparison of Developed Areas in 1996 and 2006

2.7 Other Planning Efforts

2.7.1 Total Maximum Daily Load (TMDL) Reports

A TMDL calculates the maximum amount of a pollutant that can enter a waterbody and still have that waterbody meet water quality standards. The load for the particular pollutant for which the TMDL is developed (ex. *E. coli*) is allocated towards point and nonpoint sources. A TMDL also includes a margin of safety to account for uncertainty. The following formula is used to calculate the TMDL where WLA is the sum of wasteload allocations (point sources), LA is the sum of load allocations (nonpoint sources and background), and MOS is the margin of safety.

TMDL = ΣWLA + ΣLA + MOS

The TMDL process offers an excellent opportunity to identify and restore water quality and aquatic life in streams, rivers, and lakes, as well as enhance the involvement of watershed residents and stakeholders in water quality issues (Jasperson). Other potential benefits of the TMDL process include:

- Encourages the development of a consistent framework for conducting water quality studies

- Defines existing impairments and pollution sources, quantifies source reductions, and sets comprehensive restoration strategies to meet water quality standards
- Provides a framework for assessing future impacts to water quality
- Accelerates the schedule at which impaired waters are addressed through more effective coordination of existing and future resources among local entities, state, and federal environmental agencies
- Provides a basis for revising local regulations (e.g., zoning and sub-division) and developing performance-based standards for future development
- Facilitates the incorporation of TMDL schedules and implementation activities into local government water plans.

An *E. coli* TMDL for the Little Calumet River and Portage Burns Waterway was completed in 2004 by Earth Tech. Analysis of pollutant loads indicated that nonpoint source pollution was the dominant cause of the water quality impairment. The report also found that *E. coli* impairs water quality in the Little Calumet and Portage Burns Waterway even without the impact of CSOs. Estimated loads under wet conditions were not that much different from those estimated for dryer conditions in the more developed western portion of the study area, including Deep River. A 95% reduction in pollutant loads from nonpoint sources is needed in wet conditions and 80% in dry conditions according to the report. Sources of *E. coli* in the West Branch Little Calumet River/ Portage Burns Waterway included urban nonpoint, illicit discharges, bacteria laden sediments, and wildlife.

No TMDL currently exists for the Deep River-Portage Burns Waterway watershed; however, a formal request for IDEM to develop a TMDL has been submitted by NIRPC.

2.7.2 Municipal Separate Storm Sewer System Program

Municipal Separate Storm Sewer Systems (MS4s) are defined as storm water conveyances owned by a state, city, town, or other public entity that discharges to waters of the United States. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels and conduits. The Clean Water Act requires storm water discharges from certain types of urbanized areas to be permitted under the National Pollutant Discharge Elimination System (NPDES) program. Under Phase II, 327 IAC 15-13 (Rule 13) was written to regulate most MS4 entities (cities, towns, universities, colleges, correctional facilities, hospitals, conservancy districts, homeowner's associations and military bases) located within mapped urbanized areas, as delineated by the United States Census Bureau, or, for those MS4 areas outside of urbanized areas, serving an urban population greater than 7,000 people.

MS4 conveyances within urbanized areas have one of the greatest potentials for polluted storm water runoff. The Federal Register Final Rule explains the reason as: “urbanization alters the natural infiltration capacity of the land and generates...pollutants...causing an increase in storm water runoff volumes and pollutant loadings.” Urbanization results “in a greater concentration of pollutants that can be mobilized by, or disposed into, storm water discharges.”

A review of MS4 entities data from IDEM shows there are twelve municipalities within the watershed that are designated MS4s (Figure 38). These include Cedar Lake, Crown Point, Gary, Griffith, Hobart, Lake Station, Merrillville, New Chicago, Saint John, Schererville, Portage, and Lakes of the Four Seasons. The entirety of Hobart, Lake Station, Merrillville and New Chicago fall within the watershed’s boundary. Significant portions of Crown Point, Gary, Griffith, Saint John, Schererville and Portage are also located within the watershed boundary. Very small parts of Cedar Lake and Lakes of the Four Seasons fall within the watershed boundary.

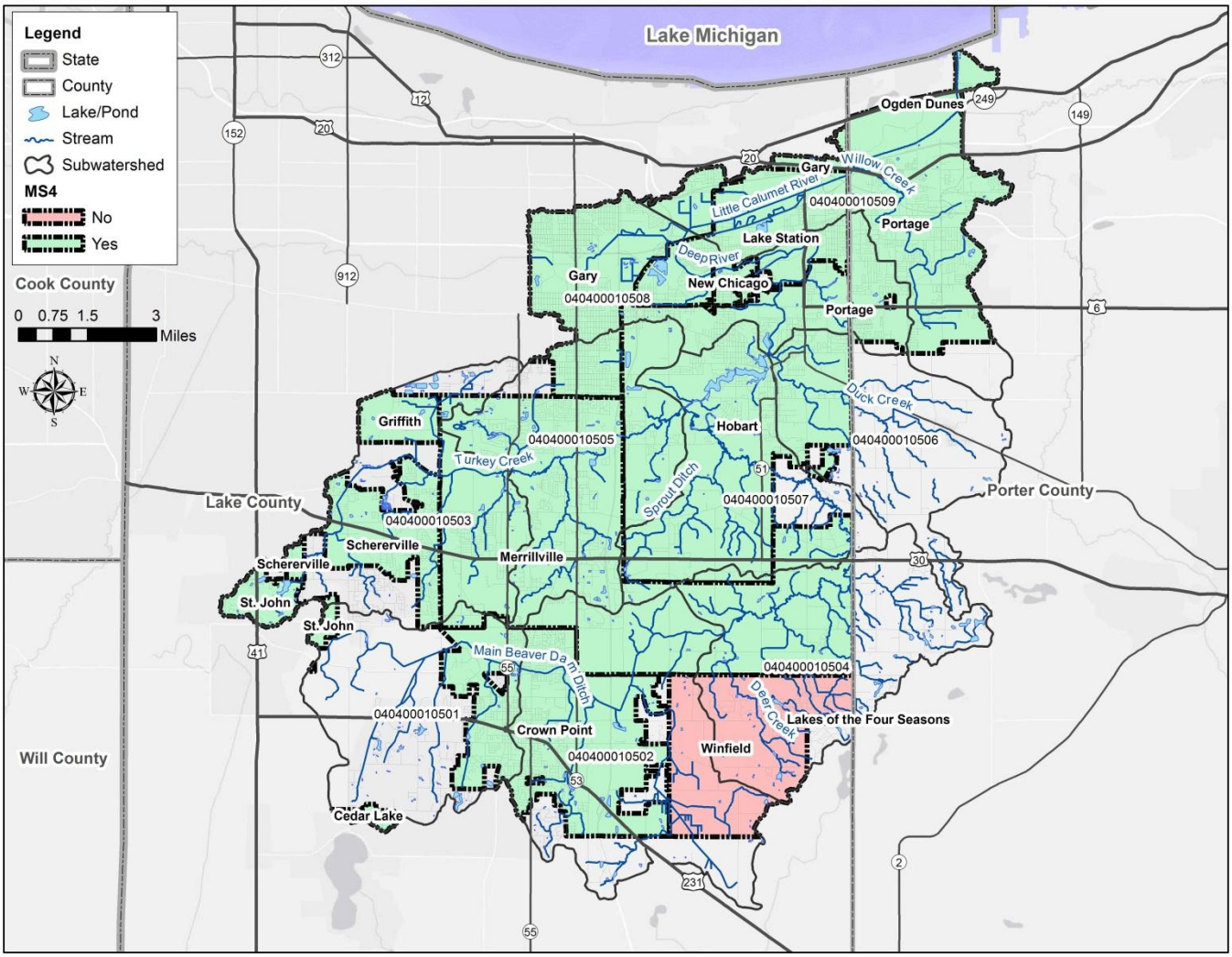

Figure 38 Designated MS4 Municipalities

MS4s are required to develop and implement a Storm Water Quality Management Plan (SWQMP). Two of the most important aspects of the SWQMP are Parts B and C. The SWQMPs are updated periodically for instance when the entities MS4 permit expires and needs to be reissued or when a significant program element is changed.

Part B requires MS4s to collect baseline data to characterize all known receiving waterbodies. The baseline characterization is expected to provide a "snapshot" of existing water quality, determination where improvements need to be made and where BMPs should be utilized, and documentation that an opportunity for the public to give feedback and suggestions was provided. The baseline characterization assessment is to include an evaluation of:

- Land use
- Identification of sensitive areas
- Review of existing and available monitoring data
- Identification of problem areas
- Current structural and nonstructural BMPs

The identification of problems areas and determination of where improvements need to be made and BMPs utilized is particular importance for the watershed management process.

Part C outlines the priorities, goals, and implementation strategies that the MS4 will utilize to improve water quality. Each MS4 must address six minimum control measures in their Part C. These include:

- Public education and outreach
- Public participation and involvement
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water runoff control
- Municipal operations pollution prevention and good housekeeping

With the exception of Lakes of the Four Seasons, each of the communities identified above is a member of the Northwestern Indiana Partnership for Clean Water. With support from NIRPC, the Partnership focuses on public education and outreach and public participation and involvement to help address the minimum control measures included in their Part C's. Some example activities of the Partnership include stormwater education programs for youth and adults at fairs or in schools and training workshops for municipal employees and contractors.

2.7.3 Combined Sewer Overflow Long Term Control Plans

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows (CSOs), contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris.

