2 Watershed Inventory- Part I

2.1 Watershed Location

Located near the southern tip of Lake Michigan, the Deep River-Portage Burns Waterway watershed (HUC 0404000105) drains nearly 180 mi^2 of north central Lake and Porter Counties into Lake Michigan through the Burns Waterway in Portage (Figure 1). The watershed is comprised of nine smaller drainage areas known as subwatersheds and several municipalities 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 4, Table 4).

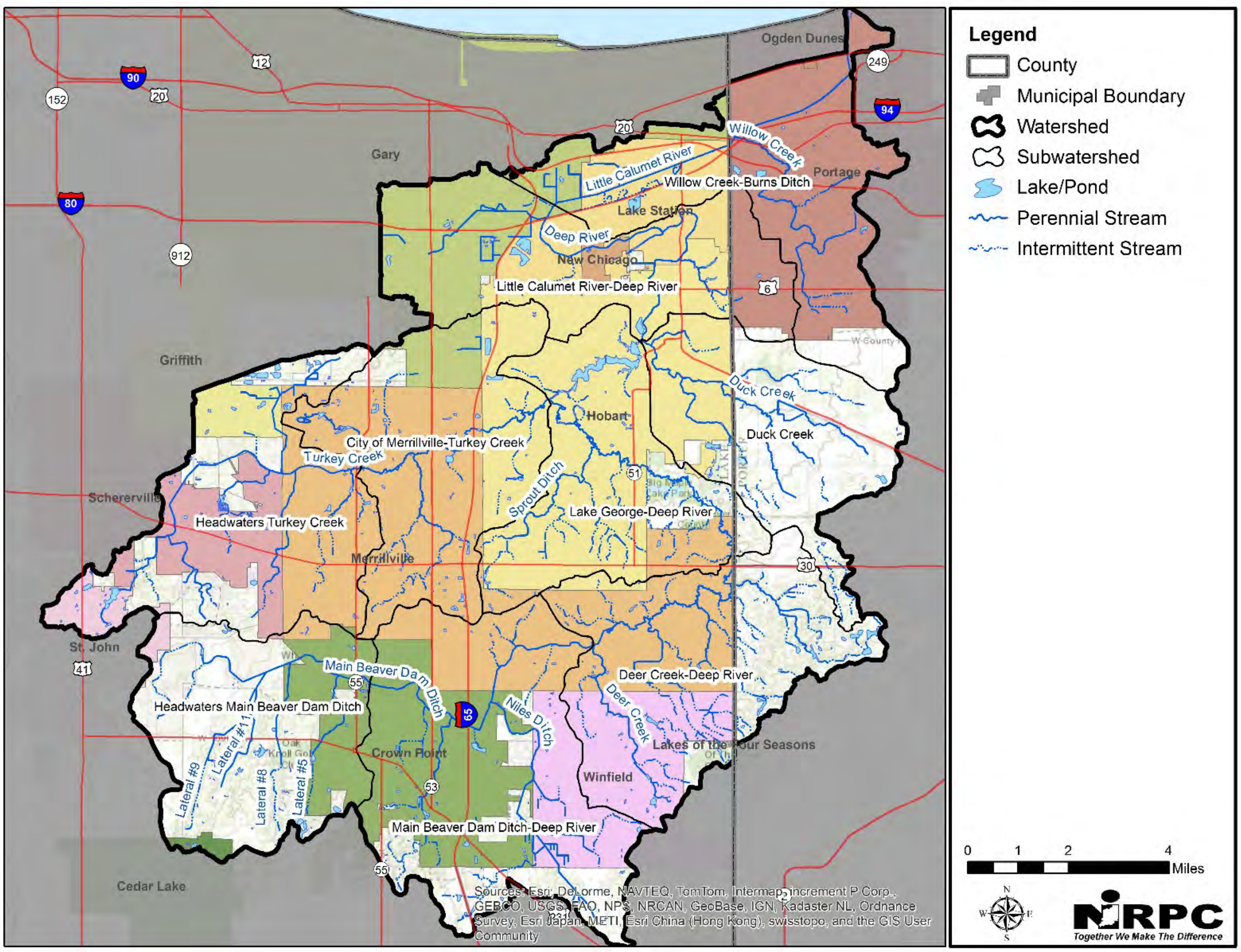


Figure 4 Subwatersheds & municipalities

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

Table 4 Subwatershed drainage area and downstream subwatershed

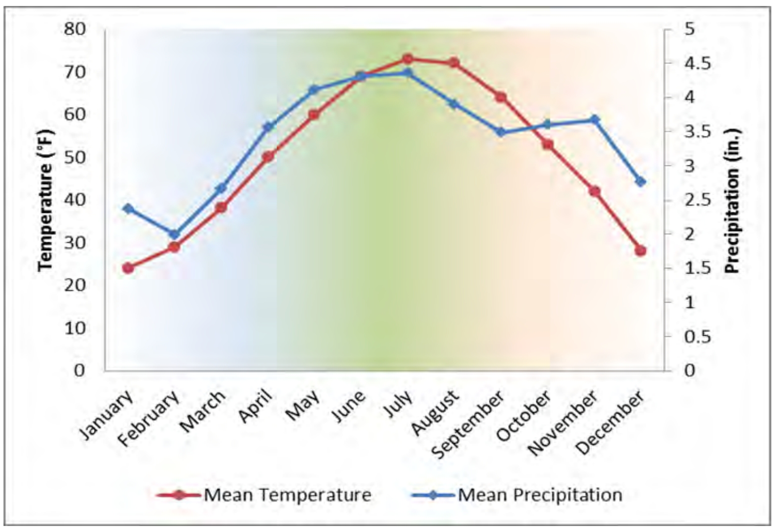
Hydrologic Unit Codes: What Are They?

A hydrologic unit code or HUC is a numbering system used by natural resource agencies to identify watersheds. It's the numeric equivalent to a home's mailing address. The U.S. Geological Survey has mapped the entire country using different HUC levels: 8-digit HUCs identify large drainage areas known as sub-basins (ex. the Little Calumet-Galien), 10-digit HUCs identify smaller drainage areas known as watersheds (ex. the Deep River-Portage Burns Waterway), and 12-digit HUCs identify even smaller drainage areas known as subwatersheds (ex. Duck Creek). Notice how each subwatershed in the table above share the same first 10 digits? That's because they are all part of the larger Deep River-Portage Burns Waterway watershed.

2.2 Climate

In Northwest Indiana, the presence of Lake Michigan has a pronounced influence on climatic conditions. The most distinct effects generally occur 1-2 miles inland but can extend as far as 25 miles inland. Overall our region experiences warmer falls, cooler springs, higher humidity, and greater amounts of snow compared to other nearby regions. This is primarily due to differences in Lake Michigan surface water temperature relative to land surface temperature.

On average, over the last 30 years, 40.8 inches of precipitation falls over the watershed during the course of a year with the highest amounts occurring between May and July (Figure 5). Approximately 64% of the precipitation that falls over a 24-hour period is 1-inch or less while 34% is between 1-2 inches. The normal monthly maximum temperature measures 83° F in July, while the minimum measures 18° F in January. Climate data is based on information from the Valparaiso Waterworks Cooperative weather station. Table 5 shows monthly average precipitation data and monthly extreme precipitation observed during the water quality monitoring baseline assessment conducted by IDEM.



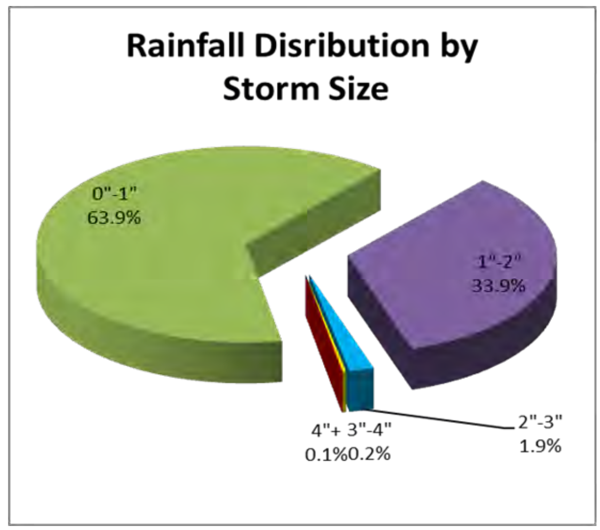


Figure 5 Precipitation & temperature

Date	Precipitation (in.)	Snowfall (in.)	High Precipitation (in.)
Apr-2013	6.02	0	1.58
May-2013	3.18	0	0.83
Jun-2013	4.81	0	1.19
Jul-2013	1.44	0	0.85
Aug-2013	4.11	0	1.78
Sep-2013	3.44	0	1.90
Oct-2013	5.42	0	2.67
Nov-2013	3.18	1.0	1.04
Dec-2013	1.03	5.6	0.46
Jan-2014	2.51	23.7	1.00
Feb-2014	2.28	16.6	0.90
Mar-2014	1.70	13.5	0.62

Table 5 Monthly precipitation data during baseline assessment monitoring period

Precipitation depth and frequency curves are presented in Figure 6. This data was obtained from NOAA's National Weather Service, Hydrometeorological Design Studies Center Precipitation Frequency Data Server. The precipitation depth of a 1-year, 24-hour storm is approximately 2.39 inches, while the 2-year 24-hour storm is approximately 2.91 inches.

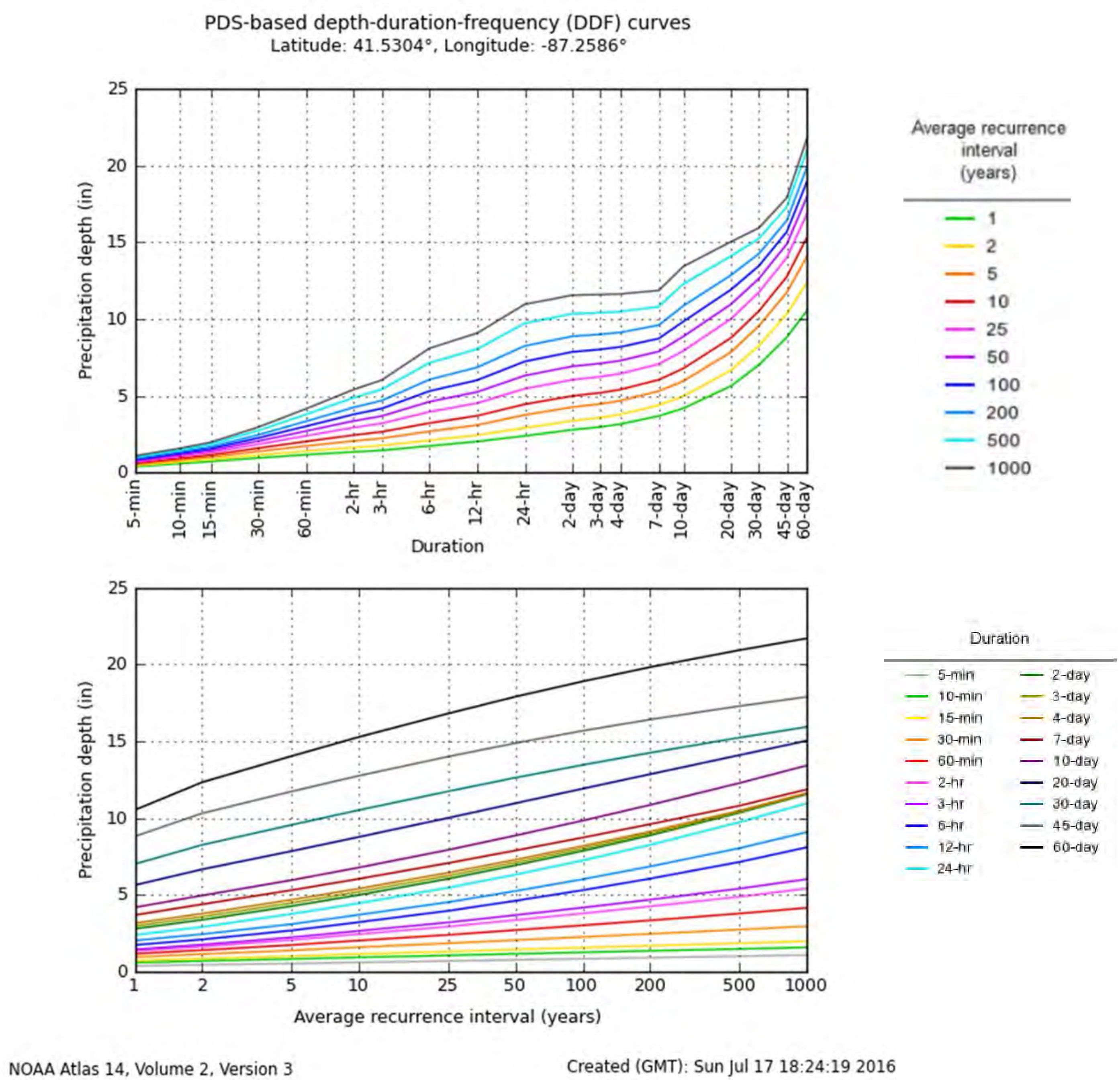


Figure 6 Precipitation depth-duration frequency curves

2.3 Geology and Topography

2.3.1 Surficial Geology

Surficial geology refers to the study of landforms and the unconsolidated (loosely arranged) sediments that lie beneath them. Surficial geology greatly influences topography and soil development, which in turn, control runoff and infiltration of precipitation. This influences water quality in streams, lakes and ground water.

In our region the majority of the unconsolidated sediments found at the land surface 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 7 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.

Stakeholder Concerns Related to Geology & Topography:

- Increased runoff
- Erosion & sedimentation
- Stream flashiness
- Ability to absorb excess water

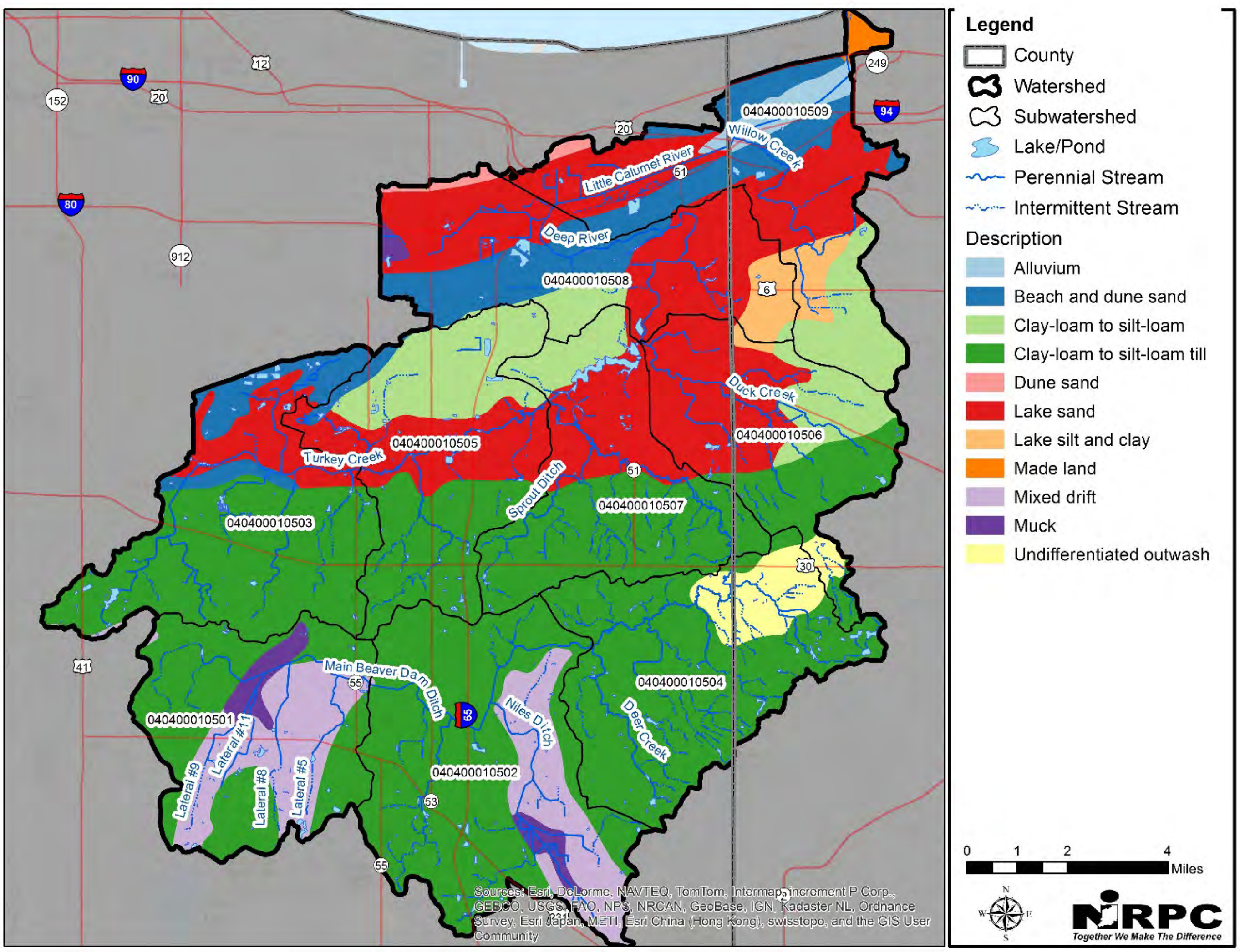


Figure 7 Surficial geology

2.3.2 Physiography

Physiographic regions share a similar topography, geologic structure and history. The Deep River-Portage Burns Waterway watershed is located in the physiographic region known as the Northern Moraine and Lake Region. The topography of our region was created almost entirely by the erosional and depositional forces of the last glaciation event, the Wisconsin. The Northern Moraine and Lake Region 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 further 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 8).

The Lake Michigan Border forms a 4-11 mile wide band along the southern shore of Lake Michigan. It 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.

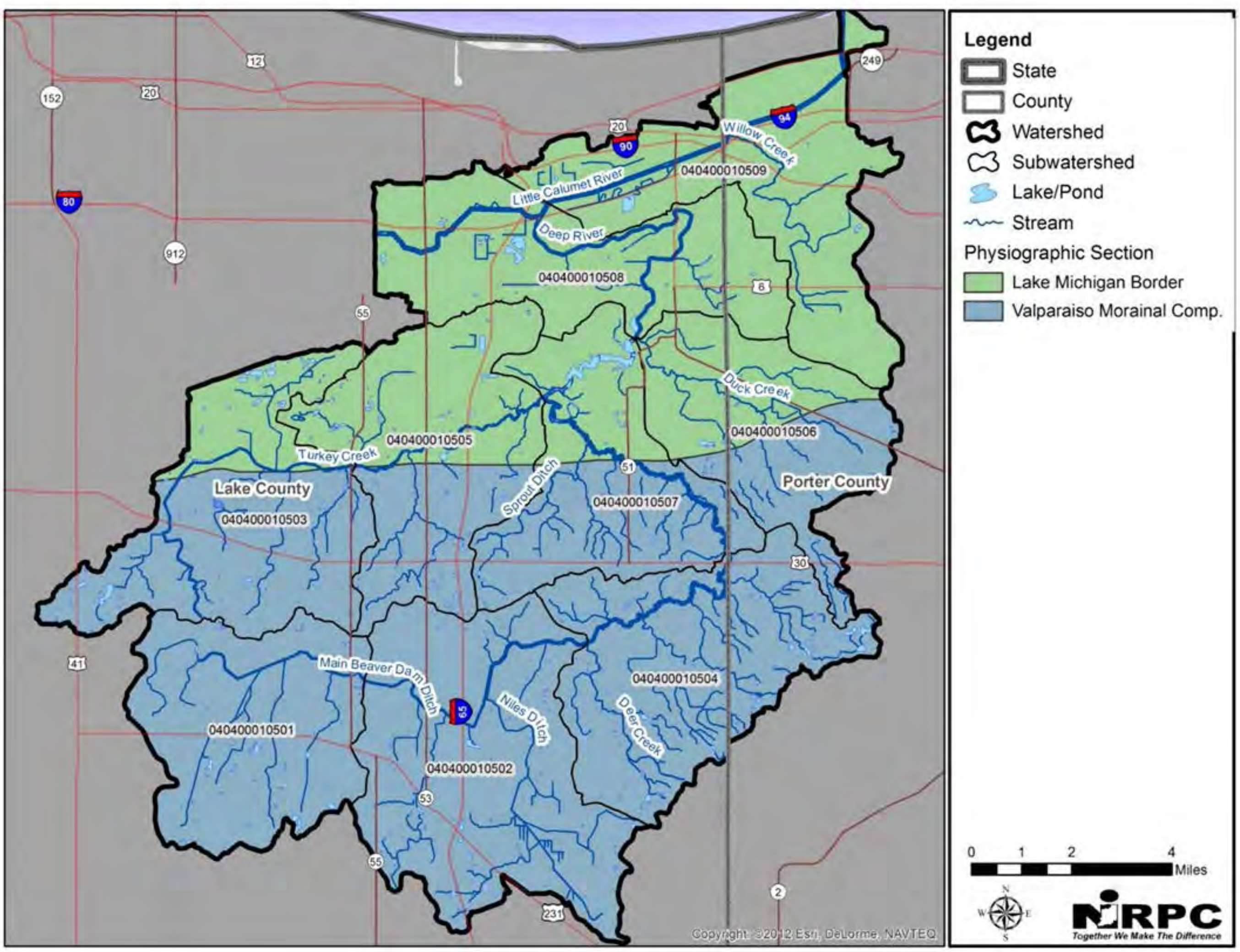


Figure 8 Physiography

2.3.3 Elevation

Elevation in the watershed ranges from a high of 823 ft. (251 m) to a low of 574 ft. (175 m) (Figure 9). The highest elevations occur in the southern portion of watershed along the Valparaiso Moraine. In general the lowest elevations occur along a corridor adjacent to the West Branch of the Little Calumet River west of State Road 51.

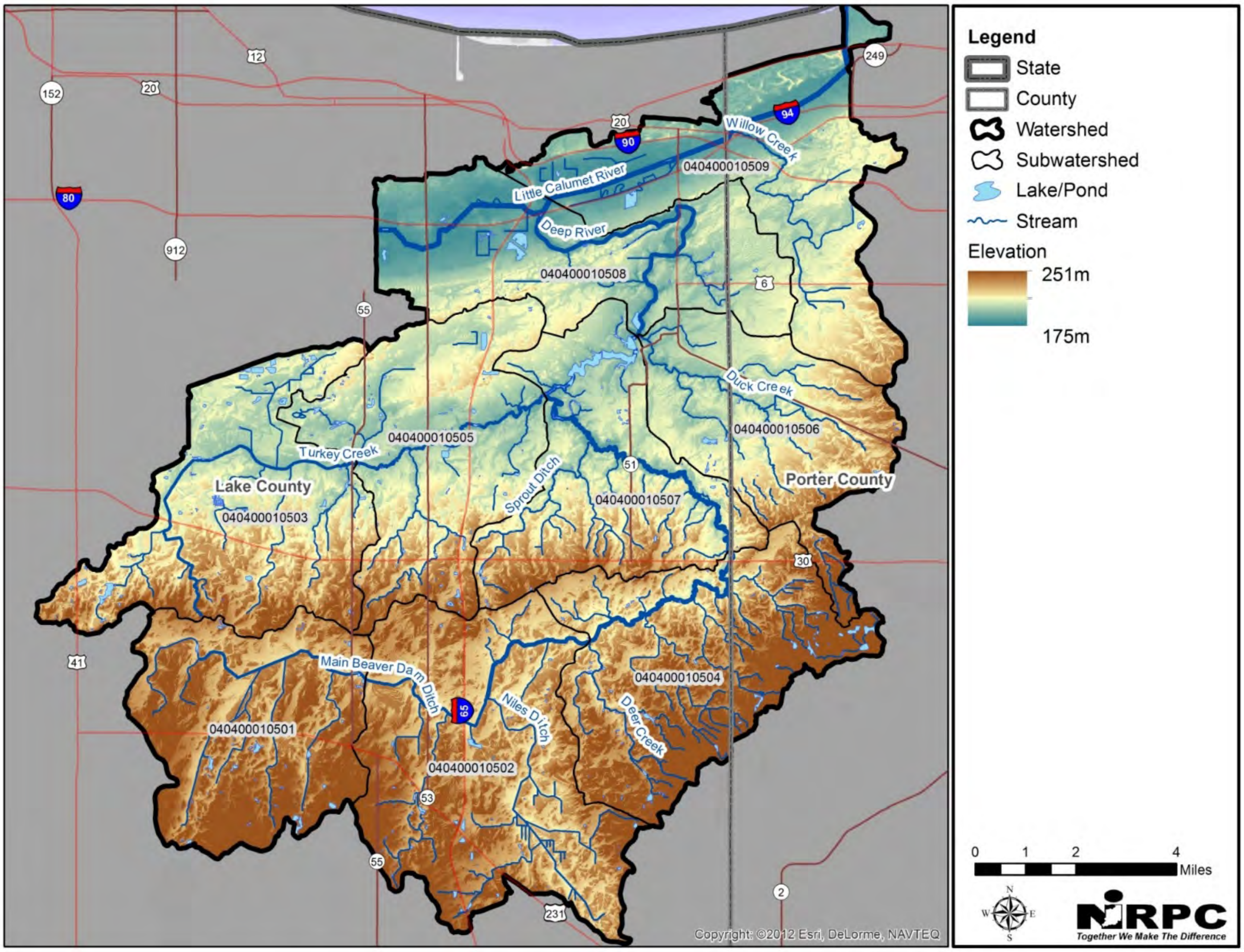


Figure 9 Elevation

2.3.4 Slope

Slopes influence a watershed's drainage pattern. Streams occurring in low gradient areas have meandering (winding) channels. Even straight channels will eventually erode into meandering channels if the streambank's soils are erodible. Because meandering streams are continually eroding on the outer bends and depositing sediment on the inner points, meandering stream channels tend to migrate back and forth across their floodplain. In areas where steep slopes do exist, it is difficult for rain to soak into the ground and for plant cover to become established. This combination of factors can lead to increased runoff and erosion potential.

Slope within the Deep River-Portage Burns Waterway watershed ranges from 0 to 71.5% (Figure 10). However most of the watershed can best be described as flat to gently rolling with an average slope of 2%. The areas of greatest topographic relief generally occur in the headwater areas of the Valparaiso Moraine and along Deep River. Slopes exceeding 15% can be found along Lake George, the river valley edges of Duck Creek, Deep River and one of its small, unnamed tributaries located south of U.S. Highway 30 in Porter County. Other areas with slopes exceeding 15% are found 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.

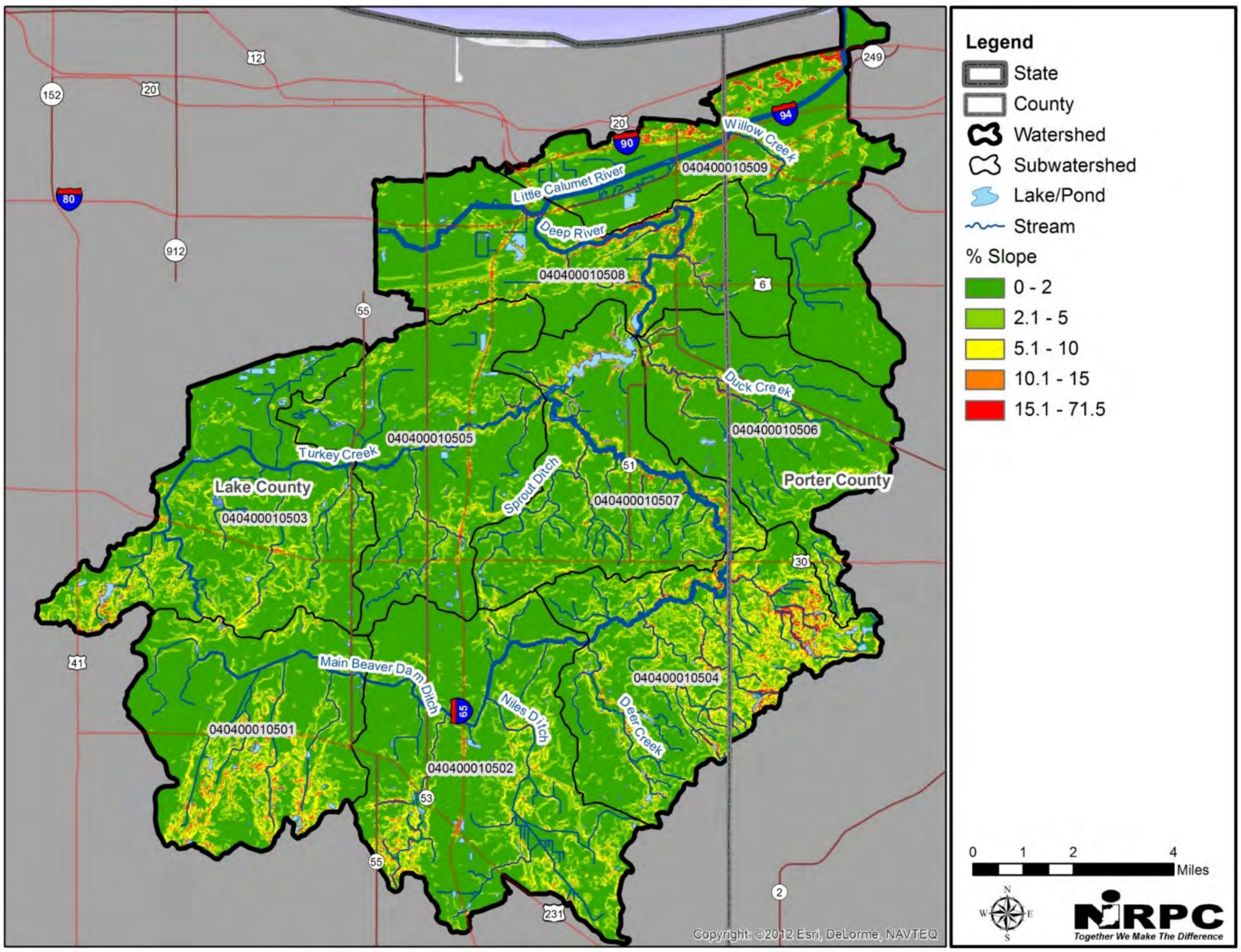


Figure 10 Slope

2.4 Soils

Soil development is the product of the interaction of parent material, topography, climate, organisms and time. 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. Soils information can also be useful for identifying and prioritizing future restoration activities.

Stakeholder Concerns Related to Soils:

- Increased runoff
- Erosion & sedimentation
- Stream flashiness
- Ability to absorb excess water
- Failing septic systems
- Sediment loading
- Excess nutrients
- Chemicals in runoff
- Soil health
- Wetland habitat loss
- Increased runoff volume
- Streambank erosion
- Flooding
- Ability of watershed to store water
- Maintain drainage while protecting quality of resource

In the Lake Michigan region the distribution of major soil types is closely related to the physiographic terrain of the region (Section 2.3.2). Clayey or loamy soils are typical of the Valparaiso Morainal Complex while sandy soils are more typical in the Lake Michigan Border.

The following subsections provide details about soil characteristics that influence runoff and water quality.

2.4.1 Hydrologic Soil Groups

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups (A, B, C, and D) or one of three dual classes (A/D, B/D, and C/D) 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. 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.

Table 6 provides a summary of hydrologic soil group data for each subwatershed and the watershed as a whole while Figure 11 shows their locations. 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 wide band of Group A, A/D, and B soils is found in the northern portion of the watershed paralleling the Little Calumet River. 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, Main Beaver Dam Ditch-Deep River and City of Merrillville-Turkey Creek subwatersheds have low or very low infiltration rates.

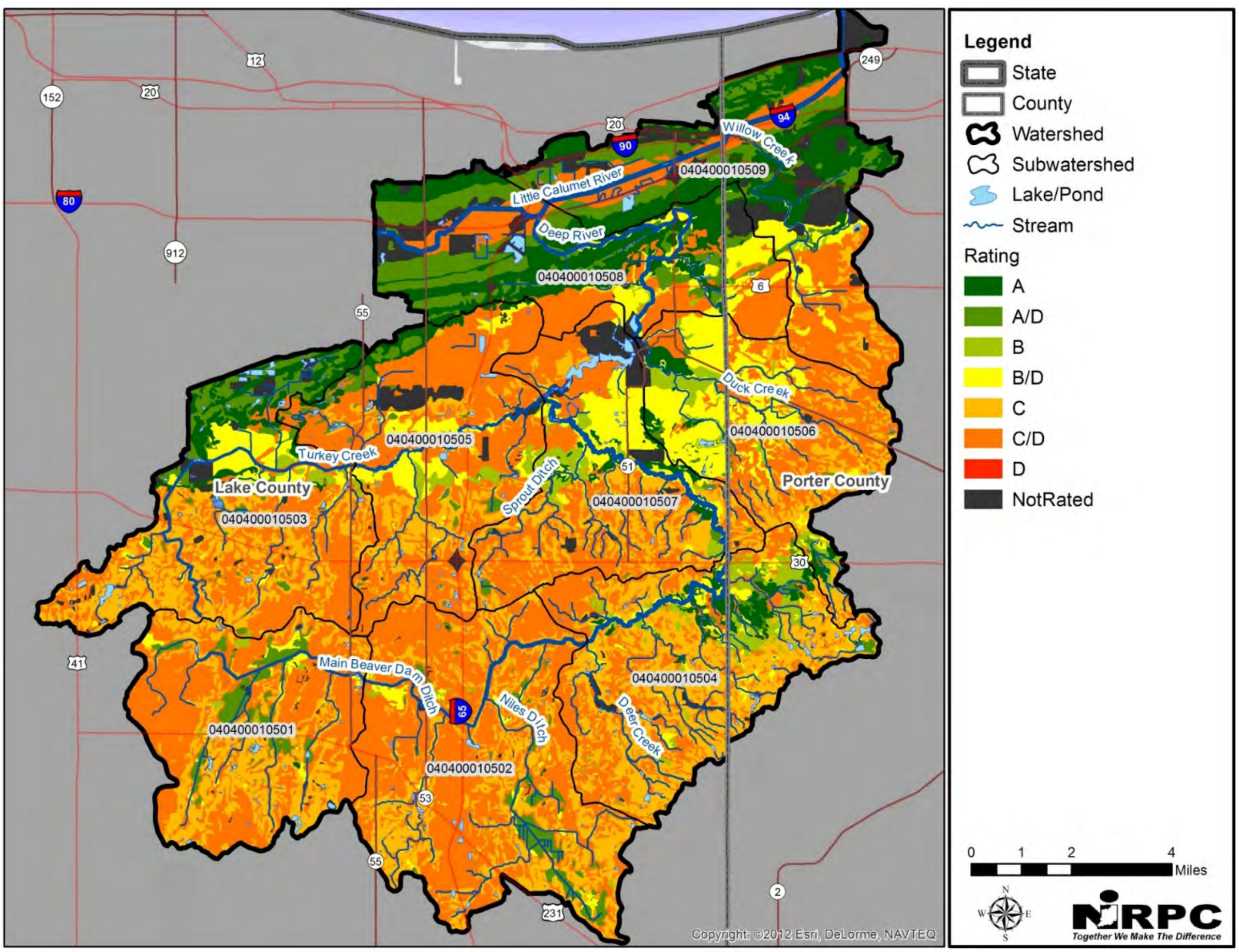


Figure 11 Hydrologic soil groups

Name	HUC-12	A (ac.)	%	A/D (ac.)	%	B (ac.)	%	B/D (ac.)	%	C (ac.)	%	C/D (ac.)	%	D (ac.)	%	NR (ac.)	%
Headwaters Main Beaver Dam Ditch	040400010501	12	0	959	8	95	1	331	3	3,386	29	6,737	58	0	0	189	2
Main Beaver Dam Ditch-Deep River	040400010502	10	0	889	5	80	0	384	2	4,918	29	10,427	62	0	0	113	1
Headwaters Turkey Creek	040400010503	1,344	10	1,231	9	260	2	1,137	8	3,790	28	5,108	38	0	0	724	5
Deer Creek-Deep River	040400010504	677	5	311	2	1,061	8	855	6	5,963	43	4,547	33	0	0	331	2
City of Merrillville-Turkey Creek	040400010505	570	5	534	4	350	3	1,250	10	1,998	16	7,064	57	0	0	726	6
Duck Creek	040400010506	386	4	216	2	646	6	3,138	31	1,788	18	3,830	38	0	0	136	1
Lake George-Deep River	040400010507	364	3	108	1	514	5	1,826	16	2,647	24	4,669	42	0	0	953	9
Little Calumet River-Deep River	040400010508	3,345	28	3,067	25	87	1	1,201	10	82	1	2,922	24	0	0	1,444	12
Willow Creek-Burns Ditch	040400010509	3,605	27	2,409	18	38	0	685	5	491	4	3,764	28	0	0	2,413	18
Watershed 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 6 Hydrodologic 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 wind or water erosion for agricultural purposes. The NRCS maintains a list of highly erodible land units for each county. A list of the HEL or potentially HEL soil types and acreages within the watershed are listed by county in Table 7. To be eligible for USDA benefits, farmers that produce annually tilled agricultural commodity crops such as corn or soybeans must use an approved conservation system on all highly erodible land.

County	Map Unit	HES/Potential HES Soil Types	Acres
Lake	Bp	Borrow pits	305
	Cp	Clay pits	14
	DoB	Door loam	92
	DrB	Door loam, silty clay loam substratum	53
	LyB	Lydick loam	12
	MaB2	Markham silt loam	3,968
	MuD2	Morley silt loam	763
	MvB3	Morley silty clay loam	421
	OaE	Oakville fine sand	104
	OsA	Oshtemo fine sandy loam	636
	PlB	Plainfield fine sand	4,269
	TcC	Tracy loam	24
	TrB	Tracy loam, silty clay loam substratum	84
		Total	**10,745**
Porter	BaA	Blount silt loam	665
	ChB	Chelsea fine sand	312
	LyB	Lydick loam	22
	McB	Markham silt loam	979
	MfA	Martinsville loam	59
	MrD2	Morley silt loam	272
	MsC3	Morley silty clay loam	44
	OaE	Oakville fine sand	315
	Pk	Pits	13
	RaC2	Rawson loam	8
	RmC2	Riddles loam	73
	RlB	Riddles silt loam	223
	TcD	Tracy sandy loam	32
	UcG	Udorthents, loamy	81
		Total	**3,098**

Table 7 HEL/Potential HEL soil units by county

Table 8 provides a summary of HEL soils data for each subwatershed and the watershed as a whole. Figure 12**Error! Reference source not found.** shows the locations of HEL soils in the watershed. Approximately, 14, 108 acres or 12.3% of the soils in the watershed are classified as HEL or potentially HEL.

Name	HUC-12	HEL (ac.)	%
Headwaters Main Beaver Dam Ditch	040400010501	828	7.1
Main Beaver Dam Ditch-Deep River	040400010502	1,848	11.0
Headwaters Turkey Creek	040400010503	1,946	14.3
Deer Creek-Deep River	040400010504	1,906	13.9
City of Merrillville-Turkey Creek	040400010505	1,616	12.9
Duck Creek	040400010506	1,268	12.5
Lake George-Deep River	040400010507	425	3.8
Little Calumet River-Deep River	040400010508	2,639	21.7
Willow Creek-Burns Ditch	040400010509	1,634	12.2
Watershed Total		14,108	12.3

Table 8 HEL/ Potentially HEL soil units by subwatershed

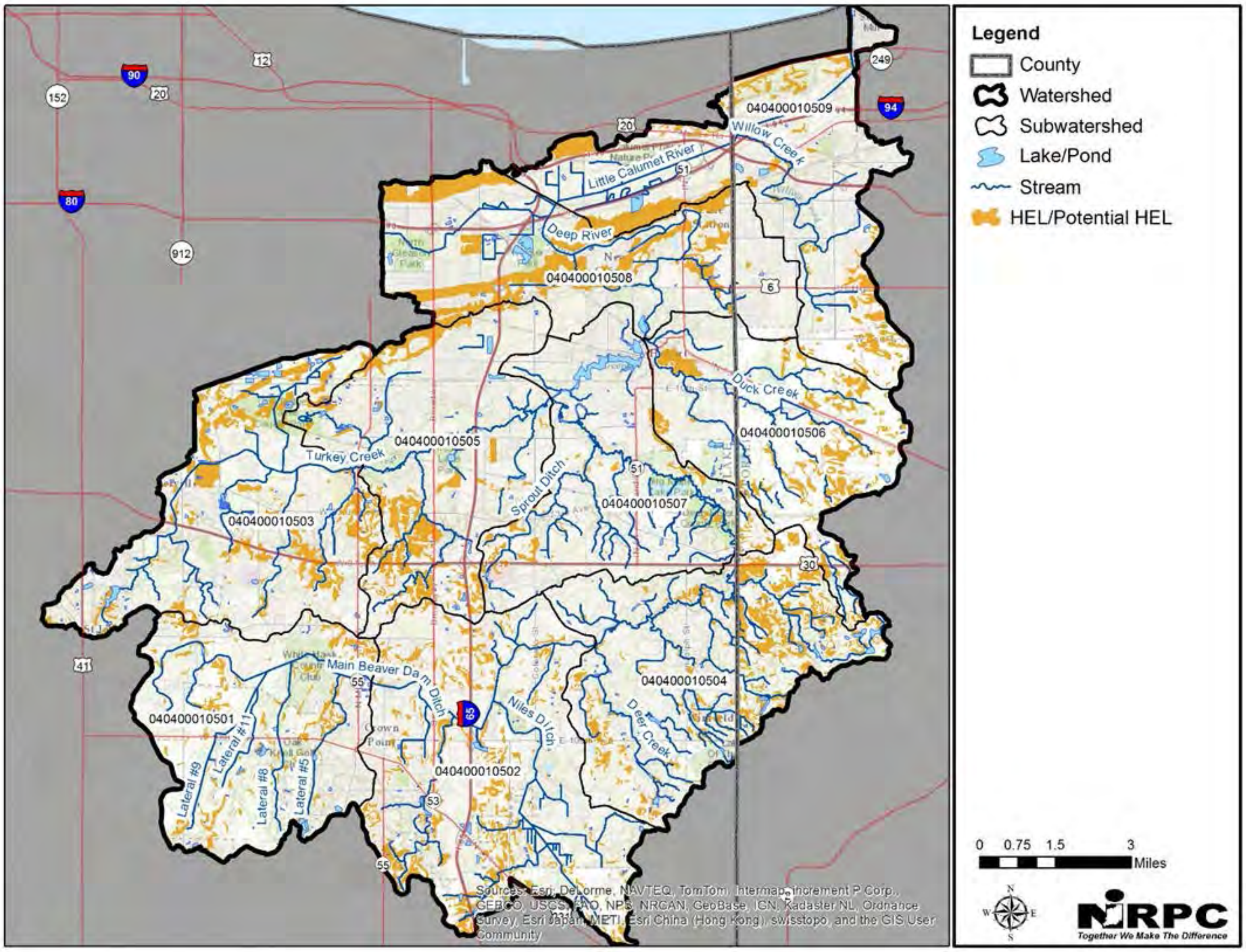


Figure 12 HEL/Potential HEL soils in the watershed

2.4.3 Hydric Soils

Hydric soils are one of three characteristics used to identify wetlands. These soils formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic (oxygen depleted) 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 9 provides a summary of hydric soils data for each subwatershed and the watershed as a whole while Figure 13 provides us with a sense of their locations. 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 or ditches.

