PENNSYLVANIA LAKE ERIE WATERSHED INTEGRATED WATER RESOURCES MANAGEMENT PLAN

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One of the fundamental principles of integrated water resource management is bringing together stakeholders to address the social, environmental, and technical aspects of water management. A volunteer Advisory Council representative of industry, agencies, academia, municipal government, non-profits, and citizens was formed to provide advice in the development of the *Pennsylvania Lake Erie Watershed Integrated Water Resources Management* (PALE IWRM) *Plan*. Specifically, the Advisory Council assisted in identifying goals and objectives for the plan and formulating comprehensive watershed management strategies and priorities.

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1.0 EXECUTIVE SUMMARY

In April 2010, Pennsylvania Sea Grant (PASG) and the Pennsylvania Department of Environmental Protection (DEP) issued the *Presque Isle Bay Watershed Restoration, Protection, and Monitoring Plan* (*PIB Plan*), which provides a framework for action to ensure that the quality and quantity of water and sediment entering Presque Isle Bay will not cause adverse impacts to the ecosystem. The *PIB Plan* summarizes a comprehensive GIS-based data collection, assessment, and analysis effort; and serves as a living document, providing a model to drive coordinated restoration, protection, and monitoring projects within the watershed. To build on the success of *PIB Plan*, PASG, DEP, and the Erie County Conservation District (ECCD) secured funding to expand the data collection and analysis effort to encompass the entire Pennsylvania Lake Erie watershed.

In scoping the *Pennsylvania Lake Erie Watershed Integrated Water Resources Management Plan* (*PALE IWRM Plan*), the authors decided to take a different approach using the principles of Integrated Water Resources Management (IWRM). IWRM is a method for understanding, identifying, and prioritizing actions to restore and protect watersheds, and serves as a tool for putting an array of information from different disciplines together with the goal of making existing water planning, management, and decision-making more rationale, efficient, and equitable. IWRM is a participatory process, bringing together users, planners, and policy makers representing the social, environmental, and technical aspects of water management to solve problems and address conflicts. PASG, DEP, and ECCD convened an advisory group with representatives from all reaches of the watershed to assist with identifying goals and objectives. The advisory group guided the plan development and provided insight into what data were available and what data were needed.

IWRM supports an ecosystem approach to managing water resources on a watershed basis, links water quantity with water quality, and connects land use to water management. To support good decision-making and prevent choices that would negatively impact Lake Erie and its watershed, information, analysis, and planning were needed. The *PALE IWRM Plan* was created to compile and make available information for agency staff and watershed organizations that supports informed decision-making regarding the management of water resources and guides users to the areas in the watershed where restoration, conservation, and/or monitoring projects are needed.

The *PALE IWRM Plan* summarizes existing regulatory, management, and monitoring programs implemented by government agencies at the federal, state, and local level. Several plans developed by various government and non-profit entities are also summarized, providing the results of data collections, studies, and proposals that address water and water-related resources in Pennsylvania's Lake Erie watershed. The *PALE IWRM Plan* includes an inventory of available data on the natural resources, permitted facilities and discharges, ecological systems, recreation and public access opportunities, and real-time data from Lake Erie buoys and weather stations. A series of maps illustrates the information that was collected and will be viewable as GIS layers, allowing multiple layers of information to be viewed simultaneously. Integrating this information offers a clearer picture of what we know and can be used to make more informed choices and decisions regarding the management of water resources within the Pennsylvania Lake Erie watershed.

2.0 PURPOSE, GOALS, AND OBJECTIVES

The Pennsylvania Coastal Resources Management Program (CRMP) provided funding to ECCD and PASG to initiate the development of an integrated water resources management plan for the Pennsylvania Lake Erie watershed. In addition, Pennsylvania Sea Grant was awarded additional funding from DEP, through the Great Lakes Restoration Initiative (GLRI) State Capacity Funding Program, to complete the plan. Both the CRM and GLRI funding were provided so that the concepts used to develop the Presque Isle Bay watershed plan could be applied to the entire Pennsylvania Lake Erie watershed.

In an effort to develop the most meaningful and useful plan, a wide variety of local stakeholders, with historical and ongoing interest and involvement in the area, were selected to form an advisory council to assist and guide the plan's authors in the development of the *PALE IWRM Plan* (*see Acknowledgements Section for full list of members*). Throughout the course of the project, the authors of this plan met with the advisory council to develop goals and objectives to further guide the development of the *PALE IWRM Plan*. In addition, the advisory council helped guide the development of the watershed characterization and data inventory section of the *PALE IWRM Plan* (*Section 4.0*).

The purpose of the *PALE IWRM Plan* is to simplify the management of water resources in the Pennsylvania Lake Erie watershed through the integration of data and information. The purpose of the plan is not to re-write or replace existing watershed plans (*Section 3.3*); rather, it is to provide those data needed for the management of the watershed in one central plan and web-based database. The goals of the *PALE IWRM Plan* are to: 1) assist watershed stakeholders in identifying restoration actions, promoting green infrastructure, protecting environmentally sensitive lands, and improving access to and use of water resources in the watershed; and 2) enhance the ability of agency staff to manage water resources in the watershed.

The objectives of the *PALE IWRM Plan* are to:

- ✓ Support an integrated approach to regulatory decision making in permitting new and controlling existing discharges to the water resources in the watershed.
- ✓ Encourage water conservation strategies that protect individual tributaries and the lake from overuse and support a balanced approach to water withdrawal decisions.
- ✓ Reduce the loadings of toxic substances and emerging contaminants to Lake Erie and its tributaries.
- ✓ Minimize the harmful ecological, economic, and human health impacts of aquatic invasive species through the prevention and management of their introduction, expansion, and dispersal.
- ✓ Reduce the loading of nonpoint source pollution to Lake Erie and its associated tributaries.
- ✓ Promote the wise management of land use, recreation, and economic activities that ensure near-shore aquatic, wetland, and upland habitats will sustain the function of natural communities
- ✓ Protect, restore, and enhance aquatic and terrestrial diversity and habitat with the Lake Erie watershed.
- ✓ Establish a cooperative monitoring program that provides a comprehensive assessment of the watershed.
- ✓ Increase public awareness of and involvement in watershed activities; and provide opportunities for stakeholders to participate in the decision-making process.
- ✓ Integrate planning and management to ensure the sustainable use of water resources.

3.0 BACKGROUND

3.1 Introduction to Lake Erie

Lake Erie is the smallest of the five Laurentian Great Lakes by volume (116 cubic miles) and second smallest in surface area (9,910 square miles). Lake Erie is 241 miles long and 57 miles wide, with an average depth of 62 feet and maximum depth of 210 feet (***Figure 1***). Lake Erie is the shallowest of the Great Lakes, warming quickly in the spring and summer and cooling quickly in the fall, making it the most biologically productive of the Great Lakes (LaMP Work Group, 2008). The Detroit River is responsible for 80 percent of Lake Erie's total inflow, 11 percent comes from precipitation, and the remaining 9 percent comes from the other tributaries flowing directly into the lake from Michigan, Ohio, Pennsylvania, New York, and Ohio (Bolsegna and Herdendorf, 1993). The Niagara River is the main outflow from Lake Erie. The retention time of Lake Erie is 2.6 years. The length of the Lake Erie shoreline is 871 miles, including 76.6 miles in Pennsylvania. The Lake Erie watershed drains an area of 29,702 square miles, including 508 square miles in portions of 33 municipalities in Erie and Crawford Counties, Pennsylvania. The Pennsylvania Lake Erie watershed includes 52 streams totaling a length of 1,122 miles.

Figure 1. Lake Erie

Approximately 11.6 million people reside in the Lake Erie watershed, representing one-third of the total population of the Great Lakes (LaMP Work Group, 2008). The Pennsylvania Lake Erie and Delaware coastal zone regions combined provide one million jobs for its 3 million residents (GLC, 2013). Lake Erie provides drinking water for 11 million residents. Coastal communities across Lake Erie rely on the lake and its watershed to support their economies. The United States Geological Survey (USGS) estimates 5,684,863 pounds of fish worth $5,720,364 were harvested from Lake Erie (Michigan, Pennsylvania, New York, and Ohio) by commercial fisheries in 2011. In Pennsylvania, 15,432 pounds of fish worth $51,081 were harvested in 2011. The United States Fish and Wildlife Service (USFWS, 2006) estimates 1.4 million anglers spent $1.5 billion on sport fishing (trips and equipment) in the Great Lakes, including tributaries. Lake Erie was the most popular lake, attracting 37 percent of all Great Lakes Anglers. Approximately 518,000 Lake Erie anglers spent $5.55 million on sport fishing. Murray and Shields (2004) suggest that anglers attracted to the Erie County, Pennsylvania stream and shoreline steelhead fishery (***Figure 2***) spent nearly $9.5 million on trip-related expenditures in 2003. Overall, this activity generates $5.71 million in new value-added activity in Erie County, supporting 219 jobs in the economy through direct and indirect effects. The National Marine Manufacturers Association (NMMA, 2013) estimates for Pennsylvania Congressional District 3, which includes the Lake Erie watershed, there are 28,721 registered boats, 72 recreational boating-related businesses that support 2,301 jobs, $123.4 million is spent annually on recreational boating-related spending, and the total economic impact of recreational boating in the District is valued at $291.1 million.

Figure 2. Steelhead Anglers on Twentymile Creek

Tourism Economics (2012) estimates visitors to the Pennsylvania Great Lakes region (Erie, Crawford, Mercer, and Venango Counties) spent approximately $1.56 billion on tourism-related activities, including recreation ($289 million), lodging, transportation, food and beverage, and shopping. The tourism industry in the Great Lakes region supports 12,989 jobs. Recreation includes spending at attractions and on both indoor and outdoor activities (e.g., hiking). In Erie and Crawford Counties, tourism supports 9,352 jobs and visitors spend approximately $1.16 billion on tourism-related activities ($225.3 million on recreation). Mowen et al. (2013), based on 2,593 interviews, estimates that the average trip expenditure by visitors to Presque Isle State Park alone is $80.95. Presque Isle State Park, located in northwest Pennsylvania along the southern shore of Lake Erie, receives an estimated 4.2 million visitors annually. Multiplying the expenditure estimates ($80.95/visitor) by the number of visitors to the park (4.2 million), visitors to the park spend approximately $340 million annually.

Stress from urbanization, industrialization, and agriculture pose a threat to Lake Erie's recreation and tourism-based economy, ecosystem, and the health of its residents and visitors. Current pressures impacting Lake Erie's economy and ecosystem include: land use, nutrients, natural resource use and disturbance, chemical and biological contaminants, and non-native invasive species (LaMP Work Group, 2008). The LaMP Work Group (2008) identifies land use practices as the dominant management category affecting the Lake Erie ecosystem. Poor land use management has resulted in increased water runoff containing sediments, nutrients, and chemicals to Lake Erie, and reduced areas of natural landscapes and habitats. Nutrient inputs are resulting in reduced use of beaches, changes in aquatic community structure, increased algal blooms, and anoxia. Water withdrawal and disturbance by human presence or activity may have negative impacts on target species, habitats, and more broadly on other components of the ecosystem if not properly managed. Biological contaminants (e.g. pathogens and toxins released by cyanobacteria or bacteria), toxic chemicals, and emerging contaminants (e.g. estrogenic compounds) degrade watersheds, not only impacting local fauna, but potentially having lakewide impacts. Locally contaminated areas may affect populations of fish and wildlife in the open waters of the lake if those locations are used for feeding, spawning or nursery habitat. Successful invaders may prey upon native species or compete with them for limited resources, altering the structure of the local and lakewide ecosystems.

In developing the current plan, we utilize the integrated water resource management framework as a tool for coordinating efforts to address those ecosystem issues impacting Pennsylvania Lake Erie waters and its watershed.

3.2 Integrated Water Resources Management

IWRM as a concept existed as early as the 1900s and is an internationally recognized paradigm for making water management more efficient. The most widely accepted definition of IWRM is one formulated by the Global Water Partnership in 2002 at the Johannesburg World Summit on Sustainable Development. The Partnership defined IWRM as "*a process which promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.*" While international forums endorse and promote IWRM, its actual use has been minimal and many are unclear as to what exactly the concept means in operational terms. There are some areas of agreement. IWRM recognizes water as a finite resource with an economic value. IWRM is a process and a tool for putting an array of information from different disciplines together with the goal of making existing water planning, management, and decision-making more rational, efficient, and equitable. The overall approach envisioned is participatory bringing together users, planners, and policy makers representing the social, environmental, and technical aspects of water management to solve problems and address conflicts. IWRM supports an ecosystem approach managing water resources on a river basin and watersheds basis, links water quantity with water quality, and connects land use to water management.

The decision to develop an IWRM plan for the Pennsylvania Lake Erie watershed came out of the State Water Plan process and the success of the *Presque Isle Bay Watershed Restoration, Protection, and Monitoring Plan*. Both identified the need to integrate geospatial data and information to facilitate management of water resources and decision-making at all levels of government. Within the DEP, the IWRM approach encourages coordination in administration of water resources management, watershed restoration, and conservation, and water quality management programs. Successful IWRM would bring together all the water management and policy programs DEP oversees and allow for cross-planning, prioritizing, strategizing, and implementing projects/permits both within DEP, with other state agencies, and among local government agencies.

The Pennsylvania Lake Erie Watershed presents an opportunity to implement the IWRM concept and serve as a tangible example of how this approach to planning and implementation can be incorporated in other settings throughout the Commonwealth. A watershed approach uses hydrologically defined areas (watersheds) to coordinate the management of water resources. The approach is advantageous because it considers all activities within a landscape that affect watershed health. A watershed approach offers a blueprint for water resource management. Those communities along the shores of Lake Erie hold many characteristics in common, the greatest of which is they are neighbors to and derive their identities from one of the largest freshwater resources in the world, and the many Pennsylvania tributaries that feed it. This section provides an overview of and identifies data needs for those programs to be integrated under the *PALE IWRM Plan*.

3.2.1 Stormwater Management (Act 167)

Waterways and receiving waters near urban and suburban areas are often adversely affected by urban stormwater runoff (***Figure 3***). The degree and type of impact varies, but it is often significant relative to other sources of pollution and environmental degradation. Urban stormwater runoff affects water quality, water quantity, habitat and biological resources, public health, and the aesthetic appearance of urban waterways (USEPA, 1999). Pennsylvania is authorized to implement the National Pollutant Discharge Elimination System (NPDES) Stormwater Program which regulates stormwater discharges from three potential sources: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. DEP administers this program for impacts due to construction activities with authority under the Clean Stream Law, Act of June 22, 1937, P.L. 1987, *as amended*, 35 P.S. §§691.1-691.1001 ("Clean Streams Law") and Chapter 102, Erosion and Sediment Control, regulations.

Figure 3. Stormwater runoff entering Cascade Creek

For construction activities, Chapter 102 requires erosion and sediment controls for any earth disturbance activity. If the amount of earth disturbance is 5,000 square feet up to 0.99 acres, then a written erosion and sediment control plan is required and must be kept on site. With a few exceptions (e.g., timber harvesting and road maintenance activities), a permit is required for earth disturbance activities equal to or greater than 1 acre. Additionally, sites where a permit is required also need to have a written Post Construction Stormwater Management Plan.

Local townships, boroughs, and municipalities also have a role in managing stormwater. The Stormwater Management Act (Act 167) was passed in 1978 to encourage planning and management of stormwater runoff from land development. DEP's responsibility is to ensure that counties develop countywide stormwater plans and local municipalities adopt ordinances to implement the countywide plan. The Erie County Plan was approved on March 25, 2011, and the Crawford County Plan was approved October 8, 2010, and all 33 municipalities within the Lake Erie watershed enacted ordinances that comply with the county plans.

3.2.2 Drinking Water (source water)

The federal Safe Drinking Water Act (Act) of 1974 charged the United States Environmental Protection Agency (EPA) with protection of public health through the regulation of public drinking water supplies. The Act authorizes US EPA to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants. US EPA, states, and water systems work together to make sure that these standards are met. In Pennsylvania, the state drinking water standards are at least as stringent as the federal standards and since 1985, DEP has the primary responsibility for implementing the Safe Drinking Water Act requirements.

DEP regulates public water systems with 15 or more service connections or those that serve at least 25 people per day for 60 days of the year. Drinking water standards must be met regardless of the source of the water. Private wells serving individual homes are not regulated. Nationwide, there are 163,000 community and non-community water systems regulated under the Act. In Pennsylvania's Lake Erie Watershed, there are approximately 150 regulated public water systems.