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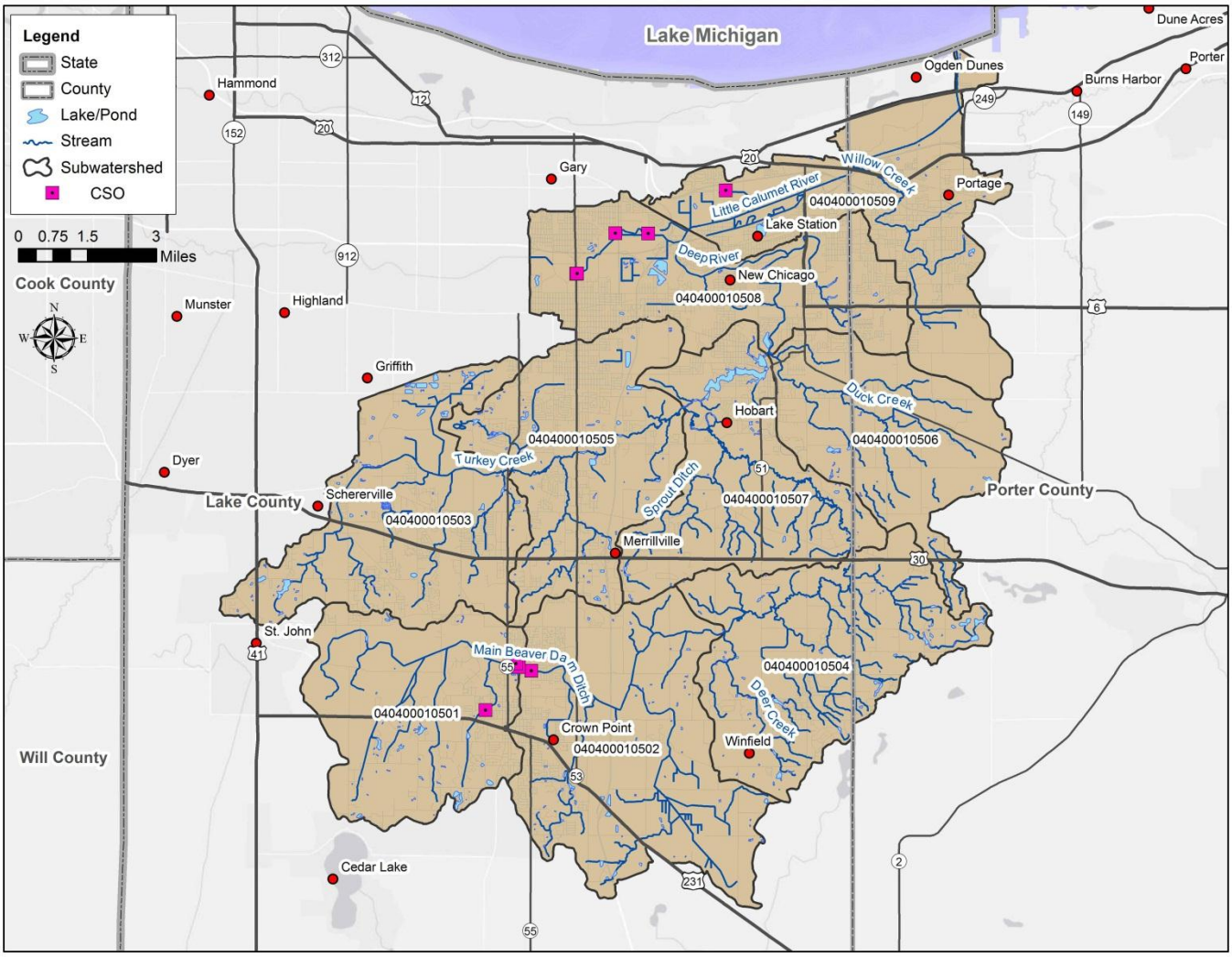

Figure 39 Combined Sewer Overflows

In total, there are 11 CSOs within the watershed (Figure 39). Six are located in Crown Point on or near Main Beaver Dam Ditch. Five are located in Gary along the West Branch of the Little Calumet River. CSO communities are required to submit Long Term Control Plans (LTCP) to IDEM as an NPDES permit requirement. IDEM's CSO program augments the NPDES municipal permitting program by implementing a strategy for the maintenance and management of combined sewer collection systems. The primary objective of this group is to insure the minimization of impacts to waters of the state from CSOs. Based upon information from IDEM's Municipal NPDES Permits Section, LTCP's have been submitted by the Gary Waste Water Treatment Plant (WWTP) and Crown Point WWTP. CSOs are a known source of E. coli and play a major role in the water quality impairment when they occur. However, the Little Calumet and Portage Burns Waterway TMDL for *E. coli* Bacteria found that the impairment would exist outside the inclusion of CSO events. Therefore nonpoint sources must also be controlled or remediated to achieve state water quality standards for *E. coli*.

2.7.4 Regional Land Use Planning

In 2011, NIRPC completed the Northwest Indiana 2040 Comprehensive Regional Plan (CRP). It was developed as a comprehensive, citizen-based regional vision to guide the development of land use and transportation programming in Northwest Indiana. It is a policy program with strong coordination and implementation elements. The CRP deals largely with multijurisdictional needs and opportunities that no single entity can manage or effect on its own. The

means of enhancing the region's prosperity and quality of life, improving mobility, supporting communities and realizing environmental justice were among the key considerations during the CRP's development.

While the CRP's vision, goals and objectives provide a critical policy framework for the CRP, the Growth and Revitalization Vision presents a physical expression of the vision and goals combined. The Growth and Revitalization Vision was developed through the CRP's scenario planning process. The rationale behind the development of the Growth and Revitalization Vision and, by extension, the growth of Northwest Indiana through 2040, is based on the following principles:

- Support urban reinvestment
- Ensure environmental justice/social equity
- Protect natural resources and minimize impact to environmental features and watersheds
- Integrate transportation and land use

Using a watershed approach has been recognized as an effective way to deal with often complex water quality and quantity issues. Therefore development and implementation of local watershed management plans was identified as a key strategy to help the region meet a number of the CRP goals and objectives. Additionally the CRP called for the need to invest in green infrastructure as a means of protecting and connecting environmentally sensitive natural areas, managing stormwater and attenuating flood impacts, and increasing passive recreational opportunities. The resulting Green Infrastructure Network, shown below in Figure 40, was used to help frame where and how future development might occur in the region to protect and restore its environmental assets.

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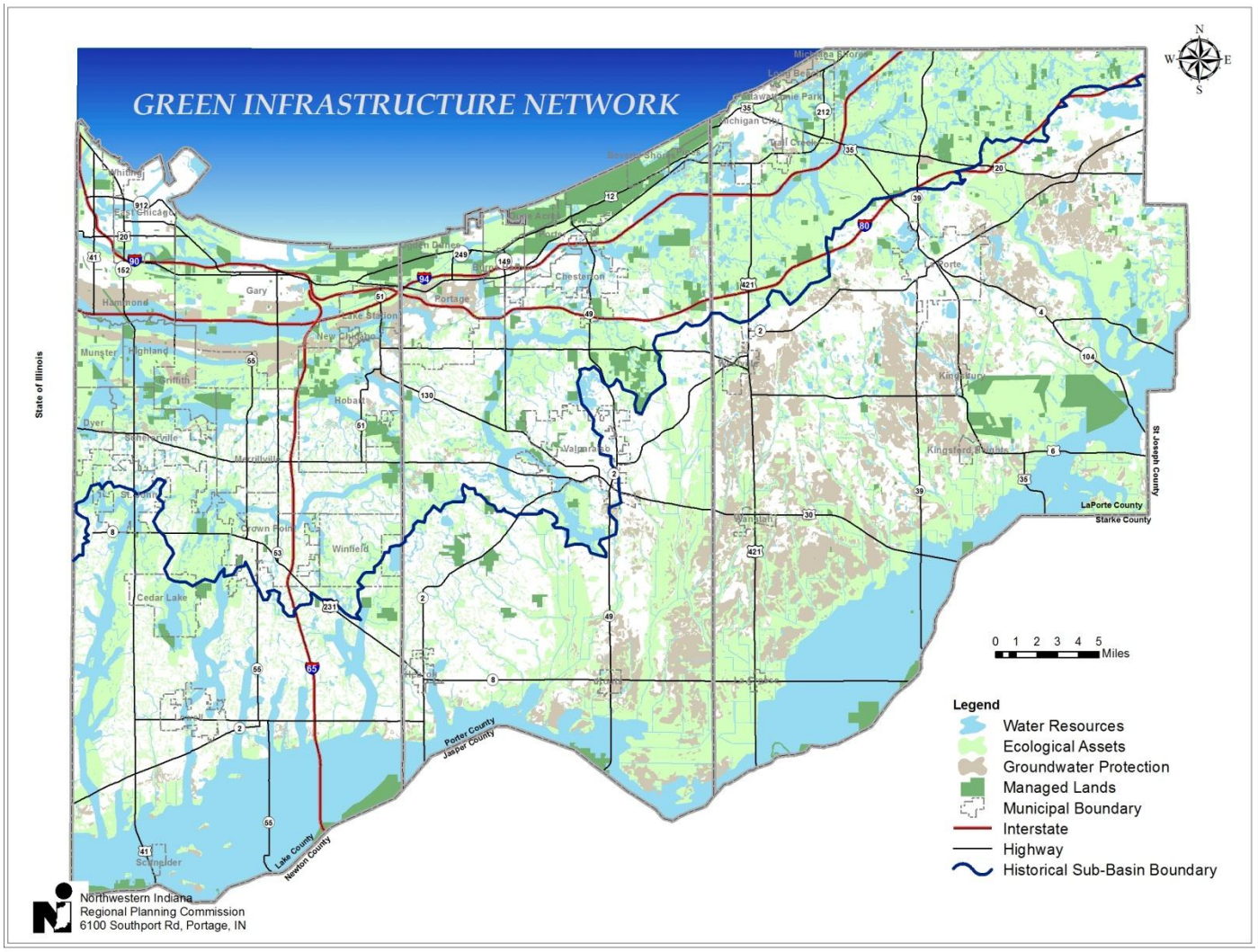

Figure 40 Northwest Indiana Green Infrastructure Network

2.7.5 Wellhead Protection

IDEM's Ground Water Section administers the Wellhead Protection Program, which is a strategy to protect ground water drinking supplies from pollution. The Safe Drinking Water Act and the Indiana Wellhead Protection Rule (327 IAC 8.4-1) mandates a wellhead program for all Community Public Water Systems. The Wellhead Protection Programs consists of two phases. Phase I involves the delineation of a Wellhead Protection Area (WHPA), identifying potential sources of contamination, and creating management and contingency plans for the WHPA. Phase II involves the implementation of the plan created in Phase I, and communities are required to report to IDEM how they have protected ground water resources.

Due to recent legislation wellhead protection area locations are no longer spatially available. However, a data request to IDEM's Ground Water-Drinking Water sections shows that there are six wellhead protection areas within the Deep River-Portage Burns Waterway watershed. Three of these have been modeled (systems that pump over 100,000 GPD) while the remaining three are 3,000-foot fixed radius (systems that pump less than 100,000 GPD)

protection areas. Additionally there are at least 58 active drinking water wells within the watershed. Of these, 13 are community drinking water wells, nine are non-transient non-community, and 35 are transient non-community.

- Community: Serves at least 15 service connections used by year-round residents or regularly serves 25 year-round residents.
- Non-Transient Non-Community: Serves at least the same 25 non-residential individuals during 6 months of the year.
- Transient Non-Community: Regularly serves at least 25 non-residential individuals (transient) during 60 or more days per year.

2.7.6 Little Calumet-Galien/Chicago Watershed Restoration Action Strategy

A Watershed Restoration Action Strategy (WRAS) is essentially a large-scale coordination plan for an eight-digit hydrologic unit watershed (sub-basin). They were intended to foster greater cooperation among State and Federal agencies. Each WRAS was written to be flexible and broad enough to accommodate changes when new assessments or other data became available.