Name	HUC-12	All Hydric (ac.)	%	Partially Hydric (ac.)	%	Not Hydric (ac.)	%	Unranked (ac.)	%
Headwaters Main Beaver Dam Ditch	040400010501	4,540	39	0	0	7,146	61	24	0
Main Beaver Dam Ditch-Deep River	040400010502	5,665	34	0	0	11,137	66	21	0
Headwaters Turkey Creek	040400010503	4,922	36	0	0	8,236	61	430	3
Deer Creek- Deep River	040400010504	3,588	26	0	0	10,159	74	0	0
City of Merrillville-Turkey Creek	040400010505	4,278	34	25	0	7,690	62	500	4
Duck Creek	040400010506	2,781	27	0	0	7,282	72	82	1
Lake George- Deep River	040400010507	2,808	25	0	0	7,650	69	623	6
Little Calumet River-Deep River	040400010508	4,025	33	61	1	7,359	61	689	6
Willow Creek-Burns Ditch	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 9 Hydric Soils Data

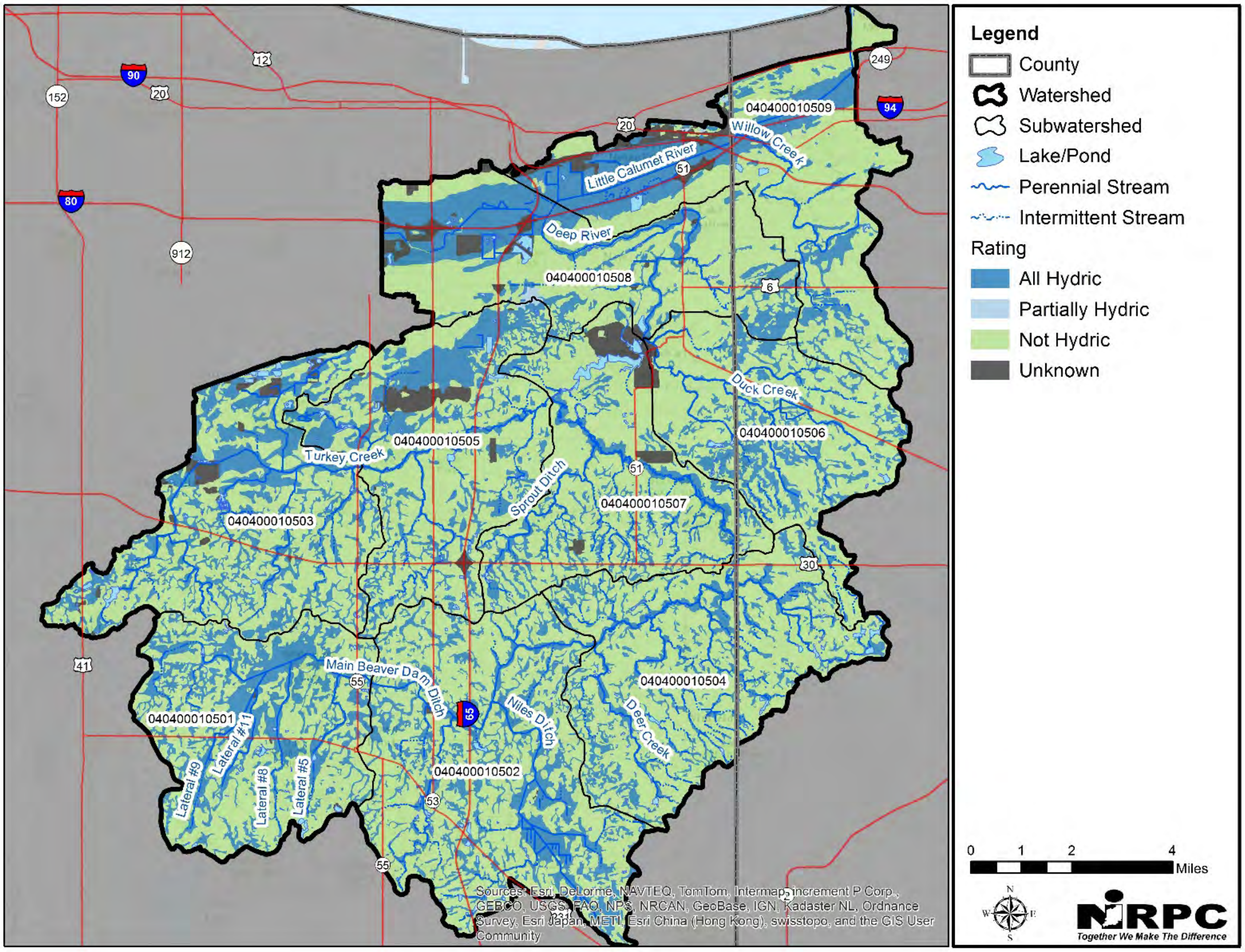


Figure 13 Hydric soils rating

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.

Table 10 provides an overview of soil drainage class data for each subwatershed and the watershed as a whole while Figure 14 shows their locations. 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. As referenced in the discussion about hydrologic soils groups, dual soil ratings are influenced by whether the soil is artificially drained or not. Section 2.10.5 includes further information about cultivated land existing on poorly drained soils where subsurface drainage would likely be needed.

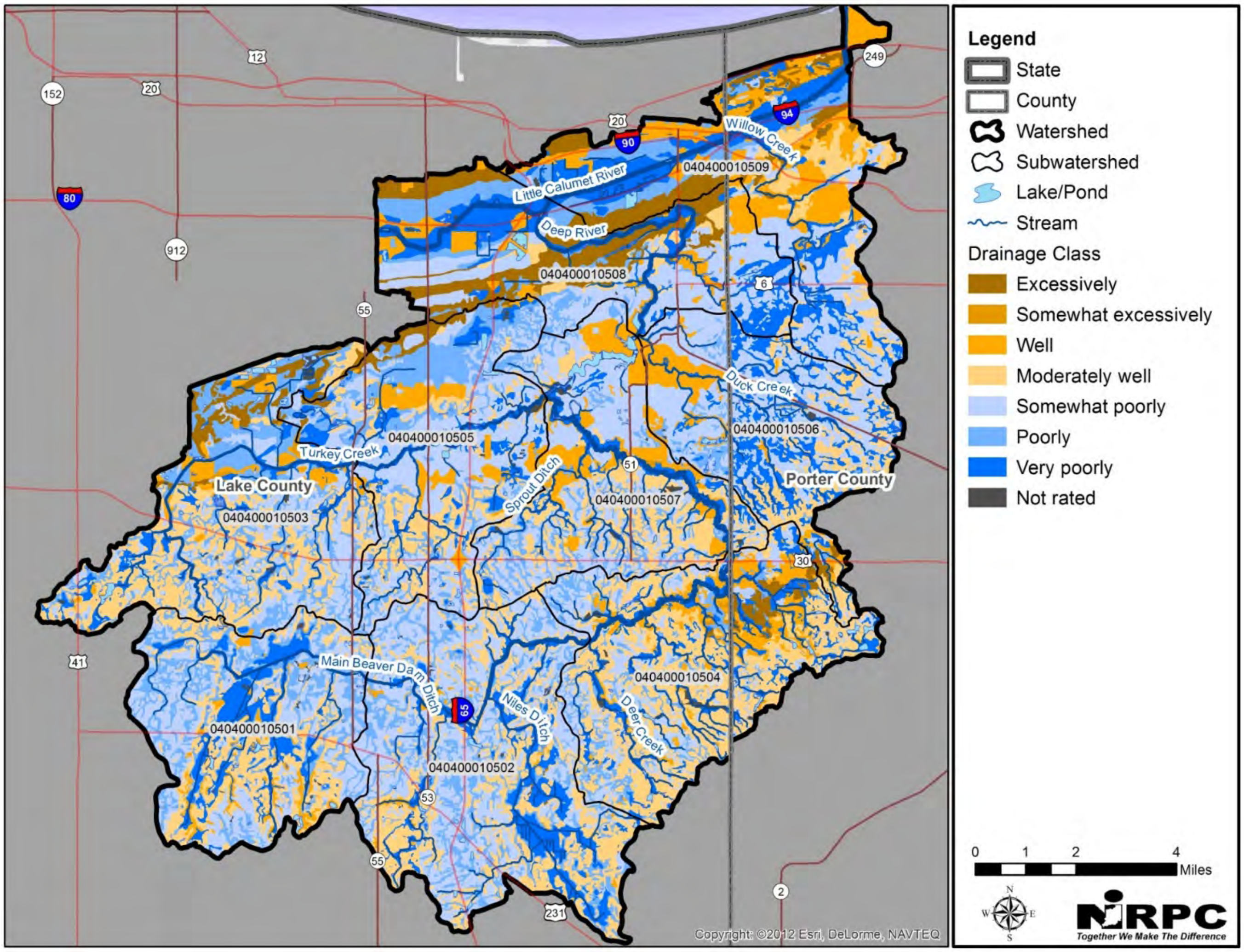


Figure 14 Soil Drainage Class

Name	HUC-12	Excessively Drained	%	Somewhat Excessively	%	Well Drained	%	Moderately Well Drained	%	Somewhat Poorly Drained	%	Poorly Drained	%	Very Poorly Drained	%	Not Rated	%
Headwaters Main Beaver Dam Ditch	040400010501	0	0	0	0	484	4	3,033	26	3,497	30	2,886	25	1,654	14	155	1
Main Beaver Dam Ditch-Deep River	040400010502	7	0	2	0	186	1	4,830	29	6,035	36	3,454	21	2,211	13	95	1
Headwaters Turkey Creek	040400010503	860	6	72	1	788	6	4,052	30	2,574	19	3,734	27	1,188	9	327	2
Deer Creek-Deep River	040400010504	395	3	48	0	1,480	11	5,783	42	2,203	16	1,505	11	2,084	15	247	2
City of Merrillville-Turkey Creek	040400010505	475	4	8	0	898	7	2,038	16	4,598	37	2,946	24	1,332	11	198	2
Duck Creek	040400010506	90	1	0	0	1,038	10	1,778	18	4,403	43	407	4	2,374	23	50	0
Lake George-Deep River	040400010507	0	0	21	0	1,511	14	2,615	24	3,803	34	1,735	16	1,073	10	322	3
Little Calumet River-Deep River	040400010508	2,655	22	7	0	1,253	10	499	4	3,427	28	1,514	12	2,511	21	281	2
Willow Creek-Burns Ditch	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 10 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 15. 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 15 is a general reference of likely field conditions. A soil scientist is necessary to determine actual site conditions which may vary greatly compared to 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.
- "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 higher maintenance can be expected which is particularly problematic since there currently is no operation and maintenance program in place for existing systems within Lake and Porter Counties.

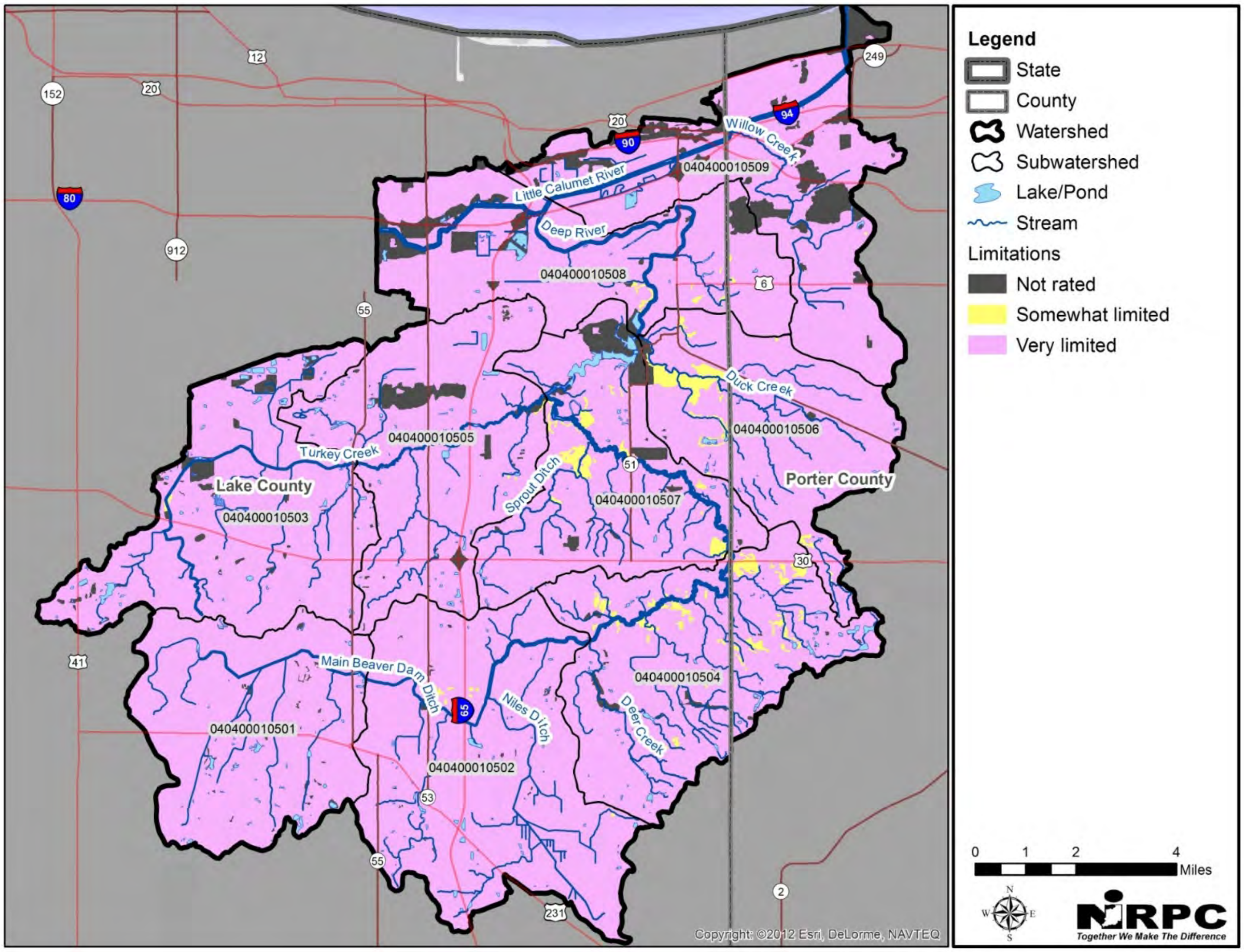


Figure 15 Septic System Soil Limitation Rating

2.5 Hydrology

Characterizing how water is transported from the watershed to stream channels (i.e. hydrology) and how water is transported within the stream channel and its floodplain (i.e. hydraulics) are very important components in understanding watershed processes that can affect water quality and aquatic life.

Hydrology in the watershed is markedly different from when the area was first settled. Pre-settlement vegetation data that has been pieced together from surveyor notes suggest that much of the watershed's landscape included a dynamic mix of prairie, savanna, marsh, wetland, and forest communities. As the area was settled, wetlands and marshes were drained and prairies were plowed under for agricultural production and forests and savannas were logged for their timber. The loss of natural land is known to increase surface runoff volume and rates which results in streams receiving more water as overland flow than they had developed under. Additionally, impervious surface cover has been steadily increasing with the expansion of development. This increase in impervious cover has resulted in even greater runoff and less infiltration.

Historically the Little Calumet River and the Grand Calumet River were once 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 turn back east near present-day Blue Island in Illinois and eventually emptying into Lake Michigan near the Marquette Park Lagoon in Gary.

In 1926 Burns Ditch was completed 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.

Stakeholder Concerns Related to Hydrology:

- Flooding
- Floodway/ floodplain encroachment
- Stream flashiness
- Reconciling drainage w/ water quality & habitat
- Loss of recreational opportunities
- Impaired stream impacts on recreation & tourism
- Wetland loss
- Storm water storage
- Excess sediment & nutrient loading
- Stream habitat loss
- Riparian area and floodplain encroachment
- Reconciling drainage/ flood control w/ water quality and habitat
- Water viewed as "enemy"
- Streambank and shoreline erosion
- Ability of watershed to absorb or carry away excess water
- Dredging Burns Ditch and Lake George
- Dredging impacts on shoreline erosion
- Dams

Drainage improvement projects have altered the area to such an extent that land that once drained to Lake Michigan now empty into the Gulf of Mexico. Figure 16, which was provided by Steve Davis with the DNR's Division of Water, 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.

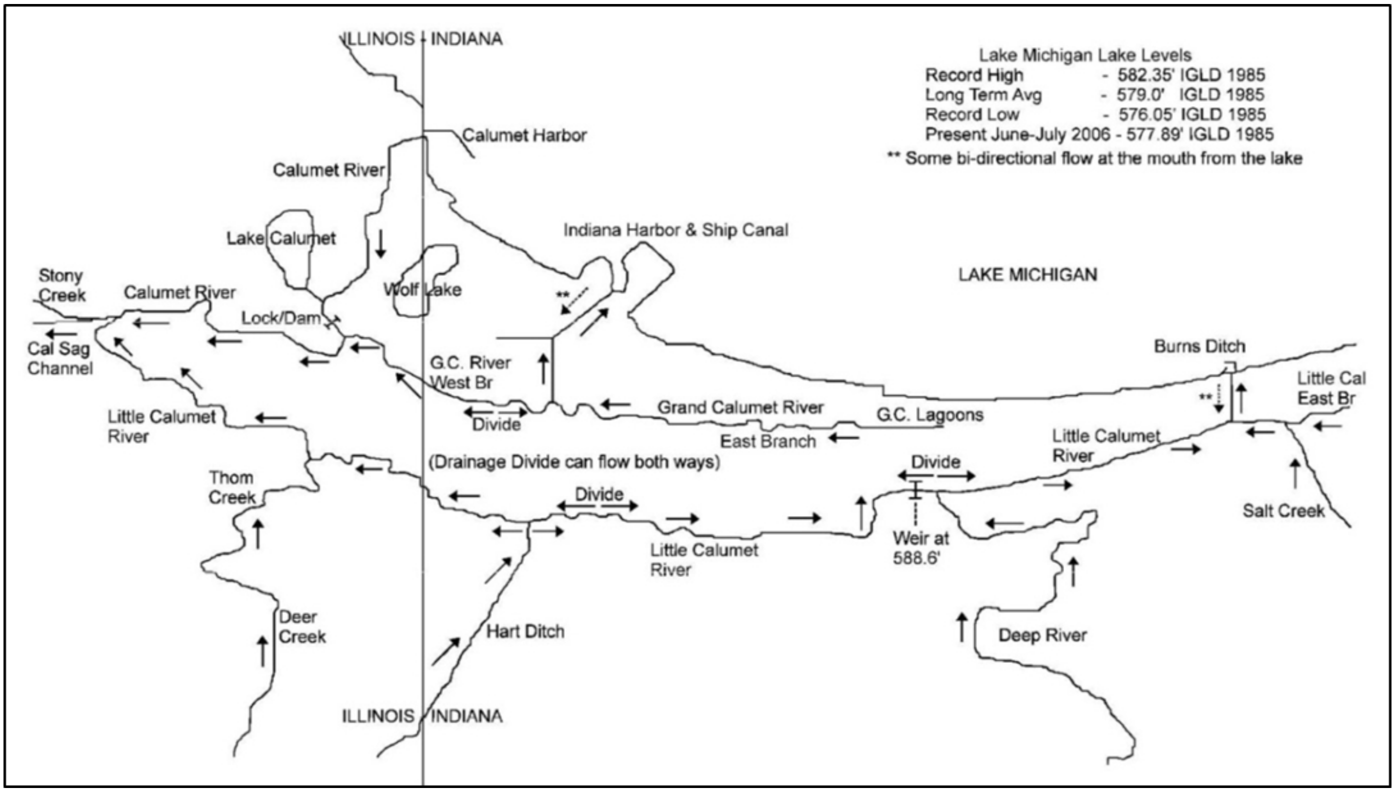


Figure 16 Stream Flow Directions

2.5.1 Surface Waterbody Features

2.5.1.1 *Streams*

Today, nearly 290 miles of stream and manmade ditch drain the landscape of the Deep River-Portage Burns Waterway watershed (Figure 17). Some of the major tributaries within the watershed include the West Branch Little Calumet River, Deep River, Turkey Creek, and Main Beaver Dam Ditch. Tributaries feeding into Deep River include Main Beaver Dam Ditch, Deer Creek, Duck Creek, and Turkey Creek. Deep River joins the West Branch Little Calumet River 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. Main Beaver Dam Ditch joins Deep River near Interstate 65 in Crown Point.

2.5.1.1.1 Special Designation Streams

Nearly 22 miles of Deep River is included on the “Outstanding Rivers List for Indiana” by the Natural Resources Commission, from one mile south of U.S. 30 to the Little Calumet River (Figure 17). Rivers and streams included on this list are considered to have a particular environmental, recreational, or aesthetic interest. The Burns Waterway is designated as a salmonid (trout and salmon) stream by the Indiana Department of Natural Resources. This man-made channel, measuring slightly more than 1 mile in length, cuts through the dunes connecting the East and West Branches of the Little Calumet River to Lake Michigan (Figure 17). No other stream segments within the watershed are designated salmonid streams or have the additional protections afforded to them under the state water quality standards (327 IAC 2-1.5). Natural water temperatures are generally not conducive of supporting put-and-take trout and salmon fishing in the Deep River-Portage Burns Waterway watershed like in the Little River East Branch watershed.

However, trout and salmon are known to stray/migrate up Willow Creek, the West Branch Little Calumet River, and Deep River as far upstream as the Lake George dam, shown as dam 45-2 in Figure 17, in Hobart when streamflow allows. Under typical conditions the Deep River dam in Lake Station, shown as dam 45-1, is a barrier to upstream fish migration.

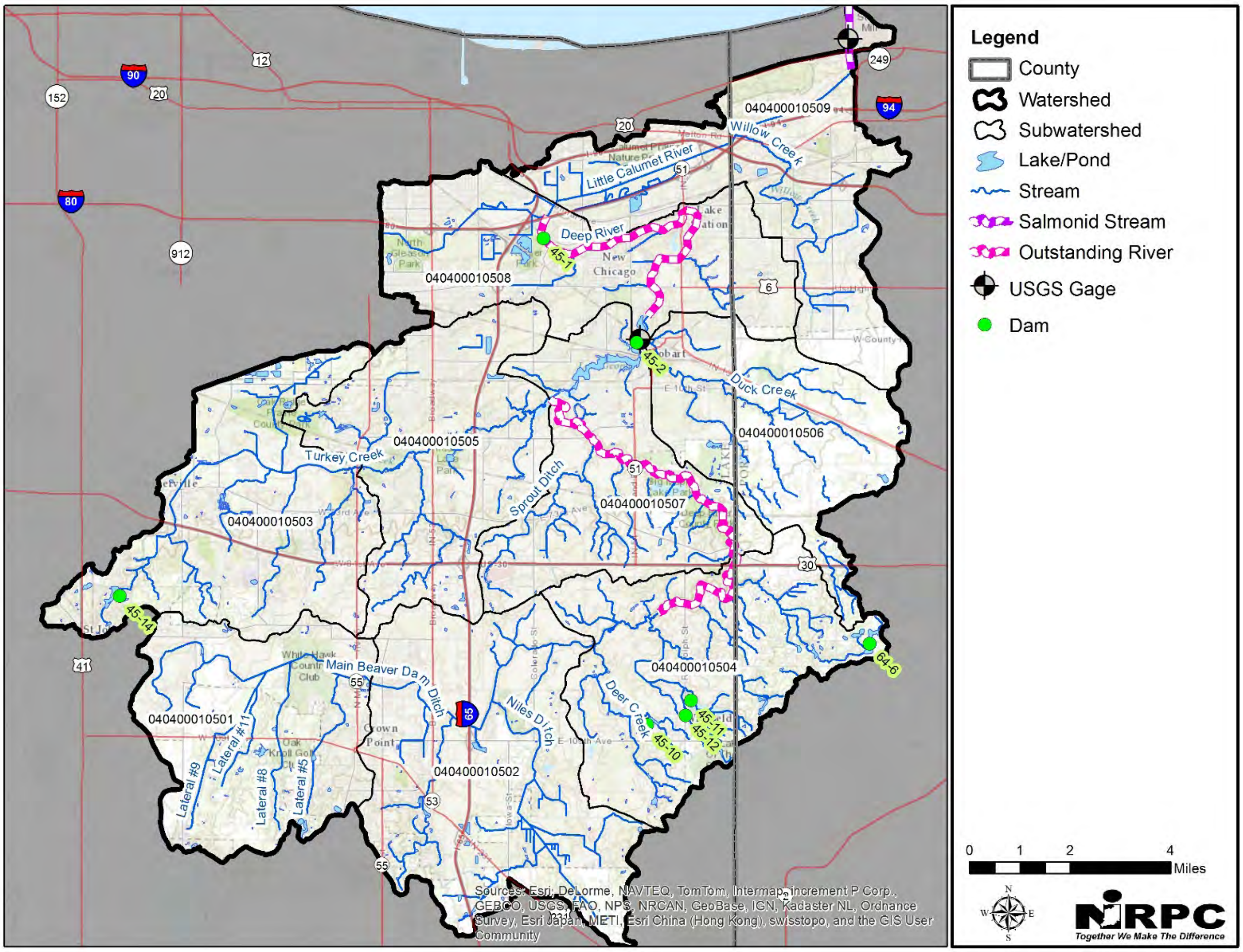


Figure 17 Surface Waterbody Features

2.5.1.1.2 Stream Flow Data

Flooding, stream geomorphology, and aquatic life are all influenced by stream flow. Additionally stream flow and surface runoff from precipitation events (See Section 2.2 for discussion on precipitation) drive the generation, transport, and delivery of many nonpoint source pollutants. Stream flow is simply the continuous movement of water in stream channels. It is often quantified as discharge which is defined as the volume of water that passes through a channel cross section in a specific time period.

The U.S. Geological Survey maintains and operates a stream gaging station (ID # 04093000) on Deep River at the outlet of Lake George in Hobart (Figure 17). Nearly 124 mi^2 (69%) of the watershed's land area drains through this point on Deep River.

The annual mean flow for Deep River at the Lake George outlet is 122 CFS. The highest annual mean was 233 CFS in 1993 and the lowest was 35 CFS in 1963. Monthly mean flow data for water years 1948-2014 is shown in Figure 18. The highest mean monthly flows occur during March and April. Mean monthly flows drop by nearly half in July and sustain those levels to nearly November.

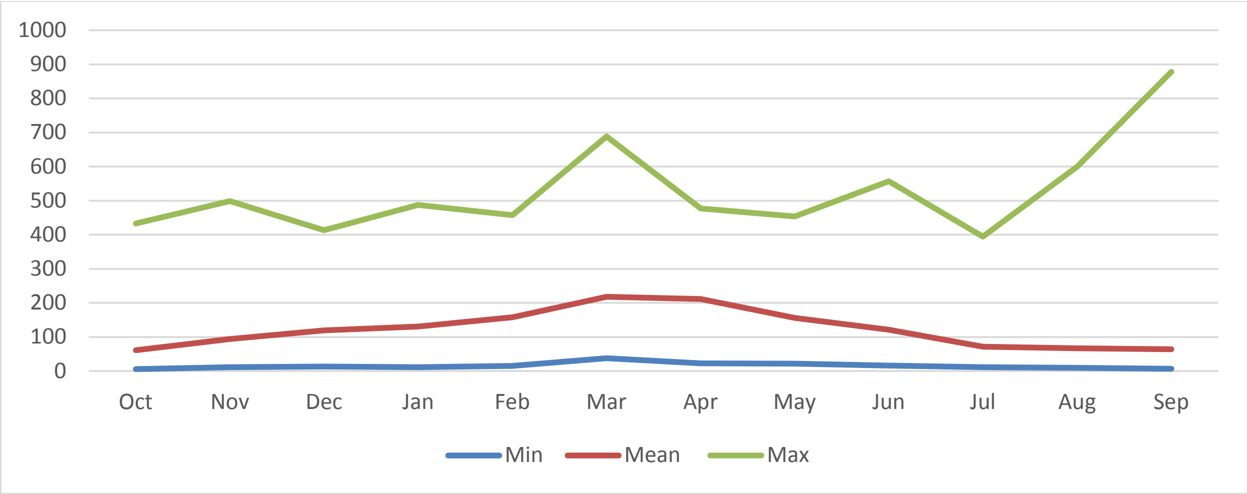


Figure 18 Monthly mean flow data for Deep River gage at Deep River Lake George Outlet Gaging Station

A flow-duration curve is a plot that shows the percentage of time that stream flow is likely to equal or exceed a specified value of interest. This type of information can be useful for the design of structures on a stream. The curve may also be used to evaluate the characteristics of a watershed. A flow-duration curve with a steep slope throughout denotes a highly variable stream whose flow is largely from direct runoff, whereas a curve with a flat slope reveals the presence of surface or groundwater storage, which tends to equalize the flow. The slope of the lower end of the flow-duration curve shows the characteristics of the perennial storage in the watershed; a flat slope at the lower end indicates a large amount of storage; and a steep slope indicates a negligible amount. Streams with large floodplain storage or those that drain wetland areas tend to have a flat slope at the upper end.

Figure 19 shows two flow-duration curves for comparison. The one on the left if for Deep River at Lake George. The one on the right is for the Galena River near LaPorte. Both are part of the Little Calumet-Galien sub-basin in Northwest Indiana. The Galena River has much less human land cover (development and agriculture) and a high percentage of forest and wetland. Deep River's curve is slightly steeper indicating higher streamflow variability from runoff while the Galena River's is flatter indicating the watershed has greater storage. The curve also indicates that during low-flow conditions, Deep River becomes stagnant with minimal flow.

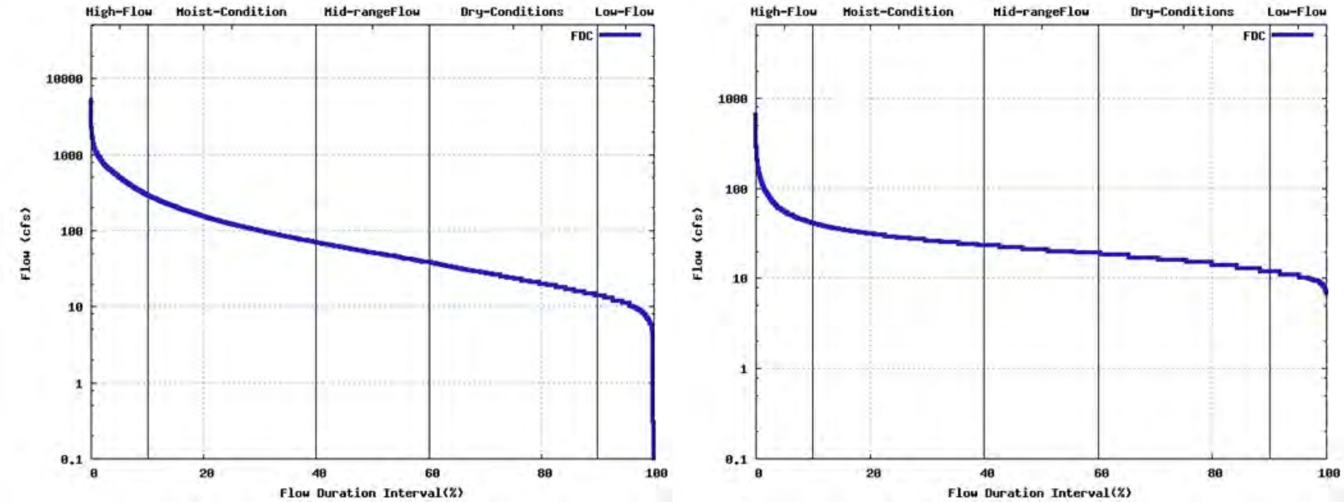


Figure 19 Flow duration-curve comparison between Deep and Galena River.

Figure 20 compares annual peak stream flow at this station with annual total precipitation. The figure indicates increasing trends for annual peak discharge and precipitation. However, annual peak discharge is increasing at a much higher rate (57%) than annual total precipitation (11%) over this time period. Peak flow 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.

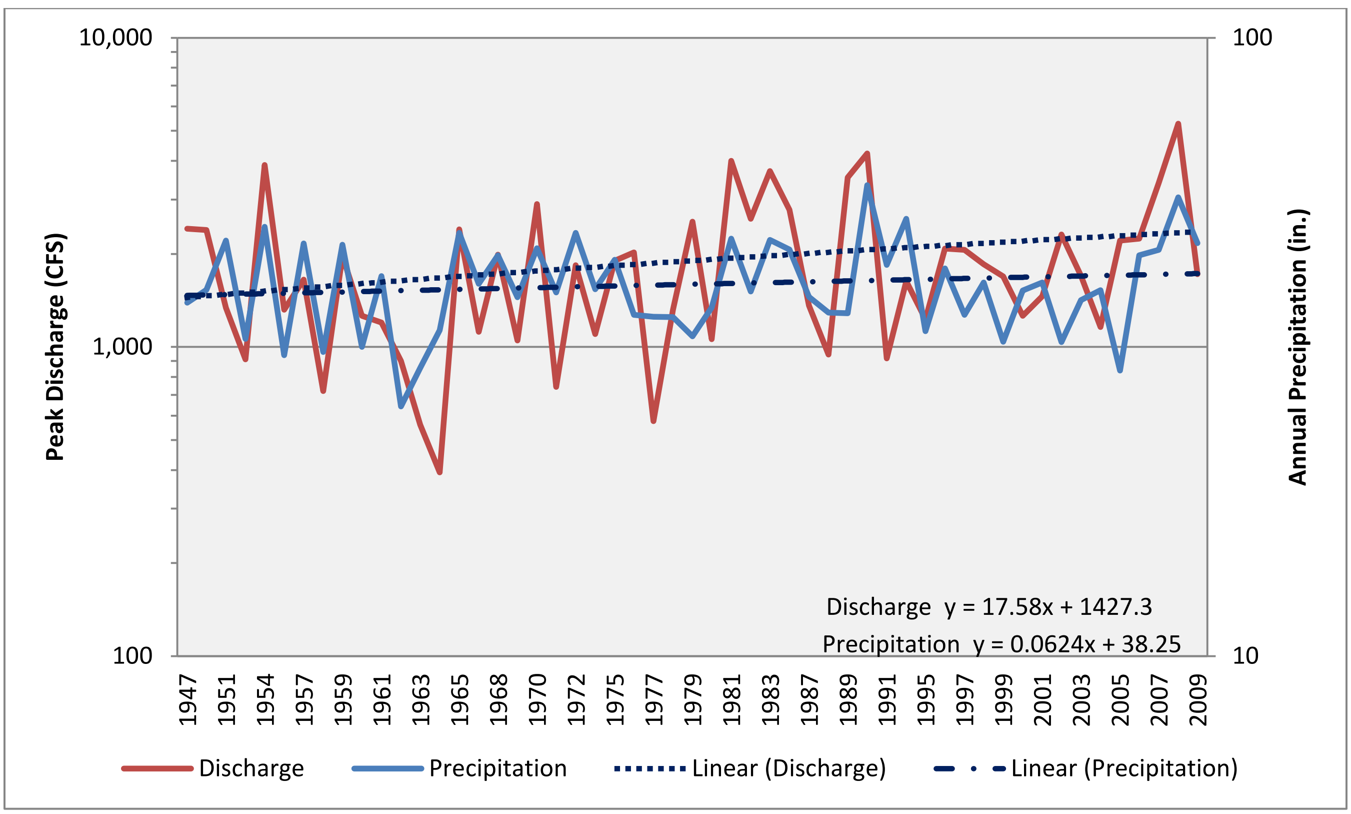


Figure 20 Trend Data for Annual Peak Discharge & Precipitation at Deep River Lake George Outlet Gaging Station

2.5.1.2 *Floodplains*

Floodplains play an important role in the health and function of streams. Development and alteration of floodplains can eliminate or degrade the beneficial services they provide. Table 11, adapted from the Ohio DNR Division of Soil & Water Resources, outlines some of these services.

Water Resources	
Natural Flood & Erosion Control	*Water Quality Maintenance*
• 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 11 Natural and Cultural Benefits of Floodplains

Floodplain (or more accurately, flood hazard) locations in the watershed are shown in Figure 21. 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. Channelization is the primary impact that has directly disconnected streams from their adjacent floodplains (Harman et al, 2012).

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 storage during floods (Indiana Department of Natural Resources, 1994).

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 DNR, 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 DNR.

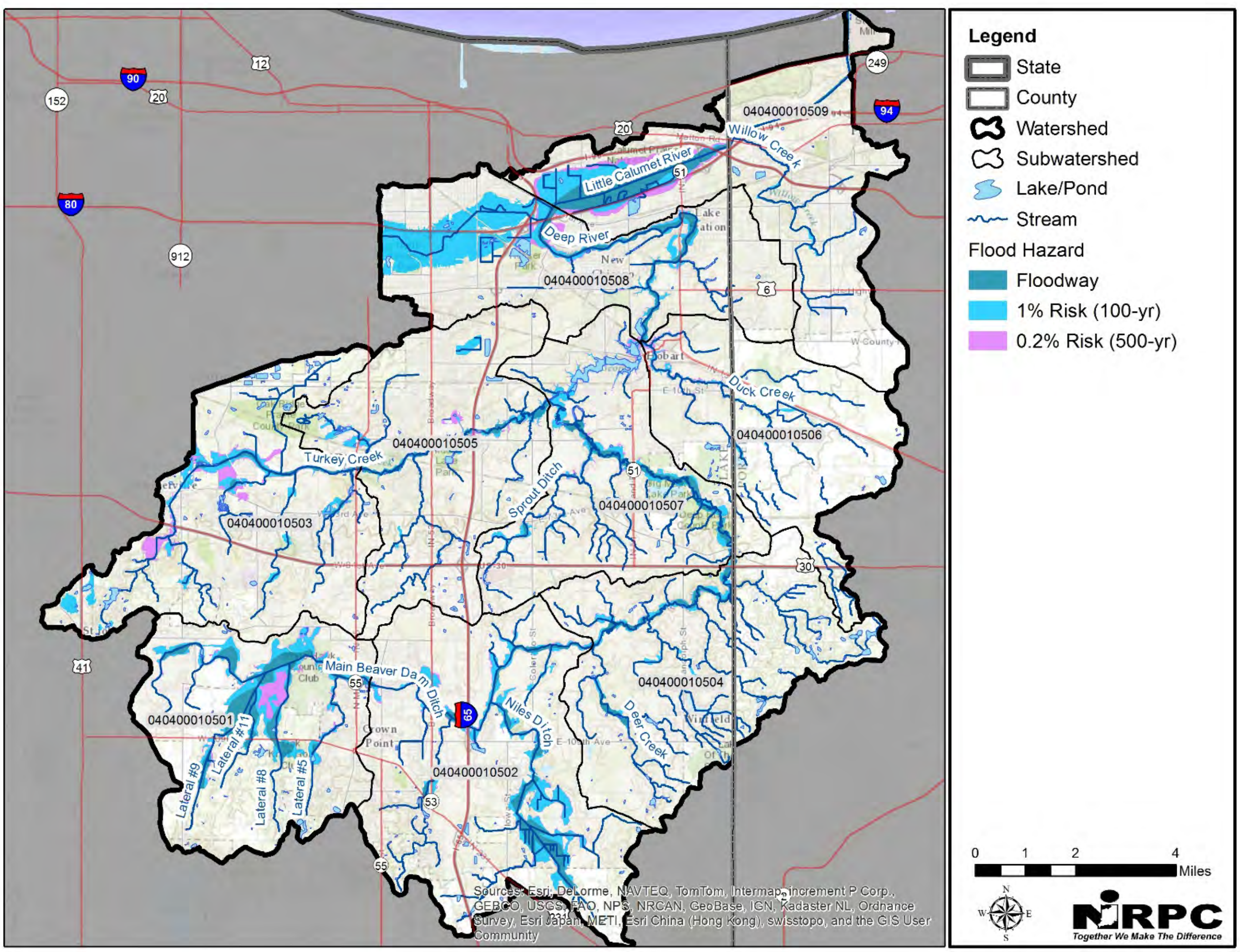


Figure 21 Floodplains (Flood Hazard)

Flooding

Flooding is defined differently by different disciplines. For example, the geomorphologist defines flooding as the flow that leaves the channel and spreads onto a floodplain that was built by a meandering river, sometimes called a geomorphic floodplain. A traditional water resources engineer might define flooding as the flow that would impact personal property, such as a home. In both cases, flood frequency can be used to predict the probability that a flow will reach a certain elevation (active floodplain or house) within a given timeframe. The geomorphologist typically associates the flood frequency of the active floodplain as the discharge with a 1.5-year return interval (on average). The water resources engineer typically delineates floodplains by the elevation of the 100-year return interval discharge. The 1.5-year return interval and the ability of the river to access this floodplain is extremely important for channel formation and maintenance. This is important to understand later on in the watershed plan when floodplain connectivity is further discussed.

2.5.1.3 *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 averaging 2.3 acres in size. 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 are 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. While Lake George no longer serves as a water supply or is used to power a mill, the gristmill burned down in 1953, the lake remains as a community focal point in downtown Hobart as a center for recreation and businesses.

2.5.1.4 *Wetlands*

Wetlands are an important feature in the landscape providing beneficial services for people, fish and wildlife. They function as natural sponges that trap, filter, and slowly release rain, snowmelt, groundwater and flood waters. Additionally many breeding bird populations including ducks and wading birds feed, nest, and raise their young in wetlands. Within our watershed, 214 state endangered, threatened or rare (ETR) species observations have been documented in or directly adjacent to wetland habitats. A discussion on ETR species and the natural communities types in which they occur is included in Section 2.8

Today, approximately 9,247 acres of wetland exist within our watershed (Table 12) accounting for 8% of its drainage area. Historically, there would have been nearly 37,354 acres of wetland covering 32% of the watershed's drainage area based on the hydrologic soils data presented earlier. Contiguous tracts of wetland exist along stream corridors such as Deep River, the Little Calumet River, and Main Beaver Dam Ditch (Figure 22). Subwatershed percent wetland area ranges from 4.7-10.3%.

Name	HUC-12	Emergent (ac)	Forested/ Shrub (ac)	Lake (ac)	Pond (ac)	Riverine (ac)	Total	% Wetland
Headwaters Main Beaver Dam Ditch	040400010501	547	363	23	213	0	1,146	9.8
Main Beaver Dam Ditch- Deep River	040400010502	516	134	0	146	0	797	4.7
Headwaters Turkey Creek	040400010503	438	396	56	299	0	1,189	8.7
Deer Creek- Deep River	040400010504	293	438	55	237	0	1,024	7.4
City of Merrillville- Turkey Creek	040400010505	296	463	67	182	8	1,016	8.1
Duck Creek	040400010506	183	262	0	74	0	520	5.1
Lake George- Deep River	040400010507	188	570	218	108	3	1,086	9.8
Little Calumet River- Deep River	040400010508	446	470	88	138	104	1,246	10.3
Willow Creek- Burns Ditch	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 12 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 13). The average forested/shrub wetland size is 8.4 acres while the average 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 (ac)	Mean (ac)
Emergent	848	<0.1	76.3	3,377.1	4.0
Forested/ Shrub	448	0.2	157.7	3,752.4	8.4
Lake	11	20.4	262.2	562.3	51.1
Pond	824	<0.1	20.7	1,456.0	1.8
Riverine	12	0.2	133.2	243.1	20.3

Table 13 Watershed Wetland Type Statistics

In a 1998 Wisconsin Department of Natural Resources publication on small wetlands and cumulative impacts of small wetland losses, the authors documented that watersheds with less than 10% wetland coverage had higher suspended solid loading per unit area and higher peak flows following storms and lower base flows between rains. This 10% threshold has already been surpassed for our watershed.