The 1996 reauthorization of the Act mandated that each state develop a Source Water Protection Program (SWPP). The SWPP is a proactive, voluntary and free technical assistance program which is offered to all community public water supplies. The intent of the program is to proactively engage community public water supplies to foster partnerships, collaboration, and increased communication amongst organizations, agencies, government officials, and public water supplies to actively protect groundwater and surface water sources through the development of source water protection plans. These plans delineate the sources of water for the system, identify threats to source water quality, develop management plans to address source water threats and document plans for outreach to the public on emergency and nonemergency information. Actively identifying activities that may threaten the quality of source water allows the community to address, prepare for, and mitigate those threats in making decisions on land uses and protective measures that need to be taken. Source Water Protection Plans are in the early stages of development in two of the municipalities in the Lake Erie Watershed: Girard and Lake City Boroughs.

There are a number of threats to drinking water: improperly disposed of chemicals, animal wastes, pesticides, human wastes, wastes injected deep underground, and naturally-occurring substances. Information on land use, permitted discharges, water withdrawals, and proximity to other activities or features that may impact public water sources supports decisions on system expansion as well as treatment. Outreach and restoration activities across a watershed or in a stream serve to improve the quality of source water for all those served.

Drinking Water Program Data Needs:

- ✓ Public Water Systems
- ✓ Private Wells

3.2.3 Water Withdrawal (Act 220)

Pennsylvania manages water withdrawals in the Great Lakes basin through the Water Resources Planning Act of 2002 (Act 220) and the Great Lakes-St. Lawrence River Basin Water Resources Compact. Under both instruments there are requirements for reporting and decision-making for water withdrawals over specific thresholds. The two are interrelated with shared reporting, baseline water use development, and the requirement to implement water conservation measures in the Lake Erie watershed.

Act 220 established a Statewide Water Resources Committee and six Regional Water Resources Committees charged with assisting DEP in the development of a State Water Plan. The goal of the state plan is to provide both a qualitative and quantitative description of water resources as well as guidance on how to use the data to make decisions. The plan is on a 5-year cycle for updating. The Great Lakes Regional Water Resource Subcommittee is focused on the Lake Erie and Genesee River watersheds. The Regional Committees compiled an inventory of existing water withdrawals greater than 10,000 gallons per day, developed priorities, and identified critical water planning areas where demand for water is already or is expected to exceed the current supply. One of the three priorities for the statewide plan is to encourage and sustain an integrated approach to managing water resources. The Great Lakes Regional Committee priorities are to integrate land use changes and their impact on surface and groundwater and to support legislation that protects the quantity and quality of Lake Erie's water.

Since 2003, Act 220 has required under an interim registration and reporting program, that all public water supply agencies, all hydropower facilities and all persons who withdraw or use more than 10,000 gallons per day of water in a 30-day period to register with DEP their sources and amount of their withdrawal or withdrawal use. Under the interim program, all withdrawers and withdrawal users that were not defined as community water systems under the PA Safe Drinking Water Act may have voluntarily submitted annual reports.

In 2008, a new regulation 25 Pa. Code Chapter 110, became effective and established non-voluntary water withdrawal and use registration, monitoring, record-keeping and reporting requirements. Chapter 110 applies to public water supply agencies (defined as community water systems) and hydropower facilities, irrespective of the amount of withdrawal, and any person whose total withdrawal from one or more points of withdrawal within a watershed operated as a system either concurrently or sequentially exceeds an average rate of 10,000 gallons per day of water in any 30-day period. Those persons who obtain their water through an interconnection with another person in an amount that exceeds an average rate of 100,000 gallons per day in any 30-day period also must register. Registrants must annually report their water usage and other information and retain records for at least 5 years.

In 2008 Pennsylvania joined the seven other Great Lakes states and passed legislation adopting the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact). Pennsylvania's participation in the Compact was authorized on July 4, 2008, when Governor Rendell signed Act 43, resulting from HB 1705 (introduced by Harkins, et al). The Act is self-implementing and authorizes Pennsylvania to join the Compact, provides for the form of the Compact and development of regulations, and provides for penalties. The impetus for the Compact was to make the states more consistent in managing and protecting the water and water-dependent natural resources of the Great Lakes basin. The Compact applies to both surface and groundwater; defining the Basin by its surface water divide. It also establishes a "decision-making standard" applicable to new or increased withdrawals and consumptive uses that requires return of the same amount of water withdrawn (minus an allowance for consumptive use), incorporation of water conservation measures, and withdrawal that does not result in significant individual or cumulative adverse impacts.

The Compact is applicable to any new or increased diversion, consumptive use of 5 million gallons per day (MGD) or more, or withdrawal of 100,000 gallons per day (GPD) or more that occurs within the Basin. All new or increased diversions out of the Basin are prohibited, with limited exceptions for public water supply purposes to an area within a "straddling community" but outside the basin if certain standards are met. Proposed diversions are subject to review and approval by all eight Great Lakes states.

Water Withdrawal Program Data Needs:

- ✓ Public Water Systems

3.2.4 Wastewater Management (Act 537)

Malfunctioning or improperly functioning sewage disposal systems, regardless of type, can pose a serious threat to public health and the environment. Sewage is defined as a substance that contains the waste products or excrement or other discharge from the bodies of human beings or animals and noxious or deleterious substances being harmful to the public health, or to animal or aquatic life, or to the use of water for domestic water supply or for recreation (***Figure 4***). On January 24, 1966, the Pennsylvania Sewage Facilities Act (Act 537, as amended) was enacted to correct existing sewage disposal problems and prevent future problems. To meet this objective, the Act requires proper planning in all types of sewage disposal situations. Local municipalities are largely responsible for administering the Act 537 sewage facilities program. Local agencies employ Sewage Enforcement Officers (SEO) and other staff as necessary to meet this obligation.

Figure 4. Erie Wastewater Treatment Plant

To assist local municipalities in fulfilling this responsibility, DEP provides technical assistance, financial assistance, and oversight. The purpose of the DEP sewage facilities program is to implement Act 537, in order to help address existing sewage disposal needs, and to help prevent future problems through the proper planning, permitting, and design of all types of sewage facilities. Act 537 requires Pennsylvania municipalities to develop and implement comprehensive official plans that provide for the resolution of existing sewage disposal problems, provide for the future sewage disposal needs of new land development, and provide for future sewage disposal needs of the municipality. This official plan is often referred to as an Act 537 plan. The main purpose of the Act 537 Plan is to protect the health, safety, and welfare of the citizens living in the municipality. It is the plan for correcting malfunctioning onlot septic systems, overloaded treatment plants or sewer lines, and wildcat sewers.

Wastewater Management Program Data Needs:

- ✓ Public Wastewater Treatment Areas
- ✓ Onlot Wastewater Treatment Areas
- ✓ Hydric Soils

3.2.5 Flood Management

Pennsylvania operates one of the few state level comprehensive flood protection programs. In addition to building flood protection projects such as dams and levees, DEP designs, inspects, and monitors these projects and state laws regulate activity in the floodplain and floodway. Floodplains are defined as the lands contiguous to a river or stream that may be expected to be inundated by flood waters in a 100-year frequency flood. A 100-year flood does not happen every 100 years. Rather it has a one percent chance of being equaled or exceeded in a given year. Pennsylvania regulates activities in the floodplain through the Flood Plain Management Act (***Figure 5***). The activities regulated are actually local government zoning and other ordinances affecting development in the floodplain.

Figure 5. Flooding along Mill Creek on June 30, 2009

Floodways are designated and mapped through detailed engineering studies. Mapped floodways include the channel of a river or other watercourse and the parts of the floodplain adjacent to the channel that are required to carry the 100-year flood flow without any increase in water surface elevations. Pennsylvania regulates activities in the floodway under its Dam Safety and Encroachments Act, Act of November 26, 1978, P.L. 1375, *as amended*, 32 P.S. §§693.1-693.27 ("Dam Safety Act") and the Chapter 105, Dam Safety and Waterways Management. The Federal Emergency Management Agency or FEMA delineates floodways for flood insurance maps. In areas where no FEMA maps exist or studies have defined the boundary of the 100year frequency floodway, the floodway is defined as the area extending from the stream to 50 feet from the top of the bank of the stream. Floodway regulation and permitting of obstructions and encroachments in the floodway is essential to ensure there are no increases in upstream flood elevations.

Flood Management Program Data Needs:

- ✓ Floodway
- ✓ Floodplain

3.2.6 AIS Management

Figure 6. Round goby collected from Sixteenmile Creek

More than 180 non-native species have infiltrated the Great Lakes and made them their permanent home, including invasive mussels, round gobies (***Figure 6***), Eurasian watermilfoil, and fishhook and spiny waterfleas. The AIS number continues to grow through vectors such as maritime commerce, recreational activities, organisms in trade, natural waterways, and public and private aquaculture. Once established, these species can become invasive, causing harm to important ecological functions such as the Great Lakes food web, native species, and delicate wetlands, as well as economic damage as communities spend huge amounts of time, money, and resources on control and management. In order for Pennsylvania to be effective in addressing AIS issues, agencies and organizations must collaborate and coordinate on all aspects of AIS management, including working closely with neighboring states in the Great Lakes region. In 2007, the National Aquatic Nuisance Species Task Force approved the Pennsylvania Aquatic Invasive Species Management Plan (PA AISMP), which was developed by Pennsylvania stakeholders to provide a coordinating framework of actions and strategies for local and statewide agencies, organizations, and stakeholders to implement. The plan is available at http://www.paseagrant.org/topics/invasive-species/#management.

AIS Management Data Needs:

- ✓ Expanded monitoring and distribution information

3.2.7 Bluff Management

CRMP, a program of DEP, seeks to protect and enhance the fragile natural resources situated along Pennsylvania's portion of the Lake Erie shoreline through a range of ten policy areas, one being Coastal Hazards. The Coastal Hazards policy area addresses impacts associated with bluff management and shoreline erosion and works to create and maintain a balance between environmental protection and economic development along the Lake Erie shoreline in Pennsylvania.

Figure 7. Bluff recession along the Pennsylvania Lake Erie coast

A bluff, as defined in Chapter 85 of the Pennsylvania Code, is a high bank or bold headland with a broad precipitous cliff face overlooking a lake. Bluffs along the Lake Erie shoreline range in height from 5'to 180' and are comprised of six main landscape features including the tableland, crest, bluff face, toe of bluff, beach, and shoreline (Cross et al., 2007). Bluff soil layers stratify into four general layers constituted of a thin layer of topsoil, a sandy layer with minor deposits of clay and silt, an impermeable silt and clay layer, and bedrock (Cross et al., 2007). These are unconsolidated (loose) glacial sediments and are vulnerable to erosion from several factors.

Bluff recession, as defined in Chapter 85 of the Pennsylvania Code, is the loss of material along the bluff face caused by the direct or indirect action by one or a combination of groundwater seepage, water currents, wind generated water waves, or high water levels (***Figure 7***). Additional factors involved with bluff recession and shoreline erosion include stormwater runoff and human activity. Areas along the bluff where the rate of progressive bluff recession creates a substantial threat to the safety or stability of nearby existing or future structures or utility facilities are known as Bluff Recession Hazard Areas (BRHA) (DEP, 2013). Nearly all the Pennsylvania Lake Erie shoreline is designated as a BRHA under the framework established in the Bluff Recession and Setback Act (BRSA) and companion regulations in Pa. Code Title 25, Chapter 85 (DEP, 2013).

The CRMP Coastal Hazards policy addresses bluff recession management through assisting with the local administration and enforcement of the BRSA and Chapter 85, providing technical assistance to Lake Erie property owners, measuring rates of bluff recession, and working with other agencies in monitoring coastal activities. The BRSA and Chapter 85, Bluff Recession and Setback regulations create restrictions on new development and on improvements to existing development within areas designated as BRHAs (DEP, 2013). Municipalities having BRHAs designated within their jurisdictions are required to enact specific setback ordinances (i.e., regulating the construction of stationary building or structure within a specified distance from the edge of the bluff) that satisfy Chapter 85 requirements (DEP, 2013). CRMP works with those affected municipalities to provide guidance on the implementation of Chapter 85 regulations. CRMP also ensures compliance and enforcement of the BRSA through routine surveillance, communication with municipal zoning administrators and code enforcement officers, and annual municipal reporting requirements mandated by the BRSA.

Technical assistance to property owners is provided through on-site assessments and data reviews which rely upon physical site assessments, aerial imagery reviews, web based and geographic information system data reviews (i.e. soils, topography, and land use), and personal accounts from property owners and municipal officials. Recommendations for coastal property owners are provided for shoreline protection, surface and groundwater control, bluff stabilization, and vegetation best management practices.

Rates of bluff recession are physically measured by CRMP staff every 4-5 years along the Pennsylvania Lake Erie shoreline. DEP has approximately 130 control points located along the Lake Erie coast line which are used to measure and determine rates of bluff recession. These data are compiled into a report and provided to municipalities and property owners. According to work by the United States Geologic Survey and CRMP, the long-term average rate of bluff recession is approximately 1' per year (Hapke et al., 2009). DEP also works with other agencies such as the Pennsylvania Fish and Boat Commission, Pennsylvania Game Commission, the Erie County Planning Department, coastal municipalities, and others to monitor coastal activities.

Bluff Management Program Data Needs:

- ✓ Steep Slopes
- ✓ Soils
- ✓ Topography
- ✓ Streams
- ✓ Impervious Cover
- ✓ Land Use/Land Cover Classifications
- ✓ Floodplains
- ✓ Aerial Imagery
- ✓ Watershed Boundaries
- ✓ Bluff Crest Lines

3.2.8 Wetlands Management

A survey conducted by U.S. Department of Agriculture found that urbanization was implicated in wetland loss in 96 percent of watersheds assessed in the United States and may account for 58 percent of the total wetland loss nationally (reviewed by Ehrenfeld 2000). Wetlands are important elements of a watershed because they serve as the link between land and water resources (***Figure 8***). Wetlands store precipitation and surface water and release it into other surface and groundwater reserves and to the atmosphere, and in doing so, serve an important role in controlling water flow, regulating discharge of water from catchments, retarding flows and mitigating flood damage, and protect against erosion (Werren *et al.* 2000). Wetlands also provide nutrient transformation and habitat for wildlife. Mitch and Gosselink (2000) suggest that 3-7 percent of watersheds should contain wetlands to optimize the landscape for their ecosystem values such as flood control and water quality enhancement.

Figure 8. Wetlands located in the Walnut Creek watershed

In July 2012, USFWS and CRMP began work on updating the wetlands inventory for the Lake Erie watershed. The work involved wetland mapping and field views to produce an updated and enhanced wetland inventory for the USFWS's National Wetland Inventory. The data were also used to predict wetland functions for the entire watershed. The data showed that the Lake Erie watershed contains 29,904 acres of wetlands which equals roughly 9 percent of the land area (USFWS, 2014). A breakdown by type of watershed shows that 75 percent of the watershed's wetlands are wooded swamps and 25 percent are shrub swamps, marshes, wet meadows, and ponds. Approximately two-thirds of the wetlands are classified as "terrene" which means they are the sources of streams and vitally important to stream health. USFWS estimates that historically (i.e., prior to European settlement) wetlands may have covered up to 94,000 acres or 29 percent of the watershed (USFWS, 2014).

Pennsylvania's the Dam Safety and Encroachments Act, Act of November 26, 1978, P.L. 1375, *as amended*, 32 P.S. §§693.1-693.27 ("Dam Safety Act") and the Chapter 105, Dam Safety and Waterways Management, regulations control impacts to wetlands. Most activities in Pennsylvania water courses, water bodies, or wetlands require an authorization or permit from DEP to protect public health, safety, and the environment. Activities that change, expand or diminish the course, current or cross section of a watercourse, floodway or waterbody are termed encroachments, obstructions in certain cases, and are regulated by Chapter 105 regulations. If a wetland is impacted under a permit from the DEP, the regulations require a minimum area replacement ratio of 1:1 and consideration of the functions and values provided by the wetland in determining the final replacement ratio.

USEPA (2001b) defines wetland restoration as the return of a degraded wetland or former wetland to its preexisting naturally functioning condition, or a condition as close to its natural condition as possible. The Interagency Workgroup on Wetland Restoration (2003) discusses two methods for renewing wetland function, the passive approach and active approach. The passive approach is designed to remove the factors causing wetland degradation or loss and let nature do the work to restore the wetland. Passive approaches are most appropriate when the degraded site still retains basic wetland characteristics and the source of the degradation is an action that can be stopped. Active approaches involve physical intervention in which humans directly control site processes to restore, create, or enhance wetland systems. The active approach is most appropriate when a wetland is severely degraded or when goals cannot be achieved in any other way.