The Little Calumet-Galien/Chicago WRAS was completed in 2002 but never updated. It is broken into two sections. The overall goal and purpose of Part I of the WRAS was to provide a reference point and roadmap to assist with improving water quality. It includes a compilation of information, facts, and local concerns. Part II of the WRAS discusses the water quality concerns identified by stakeholder groups and state and federal agencies. Additionally it recommends management strategies to address those concerns. While the Little Calumet-Galien/Chicago WRAS did identify a number of the local stakeholder groups present in the region and their overarching program mission or goals, it never actually listed specific local stakeholder concerns. Generalized priority issues identified in the Little Calumet-Galien/Chicago WRAS included:

- Data/information targeting
- Streambank erosion and stabilization
- Failing septic systems and straight pipe discharges
- Water quality
- Fish consumption advisories
- Nonpoint source pollution & education and outreach
- Point sources

2.7.7 Watershed Management Plans

Two previous watershed management plans have been developed within the Deep River-Portage Burns Waterway watershed. These include the 2002 Deep River-Turkey Creek Watershed Management Plan and the 2008 West Branch Little Calumet River Watershed Management Plan. Currently no active watershed group or committee structure exists to coordinate implementation of these plans. Additionally fairly significant changes in land use have occurred in the watershed since the Deep River-Turkey Creek Watershed Management Plan was developed as have priorities.

The following sections provide brief descriptions and information from these plans.

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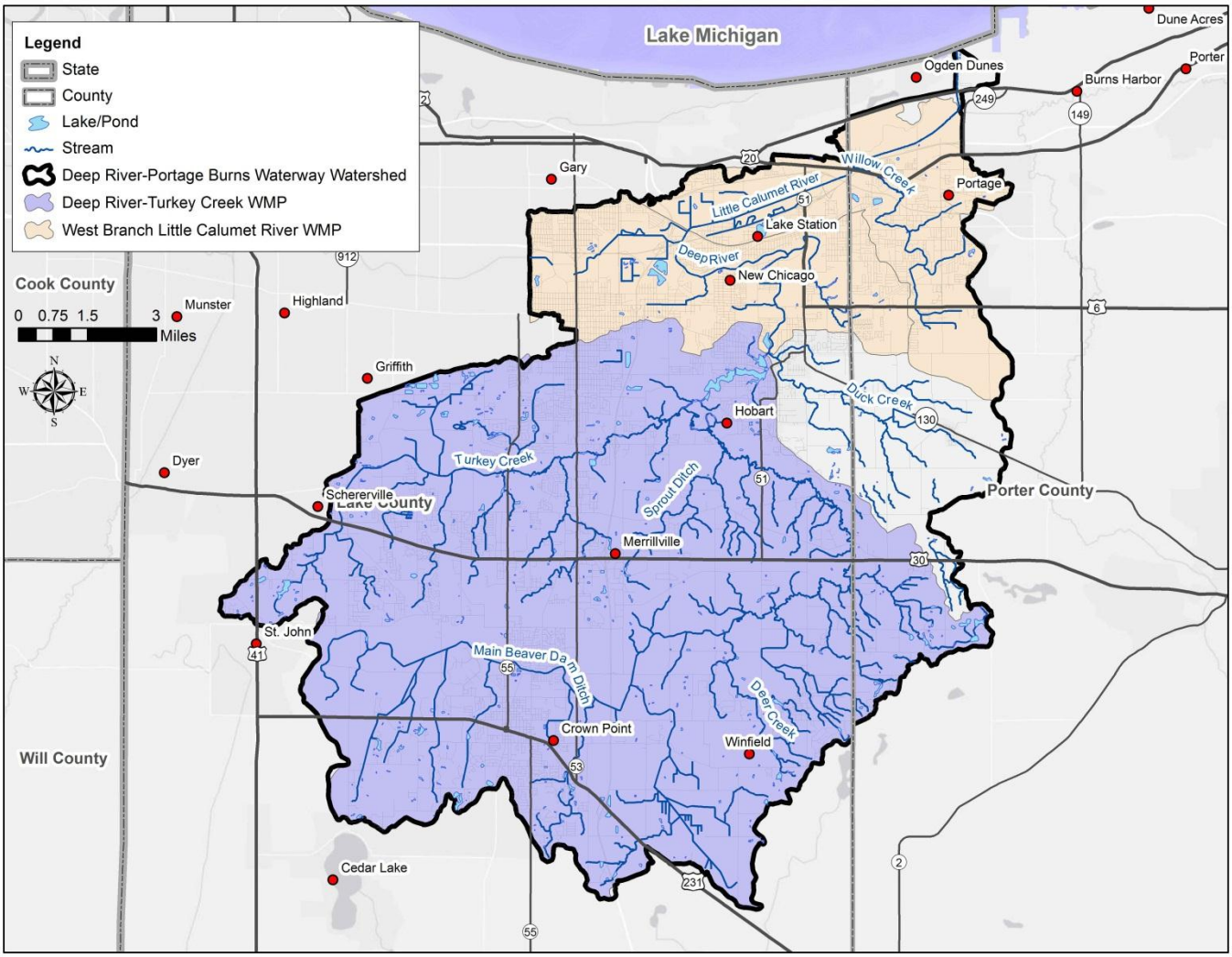

Figure 41 Existing Watershed Management Plans

2.7.7.1 Deep River-Turkey Creek Watershed Management Plan

The Deep River-Turkey Creek Watershed Management plan was coordinated by the City of Hobart and completed in 2002. The plan was developed at the 11-digit watershed scale (HUC 04040001030), covering an area of approximately 124 mi^2 in Lake and Porter Counties. However, as Figure 42 shows below, the plan's primary focus was the Deep River-Lake George Dam subwatershed (HUC 04040001030060).

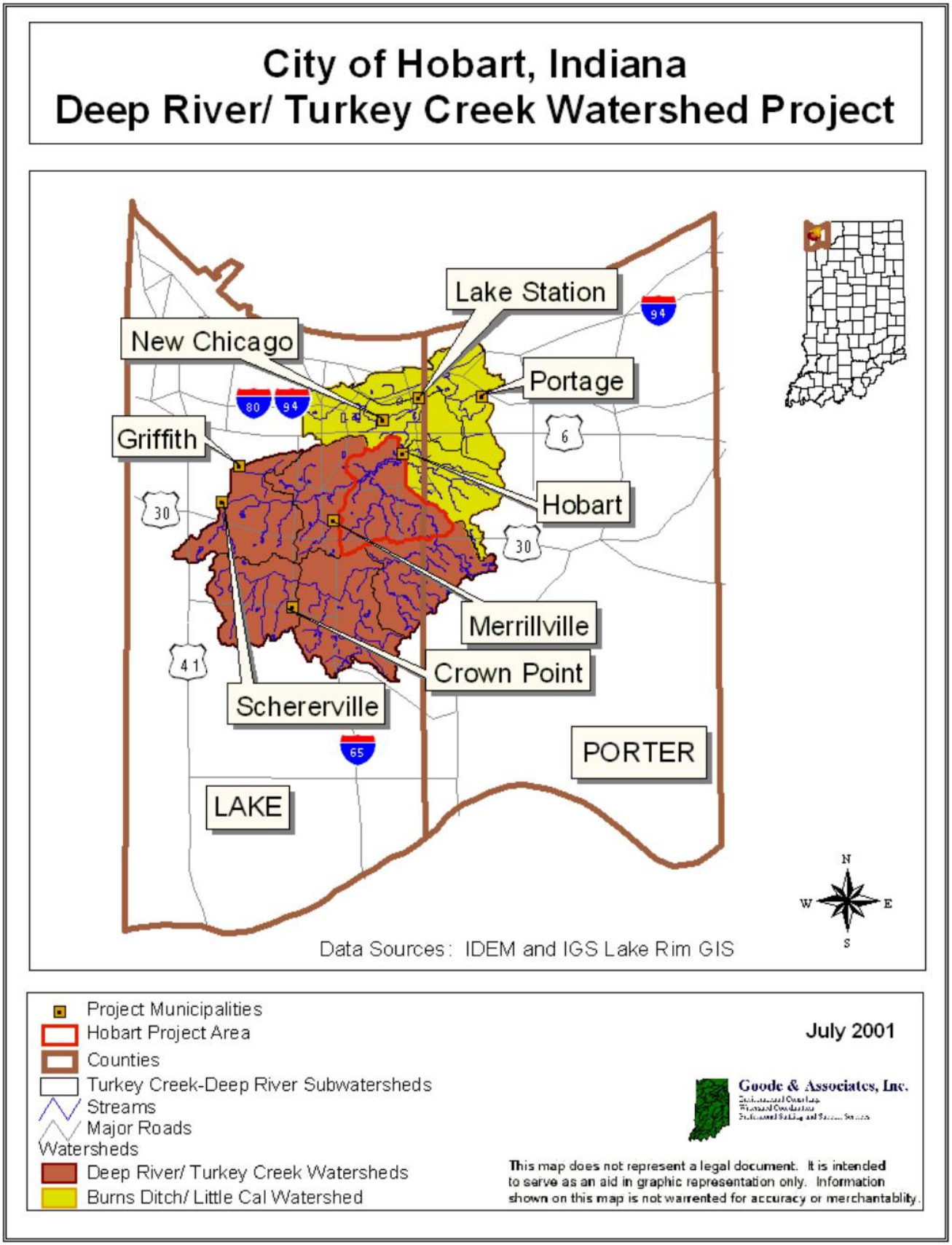

Figure 42 Deep River-Turkey Creek Watershed Management Plan Study Area

To facilitate the development of the 2002 Deep River-Turkey Creek WMP, an assessment of existing water quality from nine sites in the watershed was done to supplement historical water quality data. Sampling was generally focused around the Deep River-Lake George Dam subwatershed (Figure 43). No monitoring stations were established in any of the three 14-digit subwatersheds that drain to the Deep River-Lake George subwatershed from the south through Deep River and Main Beaver Dam Ditch. Two stations were located in the Turkey Creek-Merrillville subwatershed while none were located in the Turkey Creek Headwaters subwatershed.