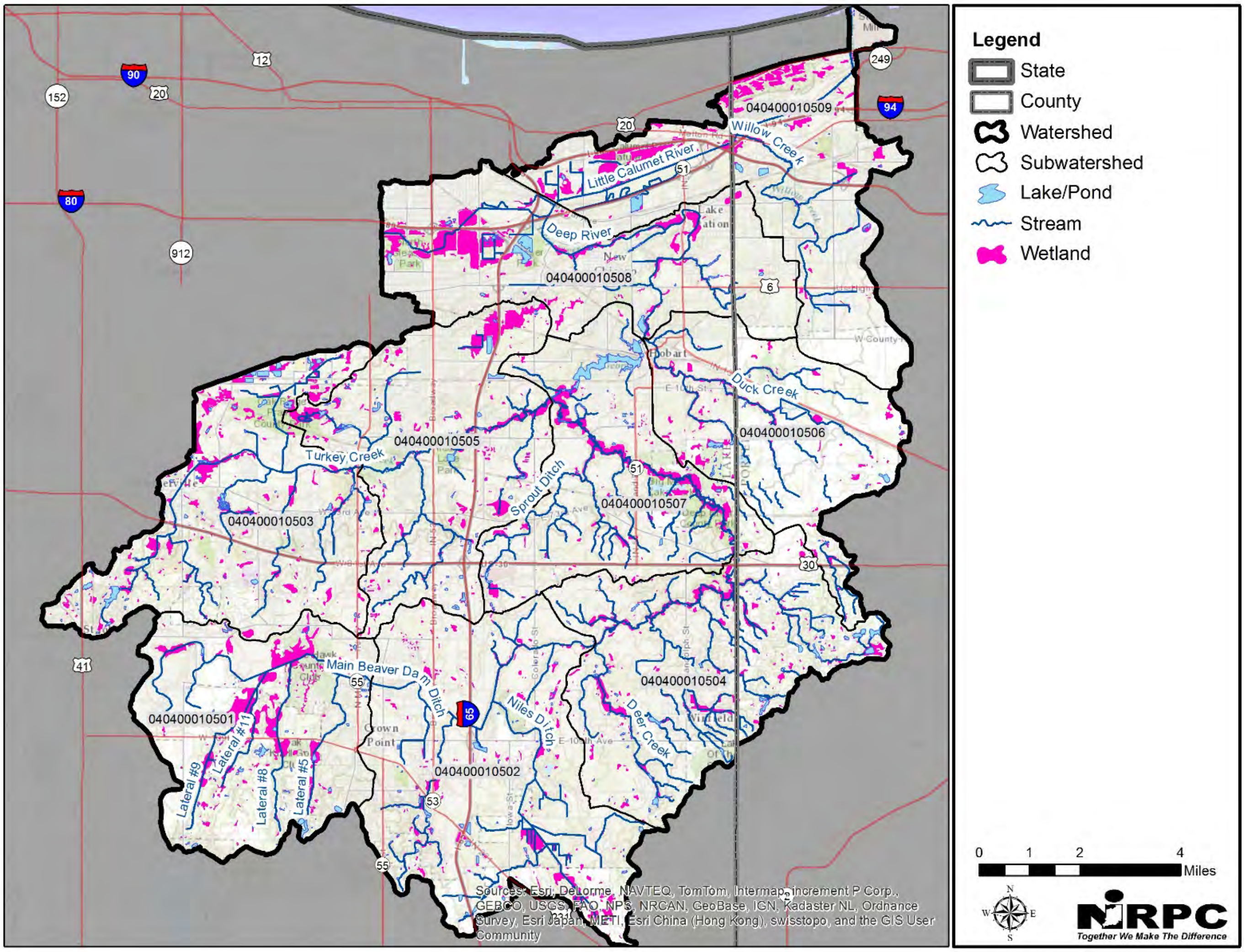


Figure 22 Wetlands

2.5.2 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 U.S. Environmental Protection Agency, 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 streambank and shoreline 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 dam's 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 in-stream and riparian habitats
- Impede or block fish migration routes
- Alter water temperature and chemistry

2.5.2.1 *Channelization & Channel Modification*

Throughout much of the watershed, streams have been modified or ditches excavated to enhance surface and subsurface drainage. These modifications generally involved lowering of the streambed or excavating channels through wetland sloughs to provide freeboard for subsurface drainage systems and enlargement of channels to increase downstream conveyance capacity.

As a general observation, areas that could be effectively drained by ditching to support cultivated crops when the area was being settled were. However, the true extent of past channelization and channel modification activities within the watershed is currently unknown. The most readily available data that provides at least some insight to the prevalence of ditching comes from county GIS data showing waterways maintained as "regulated drains" (Figure 23). However, it must be pointed out that more ditches exist beyond what is shown in this figure. Aerial imagery clearly shows waterways that were either channelized or excavated to improve drainage beyond reaches maintained as regulated drains. That being said, there are approximately 112 miles of regulated drain within the watershed. This alone equates to nearly 40% of the stream miles in the watershed.

Deep River and portions of Turkey Creek and Duck Creek near Deep River, appear to have avoided this outcome because of their location in floodplain valleys. These floodplain valleys are evident when viewing a hillshade representation of elevation data in GIS. Also streams within the eastern half of the Deer Creek subwatershed (HUC 040400010504) do not appear to have been altered to the extent of other streams in the watershed most likely due to greater topographic relief and subsequent soil conditions in this area.

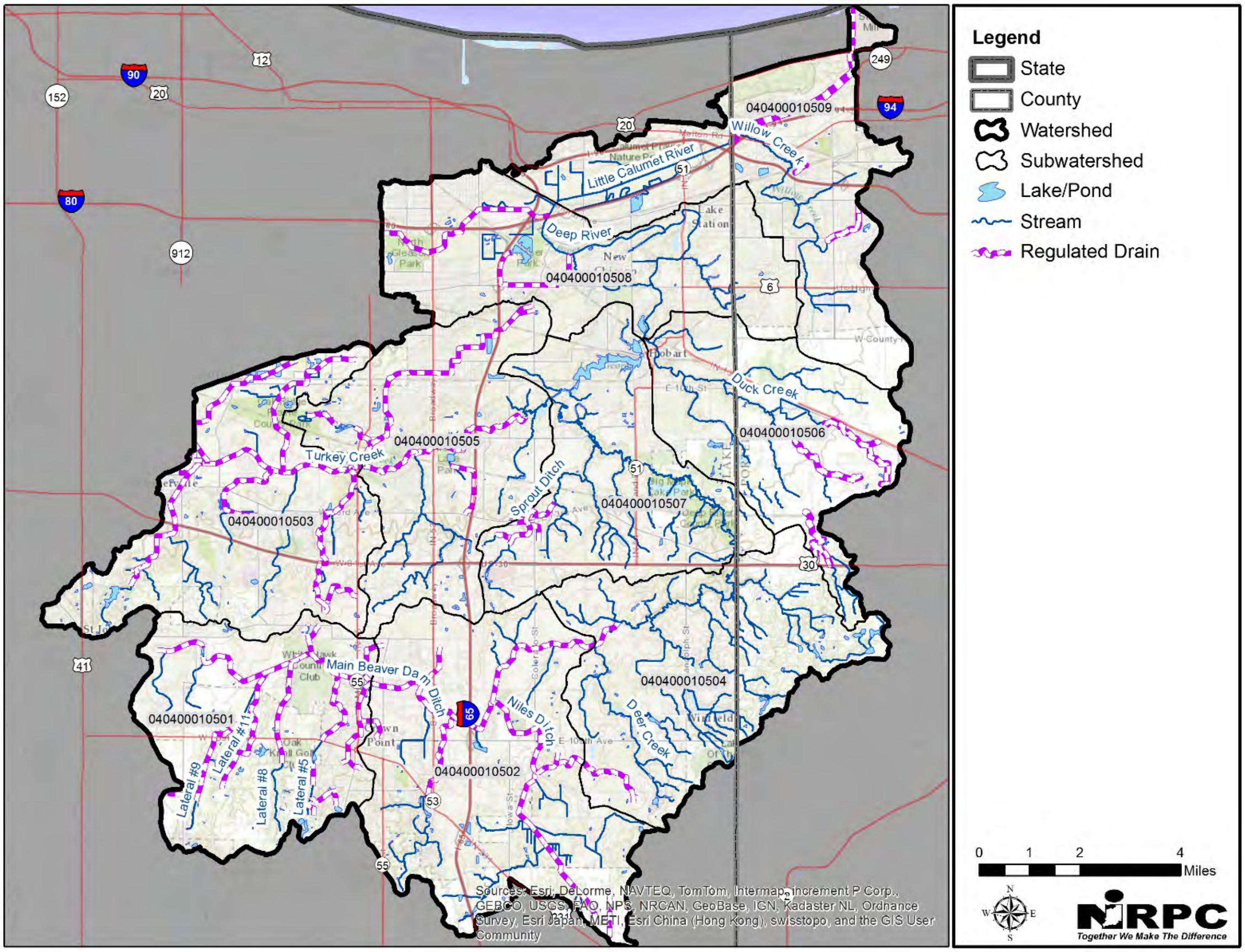


Figure 23 County Regulated Drains

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.

2.5.2.2 *Dams*

Dams are another common type of hydromodification found within 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. Additionally, 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 7 dams located within the watershed (Figure 17). General location, drainage area, associated lake surface area, and storage information is included in Table 14. Lakes with large drainage areas and small surface areas, such as Lake George, tend to be prone to nonpoint source pollution impacts.

Name	State ID	County	Drainage Area (mi^2)	Drainage Area (ac.)	Lake Surface Area (ac.)	DA:LSA	Max Storage (ac.-ft.)	Height (ft.)
Doubletree Lake Estates Dam (North)	45-11	Lake	1	640	90	7:1	NA	NA
Doubletree Lake Estates Dam (West)	45-12	Lake	NA	NA	90	NA	270	6
Deep River Dam (Lake Station)	45-1	Lake	141	89,600	NA	NA	0	14
Hooseline & Molchan Lake Dam	45-10	Lake	0.65	416	14	30:1	147	21
Lake George Dam	45-2	Lake	124	79,360	242	328:1	3,450	22
Lake Hills Dam	45-14	Lake	1.33	851	34	25:1	NA	12
Norman Olson Lake Dam	64-6	Porter	0.23	147	14	11:1	172	18

Table 14 Dams

In 1995 the U.S. Army Corps of Engineers (USACE), Chicago District, published a report investigating the feasibility of dredging Lake George. 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. The City of Hobart is once again considering dredging portions of Lake George because of sediment build up.

Another dam of particular interest in the watershed is the Deep River Dam (State ID # 45-1). It is located in Lake Station approximately 1/3 mile downstream from where Deep River joins the West Branch of the Little Calumet River (Figure 25) and is shown in Figure 24. The dam structure consists of a sheet pile wall crossing the channel with remnants of a rock-filled wooden crib structure. Crushed rock has been placed immediately downstream of the sheet pile wall in an effort to stabilize the channel and prevent erosion. The dam impounds approximately 10 feet of hydraulic head during normal river stage conditions. According to the Deep River Flood Risk Management Plan (Section 2.7.12), the dam controls the normal water level of Deep River up to 37th Avenue, a distance of nearly 6 miles. Due to the deteriorated physical nature of the dam, if a complete failure were to occur, it would likely be due to washout at the abutment ends or seep through the sheet pile wall.

Figure 24 Deep River Dam

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 whose property is adjacent to the dam. 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.

In 2013 the U.S. Army Corps of Engineers completed a Federal Interest Determination study to provide initial insight of the restoration of Deep River and adjacent riparian zone at this site. The study states that the existing structure inhibits fluvial functions that would support riverine fish species and other organisms and also physically prevents fish from migrating to upstream reaches. Upstream of the dam, Deep River resembles more of a lake system, devoid of critical fluvial hydraulics that support riverine specific organisms. The dam also prevents the downstream transport of fluvial materials such as silt, sand, gravel and cobbles, which is causing the stream to incise below the dam. This channel incision causes the resulting steep banks to fall or cave in, which has prompted the placement of broken concrete blocks or chunks to act as rip-rap in an attempt to armor the banks against further slumping. This technique, however, does not work for channel incision and is destined to fail.

Based on the results of the Federal Interest Determination study, the U.S. Army Corps of Engineers found that a viable and implementable restoration plan could be developed. The next steps with Section 506-Great Lakes Fishery and Ecosystem Restoration funding would include the development of a Project Management Plan, the initiation of a Detailed Project Report and a Feasibility Cost Sharing Agreement at a cost of approximately $150k. However, to date, there is a shortfall in local match ($60-87k) to proceed further.

The Indiana Department of Environmental Management monitored upstream and downstream (Sites 5 & 6) of the dam as part of the watershed baseline assessment and TMDL study as documented in Section 3.3. The strategy behind this was to: 1) help identify what potential water quality and aquatic life impacts the dam was having on this reach of Deep River; and 2) evaluate the impacts of any future restoration activity associated with the dams modification or removal.

The City of Lake Station has shown interest in acquiring the former Riverside Mobile Home Park parcel which is located on the opposite streambank of the Education Center. The trailer park had flooded several times in recent years including the severe September 2008 flood. The trailers have been since been removed, however a large amount of debris still remains. A significant opportunity exists to restore hydrology, habitat, and fish migration within this reach of Deep River by removing the dam.

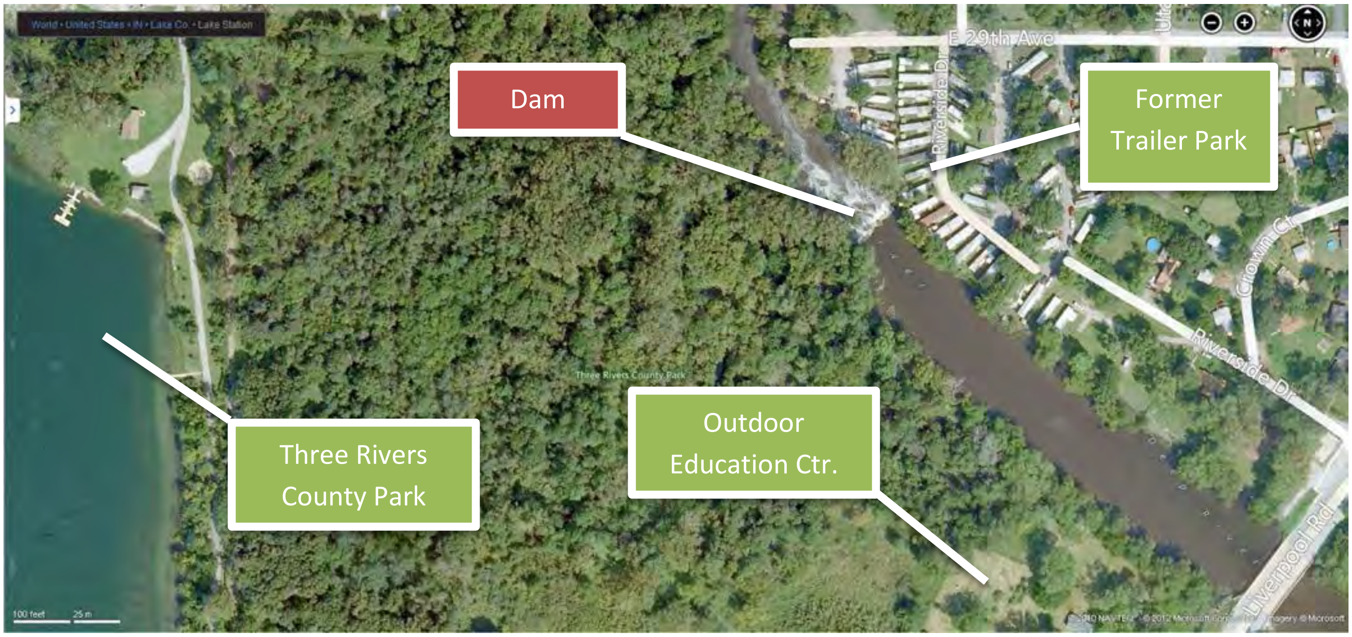


Figure 25 Hobart Deep River Dam Location

2.5.2.3 *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 return frequency 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.

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.

2.5.2.4 *Tile Drainage*

Tile drainage (subsurface drainage) is a common practice for row crop production on agricultural lands where poorly drained soils exist. Many agricultural drainage systems include drain tiles placed strategically throughout a field to create a network of gravity fed drains. The drain tiles empty into a collection pipe that drains to a nearby waterbody. With the drain system in place and operating, water will leave the affected area quicker and at one or more focused points. Water from the drainage system can increase streambank erosion, contribute to stream flashiness, and increase the nutrient, sediment, and pesticide pollutant loading.

The exact location and extent of tile drainage in the watershed is unknown which is not all that uncommon. Purdue University Hydrologic Impacts Group has used a combination of agricultural land cover, soils drainage class, and soil slope data to identify potentially tile drained areas (www.agry.purdue.edu/hydrology/projects/indiana.asp). The same approach was used to identify potentially tile drained areas for the Deep River-Portage Burns Waterway watershed. See Section 2.10.5 for further discussion about cultivated land on poorly drained soils.

2.5.3 Water-Based Recreational Opportunities

The lakes and streams of the watershed provide many recreational opportunities including boating, fishing, swimming and nature watching for residents and visitors alike. A review of recreational facility information maintained by the DNR shows approximately 30 facilities have a lake, pond or stream on site. These facilities include parks, fish & wildlife areas, nature preserves, marinas, and golf courses.

A few of the popular public access sites/areas in the watershed include Deep River and Oak Ridge Prairie County Parks, Fred Rose and Jerry Pavese Park located on Lake George in Hobart, Riverview Park located on Deep River in Lake Station, and Portage Lakefront and Riverwalk located along Burns Waterway and Lake Michigan. Portage Lakefront and Riverwalk is a former brownfield reclamation site owned by the Indiana Dunes National Lakeshore and operated by the City of Portage.

In addition to these facilities, there is a growing effort to establish a water trail along Deep River from Lake George to Lake Michigan which would greatly expand water-based recreational opportunities within the watershed. The City of Hobart is currently installing a launch ramp for canoes and kayaks on Lake George and below the Lake George dam on Deep River.

Site ID	Site	Owner
1	Lake County Fairgrounds	Lake County Board of Commissioners
2	Beaver Dam Wetland Conservation Area	IDNR Division of Fish & Wildlife
3	Three Rivers County Park	Lake County Parks Department
4	Oak Ridge Prairie County Park	Lake County Parks Department
5	Griffith Izaak Walton League	Izaak Walton League
6	Gone Fishing Private Fishing Lake	Private
7	Deep River County Park	Lake County Parks Department
8	John Robinson Lake Park	Hobart Parks Department
9	Hobart Marsh	IDNR Division of Nature Preserves
10	Lakeshore Park	Hobart Parks Department
11	Jerry Pavese Park	Hobart Parks Department
12	Festival Park & Lakefront Park	Hobart Parks Department
13	Riverfront Park	Hobart Parks Department
14	Rosser Park	Hobart Township Trustee
15	Johnson Park	Lake Station Parks Department
16	Riverview Park	Lake Station Parks Department
17	Independence Park/Bicentennial Park	Lake Station Parks Department
18	Grand Boulevard Lake Recreation Area	Lake Station Parks Department
19	Broadmoor Country Club	Private
20	Independence Park	Ross Township Trustee
21	Innsbrook Country Club	Private
22	Hidden Lake Park	Ross Township Trustee
23	Turkey Creek Golf Course	Lake County Parks Department
24	Twin Oaks Park	New Chicago Parks Board
25	Lefty's Coho Landing	Private
26	Countryside Park	Portage Parks Board
27	Arthur H. Olson Memorial Park	Portage Parks Board
28	Yogi Bear Jellystone Campground	Private
29	Louis Estates Park	St. John Park Board
30	Lake Hills Park	St. John Park Board

Table 15 Recreational facilities with access to water

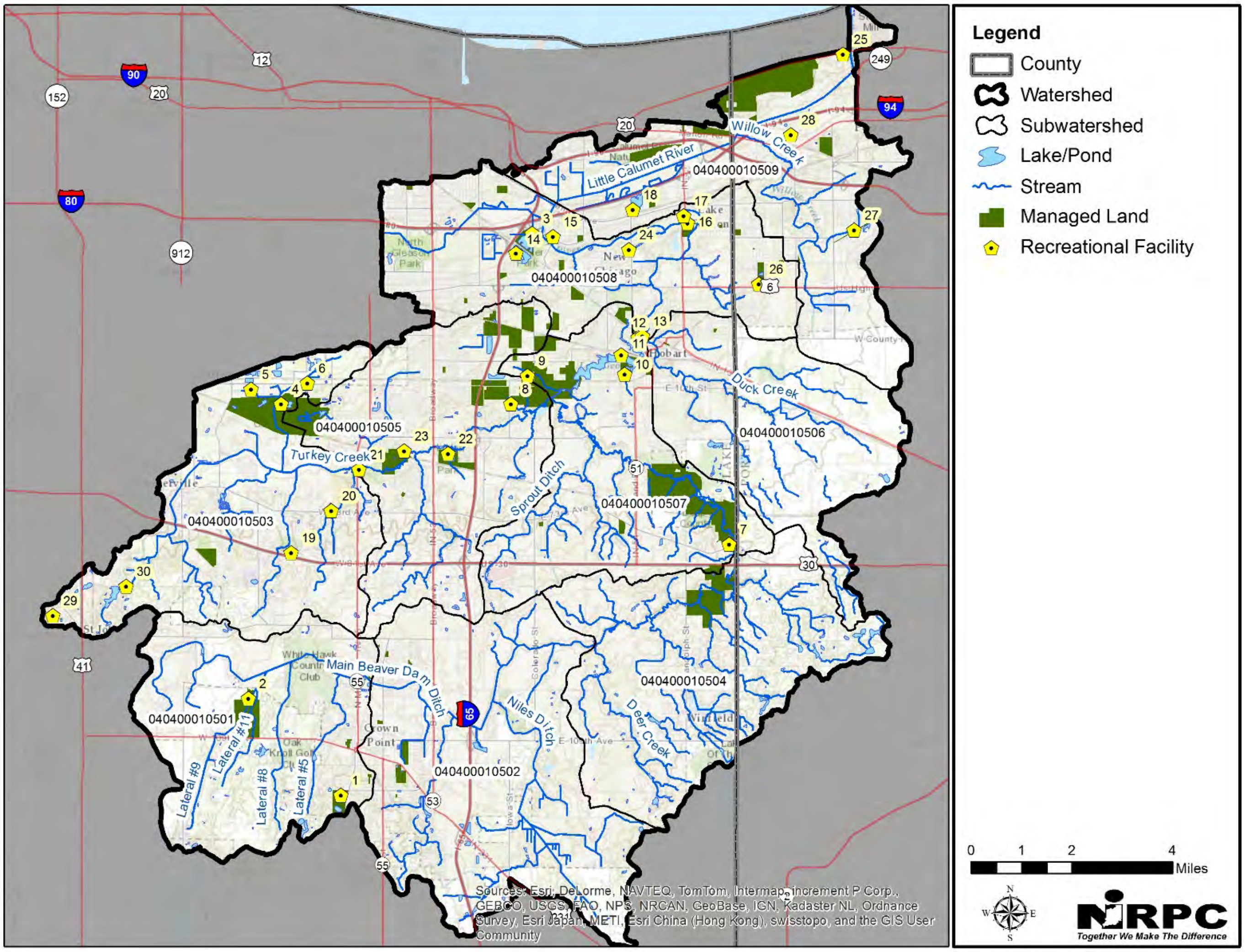


Figure 26 Recreational facilities with access to water

2.5.4 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(s), the waterbody may be removed from the 303d list and placed under Category 4 on the consolidated list. Being placed under Category 4 in this case simply means that the waterbody is still impaired or threatened but a TMDL has been completed. An E. coli and Impaired Biotic Communities TMDL was approved for the watershed on September 26, 2014. See Section 2.7.1 for further information on the TMDL.

There are 30 stream segments within our watershed that will be included by IDEM on the draft 2016 303d List under Category 4A. The types and locations of these impairments are presented in Figure 27 and Table

16. The impairments identified include high *E. coli* levels, low dissolved oxygen (DO) concentrations, high levels of nutrients and siltation, and impaired biotic communities (IBC).

Approximately 210 miles of stream will be listed for *E. coli*, 97 miles for dissolved oxygen, 61 miles for nutrients, 12 miles for siltation and 225 miles for impaired biotic communities. Thirty four miles of stream are listed for PCB's in fish tissue. Approximately 223 miles of stream are listed for multiple impairments (example Willow Creek- *E. coli* and IBC). The most common impairment by far is for biotic communities.

Biological impairments differ from some traditional water quality impairments, such as *E. coli*, in that the impaired biotic communities (fish and macroinvertebrates) 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 sometimes not considered conventional pollutants within our water quality rules (ex. altered flow regimes).

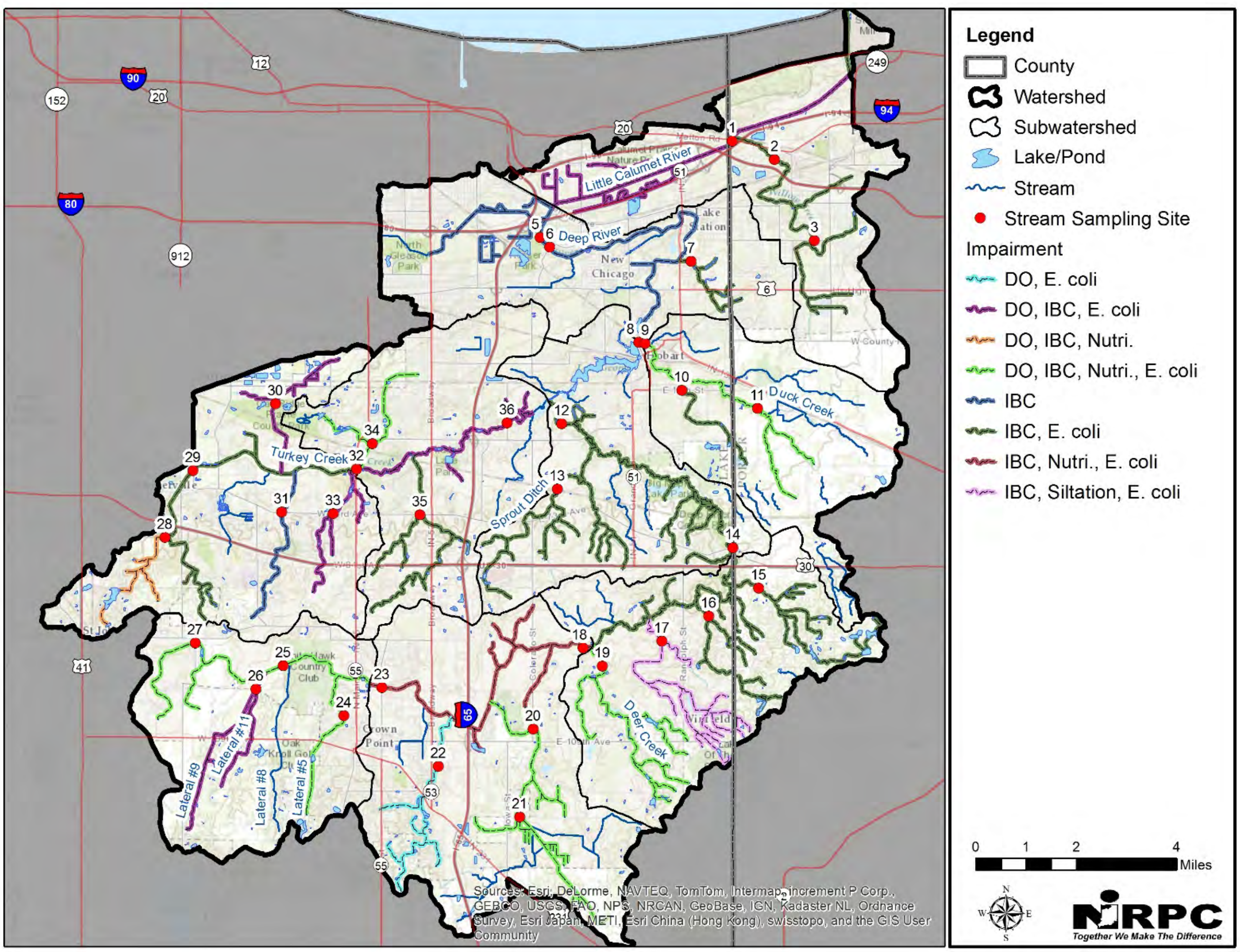


Figure 27 Impaired Waterbodies

Subwatershed (12-digit HUC)	AUID	2012Section 303(d) Listed Impairment	Updated Impairments to be Listed on 4A in 2016
Headwaters of Main Beaver Dam Ditch (040400010501)	INC0151_01	IBC	DO, *E. coli,* Nutrients, IBC
	INC0151_T1001		DO, *E. coli,* IBC
	INC0151_T1003		DO, *E. coli,* Nutrients, IBC
Main Beaver Dam Ditch (040400010502)	INC0152_04	IBC	*E. coli,* Nutrients, IBC
	INC0152_T1008		DO, *E. coli,*
	INC0152_T1009	IBC	DO, *E. coli,* Nutrients, IBC
Headwaters of Turkey Creek (040400010503)	INC0153_01	IBC, *E.coli*	IBC, *E.coli*
	INC0153_T1001		DO, IBC, Nutrients
	INC0153_T1003		DO, *E. coli,* IBC
	INC0153_T1004		IBC
	INC0153_T1005		DO, *E. coli,* IBC
Deer Creek (040400010504)	INC0154_01	IBC, *E.coli*	IBC, *E.coli*
	INC0154_T1001	*E.coli*	DO, *E. coli,* Nutrients, IBC
	INC0154_T1003	IBC, Siltation	IBC, *E.coli,* Siltation
	INC0154_T1004		IBC, *E.coli*
	INC0154_T1005		IBC, *E.coli*
City of Merrillville (040400010505)	INC0155_01	*E.coli*	DO, IBC, *E.coli*
	INC0155_T1002		IBC, *E.coli*
	INC0155_T1003		DO, *E. coli,* Nutrients, IBC
Duck Creek (040400010506)	INC0156_01		DO, *E. coli,* Nutrients, IBC
	INC0156_T1003		IBC, *E.coli*
Lake George (040400010507)	INC0157_01		IBC, *E.coli*
	INC0157_P1001		IBC, DO, *E.coli*
	INC0157_T1002		IBC, *E.coli*
Little Calumet River (040400010508)	INC0158_01	IBC, cyanide	IBC
	INC0158_T1002		IBC, *E.coli*
	INC0158_T1005	IBC, PCB Fish	IBC
Willow Creek (040400010509)	INC0159_01	DO, PCB Fish	DO, IBC, *E.coli*
	INC0159_02	IBC, *E.coli,* PCB Fish	IBC, *E.coli*
	INC0159_T1001	IBC, *E.coli,* PCB Fish	IBC, *E.coli*

Table 16 Impaired Waterbodies

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 types such as forest, wetland, and grassland 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.

Stakeholder Concerns Related to Land Use:

- **Riparian area and floodplain encroachment**
- **Habitat loss to development**
- **Coordination amongst municipalities, businesses, and residents**
- **Development standards protective of watershed**
- **Uncontrolled development in unincorporated areas**
- **Enforcement of existing regulations to protect stream health**
- **Lack of retention/ detention pond maintenance**
- **Reconciling need for drainage/ flood control with water quality and habitat**
- **Storm water storage**
- **Ability of watershed to clean water by removing pollutants and provide habitat (green infrastructure)**
- **Impervious surface area**
- **Construction site runoff**
- **Parking lot runoff**
- **Combined sewer overflows (CSOs)**
- **Failing septic systems**
- **Erosion and sedimentation**
- **Excess nutrients**
- **Chemicals in runoff**
- **Loss of cropland to development**
- **Some absentee landowners seem to be land speculators and lack interest in investing in BMPs to protect water quality**
- **Reconciling need for drainage with water quality and habitat**
- **Soil health**

What is the difference between land cover and land use?

Land cover refers to the surface cover on the ground (ex. natural vegetation, agricultural crops, impervious surface, or waterbodies). Land use shows how people use the landscape (ex. agricultural, residential, commercial, or recreational).

2.6.1 Land Cover

A review of the most recent land cover data available (2010) shows that developed land is the most prominent land cover type within our watershed followed by agriculture (Figure 28, Figure 29 and Table 17). However, distinct differences in land cover can be observed 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 (46-51% by land area). The Headwaters Main Beaver Dam Ditch (HUC 040400010501), 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 (44-71% by land area). The remaining subwatersheds is more balanced in the percent distribution of agricultural and developed land uses.

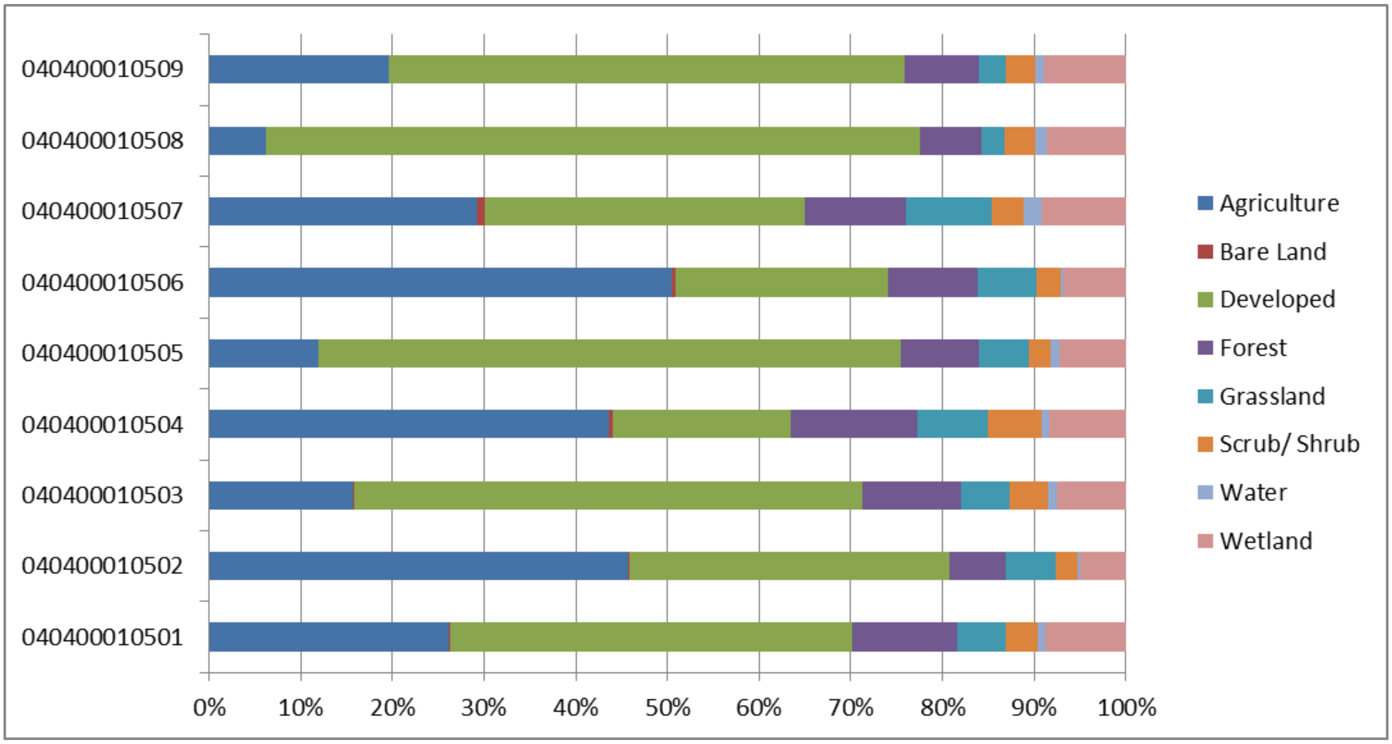


Figure 28 Land cover by subwatershed

Natural land cover (forest, grassland, scrub/shrub, water and wetland) accounts for 27% of the watershed's land area. The Deer Creek-Deep River (HUC 040400010504) subwatershed has the highest percentage of natural land cover in the watershed at 37%. Forestland covers approximately 9% of the watershed with subwatershed coverage ranging between 7-14%. Grassland covers 6% of the watershed with subwatershed coverage ranging from 5-9%. Wetland covers 8% of the watershed with subwatershed coverage ranging from 5-9%.

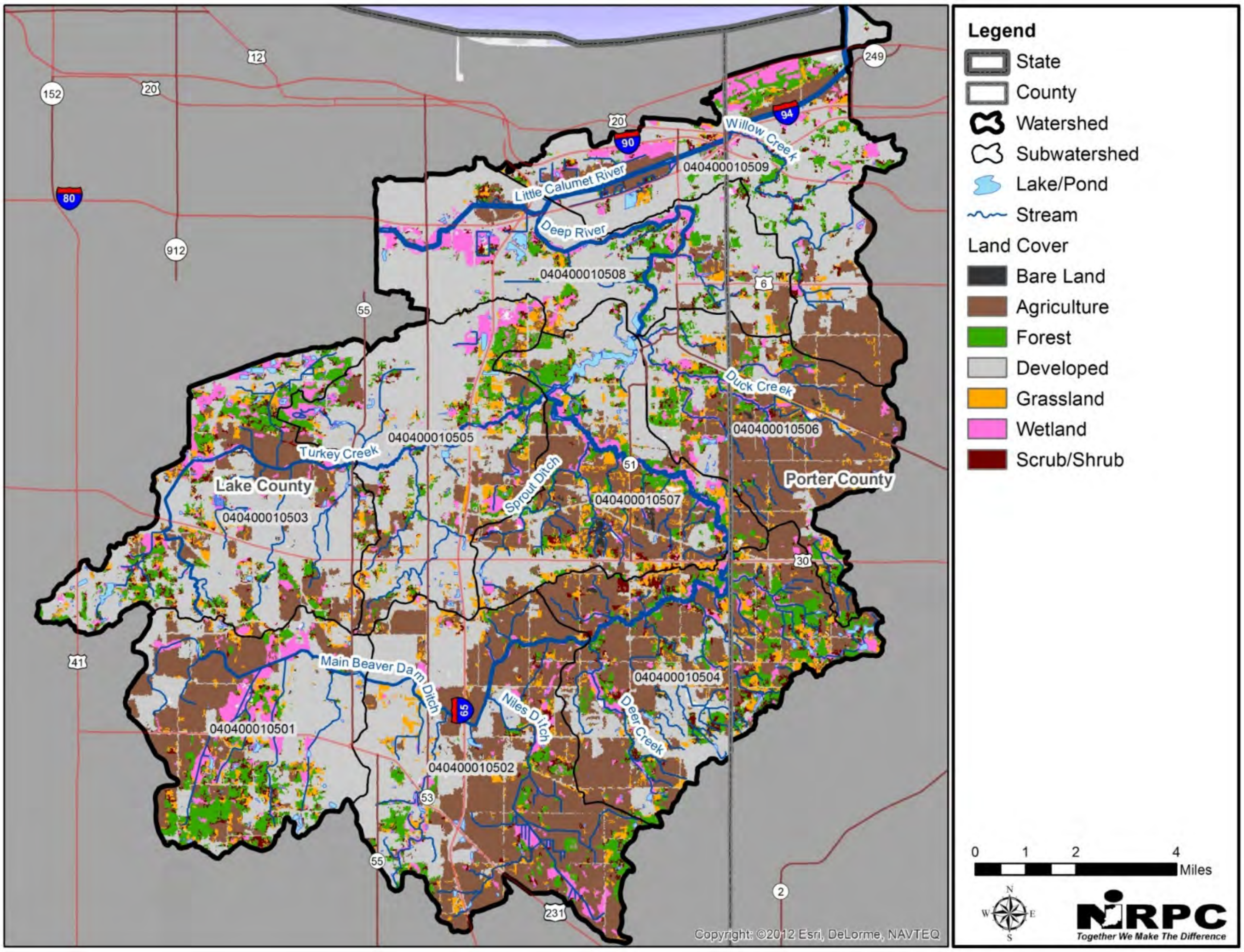


Figure 29 Land Cover (2010)

Name	HUC-12	Agriculture (ac.)	%	Bare Land (ac.)	%	Developed (ac.)	%	Forest (ac.)	%	Grassland (ac.)	%	Scrub/ Shrub (ac.)	%	Water (ac.)	%	Wetland (ac.)	%
Headwaters Main Beaver Dam Ditch	040400010501	3,072	26	17	0	5,131	44	1,336	11	617	5	415	4	88	1	1,034	9
Main Beaver Dam Ditch-Deep River	040400010502	7,690	46	19	0	5,874	35	1,038	6	916	5	390	2	57	0	837	5
Headwaters Turkey Creek	040400010503	2,133	16	19	0	7,545	55	1,445	11	728	5	568	4	127	1	1,031	8
Deer Creek-Deep River	040400010504	5,994	44	53	0	2,675	19	1,891	14	1,060	8	807	6	124	1	1,141	8
City of Merrillville-Turkey Creek	040400010505	1,485	12	11	0	7,924	63	1,063	9	693	6	285	2	125	1	905	7
Duck Creek	040400010506	5,121	51	35	0	2,344	23	995	10	653	6	262	3	32	0	693	7
Lake George-Deep River	040400010507	3,235	29	103	1	3,859	35	1,223	11	1,047	9	377	3	223	2	1,015	9
Little Calumet River-Deep River	040400010508	750	6	4	0	8,664	71	812	7	308	3	406	3	152	1	1,055	9
Willow Creek-Burns Ditch	040400010509	2,619	20	10	0	7,538	56	1,087	8	388	3	441	3	129	1	1,188	9
Watershed Total		32,100	28	270	0	51,555	45	10,891	9	6,411	6	3,950	3	1,058	1	8,899	8

Table 17 Land cover summary data

2.6.2 Land Use

A review of 2008 land use data compiled by the Northwestern Indiana Regional Planning Commission shows that residential and agricultural land uses are the most common within the watershed. Residential land use accounts for approximately 45% of the total land area while agricultural accounts for approximately 24%. The next most common land uses are park/open space (16%) and commercial/office (6%).