Wetland Data Needs:

- ✓ Aerial Imagery
- ✓ Location of Projects with Existing Chapter 105 Permits
- ✓ Soils
- ✓ Streams
- ✓ Land Use

3.2.9 Beach Monitoring

Contaminants in the water do not only affect aquatic life; they also pose a risk to human health. United States Environmental Protection Agency (USEPA) developed human health water quality criteria by assessing the relationship between pollutants and their effect on human health. The criteria represent the highest concentration of a pollutant in water that is not expected to pose a significant risk to human health. USEPA (2011) provides recommended recreational (i.e. bathing, swimming, or surfing) water quality criteria for states. USEPA recommends the use of *E. coli* as an indicator as it is a good predictor of gastrointestinal illness in fresh waters. USEPA (2011) recommends using a recreational *E. coli* standard of 235 colony forming units (cfu)/100 milliliters. *E. coli* is bacteria found in the digestive tracts and feces of humans, wildlife, and domestic animals (Whitlock *et al.* 2002). Sources of *E. coli* pollution include stormwater runoff, failing septic systems, direct deposition of animal feces, wastewater treatment plants, illicit discharges, and storm drains (Petersen *et al.* 2005).

The swimming beaches along the Pennsylvania Lake Erie shoreline are monitored during the swimming season (May – September) for bacterial concentrations by the Regional Science Consortium (RSC) and Erie County Department of Health. The objectives for the monitoring program are to issue advisories/

restrictions when water quality is not suitable for swimming, and to protect human health. The objective for the research program is to develop more rapid techniques to determine water quality against present standards. In addition, the RSC utilizes weather stations and water quality buoys for real-time data to support two predictive models used to determine elevated *E. coli* concentrations in swimming beach waters. The beach monitoring project is worked on cooperatively with the Erie County Department of Health, DCNR, U.S. Geological Survey, Penn State Behrend, and Gannon University.

The Erie County Department of Health uses the following water quality criteria when issuing advisories and restrictions for swimming beaches:

- If the *E. coli* level in a regulatory sample is greater than or equal to 235 cfu/100ml, but less than 1,000 cfu/100ml, the beach will be posted with a **swimming advisory**. Swimming will be permitted and the public will be informed that the *E.coli* level exceeds standards and what precautions to take if they choose to enter the water.
- If the *E. coli* is equal to or greater than 1,000 cfu/100 ml, the beach will be posted with a **swimming restriction** and **swimming will not be permitted**.
- When an *E. coli* level drops below 1,000cfu/100ml but remains above 235 cfu/100ml, the beach will be posted as an advisory.
- In addition, **precautionary advisories** will be issued when water conditions are similar to conditions that historically produced elevated *E. coli* levels. This type of advisory will be posted prior to receiving any bacteria results. Swimming will still be permitted, and the public will be informed of what precautions to take if they enter the water.
- Advisories will be lifted only when resampling indicates a bacteria level below 235.

Beach Monitoring Program Data Needs:

- ✓ Natural Resource Data
- ✓ Coastal Development Data
- ✓ Point Source Data
- ✓ Ecological Data
- ✓ Public Access Data
- ✓ Water Use Data
- ✓ Public Sewer Area
- ✓ Residential Septic Systems
- ✓ Agricultural Land

3.2.10 Watershed Restoration

USEPA (2006), based on the analysis of macroinvertebrate communities in streams across the United States, concluded that 41.9 percent of the nation's stream length is in poor biological condition compared to least-disturbed reference sites, 24.9 percent is in fair biological condition, and 28.2 percent is in good biological condition (5 percent were not assessed). Imperilment of North American fishes has increased by 92 percent since 1989 (Jelks et al. 2008). As of 2008, 39 percent of fish in North American freshwater streams, rivers, and lakes were found to be vulnerable, threatened, or endangered. Jelks et al. (2008) list habitat degradation and non-native species as the main threats to at-risk fishes. Restoration is a tool that can be used to reestablish the chemical, physical, and biological components of an aquatic ecosystem that have been compromised by stressors such as point or nonpoint sources of pollution, habitat degradation, and hydro-modification. Watershed restoration can be generally defined as those activities that seek to restore healthy aquatic communities and provide clean waters for recreation, irrigation, and public consumption (USEPA, 2001a).

The negative impacts associated with urbanization on the physical, chemical, and biological attributes of streams have been well documented (Schueler, 1994; Arnold and Gibbons, 1996; Wang et al., 2001; Morse et al., 2003; Paul and Meyer, 2008). Impacts of urbanization on streams include changes in stream hydrology, physical alteration of the stream corridor, degradation of stream habitat, decline in water quality, and loss of aquatic diversity (Schueler, 2005). Restoration should consider all sources of stress on a stream and is therefore not restricted to in-stream mitigation of impacts. Stream restoration can include an assortment of in-stream, riparian, and upland techniques used in combination to eliminate or reduce the impact of stressors on aquatic ecosystems (***Figure 9***).

Figure 9. Restoration of Cascade Creek in Frontier Park

Watershed Restoration Data Needs:

- ✓ Watershed Boundaries
- ✓ Streams
- ✓ Impervious Cover
- ✓ Vegetated Riparian Buffers
- ✓ Vegetated Floodplains
- ✓ Steep Slopes
- ✓ Wetlands
- ✓ Hydrologic Soils
- ✓ Stream Habitat
- ✓ Stream Fish Community
- ✓ Natural Heritage Inventory
- ✓ Existing Restoration Projects
- ✓ Existing Low Impact Development Projects

3.2.11 Watershed Conservation

A healthy watershed is one in which natural land cover supports dynamic hydrologic and geomorphic processes, habitat of sufficient size and connectivity supports native aquatic and riparian species, and water quality supports healthy biological communities (USEPA 2012). Healthy watersheds sustain water-related recreation opportunities, such as fishing, boating, and swimming, and provide hiking, birding, hunting, and ecotourism opportunities. Vulnerability to floods, fires, and other natural disasters is minimized in healthy watersheds. Healthy watersheds can also help to assure availability of sufficient amounts of water for human consumption and industrial uses. Protecting watersheds helps prevent degradation of water quality; improves quality of life; and provides ecological, economic, recreational, and health benefits to coastal communities.

Land conservation is a tool designed to help communities protect their watersheds. Land conservation is voluntary and incentives based; open space and development rights are acquired from property owners through fee simple purchase, conservation easements, and/or donations (The Trust for Public Land, 2004). Through these conservation techniques, natural resources are protected permanently while landowners are compensated for their properties. Fee simple acquisition occurs when a parcel of land is sold from one party to another. A fee simple purchase transfers full ownership of the property to another party. The most traditional tool for conserving private land is a conservation easement. Easements are a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows landowners to continue to own and use their land, and they can also sell it or pass it on to heirs. Land may also be acquired through a donation, with the landowner realizing tax benefits from the donation. Public parks and conservation subdivisions result in the conservation of open space as well.

Watershed Protection Data Needs:

- ✓ Watershed Boundaries
- ✓ Streams
- ✓ Active River Area Boundaries
- ✓ Impervious Cover
- ✓ Vegetated Riparian Buffers
- ✓ Vegetated Floodplains
- ✓ Steep Slopes
- ✓ Wetlands
- ✓ Forested Land
- ✓ Agricultural Land
- ✓ Hydrologic Soils
- ✓ Stream Habitat
- ✓ Stream Fish Community
- ✓ Active River Area
- ✓ Natural Heritage Inventory
- ✓ Exceptional/High Value Greenways
- ✓ Existing Conserved Land

3.2.12 Watershed Monitoring

Monitoring refers to the periodic or continuous collection of data using consistent methods (USEPA, n.d.). There are various types of monitoring and reasons for collecting data vary. For example, water quality monitoring can evaluate the physical, chemical, and biological characteristics of a waterway in relation to human health, ecological conditions, and designated water uses (USEPA, n.d.). Watershed monitoring provides a more comprehensive approach to data collection that incorporates water quality and watershed conditions. Watershed monitoring evaluates the condition of water resources and provides watershed information to help establish relationships between variables (***Figure 10***). Watershed monitoring data can be used for many purposes, including determining sources of impairment, providing input for modeling tools, supporting decisions for preserving or restoring a water resource, and evaluating the impact of conservation and restoration efforts.

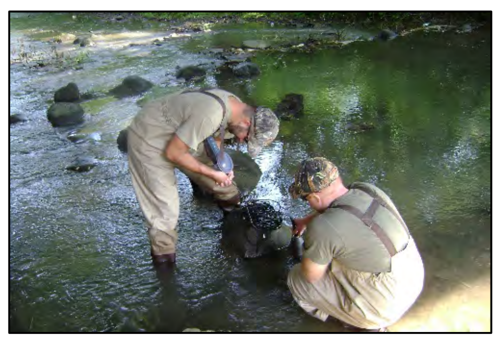

Figure 10. Staff assessing pH, temperature, conductivity, and DO in Conneaut Creek

There are several evaluation tools and indicators that can be used to assess the quality of water within a watershed, including biological parameters, chemical analysis, physical measurements, habitat evaluations, and toxicity measurements. Biological parameters such as fish and macroinvertebrates can be monitored for general health, abundance, composition, and diversity. These indicators naturally integrate water quantity and quality impacts within the watershed; therefore, they provide an indication of the cumulative effects of acute and chronic pollution inputs (USEPA, n.d.). Chemical analyses of water samples and biota (e.g. fish tissue sampling for toxic substances) can determine the presence and concentration of parameters like nutrients, metals, and organochlorine compounds (USEPA, n.d.). Toxicity measurements can be used to determine the impacts of chemicals in the environment on aquatic life. Physical measurements, including stream flow, temperature, turbidity and color, dissolved oxygen, and pH are collected in the field and can provide additional clues to the quality of a resource and potential problems which may exist (USEPA, n.d.). Habitat evaluations can also provide data important to determining why fish and macroinvertebrate communities are degraded. Habitat evaluations can include measurements of the riparian corridor condition, the amount and types of overhanging vegetation, stream bottom substrate, and the amount of hydrologic modification (USEPA, n.d.). In addition, supplemental data such as changes in impervious cover, forest cover, wetland coverage, vegetated riparian buffers and floodplains, conserved lands, and restored stream segments can be used to assess watersheds. By integrating these monitoring and supplemental data, the relationships between sources of stress and their effects on the waterway may be determined, and appropriate management strategies to improve water quality can be selected. Chemical, physical, biological, habitat, and toxicity measurements are all valuable tools to monitor the health of a water resource, but it is important to match these tools with objectives (USEPA, n.d.).

Watershed Monitoring Data Needs:

- ✓ Watershed Boundaries
- ✓ Streams
- ✓ Impervious Cover
- ✓ Vegetated Riparian Buffers
- ✓ Vegetated Floodplains
- ✓ Wetlands
- ✓ Forested Land
- ✓ Stream Habitat
- ✓ Stream Fish Community
- ✓ Stream Macroinvertebrate Community
- ✓ Stream Water/Sediment Chemistry
- ✓ Existing Conserved Land
- ✓ Existing Restoration Projects

3.3 Existing Plans

Building on prior efforts and incorporating related information is an efficient and effective response to the need for comprehensive water resource management planning (USEPA, 2008). Numerous watershed and county-based plans addressing water resource-related issues exist for the Pennsylvania Lake Erie watershed. These plans provide a valuable framework and data for producing the current plan. This section provides a summary of and links to the management plans that were reviewed as part of the current planning process.

3.3.1 Erie County Act 167 County-wide Stormwater Management Plan and Crawford County Act 167 Countywide Watershed Stormwater Management Plan (HRG, 2010)

This Erie County Act 167 Plan and Crawford County Act 167 Plan were developed to present the findings of a two-phased multi-year study of the watersheds within the counties. Watershed-based planning addresses the full range of hydrologic and hydraulic impacts from cumulative land developments within a watershed rather than simply considering and addressing site-specific peak flows. Although this plan represents many things to many people, the principal purposes of the plan are to protect human health and safety by addressing the impacts of future land use on the current levels of stormwater runoff and to recommend measures to control accelerated runoff to prevent increased flood damages or additional water quality degradation.

The objective of the plans is to provide a plan for comprehensive watershed stormwater management throughout Erie and Crawford counties. The plan is intended to enable every municipality the County to meet the intent of Act 167 through the following goals:

- Manage stormwater runoff created by new development activities by taking into account the cumulative basinwide stormwater impacts from peak runoff rates and runoff volume.
- Meet the legal water quality requirements under federal and state laws.
- Provide uniform stormwater management standards throughout Crawford County.
- Encourage the management of stormwater to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to protect water resources.
- Preserve existing natural drainage ways and water courses.
- Ensure that existing stormwater problem areas are not exacerbated by future development and provide recommendations for improving existing problem areas.

http://www.crawfordcountypa.net/portal/page?_pageid=393,848324,393_2542261&_dad=portal&_schema=PORTAL

http://www.eriecountygov.org/media/19845/ERIE_SWM-Ordinance_Revised_3-28-11.pdf

3.3.2 Conneaut Creek Conservation Plan (Campbell et al., 2010)

The Conneaut Creek watershed on the southern shore of Lake Erie is the largest sub-watershed within Pennsylvania's portion of the Great Lakes Basin, and occupies portions of Erie and Crawford Counties in Pennsylvania and Ashtabula County in Ohio. The watershed contains Pennsylvania State Game Land 101, which includes extensive wetlands. Heritage resources of special concern in Pennsylvania, including populations of nearly two dozen species of rare plants, fish, native mussels, and birds, are concentrated in areas along the main stem of Conneaut Creek, especially in the northern half of the watershed. The Conneaut Creek Conservation Plan provides recommendations for conserving nearly 20 miles of stream channel and several thousand acres in the Pennsylvania portion of the Lake Erie watershed. The plan also emphasizes pre-emptive actions to address invasive species and impending climate change in the watershed.

http://www.planerieregion.com/uploads/PDF/LERC_Conneaut_Creek_Plan_Final_Reduced.pdf

3.3.3 Erie and Crawford County Natural Heritage Inventory (PNHP, 2012; PNHP, 2008)

The Pennsylvania Natural Heritage Program (PNHP) is responsible for collecting, tracking, and interpreting information regarding the Commonwealth’s biological diversity. County Natural Heritage Inventories (CNHIs) are an important part of the work of PNHP. Since 1989, PNHP has conducted county inventories as a means to gather new information about natural resources and to pass this information along to those responsible for making decisions about the resources in the county, including the community at large. This CNHI focuses on the best examples of living ecological resources in Erie County.

The CNHI report presents the known outstanding natural features in the county. The CNHI provides maps of the best natural communities (habitats) and all the known locations of animal and plant species of concern (endangered, threatened, or rare) in Erie County. A written description and a summary table of the sites, including quality and degree of rarity are included. Potential threats and some suggestions for protection of the rare plants or animals at the site are included in many of the individual site descriptions. Selected geologic features of statewide significance are also noted. In addition, the inventory describes areas that are significant on a countywide scale, but do not merit state-wide status as exemplary natural communities. These locally significant sites represent good examples of habitats that are relatively rare in the county, support a high diversity of plant species, and/or provide valuable wildlife habitat on a local level. The information and maps presented in this report provide a useful guide for planning development and parks, conserving natural areas, and setting priorities for the preservation of the most vulnerable natural areas. All of the sites in this report were evaluated for their importance in protecting biological diversity on a state and local level, but many also have scenic value and provide water quality protection; they are also often potential sites for low-impact passive recreation, nature observation, and environmental education.

http://www.naturalheritage.state.pa.us/CNAI_PDFs/ErieNHI_Update2012.pdf

3.3.4 Lake Erie Lakewide Action and Management Plan

Working under the adaptive management concept, the Binational Executive Committee (BEC) recommended that a LaMP be produced for each lake by April 2000, with updates every two years thereafter. The development and implementation of Lakewide Action and Management Plan (LAMPs) are an essential element of the process to restore and maintain the chemical, physical, and biological integrity of the Great Lakes ecosystem. The Lake Erie LaMP document is a management plan and not a state of the lake report. The LAMP identifies three steps for setting a direction for the Lake Erie ecosystem: 1) a preferred ecosystem management alternative must be selected; 2) ecosystem vision and management objectives must be developed that describe in narrative form more details to set the stage for the actions needed to achieve the preferred alternative; and 3) indicators must be developed to measure progress in achieving the desired ecosystem alternative.