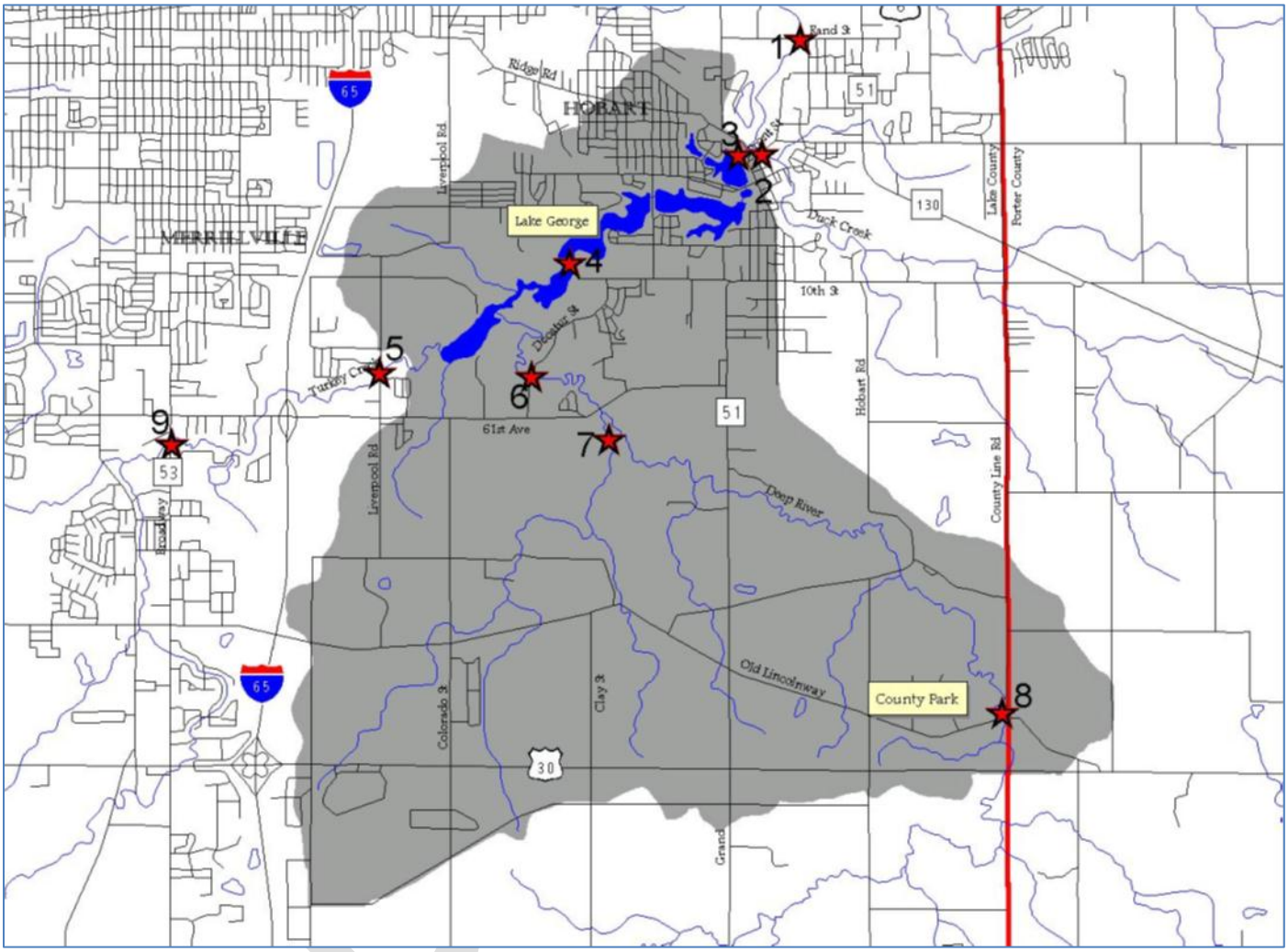

Figure 43 Deep River-Turkey Creek WMP Sampling Locations

According to the plan there appeared to be a strong correlation between pollutant loading (total suspended solids, nutrients, and *E. coli*), potential soil erodibility ratings, and the presence of highly erodible lands in the Deep River subwatersheds. In the Turkey Creek subwatersheds, *E. coli* concentrations and poor in-stream habitat quality showed a correlation with urban land uses and channel modifications. Streambank erosion was also identified as an issue partly due to riparian zone and floodplain modifications.

Water quality improvement and protection goals identified in the plan included:

1. Minimize deposition of new sediments into Lake George
   - Reduce sedimentation in Lake George by 75% over the next 5 years via BMP treatment train principle for both urban/ rural areas
2. Improve water quality in Deep River/Turkey Creek watersheds

- Reduce sediment, nutrient, and *E. coli* loads in DR/ TC upstream of Lake George by 15% over the next 5 years
- Improve in-stream habitat in DR/ TC by 15% over the next 5 years

3. Improve education about water quality problems/concerns
   - Educate 75% of Lakeshore residents about watershed protection efforts for Lake George over the next 2 years
   - Educate 75% of community officials in the DR/ TC watersheds about watershed protection efforts for Lake George over the next 2 years
4. Eliminate illegal discharges
   - Conduct dry weather screening/ surveys of 100% of MS4 outfalls into Lake George/ tributaries over the next 5 years – Hobart
   - Conduct dry weather screening/ surveys of 100% of MS4 outfalls in DR/ TC watersheds over the next 5 years – All Designated SW Phase II Entities
   - Conduct dry weather screening/ surveys of 25% of outfalls in non-MS4 areas in DR/ TC watersheds over the next 5 years
5. Eliminate failing septic systems
   - Survey 30% of non-sewered areas to identify failing septic systems within municipal jurisdictions over the next 5 years
   - Implement appropriate community solutions for 10% of problematic septic systems over the next 5 years
6. Promote consistency among communities developing stormwater management programs
   - Develop joint stormwater/ water quality education programs w/ communities in DR/ TC watershed over the next 5 years
   - Develop consistent stormwater ordinances w/ communities in DR/ TC watershed over the next 5 years

A review of the implementation measures and strategies in the plan show a mix of both structural and non-structural practices. However, a number of the implementation measures (ex. developing stormwater programs-ordinances, enforcement, and illicit discharge detection and elimination) are now consistent with MS4 requirements and have therefore have been or should be met. At the time the Deep River-Turkey Creek WMP was being developed, Rule 13 had not come into effect.

The plan does not specifically identify critical areas where implementation is needed. Rather discretion is left to the municipalities. However the plan does encourage the following restoration strategies throughout the watershed where opportunities present themselves:

- Wetland and tree conservation
- Minimizing impervious surfaces
- Linear parks and open space preservation
- Constructed wetlands, bio-filters, catch basin inserts, buffer/ filter strips, etc.
- Shoreline and streambank bioengineering stabilization
- Native shoreline plantings
- Bridge storm water outlet retrofits
- Target BMP's towards highly erodible lands

Besides the implementation of MS4 requirements, a number of plan milestones have been reached including:

- Lake George shoreline stabilization at Pavese Park and Fred Rose Park in the City of Hobart
- Streambank stabilization project at Deep River County Park
- Web-based septic system tracking database (ISDH's iTOSS)

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2.7.7.2 West Branch Little Calumet River Watershed Management Plan

The West Branch Little Calumet River Watershed Management Plan was coordinated by the City of Gary and completed in 2008. The plan included three 14-Digit HUC watersheds. The plan was developed for three, 14-digit subwatersheds which encompassed the West Branch of the Little Calumet River including the Deep River-Little Calumet River subwatershed (HUC 04040001040020) and Burns Ditch-Willow Creek (HUC 04040001040030) in the current study area. The primary pollutants of concern identified in the plan include *E. coli*, total suspended solids, nitrogen and phosphorus.

The goals identified as part of this plan include:

- Reduce E. coli levels in the Little Calumet River by reducing loads to the River to meet beneficial uses.
- Reduce sediment loads by source reduction strategies and, in priority subwatersheds, through the use of Best Management Practices (BMPs).
- Reduce nutrient loads by source reduction strategies and, in priority subwatersheds, through the use of BMPs.
- Restore, improve, and/or protect floodplains, wetlands, natural areas, and riparian corridors.
- Improve public awareness/knowledge of pollutant loads, sources, and solutions, especially with regard to E. coli, and the impacts and risks associated with them.
- Create an active watershed alliance or conservancy district that facilitates and implements information sharing including ordinances, projects/experiences, and educational materials in a central location.
- Increase river corridor connectivity, river navigability, and public access sites and make the public aware of them.

The following long-term implementation actions were identified for critical areas within the watershed (**Error! Reference source not found.**):

- Land acquisition and funding to restore 4,780 acres of wetland
- Install 300 rain gardens in participating communities
- Install 20 green roofs or green parking lots
- Install infiltration BMP's at 10 sites
- Install 2,000 lineal feet of vegetated buffer
- Install 10 retention/detention ponds
- Implement stream and riparian restoration at 5 sites
- Install 5,000 lineal feet of vegetated channel in urban area
- Identify 20 existing priority wetland and riparian restoration areas and mitigate/restore at least 10
- Acquire at least 10 existing priority wetland and riparian areas through purchase or conservation easement
- Design and construct at least five projects that improve connectivity along river
- Install at least three projects that increase navigability along river
- Acquire land and construct at least 3 new public access sites

One problematic issue with the critical areas identified within the plan is that that a majority occurs within the Little Calumet River levee system (Figure 44). While there are likely restoration activities that could occur within this area, this approach does not account for upland sources contributing to observed impairments. This may be just an oversight given that some of the BMPs identified above would be most appropriate for upland urbanized areas (ex. rain gardens and green roofs).

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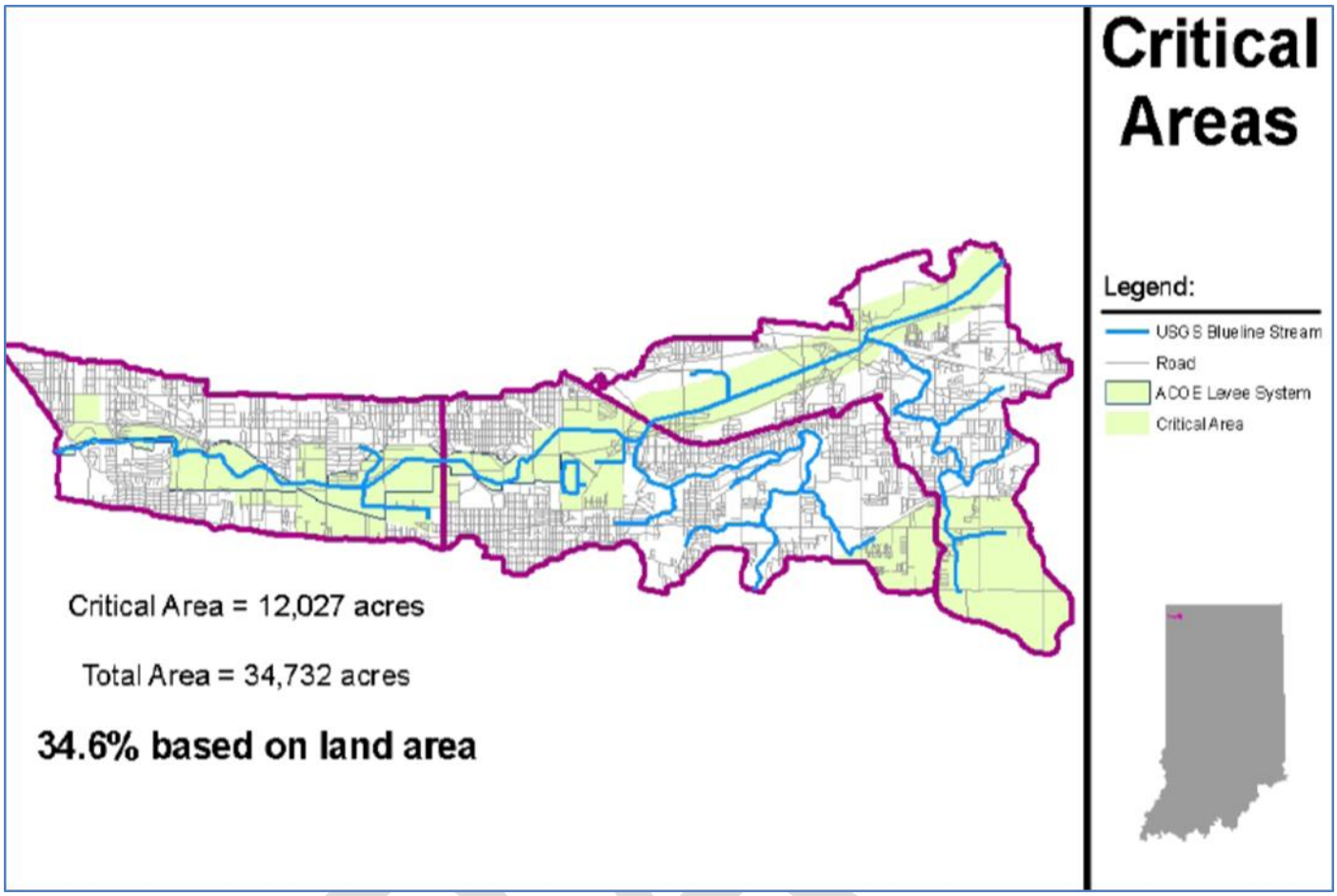