Land Use	Acres	%
Agricultural	25,914	24
Commercial/Office	6,230	6
Industrial	4,885	5
Institutional	1,776	2
Mixed Used	178	<1
Park/Open Space	16,480	16
Residential	47,179	45
Unknown	1,683	2
Vacant	909	1

Table 18 Land use summary data

Figure 30 shows the various land uses throughout the watershed. We can see from the figure that the U.S. Highway 30 and Broadway corridors have the highest concentration of commercial/office land use in the watershed. Smaller pockets of commercial/office can be seen along other primary roads and highways. Industrial areas (both light and heavy) area also readily apparent in the figure. The "unknown" land uses shown near Niles Ditch in the southern portion of the watershed generally appear to correspond with agricultural uses that include a dairy operation and equestrian facilities.

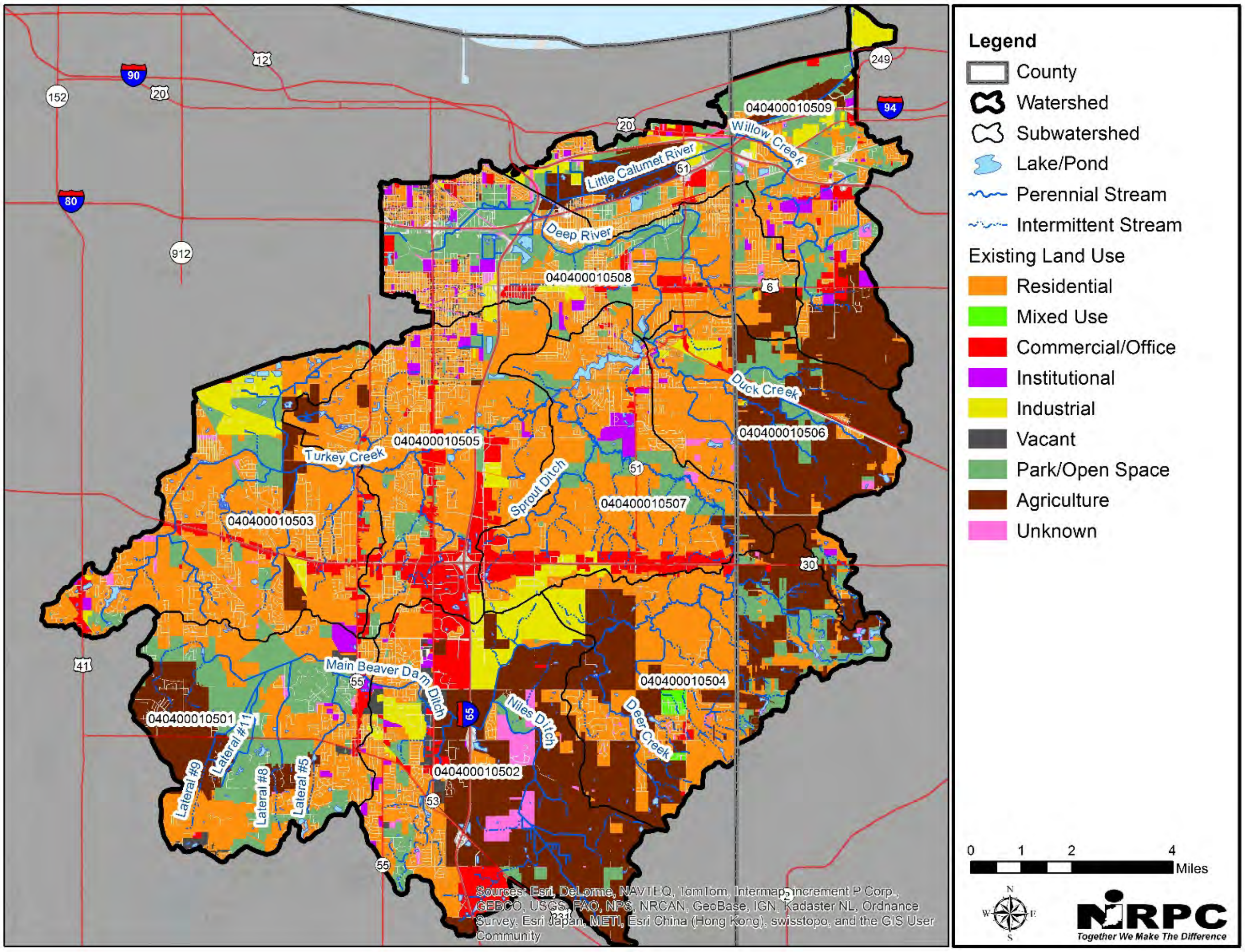


Figure 30 Existing land use

2.6.3 Agricultural Lands

Agriculture remains a prominent land use within portions of the watershed. In 2010, approximately 32,100 acres (28%) of land was devoted to agricultural production. Cultivated land accounted for 81% of agricultural use with corn and soybeans being the predominant crops. Pasture/hay accounted for the remaining 19%. The percentage of agricultural land cover for each subwatershed is presented in Table 17.

A number of the stakeholder concerns associated with agriculture are related to soil health on cultivated lands. Assessing overall soil health for our watershed is difficult because it is site (field) specific. However, we can approximate to what extent some of the conservation practices that promote soil health, as identified by the Conservation Cropping Systems Initiative, are being used.

- Continuous no-till/ strip-till
- Cover crops
- Precision farming
- Nutrient and pesticide management

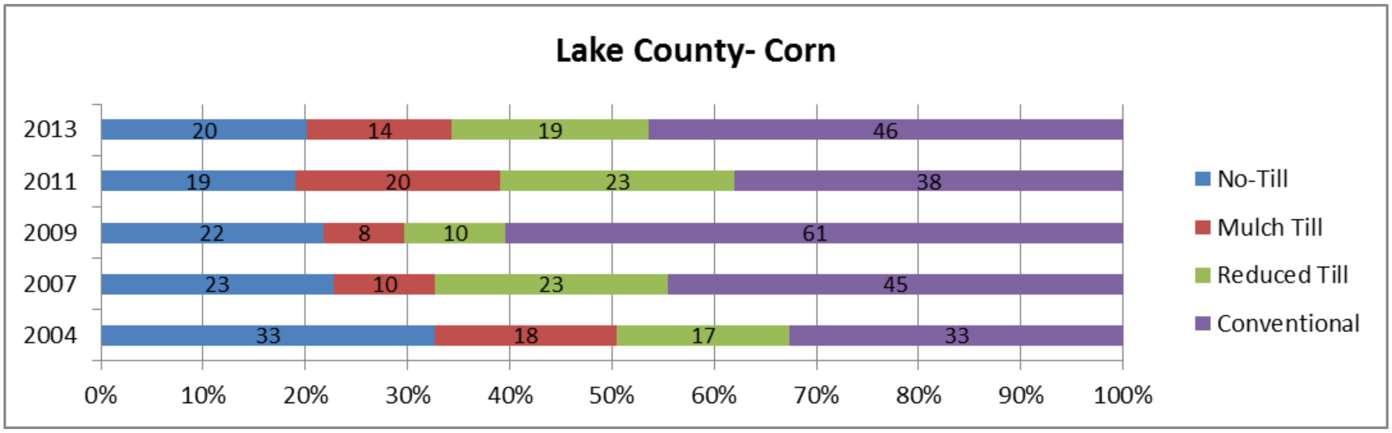
2.6.3.1 *Cropland Conservation Tillage Practices*

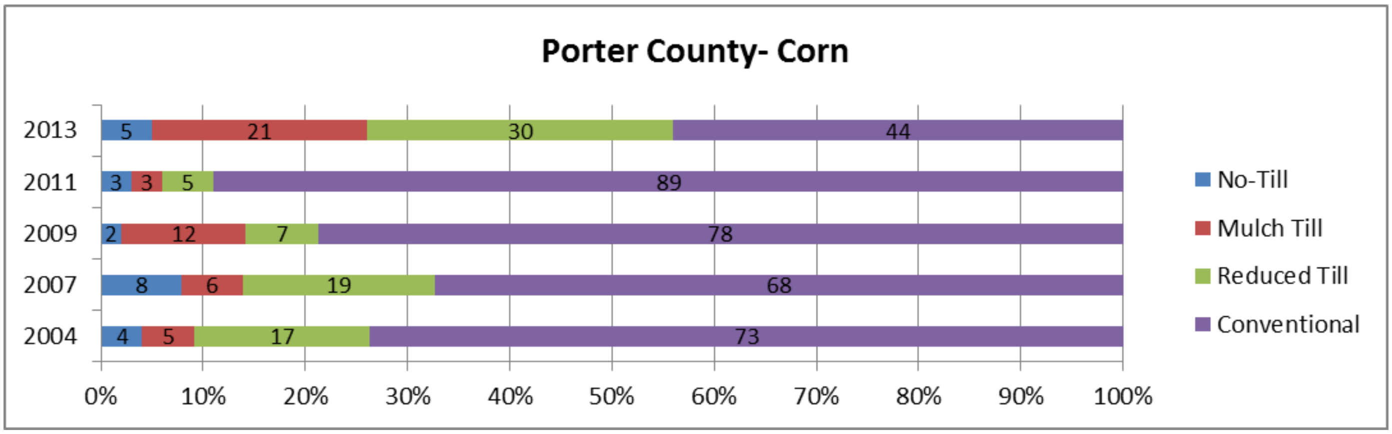
In cultivated areas, tillage practices can have a major effect on water quality. Conventional tillage leaves the soil surface bare and loosens soils particles making them susceptible to wind and water erosion. Conservation tillage reduces erosion by leaving at least 30% of the soil surface covered with 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.

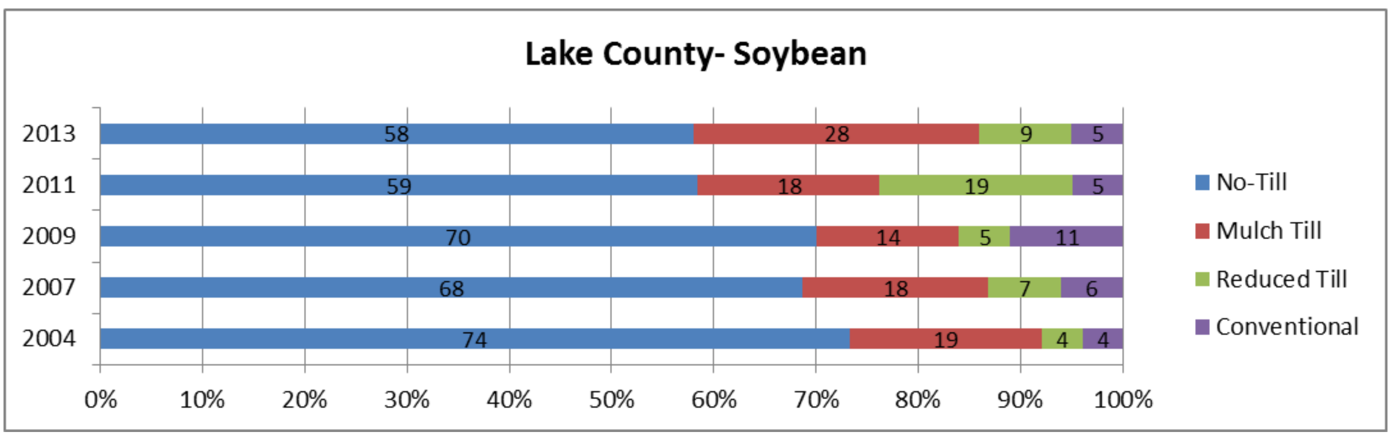
Tillage System Definitions

- “No-till” - any direct seeding system, including site preparation, with minimal soil disturbance.
- “Mulch-till” - any tillage system leaving 30% - 75% residue cover after planting, excluding no-till.
- “Reduced-till” - any tillage system leaving 16% - 30% residue cover after planting.
- “Conventional-till” - any tillage system leaving less than 15% residue cover after planting
- “Conservation Tillage” - any system that leaves at least 30% residue cover after planting is considered to be conservation tillage.

While no watershed scale data currently exists for conservation tillage practice use, countywide data is available from the Indiana State Department of Agriculture. Cropland tillage data for 2004-2013 is displayed in Figure 31. The data shows that the use of conservation tillage practices is much more common with soybeans than corn.







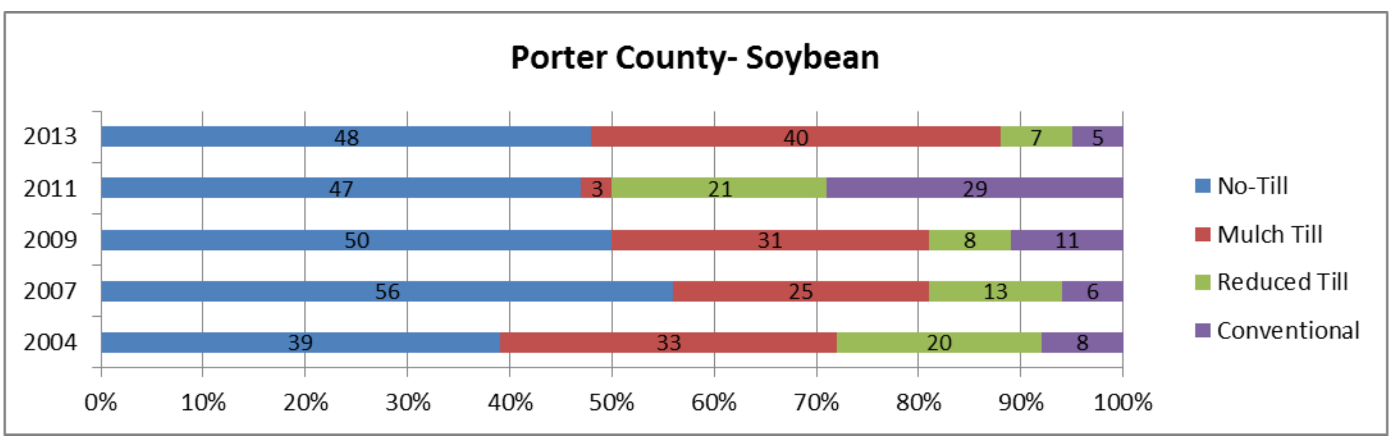


Figure 31 Conservation Tillage Data

2.6.3.2 *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 poultry. A concentrated animal feeding operation (CAFO) is a larger scale confined feeding operation. Approval must be received from IDEM before starting construction of a CFO, or expanding to increase animal population or manure storage capacity.

As of July 1, 2012, the Confined Feeding Program has two types of approvals:

1. CFOs or CAFO-sized CFOs that do not discharge manure or pollutant-bearing water need a CFO Approval under 327 IAC 19 [PDF]. There are slightly different requirements for a CFO versus a CAFO.
2. CFOs and CAFO-sized CFOs that discharge manure or pollutant-bearing water to waters of the state must have a NPDES CAFO Individual Permit under 327 IAC 15-16 [PDF]. The CAFO rule incorporates by reference the federal NPDES CAFO regulations.

The purpose of the confined feeding program is to help producers construct and operate CFOs in a manner that protects human health and the environment. The main environmental and public health concern with CFOs is manure and pollutant-bearing water contaminating surface and ground water resources. The program has three main areas of focus to protect these resources:

1. Design, construction, and capacity requirements for confinement buildings, manure storage structures, and other waste management structures.
2. Operation and maintenance requirements including self-inspections, record keeping, and spill response.
3. Land application requirements including setbacks, application at agronomic rates, and avoiding weather conditions that could lead to contaminated runoff.

A review of CFO facility data showed one facility located in the Main Beaver Dam Ditch-Deep River subwatershed. IDEM records indicate that the facility houses dairy cattle and that 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.

2.6.3.3 *Agricultural Animals*

The table below presents the approximate types and numbers of agricultural animals located in the watershed and its subwatersheds. This data was obtained by querying the EPA's STEPL Data Server which used data 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.

Name	HUC-12	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck
Headwaters Main Beaver Dam Ditch	40400010501	19	50	0	5	36	12	0	12

Name	HUC-12	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck
Main Beaver Dam Ditch-Deep River	40400010502	27	72	0	8	54	20	0	14
Headwaters Turkey Creek	40400010503	22	57	0	8	44	15	0	13
Deer Creek-Deep River	40400010504	25	42	200	9	36	10	0	6
City of Merrillville-Turkey Creek	40400010505	21	53	0	8	39	13	0	12
Duck Creek	40400010506	29	20	324	13	25	9	0	2
Lake George-Deep River	40400010507	17	44	17	4	32	12	0	9
Little Calumet River-Deep River	40400010508	23	45	86	8	36	13	0	10
Willow Creek-Burns Ditch	40400010509	36	29	427	19	37	16	1	6
Watershed Total		219	412	1054	82	339	120	1	84

Table 19 Agricultural Animals

A desktop analysis was done using GIS land cover data and Google Maps aerial imagery and street views to identify the approximate number and location of livestock facilities. Indicators such as fencing, buildings, worn paths, absent vegetation, and potential watering areas were used in this process. In some cases the livestock were visible in the aerial image or a facility name indicative of an operation was shown in Google Maps. A point was placed in the general location of the facility as the confinement boundaries were too difficult to determine (Figure 32).

A total of 56 potential livestock facilities were identified through the desktop analysis. As a general observation many of the facilities appeared to be for equestrians. There was no clear evidence of unrestricted livestock access to streams using this process. However, 21 of these general locations did fall within 500 feet of a stream. The Lake George subwatershed had the greatest number of facilities followed by the Main Beaver Dam Ditch and Duck Creek subwatershed.

Name	HUC-12	Approximate # of Livestock Facilities
Headwaters Main Beaver Dam Ditch	40400010501	5
Main Beaver Dam Ditch-Deep River	40400010502	12
Headwaters Turkey Creek	40400010503	3
Deer Creek-Deep River	40400010504	9
City of Merrillville-Turkey Creek	40400010505	4
Duck Creek	40400010506	10
Lake George-Deep River	40400010507	13
Little Calumet River-Deep River	40400010508	0
Willow Creek-Burns Ditch	40400010509	0
Watershed Total		56

Table 20 Estimated number of livestock facilities by subwatershed

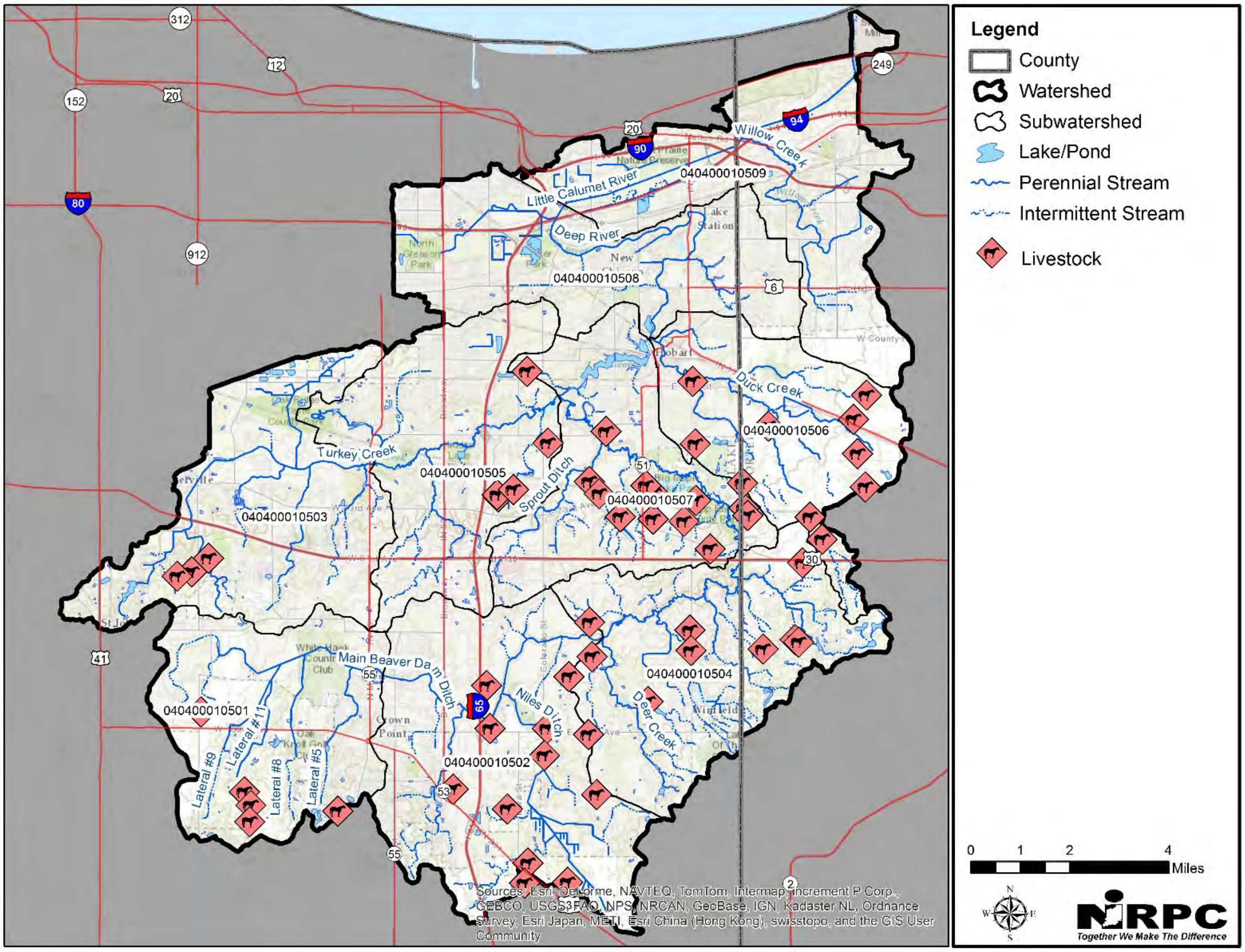


Figure 32 Livestock facilities

2.6.4 Developed Lands

In 2010, approximately 51,555 acres (45%) of land in the watershed was developed. This includes low, medium, high intensity development as well as developed open space. The percentage of developed land cover for each subwatershed is presented in Table 17.

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 down-cutting • increased streambank erosion • shifting bars of course-grained sediments • elimination of pool\riffle structure • imbedding of stream sediments

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 • trash\debris jams	• shift from external to internal stream energy production • reduction in diversity of aquatic and terrestrial species • destruction of wetlands, riparian buffers, and springs

Table 21 Development Impacts on Streams

2.6.4.1 *Population Growth & Density*

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 22 shows population change between 1980 and 2010 for the municipalities located within the watershed. Between 1980 and 2010 the population of Crown Point increased by nearly 11,000 people. Winfield's population increased 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. Population density based on 2010 census block data is displayed in Figure 33.

Community	Population				Change by Decade			% Change by Decade		
	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
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 22 Population Change by Municipality

The high population density of urban areas can potentially increase the concentration of pollutants in runoff when compared with less populated rural areas. Examples would include higher nutrient concentrations from lawn fertilizer use and pathogens from pet waste. Residential areas surrounding ponds or lakes can also be localized hotspots for elevated pathogen levels from the droppings of nuisance level goose populations.

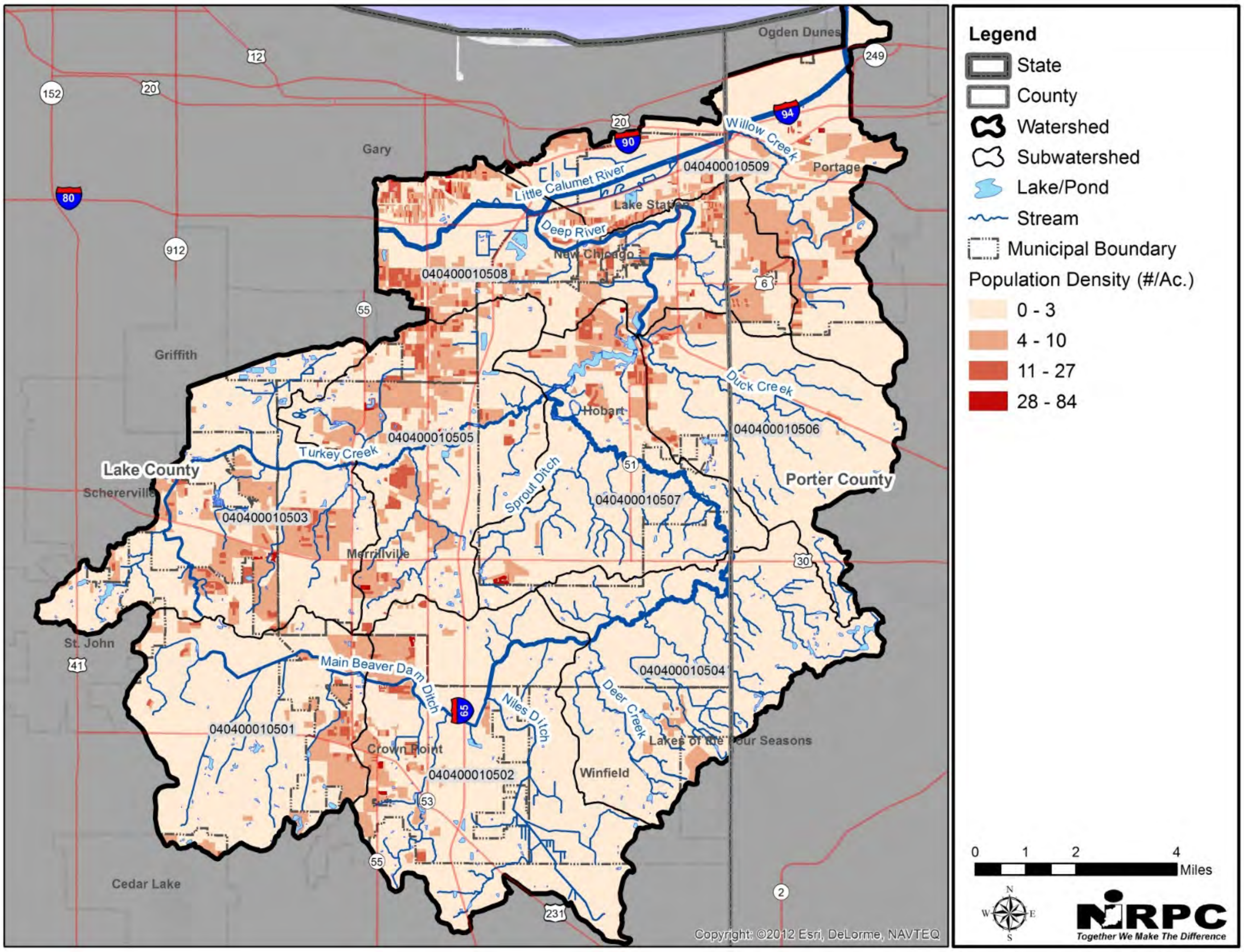


Figure 33 Population Density

2.6.4.2 *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

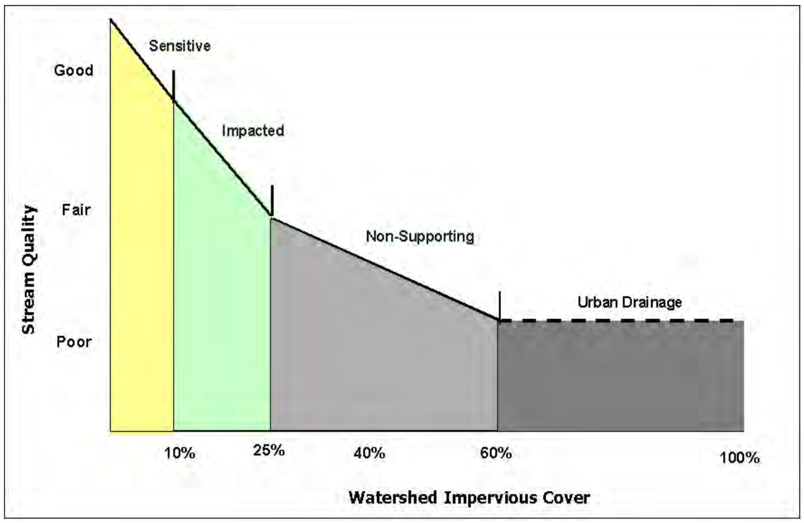


Figure 34 Relationship between Impervious Cover & Stream Quality

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). Center for Watershed Protection studies indicate that the size of one-hundred-year floods (or floods that have a one percent chance of occurring in any given year) can potentially double in watersheds with impervious cover levels greater than 20-30%. The following table adapted from the CWP's Watershed Vulnerability Analysis (2002) provides general observation descriptions for each ICM category.

ICM Category Category	Description
Sensitive (0-10% IC)	Streams are of high quality, and are typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects. Since impervious cover is so low, they do not experience frequent flooding and other hydrological changes that accompany urbanization.
Impacted (11-25% IC)	Streams show clear signs of degradation due to urbanization. Greater storm flows begin to alter stream geometry. Both erosion and channel widening are evident in alluvial streams. Stream banks become unstable, and physical habitat in the stream declines noticeably. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with the most sensitive fish and aquatic insects disappearing from the stream.
Non-Supporting (>25% IC)	Streams essentially become a conduit for conveying storm water flows and can no longer support a diverse stream community. The stream channel is often highly unstable and stream reaches can experience severe widening, down-cutting and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated, and the stream substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Water quality is consistently rated as fair to poor, and water contact recreation is no longer possible due to the presence of high bacterial levels. The biological quality is generally considered poor, and is dominated by pollution tolerant insects and fish.

Table 23 Impervious Cover Model Category Observation Descriptions

An analysis of impervious cover was done for each subwatershed using USGS impervious surface cover data (Table 24). The impervious surface data was derived from the 2011 National Land Cover Database. The results show that seven of the nine subwatersheds are impacted by impervious cover, exceeding the 10% threshold classification for a sensitive stream. Figure 35 shows the areas of high to low impervious cover throughout the watershed.

Name	HUC-12	Downstream Subwatershed	% IC	IC Category
Headwaters Main Beaver Dam Ditch	40400010501	040400010502	15.2	Impacted
Main Beaver Dam Ditch-Deep River	40400010502	040400010504	14.4	Impacted
Headwaters Turkey Creek	40400010503	040400010505	20.7	Impacted
Deer Creek-Deep River	40400010504	040400010507	5.9	Sensitive
City of Merrillville-Turkey Creek	40400010505	040400010507	26.4	Non-Supporting
Duck Creek	40400010506	040400010508	7.0	Sensitive
Lake George-Deep River	40400010507	040400010508	14.6	Impacted

Little Calumet River-Deep River	40400010508	040400010509	28.5	Non-Supporting
Willow Creek-Burns Ditch	40400010509	Lake Michigan	2	Non-Supporting

Table 24 Subwatershed Percent Impervious Cover

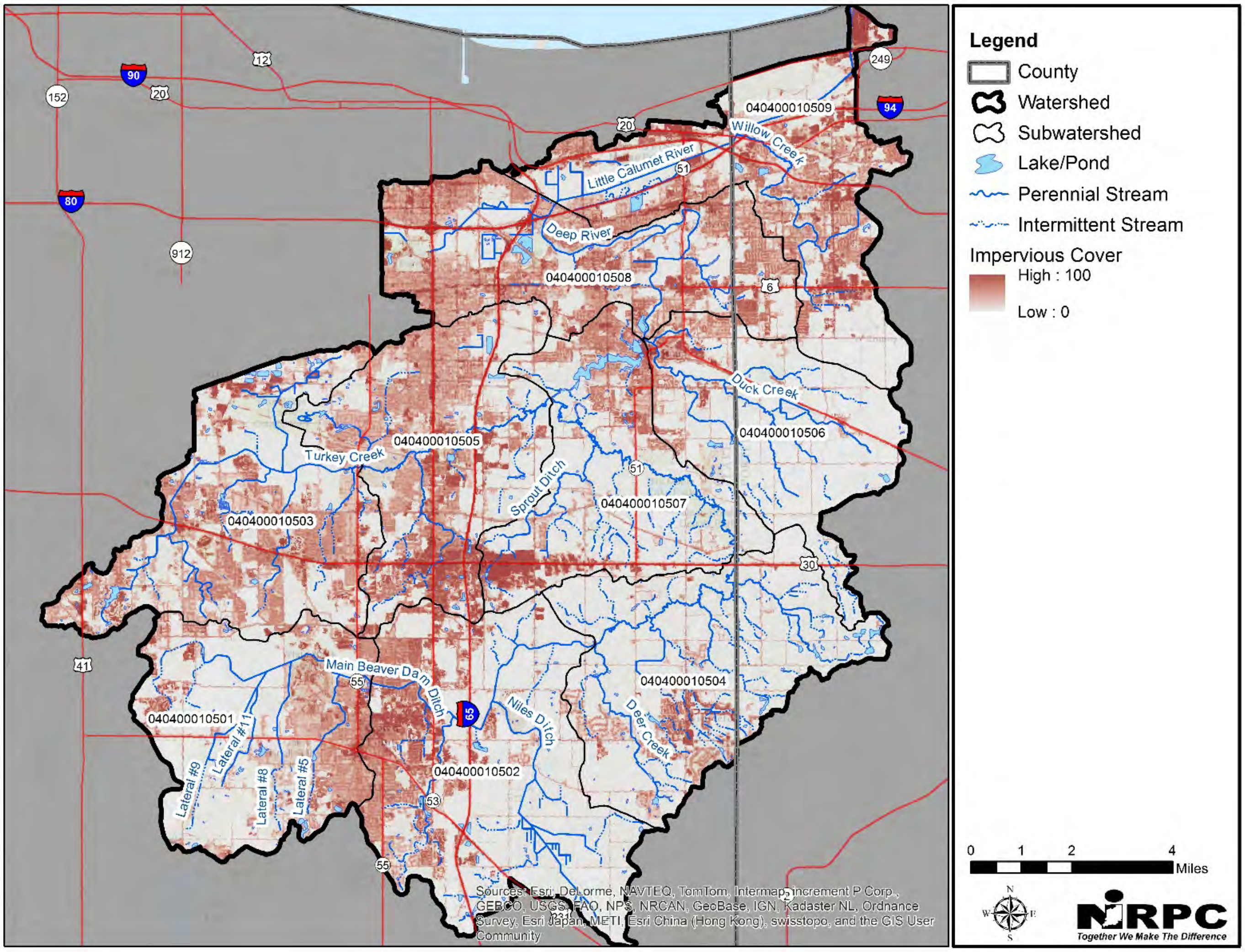


Figure 35 Impervious surface cover

2.6.4.3 *Point Sources*

This section summarizes the potential point sources of pathogens (*E. coli*), nutrients, and total suspended solids in the watershed as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

2.6.4.3.1 Wastewater Treatment Plants

There are seven active NPDES permitted wastewater treatment plants WWTPs that discharge wastewater containing *E. coli*, nutrients, and TSS within the watershed (Figure 36, Table 25). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States.

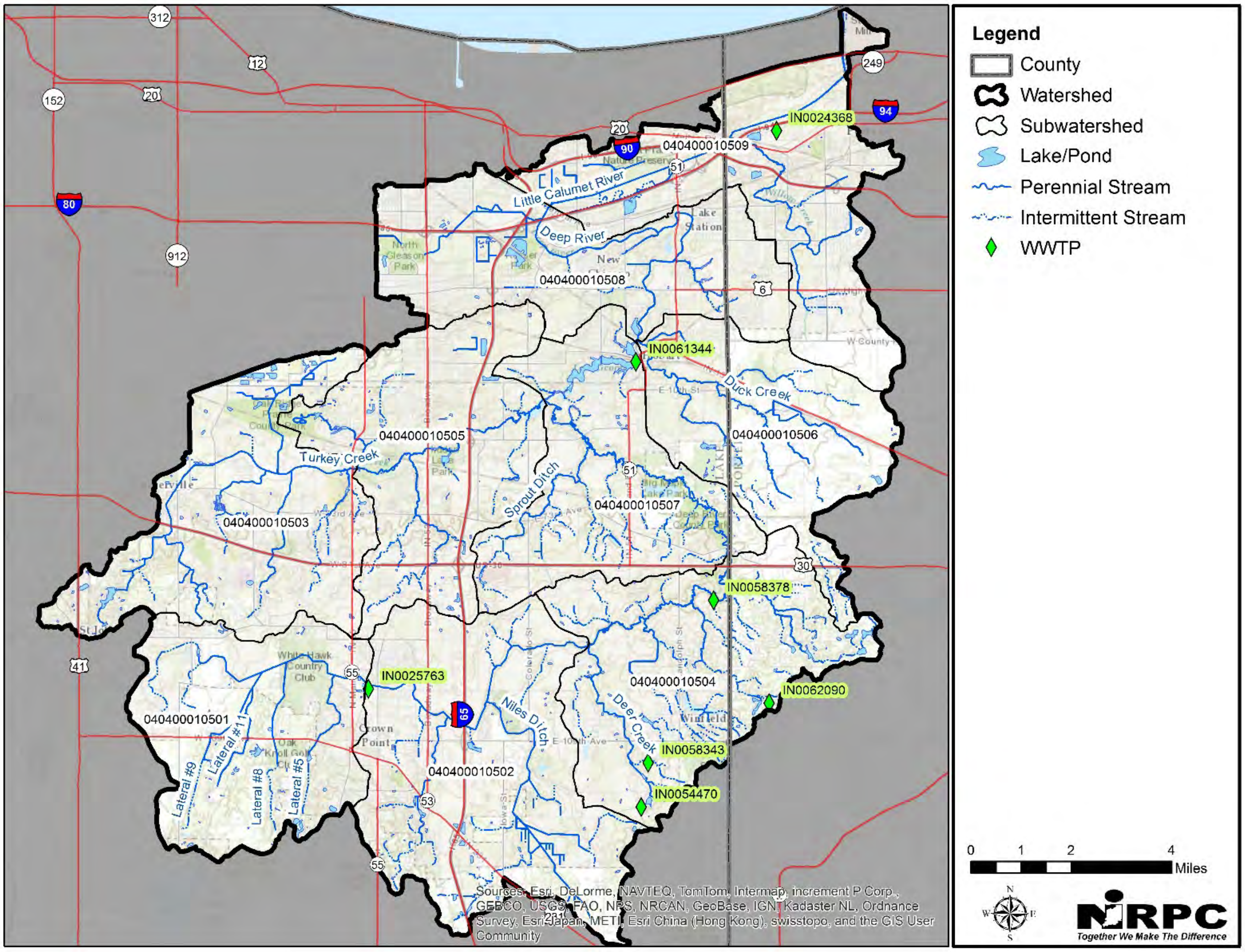


Figure 36 Wastewater treatment plants

The City of Crown Point currently owns and operates a Class III, 5.2 MGD conventional activated sludge treatment facility with primary and secondary clarification, phosphorus removal, mixed media filters and ultraviolet light disinfection. Biosolids are anaerobically treated to a Class B product, dewatered via a belt filter press and disposed of through a permitted land application program. The effluent limits contained in the permit are based on an effluent peak design flow of 8.1 MGD in accordance with IDEM's CSO policy to allow for the maximization of flow through the treatment facility in accordance with 327 IAC 5-2-11.6(g) (2). The collection system is comprised of combined sanitary and storm sewers with five Combined Sewer Overflow (CSO) locations. The CSO locations have been identified and permitted with provisions in Attachment A of their permit. The facility discharges into Main Beaver Dam Ditch via outfall 001. The receiving water has a seven day, ten year low flow (Q7,10) of zero cubic feet per second at the outfall location. There is no significant industrial flow into the City of Crown Point WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The Town of Winfield currently operates a Class II, 0.4 MGD activated sludge treatment facility consisting of a semi-cylindrical fine screen, an equalization influent basin, two-bioreactor basins, three secondary clarifiers, three final chlorine contact basins with fine bubble diffused post-aeration, dechlorination, phosphorus removal, an effluent flow meter, and one sludge holding tank. The collection system is comprised of 100% separate sanitary sewers be design with no overflow or bypass points. The facility discharges into an unnamed tributary to Deer Creek via Outfall 001. The receiving water has a seven day, ten year low flow (Q7,10) of 0.0 cubic feet per second at the outfall location. There is no industrial flow into the WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The Deep River Water Park (IN0062596) is limited to pool filter backwash. Samples taken in compliance with the monitoring requirements in the permit shall be taken at a point representative of the discharge but prior to entry into the unidentified ditch into Deep River. The Deep River Water Park WWTP (IN0058378) currently operates a Class I, 0.030 MGD treatment facility consisting of two septic tanks, with two re-circulating sand filters containing eight submersible pumps that recirculate the inflow through the sand filters, chlorination/dechlorination facilities, and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers by design with now overflow or bypass points. The facility discharges into the Deep River to Burns Ditch via Outfall 001. The Deep River has a seven day, ten year low flow (Q7,10) of 2.9 cubic feet per second (1.9 MGD) at the outfall location; this provides a dilution ratio of 63:1. There is no industrial flow into the WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The Chicagoland Christian Village WWTP currently operates a Class I, 0.05 MGD extended aeration type wastewater treatment plant consisting of a surge tank, a bar screen, a splitter box, two aeration basins, two primary clarifiers, three secondary clarifiers, a contact chamber, ultraviolet light disinfection, two digester, and an effluent flow meter. Final sludge is hauled offsite for disposal. The collection system is comprised of 100% separate sanitary sewers be design with no overflow or bypass points. The facility discharges to an on-site lake via Outfall 001. The on-site lake flows to an unnamed tributary of Deer Creek. The receiving water has a seven day, ten year low flow (Q7,10) of 0.0 cubic feet per second at the outfall location. There is no industrial flow into the WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The Falling Waters Conservancy District WWTP currently operates a Class I, 0.214 MGD Intermittent Cycle Extended Aeration System (ICEAS) Sequential Batch Reactor (SBR) treatment facility consisting of ultraviolet light disinfection and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers be design with no overflow or bypass points. The facility discharges into an unnamed tributary to Deep River via Outfall 001. The receiving water has a seven day, ten year low flow (Q7,10) of 0.0 cubic feet per second at the outfall location. There is no industrial flow into the WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The City of Hobart WWTP proposes to construct a wastewater treatment plant which would be a Class IV, 4.8 MGD facility with two equalization basins, microscreening, grit removal, extended aeration basins operated in conjunction with membrane filtration, chemical addition for pH and phosphorus control, ultraviolet light disinfection, and effluent reaeration. The collection system is comprised of 100% separate sanitary sewers be design with no overflow or bypass points. The facility discharges to the Deep River via Outfall 001. The receiving water has a seven day, ten year low flow (Q7,10) of 5.8 cubic feet per second (3.7 MGD) at the outfall location. There are no plans for significant industrial flow into the WWTP; the NPDES permit doesn't authorize the facility to accept industrial contributions until the permitee has provided IDEM with a characterization of the waste.

The Portage Utility Service Facility WWTP currently operates a Class III, 4.95 MGD extended aeration wastewater treatments facility with a 12 MGD equalized flow treatment capacity and a 15 MGD peak hydraulic capacity. The treatment facility consists of two mechanical screens, two aerated grit chambers, two primary clarifiers, and Aqua Diamond cloth media filtration system, post-aeration, ultra violet light (UV) disinfection and influent and effluent flow meters. Final solids are land applied under Land Application Permit No. INLA000076. The collection system is comprised of 100% sanitary sewers by design with one Sanitary Sewer Overflow (SSO) point. The SSO has been identified and prohibited in Attachment A of the permit. The facility discharges to Burns Ditch via outfall 001, Burns ditch has a seven day, ten year low flow (Q7,10) of 7.2 cubic feet per second (4.7 MGD) at the outfall location. This provides a dilution ratio of receiving stream flow to treated effluent of 1:1.1. The permitee accepts industrial flow from Advanced Waste Services, Indiana Pickling and Processing Co., Meritex, Inc., MonoSol, Rx Melton, Monosol, Rx Ameriplex, NEO industries Inc., and Precoat Metals Division- Sequa Coatings Division.