The Lakewide Management provisions in Annex 2 of the 2012 Amendments to the Great Lakes Water Quality Agreement established a new method for developing and implementing management plans on each of the individual Great Lakes. The Collaborative Science Monitoring Initiative (CSMI) for Lake Erie occurred in 2014 in preparation for the development of a new Lake Erie LAMP in 2018. In addition to the CSMI informing the 2018 Lake Erie LAMP, the Annex 4 Subcommittee will be providing phosphorus reduction recommendations and domestic action plans that will be integrated into the LAMP. Also, the governmental management structure for Lake Erie is being reformed with the BEC being replaced with the Great Lakes Executive Committee (GLEC), and further refinements to the LAMP Partnership Management Committee and Working Groups.

http://www.epa.gov/greatlakes/lakeerie/

3.3.5 Northwest Pennsylvania Greenways: Crawford County, Pennsylvania (Pashek Associates, 2009) and Erie County, Pennsylvania (Pashek Associates, 2010)

A greenway is a corridor of open space. Greenways vary greatly in scale, from narrow ribbons of green that run through urban, suburban, and rural areas to wider corridors that incorporate diverse natural, cultural, and scenic features. They may follow old railways, canals, or ridge tops, or they may follow stream corridors, shorelines, or wetlands, and include water trails. Some greenways are for human activity and may accommodate motorized and non-motorized recreation and transportation uses. Other greenways conserve natural infrastructure for the benefit of community, economy, and environment and are not designed for human passage.

The purpose of these plans were to gather information about the natural and cultural assets of Crawford and Erie counties that may form the building blocks of conservation and recreational greenway corridors. The plan also examines some of the methods by which a greenway network can be developed for the counties, and explores the potential opportunities that exist for the expansion and/or creation of greenways throughout the counties.

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/d_001223.pdf

http://www.northwestpa.org/greenways/Erie_County_Greenway_Plan_-_05-22-09_-_Final%5B1%5D.pdf

3.3.6 Pennsylvania Coastal and Estuarine Land Conservation Plan (DVRPC, 2009)

The Coastal and Estuarine Land Conservation Program (CELCP) was created by an Act of Congress in 2002 to provide Federal funding for coastal land conservation. The primary goal of CELCP is to protect "important coastal and estuarine areas" that have significant conservation, recreation, ecological, historical, or aesthetic values – giving priority to lands which can be effectively managed and protected and that have significant ecological value. In fulfillment of the requirements for participation in CELCP, The Commonwealth of Pennsylvania prepared and submitted this CELCP Plan for approval by the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management. The plan provides an assessment of priority land conservation needs and clear guidance for selecting land conservation projects within the state for nomination to NOAA for funding.

http://www.dep.state.pa.us/river/grants/celcp/Docs/PACELCPPlan.pdf

3.3.7 Pennsylvania Invasive Species Management Plan (Walter et al., 2009)

The purpose of the Pennsylvania Invasive Species Management Plan is to provide a framework to guide efforts to minimize the harmful ecological, economic, and human health impacts of nonnative invasive species through the prevention and management of their introduction, expansion and dispersal into, within and from Pennsylvania. This document outlines goals and actions identified by the Pennsylvania Invasive Species Council as critical to protecting Commonwealth resources. It will not be possible to prevent every nonnative invasive species from entering the state, or to eradicate all of those already present, but this plan will aid Pennsylvania in decreasing manyof the deleterious effects posed by invasive species.

http://www.invasivespeciescouncil.com/Documents/FINAL%20Plan_low_res.pdf

3.3.8 Pennsylvania Lake Erie Watershed Conservation Plan (LERC, 2008)

The primary purpose of the Pennsylvania Lake Erie Watershed Conservation Plan is to guide the protection of water resources important to the economic future of Pennsylvania. In addition to charting a course for future efforts to protect the aquatic resources of our watershed, the plan provides benchmarks for future conservation-related research in the Pennsylvania Lake Erie watershed as well as recommendations for sustainable land use planning and the management of water, natural, and recreational resources. Many of these recommendations may be addressed by plan users independent of the advancement of action steps outlined in the plan's final chapter.

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_002148.pdf

3.3.9 *Presque Isle Bay Watershed Restoration, Protection, and Monitoring Plan (Rafferty et al., 2010)*

The *Presque Isle Bay Watershed Restoration, Protection, and Monitoring Plan* serves as the framework for restoring and protecting water resources within the Presque Isle Bay watershed and provides a model that can be adapted to other urban watersheds. The Presque Isle Bay watershed drains a highly urbanized area of approximately 26.22 square miles, including portions of Millcreek Township, City of Erie, Harborcreek Township, Summit Township, and Greene Township in Erie County, Pennsylvania. Tributaries of the bay include, from west to east, Scott Run, Unnamed Tributary One, Unnamed Tributary Two, Cascade Creek, Mill Creek, and its tributary Garrison Run. These tributaries comprise 90 percent of the bay's watershed; the remainder of the watershed (10 percent) is comprised of direct runoff to the bay. Geospatial data collected as part of the watershed characterization of the plan were used to prioritize restoration, protection, and monitoring needs in the watershed. The 18 watershed characterization parameters were analyzed using geospatial technology and scored on a scale of 0 to 5, based on criteria developed by the watershed planning committee, in each of 78 sub-watersheds. Total restoration scores were then calculated in each of the sub-watersheds by summing each individual parameter score. Higher total restoration scores indicated a higher priority for restoration actions.

http://seagrant.psu.edu/topics/watershed-planning-and-monitoring/projects/presque-isle-bay-watershed-restoration-protection

3.3.10 *Trout Run and Godfrey Run Watershed Implementation Plan (ECCD, 2009)*

This plan attempts to identify sources of pollution, including nutrients, which are affecting attainment of aquatic life uses within the streams. Recommendations are made for methods to reduce the sources of pollution, including identifying key people and organizations that may participate and cost estimates for improvement measures. In addition, load reductions were estimated for the recommended best management practices (BMPs). Taking the load reductions, cost estimate, and participation level of stakeholders, priorities were set for the BMPs and a timeline was developed with milestones and measurable outcomes.

http://files.dep.state.pa.us/water/Watershed%20Management/WatershedPortalFiles/Trout%20Run-Godfrey%20Run%20Watershed%20Implementation%20Plan.pdf

3.3.11 *Walnut Creek Watershed Assessment Environmental Quality Report (DEP, 2007) and Walnut Creek Watershed Restoration and Protection Plan (DEP, 2008)*

DEP's Watershed Management Program conducted a comprehensive, watershed-based assessment to determine if the environmental conditions in the watershed were supporting public health and safety, economic stability, and quality of life for Erie County residents. The assessment involved a detailed look at: watershed features and characteristics; conditions affecting public health and safety; habitat and biological diversity; water use and sustainability; and community efforts to reduce pollution and conserve resources. The results of the assessment identified activities that encourage support of, and conflict with, resource protection. The watershed provides citizens with good air quality, safe drinking water, outstanding recreational and economic opportunities and available land. But the health of the watershed is at risk when land development and related activities are in conflict with environmental quality.

http://files.dep.state.pa.us/RegionalResources/NWRO/documents/Part_1_Intro.pdf

The Walnut Creek Assessment Report recommends implementation of a comprehensive, community-based restoration plan for the Walnut Creek Watershed where partners take individual responsibility for working towards overall improvement. The Assessment Report, based on the results of DEP (2007) makes numerous recommendations for actions that would improve the environmental quality of the watershed. In keeping with those recommendations, DEP has developed this Protection and Restoration Plan document to guide protection and restoration activities, and present the agency's goals for the Walnut Creek watershed.

http://files.dep.state.pa.us/RegionalResources/NWRO/documents/Walnut_Creek_Prot-Rest_FINAL.pdf

4.0 DATA INVENTORY

The watershed characterization and geospatial data inventory serve as the backbone of the PALE IWRM Plan. The data included in this inventory reflects those data needs identified in the Integrated Water Resources Management Section of the PALE IWRM Plan (*Section 2.2*). These data are intended to assist watershed stakeholders and agency staff address the goals and objectives of the PALE IWRM Plan (*Section 3.0*). This section provides descriptions of and static maps for each of the data layers inventoried. A total of seven categories of data were used to characterize the Pennsylvania Lake Erie watershed, including:

- Natural Resource Data
- Coastal Development Data
- Point Source Data
- Ecological Data
- Recreational Opportunity and Public Access Data
- Water Use Data;
- Watershed Restoration and Land Conservation Data Inventory;
- Real-Time Data

4.1 Natural Resource Data Inventory

4.1.1 Watershed Boundaries and Streams

The Pennsylvania portion of the Lake Erie watershed, located in northwest Pennsylvania, drains an area of approximately 507.72 mi^2 (1314.98 km^2) (***Map 1***). There are 56 streams totaling a length of 1121.35mi (1804.64 km) within the watershed (***Map 2*; *Table 1*; *Figure 11***). The PALE IWRM Plan will focus on the Pennsylvania Lake Erie watershed as a whole and 15 major sub-watersheds, including: Ashtabula Creek, Conneaut Creek, Turkey Creek, Raccoon Creek, Crooked Creek, Elk Creek, Trout Run, Walnut Creek, Fourmile Creek, Sixmile Creek, Sevenmile Creek, Eightmile Creek, Twelvemile Creek, Sixteenmile Creek, Twentymile Creek (***Map 3*; *Table 2***). Data for the other streams are presented when available. Those streams that drain to Presque Isle Bay were excluded from the current characterization as they were previously assessed during the development of the *Presque Isle Bay Watershed Restoration, Protection, and Monitoring Plan* (Rafferty *et al.* 2010).

Figure 11. Sixteenmile Creek

4.1.2 Flood Zones

Flood zones are geographic areas that the Federal Emergency Management Agency (FEMA) defines according to varying levels of flood risk. Zone A includes areas that have a 1 percent probability of flooding every year (i.e. 100-year floodplain) and where predicted flood water elevations have not been established. Zone AE are areas that have a 1 percent probability of flooding every year and where predicted flood water elevations above mean sea level have been established. Properties in Zone A and Zone AE are considered to be at high risk of flooding under the National Flood Insurance Program (NFIP). Zone X are areas that have a 0.2 percent probability of flooding every year (i.e. 500-year floodplain). Properties in Zone X are considered to be at moderate risk of flooding under NFIP. There are

20.65 mi^2 (53.48 km^2) of Zone A, 2.63 mi^2 (6.81 km^2) Zone AE, and 0.45 mi^2 (1.16 km^2) of Zone X Flood Zone within the Pennsylvania Lake Erie watershed (***Map 4*****;** ***Table 3***).

In streams unaffected by human activities, floodplains often contain well-established, rooted vegetation to help absorb the force and volume of rising floodwaters, which serve to protect and stabilize stream banks from erosion (Ward *et al.* 2008). Vegetated floodplains also filter pollutants, shade and cool the stream, reduce floods by slowing down the velocity of floodwaters, and provide wildlife and recreational habitat. Impervious surfaces within floodplains impair a floodplains capacity to slow and absorb floodwaters and runoff, and increase the volume and velocity of runoff in stream channels, resulting in down cutting and widening of the stream channel (Ward *et al.* 2008). This may eventually lead to development of a new floodplain at a lower elevation as the stream channels begin to recover.

4.1.3 Hydric soils

Soils are grouped into groups (A, B, C, or D) or dual-groups (A/D, B/D, or C/D) based on estimates of runoff potential. The assignments are based on the rate of water infiltration when soils are not protected by vegetation, are wet, and received precipitation from prolonged storms. For soils assigned to a dual-group, the first letter is for drained areas and the second is for undrained areas. For the purposes of the current analysis, soils assigned to dual-groups were re-classified according to the first letter. Group A soils are sand, loamy sand, or sandy loam, and have low runoff potential and high infiltration rates even when thoroughly wetted (Diz *et al.* 2004). Group B soils are silt loam or loam, and have a moderate infiltration rate when thoroughly wetted. Group C soils are sandy clay loam, and have low infiltration rates when thoroughly wetted. Group D soils are clay loam, silty clay loam, sandy clay, silty clay, or clay, and have very low infiltration rates when thoroughly wetted. Other soils include escarpments, water, and gravel pits. Group C soils are the dominant soil type within the Pennsylvania Lake Erie Watershed, comprising 43.99 percent of the watershed; followed by Group D soils at 32.65 percent, Group A at 16.32 percent, Group B at 5.34 percent, and other soils at 1.70 percent (***Map 5*****;** ***Table 4***).

4.1.4 LiDAR

In fall 2012, Woolpert, Inc. was contracted to acquire 1-meter point density LiDAR (Light Detection and Ranging) data for the Pennsylvania portion of the Lake Erie watershed. LiDAR is a remote sensing technique that uses light (pulsed laser) to measure distances to Earth. These pulses, combined with other data recorded by the airborne system, produced detailed three-dimensional information about the shape of Earth and its surface characteristics. For the purposes of the PALE IWRM Plan, the LiDAR data was used to delineate impervious surfaces in the watershed (refer to *Section 4.2.4*) and produce a 1-meter resolution digital elevation model (DEM) for the watershed (refer to *Section 4.1.5*).

The LiDAR data can be downloaded at:

http://www.pasda.psu.edu/uci/MetadataDisplay.aspx?entry=PASDA&file=Lake_Erie_Watershed_LiDAR2012.xml&dataset=3163

4.1.5 Elevation and Slope

The elevation of the Pennsylvania Lake Erie watershed ranges from a low of approximately 570 feet above mean sea level to a high of 1,701 feet above mean sea level (***Map 6***). The slope, a measure of change in elevation, for the watershed was derived from the DEM in order to identify regions with steep slopes (***Map 7***). Disturbance of steep slopes along stream banks can result in erosion processes from stormwater runoff and the subsequent sedimentation of surface waters, often leading to degraded water quality and loss of aquatic life. Other effects include soil loss, changes in natural topography and drainage patterns, increased flooding potential, further fragmentation of forest areas, and compromised aesthetic values. Because sloping terrains are prone to erosion if disturbed, Arendt (1999) suggests slopes over 25 percent should be avoided for clearing, re-grading, or construction, and slopes between 15-25 percent require special site planning and should also be avoided whenever possible. The majority of the Pennsylvania Lake Erie watershed is sloped less than 15 percent (***Map 8***).

The 1-meter resolution DEM can be downloaded at:

http://www.pasda.psu.edu/uci/MetadataDisplay.aspx?entry=PASDA&file=Lake_Erie_Watershed_LiDAR2012.xml&dataset=3163

4.1.6 Forest Cover

Forest cover in the Pennsylvania Lake Erie watershed is comprised of deciduous forest, evergreen forest, and mixed forest (***Figure 12***). Deciduous, evergreen, and mixed forests are areas dominated by trees generally greater than five-meters tall and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species in deciduous forests shed foliage simultaneously in response to seasonal change. More than 75 percent of the tree species in evergreen forests maintain their leaves all year. Neither deciduous nor evergreen species comprise more-than 75 percent of total tree cover in mixed forests. Watersheds with a high proportion of forested land and wetlands are effective at filtering out contaminants and trapping sediments (Postel and Thompson, 2005). Postel and Thompson (2005), based on analysis of 27 water suppliers in the United States, suggest that treatment costs for drinking water derived from watersheds comprised of at least 60 percent forest cover were half of those derived from watersheds with 30 percent forest cover, and one-third of the cost of treating water from watershed with 10 percent forest cover.

Figure 12. Forest cover along Twelvemile Creek

Forest cover types for the watershed were derived from the 2011 National Land Cover Dataset (NLCD) Edition (amended in 2014) published by the U.S. Geological Survey. Deciduous forest is the dominant forest cover type in the Pennsylvania Lake Erie watershed, covering 37.94 percent of the watershed; followed by evergreen forest at 1.24 percent; and mixed forest at 0.86 percent (***Map 9*****;** ***Table 5***). Of the 15 major sub-watersheds, Turkey Creek has the highest percent forest cover (60.57 percent) and Sevenmile Creek has the lowest percent forest cover (22.76 percent).

4.1.7 Wetlands

The Clean Water Act defines wetlands as those areas that are inundated or saturated by surface or ground water (hydrology) at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation (hydrophytes) typically adapted for life in saturated soil conditions (hydric soils). Wetlands are important elements of a watershed because they serve as the link between land and water resources (refer to *Section 2.2.8*). Wetland types, derived from the 2014 U.S. Fish and Wildlife Service National Wetland Inventory dataset, in the Pennsylvania Lake Erie watershed include:

- Freshwater Emergent Wetland: Herbaceous Marsh, Fen, Swale and Wet Meadow
- Freshwater Forested/Shrub Wetland: Forested Swamp or Wetland Shrub Bog or Wetland
- Freshwater Pond: Pond

- Riverine: River or Stream Channel
- Other: Farmed Wetland, Saline Seep and Other Miscellaneous Wetland

Mitch and Gosselink (2000) suggest that an ideal amount of wetlands be around 3-7 percent (average of 5 percent) in watersheds to optimize the landscape for their ecosystem values such as flood control and water quality enhancement. There are approximately 17,487.01 acres of wetlands within the Pennsylvania Lake Erie watershed, which comprises 5.38 percent of the watershed (***Map 10*****;** ***Table 6***). Of the 15 major sub-watersheds, Turkey Creek has the highest percent wetlands (37.68 percent) and Fourmile Creek has the lowest percent wetlands (0.66 percent).