Figure 44 Critical Areas Identified in the West Branch Little Calumet River WMP

2.7.8 Hobart Marsh Plan

The Hobart Marsh Plan was completed in 2012 by the City of Hobart. The City was awarded a grant from the DNR Lake Michigan Coastal Program to develop a plan that would help explore future open space, educational and recreational opportunities in the area of Hobart Marsh. A wetland mitigation project required for the USACE Little Calumet River Flood Control Project was a major reason behind the plans development. A portion of the mitigation will be taking place on approximately 355 acres in the area of Hobart Marsh.

The Hobart Marsh project area is generally flat and has poorly drained soils that are considered good for intensive cropping and topsoil. However the area is also vulnerable to periodic flooding and has highly erodible soils. Lake George and Turkey Creek flow along the southeastern edge of the project area, and fingers of deep ravines reach up into the southern properties of the Hobart Marsh, offering diverse ecosystems and relatively dramatic topography given the flatness of the surroundings.

The City held a series of stakeholder input meetings and design charette that included residents, elected officials and the owners of the various managed lands near Hobart Marsh, and the USACE. Connectivity between the mitigation sites and the adjacent open space and recreation areas was considered important by the stakeholders, as was the exploration of shared management opportunities for the agencies with land ownership.

2.7.9 Community & Urban Forestry Program

The DNR Division of Forestry's Community & Urban Forestry Program provides statewide leadership to increase public awareness of the value of trees and associated natural resources in urban areas. The program assists municipalities and non-profits by offering a visiting urban forester for a day, technical assistance, tree board assistance, workshops, grant dollars for urban forestry management, and help in becoming a Tree City USA. Tree Cities located in the watershed as of 2011 include Crown Point and Merrillville.

The program goals include:

- Protect, enhance and expand urban forests and related natural resources.
- Promote awareness of urban forestry issues which will result in increased broad-based support.
- Improve the expertise of urban forestry practitioners.
- Promote networking and partnership building among public and private entities.
- Increase funding opportunities for urban forestry programs.

Some of the benefits of urban trees include:

- Reduce surface runoff from storms
- Reduce soil erosion and sedimentation in streams
- Increased groundwater recharge
- Reduce thermal impacts to streams

In 2008, the DNR's Community and Urban Forestry Program commissioned a study to assess the status of the state's urban forest resource via a sample statewide inventory and analysis. The project utilized a computer application called "i-Tree" to calculate forest resource structure, function, and value in 23 communities across the state. The combination of street tree inventories and data analyses provided the State with scientifically reliable estimations of economic and environmental benefits that street tree populations provide to communities. Street trees in the City of Gary, the only community included in the study that also falls within the Deep River-Portage Burns Waterway watershed, provide over $5.6 million in total benefits including $643,761 for stormwater.

2.7.10 Lake Michigan Lakewide Management Plan

In the 1987 amendments to the Great Lakes Water Quality Agreement (GLWQA), the United States and Canada agreed "to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem." The Lakewide Management Plan (LaMP) is an adaptive management program that integrates and targets actions for contaminated Areas of Concern (AOCs), watershed plans that address land based activities contributing to degraded water quality, and strategies for habitat and biodiversity protection. The LaMP is a collaborative effort among federal, state, tribal governments, and a public involvement partnership with the Lake Michigan Forum, planning commissions and local groups.

The Lake Michigan LaMP vision is of "a sustainable Lake Michigan ecosystem that ensures environmental integrity and that supports and is supported by economically viable, healthy human communities." The primary goal "is to restore and protect the integrity of the Lake Michigan ecosystem through collaborative, place based partnerships." The LaMP focuses its efforts through a collaborative effort in meeting the vision and goal through monitoring the changing environmental conditions and adapting management strategies by addressing the following:

1. Can we eat any fish?
2. Can we drink the water?
3. Can we swim in the water?

4. Are habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?
5. Does the public have access to abundant open space, shorelines, and natural areas, and does the public have enhanced opportunities for interaction with the Lake Michigan ecosystem?
6. Are land use, recreation, and economic activities sustainable and supportive of a healthy ecosystem?
7. Are sediment, air, land, and water sources or pathways of contamination that affect the integrity of the ecosystem?
8. Are aquatic and terrestrial nuisance species prevented and controlled?
9. Are ecosystem stewardship activities common and undertaken by public and private organizations in communities around the basin?
10. Is collaborative ecosystem management the basis for decision making in the Lake Michigan basin?
11. Do we have enough information, data, understanding, and indicators to inform the decision making process?
12. What is the status of the 33 Lake Michigan subwatersheds?

2.7.11 Indiana Wetlands Conservation Plan

The purpose of the Indiana Wetlands Conservation Plan (IWCP) is to achieve wetland conservation in a manner that is mutually beneficial. The IWCP serves as a framework for discussion and problem solving while establishing common ground on which progress of wetland conservation can be made. It also sets specific actions to achieve progress and recommendations regarding prioritization. According to the IWCP, priorities for conserving wetlands based on water quality, flood control, and groundwater benefits should be made locally at the watershed or subwatershed level.

The Northwest Indiana Advance Identification (ADID) study, completed in 2002, addresses many of the IWCP recommendation for prioritizing wetlands for conservation. ADID was designed to provide landscape-level information on critical wetlands in advance of development pressure so that planners, regulators, developers, landowners, and others would consider the information when making land-use decisions. The study was designed by a diverse group of partners to identify which area wetlands provide important wetland functions. However, the Northwest Indiana ADID study is now over 10 years old and likely could benefit from an update.

One factor not thoroughly addressed by ADID but referenced in the IWCP was the need for wetland restoration. The ADID does include restoration information pertaining to invasive species control and hydraulic modification for existing wetlands. However no comprehensive plan exists to prioritize restoration of historical wetland habitat (i.e. drained) and therefore remains a significant need.

2.8 Endangered, Threatened & Rare Species and High Quality Natural Areas

The Deep River-Portage Burns Waterway watershed is home to large variety of endangered, threatened, and rare (ETR) species and high quality natural communities. Based on information from the Indiana Natural Heritage Data Center, nearly 400 observations (element occurrences) of ETR species, including plants, reptiles, amphibians, birds, mammals, crayfish, mollusk and crayfish have been documented. Additionally, 32 high quality natural communities, including forest, savanna, prairie and wetland habitats, are located in the watershed. A list of the observations included in the Natural Heritage Data Center database is included in the appendices.

Figure 45 shows ETR and high quality natural community “hot spots” both in and outside of the watershed. The NPS, DNR, local land trusts, parks departments and environmental organizations have focused a great deal of their land conservation efforts around these areas as can be seen by the location of managed lands in Figure 45. However, high concentration areas do remain unprotected that could serve as corridors or adjacent to existing

managed lands. Notable areas include along the Little Calumet River and Deep River, downstream of Lake George. Conservation of these land areas is not only important to protect critical habitat for ETR species, but also in protecting the variety of services (ecosystem services) that benefit society and the watershed as a whole. Flood water attenuation and nutrient sequestration by riparian wetlands would be an example.