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Headwaters of Main Beaver Dam Ditch	Crown Point WWTP	IN0025763	INC0151_01	Main Beaver Dam Ditch	8.1
Main Beaver Dam Ditch	NA	NA	NA	NA	NA
Headwaters of Turkey Creek	NA	NA	NA	NA	NA
Deer Creek	Winfield WWTP	IN0058343	INC0154_T1001	Unnamed Tributary to Deer Creek	0.4
	Deep River Water Park WWTP	IN0058378	INC0154_01	Deep River	0.030
	Chicagoland Christian Village	IN0054470	INC0154_T1001	Unnamed Tributary to Deer Creek	0.05
	Falling Waters Conservancy District	IN0062090	INC0154_T1004	Unnamed Tributary to Deep River	0.124
City of Merrillville	NA	NA	NA	NA	NA
Duck Creek	NA	NA	NA	NA	NA
Lake George	NA	NA	NA	NA	NA
Little Calumet River	Hobart WWTP	IN0061344	INC0157_P1001	Deep River	4.8
Willow Creek	Portage Utility Service Facility WWTP	IN0024368	INC0159_01	Burns Ditch	4.95

Table 25 Wastewater treatment plants

2.6.4.3.2 Combined Sewer Overflows

Combined sewer overflows (CSO) systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater into 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 waterbody. During periods of heavy rainfall or snowmelt, 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 waterbodies. These overflows, called CSOs, can contain both storm water and untreated human and industrial waste, including pollutants such as *E. coli*, nitrogen, phosphorus, and total suspended solids. Because they are associated with wet weather events, CSOs typically discharge for short periods of time at random intervals. IDEM regulates CSOs in Indiana through the state's NPDES program. Combined Sewer Overflows are point sources subject to both technology-based and water quality based requirements of the Clean Water Act and state law. The permitee is authorized to have wet weather discharges from outfalls listed in their permit. One key component of this program is locating all CSO outfalls for tracking purposes. There are two combined sewer systems in the watershed operated by City of Crown Point and the City of Gary. There are nine CSO outfalls associated with these combined sewer systems.

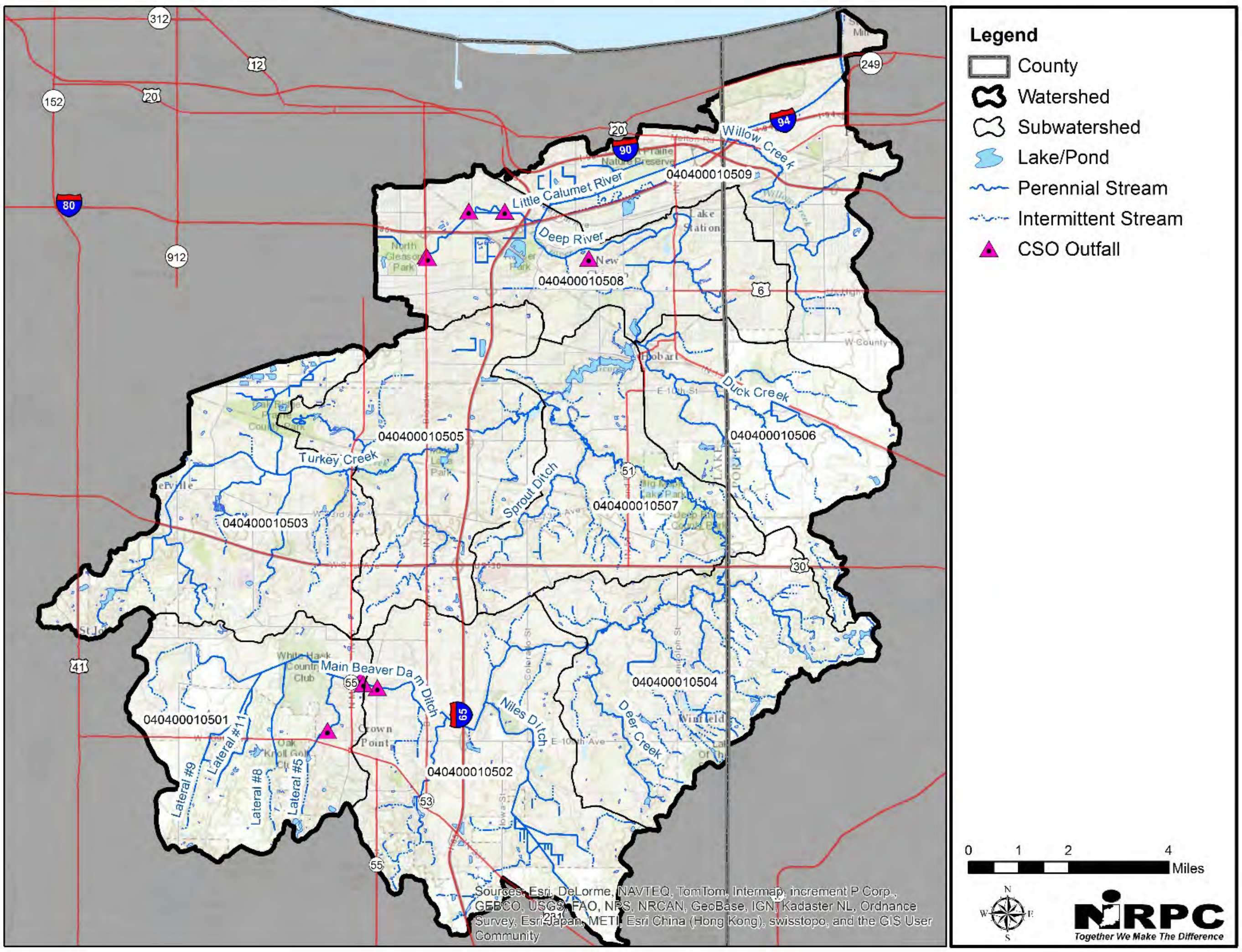


Figure 37 Combined sewer overflows

Subwatershed	Facility	Permit #	AUID	Outfall #	Pipe Description	Receiving Stream
Headwaters of Main Beaver Dam Ditch	Crown Point WWTP	IN0025763	INC0151_01	002	Treated CSO	Main Beaver Dam Ditch
				003	Untreated CSO	Main Beaver Dam Ditch
				005	Untreated CSO	Main Beaver Dam Ditch
				006	Untreated CSO	Main Beaver Dam Ditch
Main Beaver Dam Ditch	Crown Point WWTP	IN0025763	INC0152_04	004	Untreated CSO	Main Beaver Dam Ditch

Headwaters Turkey Creek	NA	NA	NA	NA	NA	NA
Deer Creek-Deep River	NA	NA	NA	NA	NA	NA
City of Merrillville-Turkey Creek	NA	NA	NA	NA	NA	NA
Duck Creek	NA	NA	NA	NA	NA	NA
Lake George-Deep River	NA	NA	NA	NA	NA	NA
Little Calumet River- Deep River	Gary Sanitary District WWTP	IN0022977	INC0142_T1009	004	Untreated CSO	Little Calumet River
				005	Untreated CSO	Little Calumet River
				013	Untreated CSO	Little Calumet River
				014	Untreated CSO	Little Calumet River
				015	Untreated CSO	Little Calumet River
Willow Creek-Burns Ditch	NA	NA	NA	NA	NA	NA

Table 26 Combined sewer overflows

2.6.4.3.3 Sanitary Sewer Overflows

Sanitary sewer overflows (SSOs) are unintentional and illegal discharges of raw sewage from municipal sanitary sewers. Sanitary sewer overflows discharge *E. coli* to waterbodies and may occur due to:

- Severe weather resulting in of excessive runoff of storm water into sewer lines
- Vandalism
- Improper operation and maintenance
- Malfunction of lift stations
- Electrical power failures

Overflows in the sanitary sewer system or in a sanitary portion of a combined sewer system are expressly prohibited from discharging at any time. Should any release from the sanitary sewer system occur, the permitee is required to notify the Enforcement Section of the Office of Water Quality orally within 24 hours and in writing within 5 days of the event in accordance with the requirements in Part II.C.2.b of the permit. The correspondence shall include the duration and cause of discharge as well as the remediation action taken to eliminate it.

The Merrillville Conservancy District operates a sewer collection system. The Merrillville Conservancy District transports wastewater to the Gary Sanitary District Wastewater Treatment Plant (WWTP). The wastewater collection system is 100% separate sanitary sewers by design with no bypass points and one SSO point.

For discussion on the Portage Utility Service Facility WWTP, see the WWTP discussion in Section 2.6.4.3.1.

Two permitted sites with two SSO locations were identified in the watershed (Figure 38, Table 27).

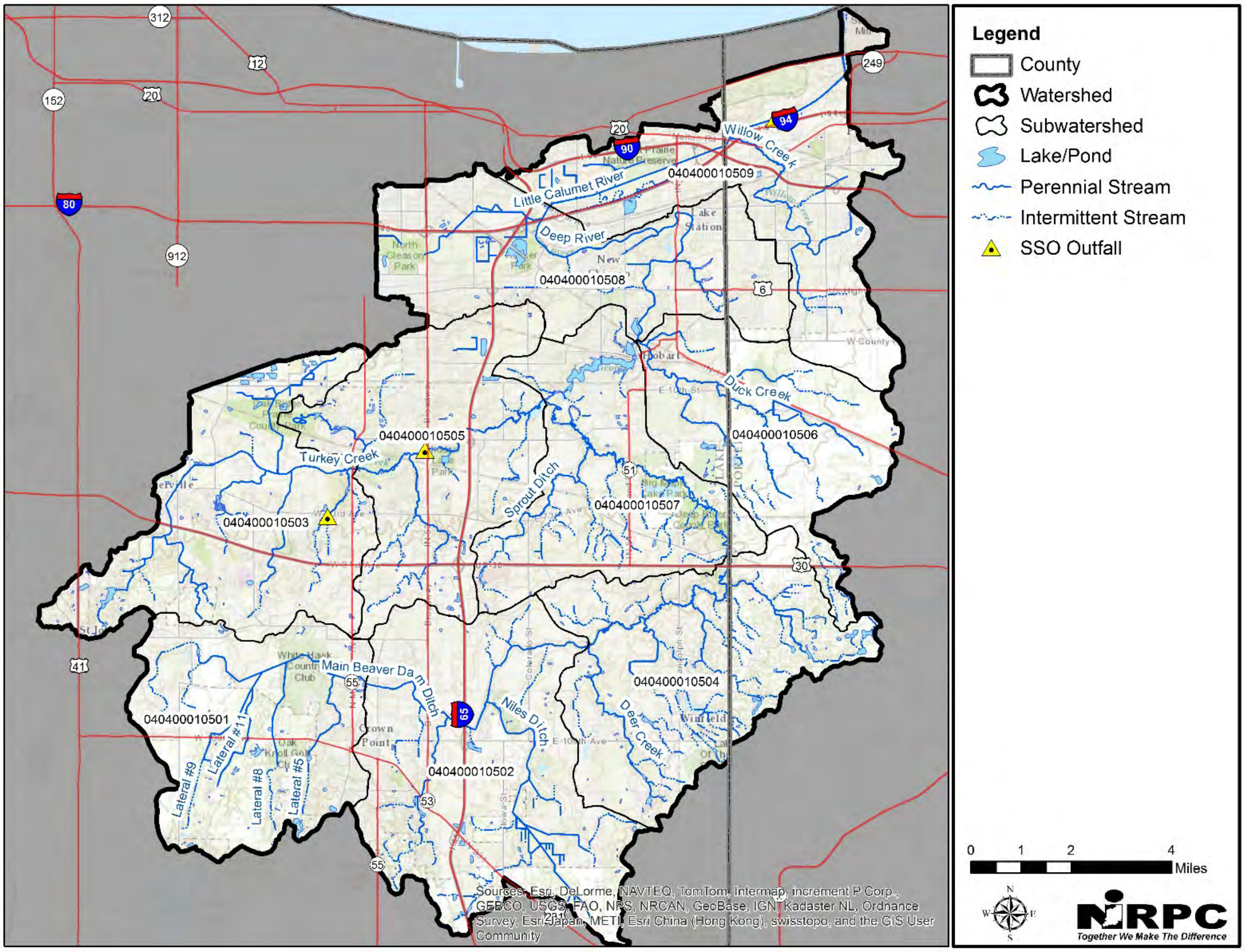


Figure 38 Sanitary sewer overflows

Subwatershed	Facility Name	Permit #	Type	AUID
Headwaters of Main Beaver Dam Ditch	NA	NA	NA	NA
Main Beaver Dam Ditch	NA	NA	NA	NA
Headwaters of Turkey Creek	NA	NA	NA	NA
Deer Creek- Deep River	NA	NA	NA	NA
City of Merrillville- Turkey Creek	Merrillville Conservancy District	INJ035548	Lift Station	INC0155_01
Duck Creek	NA	NA	NA	NA
Lake George- Deep River	NA	NA	NA	NA
Little Calumet River- Deep River	NA	NA	NA	NA
Willow Creek- Burns Ditch	Portage Utility Service Facility WWTP	IN0024368	Lift Station	INC0159_01

Table 27 Sanitary sewer overflows

2.6.4.3.4 Industrial Facilities

Industrial facilities with NPDES permits produce wastewater generated through producing a product. Wastewater discharges from industrial sources may contain pollutants at levels that could affect the quality of receiving waters. The NPDES permit program establishes specific requirements for dischargers from industrial sources. If the industrial facility discharges wastewater directly to a surface water then it requires an individual or general NPDES permit. A general permit, or permit-by-rule, is a "one size fits all" type of activity-specific permit. The general permit rule (327 IAC 15-1 through 15-4 and 15-10) covers the following activities: coal mining, coal processing, and reclamation activities, noncontact cooling water, petroleum products terminals, groundwater petroleum remediation systems, hydrostatic testing of commercial pipelines, and sand, gravel and stone operations. In contrast, individual permits are tailored to the specific activities of the facility and may regulate a number of additional pollutants other than those described under the general permits.

Depending on the type of industrial facility operated more than one NPDES program may apply. Some industrial facilities require an additional permit under the storm water program.

Industrial storm water permits are required for facilities where activities of the industrial operation are exposed to storm water and runoff is discharged though a point source to waters of the state. The general permit 327 IAC 15-6 (Rule 6) applies to specific categories of industrial activities that must obtain permit coverage. Determination of applicable industrial activities is based on a facility's Standard Industrial Classification (SIC) Code(s) or facility activities included in the listed narrative descriptions within the rule. Under certain circumstances, a facility may require an individual storm water permit. This permit is typically required only if a regulated industrial activity category has established effluent limitations or IDEM determines the storm water discharge will significantly lower water quality.

The facility must develop and implement a Storm Water Pollution Prevention Plan (SWP3), and submit a completed SWP3 Checklist Form certifying to IDEM that such a plan is in place. The SWP3 is used to identify potential and actual storm water pollutant sources, and to determine best management practices and measures that will minimize the pollutants transported in storm water run-off. The SWP3 itself must be retained at the facility, and made available for review during any on-site inspection. Periodically, the plan must be reviewed, and revised if changes at the facility alter conditions that could affect run-off.

Based on information from the TMDL, there are a total of 23 industrial facilities with NPDES permits within the watershed (Table 28).

Subwatershed	Facility Name	Permit Number	Receiving Stream
Headwaters Main Beaver Dam Ditch	Bulk Marathon 2108	ING080230	Main Beaver Dam Ditch
	Speedway LLC Store 6677	ING080263	Main Beaver Dam Ditch
Main Beaver Dam Ditch	Vesuvius USA Crown Point Plant	INR00B062	Main Beaver Dam Ditch
	East Chicago Machine Tool Corporation	INR00B085	Main Beaver Dam Ditch
	Conquest Ready Mix	INR00C073	Main Beaver Dam Ditch
	Crown Brick & Supply Inc.	INR210008	Main Beaver Dam Ditch
	US Gypsum Company	INR210155	Niles Ditch
	Illiana Disposal and Recycling	INR800146	Main Beaver Dam Ditch

Headwaters of Turkey Creek	Calumet Bus Service Inc.	INR00C114	Unnamed Tributary to Turkey Creek
	Laketon Refining Corporation	INR00L018	Unnamed Tributary to Turkey Creek
	American Chemical Service Inc.	INR230064	Unnamed Tributary to Turkey Creek
	Wild Bills Incorporated	INR600286	Unnamed Tributary to Turkey Creek
	Travel Centers of America	INR700040	Unnamed Tributary to Turkey Creek
	Griffith Merrillville Airport	INR800012	Unnamed Tributary to Turkey Creek
	Walsh and Kelly Incorporated	INRM00438	Unnamed Tributary to Turkey Creek
Deer Creek	NA	NA	NA
City of Merrillville	CHNUPA & Hoffman Corp. Nummies Auto Parts	INR00N049	Unnamed Tributary to Turkey Creek
	Frito Lay Incorporated	INRM00083	Unnamed Tributary to Turkey Creek
Duck Creek	NA	NA	NA
Lake George	NA	NA	NA
Little Calumet River	NA	NA	NA
Willow Creek	Precoat Metals Division Sequa	INR200111	Burns Ditch
	Steel Technologies LLC	INR200173	Little Calumet River
	Illiana Transfer 4	INR500030	Little Calumet River
	Pauls Auto Lake Station Yard	INRM00623	Little Calumet River
	NLMK- Indiana	IN0059714	Burns Ditch
	US Steel Corp Midwest Plant	IN0059714	Burns Ditch

Table 28 NPDES permitted industrial facilities

2.6.4.3.5 NPDES Facility Inspection and Compliance

The following table presents a summary of permit compliance for all NPDES facilities in the watershed for the five year period between 2010 and 2014. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation for facility maintenance). The table also presents the total number of violations in the five year period for the NPDES permitted parameters. According to the table, there have been 31 NPDES facility inspections resulting in violations in the five year period. Overall, there are a total of 52 permit violations for the NPDES permitted parameters in the watershed.

Subwatershed	Facility Name	Permit Number	Stream	Date of Inspection for the Last Five Years	Violations for the Last Five Years				
					Month	Year	Parameter	Type	# violations

Headwaters of Main Beaver Dam Ditch	Crown Point	IN0025763	Main Beaver Dam Ditch	8/25/2009: No Violations 2/24/2010: No Violations 9/24/2010: No Violations 8/10/2011: Potential Problems Observed 1/30/2012: Potential Problems Observed 9/27/2013: No Violations 1/3/2014: Violations Observed 6/27/2014: Violations Observed (Phosphorus June 2013- May 2014)	Dec.	2010	TSS	Mx Wk Avg	1
					Jan.	2011	TSS	Mo. Avg	1
					Jan.	2011	TSS	Mx Wk Avg	1
					Feb.	2011	Copper	Mo. Avg	1
					Feb.	2011	Copper	D. Max	1
					July	2011	NH3-N	Mx Wk Avg	1
					July	2011	NH3-N	Mo. Avg	1
					Feb.	2011	Copper	D. Max	1
					Feb.	2011	Copper	Mo. Avg	1
					Jan.	2011	TSS	Mx Wk Avg	1
					Jan.	2013	TSS	Mx Wk Avg	1
					Jan.	2013	NH3-N	Mx Wk Avg	1
					Feb.	2013	NH3-N	Mx Wk Avg	1
					Apr.	2013	TSS	Mx Wk Avg	1
					Sep.	2013	Copper	Mo. Avg	1
					Oct.	2013	TSS	Mx Wk Avg	1
					Oct.	2013	Copper	Mo. Avg	1
					Nov.	2013	NH3-N	Mx Wk Avg	1
					Nov.	2013	NH3-N	Mo. Avg	1
Main Beaver Dam Ditch	NA	NA	NA	NA	NA				
Headwaters Turkey Creek	NA	NA	NA	NA	NA				
Deer Creek-Deep River	Winfield WWTP	IN0058343	Unnamed Tributary to Deer Creek	2/23/2010: Violations Observed 9/2/2010: No Violations Observed 1/3/2012: Violations Observed 2/6/2014: No Violations Observed	Sep	2011	TSS	Mx Wk Avg	1
	Deep River Water Park WWTP	IN0058378	Deep River	12/15/2010: Violations Observed 7/16/2012: No Violations Observed 6/7/2013: No Violations Observed 6/5/2014: No Violations Observed	Jan.	2010	NH3-N	Mo. Avg	1
					July	2010	NH3-N	Mo. Avg	2
					July	2010	NH3-N	Mx Wk Avg	2
					Aug.	2010	NH3-N	Mx Wk Avg	1
					Aug.	2010	NH3-N	Mo. Avg	1
					Aug.	2010	*E. coli*	D. Max	1
					May	2013	Chlorine	D. Max	3
City of Merrillville-Turkey Creek	Chicagoland Christian Village	IN0054470	Unnamed Tributary to Deer Creek	8/28/2010: Violations Observed 12/6/2010: No Violations Observed 11/15/2011: Violations Observed 6/21/2013: Violations Observed:(Referred to Enforcement) 11/14/2013: Violations Observed	May	2010	CBOD	Mx Wk Avg	1
					June	2010	*E. coli*	Mo. Avg	3
					June	2010	*E. coli*	Mo. Geo Mean	1
					Nov	2010	NH3-N	Mo. Avg	1
					April	2011	TSS	% removal	1
					June	2011	NH3-N	Mx Wk Avg	1
					June	2011	NH3-N	Mo. Avg	1
					July	2011	*E. coli*	D. Max	1
					July	2011	NH3-N	D. Max	2
					July	2011	NH3-N	Mo. Avg	1
					Aug.	2011	NH3-N	D. Max	1
					Aug.	2011	NH3-N	Mo. Avg	1
					Aug.	2011	*E. coli*	D. Max	1
					May	2012	*E. coli*	D. Max	1
					May	2012	NH3-N	Mo. Avg	1
					May	2012	NH3-N	Mx Wk Avg	1
					May	2012	NH3-N	Mo. Avg	1
					May	2012	NH3-N	Mx Wk Avg	1
					June	2012	*E. coli*	D. Max	3
					June	2012	*E. coli*	Mo. Geo Mean	1
					July	2012	*E. coli*	D. Ma	1
					Aug	2012	NH3-N	Mx Wk Avg	3
					Aug	2012	NH3-N	Mo. Avg	1
					Aug	2012	Phosphorus	Mo. Avg	1
					Sep	2012	NH3-N	Mx Wk Avg	1
					Sep	2012	NH3-N	Mo. Avg	1
	Falling Waters Conservancy District	IN0062090	Unnamed Tributary to Deep River	1/29/2010: No Violations Observed 1/25/2012: No Violations Observed 2/8/2013: Violations Observed 5/22/2014: Violations Observed	Jul.	2011	*E. coli*	D. Max	1
					Aug.	2011	*E. coli*	D. Max	1
					Apr.	2012	*E. coli*	D. Max	2
					May.	2012	*E. coli*	D. Max	1
					May.	2012	NH3-N	Mx Wk Avg	1
					Jun.	2012	NH3-N	Mx Wk Avg	1
					Aug.	2013	*E. coli*	D. Max	1

Duck Creek	NA	NA	NA	NA	NA				
Lake George-Deep River	NA	NA	NA	NA	NA				
Lake George-Deep River	NA	NA	NA	NA	NA				
Little Calumet River- Deep River	Hobart WWTP	IN0061344	Deep River	3/31/2010: Violations Observed 4/5/2010: Violations Observed 6/15/2011: Violations Observed:(Referred to Enforcement)	NA	NA	NA	NA	NA
Willow Creek-Burns Ditch	Portage Utility Service Facility WWTP	IN0024368	Burns Ditch	4/27/2010: No Violations Observed 5/2/2011: No Violations Observed 6/12/2012: No Violations Observed 2/20/2013: Violations Observed	NA	NA	NA	NA	NA

Table 29 Wastewater treatment plant summary of inspections and permit compliance

2.6.4.4 *Remediation & Waste Sites*

Although not identified as a public concern, information on remediation and waste sites located within the watershed is included here because of their potential environmental impact. The data used to create the map figure below was generated by IDEM and is also available to the general public through Indiana Map (www.indianamap.org). Descriptions of site types is provided below.

Industrial waste sites- facilities that generate and/or manage hazardous waste, non-hazardous industrial waste, and solid waste.

Waste treatment disposal sites- facilities that may treat, store, and/or dispose hazardous waste. These facilities are also usually generators of hazardous waste.

Waste transfer stations- facilities that transfer solid waste from one collection vehicle to another. The waste is later disposed of at a state approved solid waste permitted facility.

Tire sites- facilities that contain tires for processing, storage, or transport, as well as some illegal tire dumps.

Active permitted solid waste sites- facilities that are permitted solid waste landfills.

Restricted waste sites- facilities that accept only specific types of solid wasted.

Voluntary Remediation Program (VRP) sites- sites where owners or operators have voluntarily entered into an agreement with IDEM to clean up contaminated property. When the cleanup is successfully completed, IDEM will issue a Certificate of Completion and the Governor's office will issue a Covenant Not to Sue to the cleaned up property.

Superfund sites- Sites include current and former chemical and manufacturing plants; rail yards; smelter sites; landfill and dump sites; and sediment sites. These sites are typically large and complex, requiring long-term investigations and cleanups. Many sites require ground water treatment and monitoring that may continue for 30 years or more after construction completion.

Open dumps sites- sites that are not regulated and are illegal dump sites of solid waste.

Landfill boundary- shows boundaries for open dump sites, approved landfills, and permitted landfills.

Institutional control sites- When any amount of contamination above a residential closure level is left on a property, a legal measure called an Institutional Control (IC) may be needed. An IC protects human health and the environment by restricting property activity, use, or access.

Corrective action sites- facilities that are subject to RCRA Corrective Action if they meet any of the following conditions: operating under a hazardous waste permit (A or B) or an interim status facility and lawsuit against any handler.

Cleanup sites- sites that are on the Commissioner's Bulletin or referred remedial response locations or other IDEM programs that require mitigation of risk to human health and the environment through investigation, remediation or institutional controls.

Brownfield sites- a parcel of real estate that is abandoned or inactive, or may not be operated at its appropriate use, and on which expansion, redevelopment, or reuse is complicated because of the presence or potential presence of a hazardous substance, a contaminant, petroleum, or a petroleum product that poses a risk to human health and the environment.

Leaking underground storage tanks- Shows regulated leaking underground storage tank locations. Regulated underground storage tanks are those that have 10 percent or more of the tank and piping buried beneath the ground and contain a regulated substance.

Waste disposal storage handling- sites for the disposal, storage, and handling of solid and hazardous waste. Types of waste sites include constructions/demolition waste, composting of CFO waste, clean fill, municipal, non-municipal, open dumps, restricted waste, surface impoundments, sanitary landfills, incinerators, material recovery, medical waste, recycling, and waste transfer stations.

In general, the location of remediation and waste sites corresponds to areas of medium to high intensity development. By number, leaking underground storage tanks is the most extensive remediation and waste site concern (Table 30). A review of the Deep River-Portage Burns Waterway TMDL did not reference remediation or waste sites contributions to any of the observed stream impairments in the watershed.

Site Type	# of Sites	Site Type	# of Sites
Industrial Waste Sites	100	Open Dump Sites	4
Waste Treatment Disposal Sites	3	Landfill Boundary	9
Waste Transfer Stations	5	Institutional Controls Sites	31
Tire Sites	1	Corrective Action Sites	5
Active Permitted Solid Waste Sites	2	Cleanup Sites	26
Restricted Waste Sites	1	Brownfield Sites	10
VRP Sites	4	Leaking Underground Storage Tanks	434
Superfund Sites	1	Waste Disposal Storage Handling	21

Table 30 Summary of remediation and waste sites

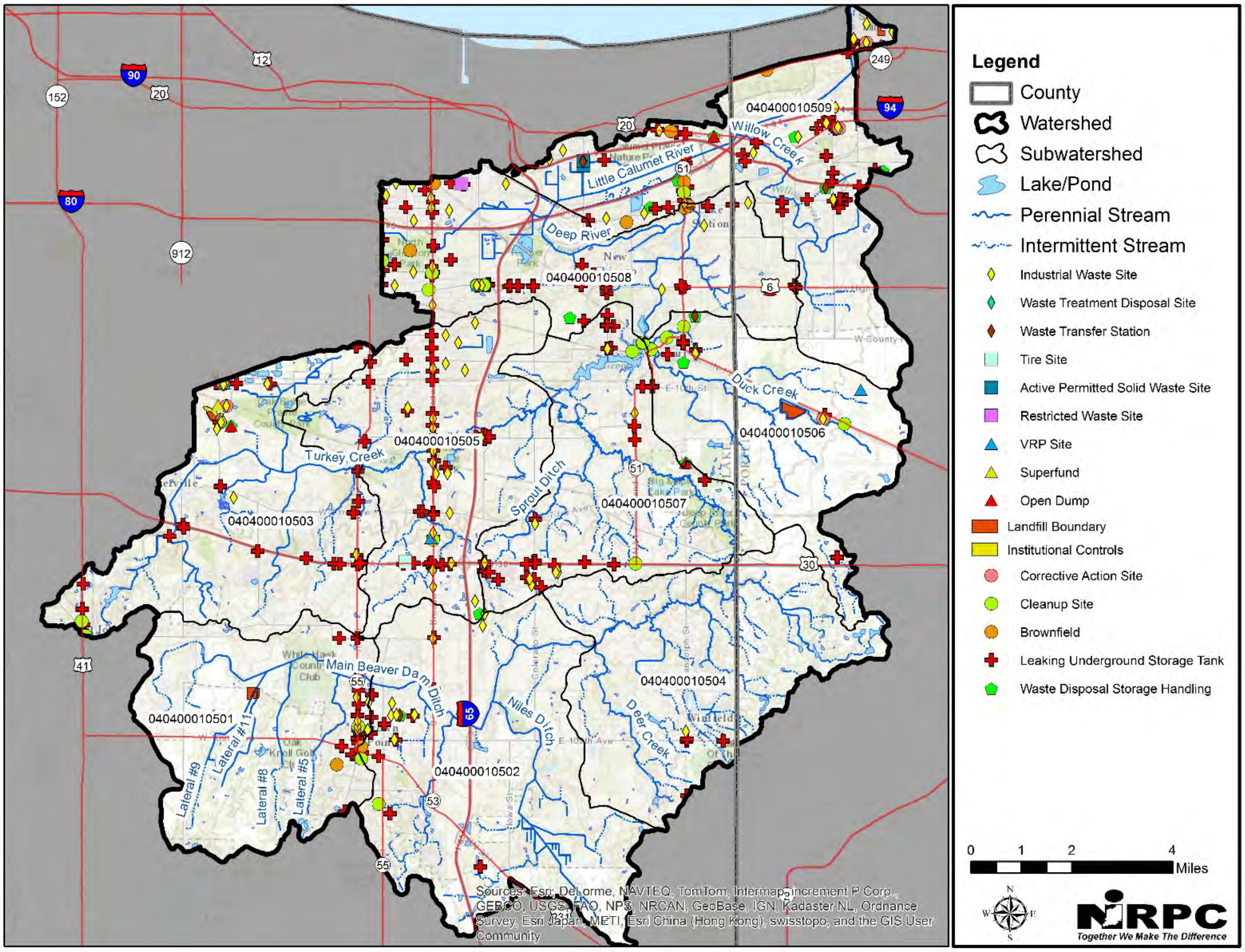


Figure 39 Remediation and waste sites

2.6.5 Natural Land Cover

The type, quantity, and structure of the natural vegetation within a watershed have important influences on aquatic habitats. Natural vegetative land cover regulates watershed hydrology, stabilizes soil, cycles nutrients, and provides habitat for terrestrial and riparian species. Natural land cover provides connectivity among riparian habitats and between terrestrial and aquatic ecosystems. Many aquatic organisms depend on being able to move through connected systems to habitats in response to variable environmental conditions.

Figure 40 shows the distribution of natural land cover in the watershed. Overall there is approximately 30,150 acres of forest, scrub/shrub, grassland and wetland cover in the watershed. Forest habitat comprises the largest percentage of natural land cover at 36% followed by wetland (30%), grassland (21%), and scrub/shrub habitat (13%).

Pre-settlement vegetation data, based on the accounts of land survey information, suggests that much of the watershed's upland landscape was dominated by savanna and prairie habitat. The Little Calumet River was bound by wetland and marshes. Marshes surrounded the low lying areas along Turkey Creek, Deep River and what is now Main Beaver Dam Ditch and Niles Ditch. Forested land was described along Deep River and a Duck Creek. The northern edge of the watershed was described as dune.

Today, the largest contiguous tract of natural cover is located along Deep River. This corridor is comprised or upland forest and floodplain wetland. Other notable concentrations of natural land cover include the eastern portion of the Deer Creek subwatershed, an the south central portion of the Headwaters Main Beaver Dam Ditch subwatershed, the northern portion of the Headwaters Turkey Creek subwatershed, and the area west of Lake George.

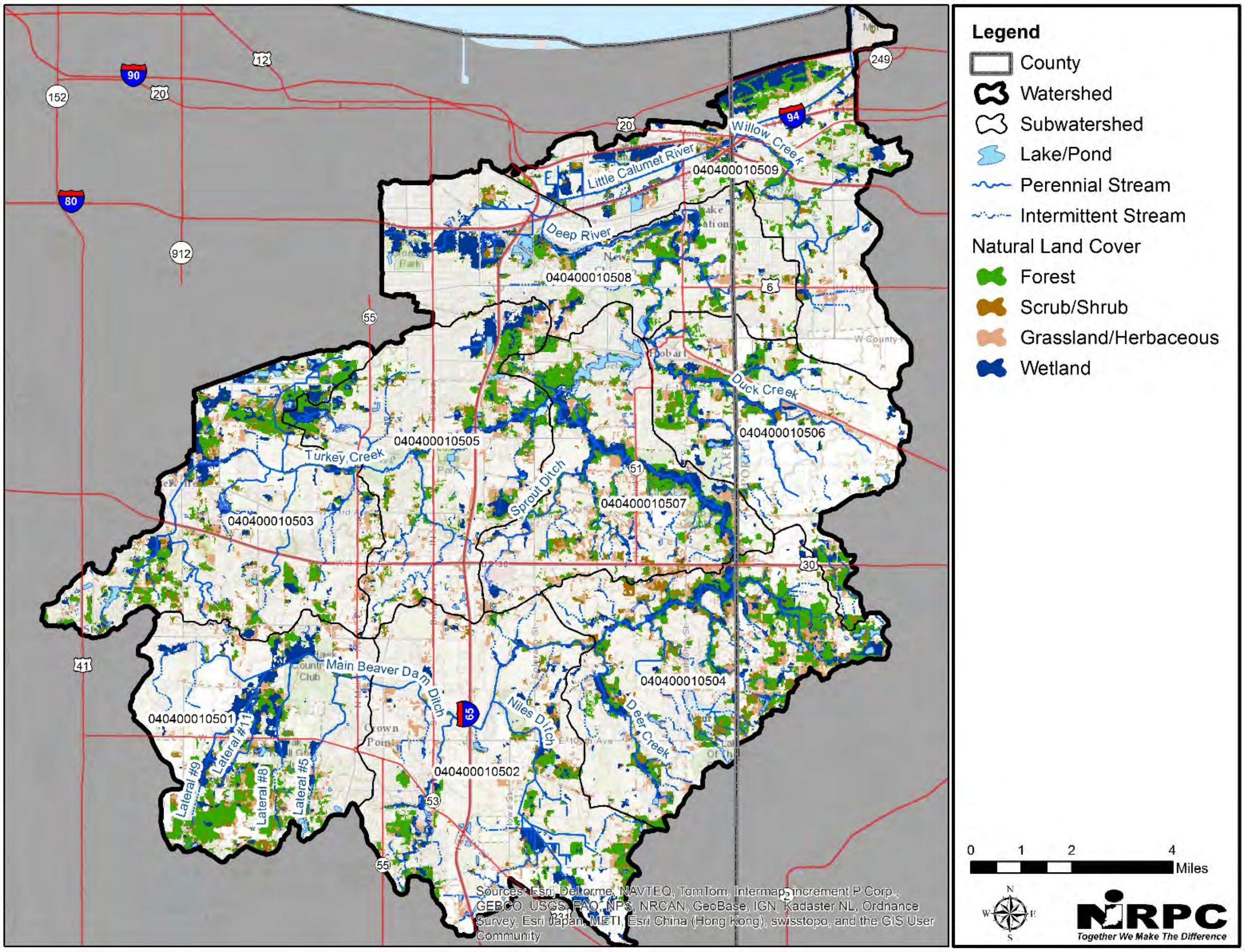


Figure 40 Natural land cover

2.6.5.1 *Forests*

The following section includes further discussion on watershed forested land cover and urban forests.

2.6.5.1.1 Forested Lands

Forests play a critical role in the health of a watershed. Forest cover reduces storm water 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 2010 there was approximately 10,891 acres of forestland within the watershed. Overall this accounts for 9% of the land area. Forest cover by subwatershed ranged from a low of 6% in the Main Beaver Dam Ditch-Deep River subwatershed to a high of 14% in the Deer Creek-Deep River subwatershed.

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 shown in Figure 41 and Figure 42. 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.

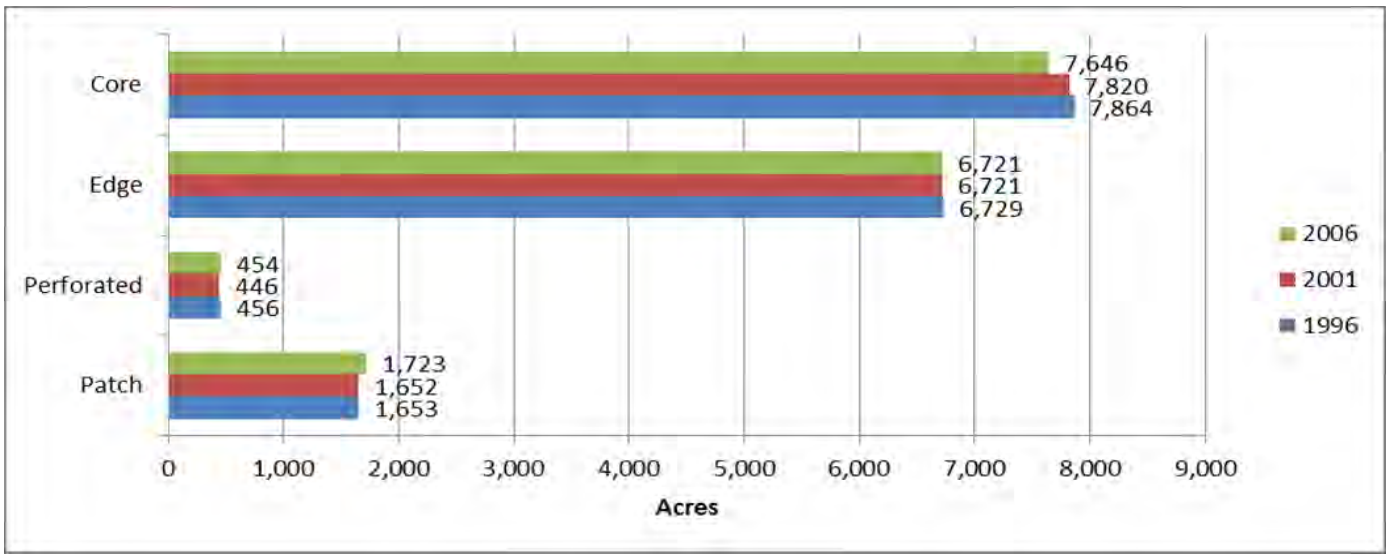


Figure 41 Forest fragementation data (1996-2006)

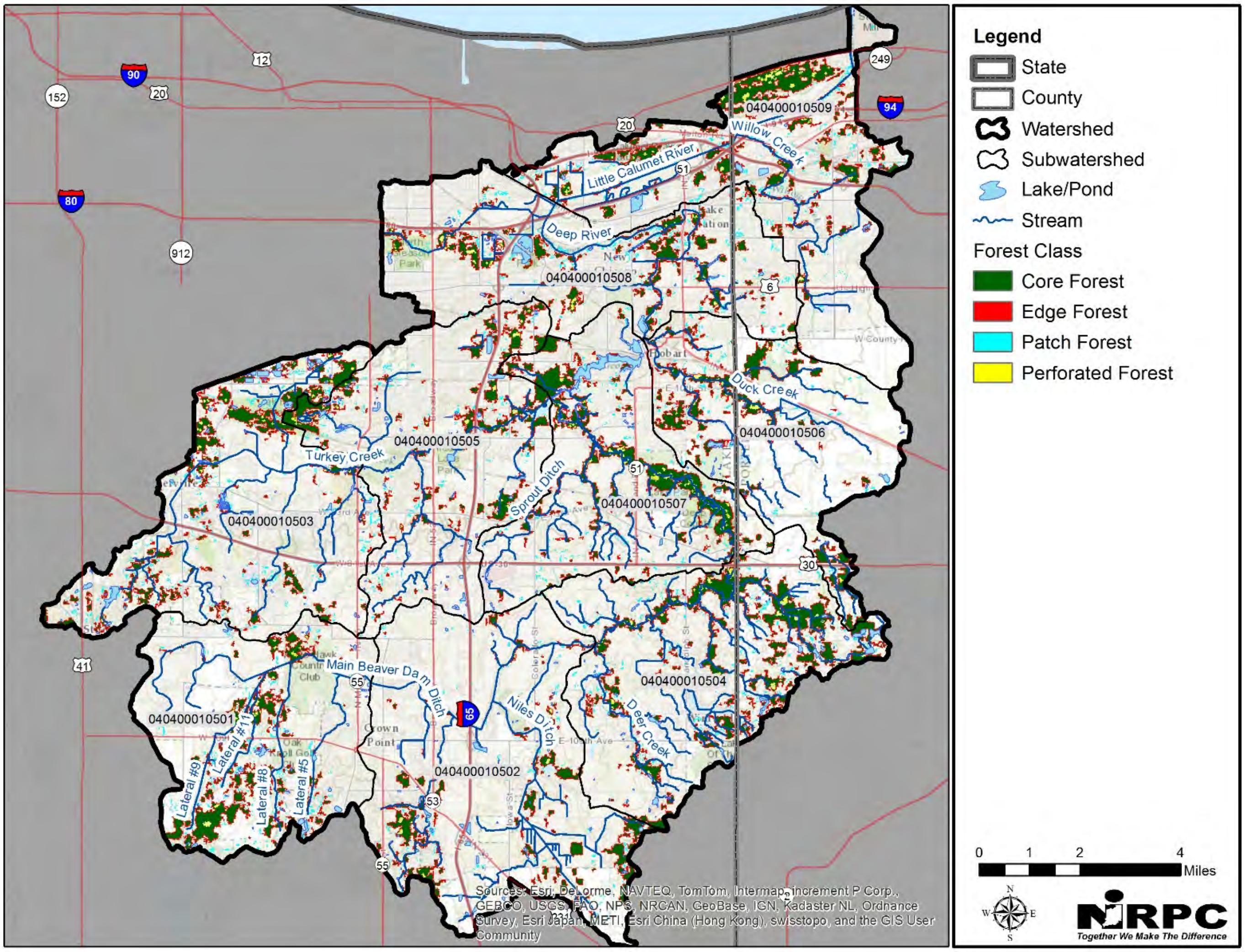


Figure 42 Forest Habitat

2.6.5.1.2 Urban Forest

There is an increasing awareness of how trees and forests in the urban landscape can improve air and water quality, reduce storm water runoff, conserve energy, and protect public health. At the same time, the loss of trees and forest cover to development continues. Also within existing developed areas, the urban tree canopy deteriorates through removal or lack of replacement. Impacts due to the loss of green space in urban watersheds, such as increased runoff and impervious cover, demonstrates the vital role of urban forestry in watershed management.