4.1.8 Orthoimagery

In fall 2012, Woolpert, Inc. was contracted to acquire 0.5-foot resolution leaf-off, color orthoimagery for the Pennsylvania portion of the Pennsylvania Lake Erie watershed (***Map 11***). Orthoimagery data are aerial images that combine aerial photographs with spatial accuracy and reliability. For the purposes of the PALE IWRM Plan, the orthoimagery was used to delineate impervious surfaces in the watershed (refer to *Section 4.2.4*).

The orthoimagery can be downloaded at:

http://www.pasda.psu.edu/uci/MetadataDisplay.aspx?entry=PASDA&file=Lake_Erie_Watershed_Imagery2012.xml&dataset=3162

4.1.9 Riparian Buffers

Riparian buffers serve as a link between stream environments and their terrestrial surroundings. Because of their physical proximity, riparian ecosystems influence the structure of aquatic and upland terrestrial habitats and affect important functional processes in the stream channel (Osborne and Kovacic 1993). Riparian ecosystems have been widely accepted as a viable and useful tool for restoring and managing streams because of their ability to moderate stream temperatures; reduce sediment, pathogen, metal, pesticide, toxin, and nutrient input; provide important sources of organic matter to stream communities; provide important wildlife habitat; and stabilize stream banks (Osborne and Kovacic 1993; Klapproth and Johnson 2000).

Prior to the enactment of Act 162 in 2014, Title 25 Pennsylvania Code Chapter 102 (025 Pa. Code § 102.14) required average minimum widths for riparian buffers (Zone 1 and Zone 2) along Pennsylvania's rivers, perennial or intermittent streams, lakes, ponds, or reservoirs. In Zone 1, undisturbed native trees must begin at the top of the streambank or normal pool elevation of a lake, pond or reservoir and occupy a strip of land measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir. Predominant vegetation must be composed of a variety of native riparian tree species. In Zone 2, managed native trees and shrubs must begin at the landward edge of Zone 1 and occupy an additional strip of land measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond or reservoir. Predominant vegetation must be composed of a variety of native riparian tree and shrub species. Act 162 replaces the required minimum riparian width in high quality and exceptional value watersheds with a choice of alternative methods as long as the method is at least as effective as the buffer in controlling stormwater.

The previously required average minimum riparian widths were:

- *Waters other than special protection.* A total of 100 feet (30.5 meters), comprised of 50 feet (15.2 meters) in Zone 1 and 50 feet (15.2 meters) in Zone 2 for newly established riparian forest buffers established under subsection (e)(3) along all rivers, perennial or intermittent streams, lakes, ponds, or reservoirs.
- *Special protection waters.* A total of 150 feet (45.7 meters), comprised of 50 feet (15.2 meters) in Zone 1 and 100 feet (30.5 meters) in Zone 2 on newly established riparian forest buffers along all rivers, perennial or intermittent streams, lakes, ponds, or reservoirs in special protection waters (high quality and exceptional value designations).

4.2 Coastal Development Data Inventory

4.2.1 County and Municipal Boundaries

The Pennsylvania portion of the Lake Erie watershed drains portions of two counties (***Map 12***) and 33 municipalities in northwest Pennsylvania, including seven municipalities in Crawford County and 26 municipalities in Erie County (***Map 13*****;** ***Table 7***). Approximately 51.1 percent of Erie County and 9.3 percent of Crawford County drains to Lake Erie. Of the 33 Lake Erie municipalities, Conneaut Township has the largest area of land that drains to Lake Erie 43.49 mi^2 (112.63 km^2).

4.2.2 Human Population

Based on the 2010 U.S. Census, 262,718 people reside in the 33 Lake Erie municipalities (***Map 14*****;** ***Table 8***). Of the 33 Lake Erie municipalities, the City of Erie is the most populated (101,786) and McKean Borough is the least populated (388).

4.2.3 Urbanized Area and MS4 Communities

Figure 13. Erie Urbanized Area

In 1990, Phase I of the National Pollutant Discharge Elimination System (NPDES) storm water program was established under the Clean Water Act to address stormwater from: (1 medium and large municipal MS4s generally serving populations of 100,000 or greater; (2 construction activity disturbing five acres of land or more; and (3 ten categories of industrial activity. In 1999, the NPDES Phase II Rule was promulgated to expand the Phase I program by requiring those small MS4s located within urbanized areas (***Figure 13***), but not already covered by the Phase I program and operators of small construction sites (operations that disturb equal to or greater than one and less than five acres of land), through the use of NPDES permits, to implement programs and practices to control polluted stormwater runoff. An urbanized area is an area of land (independent of county and municipal borders) that has a residential population of at least 50,000 and an overall population density of at least 1,000 people per square mile. Municipal Separate Storm Sewer Systems (MS4) are systems of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains; owned or operated by a state or local jurisdiction, state departments of transportation, universities, local sewer districts, hospitals, military bases, associations, or other public body; used for collecting stormwater; which is not a combined sewer. Currently, there are 11 MS4 communities within the Pennsylvania Lake Erie watershed (***Map 15*****;** ***Table 9***).

4.2.4 Impervious Cover

Arnold and Gibbons (1996) define impervious surfaces as any material that prevents the infiltration of water into the soil. Imperviousness includes the sum of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of the urban landscape (Schueler 1994). Impervious surfaces are a critical contributor to the hydrologic changes that degrade waterways; are a major component of the intensive land uses that generate pollution; prevent natural pollutant processing in the soil by preventing percolation; and serve as an efficient conveyance system transporting pollutants into waterways (Arnold and Gibbons 1996). There are approximately 29.96 mi^2 (77.58 km^2) of impervious surfaces in the Pennsylvania Lake Erie watershed, which comprise 5.90 percent of the watershed (***Map 16*****;** ***Table 10***). Of the 15 major sub-watersheds, Walnut Creek has the highest percent impervious cover (11.17 percent) and Ashtabula Creek has the lowest percent impervious cover (0.93 percent).

There is a strong relationship between the imperviousness of a watershed and the health of its receiving stream; generally, as impervious coverage increases, stream health decreases. Schueler *et al.* (2009) divides streams into four management categories based on the general relationship between impervious cover and stream quality, including: 1) sensitive streams (0-10 percent impervious cover); 2) impacted streams (10-25 percent impervious cover); 3) non-supporting streams (25-60 percent impervious cover); and urban drainages (60-100 percent impervious cover). Schueler *et al.* (2009) also developed three transitional categories: 1) 5-10 percent (transitioning to impacted); 2) 20-25% (transitioning to non-supporting); and 3) 60-70 percent (transitioning to urban drainage). Of the 15 major sub-watersheds, Walnut Creek is the only watershed that falls outside of the sensitive range (***Map 17***).

The impervious cover data can be downloaded at:

http://www.pasda.psu.edu/uci/MetadataDisplay.aspx?entry=PASDA&file=Lake_Erie_Watershed_PALE_IC_2012.xml&dataset=3160

4.2.5 Transportation Infrastructure

The combustion process of vehicles and wearing of vehicles, road construction and maintenance, road surface degradation, and application of road maintenance chemicals all contribute to pollutants in the environment (Bohemen and Janssen Van de Laak 2003). Water that runs off a road surface carries many of these pollutants to the roadside and eventually into surface waters and groundwater. There are approximately 2,233.65 miles (3,594.72 kilometers) of roadways in the Pennsylvania Lake Erie watershed, with a density of 4.40 mi/mi^2 (***Map 18*****;** ***Table 11***). Of the 15 major sub-watersheds, Walnut Creek has the highest density of roads (6.44 mi/mi^2; 4.00 km/km^2) and Ashtabula Creek (1.90 mi/mi^2; 1.18 km/km^2) has the lowest density of roads.

4.2.6 Land Cover

Land cover describes how much of an area is covered by various land and water types. The way water is transported and stored is largely dependent on the type of land cover. In forested areas, most of the rain soaks into the soil and slowly flows into streams. In developed areas, most of the rain runs off and rapidly flows into streams, carrying pollutants with it. Land cover types for the Pennsylvania Lake Erie watershed were derived from the 30-meter resolution 2011 National Land Cover Database (Jin *et al.* 2013) (***Table 12***). Forest land and agricultural land are the dominant land cover types within the Pennsylvania Lake Erie watershed, covering 40.11 percent and 31.76 percent of the watershed respectively; followed by developed, open space at 7.65 percent; developed, low intensity at 7.47 percent; wetlands at 5.13 percent; shrub/grasslands at 2.94 percent; developed, medium intensity at 2.94 percent;

developed, high intensity at 1.10 percent, barren land at 0.19 percent; and open water at 0.71 percent (***Map 19***; ***Table 13***).

4.3 Point Source Data Inventory

Point source pollution, commonly associated with facilities and/or locations with the potential to impact the watershed, refers to single, identifiable sources that discharge pollutants into the environment. While there are many federal (e.g. Clean Water Act and Clean Air Act) and state (e.g. Pennsylvania Clean Streams Law and Air Pollution Control Act) regulations in place to prevent these facilities and locations from impacting the watershed, it is important to document these facilities due to the fact that pollutants have the potential to be introduced into the environment through point sources (e.g. air emission, wastewater discharge, etc.).

4.3.1 Air Emission Facilities

Air emission facilities are regulated under the DEP Air Quality Program (***Figure 14***). Sub-facilities regulated include:

Figure 14. Coking plant located on the Lake Erie shoreline

- *Air Pollution Control Device* - facility that removes one or more pollutants from an exhaust stream.
- *Combustion Units* - used to produce either electricity, steam, hot gases, or some combination of these.
- *Fuel Material Location* - facility for storage of fuels shared by multiple combustion units, incinerators, or processes.
- *General Administrative Location* - created automatically for every new air emission plant primary facility.
- *Incinerator* - facility that destroys solid waste products using a variety of fuels.
- *Point of Air Emission* - exact location or structure from which all other air emission plant sub-facilities exhaust their emissions.
- *Process* - facility that produces or modifies a product, and creates an air emission from either the materials used or a fuel consumed.

There are 2,517 air emission facilities located within the Pennsylvania Lake Erie watershed (***Map 20***).

4.3.2 Land Recycling Cleanup Locations

The Pennsylvania Land Recycling Program (Act 2) encourages the voluntary cleanup and reuse of contaminated commercial and industrial sites. The Land Recycling Program allows an owner or purchaser of a Brownfield site to choose any one or combination of cleanup standards to guide the remediation. By meeting one or a combination of the background standards, the statewide health standard, or the site-specific standard, the remediator will receive liability relief for the property. Also, the Hazardous Sites Cleanup Act (HSCA) provides DEP with the funding and authority to conduct cleanup actions at Land Recycling Cleanup Locations where hazardous substances have been released, and also provides DEP with enforcement authority to force the persons who are responsible for releases of hazardous substances to conduct cleanup actions or to repay public funds spent on a DEP-funded cleanup action. There are 167 Land Recycling Cleanup Locations located within the Pennsylvania Lake Erie watershed (***Map 21***).

4.3.3 Captive and Commercial Hazardous Waste Operations

A Captive or Commercial Hazardous Waste Operation is a DEP primary facility type related to the Waste Management Hazardous Waste Program. Regulated sub-facilities include:

- *Boiler/Industrial Furnace* - facility permitted to burn or process hazardous waste generated onsite to recover thermal energy, or to accomplish recovery of materials in association with a manufacturing process.
- *Disposal Facility* - facility permitted to dispose of hazardous waste generated onsite by incineration, or by intentionally placing the waste in or on land or water in specially designed and constructed containment units where the waste will remain after closure of the facility.
- *Hazardous Generator* - site where hazardous waste is first produced.
- *Incinerator* - facility permitted to burn or thermally combust hazardous waste generated onsite in an enclosed device using controlled flame.
- *Recycling Facility* - facility permitted to treat hazardous waste generated onsite, making it suitable for upcoming recovery of a usable product or material.
- *Storage Facility* - facility permitted to hold hazardous waste generated onsite for a temporary period (not to exceed one year).
- *Treatment Facility* - Facility permitted to change the physical, chemical or biological character or composition of hazardous waste that is generated onsite for the purpose of neutralizing the waste or to render the waste non-hazardous, safer for transport, suitable for recovery, suitable for storage, or reduced in volume.

There are two permitted captive hazardous waste operations and one commercial hazardous waste operation located within the Pennsylvania Lake Erie watershed (***Map 22***).

4.3.4 Illegal Dump Sites

In 2011, Keep Pennsylvania Beautiful documented illegal dump sites through the Commonwealth (***Figure 15***). The purpose of the illegal dump survey was to assess and document as many illegal dump sites as possible within a county. The survey is a tool that can be used for planning purposes within a community. It can provide valuable insight into development of solid waste and recycling programs. It can be used to gain support for funding for public awareness programs and education, as well as generate funds to clean the existing dumpsites. By providing these data, we can begin addressing the problem through public policy, resource allocation, community education, and cleanups. There are 68 documented illegal dump sites located within the Pennsylvania Lake Erie watershed (***Map 23***).

Figure 15. Former Currie Landfill site in Millcreek Township

4.3.5 Encroachment Locations

An encroachment location is a DEP primary facility type related to the Water Resources Management Water Obstructions Program. An encroachment permit is needed for any structure or activity which changes, expands, or diminishes the course, current, or cross section of a watercourse, floodway, or body of water. There are many sub-facility types relating to encroachment locations, ranging from Boat

Launch Ramps to Dredging to Wetland Impact. In the Pennsylvania Lake Erie watershed, these sub-facilities may pertain to more than one primary facility listed in ***Table 14***. There are 530 encroachment locations within the Pennsylvania Lake Erie watershed (***Map 24***).

4.3.6 Erosion and Sediment Control Facilities

An erosion and sediment control facility is a DEP primary facility type related to the Water Pollution Control program. The following sub-facility types related to erosion and sediment control facilities are included:

- Agricultural Activities
- Commercial or Industrial Development
- Government Facilities
- Oil and Gas Development
- Private Road or Residence
- Public Road Construction
- Recreational Activities
- Remediation/Restoration
- Residential Subdivision
- Sewerage or Water Systems
- Silviculture
- Utility Facility and/or Transmission Line

Any of these activities that may discharge stormwater during construction fall under the erosion and sediment control permit category. There are 38 permitted erosion and sediment control facilities located within the Pennsylvania Lake Erie watershed (***Map 25***).

4.3.7 Storage Tanks

A Storage Tank Location is a DEP primary facility type, and its sole sub-facility is the storage tank itself. Storage tanks are aboveground or underground, and are regulated under Chapter 245 pursuant to the Storage Tank and Spill Prevention Act. Storage tanks currently contain, have contained in the past, or will contain in the future, petroleum or a regulated hazardous substance. There are 319 storage tanks located within the Pennsylvania Lake Erie watershed (***Map 26***).

4.3.8 Toxic Release Inventory Sites

In 1987, The Toxics Release Inventory (TRI) program was created under the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 with the intention of empowering communities to hold companies accountable and make informed decisions about how toxic chemicals are to be managed. The TRI program contains information about more than 650 toxic chemicals that are being used, manufactured, treated, transported, or released into the environment. There are 100 TRI facilities located within the Pennsylvania Lake Erie watershed (***Map 27***).

4.3.9 Water Pollution Control Facilities

A water pollution control facility is a DEP primary facility type related to the Water Pollution Control Program. The sub-facility types related to Water Pollution Control that are included are:

- *Agricultural Activities* - the management and use of farming resources for the production of crops, livestock, or poultry.

- *Compost/Processing* - indicates that the facility treats sewage sludge by composting to produce a material that can be beneficially used, biosolids.
- *Conveyance System* - sewerage system without treatment.
- *Discharge Point* - discharge point to stream.
- *Groundwater Monitoring Point*.
- *Internal Monitoring Point* - used to monitor internal processes; not a discharge.
- *Land Discharge* - land application of wastewater.
- *Manure Management* - activities related to or supporting storage, collection, handling, transport, application, planning, record keeping, generation, or other manure management activities.
- *Outfall Structure* - outfall structure to stream.
- *Pipeline or Conduit* - pipes or other smaller diameter conveyances that are used to transport or supply liquids or slurries from collection, storage, or supply facilities or areas to other facilities or areas for storage, modification or use. These can be for longer-term, medium-term, or short-term and would include design, capacity, maintenance, safety, inspection, accident, and varying use, and weather considerations.
- *Pump Station* - sewerage pump station.
- *Storage Unit* - storage of wastewater.
- *Treatment Plant* - sewage or industrial wastewater treatment plant.