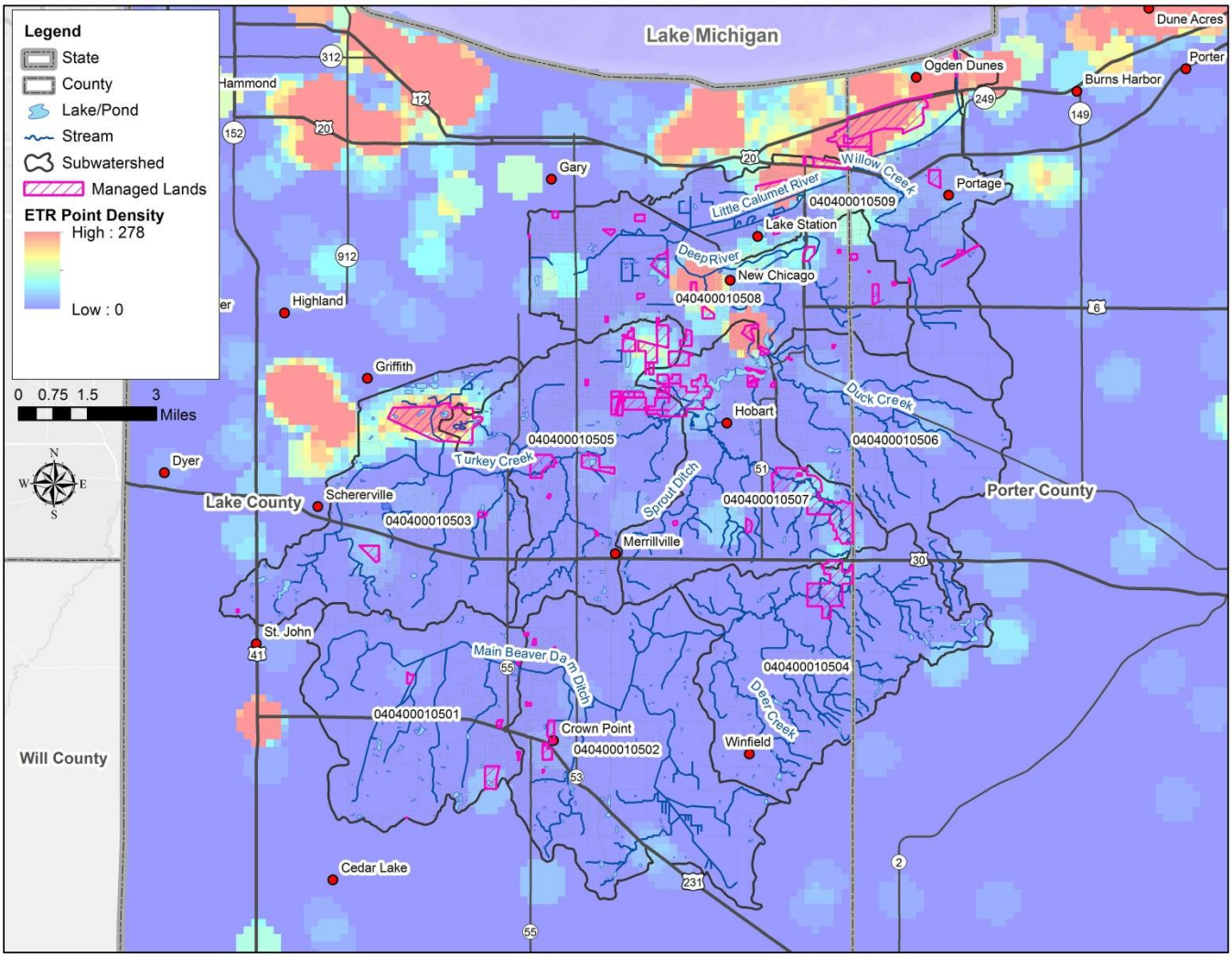

Figure 45 ETR Point Density

2.9 Relevant Relationships

2.9.1 Cultivated Land and Soil Drainage Class

Drainage improvements such as surface, open ditch and subsurface practices are often necessary for efficient row crop production in Indiana. Without these improvements, plantings would be delayed in the spring and the crop's roots would be saturated for long periods. Additionally, some soils would be more prone to surface runoff as described in Section 2.4.1 without drainage improvements.

While there are positives associated with drainage improvement on agricultural lands, there can also be some negative ones. A number of studies have been done comparing drained to undrained cropland. Drainage enhancements can increase the chance of down-stream flooding because of water leaving the fields more quickly compared to undrained areas. This may result in increased peak flows for receiving streams which in turn can lead

to increased streambank erosion. Some additional findings that have been highlighted in **THE INDIANA SOILS EVALUATION AND CONSERVATION MANUAL** include:

- Up to 63% of the rain that falls on a drained field leaves the field through the drainage system.
- Surface runoff is 29% to 65% less in drained fields.
- Soil erosion is reduced by 16% to 65% in drained fields.
- Phosphorus loss is reduced by up to 45% in drained fields because much of the phosphorus is bound to the soil.
- Total nitrogen loss is reduced in drained fields because much of the nitrogen also moves with the sediment.
- Loss of nitrate-nitrogen, a soluble form of nitrogen, is increased in drained fields because nitrate moves with water.

Subsurface drainage (field tiles) in cultivated areas can provide water quality benefits by reducing the volume of surface runoff and the amount of sediment and phosphorus leaving the fields. However, field tiles can also negatively impact surface and groundwater by increasing nitrate levels. Some level of nitrate is usually present at all times in tile drains. However it is usually most concentrated when water first begins to flow from the field tiles after the growing season in late fall or early winter. Nitrate levels in tile outflows can exceed the 10mg/l water quality standard for drinking water (Purdue University, 2009).

Cover crops can be used by row crop producers to effectively scavenge or trap soil nitrate that would otherwise move out of the root zone and into field tiles during the fallow season (fall –spring). Cover crops are grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil. Additional advantages of cover crops include water and wind erosion control, improved soil tilth, and improved crop yield. Cover crops used in no-till production of corn or soybeans can provide surface mulch after being killed with a contact herbicide. The mulch not only reduces soil erosion, but also slows evaporation of soil moisture, increases infiltration of rainfall, increases soil organic matter and aids in control of annual weeds (Purdue University).

In total there are 27,739 acres of cultivated land within the watershed based of which approximately 19,593 acres (71%) exists on a poorly drained soil class. The locations of cultivated land on poorly drained soil classes are shown below in Figure 46. The Main Beaver Dam Ditch subwatershed (HUC 040400010502) has the greatest number of acres and highest percentage of cultivated land on poorly drained soils followed by the Duck Creek (HUC 040400010506) and Headwaters Main Beaver Dam Ditch (HUC 040400010501) subwatersheds.

Subwatershed	Acres	% of Drainage Area	Rank
040400010501	2,515	21.5	3
040400010502	5,012	29.8	1
040400010503	1,401	10.3	6
040400010504	2,338	17	4
040400010505	1,067	8.54	8
040400010506	3,181	31.4	2
040400010507	1,328	12	7
040400010508	517	4.26	9
040400010509	2,234	16.7	5
Watershed Total	19,593	17.0	

Table 17 Acres of Cultivated Land on Poorly Drained Soils

These cultivated fields could be a significant source of nitrate loading to receiving waterbodies if appropriate management measures and practices are not in place. Additionally field tile drainage in these areas may contribute to increases in peak stream flow, downstream flooding and streambank erosion. More detailed information on cover crop, conservation tillage, and field tile drainage is needed to more accurately determine how much of a concern or contributing factor these areas may be to observed water quality impairments.

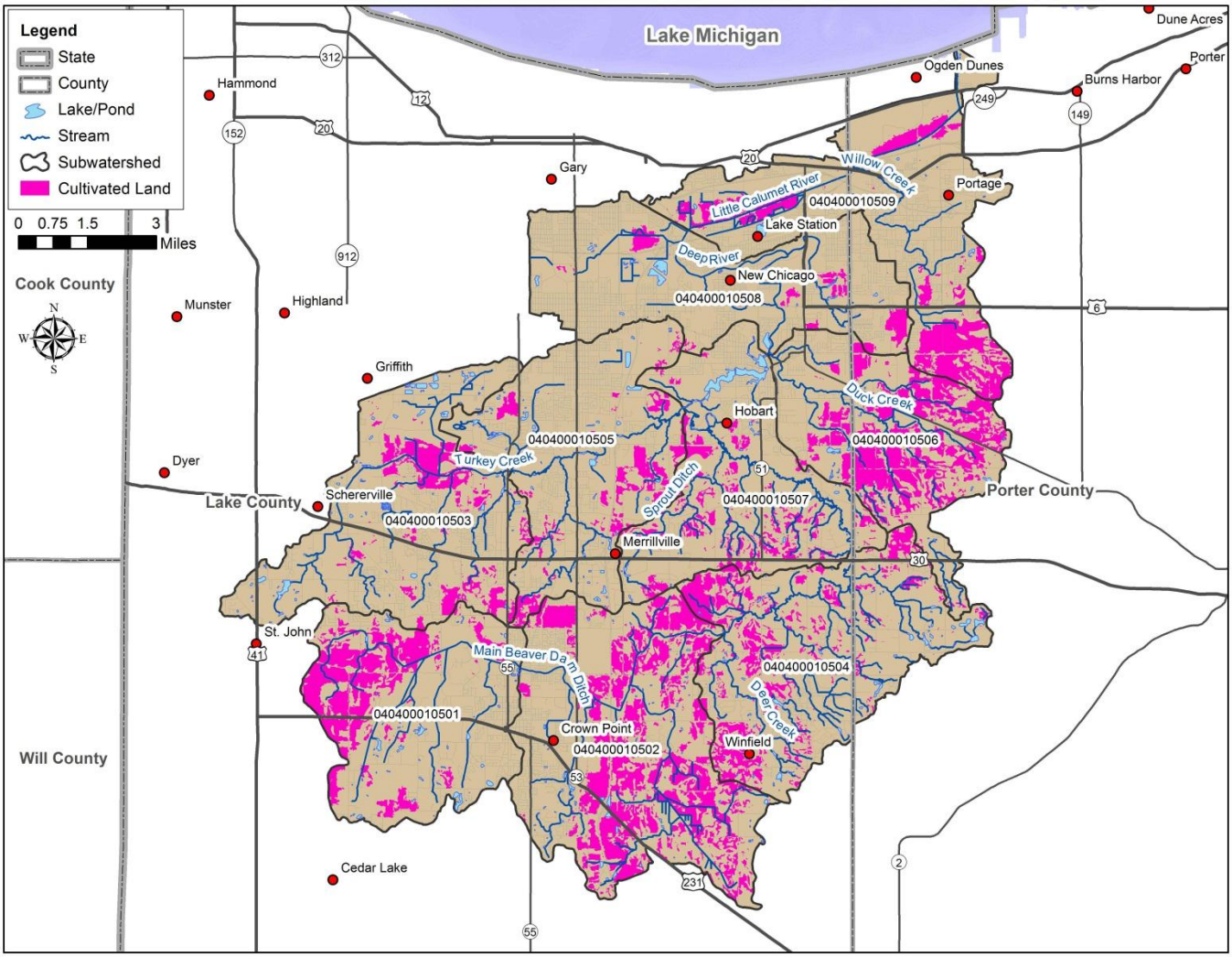

Figure 46 Cultivated Land on Poorly Drained Soil Classes

2.9.2 Cultivated Land on Soils Classified as Highly Erodible Land

Highly erodible land is cropland, pasture or hay land that can erode at excessive rates. A field is considered highly erodible if either one-third or more of the field is highly erodible, or if the highly erodible land in the field totals 50 acres or more. NRCS can make an HEL determination upon request. The Food Security Act of 1985 requires producers participating in most programs administered by the Farm Service Agency (FSA) and the Natural Resources Conservation Service (NRCS) to abide by certain conditions on any land owned or farmed that is highly erodible or that is considered a wetland. Producers participating in these programs and any person or entity considered to be an "affiliated person" of the producer, are subject to these conditions. If a producer has a field identified as highly erodible land, they are required to maintain a conservation system of practices that keeps erosion rates at a

substantial reduction of soil loss. Fields that are determined not to be highly erodible land are not required to maintain a conservation system to reduce erosion (Farm Service Agency, 2012).

Of the 61,196 acres of highly erodible land that exist in the watershed, 17,380 acres or 28% are cultivated. Nearly 63% of all cultivated land within the watershed exists on soils that are classified as highly erodible. The Main Beaver Dam Ditch-Deep River subwatershed (HUC 040400010502) has the greatest amount of cultivated land on highly erodible soils by acreage followed by the Deer Creek-Deep River (HUC 040400010504) and Duck Creek (HUC 040400010506) subwatersheds. The Duck Creek subwatershed has the highest percentage by drainage area followed by the Main Beaver Dam Ditch-Deep River and Deer Creek-Deep River subwatersheds.