Urban tree canopy is defined as the layer of tree leaves, branches, and stems that cover the ground when viewed from above. Measuring tree canopy is important because it is the tree canopy that provides such benefits as rainfall interception, pollutant removal, and shading of streams and impervious surfaces. The following figure shows the percent canopy cover for municipalities within the watershed. The percent canopy cover ranges from a low of 14.4% in Crown Point to a high of nearly 58% in Ogden Dunes. The average percent canopy cover is slightly more than 26%. Forty percent (40%) canopy cover for metropolitan areas is a common target based on the recommendation by American Forests. However, it may not be realistic for some communities to meet this canopy cover goal, while others may surpass it.

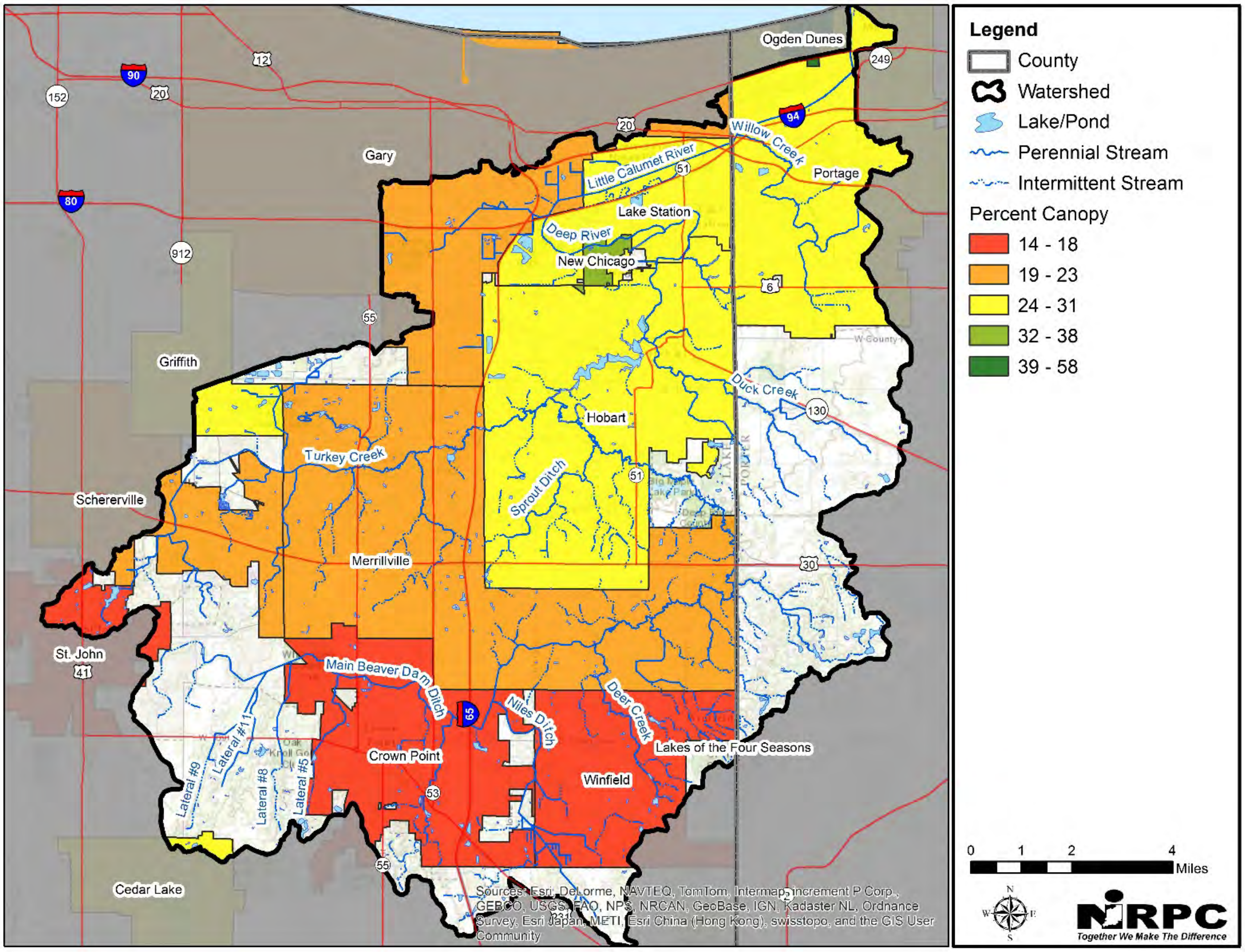


Figure 43 Municipal tree canopy cover

2.6.6 Land Cover Change & Trends

A review of land cover data from 1985 to 2010 shows a steady decline in agricultural land and increase in development (Figure 44). Between 1985 and 2010, 6,644 acres of agricultural land (-17%) was converted to other uses while development expanded by nearly 10,578 acres (26%). Decreases in natural land cover were also observed over this time period: 95 acres of forest (-1%), 1,427 acres of scrub/shrub (-27%), 2,061 acres of grassland (-24%), and 461 acres of wetland (- 5%). The most drastic changes came between 2006 and 2010 with 6,870 acres of new development (15%) and a loss of 2,718 acres of agricultural land (-8%), 2,004 acres of grassland (-24%), 1,330 acres of scrub/shrub habitat (-25%), and 423 acres of wetland (-5%).

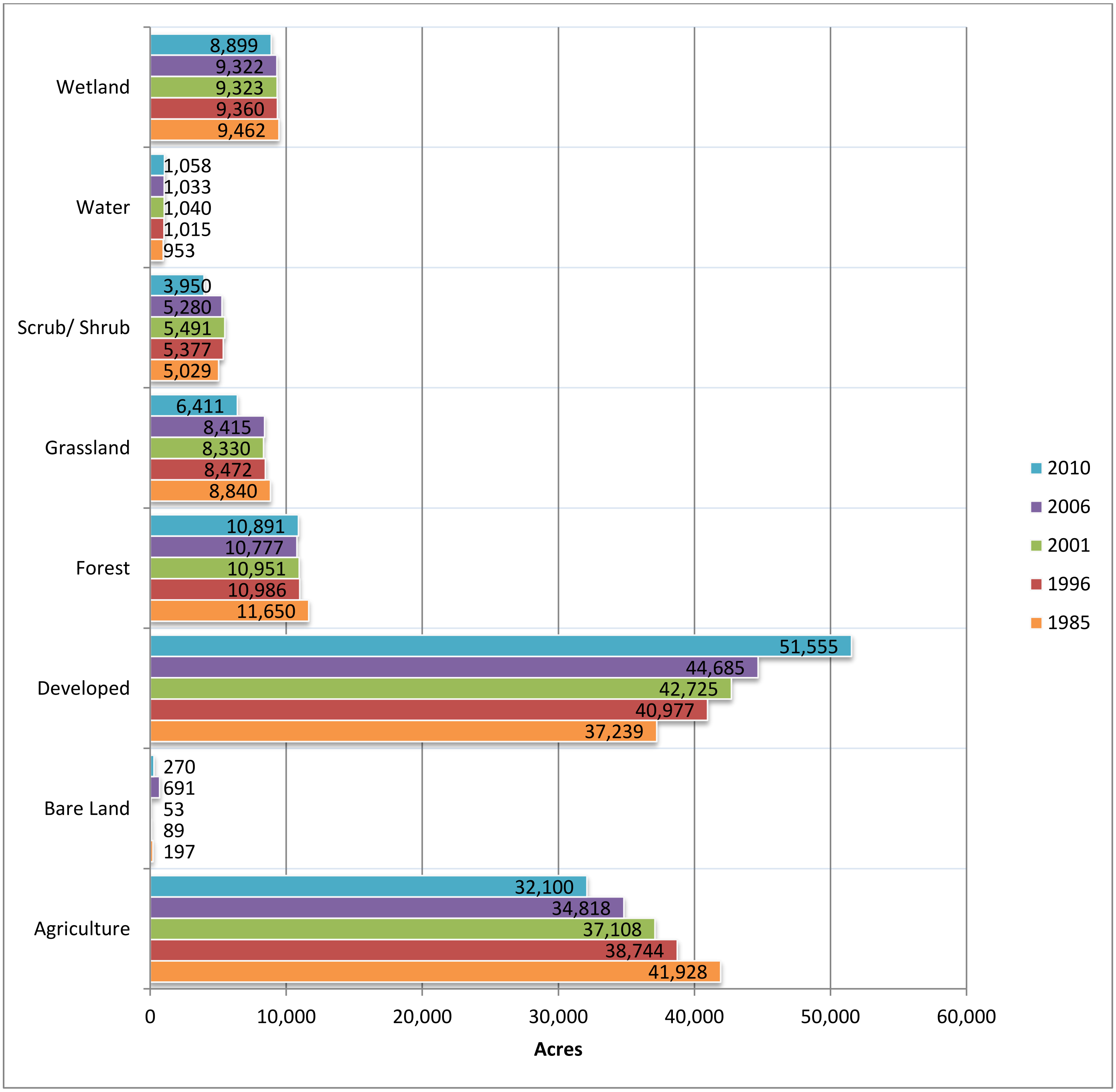


Figure 44 Land Cover Change (1985-2010)

Figure 45 highlights the successive pattern of new development observed in the watershed between 1985 and 2010. The heaviest area of recent growth is located south of US 30 around Crown Point, Merrillville and Winfield. Winfield's development has been considerable since its incorporation in 1993. Much of the development in the watershed 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.

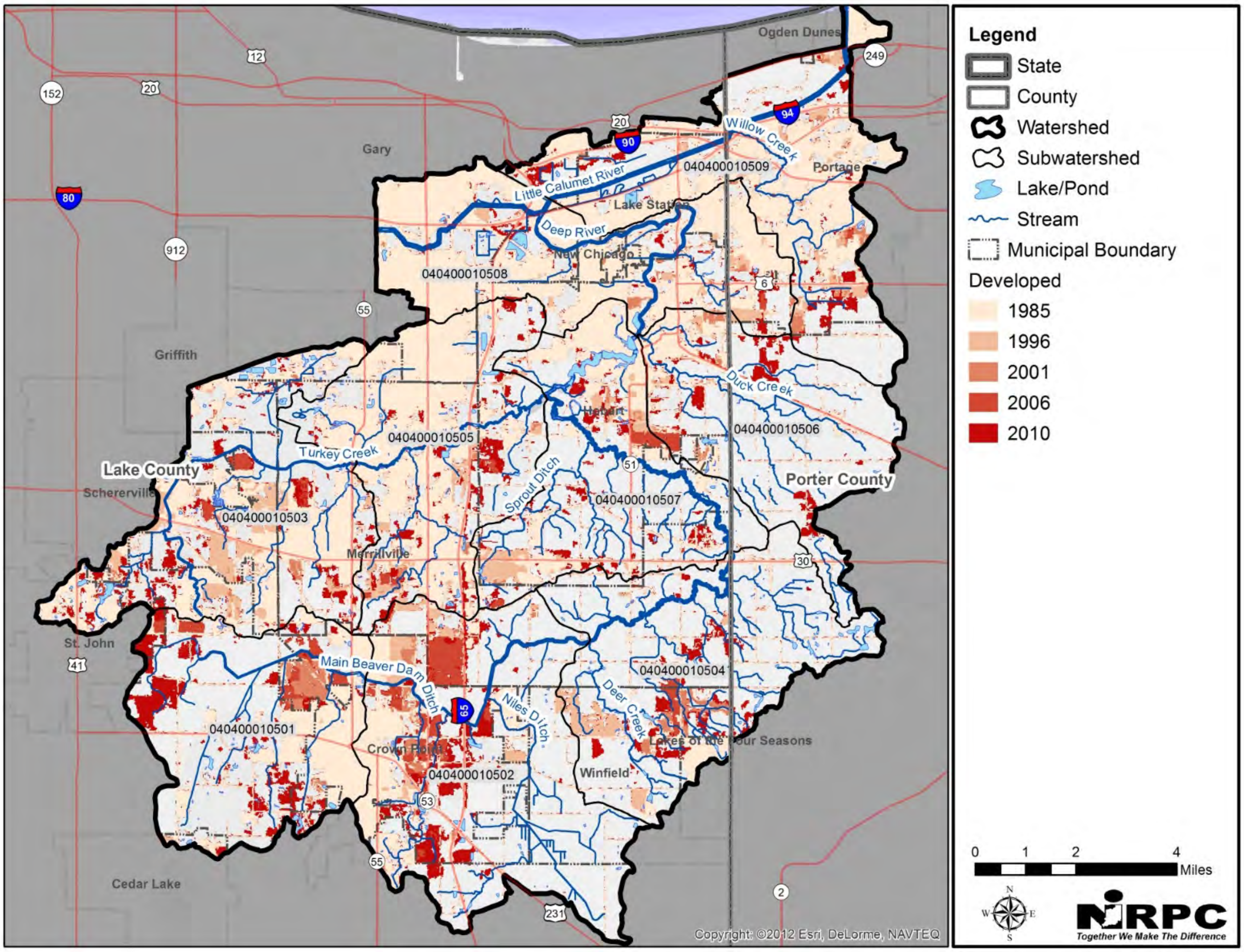


Figure 45 Successive Development Pattern for Watershed (1985-2010)

2.7 Other Planning Efforts

There are a number of past and current projects and other planning efforts that complement components of this watershed plan watershed plan.

Stakeholder Concerns Related to Other Planning Efforts:

- **Coordination amongst municipalities, businesses, and residents**
- **Maintenance of existing plans**
- **Lack of common goals/ manage for competing outcomes**
- **Enforcement of existing regulations to protect stream health**
- **Not enough inspection and monitoring**
- **Reconciling need for drainage/flood control with water quality and habitat**

2.7.1 Total Maximum Daily Load Reports

A Total Maximum Daily Load (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.

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

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. 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 drier 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.

The Indiana Department of Environmental Management completed a TMDL study for the Deep River-Portage Burns Waterway Watershed in 2014 (Figure 67). The TMDL was developed for *E. coli*, phosphorus, dissolved oxygen, impaired biotic communities, and siltation. Exceedances of water quality standards and target values often occurred across low to high stream flow conditions at many sites indicating the contribution of both point and nonpoint sources. Through the load duration curve approach, IDEM determined that load reductions for the parameters of concern are needed for specific flow conditions; the critical conditions (the periods when the greatest reductions are required) vary by parameter and location (Table 50 in the TMDL report).

The following table summarizes the percent reductions needed for total phosphorus, total suspended solids, and *E. coli* based on the highest observed concentrations to meet the TMDL. Dissolved oxygen is presented as the percentage below the water quality standard based on the minimum observed concentration. IDEM requires that load reductions in this plan be at least as stringent as those called for in the TMDL.

Subwatershed	IDEM Station #	Site #	DO % Below WQS	TP % Reduction	TSS % Reduction	*E. coli* % Reduction
Headwaters Main Beaver Dam Ditch	LMG-05-0022	27	72%	59%	32%	35%
	LMG-05-0020	25	83%	29%	0%	43%
	LMG-05-0021	26	87%	52%	66%	70%
	LMG-05-0019	24	92%	14%	0%	82%
Main Beaver Dam Ditch	LMG-05-0018	23	26%	82%	0%	37%
	LMG-05-0015	18	0%	53%	82%	70%
	LMG-05-0036	22	22%	0%	60%	66%
	LMG-05-0017	21	94%	77%	89%	0%
	LMG-05-0016	20	86%	0%	0%	63%
Headwaters Turkey Creek	LMG-05-0024	19	0%	0%	0%	65%
	LMG-05-0027	22	0%	0%	64%	1%
	LMG-05-0023	28	71%	89%	77%	70%
	LMG-05-0025	30	60%	0%	0%	0%
	LMG-05-0026	31	49%	0%	0%	58%
	LMG-05-0028	33	64%	0%	32%	71%
Deer Creek- Deep River	LMG-05-0035	19	15%	35%	67%	54%
	LMG-05-0014	17	0%	0%	0%	53%
	LMG-05-0034	16	0%	0%	73%	67%
	LMG-05-0013	15	0%	0%	0%	66%
	LMG-05-0031	36	0%	0%	63%	82%

Subwatershed	IDEM Station #	Site #	DO % Below WQS	TP % Reduction	TSS % Reduction	*E. coli* % Reduction
City of Merrillville- Turkey Creek	LMG-05-0030	35	0%	19%	80%	77%
	LMG-05-0029	34	90%	23%	70%	33%
Duck Creek	LMG-05-0032	11	76%	65%	69%	81%
	LMG-05-0009	9	5%	0%	0%	62%
	LMG-05-0010	10	0%	0%	0%	65%
Lake George- Deep River	LMG-05-0012	14	59%	14%	83%	46%
	LMG-05-0011	12	48%	0%	3%	65%
	LMG-30-0008	8	3%	0%	0%	62%
	LMG-05-0033	13	0%	57%	89%	76%
Little Calumet River- Deep River	LMG-05-007	6	0%	0%	0%	0%
	LMG-05-006	5	17%	0%	0%	0%
	LMG-05-0008	7	49%	0%	9%	64%
Willow Creek- Burns Ditch	LMG-05-0002	1	22%	0%	3%	57%
	LMG-05-0004	3	0%	0%	62%	81%
	LMG-05-0003	8	0%	0%	0%	83%

Table 31 Load reductions required from TMDL

2.7.2 Watershed Management Plans

Two previous watershed management plans were previously developed within the current Deep River-Portage Burns Waterway watershed boundary. These include the 2002 Deep River-Turkey Creek Watershed Management Plan and the 2008 West Branch Little Calumet River Watershed Management Plan (Figure 2). The current watershed planning effort was undertaken largely because of large changes in land use/land cover and persisting water quality issues. Additionally, neither of the two previous plans had an active watershed group or committee structure in place once they were completed to coordinate implementation watershed wide.

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

2.7.2.1 *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 the plan's primary focus was the Deep River-Lake George Dam subwatershed (HUC 04040001030060).

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 storm water management programs
    - Develop joint storm water/ water quality education programs w/ communities in DR/ TC watershed over the next 5 years
    - Develop consistent storm water 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 storm water 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 yet 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:

- Several hundred feet of Lake George shoreline has been stabilized at Pavese Park and Fred Rose Park using bioengineering techniques
- Streambank stabilization project at Deep River County Park
- Web-based septic system tracking database (ISDH's iTOSS)
- City of Hobart has initiated a sanitary sewer connection program to address known septic system problem areas

2.7.2.2 *West Branch Little Calumet River Watershed Management Plan*

The West Branch Little Calumet River Watershed Management Plan was coordinated by the City of Gary Storm Water Management District and completed in 2008. 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:

- 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

A majority of the critical areas identified within the plan occur within the Little Calumet River levee system. 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).

The City of Gary is implementing some of the recommended actions from the watershed plan through the Vacant to Vibrant (V2V) program in the Aetna neighborhood. The Vacant to Vibrant program is a Great Lakes Protection Fund initiative led by Cleveland Botanical Garden in collaboration with project partners in Gary, IN, Cleveland, OH, and Buffalo, NY. The goal of the project is to create joint storm water management / neighborhood recreational assets on small, distributed vacant residential parcels in urban neighborhoods and to measure the effectiveness of these installations as green storm water infrastructure and as tools for neighborhood stabilization. To date, several community raingardens have been installed through the program in the neighborhood. Further information is available at www.cbgarden.org/lets-learn/research/vacant2vibrant.aspx.

Adjacent to the Indiana University Northwest campus, the university is expanding and managing a nature preserve in Gary. The Little Calumet River Prairie & Wetlands Nature Preserve consists of 11 acres of prairie, wetland, and woodland immediately north of the main campus parking lot. Prior to settlement, the site featured the Little Calumet River as it meandered among associated wetlands and low dunes. During settlement, the river was straightened and ditched, and the wetlands filled in and covered with topsoil. The lowest areas still retain water and the whole area is vulnerable to flooding during heavy rain.

The Little Calumet River Prairie & Wetlands is a nature preserve that restores ecological habitats once common in the local area. The Prairie & Wetlands primary goal is to have more than 250 native plant species living on the site. Prior to the intense flood of 2008, that goal had been reached, however due to flooding, plant diversity was diminished. With knowledge gained, the site is now at 200 species and is being partially reworked to better withstand flood conditions. Additional information is available at www.iun.edu/coas/related-information/little-calumet-river-prairie-and-wetlands-preserve.htm.

2.7.3 Municipal Separate Storm Sewer System (Rule 13) & Rule 5 Programs

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. These include Cedar Lake, Crown Point, Gary, Griffith, Hobart, Lake Station, Merrillville, New Chicago, Saint John, Schererville, Portage, and Lakes of the Four Seasons (Figure 46). 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. Portions of unincorporated Lake and Porter Counties are also designated MS4s.

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

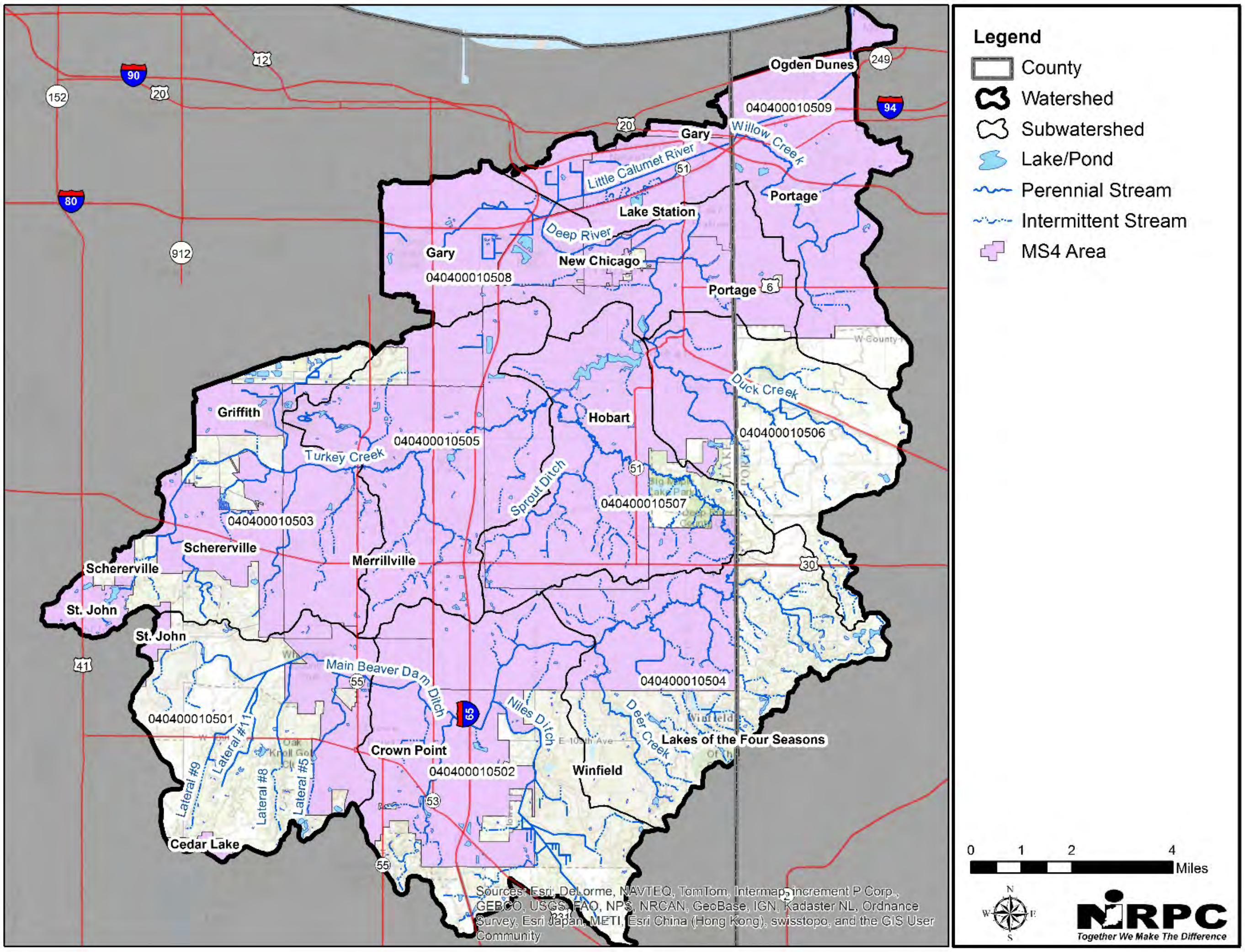


Figure 46 MS4 areas

Areas outside of the MS4 boundaries are subject to Rule 5 (327 IAC 15-5). Rule 5 is intended to reduce pollutants, principally sediment, that are a result of soil erosion and other activities associated with construction land-disturbing activities. IDEM administers a general permit program in cooperation with local Soil & Water Conservation Districts that targets construction activities that result in land disturbance of one acre or more. Construction plans are submitted to the county Soil & Water Conservation Districts for review.

The MS4, Rule 5 and Section 319 programs are both aimed at reducing storm water runoff pollution. However the MS4 and Rule 5 programs are regulatory in nature while the 319 program is generally considered a voluntary assistance program. While each of the programs are aimed at reducing runoff pollution, 319 grant funds cannot be used to pay for the storm water pollution controls required by the MS4 area's Storm Water Quality Management Plan (SWQMP).

MS4s share many of the same goals as watershed groups do. While some separation is necessary, MS4 requirements are not so broad that they preclude work from being done in the watershed. Familiarity with the individual MS4 entities and its requirements is paramount. Partnership opportunities typically exist. The greatest opportunities for collaboration exist in public education and outreach, public participation and involvement, and post-construction storm water runoff control. Using a watershed scale approach in implementing education and outreach messaging and activities usually goes above and beyond what an individual MS4 entity would include in its SWQMP. Implementing post-construction runoff control measures as retrofits in existing developed areas also typically goes above and beyond permit requirements under the MS4 rule.

2.7.4 Combined Sewer Overflow Long Term Control Plans

Combined sewer overflow 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.

CSO controls may be grouped into four broad categories: operation and maintenance practices, collection system controls, storage facilities, and treatment technologies. Most of the early efforts to control CSOs emphasized "gray infrastructure," which describes traditional practices for storm water management that involve pipes, sewers and other structures involving concrete and steel. One of the most commonly implemented types of gray infrastructure is off-line storage. Off-line storage facilities store wet weather combined sewer flows in tanks, basins, or deep tunnels located adjacent to the sewer system until a wastewater treatment plant has the capacity to treat the stored wastewater.

There are two CSO communities, which include the Cities of Crown Point and Gary, that have outfalls in the watershed (Figure 37). Based upon information from IDEM's Municipal NPDES Permits Section, LTCP's have been submitted by the Crown Point Waste Water Treatment Plant (WWTP) and Gary WWTP. Crown Point's LTCP was approved in 2008. Gary's LTCP was still awaiting approval at the time this watershed plan was drafted. Crown Point has implemented a number of tasks included in their LTCP since its approval. These include construction of Anderson Pond (2008), floatable/solids controls (2008), and high priority inflow/infiltration (I/I) reduction. WWTP filter system replacement and biosolids facility improvements are planned between 2015 and 2016 along with further inflow/infiltration reductions.

An alternative to the reliance on conventional control approaches is the incorporation of green infrastructure. Green infrastructure practices mimic natural hydrologic processes to reduce the quantity and/or rate of storm water flows into the combined sewer system (CSS). By controlling storm water runoff through the processes of infiltration, evapotranspiration, and capture and use (rainwater harvesting), green infrastructure can help keep storm water out of the CSS. Although green infrastructure alone is often unlikely to fully control CSOs, it may be able to reduce the size of more capital-intensive, "downstream" gray infrastructure control measures, such as storage facilities or treatment technologies.

Green infrastructure also supports the principals of Low Impact Development (LID), an approach to land development (or re-development) that works with nature to manage storm water as close to its source as possible. Green infrastructure can be utilized at varying scales—both at the site and watershed level. For example, small source control practices such as rain gardens, bioswales, porous pavements, green roofs, infiltration planters, trees, and rainwater harvesting can fit into individual development, redevelopment or retrofit sites. Larger scale management strategies such as riparian buffers, flood plain preservation or restoration, open space, wetland and forest preservation and restoration, and large infiltration systems can be used at the subwatershed or watershed level.

More information about incorporating green infrastructure into CSO Long Term Control Plans is available through the U.S. EPA's Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow Control www.epa.gov/sites/production/files/2015-10/documents/greening_cso_plans_0.pdf.

Inclusion of green infrastructure implementation strategies could be a common thread linking the Deep River-Portage Burns Waterway Watershed Plan and the CSO community Long Term Control Plans.

2.7.5 Comprehensive Watershed Plan: Little Calumet River- Lake County Basin (LCRBDC)

This plan is in part a result of legislation passed in 2012 under House Bill 1264 which greatly expanded the Little Calumet River Basin Development Commission's responsibilities beyond just the upkeep of the Little Calumet River levee system. The new law introduced an annual fee for all property owners within the "Little Calumet River Watershed". These funds can be used for expenses directly related to the operation, repair and maintenance of flood protection systems within the entire project area which includes the Lake County Portion of the Deep River-Portage Burns Waterway watershed (Figure 4).

A primary objective of the plan, which was completed in August 2013, was to identify opportunities within the watershed that improve the quality of life by reducing flooding and improving recreational and environmental aspects within the watershed. Flooding, recreational use, and environmental quality are also public concerns that have been identified here in the Deep River-Portage Burns Waterway Watershed Plan.

The plan's project consulting team interviewed local stakeholders who included municipal and county representatives and U.S. Army Corps of Engineer technical staff to develop a list of opportunities within the Little Calumet River watershed. Project opportunities were classified as regional, semi-regional, local, maintenance or operational. The focus was on conveyance and storage to reduce flooding impacts. Both conveyances and storage play important roles in a watershed. They can both keep an area from flooding if managed properly. Conveyances play the important role of carrying storm water to the outfall. Storage plays a vital role in the attenuation of downstream flood flows, the recharge of groundwater, enhancement of water quality, and enhancement of wildlife habitat. Conveyances include streams, channels, waterways, culverts, sewers, and even overland routes (e.g. roadways, fields). Storage occurs in floodplains, depressional areas, detention basins, retention basins, and natural and constructed wetlands

The following table adapted from the Comprehensive Watershed Plan outlines opportunities within the Deep River-Portage Burns Waterway watershed. Further details about project opportunities is available at http://littlecalriverbasin.org/pdf/WatershedStudy.pdf.

Summary of Regional Opportunities					
Unique ID	**Community**	**Major Project Name**	**Minor Project Name**	**Major Watershed**	**Minor Watershed**

General 2	General	Little Calumet River/Deep River- Confluence Improvement	Storage Adjacent to LCR at I-65/I-80	Little Calumet River	Little Calumet River
General 4	General	Little Calumet River/Deep River- Confluence Improvements	Burns Ditch Conveyance Improvements	Little Calumet River	Little Calumet River
General 5	General	Little Calumet River/Deep River- Confluence Improvements	Deep River Deep Tunnel	Deep River	Deep River
Lake Station 3	Lake Station	Little Calumet River/Deep River- Confluence Improvements	Deep River Dam Rehabilitation	Deep River	Deep River
Lake Station 7	Lake Station	Little Calumet River/Deep River- Confluence Improvements	Lake George Dam Control Policy	Deep River	Deep River
LCRBDC 15	LCRBDC	Little Calumet River/Deep River- Confluence Improvements	I-65/I-94 Interchange Storage Area Repairs	Little Calumet River	Deep River
Summary of Semi-Regional Opportunities					
Unique ID	**Community**	**Major Project Name**	**Minor Project Name**	**Major Watershed**	**Minor Watershed**
Lake County 7	Lake County	Beaver Dam Ditch- Storage	Beaver Dam Ditch- Lateral 1 (Regional Detention Basin)	Deep River	Beaver Dam Ditch
LCHWY 14	LCHWY	Deep River Conveyance- Bridge Reconstruction	Bridge 254 Reconstruction	Deep River	Lake George
LCHWY 15	LCHWY	Deep River Conveyance- Bridge Reconstruction	Bridge 252 Reconstruction	Deep River	--
LCHWY 18	LCHWY	Deep River Conveyance- Bridge Reconstruction	Bridge 89 Reconstruction	Deep River	--
LCHWY 19	LCHWY	Deep River Conveyance- Bridge Reconstruction	Bridge 98 Reconstruction	Deep River	--
LCHWY 20	LCHWY	Deep River Conveyance- Bridge Reconstruction	Bridge 92 Reconstruction	Deep River	Niles Ditch
Winfield 1	Winfield	Deep River- Storage	Hidden Creek Subdivision Regional Stormwater Project	Beaver Dam	Hidden Creek
LCHWY 3	LCHWY	Turkey Creek Conveyance- Bridge Reconstruction	Bridge 116 Reconstruction	Turkey Creek	--
LCHWY 4	LCHHWY	Turkey Creek Conveyance- Bridge Reconstruction	Bridge 113 Reconstruction	Turkey Creek	--
Lake County 1	Lake County	Turkey Creek Storage	Upper Turkey Creek Stormwater Storage Project	Turkey Creek	--
Lake County 4	Lake County	Turkey Creek Storage	Upper Turkey Creek Overbank Detention	Turkey Creek	--
Lake County 5	Lake County	Deep River Storage	121st and Iowa Drainage	Deep River	Niles Ditch

			Improvements w/ NRCS		
Merrillville 1	Merrillville	Turkey Creek Storage	Lincoln Gardens and Southbrook Subdivision Drainage Project	Deep River	Kaiser Ditch
Merrillville 2	Merrillville	Turkey Creek Storage	Country Club Heights and Meadowdale Subdivision Drainage Project	Deep River	Griffith Lateral 6

Summary of Local Opportunities

Unique ID	Community	Major Project Name	Minor Project Name	Major Watershed	Minor Watershed
Hobart 20	Hobart	Deep River Storage	Northwinds Regional Detention Basin	Deep River	--
Hobart 21	Hobart	Deep River Storage	Nob Hill Regional Detention Basin	Deep River	--
Hobart 14	Hobart	Turkey Creek Storage	Evergreen Memorial Park Storage	Turkey Creek	--
Schererville 6	Schererville	Turkey Creek Storage	Potential Stormwater Storage Project	Turkey Creek	--
Schererville 7	Schererville	Turkey Creek Storage	Potential Stormwater Storage Project	Turkey Creek	--
Schererville 8	Schererville	Turkey Creek Storage	Potential Stormwater Storage Project	Turkey Creek	--
Crown Point 3	Crown Point	--	Stillwater Subdivision Drainage Improvements	Beaver Dam	Crooked Creek
New Chicago 4	New Chicago	--	Culvert Improvements under Wisconsin St. at Huber Blvd.	Deep River	--
New Chicago 5	New Chicago	--	Twin Oaks Park Pond Improvements	Deep River	--
Hobart 4	Hobart	--	"Stinky Creek"	Deep River	Stinky Creek
Hobart 5	Hobart	--	Brickie Bowl Flooding	Deep River	Duck Creek
Hobart 6	Hobart	--	Barrington Ridge Stormwater Drainage Improvements	Deep River	Duck Creek
Hobart 7	Hobart	--	61st Ave. and Wisconsin St. Regional Storage	Deep River	Lake George
Hobart 8	Hobart	--	Preserves Storage	Deep River	Turkey Creek
Hobart 9	Hobart	--	Liverpool Rd. Constructed Wetland	Deep River	--

Lake Station 6	Lake Station	--	Residential Drainage Improvements between 27th and 29th Avenues	Deep River	--
Summary of Maintenance Opportunities					
Unique ID	**Community**	**Major Project Name**	**Minor Project Name**	**Major Watershed**	**Minor Watershed**
LCRBDC 10	LCRBDC	Culvert Repair/Maintenance	Culvert Repair between Chase and Grant	Deep River	--
LCRBDC 11	LCRBDC	Little Calumet River-Conveyance Opportunity	Aerial Sanitary Sewer East of Broadway	LCR	LCR
Hobart 2	Hobart	Dredging	Lake George Dredging	Turkey Creek	Turkey Creek
Merrillville 3	Merrillville	General Waterway Stabilization and Sediment Control Opportunities	Turkey Creek Stabilization	--	--
Hobart 15	Hobart	Stabilization and Sediment Control Opportunities	Sediment Control for Deep River and Turkey Creek	Deep River	--
Hobart 16	Hobart	Stabilization and Sediment Control Opportunities	Lake George Shoreline Stabilization	--	Niles, Crooked Creek
Crown Point 5	Crown Point	Waterway Clearing Opportunities	Beaver Dam Ditch Maintenance	Deep River	Deep River
Lake County 6	Lake County	Waterway Clearing Opportunities	Unregulated Deep River Clearing	--	--

Table 32 LCRBDC Comprehensive Watershed Plan project opportunities to improve conveyance and storage

2.7.6 Indiana Coastal Nonpoint Pollution Control Plan

As a part of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), Congress created a stand-alone provision, Section 6217, which requires that states and territories with approved coastal management programs develop a coastal nonpoint pollution control program to address water quality impairment of coastal waters. Indiana's Coastal Nonpoint Pollution Control Plan identifies the programs and enforceable authorities that the state uses to control nonpoint pollution in each of six nonpoint source categories which include:

- Agriculture
- Forestry
- Urban and Rural Areas
- Marinas
- Hydromodification
- Wetlands, Riparian Areas and Vegetated Treatment Systems

Watershed management is a key implementation mechanism for the Indiana Coastal Nonpoint Program and its plan. IDEM requires that watershed plans developed in the Coastal Program area be consistent with the Coastal Nonpoint Program. While there is no formal review process or checklist that check for consistency, NIRPC has and will continue to coordinate with the Coastal Program to assure consistency between this watershed plan and the Coastal Nonpoint Program plan. Further details about the Coastal Nonpoint Pollution Control Plan can be found on the DNR's Lake Michigan Coastal Program website http://www.in.gov/dnr/lakemich/6084.htm.

2.7.7 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 the 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 storm water and attenuating flood impacts, and increasing passive recreational opportunities.

2.7.8 Northwest Indiana Greenways & Blueways Plan

The goals of the Northwest Indiana Greenways & Blueways Plan include:

- Create a vision for greenway preservation and water trail development in Northwest Indiana
- Create a conversation among stakeholders on the attributes in greenway development and conservation
- Provide an interactive resource for local and county jurisdictions to utilize as they develop their visions and plans and negotiate development proposals that affect their remaining open space corridors
- Facilitate active discussion on potential water trail opportunities

Water trail opportunities have been identified along portions of Beaver Dam Ditch, Turkey Creek and Deep River. The Northwest Indiana Regional Planning Commission is will be updating this plan in 2016. Recreational access and the potential impacts that stream impairments have on recreational use were identified as public concerns for the watershed.

2.7.9 Wellhead Protection Program

In Northwest Indiana a vast majority, approximately 97%, of the public water supply comes from Lake Michigan. However, in the rural areas of the watershed many residents and business rely on groundwater.

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.

The Wellhead Protection Program is relevant to the Deep River-Portage Burns Waterway Watershed Plan because groundwater and drinking water quality were identified as public concerns.

2.7.10 Indiana Wetland Program Plan

The Indiana Wetland Program Plan was coordinated by the Indiana Department of Environmental Management (IDEM). The intent of the plan is to guide continued wetland conservation and restoration. Like the Deep River-Portage Burns Waterway Watershed Restoration Plan, the Indiana Wetland Program Plan is a voluntary plan. It describes what goals a state or tribe wants to achieve related to its wetland resources over time.

The vision of this Indiana Wetland Program Plan is to advance the understanding of the beneficial services that wetlands provide, to promote the restoration and creation of high quality wetlands, and to conserve and protect remaining wetlands. The plan includes priorities, goals, and action items reflecting the opinions and needs of many wetland stakeholders located throughout the state. A number of the goals and action items in the plan reference partner groups like watershed groups. For example one of the goals calls for increasing wetland acreage and functions by targeting restoration of key properties and leveraging financial resources between agencies and partner organizations.

The Indiana Wetland Program Plan is available at www.in.gov/idem/wetlands/files/program_plan.pdf.

2.7.11 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 plan's 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 that included residents, elected officials and the owners of the various managed lands near Hobart Marsh. 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.

The Hobart Marsh area has been identified as a priority preservation area as part of this watershed plan. Please see Section 10 for more information.

2.7.12 Deep River Flood Risk Management Plan

The Deep River Flood Risk Management Plan was completed in May 2015 for the City of Hobart and Little Calumet River Basin Development Commission by SEH. The primary purpose of this Plan is to evaluate several flood risk management concepts to determine their effectiveness using a detailed hydraulic model. LiDAR-based topographic data and extensive bathymetric survey data were used together to create a significantly more detailed representation of the existing ground surface than was used for previous modeling. Several potential flood risk management alternatives were evaluated including both structural and non-structural options.

A number of findings and risk management alternatives presented in the plan are directly related to the public concerns identified here in the Deep River-Portage Burns Waterway Watershed Plan.

2.7.12.1 *Structural Alternatives*

Levee

Based on inundation mapping a set-back levee was identified a potential flood mitigation alternative in the area between the Deep River dam in Lake Station and the confluence with the Little Calumet River. Levees are a form of hydromodification that need to be planned, operated and maintained to mitigate potential negative impacts to water quality and aquatic habitats. According to the flood risk management plan, if a levee was constructed in this area, interior drainage facilities would need to be introduced to drain interior storm water through the barrier. Currently, there is limited storm sewer infrastructure in this area, with most runoff routed to Deep River through overland flow. Construction of a levee would interrupt this overland drainage pattern and would require construction of a gated storm sewer outlet system and possibly a pump station to convey storm water to Deep River. This could result in the acceleration of pollutant delivery to Deep River.

Deep River Dam in Lake Station

The Deep River dam located in Lake Station was also evaluated as part of the Flood Risk Management Plan. Due to the deteriorated physical condition of the dam, if failure were to occur, it would likely be due to washout at the abutment ends of the sheet pile wall or seepage through the sheet pile wall. If such a failure were to occur during a high flow event, when tailwater inundates the dam, it is unlikely that a significant flood wave would be produced. However, if such a failure were to occur during a low base flow or “sunny day” event, a flood wave would likely result due to the greater differential between the pool and tailwater elevations. This failure mode may be a threat to persons directly below the dam. Additionally, sediment that has accumulated over 70+ years in the upstream pool would be suddenly released.