There are 371 permitted water pollution control facilities located within the Pennsylvania Lake Erie watershed (***Map 28***).

4.3.10 Municipal Waste Operations

A Municipal Waste Operation is a DEP primary facility type related to the Waste Management Municipal Waste Program. Municipal waste is waste generated by households and commercial facilities (***Figure 16***). The sub-facility types related to Municipal Waste Operations that are included are:

Figure 16. Lake View Landfill in Summit Township. Photo Credit: goerie.com

- *Composting* - includes facilities that use land for processing municipal waste by composting. Composting is a process that biologically decomposes organic waste under controlled anaerobic or aerobic conditions to yield a humus-like product.
- *Land Application* - includes facilities that use agricultural utilization or land reclamation of waste. Sewage sludge is land applied for its nutrient value or as a soil conditioner.
- *Landfill/Abandoned* - the Abandoned Landfill Inventory Project collects geospatial and descriptive data for closed and abandoned landfills throughout The Commonwealth of Pennsylvania.
- *Landfill* - a landfill is a facility that uses land for the disposal of municipal waste.
- *Processing Facility* - a processing facility is a transfer station, composting facility, resource recovery facility, or a facility that reduces the volume or bulk of municipal waste for offsite reuse.
- *Resource Recovery* - a resource recovery is a facility that provides for the extraction and utilization of materials or energy from municipal waste. The facility can be a mechanical extraction facility or a combustion facility.

- *Transfer Station* - a transfer station is a facility that receives and processes, or temporarily stores municipal waste at a location other than the generation site. This sub-facility facilitates the transportation or transfer of municipal waste to a processing or disposal facility.

There are 49 municipal waste operations located within the Pennsylvania Lake Erie watershed (***Map 29***).

4.3.11 Residual Waste Operations

A Residual Waste Operation is a DEP primary facility type related to the Waste Management Residual Waste Program. Residual waste is waste generated at an industrial, mining, or wastewater treatment facility. The sub-facility types related to Residual Waste that are included are:

- *Generator* - a person, company, institution, or municipality that produces or creates residual waste.
- *Impoundment* - facility designed to hold an accumulation of liquid wastes.
- *Incinerator* - enclosed device using controlled combustion to thermally break down residual waste.
- *Land Application* - facility that uses agricultural utilization or land reclamation of waste. Residual waste is land applied for its nutrient value or as a soil conditioner.
- *Landfill* - facility that uses land for the disposal of residual waste.
- *Processing Facility* - transfer station, compost facility, resource recovery facility, or a facility that reduces the volume or bulk of residual waste for off-site reuse.
- *Transfer Station* - receives and processes or temporarily stores residual waste at a location other than the generation site. This sub-facility facilitates the transportation or transfer of residual waste to a processing or disposal facility.

There are six residual waste operations located within the Pennsylvania Lake Erie watershed (***Map 30***).

4.4 Ecological Data Inventory

4.4.1 Natural Heritage Area

The Pennsylvania Natural Heritage Program, through the Natural Heritage Inventory process, identified Core Habitat of Biological Diversity Areas and Supporting Landscapes (PNHP 2012). Natural Heritage Inventories focus on areas that are the best examples of ecological resources. The emphasis for the designation and delineation of the areas are the ecological value present. Important selection criteria for Natural Heritage Areas are the existence of habitat for plants and animals of special concern, the existence of uncommon or especially important natural communities, and the size and landscape context of a site containing good quality natural features. Large areas and areas that are minimally disturbed by development provide the backbone that links habitats and allows plants and animals to shift and move across sizable portions of the landscape. Core Habitat areas identify the essential habitat of the species of concern or natural community that can absorb very little activity or disturbance without substantial impact to the natural features. Supporting Landscape areas directly connect to Core Habitat and maintain vital ecological processes and/or secondary habitat that may be able to withstand some lower level of activity without substantial negative impacts to elements of concern.

There are approximately 37.00 mi^2 (95.83 km^2) of Core Habitat within the Pennsylvania Lake Erie watershed, which comprises 7.29 percent of the watershed (***Map 31*****;** ***Table 15***). Of the 15 major sub-watersheds, Turkey Creek has the highest percent Core Habitat (53.90 percent), and Twelvemile Creek and Sevenmile Creek have the lowest percent Core Habitat (0.00 percent).

4.4.2 Active River Area

The Active River Area framework, developed by The Nature Conservancy, provides a comprehensive view of rivers that includes both the channels and the riparian lands most significant to the physical and ecological processes within a river system (Smith *et al.* 2008). The model identifies areas within a watershed that are essential to key natural processes, including floodplains, riparian wetlands, and headwater and steep-sloped areas that are important sources of organic material, nutrients, and habitat-forming sediment to the river system. The Active River Area framework is designed to serve as a tool to inform watershed conservation, restoration, and management. There are approximately 172.54 mi^2 (446.87 km^2) of Active River Area within the Pennsylvania Lake Erie watershed, which comprises 33.98 percent of the watershed (***Map 32*****;** ***Table 16***). Of the 15 major sub-watersheds, Turkey Creek has the highest percent Active River Area (76.39 percent) and Ashtabula Creek has the lowest percent Active River Area (0.07 percent).

4.4.3 Natural Systems Greenways

Natural Systems Greenways are corridors whose primary function is preservation of unique natural infrastructure including habitats such as wetlands, steep slopes, floodplains, and exceptional value water-quality streams, high-value natural areas identified by the County Natural Heritage Inventory, interior forests, important bird areas, and important mammal areas (Pashek Associates 2010). The Natural Systems Greenways network was built using a green infrastructure approach that identified the building blocks that contribute to the region's well-being. Green infrastructure refers to an interconnected network of natural areas and other open space that helps conserve natural ecosystem values and functions, sustains clean air and water, and provides a variety of benefits to people and wildlife. Each greenway corridor is broken down by its sensitivity level and designated as having exceptional, significant, or high value based on scoring criteria described by Pashek Associates (2010). Exceptional value natural system corridors are those areas receiving a cumulative value greater than 24, and contain the most sensitive green infrastructure in the Pennsylvania Lake Erie watershed. Significant value corridors received a cumulative value between 18 and 24 and high value corridors received a cumulative value between 7 and 18. Islands refer to those areas that were evaluated by are not part of a Greenway Corridor.

There are approximately 115.41 mi^2 (298.91 km^2) of Natural Systems Greenways within the Pennsylvania Lake Erie watershed, which comprises 22.73 percent of the watershed (***Map 33*****;** ***Table 17***). Of the 15 major sub-watersheds, Ashtabula Creek has the highest percent Greenways area (66.55 percent) and Twelvemile Creek has the lowest percent Greenways area (5.39 percent).

4.4.4 Pennsylvania Integrated Water Quality Assessment

The purpose of the Pennsylvania integrated water quality assessment is to report on the condition of the waters in Pennsylvania (DEP 2014). The Streams Integrated List represents stream assessments in an integrated format for the Clean Water Act Section 305(b) reporting and Section 303(d) listing. DEP Streams Integrated List layer is maintained by DEP's Office of Water Management, Bureau of Water Supply & Wastewater Management, Water Quality Assessment and Standards Division. DEP protects four stream water uses, including:

- *Aquatic Life Use Attainment* - the integrity reflected in any component of the biological community (e.g. fish or fish food organisms).
- *Fish Consumption Use Attainment* - the risk posed to people by the consumption of aquatic organisms (e.g. fish, shellfish, frogs, turtles, crayfish, etc.).

- *Recreational Use Attainment* - the risk associated with human recreation activities in or on a water body (e.g. exposure to bacteria and other disease causing organisms through water contact recreation like swimming or water skiing).
- *Potable Water Supply Use Attainment* - the risk posed to people by the ingestion of drinking water.

A stream segment is considered impaired if any of the four uses are non-attaining. All non-attaining streams in Pennsylvania Lake Erie watershed are impaired for the aquatic life use attainment. There are approximately 106.07 miles (170.70 kilometers) of non-attaining streams within the Pennsylvania Lake Erie watershed (***Map 34*****;** ***Table 18***), which represents 9.46 percent of all stream miles in the watershed. Of the 15 major sub-watersheds, only Conneaut Creek, Trout Run, Walnut Creek, Ashtabula Creek, and Sixteenmile Creek include non-attaining stream segments.

4.4.5 High Quality Waters

Figure 17. Thomas Run – a high quality tributary of Walnut Creek

DEP develops water quality standards for all surface waters of the Commonwealth, which are designed to safeguard Pennsylvania's streams, rivers, and lakes. The standards consist of both use designations and the criteria necessary to protect those uses. All Commonwealth waters are protected for a designated aquatic life use as well as a number of water supply and recreational uses. The use designation shown in the water quality standards is the aquatic life use. These uses are Warm Water Fishes (WWF), Trout Stocking (TSF), Cold Water Fishes (CWF), and Migratory Fishes (MF). In addition, streams with excellent water quality may be designated High Quality Waters (HQ) or Exceptional Value Waters (EV). Chapter 93 of 25 Pa. Code (Water Quality Standards) defines high quality waters as surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in an on the water (***Figure 17***). The water quality in an HQ stream can be lowered only if a discharge is the result of necessary social or economic development, the water quality criteria are met, and all existing uses of the stream are protected. EV waters are to be protected at their existing quality; water quality shall not be lowered.

There are four waters in the Pennsylvania Lake Erie watershed designated as High Quality Waters-Cold Water Fishes and Migratory Fishes, including Crooked Creek, Godfrey Run, Thomas Run (tributary to Walnut Creek), and Twelvemile Creek (***Map 35***).

4.4.6 Lake Erie Watershed Stream Ratings (Campbell, 2005)

From 2000 to 2005, Campbell (2005) assessed the macroinvertebrate communities at 63 sites within the Pennsylvania Lake Erie watershed in an effort to determine the condition of the streams. The sampling and community analysis was performed according to *EPA's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (Plafkin *et al.* 1999). A Composite Index score was calculated for each site by summing the standardized scores for each of the following metrics: 1) total number of taxa; 2) number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa; 3) number of intolerant taxa; 4) percentage EPT; 5) percentage intolerant; and 6) Hilsenhoff Biotic Index. The resulting Composite Index scores were then used to rate the condition of the stream sites (***Table 19***). Of the 63 sites assessed, one was rated as optimum condition, 11 were rated as very good, 18 were rated as good, nine were rated as fair, 11 were rated as slightly degraded, seven were rated as poor, five were rated as very poor, and one was rated as minimum biological diversity (***Map 36*****;** ***Table 20***).

4.4.7 Conneaut Creek Fish Community Assessment (DER, 1991)

On May 23, 1991, DER (1991) conducted a fish community analysis at five sites on Conneaut Creek (***Map 37*****;** ***Table 21***). DER (1991) observed 28 species at the five sites. Site CC04 had the highest species richness with 17 species.

4.4.8 Lake Erie Watershed Fish Community Assessment (Billingsley and Johns, 1996-98)

From 1996 to 1998, Billingsly and Johns (1996; 1997a; 1997b; 1997c; 1997d; 1997e; 1997f; 1997g; 1998a; and 1998b) assessed the fish communities at 14 sites on six streams within the Pennsylvania Lake Erie watershed (***Map 38*****;** ***Table 22***). Billingsly and Johns observed 26 species at the 14 sites. Site RC-01 on Raccoon Creek had the highest species richness with 18 species.

4.4.9 Pennsylvania Lake Erie Watershed Fish Community Assessment (Phillips and Andraso, 2005)

In summer 2003 and 2004, Phillips and Andraso (2005) assessed the fish communities at 25 sites on 10 streams within the Pennsylvania Lake Erie watershed. Phillips and Andraso used a modified fish index of biotic integrity (IBI) to evaluate the fish community (***Table 23***). The IBI, first introduced by Karr (1981), uses the characteristics of fish assemblages to evaluate the biological integrity and includes scoring 12 metrics related to species composition, trophic composition, and fish abundance and condition. The sum of the 12 metrics yields an overall site score that characterizes the biotic integrity of the site. Sites were classified according to Karr *et al.* (1986) as excellent, excellent-good, good, good-fair, fair, fair-poor, poor, poor-very poor, or very poor (***Table 24***). Phillips and Andraso (2005) observed 24 species (2,528 individuals) at the 25 sites (***Table 25***). Of the 25 sites assessed, one was rated good, six were rated as good-fair, nine were rated as fair, two were rated as fair-poor, two were rated as poor, and five were rated as very poor (***Map 39*****;** ***Table 26***).

4.4.10 Fourmile Creek Fish Community Assessment (Andraso et al., 2009)

In May and June 2007, Andraso *et al.* (2009) assessed the fish communities at 12 sites on Fourmile Creek. Andraso *et al.* (2009) used the same modified IBI and IBI classification system as Phillips and Andraso (2005) to evaluate the fish community (refer to *Section 4.4.9*). Andraso *et al.* (2009) observed eight species (1,478 individuals) at the 12 sites (***Table 27***). Of the 12 sites assessed, one was rated as fair-poor, 10 were rated as poor, and one was rated as very poor (***Map 40***).

4.4.11 Lake Erie Watershed Habitat Assessment (Diz and Powley, 2005)

In 2003 and 2004, Diz and Powley (2005) assessed stream habitat at 28 sites on 13 streams within the Pennsylvania Lake Erie watershed. All sites were assessed using *EPA's Rapid Bioassessment Protocol* (Barbour *et al.* 1999). The visual-based assessment evaluates and scores 10 parameters on a range of 0 to 20 (***Table 28***). The individual parameter scores are then summed to get a total habitat score for each location. Total habitat scores were classified as optimal (160-200), suboptimal (110-159), marginal (60-109), or poor (< 60). The habitat parameters evaluated include:

- *Epifaunal Substrate/Available Cover* - the relative quantity and variety of natural structures in the stream (e.g. large rocks, fallen trees, logs and branches, and undercut banks) available as refuge, feeding, or sites for spawning and nursery functions of aquatic biota. Assessed for high and low gradient streams.

- *Embeddedness-* the extent to which rocks (e.g. gravel, cobble, and boulders) are covered by silt, sand, or mud of the stream bottom. Assessed for high gradient streams.
- *Velocity/Depth Regimes* - patterns of velocity and depth (slow-shallow, fast-shallow, slow-deep, and fast-deep). Assessed for high gradient streams.
- *Sediment Deposition* - the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Assessed for high and low gradient streams.
- *Channel Flow Status* - the degree to which the channel is filled with water. Assessed for high and low gradient streams.
- *Channel Alteration* - a measure of large-scale changes in the shape of a stream channel. Assessed for high and low gradient streams.
- *Frequency of Riffles-:* mechanism for measuring the sequence of riffles and the heterogeneity of the stream. Assessed for high gradient streams.
- *Bank Stability* - measures whether the stream banks are eroded or have the potential for erosion. Assessed for high and low gradient streams.
- *Bank Vegetative Protection* - measures the amount of vegetative protection on the stream bank and near-stream portion of the riparian zone. Assessed for high and low gradient streams.
- *Riparian Vegetative Zone Width* - measures the width of natural vegetation from the edge of the stream bank through the riparian zone. Assessed for high and low gradient streams.

Of the 28 sites assessed, two were rated as optimal, 23 were rated as sub-optimal, and three were rated as marginal (***Map 41*****;** ***Table 29***).

4.4.12 Lake Erie Watershed Sediment Chemistry Assessment (Diz and Powley, 2005)

In 2003 and 2004, Diz and Powley (2005) analyzed heavy metal concentrations in stream bed sediment collected from 28 sites on 13 streams within the Pennsylvania Lake Erie watershed (***Map 42*****;** ***Table 30***). All samples were analyzed for cadmium (Cd), copper (Cu), lead (Pb), Nickel (Ni), and Zinc (Zn). Concentrations for each of the heavy metals were compared to corresponding probable effects levels (PEL), including low effect level (LEL) and severe effect level (SEL) (NYDEC, 1999). The LEL implies a contaminant level such that the majority of benthic organisms would be able to conduct a complete life cycle; whereas, the SEL suggest the likelihood of pronounced disturbance of the sediment dwelling community (Diz and Powley, 2005).

4.4.13 Lake Erie Watershed Water Quality Assessment (Diz and Powley, 2005)

In 2003 and 2004, Diz and Powley (2005) measured 5-day biochemical oxygen demand (BOD5) concentrations, dissolved organic carbon (DOC) concentrations, temperature (°C), conductivity (mS/cm), dissolved oxygen (DO) concentrations, and pH in water samples collected from 28 sites on 13 streams within the Pennsylvania Lake Erie watershed (***Map 43*****;** ***Table 31***).