Subwatershed	Acres	% of Drainage Area	Rank
040400010501	1,750	15	4
040400010502	4,563	27	2
040400010503	916	7	8
040400010504	3,469	25	3
040400010505	971	8	7
040400010506	2,793	28	1
040400010507	1,456	13	5
040400010508	151	1	9
040400010509	1,311	10	6
Watershed Total	17,381	15	

Figure 47 Acres of Cultivated Land on Highly Erodible Land (HEL) Soils

These cultivated fields could be a significant source of sediment and nutrient loading to receiving waterbodies if appropriate management measures and practices are not in place. More detailed information on enrollment in FSA or NRCS conservation programs is needed to more accurately determine to what extent these fields contribute to observed water quality impairments.

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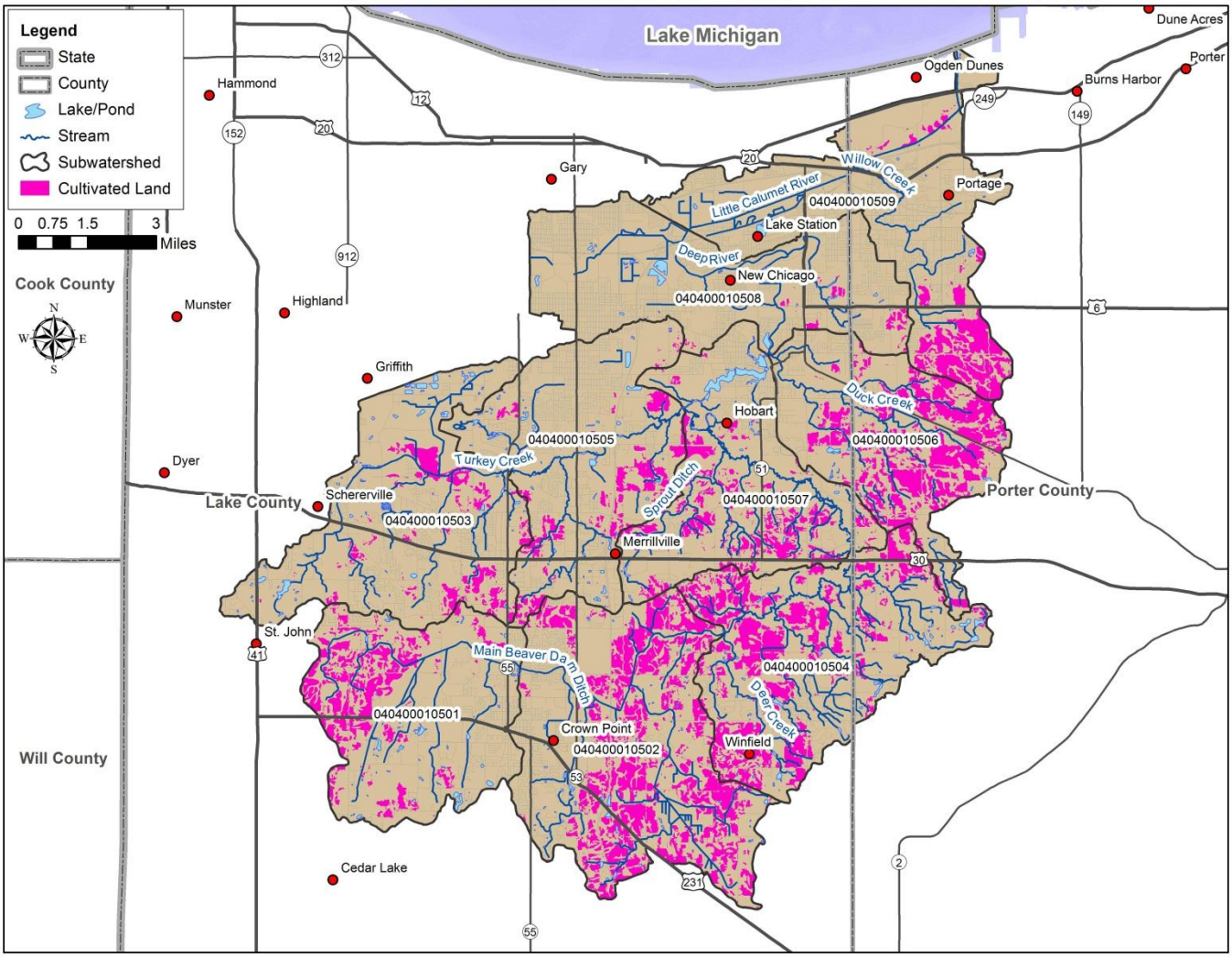

Figure 48 Cultivated land on Highly Erodible Land (HEL) Soils

2.9.3 Wetlands and Hydric Soils

Wetlands are an important landscape feature in a watershed. By intercepting runoff from upland areas they can sequester excess nutrients, sediment and other pollutants that would otherwise negatively impact receiving waterbodies and aquatic life. They also function as natural sponges, trapping and slowly releasing rain, snowmelt, groundwater and floodwaters. In watersheds where wetlands have been lost, flood peaks have been shown to increase by as much as 80% (Vermont DEC, 2011). Large wetlands located in the mid or lower reaches of a watershed contribute the most to flood control since they lie in the path of more water than their upstream counterparts (Wisconsin DNR, 2008). However, smaller wetlands located in the upper reaches of a watershed can have cumulative water storage benefits. Wetlands located downstream of urban areas are particularly valuable in offsetting the greatly increased rate and volume of runoff from impervious areas.

Subwatershed	Hydric Soils (Historic Wetland) (ac.)	% of Drainage Area	Existing Wetland (ac.)	% of Drainage Area	% Change (Wetland Loss)
040400010501	4,540	39	1,146	9.8	-75
040400010502	5,665	34	797	4.7	-86

Subwatershed	Hydric Soils (Historic Wetland) (ac.)	% of Drainage Area	Existing Wetland (ac.)	% of Drainage Area	% Change (Wetland Loss)
040400010503	4,922	36	1,189	8.7	-76
040400010504	3,588	26	1,024	7.4	-71
040400010505	4,278	34	1,016	8.1	-76
040400010506	2,781	27	520	5.1	-81
040400010507	2,808	25	1,086	9.8	-61
040400010508	4,025	33	1,246	10.3	-69
040400010509	4,626	34	1,223	9.1	-74
Watershed Total	37,233	32	9,247	8.0	-75

Table 18 Subwatershed Wetland Loss

Based on hydric soils data, approximately 37,233 acres of wetland would have historically existed within the watershed, representing 25-39% of each subwatershed's land area. Today only about 9,247 acres or 25% of that wetland area remains with wetlands accounting for 5-10% of each subwatershed's land area (Table 18). The greatest wetland losses have occurred in the Main Beaver Dam Ditch-Deep River (HUC 040400010502) and Duck Creek (HUC 040400010506) subwatersheds.

As noted above, wetland functional values are closely associated with landscape position. We can see in Figure 49 the extent to which wetland loss has occurred in both upland and riparian areas. In a Wisconsin DNR publication that focused on small wetlands and wetland loss, Trochlell and Bernthal (1998) compiled research that showed there was a threshold in which watersheds with less than 10% wetland area often experienced pronounced negative hydrological and water quality impacts, including deceased stream stability, higher peak flows, lower base flows and increased suspended solid loading rates. Within the Deep River-Portage Burns Waterway watershed only 8% of the land area is wetland. The Little Calumet River-Deep River subwatershed (HUC 040400010508) is the only subwatershed with a wetland area greater than 10%. Many of the small upland wetlands and riparian wetlands downstream of urban areas have been lost. The loss of wetland storage is exacerbated by high percentage of soils with low infiltration rates and high percentage of impervious cover in some subwatersheds.

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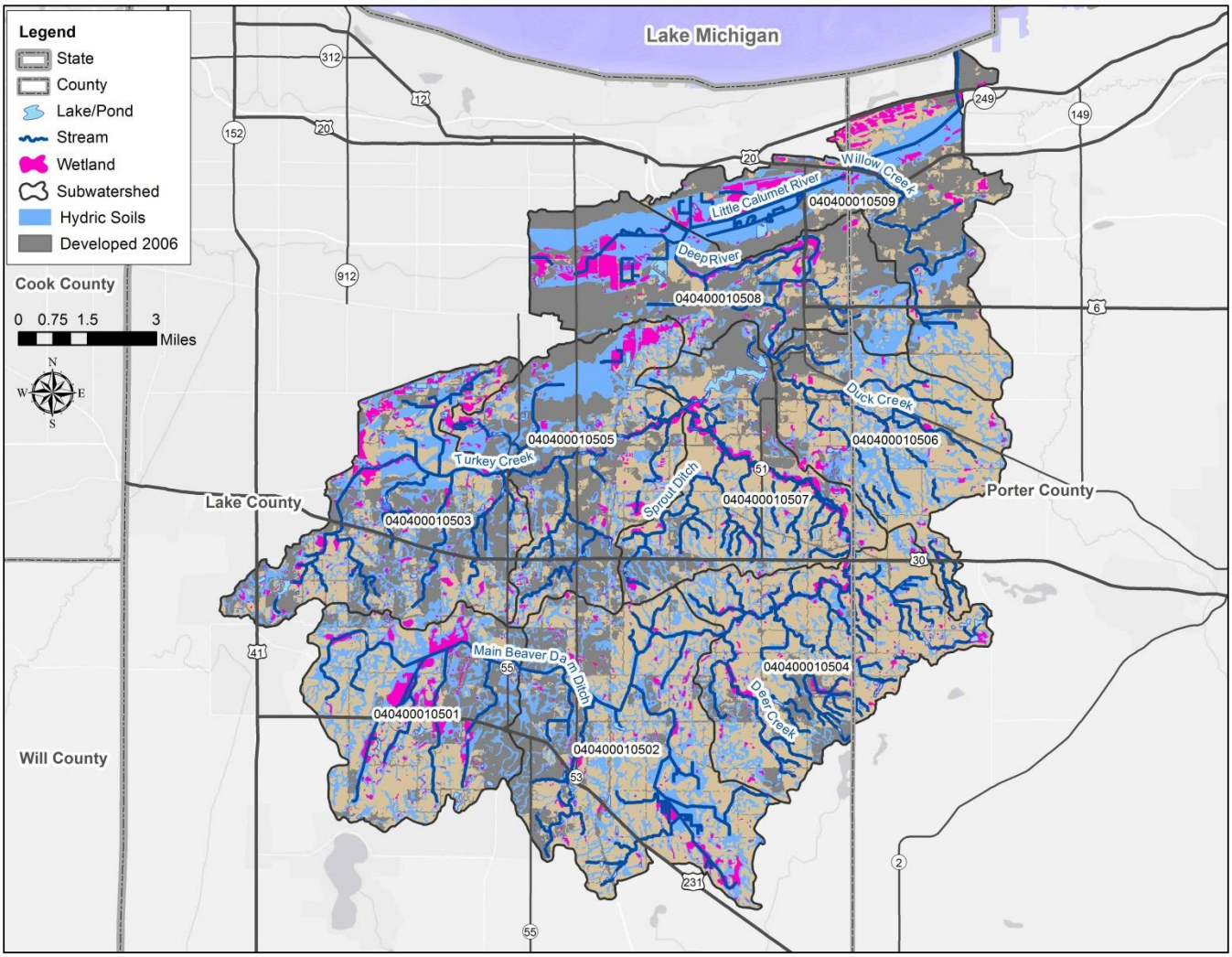

Figure 49 Wetlands and Hydric Soils

2.9.4 Riparian Area Land Cover

Riparian areas typically occur as natural buffers between upland land uses and adjacent waterbodies. They help filter our pollutants carried by stormwater runoff such as sediment, nutrients, pathogens, and metals before they reach water. The vegetation growing in healthy riparian areas help stabilize shorelines and streambanks, provide shade which in turn helps in maintain cooler water temperatures and higher dissolved oxygen levels, and also provide an important food source for fish and aquatic insects. Forested riparian corridors are also the source of large woody debris in streams. Because most streams in our region lack sufficient gradient and materials to form riffles, large woody debris is a critical habitat component in maintaining healthy aquatic communities.