Given the current condition of the existing dam, two different scenarios were evaluated for the site, one without the dam and one with a new dam that is capable of being used as a drawdown structure. If the existing dam was removed completely, the normal water surface elevation would be lowered nearly 3 feet which would reduce the river from 235 feet to 120 feet in the pool area immediately upstream. This degree of change would impact upstream wetland habitat along the periphery of the impoundment and current recreational uses (i.e. boating and fishing). Replacement of the dam showed minimal benefit in peak water surface elevations for an event similar to the September 2008 flood because of the high tailwater condition.

Floodplain Storage

Three potential areas were identified that could be used to construct flood storage basins which would serve as offline storage. The first storage area considered, Rosser Storage, involves the use of existing Rosser Lake, which is immediately south of the Three Rivers County Park in Lake Station. The second storage area considered is an undeveloped area along the left bank of Deep River between Indiana Street and Arizona Street, north of 35th Avenue. The third storage option considered is agricultural land along the left bank of Deep River immediately upstream of the 37th Avenue Bridge and along the right bank of Deep River immediately downstream of the 37th Avenue Bridge. In order to be used as flood storage basins, significant construction would be required to excavate the areas and construct inlet structures to connect them to Deep River. Based on the modeling results described above, it was determined that for the amount of storage that could be added in this area, addition of floodplain storage in this area would not be beneficial and therefore was not modeled in detail.

2.7.12.2 *Nonstructural Alternatives*

Channel Conveyance

Overbank clearing was evaluated as a means to improve conveyance. The results show that clearing the trees in the overbank area between the CFE railroad bridge and the confluence with the Little Calumet River could reduce the peak water surface elevations by up to approximately 0.8 feet for the September 2008 event. However, such an effort would significantly change the habitat and aesthetics of the Deep River corridor, and may not be economically feasible. The plan noted that while it may not be desirable to clear the overbank areas as described herein, it may be prudent to snag and remove fallen trees which could eventually become floating debris. This section of Deep River is included on the "Outstanding Rivers List for Indiana" by the Natural Resources Commission. Rivers and streams included on this list are considered to have a particular environmental, recreational, or aesthetic interest.

Another option to increase channel conveyance was to widen the channel by excavating to increase the available flow area. This would be most beneficial in an area where the channel narrows and causes a bottle-neck effect. After reviewing the study reach for this type of condition, the most significant channel narrowing was identified at the 37th Avenue Bridge. A field survey showed that rock was placed on the bridge abutments, significantly narrowing the channel through the bridge.

Lake George Sediment Management

The current average lake depth based on the bathymetric survey conducted in 2014 as part of the Flood Risk Management Plan is approximately 3 feet in the two pools immediately east and west of Wisconsin Street, approximately 6 feet for the two pools immediately upstream of the Lake George Dam, and approximately 1.5 feet for the two most upstream pools (not dredged previously). Cross sections of the post-dredging lake bottom from the 2001 record drawings were compared to the 2014 bathymetric data. The comparison shows that approximately 70,000 cubic yards of material has accumulated in the past 14 years. This evaluation also showed that the most significant accumulation occurred in the two pools immediately east and west of Wisconsin Street.

The plan states there is interest in constructing sediment traps upstream of Lake George in order to minimize the sedimentation occurring in the lake. However, calculations showed that the sediment basin(s) would need to be 110 to 230 acres, dependent on average flows, to effectively capture the very fine silt that is currently accumulating in Lake George. In effect, a basin roughly the size of Lake George itself would need to be constructed.

The U.S. Army Corps of Engineers documented in its pre-dredging environmental assessment report that sedimentation will continue to occur in Lake George, causing the lake to become increasingly shallow and converting to wetlands through natural lake succession. Aerial imagery shows that the areas of Lake George which were not dredged in 2000 have already converted back to wetlands. The plan states that when this occurs in the rest of Lake George, the reduced surface area will greatly reduce the sediment removal efficiency and suspended sediment will continue downstream, either settling out in other areas of the Deep River floodplain, or eventually discharging into Lake Michigan. The plan also states that if the sediment settles out in the Deep River floodplain downstream of Lake George, it will result in a decrease in overall floodplain storage and in increased flood risk for this reach.

2.7.12.3 *Green Infrastructure*

The plan states that green infrastructure improvements should be focused in the upstream reaches of the watershed and specifically in the Headwaters Turkey Creek, Headwaters Main Beaver Dam Ditch, and Main Beaver Dam Ditch subwatersheds. The steep rising limb of the 2008 flood hydrograph (provided in Section 3.2 of the plan) demonstrates the quick response of rainfall/runoff in the Deep River watershed. The concept of detaining more runoff in the upper watershed will allow for the lower reaches of the watershed to convey runoff through the system early in the storm thus flattening out the flood hydrograph and potentially dampening the peak flow while also maximizing available storage volume and flow capacity as the runoff from the upper watershed reaches Lake George and the downstream reaches of Deep River.

The plan mentions that care should be taken in siting future detention ponds or significant green infrastructure projects within the lower reaches of the watershed because implementation of some of these techniques could actually adversely impact flooding. The plan states that the key to implementation of green infrastructure in the lower reaches of the watershed, from a hydrologic perspective, is to get the excess storm water out of the system prior to the upstream runoff reaching Lake George. Therefore implementation of smaller green infrastructure projects in the lower watershed would be best built around water quality benefits, but once the water quality volume is exceeded, the excess storm water should be quickly moved into the downstream conveyance system.

2.7.13 Chicago Wilderness Green Infrastructure Vision 2.1

In 2004, the Northeastern Illinois Planning Commission completed a Green Infrastructure Vision (GIV 1.0) for the Chicago Wilderness region. This product identified large resource protection areas and recommended protection approaches including additional land preservation, ecological restoration or development restrictions. These recommendations were based primarily on charrettes that distilled the professional judgment of natural resource experts within Chicago Wilderness.

GIV 2.1 is a refinement of the previous work that is intended to classify and characterize important resources in a consistent and analytically robust manner, as well as to define ecological and human connectivity needs and provide enhanced information to support conservation development decisions. The building blocks of the network are core areas that contain well-functioning natural ecosystems that provide high quality habitat for native plants and animals. The hubs are aggregations of core areas as well as nearby lands that contribute significantly to ecosystem services like clean water, flood control and recreational opportunities. Finally, corridors are relatively linear features that link cores and hubs together, providing essential connectivity for animal, plant and human movement. A full description of the methodologies and results can be found in the REFINEMENT OF THE CHICAGO WILDERNESS GREEN INFRASTRUCTURE VISION FINAL REPORT- JUNE 2012.

The Chicago Wilderness Green Infrastructure Vision is relevant to the Deep River-Portage Burns Waterway Watershed Plan because of the numerous public concerns related to habitat loss, preservation, and water quality benefits associated with protecting, restoring and reestablishing natural areas.

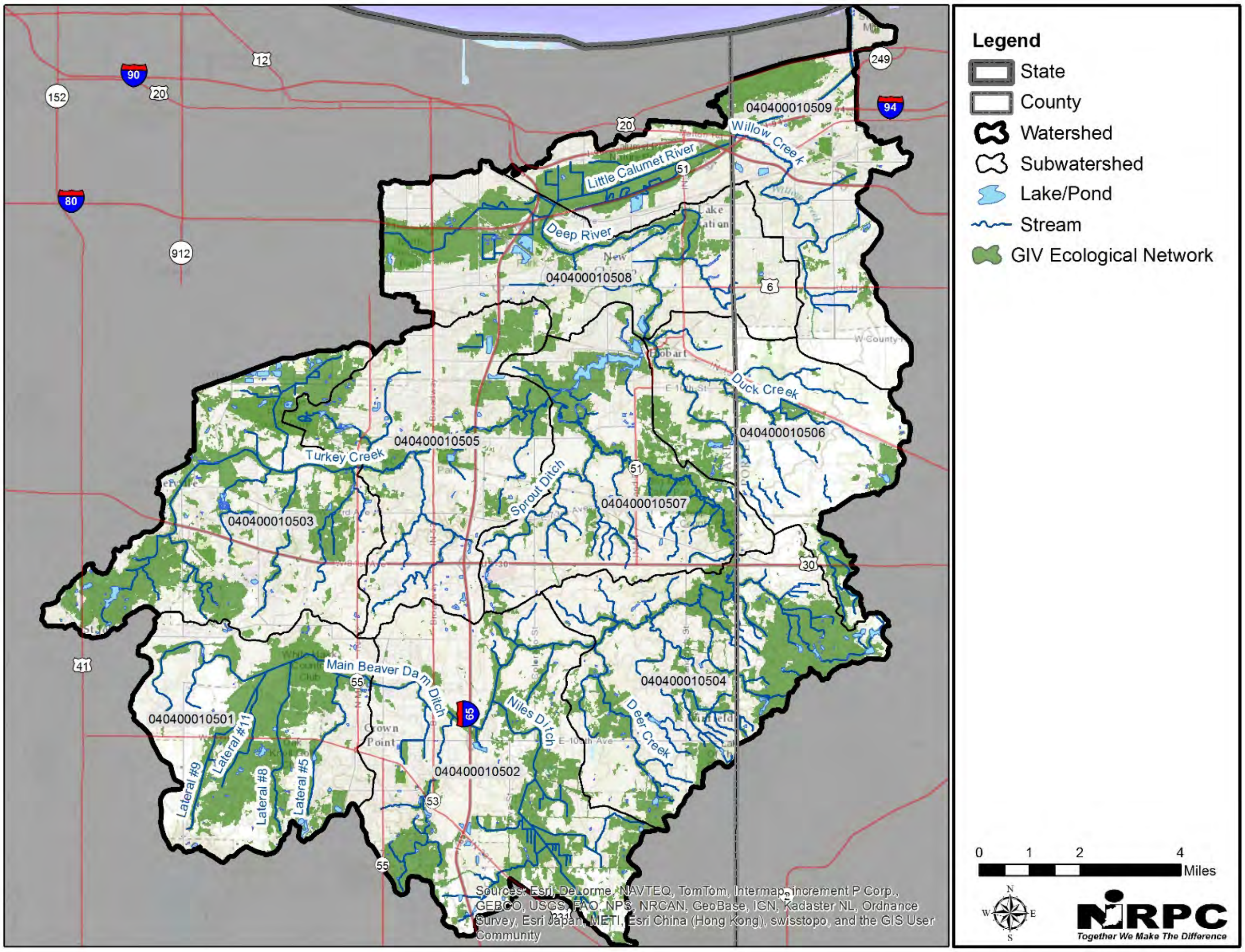


Figure 47 Chicago Wilderness Green Infrastructure Vision Ecological Network

2.7.14 Ecosystem Services Valuation Study for Lake, Porter, and LaPorte Counties

Ecosystem services are the collective benefits from an array of resources and processes that are supplied by nature. Forests, wetlands, prairies, water bodies, and other natural ecosystems support our existence. Green infrastructure is the interconnected network of forests, wetlands, waterways, grasslands, and other natural areas that support native species, maintain natural ecological resources and processes, and contribute heavily to human health and quality of life.

Since 2004, the Chicago Wilderness Green Infrastructure Vision (GIV) has served as a visual representation of the Chicago Wilderness Biodiversity Recovery Plan, but it also served as a spatial representation of the region’s ecosystem services. Only recently has it become possible to reliably estimate the contributions the GIV makes to human well-being and to measure the benefits that nature provides us for free. The Chicago Wilderness GIV can be used every day by planners and decision makers at the local, state, regional, and federal levels to prioritize and guide existing planning efforts and evaluate conservation and restoration opportunities that support preserving and managing the GIV network. Balmford et al. (2002)

found that if the values of ecological services are considered, the benefits from conserving natural land gives a return on investment of at least 100 to 1.1.

The Conservation Fund recently completed GIV Version 2.3, which focused on mapping ecosystem services within the Northwestern Indiana Regional Planning Commission (NIRPC) region. This study found that natural ecosystems contribute $8 billion per year in economic value to the three county NIRPC. Using the GIV 2.3 to estimate the monetized social benefit of conservation in comparison with the investments required to protect land can lead to increased awareness of decision makers and the general public regarding the importance and contribution of green infrastructure to the region's quality of life. The approximate value of ecosystem services provided by the GIV within our watershed is:

- $31 million in water purification
- $493 million in water flow regulation/ flood control
- $126 million in groundwater recharge

Ecosystem Service	Description
Water purification	Maintain water quality sufficient for human consumption, recreational uses like swimming and fishing, and aquatic life.
Water flow regulation/ flood control	Maintain water flow stability and protect areas against flooding (e.g., from storms).
Groundwater recharge	Maintain natural rates of groundwater recharge and aquifer replenishment

Table 33 Ecosystem services

2.7.14.1 *Water purification*

The water purification ecosystems helps maintain water quality sufficient for human consumption and support recreational uses like swimming and fishing, and aquatic life. Clean water is essential to public health and ecosystem health. Natural systems can be an effective way to reduce nonpoint source pollution, sediment, nutrients (i.e. nitrogen, phosphorus), bacteria, and other pollutants from water supplies. Natural systems also can help avoid the need to invest in or replace expensive, energy intensive gray infrastructure systems that treat water or manage storm water. Poor water quality can have other significant economic impacts, including beach closures due to high bacteria levels, the need for dredging due to sedimentation, and limits on water-based recreational activities. The Chicago Wilderness GIV helps with water purification that benefits people and wildlife by containing nearly all of wetlands and other open spaces that currently provide this ecosystem service.

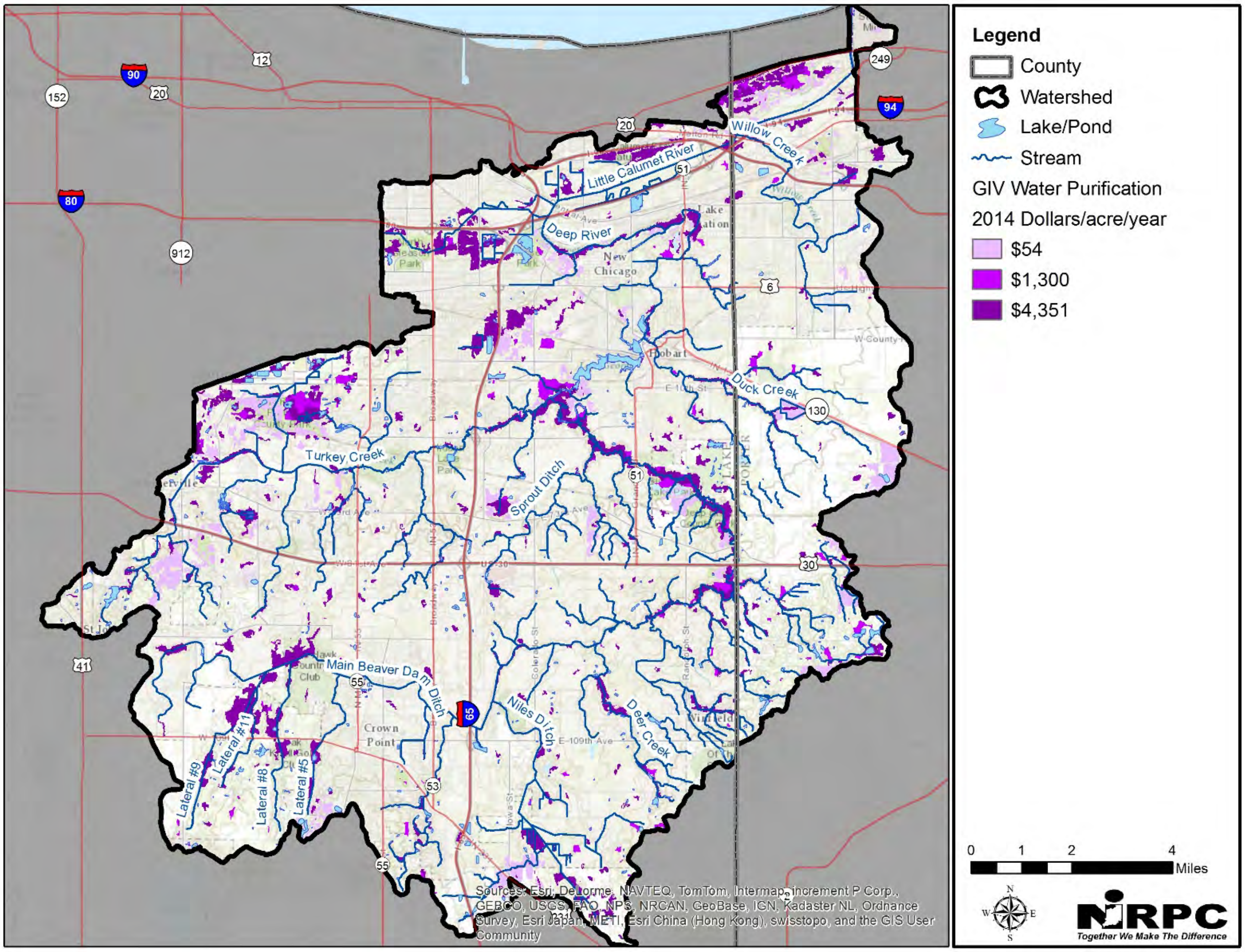


Figure 48 GIV ecosystem services water purification

2.7.14.2 *Water Flow Regulation*

The Water Flow Regulation ecosystem service helps maintain water flow stability and protect human infrastructure against flooding. One way the GIV provides flood control and water flow regulation is through reductions in peak discharges of storm water flows. Maintaining green infrastructure helps ensure that water can infiltrate in the soil and recharge the groundwater rather than enter the combined sewer and storm water systems.

This can help reduce flood damage to community infrastructure and damage to natural hydrology that could result in a loss of native riparian vegetation and loss of wildlife habitat. Fortunately, the GIV contains nearly all of the natural interconnected wetlands and riparian zones that provide this ecosystem service. Natural systems cannot manage all of the flood control needs of communities, but protection of existing green infrastructure can help avoid the problem getting worse in locations where the GIV absorbs flood waters before entering engineered flood control infrastructure.

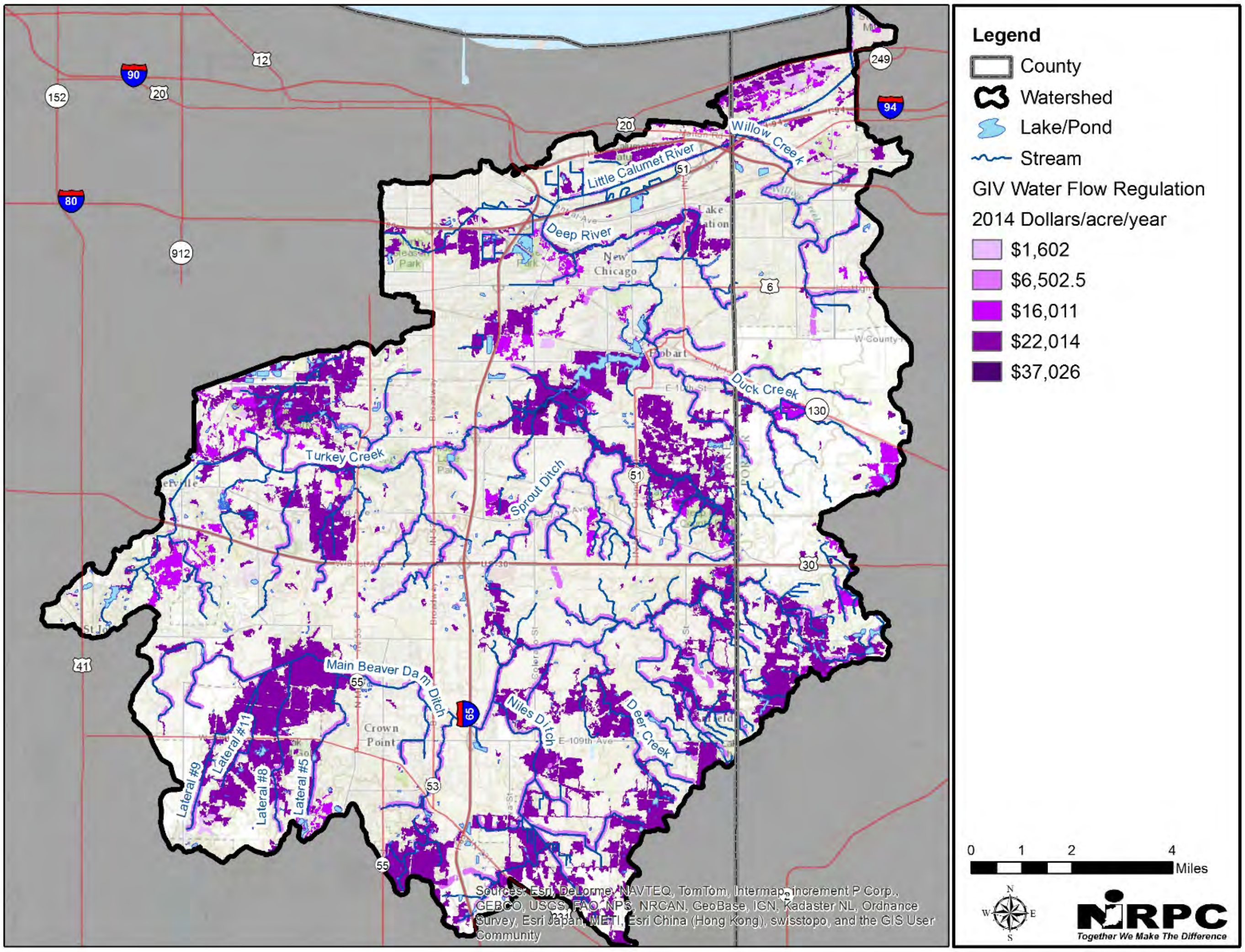


Figure 49 GIV ecosystem services water flow regulation

2.7.14.3 *Groundwater Recharge*

The groundwater recharge ecosystem service helps maintain natural rates of groundwater recharge and aquifer replenishment, which is particularly important for those municipalities that rely on groundwater aquifers for their drinking water supplies. Significant costs can be incurred when there is a need to develop, treat, and maintain deeper wells and associated treatment systems. Groundwater also helps maintain the natural base flow of rivers and streams, which is important for human and ecosystem health. The geology of groundwater infiltration and capture is complex, but one of the keys is minimizing impervious surface that diverts water into combined sewers and other storm water management infrastructure before it can soak into the ground. The Chicago Wilderness GIV includes the natural river and stream network and lands that serve as infiltration areas to underground aquifers.

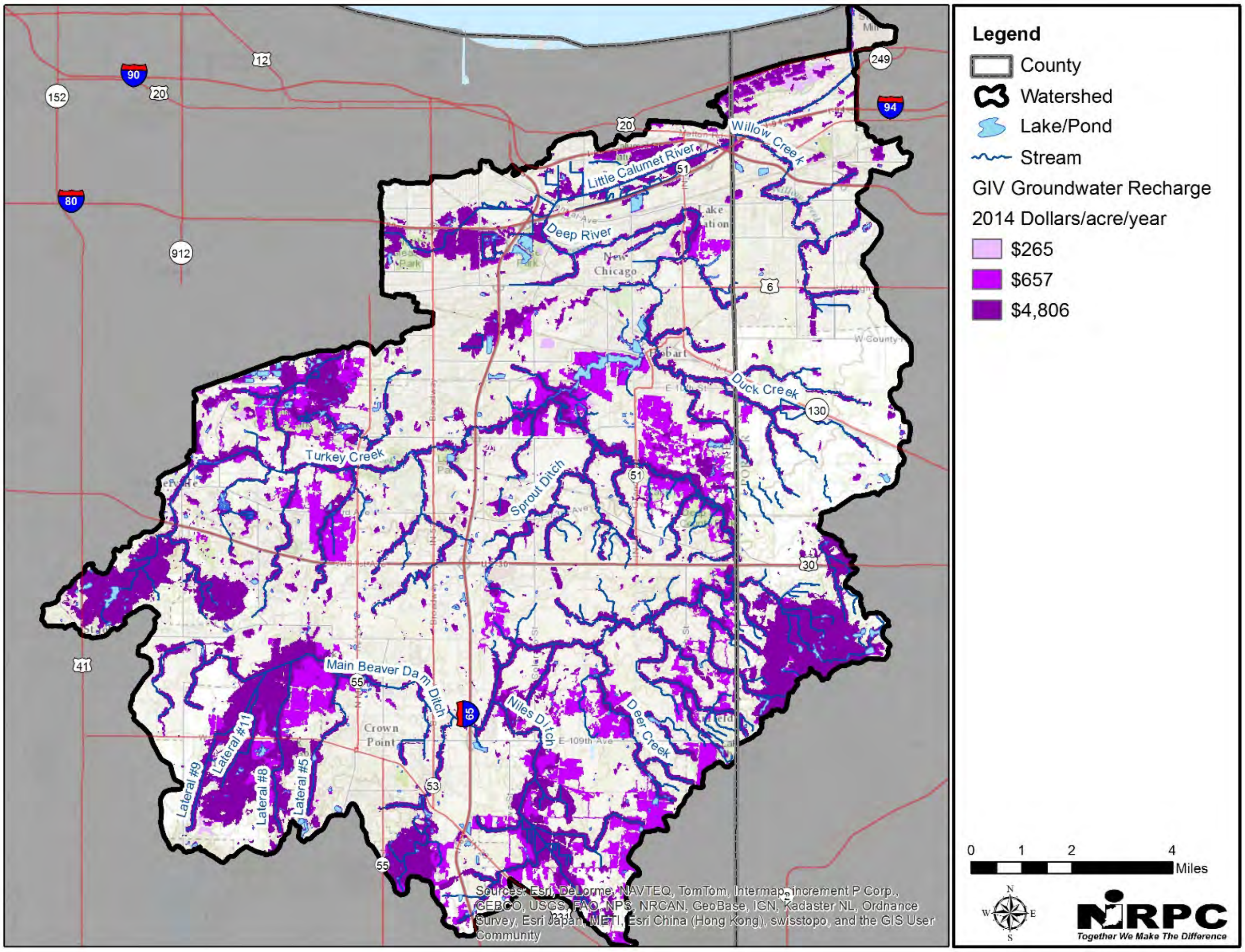


Figure 50 GIV ecosystem services groundwater recharge

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

A fairly large variety of endangered, threatened, and rare (ETR) species and high quality natural areas have been documented within the Deep River-Portage Burn Waterway watershed. The Indiana Natural Heritage Data Center has recorded nearly 400 observations of ETR species including plant, reptile, amphibian, bird, mammal, crayfish, mollusk and crayfish species and 32 high quality natural communities including forest, savannah, prairie, and wetland habitats within its boundary. The watershed's diversity can be attributed to its location in the landscape. The Deep River-Portage Burns Waterway watershed falls in an area known as the Northwestern Morainal Natural Region. Several major vegetation types including the eastern deciduous forest, the tall grass prairie, and northern forest and wetland merge in this natural area. No other natural region compares in species diversity on an acre by acre basis because of this (Homoya et al, 1985).

Stakeholder Concerns Related to ETR Species & High Quality Natural Areas:

- **Stream habitat loss**
- **Riparian area encroachment**
- **Species loss**
- **Wetland habitat loss and degradation**
- **Habitat loss to development**
- **Proper habitat restoration**
- **Lack of conserved open spaces**
- **Need to acquire public/ quasi-public riparian lands**
- **Long-term management of habitat**

Figure 51 shows the general location of ETR observations and high quality natural communities in relation to managed lands within our watershed. The National Park Service, DNR, local land trusts, parks departments and environmental organizations have focused a great deal of their land conservation efforts around these areas. However, high concentration areas still remain unprotected. 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 (ex. flood attenuation) they provide to society and the watershed as a whole. Additional high quality natural communities and ETR species may still be present in the watershed that have yet to be documented.

A list of the ETR species and high quality natural communities that have been documented in the watershed is included in the appendices. Information on which community types the ETR species and high quality natural communities occur is also provided (Source: Derek Nimetz, DNR Division of Nature Preserves).

The Indiana Natural Heritage Data Center represents a comprehensive attempt to determine the state's most significant natural areas through an extensive statewide inventory. However, the inventory is a continuous process. Over the past 10 years, 57 element occurrences were documented in the watershed including 54 ETR species and 3 high quality natural communities.

In general, land trusts active within the watershed restore and manage their properties for community types and not necessarily the ETR species themselves.

The Calumet Land Conservation Partnership, which is comprised by organizations including Shirley Heinze Land Trust, The Nature Conservancy, Indiana Department of Natural Resources, Indiana Dunes National Lakeshore, Save the Dunes, Lake County Parks Department, OpenLands, and the Northwestern Indiana Regional Planning Commission are coordinating to develop a conservation plan and coordinated management implementation plan for the Hobart Marsh area and to develop a long-term vision and strategy for the Deep River Outstanding River Corridor.

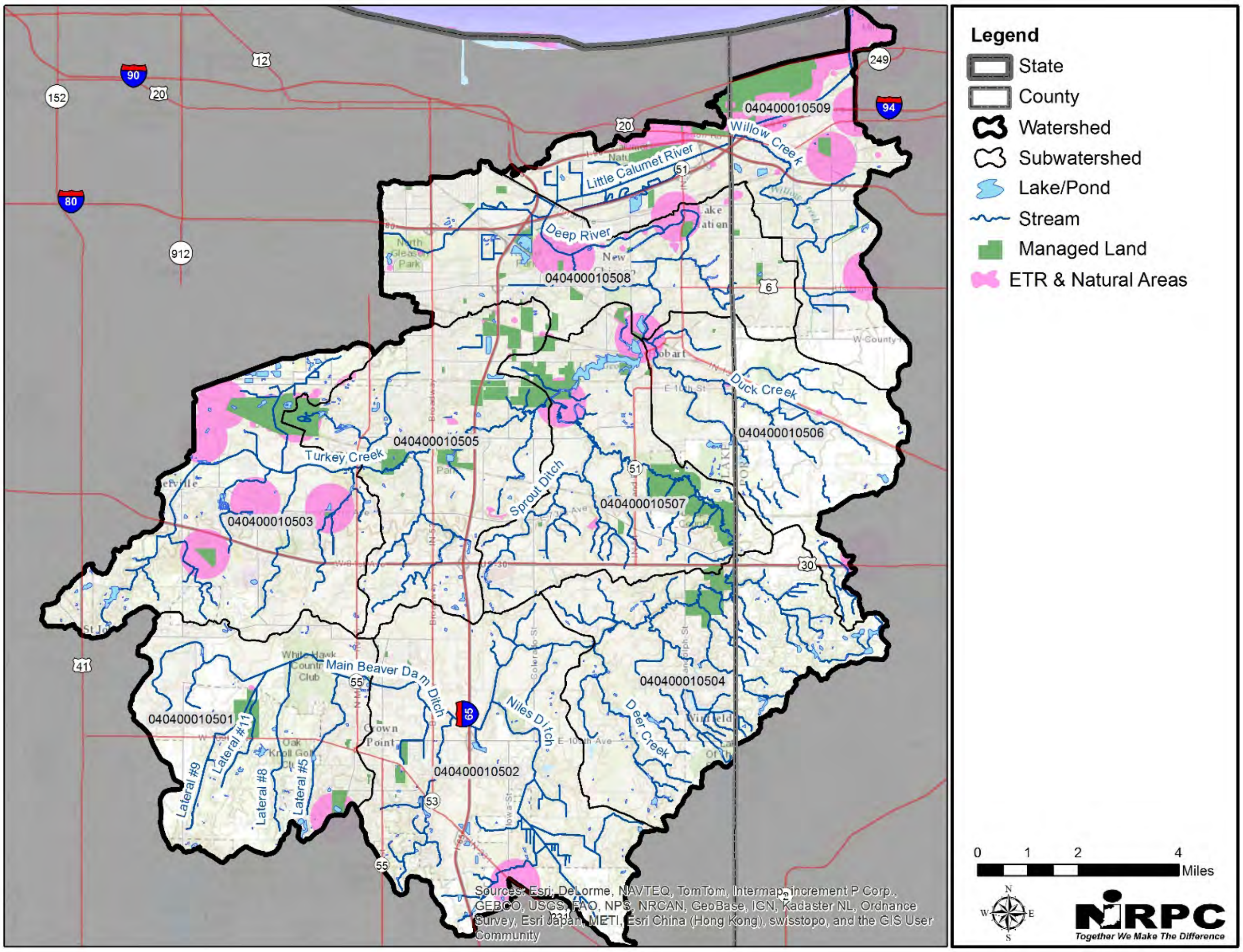


Figure 51 Endangered, Threatened & Rare Species and High Quality Natural Areas in Relation to Managed Lands

2.9 Exotic & Invasive Species

This section on exotic and invasive species was graciously prepared by Susan Mihalo with The Nature Conservancy.

Exotic and invasive species in our watershed can infest natural as well as agricultural areas, and can cause environmental and economic harm. Several species, such as giant hogweed (*Heracleum mantegazzianum*), are also known to cause harm to human health, and some species can also alter hydrology and cause erosion by changing the structure and soil of riparian areas.

According to the Indiana Invasive Species Council:

- Invasive plants hurt wildlife by crowding out the plants our native animals need for food and cover.
- Invasive plants destroy habitat for rare wildflowers and animals threatening two-thirds of all endangered species. This is very relevant to Lake County in that it contains nearly 30 percent of all of Indiana's rare, endangered and threatened species.
- Invasive plants cost money. A 2012 survey of agencies and landowners in Indiana found $5.7 million has been spent to manage these species and protect our natural areas, and each year the cost grows.
- Invasive plants can also decrease the public's ability to enjoy hunting, fishing, bird-watching, and other recreational pursuits.

The purpose of this section is to identify the most common invasive species and habitats they invade, and to promote awareness of species that are considered early detection species whose introduction could cause harm to the watershed. These species have been identified by the Indiana Coastal Cooperative Weed Management Area (ICCWMA) Steering Committee as of February 2015. The Steering Committee includes representatives from The Nature Conservancy, Shirley Heinze Land Trust (watershed landowner), Save the Dunes (watershed landowner) and the National Park Service (watershed landowner), the Indiana Department of Natural Resources (watershed landowner), the Coffee Creek Watershed Conservancy, and the Wildlife Habitat Council.

The list of invasive species targeted for control was first developed by members of the Steering Committee in 2011 and includes 83 aquatic species, flowering species, grasses, reeds, cattails, shrubs, trees and vines. Of these species, 20 are considered early detection species that have not yet been detected in our watershed. A copy of this list can be found on http://www.nature.org/cs/groups/webcontent/@web/@indiana/documents/document/prd_246280.pdf

It should be noted that this list is not static as species expand their range, new species are introduced (many times unwittingly by homeowners), and ongoing efforts are made to control invasive species. As a result, the ICCWMA Steering Committee reviews this list at least every-other year, and members have made a commitment to report new detections to Indiana's early detection and distribution mapping system known as "EDDMaps," which can be found on http://eddmaps.org/indiana/. This system can also be used by the public to report species as reports are always verified before they are included in the system and map.

A general rule-of-thumb in invasives control is that it can take several years to get rid of or minimize an infestation and exhaust the existing seed bank. Early detection and control of new infestations can be especially helpful.

Each species may require different treatment methods, which might also change based on other factors such as the size of the infestation and whether or not the plant spreads through its root system. Each species should be carefully researched prior to implementing specific control methods such as herbiciding, cutting and/or hand-pulling, and keep in mind that new methodologies and herbicides are periodically introduced.

2.9.1 Invasive Plant Species Commonly Found in the Deep River Watershed

Buckthorns (*Rhamnu frangula*, and *Rhamnus cathartica*) are present our watershed and can be expected to expand. Floodplains, mesic woodlands and areas with moist but not wet soils are most threatened. Control is possible with early detection and rapid response to new populations.

Bush Honeysuckle (*Lonicera spp*.) and **Autumn Olive** (*Eleagnus umbellata*) shrubs were introduced simultaneously and planted in the past for their hardiness and as wildlife forage. Birds do, in fact, enjoy the fruits of both plants, but they unfortunately carry the seeds far beyond their existing populations. Large amounts of money and time are being spent throughout the Midwest to control them with relative success. Both species tend to thrive in sunlit areas, but honeysuckle has the ability to infest woodlands under complete canopies. In our watershed, they are widespread and mostly infest woodlots, fallow fields and disturbed areas.

Canada Thistle (*Cirsium arvense*) is a noxious weed that occurs essentially in all sunlit areas of our watershed including prairies, savannas, streambanks, forest openings and disturbed areas. Because this plant also spreads through a creeping root system, herbicides should be used to control it that are foliar sprayed and that systemically move down to the roots.

Cattail (*Typha x glauca; Typha angustifolia*) is a serious problem throughout our watershed. The hybridization of the exotic form has essentially eliminated the native cattail (Typha latifolia). The hybrids are extremely aggressive and have infested ditches, streams, marshes, and other wetlands, including water retention basins. Further spread of this plant can be somewhat minimized by careful cleaning of equipment when road and ditch crews move from site-to-site. Because this plant also spreads through a creeping root system, herbicides should be used to control it that are foliar sprayed and that systemically move down to the roots. This species also must be controlled with an herbicide approved for aquatic use.

Common Reed (*Phragmites australis*) is an aggressive invader throughout the Lake Michigan Watershed, and our watershed is no exception. While generally limited to roadside ditches and water retention basins, it can expand rapidly and is a dominant wetland invader. Because this plant also spreads through a creeping root system, herbicides should be used to control it that are foliar sprayed and that systemically move down to the roots. This species also must be controlled with an herbicide approved for aquatic use.

Garlic Mustard (*Alliaria petiolata*) is also present our watershed. Floodplains and vectoring by foot traffic and wildlife, like deer, are the major routes of expansion of this weed. This plant has invaded to the point where it has become ubiquitous and is often ignored by the general public. However, the long-term impacts of this invader need to be more fully understood in that it is allelopathic (chemically inhibits others in its environment in order to gain competitive advantage) and emits chemicals that suppress tree seedling growth.

(http://harvardforest.fas.harvard.edu/sites/harvardforest.fas.harvard.edu/files/publications/pdfs/Stinson_PlosBiology_2006.pdf).

Japanese knotweed (*Fallopia japonica*) is well-established our watershed and is unfortunately very difficult to control. It can be found along disturbed roadsides, riparian areas, floodplains, the Oak-Savanna bike trail, abandoned farmland and woodlands. A large stand of it can be found just north of the Gordon & Faith Greiner Nature Preserve in Hobart, just south of Ridge View Elementary School's backyard in Hobart.

In some states like Washington, Japanese knotweed is considered to be a state-listed noxious weed that is particularly troublesome to watersheds because it creates bank erosion problems and is considered a potential flood control hazard. It can also lower the quality of riparian habitat for fish and wildlife by displacing native species. This plant grows densely and thickets of it are also known to clog small waterways.

Multiflora Rose (*Rosa multiflora*) is present in every woodland of our watershed. The plant grows unimpeded in shady understories. Conventional control is somewhat effective, but the result in treated areas tends to be bare soil.

Purple Loosestrife (*Lythrum salicaria*) is very prevalent our watershed and can be found in wetlands and along many ditches and streams. If a natural area is being intensively managed, populations of this invasive species can be reduced, but never entirely eliminated, by *Galerucella pussila* and *G. calmariensis*, leaf-eating beetles that have been introduced or have migrated from other areas into the watershed. These beetles seriously affect growth and seed production by feeding on the leaves and new shoot growth of purple loosestrife plants. If herbicides are used for control, they must be approved for use in aquatic habitats.

Oriental Bittersweet (*Celastrus orbiculata*). This woody, vining species is present and widespread in our watershed. This species has the ability to colonize fields, woodlands, floodplains, and essentially all other available habitats. It is extremely destructive to not only surface vegetation, but also climbs trees and competes for sunlight, resulting in tree death. This plant can also be easily confused with native bittersweet (*Celastrus scandens),* therefore positive ID is important prior to control.

Reed Canary Grass (*Phalaris arundinacea*) has invaded much of the sunlit portions of our watershed, particularly along ditches and creeks, and has smothered native vegetation. Control of this species with conventional tactics is extremely difficult, and it can spread via waterways. As forest and riparian tree canopies are reduced due to emerald ash borer (EAB) infestations of ash trees, this species will quickly invade areas previously shaded and now open to sunlight. If herbicides are used for control in a riparian or wetland habitat, they must be approved for use in aquatic habitats.

Spotted Knapweed (*Centaura maculosa*) can mainly be found in the northern half of our watershed where it thrives in sandy soils and along Right-of-Ways (ROWs). This species is also allelopathic and produces chemicals that kill soil microflora. The plant is also carcinogenic and control by hand pulling should be done with gloves. It is extremely important to eliminate small populations as they occur. Biological control has been somewhat effective out west.

Tree of Heaven (*Ailanthus altissima*) is also established and is prevalent in our watershed. This urban weed is present along many woodland edges. While no monocultures have been detected, it can be expected to dominate remnant canopies. It prolifically produces winged seeds that help it to expand very rapidly. This plant is also allelopathic. This species also poses a risk to human health, as there have been cases of heart arrhythmia in individuals after contact with its sap.

2.9.2 Invasive Plants Popular in Landscaping

The following shrub species are popular as ornamental plants and in residential landscaping and can easily be spread by birds and other wildlife eating their berries. All are making their way into woodlots and wooded natural areas, driving out native species that insects and birds are dependent upon. The public can be integral to reducing the spread of these species by not planting them.

Japanese Barberry (*Berberis thunbergii*), is established in our watershed. While it has not reached the density of Multiflora Rose, it may become a dominant species soon.

Burning Bush (*Euonymus alatus*) is a popular landscape plant due to its striking red fall foliage but is, unfortunately, finding its way into natural areas.

Privet (*Ligustrum vulgare*) has been a popular landscape plant for as long as groomed hedges have existed and can be very problematic to natural areas.

Avoid planting these species. Consider instead native species or nonnative but non-invasive, species such as:

- Black haw *(Viburnum prunifolium)*
- Common juniper (*Juniperus communis)*
- Ninebark (*Physocarpus opulifolius)*
- Red chokeberry *(Aronia arbutifolia)*
- Redosier dogwood *(Cornus sericea)*
- Serviceberry (*Amelanchier* spp.)
- Smoke bush *(Cotinus coggygria*)
- Spicebush (*Lindera benzoin*)
- Weigela (*Weigela florida)*

2.9.3 Early Detection Species Likely to Expand into the Watershed

Air Potato (*Diascorea bulbifera*) is a species that has not yet been detected in our watershed, but may be established in adjacent watersheds. This vine is a vigorous climber and often forms deep mats over low vegetation. Established populations have proven to be nearly unstoppable in southern Indiana, yet can be controlled with early detection. Its method of dispersal seems to be by following moving water and right-of-ways or perhaps has been spread by utility trucks.

Black swallow-wort *(Cynanchum louiseae)*, also known as the black dog-strangling vine, is also a species that needs early detection in order to keep it from spreading. It not only drives out native species but also is deadly to monarch caterpillars that eat it after hatching. Monarch butterflies lay their eggs on this species because it is in the milkweed family, and some research has indicated that they may even prefer it over common milkweed. A small infestation was found several years ago along a railroad line in Ogden Dunes, which is not far from our watershed.

Giant Hogweed (*Heracleum mantegazzianum*), a federally listed noxious weed, as of 2015 has not yet been found in the Lake Michigan Watershed of Northwest Indiana nor in Lake, Porter or LaPorte counties. However, periodically cow parsnip and angelica are misidentified as this plant. One way to distinguish this plant is that it is extremely tall – 13'-15' in comparison to these other species. The sap from this plant, in combination with moisture and sunlight, can cause severe skin and eye irritation, painful blistering, permanent scarring and blindness in humans. If it is found, IDNR should be immediately notified.