4.4.14 Lake Erie Watershed Water Quality Assessment (Diz et al., 2006)

From May to October 2005, Diz *et al.* (2006) assessed the water quality at 30 sites on 20 streams within the Pennsylvania Lake Erie watershed (***Map 44*****;** ***Table 32***). Each site was assessed five times throughout the sampling period. In addition, Diz *et al.* (2006) created a ranking for each parameter of interest by comparing the mean scores for that factor among all the sites. A score from 1 (lowest quality) to 30 (highest quality) was assigned to each parameter, and those scores were summed to calculate a total score for each site (***Table 33***). The site on Lamson Run (LR), a tributary to Elk Creek, received the lowest quality ranking; whereas, the site on Sixteenmile Creek (16MC) had the highest quality ranking.

4.4.15 Lake Erie Watershed Habitat Assessment (Rafferty et al., 2011)

In 2010, Rafferty *et al.* (2011) assessed stream habitat at 301 sites on 36 streams within the Pennsylvania Lake Erie watershed. All sites were assessed using *EPA's Rapid Bioassessment Protocol*, which was dependent on stream gradient (refer to *Section 4.4.11* for high gradient parameters and ***Table 34*** for low gradient parameters). Streams were classified as high gradient in locations where riffles and runs were prevalent and low gradient in locations where pools were prevalent. Of the 280 high gradient sites assessed, 32 (11.4 percent) were rated as optimal, 209 (74.6 percent) were rated as suboptimal, 38 (13.6 percent) were rated as marginal, and one (0.4 percent) was rated as poor (***Map 45*; *Table 35***). Of the 21 low gradient sites assessed, 14 (66.7 percent) were rated as suboptimal and seven (33.3 percent) were rated as marginal (***Map 46*; *Table 36***).

4.4.16 Lake Erie Watershed Fish Community Assessment (Rafferty et al., 2012)

From June to September 2011, Rafferty *et al.* (2012) assessed the fish community at 119 sites along 27 streams within the Pennsylvania Lake Erie watershed (***Map 47***). The Pennsylvania Lake Erie watershed supports a rich fish community (***Figure 18***), 54 species (24,162 individuals) representing 13 families were observed (***Table 37***). Rafferty *et al.* (2012) used the same modified IBI and IBI classification system as Phillips and Andraso (2005) to evaluate the fish community (refer to *Section 4.4.9*). Of the 119 sites assessed, three were rated as excellent-good, nine were rated as good, seven were rated as good-fair, 29 were rated as fair, 20 were rated as fair-poor, 21 were rated as poor, 22 were rated as poor-very poor, five were rated as very poor, and three sites had no fish (***Table 38***).

Figure 18. Brown trout collected from Elk Creek

4.4.17 Trout Run and Godfrey Run Water Quality Assessment (2010)

In April and August 2010, ECCD and DEP assessed the water quality at six sites on Trout Run and six sites on Godfrey Run as part of efforts to implement the recommendations of the *Trout Run and Godfrey Run Watershed Implementation Plan* (***Map 48*; *Table 39***).

4.4.18 Walnut Creek Fish Community Assessment (O'Kelly, 1972)

In summer 1972, O'Kelly (1972) assessed the fish community at five sites on Walnut Creek (***Map 49***). O'Kelly (1972) observed 22 species (2,088 individuals) at the five sites (***Table 40***). Site WC (Stat 1) had the highest species richness with 15 species.

4.4.19 Walnut Creek Fish Community Assessment (DEP, 2007)

In June and July 2006, DEP (2007) assessed the fish community at 19 sites on Walnut Creek and three reference sites (***Map 50***). DEP (2007) observed 24 species at the 22 sites (***Table 41***). Each site was assessed based on the abundances of individuals, including: very abundant (>100 individuals); abundant (26-99 individuals); common (10-25 individuals); present (3-9 individuals); and rare (<3 individuals). Site WC23 had the highest species richness with 20 species.

4.4.20 Walnut Creek Biological Condition Assessment (DEP, 2007)

In April 2006, DEP (2007) assessed the biological condition, using macroinvertbrate communities at 18 sites on Walnut Creek and two reference sites (***Map 51***). The biological condition was evaluated using five macroinvertebrate-related metrics, including: Taxa Richness, Hilsenhoff Biotic Index (modified), EPT Index (modified), Community Loss Index, and the Ratio of EPT and Chironomidae Abundances. Once a numerical value was calculated for each metric and a subsequent overall score computed for each sampling location, comparisons were made between the Walnut Creek watershed and reference waterways. A biological condition category, ranging from non-impaired to severely impaired, was given to each sampling location within the Walnut Creek watershed depending upon the percent comparison to the respective reference waterway (***Table 42***). Of the 18 Walnut Creek sites assessed, one was rated as non-impaired, six were rated as slightly impaired, eight were rated as moderately impaired, and three were rated as severely impaired (***Table 43***).

4.4.21 Walnut Creek Habitat Assessment (DEP, 2007)

In April 2006, DEP (2007) assessed stream habitat at 18 sites on Walnut Creek (***Map 52***). All sites were assessed using a modified version of *EPA's Rapid Bioassessment Protocol* (Barbour *et al.* 1999). The modified criteria separates epifaunal substrate/instream cover into two individual parameters and also adds a vegetative disruptive pressure parameter to the analysis. The visual based assessment scores the 12 parameters on a range of 0 to 20, and then sums the individual parameter scores to get a total habitat score for each location. Total habitat scores were classified as optimal (192-240), suboptimal (132-180), marginal (72-120), or poor (< 60). The decision gaps between these categories are left to the discretion of the field investigator as to which generic category they would fall into. Of the 18 sites assessed, one was rated as optimal, 14 were rated as suboptimal, two were rated as marginal, and one was rated as poor (***Table 44***).

4.4.22 Walnut Creek Water Quality Assessment (DEP, 2007)

From May to August 2006, DEP assessed the water quality at 24 sites on Walnut Creek and three reference sites (***Map 53***). All sites were assessed four times at varying temperatures and flow regimes, including:

- Low flow, cold water samples collected on May 2, 2006 (***Table 45***).
- High flow, cold water samples collected on May 11 and May 18, 2006 (***Table 46***).
- Low flow, warm water reference samples collected on August 14, 2006 (***Table 47***).
- High flow, warm water samples collected on August 29, 2006 (***Table 48***).

4.5 Recreation and Public Access Data Inventory

4.5.1 Coastal Zone Boundary

DEP's Water Planning Office coordinates and implements CRMP to execute sound coastal management program policies in Pennsylvania's two coastal areas. The coastal zone is the area where the land meets the sea (or lake) and includes both coastal waters and adjacent shore-lands. These areas face increasing pressure from development, shoreline erosion, biodiversity losses, and nonpoint source pollution. Improving public access for recreation in the coastal zones is one of CRMP's priorities. This includes supporting efforts to meet the public need for boating, fishing, walking, picnicking, sightseeing, and other recreational pursuits associated with the waterfront. The 76.6 mile-long Lake Erie coastal zone includes an area of approximately 63.4 mi^2 (164.3 km^2; 40601.9 acres) in northern Erie County (***Map 54***).

4.5.2 Parks and Recreation, and Trails

There are approximately 7,726.44 acres (12.07 mi^2; 31.27 km^2) of municipal and private park and recreation space, and 102.06 miles (164.25 km) of biking, hiking, and multi-use trails in the Erie County portion of the Pennsylvania Lake Erie watershed (***Map 55***; ***Table 49***). Park and recreation, and trail data are not available for Crawford County, Pennsylvania.

4.5.3 State Parks

Figure 19. Lagoons at Presque Isle State Park

There are two state parks within the Pennsylvania Lake Erie watershed: Presque Isle State Park (***Figure 19***) and Erie Bluffs State Park (***Map 56***). Presque Isle State Park is a 3,200-acre sandy peninsula that arches into Lake Erie. Presque Isle offers its visitors a beautiful coastline and many recreational activities, including swimming, boating, fishing, hiking, bicycling and in-line skating. A National Natural Landmark, Presque Isle is a favorite spot for migrating birds. Because of the many unique habitats, Presque Isle contains a greater number of the state's endangered, threatened and rare species than any other area of comparable size in Pennsylvania. Erie Bluffs States Park, Pennsylvania's newest park, is a 587-acre park along the Lake Erie shoreline in western Erie County, 12 miles west of the city of Erie. It is the largest undeveloped stretch of Lake Erie shoreline remaining in Pennsylvania. The park has one-mile of shoreline, 90-foot bluffs overlooking Lake Erie, Elk Creek--a shallow stream steelhead fishery, several plant species of conservation concern, uncommon oak savannah sand barren ecosystem, and forested wetlands.

4.5.4 State Game Lands

The Pennsylvania Game Commission owns and manages, for wildlife and recreation, nearly 1.5 million acres of state game lands throughout Pennsylvania. Lawful hunting and trapping are permitted during open seasons on these public hunting grounds. There are three State Game Lands within the Pennsylvania Lake Erie watershed: State Game Land 314, State Game Land 101, and State Game Land 163 (***Map 57***).

4.5.5 Pennsylvania Fish and Boat Commission Access Points

Figure 20. Walnut Creek Access

The Pennsylvania Fish and Boat Commission (PFBC) provides public fishing and boating access to Pennsylvania waters. Boating access provides access to waterways for powered and/or unpowered boats with some level of facilities including parking. Boating access is typically at a designated point of entry along a waterway. Fishing can also occur at these sites; however, the primary purpose is boating (***Figure 20***). Walk-in fishing access provides a way for anglers to reach the waterway and walk for some distance along the stream bank or in the stream bed. These types of access areas are typically linear with few amenities and do not have boat launch ramps. There are approximately 64 public or semipublic access points within the Pennsylvania Lake Erie watershed (***Map 58*****;** ***Table 50***). Of the 15 major sub-watersheds, Elk Creek has the largest number of access points with 22.

4.6 Water Use Data Inventory

4.6.1 Public Water System Service Area

A public water system is a system for providing the public with water for human consumption through pipes or other constructed conveyances, if the system has at least 15 service connections or regularly serves at least 25 individuals. Approximately, 18.73 percent of the Pennsylvania Lake Erie watershed is serviced by public water systems, with sources including both groundwater and surface water (***Map 59***).

4.6.2 Water Resources

A Water Resource is a DEP primary facility type related to the Water Use Planning Program, including:

- *Discharge* - represents the return of water used at a Water Resources primary facility. The subfacility type may be a sewage treatment plant, instream discharge, spray irrigation field, groundwater recharge, on-lot septic, or an unidentified facility type.
- *Groundwater Withdrawal* - represents the withdrawal of water used at a Water Resources primary facility. The subfacility type may be a well, spring, quarry, infiltration gallery, deep mine, surface mine, or an unidentified facility type.
- *Interconnection* - represents the point of interconnection between Water Resources primary facilities. The subfacility type may be for an interconnection between two public water supply agencies or between a public water supply agency and a commercial or industrial water user.
- *Storage* - represents the storage of water used at a Water Resources primary facility. The subfacility type represents raw or treated water storage and may be a quarry, standpipe, open off-stream reservoir, closed off-stream reservoir, instream reservoir, hydroelectric dam, natural lake, pond, silt dam, hydroelectric pumped storage, or an unidentified facility type.
- *Surface Water Withdrawal* - represents the withdrawal of water used at a Water Resources primary facility. The subfacility type may be an instream diversion, intake from a dam, natural lake, pond, river well, or an unidentified facility type.

There are 452 Water Resource facilities located within the Pennsylvania Lake Erie watershed, including 191 discharge facilities, 130 groundwater withdrawal facilities, 43 interconnections, 12 storage facilities, and 76 surface water withdrawal facilities (***Map 60***).

4.6.3 Sanitary Sewer Infrastructure

Sanitary sewer systems are systems of pump stations, force mains, and pipes used to collect and transport wastewater to a publicly owned treatment works (POTW). Approximately 72.91 mi^2 (188.84 km^2; 46,663 acres) of the Erie County portion of the Pennsylvania Lake Erie watershed is serviced by public sanitary sewer systems (**Map 61**). Sewerage data are not available for Crawford County, Pennsylvania.

4.6.4 Septic Infrastructure

Onsite wastewater treatment systems (OWTS), commonly referred to as septic systems, are used to treat wastewater from a home or business and return treated wastewater back into the receiving environment. There are 1,689 OWTS in the Erie County portion of the Pennsylvania Lake Erie watershed, servicing an area of approximately 215.63 mi^2 (558.48 km^2; 138,002.82 acres) (***Map 62***).

4.7 Real-Time Data

4.7.1 Nearshore Buoy and Weather Stations

RSC operates and maintains the *Nearshore Weather, Wave, and Water Buoy* (***Figure 21***). The buoy, located in approximately 45 feet of water two-miles northwest of the Presque Isle State Park Lighthouse, is the only buoy in the Pennsylvania waters of Lake Erie. The buoy system measures multiple parameters and records video clips every 20 minutes, and posts the data online to www.PALakeErieBuoy.com, providing researchers, weather forecasters, boaters, anglers, and beachgoers with real-time Lake Erie conditions. The parameters measured by the buoy include:

Figure 21. RSC nearshore buoy

- *Weather* - air temperature, wind speed, maximum wind speed, relative humidity, barometric pressure, daily rainfall, rain duration, rain intensity, and solar radiation.
- *Wave* - wave height, wave period, and wave direction.
- *Water* - water temperature, specific conductivity, pH, turbidity, and dissolved oxygen.

There are two additional weather stations located along the Pennsylvania Lake Erie shoreline, including the Beach 2 Weather Tower located on Presque Isle State Park and the TREC Weather Tower located at the Tom Ridge Environmental Center. Both weather towers measure air temperature, wind speed, maximum wind speed, relative humidity, barometric pressure, daily rainfall, rain duration, rain intensity, and solar radiation in real-time. The data for the stations are posted to www.PALakeErieBuoy.com.

4.7.2 United States Geological Survey Streamgages

USGS National Steamflow Information Program (NSIP) provides streamflow information and perspective, guidance, planning, and leadership to the streamgaging activities of USGS. USGS streamgages operate by measuring the elevation of the water in the river or stream and then converting the water elevation (called 'stage') to a streamflow ('discharge') by using a curve that relates the elevation to a set of actual discharge measurements. At most USGS streamgages, the stage is measured every 15 minutes and the data are stored in an electronic data recorder. At set intervals, usually every 1 to 4 hours, the data are transmitted to USGS. Currently, there are two USGS streamgages located within the Pennsylvania Lake Erie watershed, including:

- USGS Gage Station (Walnut Creek Upstream Pool near Erie, PA) http://waterdata.usgs.gov/pa/nwis/uv/?site_no=04213152&PARAmeter_cd=00065,00060,00010
- USGS Gage Station (Brady Run near Girard, PA) http://waterdata.usgs.gov/pa/nwis/uv/?site_no=04213075&PARAmeter_cd=00065,00060,00010

5.0 PRIORITIZATION AND RECOMMENDATIONS

To address the goals and objectives of the *PALE IWRM Plan* identified in *Section 2.0*, the habitat assessment (*Section 4.4.15*) and fish community assessment (*Section 4.4.16*) data collected by Rafferty et al. (2011; 2012), were used to develop GIS-based watershed restoration and conservation prioritization models for the 15 major Pennsylvania Lake Erie sub-watersheds. The models identify and prioritize those locations with the sub-watershed most in need of restoration and conservation efforts. In addition, a long-term monitoring plan was developed to measure the success of future watershed restoration and conservation efforts.

5.1 Restoration Prioritization

To prioritize restoration locations within the 15 major Pennsylvania Lake Erie sub-watersheds, two models were used. The *Habitat-Based Restoration Model* includes an analysis of only the habitat data (*Section 5.1.1*). The *Habitat and Fish Community-Based Restoration Model* includes an analysis of the habitat and fish community data (*Section 5.1.2*). Each site assessed was rated as High Priority, Medium Priority, or Low Priority. High Priority sites are those areas where restoration action is likely needed and should be considered above Medium and Low Priority sites. Medium Priority sites are those areas where restoration action is likely needed and should be considered above Low Priority sites. Low Priority sites are those areas where restoration action is unlikely needed and the focus should be on conservation. In addition, a number of factors potentially influencing the impairment of stream habitat and fish communities were identified for each of the sites assessed (***Table 51***). These factors can be used to guide restoration projects.