An assessment of riparian area land cover was done by NIRPC using a desktop GIS assessment methodology developed by the DNR Division of Forestry. The methodology is meant to be a first-round screening assessment of riparian conditions in a watershed. A variety of GIS data including land cover, soils, elevation, hydrologic lines and watershed boundaries was used to generate subwatershed indicator data. The methodology allows for riparian

buffer placement prioritization on two different scales, subwatershed and stream reach. The results of the analysis and scoring are presented below. A higher score means a higher priority.

Indicators used in the analysis included:

- Percentage of riparian lands in the subwatershed
- Percentage of nonpoint source contributing land uses in the subwatershed
- Percentage of nonpoint source contributing lands uses in riparian zone
- Average annual soil loss (Revised Universal Soil Loss Equation (RUSLE))

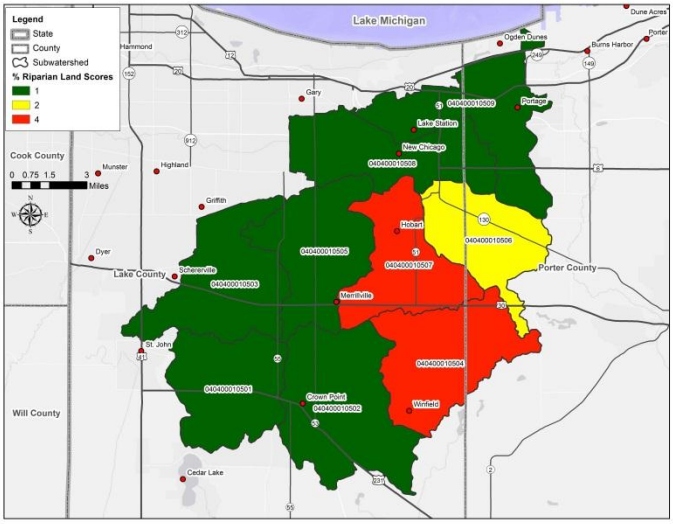

Figure 51 Percent Riparian Land Use/Land Cover Scores

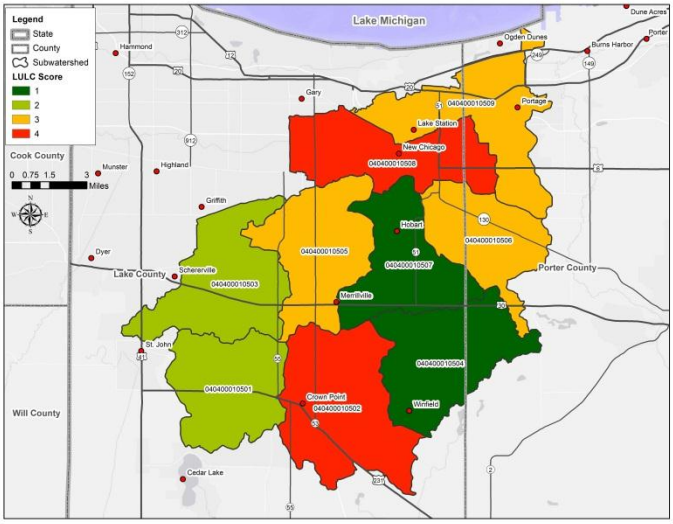

Figure 50 Percent Subwatershed Land Use/Land Cover Scores

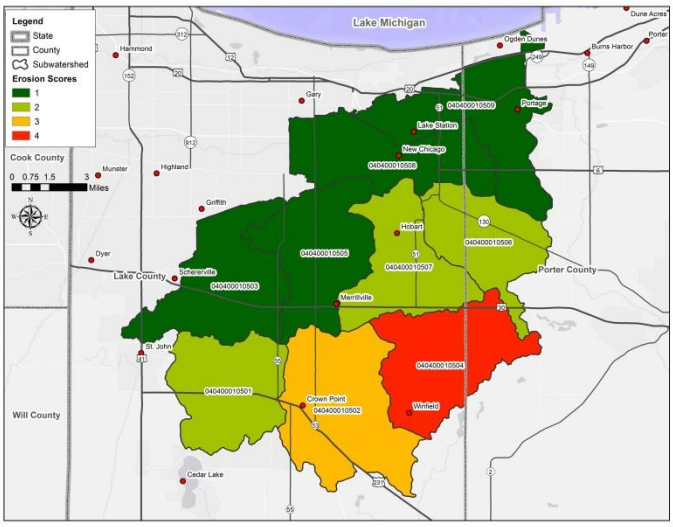

Figure 52 Percent Riparian Land Scores

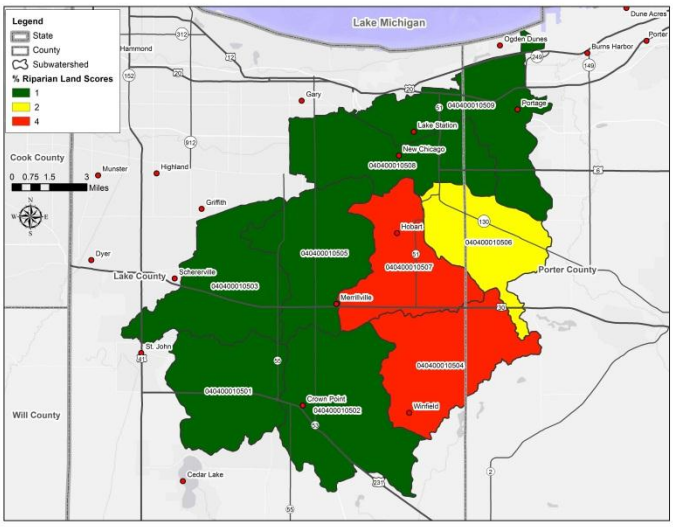

Figure 53 Erosion Scores

Figures 49-51 show the indicator scores for each subwatershed. The final subwatershed prioritization for riparian forest buffer need is shown in Figure 54. The results of this desktop analysis show that the Main Beaver Dam Ditch-Deep River (HUC 040400010502) and Deer Creek-Deep River (HUC 040400010504) subwatersheds are the two highest priorities.

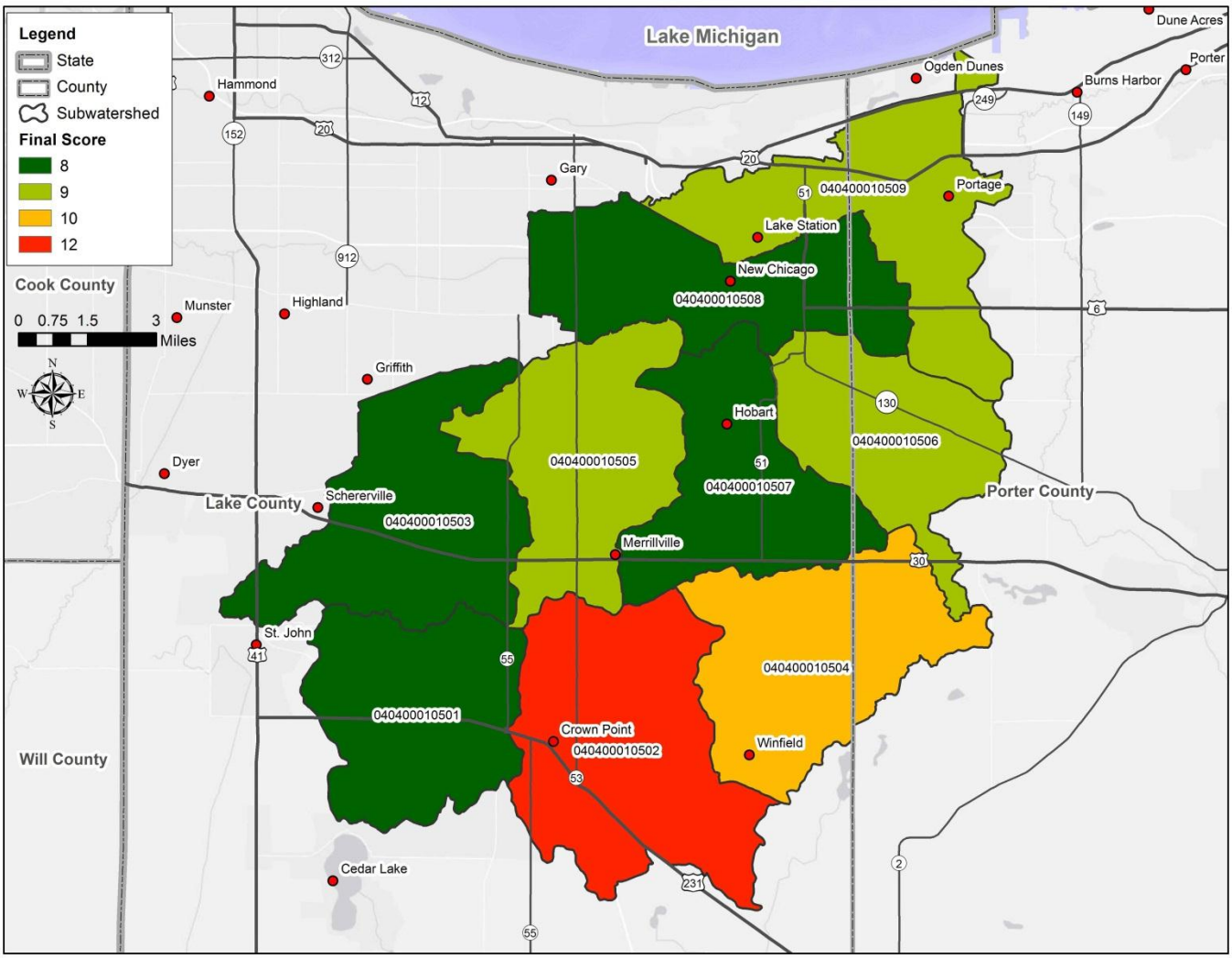

Figure 54 Riparian Forest Buffer Final Score