Japanese Stilt Grass (*Microstegium vimineum*), another species from the Orient, has not yet been reported in our watershed. However, its northward migration through the state has been relatively unimpeded by management efforts. It can be expected to establish in our watershed at some point in the future because it is easily carried on hiking and hunting boots from southerly areas.

Kudzu *(Pueraria lobata)* was detected in 2013 on the banks of the Deep River in New Chicago by members of the Northwest Indiana Paddling Association, and has since been verified by the Indiana Department of Natural Resources (IDNR), and ongoing control efforts have commenced. This regulated species needs to be reported if found to IDNR. Note: kudzu looks very similar to hog peanut (*Amphicarpaea bracteata)* is sometimes mistaken for kudzu but has much smaller leaves and the plant is much more diminutive than kudzu.

Leafy Spurge (*Euphorbia esula L*.) is a creeping perennial that reproduces from seed and vegetative root buds. It is an early detection species of great concern to ICCWMA members because entire fields of it can be found in other parts of the country, particularly west of the Mississippi.

In the highly built environment of our watershed, disturbance and fragmentation of natural areas are high hurdles to overcome with respect to preventing and controlling invasive plant species. However, with the help of early detection efforts, as well as careful planning by natural-area landowners that includes an understanding of conservation targets and how they interact with the health of a watershed, some invasive species could potentially become more manageable. This is why it is important to document invasive species reports on http://eddmaps.org/indiana/, and to understand how it spreads (sometimes via waterways) as well as how it impacts native plant communities and hydrology.

2.9.4 Invasive Forest Pests

Tree-health and the control of nonpoint source pollution are inexorably linked. Trees reduce storm water flow by intercepting rainwater on leaves, branches, and trunks. Some of the intercepted water evaporates back into the atmosphere, and some soaks into the ground, reducing run-off in the watershed.

Tree-health and water quality are also inexorably linked. Trees also reduce the amount of storm water flow from heated impervious surfaces, keeping warmer temperatures from impacting sensitive stream and river species. Forests also help slow soil erosion through canopy dispersal and with the help of surface litter cover. As a result, landowners, especially in riparian areas, are strongly encouraged to replace trees killed by forest pests with native trees appropriate for the habitat – especially trees that can survive weather extremes.

The emerald ash borer (EAB) (*Agrilus planipennis fairmaire*) and the Asian longhorn beetle (ALB) (Anoplophora glabripennis) are two exotic tree-killing pests that bear mentioning in this watershed management plan due to their devastating effects on tree health and forests.

2.9.5 EAB Impacts on the Watershed

It is highly likely that by the time this watershed management plan is published most, if not all, all varieties of ash trees will have been impacted by EAB, unless a particular tree or set of trees have been consistently treated with recommended pesticides. The adult beetles nibble on ash foliage but cause little damage. The larvae feed on the inner bark of ash trees, disrupting the tree's ability to transport water and nutrients. Even if the tree is not killed outright by this damage, all it takes is extreme drought or other factors to weaken a tree and cause it to die.

According to the Purdue University Extension Service, ash trees provide substantial economic and ecosystem benefits, ranging from increased property value, to storm water mitigation, to decreased energy demands.

2.9.6 ALB Impacts on the Deep River Watershed

If not detected early and controlled, the Asian longhorn beetle (ALB) could devastate numerous other species of hardwood trees in the watershed – especially elm, maple, willow, hackberry and birch trees. Once this pest infests a tree, there is no cure, and the tree will die.

For more information on identifying this beetle that has already devastated more than 80,000 trees – mostly in the eastern part of the U.S. - visit the U.S. Department of Agriculture website at http://asianlonghornedbeetle.com/. Again, early detection is key. Report sightings or suspected damage to IDNR by calling (317) 232-4120 and asking to speak with an entomologist.

2.10 Relevant Relationships

A number of the watershed characteristics when examined together can help provide a clearer picture of water quality and habitat issues.

Related Stakeholder Concerns:

- Riparian area and floodplain encroachment
- Habitat loss to development
- Need to acquire public/ quasi-public riparian lands
- Development standards protective of watershed
- Ability of watershed to clean water and provide habitat
- Erosion and sedimentation
- Excess nutrients
- Increased runoff volume
- Streambank and shoreline erosion

2.10.1 Riparian Land Cover

Ideally, riparian areas would occur as natural buffers between human land uses and adjacent waterbodies. Vegetated riparian areas help filter out pollutants carried by storm water 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 maintaining cooler water temperatures and higher dissolved oxygen levels, provide an important food source for fish and aquatic insects, and provide a source of large woody debris for critical in-stream habitat. Generally, the wider the buffer the greater benefit they provide (Figure 52).

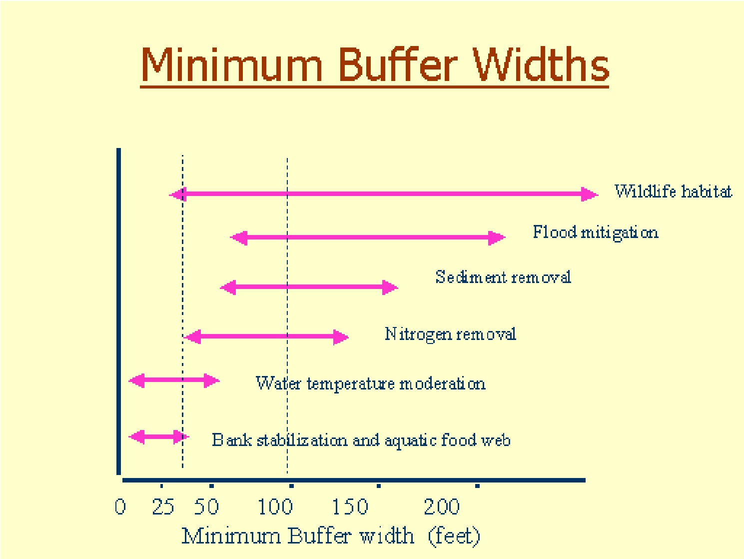


Figure 52 Riparian Buffer Widths & Benefits

A desktop analysis of riparian land cover was done for the watershed using methodologies developed by the Indiana DNR Division of Forestry. Thirty-meter buffers were created on each side of the stream centerline and land cover data shown in Figure 29 was extracted from this zone. A 30-meter (approximately 100-foot) buffer was the smallest buffer distance that could be evaluated based on the land cover datasets 30-meter resolution. Human land use/land cover occurring within the riparian zone is shown in Figure 53. The data was then grouped by subwatershed and is presented in Figure 54 as percent contribution.

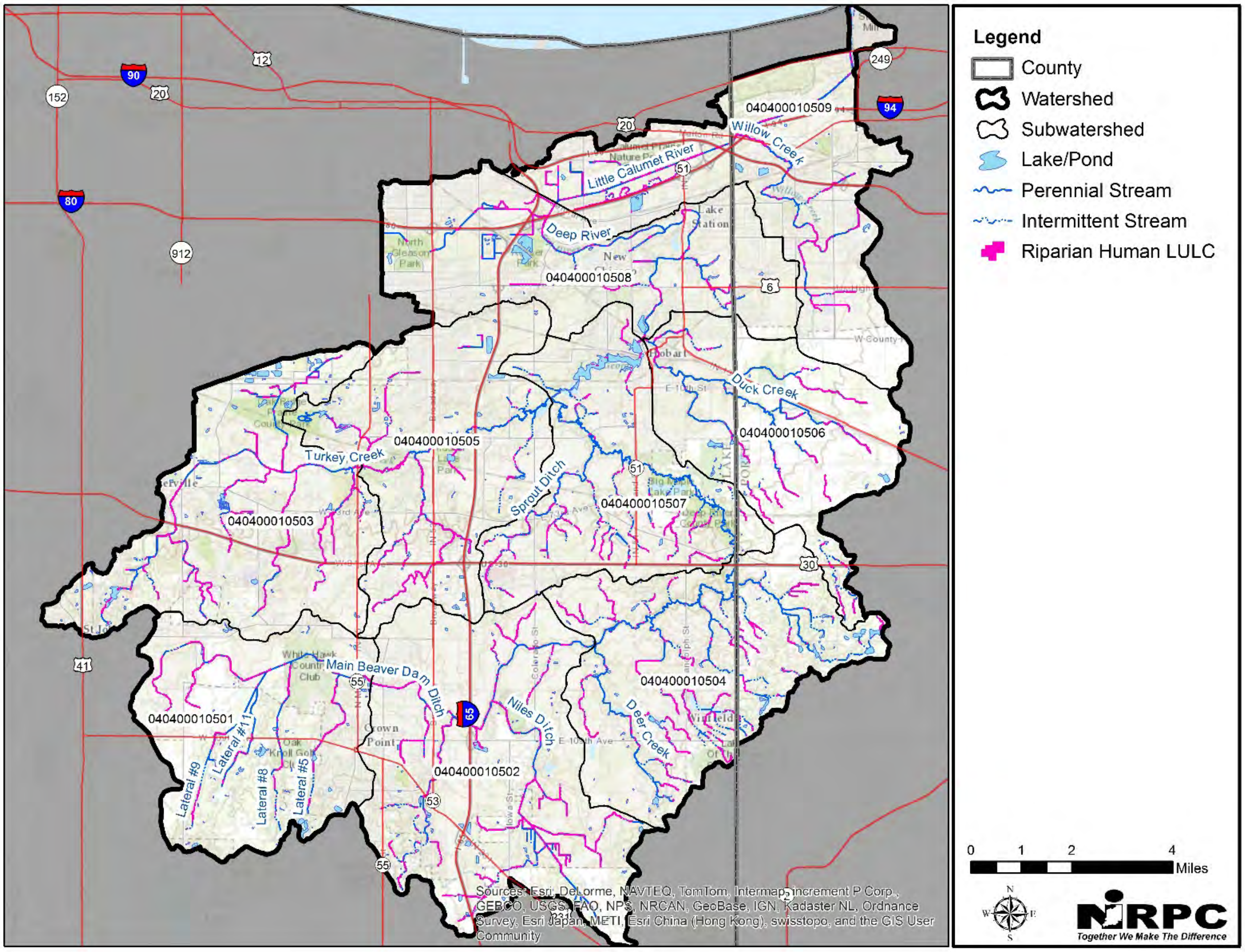


Figure 53 Riparian human land use/land cover

The results of this analysis show that human disturbance (agricultural, bare and developed land) within the riparian zone ranges from 35% to 65%. Development is the most common land cover type in the riparian zone accounting for nearly 43,000 acres followed by row crop at approximately 26,000 acres.

The highest levels of riparian encroachment occur along Main Beaver Dam Ditch, Turkey Creek and their tributaries as well as the Little Calumet River and Willow Creek. Deep River still maintains large reaches of core forest habitat within its riparian zone especially upstream of Lake George.

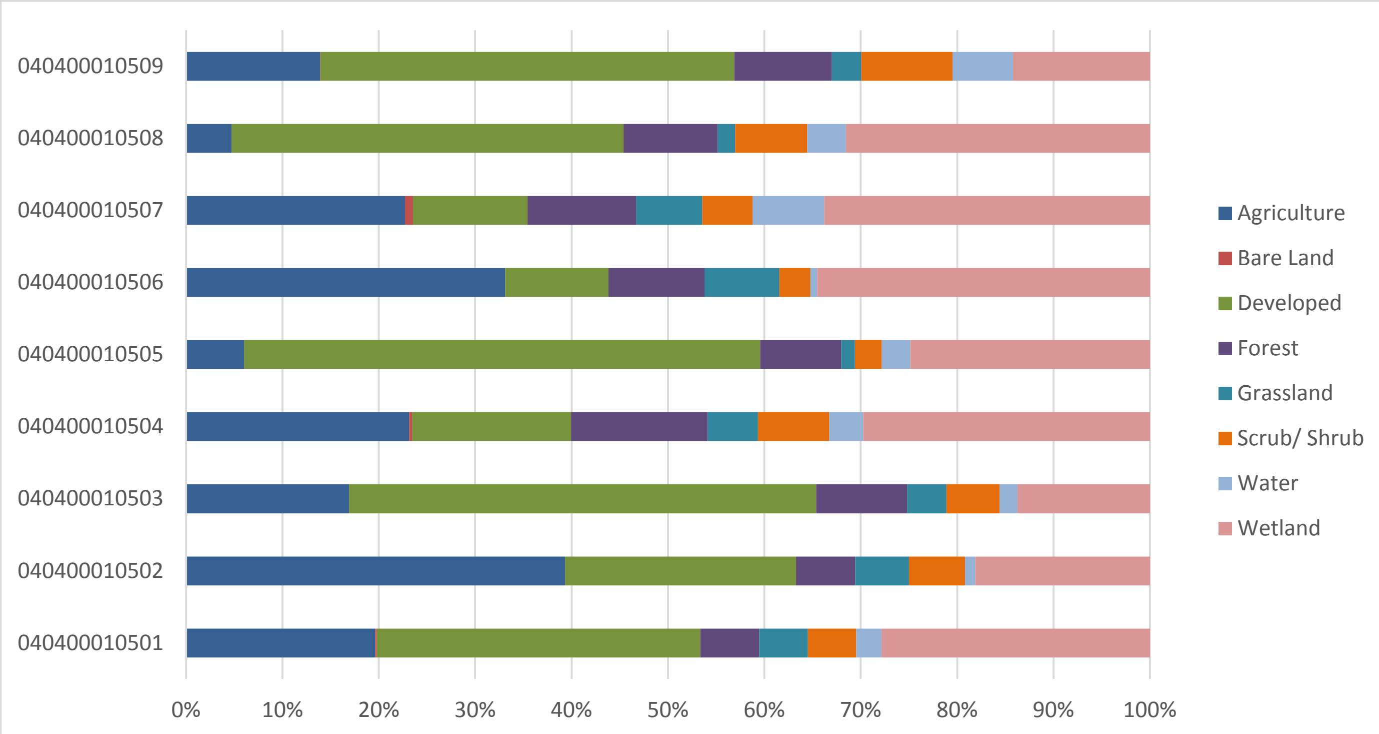


Figure 54 Subwatershed Riparian Area Land Cover

The DNR methodology also included an analysis of other indicators to help prioritize riparian buffer restoration including percent riparian lands, percent storm water runoff (nonpoint source) contributing land cover from both the riparian zone and the subwatershed, and average annual estimated erosion. For this analysis a higher score means a higher priority. The results of the analysis are presented in Table 34 and Figure 55.

Subwatershed	% Subwatershed NPS Land Cover	Score	% Riparian NPS Land Cover	Score	% Riparian Land	Score	Erosion	Score	Final Score
040400010501	70.20	1	53.37	2	4.45	1	0.69	2	6
040400010502	80.75	3	63.30	3	5.73	2	1.14	3	11
040400010503	71.33	2	65.38	3	5.45	2	0.42	2	9
040400010504	63.45	1	39.94	1	9.39	3	1.40	3	8
040400010505	75.42	2	59.58	3	4.70	1	0.33	1	7
040400010506	73.99	2	43.82	1	6.09	3	0.69	2	8
040400010507	64.94	1	35.44	1	8.46	3	0.71	3	8
040400010508	77.50	3	45.38	3	4.48	1	0.18	1	7
040400010509	75.87	3	56.88	3	4.87	2	0.24	1	8

Table 34 Riparian Buffer Analysis Results

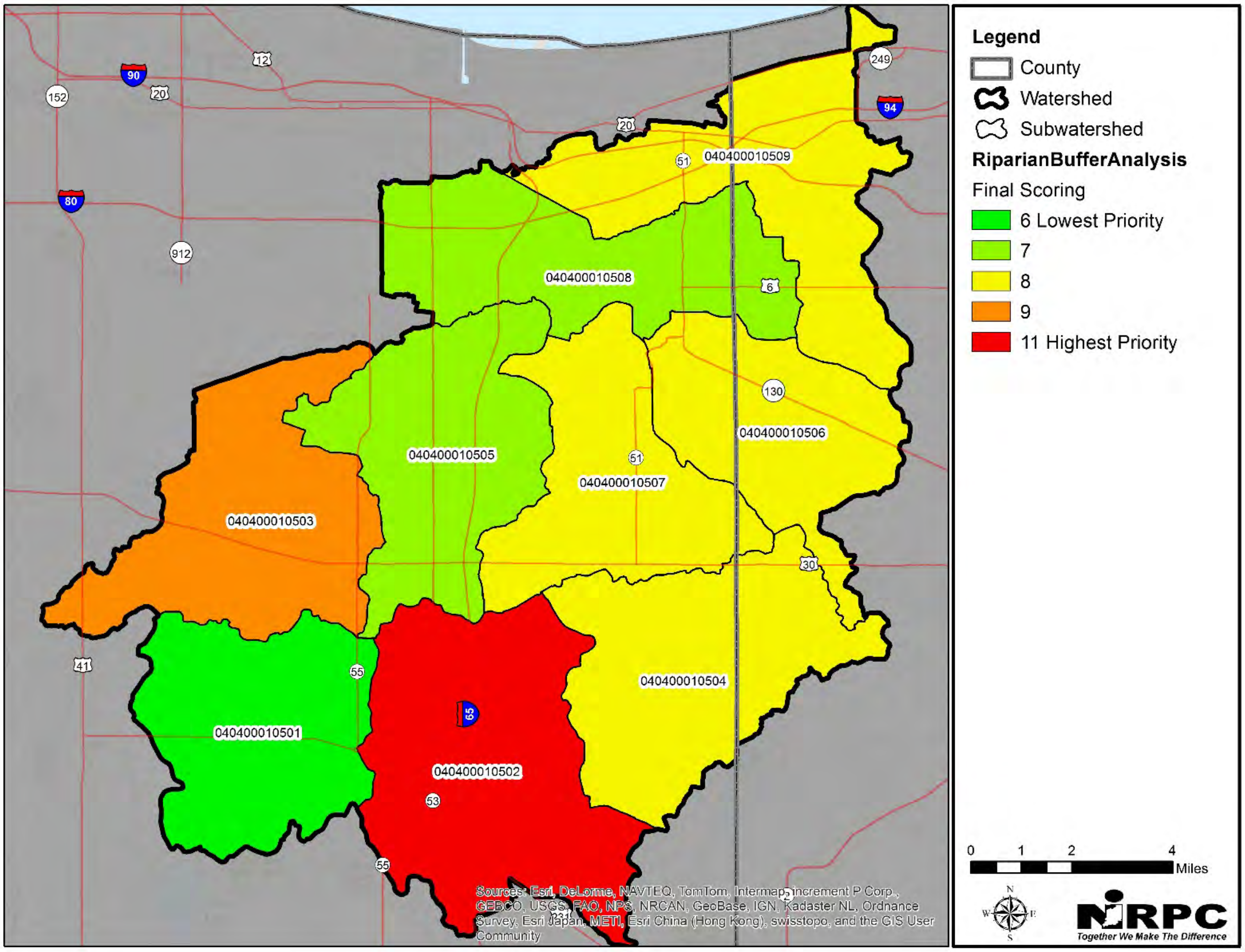


Figure 55 Riparian Buffer Analysis Results

2.10.2 Wetland Loss

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.

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 35). The greatest wetland losses have occurred in the Main Beaver Dam Ditch-Deep River and Duck Creek subwatersheds.

Name	HUC-12	Hydric Soils (Historic Wetland) (ac.)	% of Drainage Area	Existing Wetland (ac.)	% of Drainage Area	Acres Lost	% Change (Wetland Loss)
Headwaters Main Beaver Dam Ditch	040400010501	4,540	39	1,146	9.8	3,394	-75
Main Beaver Dam Ditch-Deep River	040400010502	5,665	34	797	4.7	4,868	-86
Headwaters Turkey Creek	040400010503	4,922	36	1,189	8.7	3,733	-76
Deer Creek-Deep River	040400010504	3,588	26	1,024	7.4	2,564	-71
City of Merrillville-Turkey Creek	040400010505	4,278	34	1,016	8.1	3,262	-76
Duck Creek	040400010506	2,781	27	520	5.1	2,261	-81
Lake George-Deep River	040400010507	2,808	25	1,086	9.8	1,722	-61
Little Calumet River-Deep River	040400010508	4,025	33	1,246	10.3	2,779	-69
Willow Creek-Burns Ditch	040400010509	4,626	34	1,223	9.1	3,403	-74
	Watershed Total	37,233	32	9,247	8.0	27,986	-75

Table 35 Wetland Loss Data

As noted above, wetland functional values are closely associated with landscape position. Figure 56 shows 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 our watershed only 8% of the land area is wetland. The Little Calumet River-Deep River subwatershed 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.

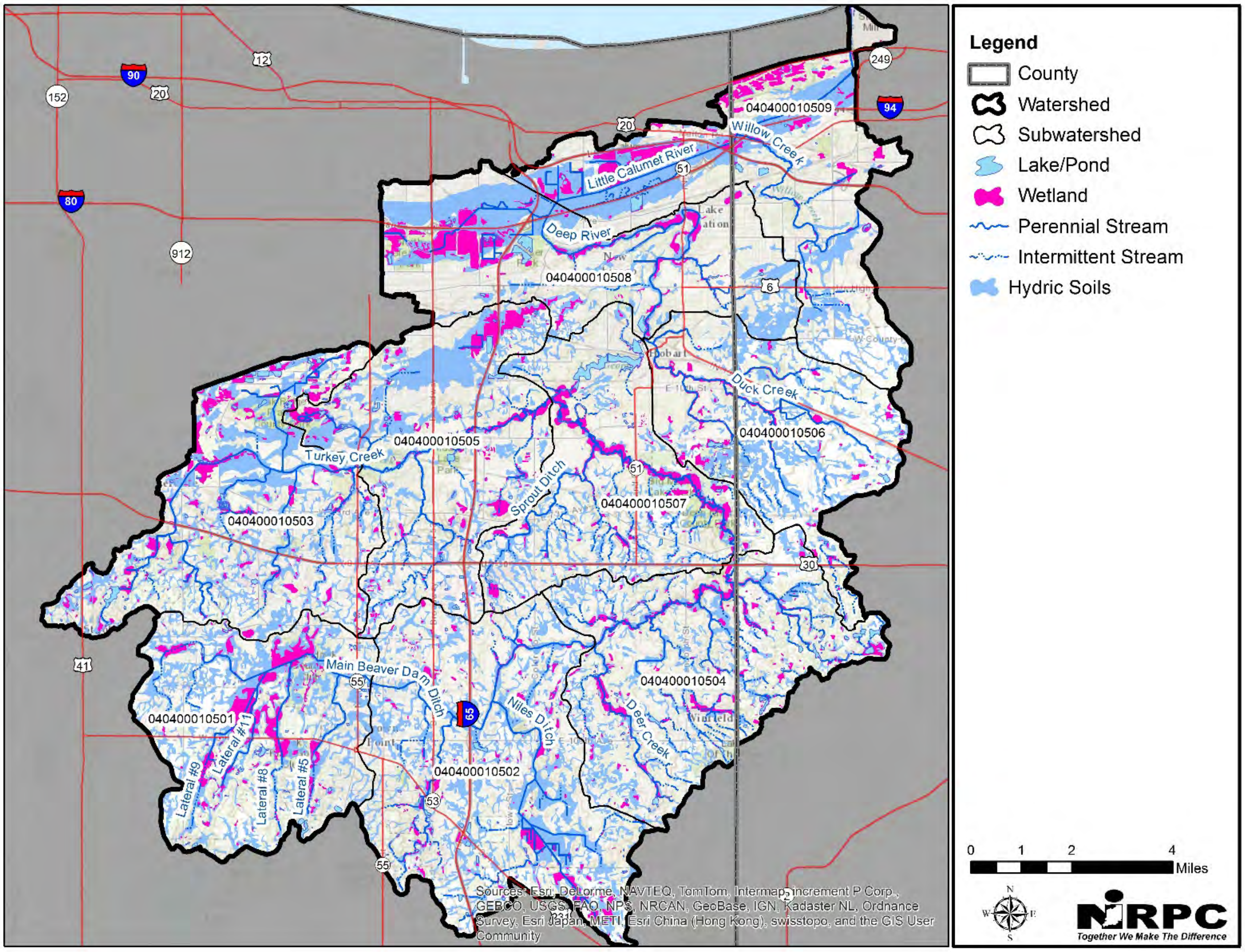


Figure 56 Wetland Loss

2.10.3 Floodplain Land Cover

Floodplains play an important role in the health and function of streams. Development and alteration of floodplains can eliminate or degrade the beneficial services they provide (Table 11). In total there is apporximatley 12,682 acres land within the 100-year and 500-year floodplain. Figure 57 shows nearly equal distribution of natural and human enfluenced land cover types within these floodplain areas.

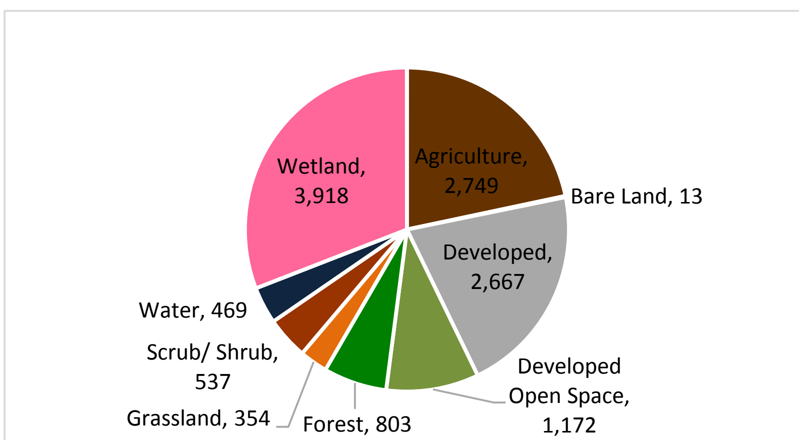


Figure 57 Floodplain Land Cover Composition

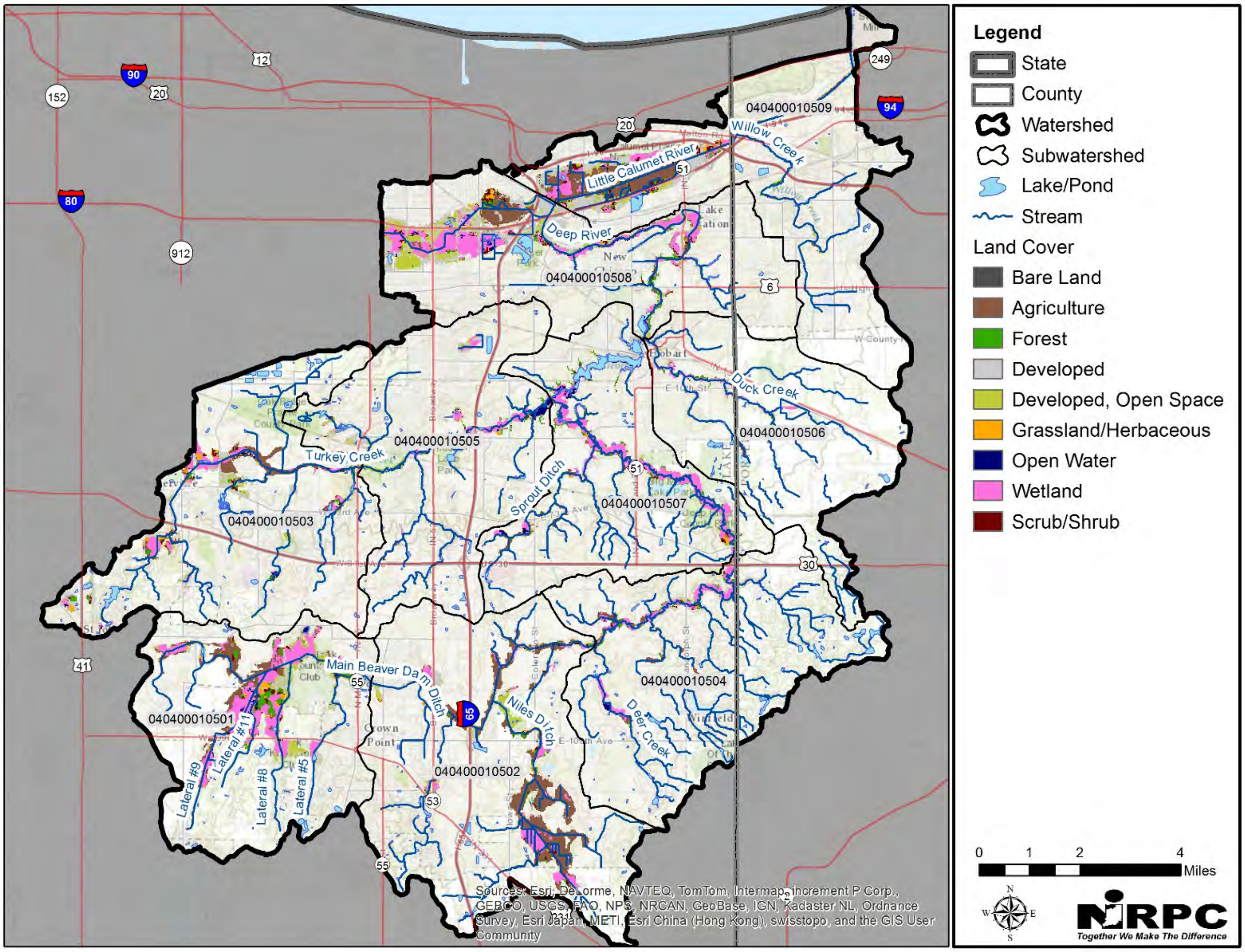


Figure 58 Floodplain land cover

2.10.4 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).

Approximately 14, 108 acres or 12.3% of the soils in the watershed are classified as HEL or potentially HEL. Of the 26,135 acres of cultivated land in the watershed approximately 2,685 acres or 10% occurs on soils that are considered highly erodible.

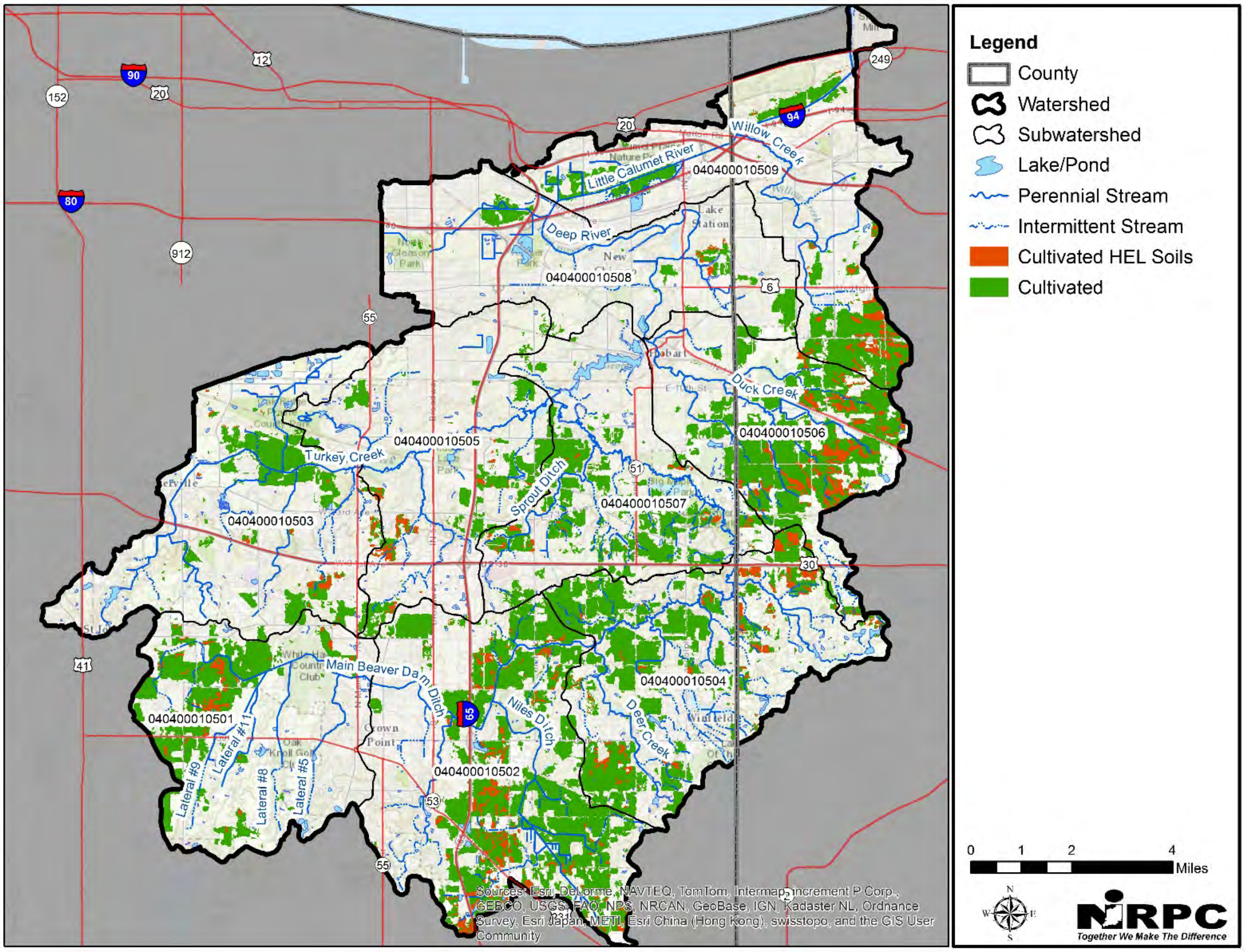


Figure 59 Cultivated Crops on Soils Classified as HEL

2.10.5 Cultivated Land on Poorly Drained Soils

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 negatives. 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.

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). Recent research in the St. Joseph River watershed (Lake Erie basin) indicates that nearly 50% of the soluble and total phosphorus losses in that watershed occur via tile drainage and that treating surface runoff may not be sufficient to meeting phosphorus runoff goals (Smith et al, 2015).

There are approximately 27,739 acres of cultivated land within our watershed of which 19,593 acres (71%) exists on a poorly drained soil class. The locations of cultivated land on poorly drained soil classes are shown in Figure 60. The Main Beaver Dam Ditch subwatershed has the greatest number of acres and highest percentage of cultivated land on poorly drained soils followed by the Duck Creek and Headwaters Main Beaver Dam Ditch subwatersheds.

Name	HUC-12	Acres	% of Drainage Area
Headwaters Main Beaver Dam Ditch	040400010501	2,515	21.5
Main Beaver Dam Ditch-Deep River	040400010502	5,012	29.8
Headwaters Turkey Creek	040400010503	1,401	10.3
Deer Creek-Deep River	040400010504	2,338	17
City of Merrillville-Turkey Creek	040400010505	1,067	8.54
Duck Creek	040400010506	3,181	31.4
Lake George-Deep River	040400010507	1,328	12
Little Calumet River-Deep River	040400010508	517	4.26
Willow Creek-Burns Ditch	040400010509	2,234	16.7
	Watershed Total	19,593	17.0

Table 36 Acres & Percentage of Cultivated Land on Poorly Drained Soil Classes

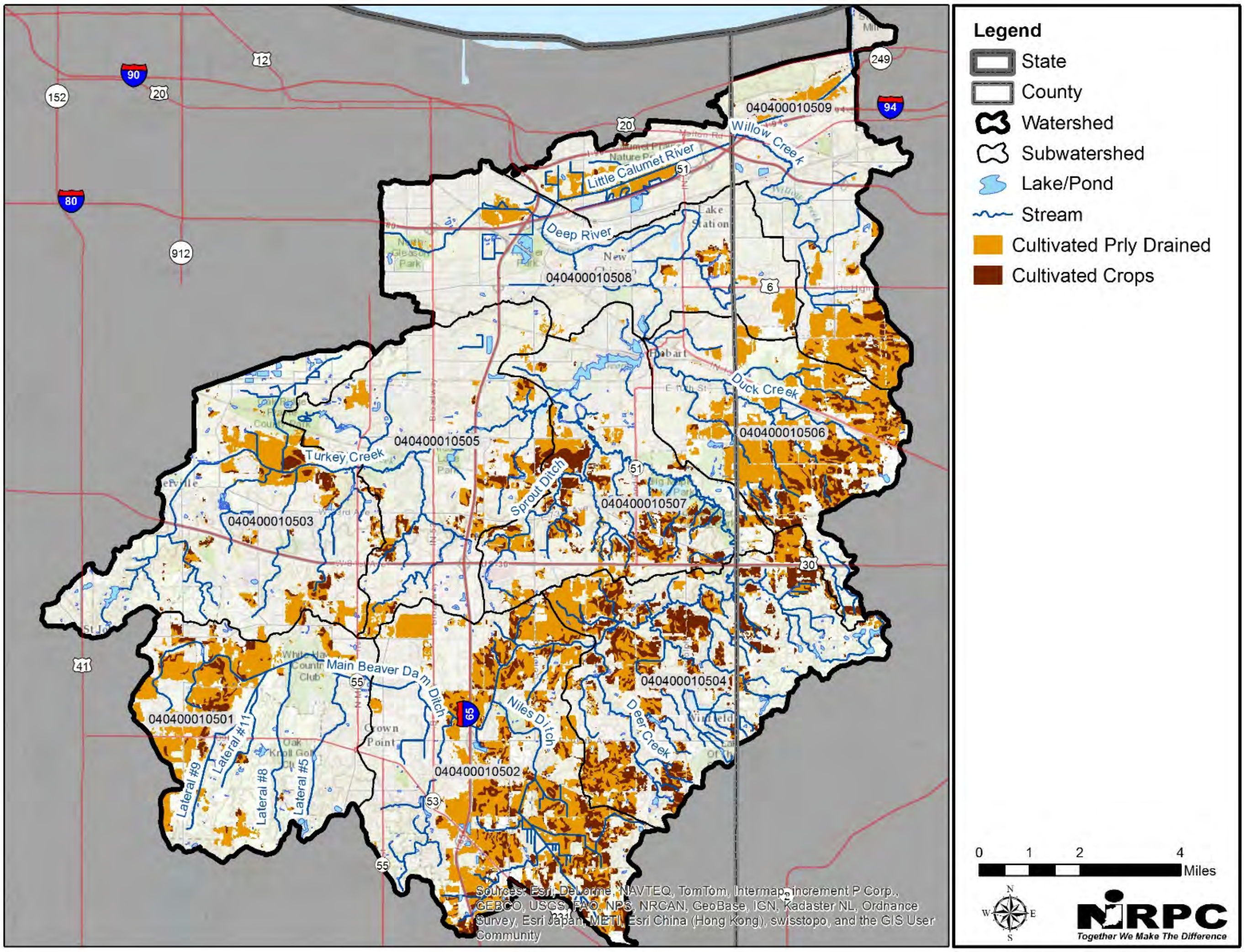


Figure 60 Cultivated Land on Poorly Drained Soil Classes

2.10.6 Unsewered Areas

There are several active waste water treatment plants that provide sanitary waste service for a large portion of the watershed's homes and businesses. However, there are areas that lie outside their service area and therefore rely on septic systems for waste treatment. As referenced previously, slightly more than 92% of the watershed's land area is rated as "very limited" for conventional septic 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 currently is no operation and maintenance program in place for existing systems within this region.

The following figure shows an approximation of unsewered areas and low intensity development occurring in these areas. The figure is meant to serve as a proxy of where septic systems may exist in the watershed. The Lake and Porter County Health Departments do not have an inventory of where all systems exist at this time.

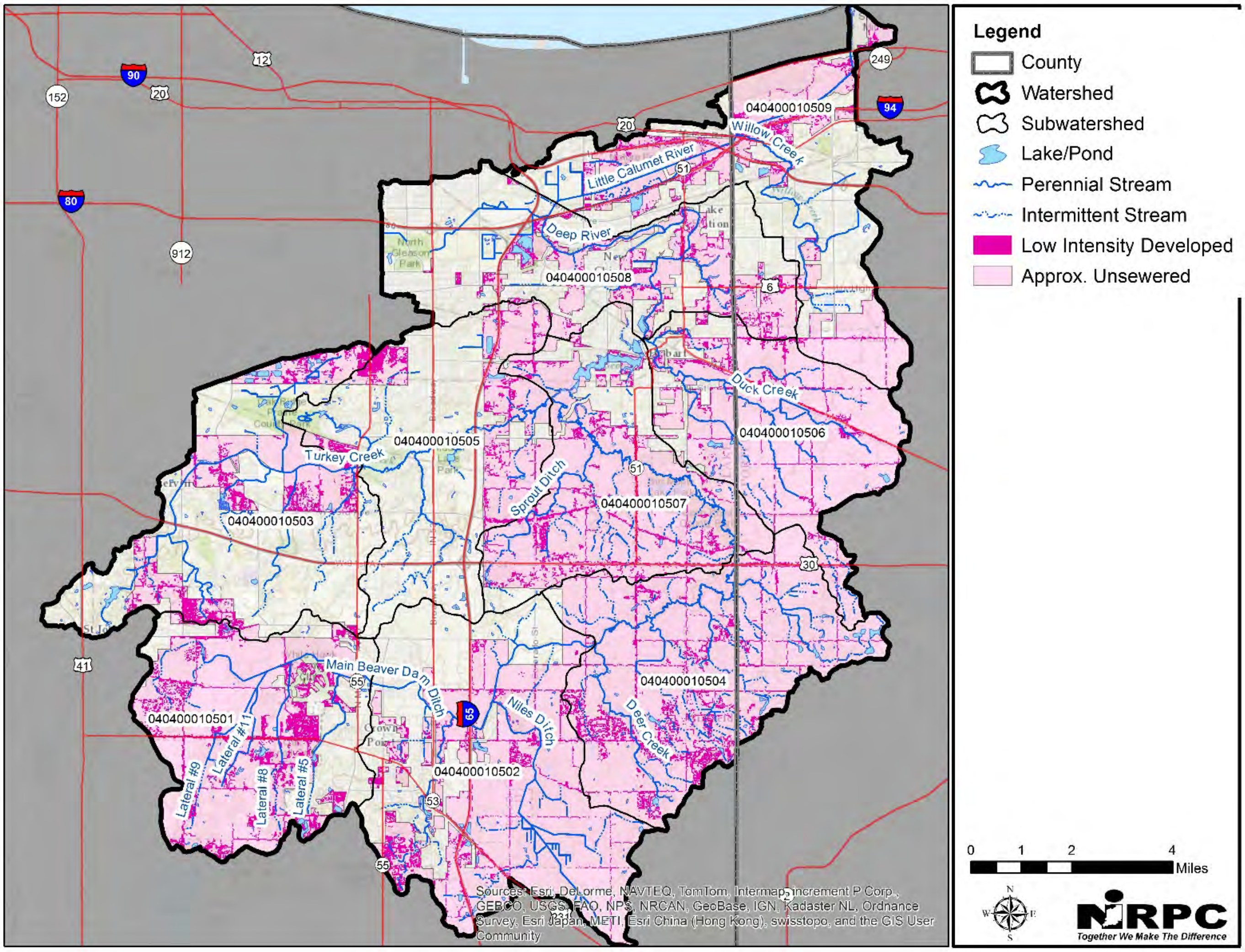


Figure 61 Approximate Unsewered Area