5.1.1 Habitat-Based Restoration Model

Rafferty *et al.* (2011) used *EPA's Rapid Bioassessment Protocol* to evaluate stream habitat within the Pennsylvania Lake Erie watershed. Sites were rated as optimal, suboptimal, marginal, or poor based on the visual-based habitat assessment. To prioritize restoration sites within the 15 major sub-watersheds, the sites were reclassified as High Priority, Medium Priority, or Low Priority according to the ratings. Sites rated as optimal were classified as Low Priority, sites rated as suboptimal were classified as Medium Priority, and sites rated as marginal or poor were classified as High Priority. There were 155 sites assessed using the *Habitat-Based Restoration Model*, 18 sites were rated as High Priority, 125 sites were rated as Medium Priority, and 12 sites were rated as Low Priority (***Map 63*; *Table 52***). The Elk Creek watershed had the most sites rated as High Priority, with 27 sites (***Table 53***).

5.1.3 Habitat and Fish Community-Based Restoration Model

The Habitat and Fish Community-Based Model was applied to those sites within the Pennsylvania Lake Erie watershed where both the habitat and fish community were assessed. A scoring system was used to classify the sites based on the habitat and fish community priority classifications (***Table 54***). Habitat sites classified as High Priority were given a Habitat Priority Score of 5, sites classified as Medium Priority were given a score of 3, and sites classified as Low Priority were given a score of 1.

Rafferty *et al.* (2012) used a modified index of biotic integrity (Phillips and Andraso 2005) to assess the Pennsylvania Lake Erie watershed fish community (*refer to Sections 4.4.9 and 4.4.16*). Sites were rated as excellent-good, good, good-fair, fair, fair-poor, poor, poor-very poor, very poor, or no fish based on the IBI calculations. To prioritize restoration sites within the 15 major sub-watersheds, the sites were reclassified as High Priority, Medium Priority, or Low Priority according to the ratings. Sites rated as excellent-good, good, good-fair were classified as Low Priority; sites rated as fair, fair-poor were classified as Medium Priority; and sites rated as poor, poor-very poor, very poor, or no fish were classified as High Priority. Fish Community sites classified as High Priority were given a Fish Community Priority score of 5, sites classified as Medium Priority were given a score of 3, and sites classified as Low Priority were given a score of 1.

Habitat Priority Scores and Fish Community Priority Scores were summed for each site, resulting in a Total Restoration Priority Score equal to 2, 4, 6, 8, or 10. Sites receiving a Total Restoration Priority Score of 8 or 10 were classified as High Priority, sites receiving a score of 6 were classified as Medium Priority, and sites receiving a score of 2 or 4 were classified as Low Priority. There were 91 sites assessed using *Habitat and Fish Community-Based Restoration Model*, 31 sites were rated as High Priority, 36 sites were rated as Medium Priority, and 24 sites were rated as Low Priority (***Map 64*****;** ***Table 55***). The Twelvemile Creek watershed had the most sites rated as High Priority, with 6 sites (***Table 56***).

5.1.3 Potential Restoration Funding Sources

- Pennsylvania Department of Environmental Protection Growing Greener Program
- Great Lakes Restoration Initiative
- Great Lakes Commission Great Lakes Sediment and Nutrient Reduction Program
- Great Lakes Protection Fund

5.2 Conservation Prioritization

To prioritize land conservation locations within the 15 major Pennsylvania Lake Erie sub-watersheds, two models were used. The *Habitat-Based Conservation Model* includes an analysis of only the habitat data (*Section 5.2.1*). The *Habitat and Fish Community-Based Conservation Model* includes an analysis of the habitat and fish community data (*Section 5.2.2*). The *Fish Community-Based Conservation Model* was removed because it did not yield any High Priority conservation locations. Only those sites rated as High Priority were identified. High Priority sites are those areas where land conservation actions should be considered in place of restoration. In addition, site assessment criteria were established to rank and prioritize potential land conservation projects (*Section 5.2.3*).

5.2.1 Habitat-Based Conservation Model

Rafferty *et al.* (2011) used *EPA's Rapid Bioassessment Protocol* to evaluate stream habitat within the Pennsylvania Lake Erie watershed. Sites were rated as optimal, suboptimal, marginal, or poor based on the visual-based habitat assessment. To prioritize conservation locations within the 15 major sub-watersheds, optimal sites were re-classified as High Priority conservation locations. There were 155 sites assessed using the *Habitat-Based Conservation Model*, 12 sites were rated as High Priority (***Map 65*****;** ***Table 57***).

5.2.2 Habitat and Fish Community-Based Conservation Model

The Habitat and Fish Community-Based Conservation Model was applied to those sites within the Pennsylvania Lake Erie watershed where both the habitat and fish community were assessed. A scoring system was used to identify High Priority sites based on the habitat and fish community priority classifications. Habitat sites classified as High Priority were given a Habitat Priority Score of 5, sites classified as Medium Priority were given a score of 3, and sites classified as Low Priority were given a score of 1. Fish Community sites classified as High Priority were given a Fish Community Priority score of 5, sites classified as Medium Priority were given a score of 3, and sites classified as Low Priority were given a score of 1. Habitat Priority Scores and Fish Community Priority Scores were summed for each site, resulting in a Total Conservation Priority Score equal to 2, 4, 6, 8, or 10. Sites receiving a Total Conservation Priority Score of 8 or 10 were classified as High Priority. There were 91 sites assessed using *Habitat and Fish Community-Based Conservation Model*, 24 sites were rated as High Priority (***Map 66*****;** ***Table 58***).

5.2.3 Conservation Evaluation Criteria

In an effort to evaluate the ecological value of parcels within the Pennsylvania Lake Erie watershed, a set of guidance criteria were developed. The metrics (***Table 59***) and associated criteria reflect the data presented in the PALE IWRM Plan and are intended to serve as guidance to assist stakeholders in selecting properties within the watershed for conservation. The conservation guidance criteria scores 14 metrics on a scale of 0-5 and sums the scores to yield a total conservation score (***Table 60***), which can be used to evaluate a parcels ecological value. Generally, higher conservation scores suggest a higher ecological value for a given parcel. These criteria are not intended to eliminate any parcels from being considered for conservation, rather they are intended to assist stakeholders in identifying the best potential property to conserve it terms of ecological value. If a parcel receives a low conservation score based on the criteria, it should not be automatically eliminated from consideration for conservation.

5.2.4 Potential Land Conservation Funding Sources

The majority of land conservation efforts in Pennsylvania are funded through the Pennsylvania Department of Conservation and Natural Resources (DCNR) Community Conservation Partnerships Program (C2P2), Pennsylvania Fish and Boat Commissions (PFBC) Erie Access Improvement Program (EAI) Grant Program, and the Commonwealth Finance Authority (CFA). The C2P2 provides competitive funding for projects that help plan, acquire, and develop parks, recreation facilities, trails, and conserved critical conservation areas and watersheds. Land Acquisition and Conservation projects funding by C2P2 involve the purchase and/or donation of land for park and recreation areas, greenways, critical habitat areas, and/or open space. C2P2 favors conserving properties that include Natural Heritage Inventory data, protect significant ecological attributes such as important bird areas and endangered species, and protect riparian buffers. Also, projects that reference prioritization models are viewed favorably. More information on C2P2 can be viewed at: https://www.grants.dcnr.state.pa.us/Dashboard/Grants.

The Pennsylvania Fish and Boat Commissions (PFBC) Erie Access Improvement Program (EAI) Grant Program was made possible by Act 159 of 2004 which created a new Lake Erie stamp (required for anglers fishing in the Lake Erie watershed) and a Combination Lake Erie Trout/Salmon stamp. The Act provides that the proceeds from the sale of stamps are to be used to provide public fishing access on or at Lake Erie and the watersheds of Lake Erie. Eligible projects include acquisition of lands and property rights including easements, and/or development of lands to improve and/or maintain angler access. PFBC initiated this grant program to ensure that anglers in the Erie watershed have the highest quality access to fishing opportunities. More information on the EAI program can be viewed at: http://fishandboat.com/promo/grants/erie_access/00erie_access.htm.

The Commonwealth Financing Authority (CFA) was established as an independent agency of the commonwealth (under the Pennsylvania Department of Community and Economic Development – DCED) to administer Pennsylvania's economic stimulus packages. The CFA holds fiduciary responsibility over the funding of programs and investments in Pennsylvania's economic growth. Act 13 of 2012 establishes the Marcellus Legacy Fund and allocates funds to CFA to fund projects under several focus areas, including the Greenways, Trails, and Recreation Program (GTRP) and Watershed

Restoration Protection Program (WRPP). The GTRP provides funding for planning, acquisition, development, rehabilitation and repair of greenways, recreational trails, open space, parks and beautification projects. The goal of WRPP is to restore and maintain restored stream reaches impaired by the uncontrolled discharge of nonpoint source polluted runoff, and ultimately to remove these streams from the Pennsylvania Department of Environmental Protection's Impaired Waters list. More information on CFA can be viewed at: http://www.newpa.com/funding-programs-loans-tax-credits-and-grants/commonwealth-financing-authority

Other Potential Conservation Funding Sources:

- Pennsylvania Coastal Resources Management Program
- Erie County Greenways Grant Program
- Northwest Commission Greenways Block Grant Program

5.3 Long-Term Monitoring and Data Needs

The *PALE IWRM Plan* was developed to provide watershed stakeholders and agency staff with data and information in one central location in an effort to enhance their ability to manage water resources within the watershed. The implementation of the plan will rely heavily upon those stakeholders and agency staff working in the Pennsylvania Lake Erie watershed. The *PALE IWRM Plan* identified a number of High Priority restoration and conservation sites within the watershed, which should provide a good starting point for restoring, protecting, and managing water resources within the watershed. The following actions are recommended to track the implementation of the *PALE IWRM Plan* and improve the Plan in the future (***Table 61***):

- Develop an interactive, web-based map service to host the watershed characterization data.
- Develop a web-based geospatial database and map service to track the implementation of restoration, conservation, and management efforts within the watershed.
- Evaluate the watershed habitat, water quality, sediment quality, and fish and macroinvertebrate communities every 10 years at the same sites assessed by Rafferty *et al.* (2011), beginning in 2022.
- Develop a riparian buffer shapefile for the watershed tributaries, identifying 100-foot and 150-foot buffers.
- Acquire updated orthoimagery, LiDAR, and impervious cover data for the watershed every 5 years, beginning in 2020.
- Evaluate historical and future changes in land cover/land use in the watershed using the National Land Cover Dataset.
- Provide an update of the PALE IWRM Plan every 10 years, beginning in 2022.

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APPENDIX A: TABLES

Table 1. Pennsylvania Lake Erie Watershed Streams

Stream ID	Stream Name	Length (mi)	Length (km)
1	Walnut Creek	80.27	129.18
2	Godfrey Run	4.18	6.73
3	Sixteenmile Creek	55.18	88.81
4	Raccoon Creek	18.17	29.24
5	Trib 62703	1.15	1.86
6	Trib 62682	0.25	0.40
7	Trib 62684	1.04	1.67
8	Crooked Creek	35.84	57.68
9	Twelvmile Creek	32.67	52.57
10	Sixmile Creek	55.37	89.11
11	Turkey Creek	18.00	28.96
12	Trib 62436	0.96	1.54
13	Duck Run	4.34	6.99
14	Peck Run	6.09	9.81
15	Marshall Run	1.68	2.70
16	Trout Run	11.77	18.95
17	Trib 62246	0.41	0.66
18	Trib 62687	2.20	3.55
19	McDannel Run	3.11	5.00
20	Trib 62683	0.64	1.04
21	Trib 62254	0.92	1.47
22	Fourmile Creek	28.87	46.47
23	Trib 62250	0.89	1.43
24	Trib 62684	3.29	5.30
25	Trib 62256	0.73	1.18
26	Twentymile Creek	4.00	6.44
27	Trib 62490	1.14	1.84
28	Trib 62259	0.83	1.34
29	Trib 62255	0.74	1.19
30	Wilkins Run	1.20	1.94
31	Woodmere Beach Run	7.31	11.76
32	Ashtabula Creek	14.23	22.89
33	Fivemile Creek	4.26	6.85
34	Motch Run	4.16	6.70
35	Sevenmile Creek	27.55	44.34
36	Trib 62489	6.04	9.73
37	Trib 62680	3.07	4.93
38	Orchard Beach Run	3.77	6.07
39	Trib 62248	0.51	0.81
40	Trib 62249	1.36	2.19
41	Conneaut Creek	380.14	611.78
42	Eightmile Creek	22.06	35.50
43	Trib 62251	0.50	0.80
44	Trib 62476	0.87	1.40
45	Trib 62483	0.61	0.98
46	Trib 62702	0.83	1.33
47	Elk Creek	239.95	386.16
48	Trib 62328	1.25	2.01
49	Unnamed Trib Three	0.52	0.83
50	Trib 62253	0.40	0.64
51	Scott Run	1.18	1.91
52	Unnamed Trib One	1.13	1.81
53	Unnamed Trib Two	0.66	1.07
54	Mill Creek	17.50	28.17
55	Garrison Run	0.79	1.28
56	Cascade Creek	4.75	7.64

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Table 2. Major Pennsylvania Lake Erie Sub-watersheds

		Area		
Watershed	*mi²*	*km²*	*acres*	*Percent (%)*
Pennsylvania Lake Erie	507.72	1314.98	324938.04	100.00
Twentymile Creek	1.29	3.35	827.78	0.25
Sixteenmile Creek	17.98	46.57	11508.35	3.54
Twelvemile Creek	12.91	33.44	8262.53	2.54
Eightmile Creek	7.10	18.38	4542.13	1.40
Sevenmile Creek	8.69	22.50	5560.47	1.71
Sixmile Creek	18.92	48.99	12106.83	3.73
Fourmile Creek	12.02	31.13	7693.56	2.37
Trout Run	6.94	17.98	4444.02	1.37
Walnut Creek	38.07	98.60	24363.37	7.50
Elk Creek	98.35	254.74	62946.87	19.37
Crooked Creek	20.29	52.54	12982.76	4.00
Raccoon Creek	8.73	22.61	5587.42	1.72
Turkey Creek	7.97	20.63	5098.07	1.57
Conneaut Creek	153.10	396.54	97986.12	30.16
Ashtabula Creek	8.24	21.35	5276.29	1.62
Other	87.11	225.62	55751.47	17.16

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Table 3. Flood Zone Area by Major Pennsylvania Lake Erie Sub-watershed

	Zone A			*Zone AE*			*Zone X*		
Watershed	*mi^2*	*km^2*	*ac*	*mi^2*	*km^2*	*ac*	*mi^2*	*km^2*	*ac*
Pennsylvania Lake Erie	20.65	53.48	13216.16	2.63	6.81	1682.51	0.45	1.16	286.96
Twentymile Creek	0.19	0.48	118.57						
Sixteenmile Creek	0.25	0.65	160.91	0.23	0.58	144.38	0.05	0.13	32.24
Twelvemile Creek	0.34	0.87	215.91						
Eightmile Creek	0.46	1.18	292.11						
Sevenmile Creek	0.41	1.07	264.78						
Sixmile Creek	0.38	0.98	242.19	0.05	0.13	31.74	0.01	0.02	4.80
Fourmile Creek	0.12	0.32	78.53	0.06	0.15	36.75	0.01	0.02	5.16
Trout Run	0.22	0.56	138.92	0.18	0.47	115.13	0.02	0.06	13.93
Walnut Creek	0.99	2.57	634.77	0.26	0.68	167.60	0.07	0.18	44.58
Elk Creek	3.51	9.10	2248.24	0.19	0.50	124.14	0.06	0.15	35.90
Crooked Creek	0.30	0.77	190.87	0.40	1.03	255.34	0.07	0.18	44.88
Raccoon Creek	0.10	0.27	66.87	0.16	0.42	103.76	0.05	0.12	30.01
Turkey Creek	0.05	0.14	33.66	0.38	0.98	242.51	0.09	54.82	54.82
Conneaut Creek	11.55	29.90	7388.80	0.62	1.62	399.77			
Ashtabula Creek	0.39	1.00	248.06						

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Table 4. Hydrologic Soil Group Area by Major Pennsylvania Lake Erie Sub-watershed

	Group A			**Group B**			**Group C**			**Group D**			**Other**		
Watershed	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%
Pennsylvania Lake Erie	82.72	214.23	16.32	27.07	70.10	5.34	222.99	577.54	43.99	165.53	428.73	32.65	8.63	22.34	1.70
Twentymile Creek	0.44	1.14	34.17	0.00	0.00	0.00	0.40	1.02	30.57	0.39	1.01	30.28	0.06	0.17	4.98
Sixteenmile Creek	2.03	5.26	11.31	0.17	0.43	0.92	6.19	16.04	34.47	9.28	24.03	51.62	0.30	0.78	1.68
Twelvemile Creek	1.93	4.99	14.92	0.04	0.10	0.29	2.77	7.19	21.50	7.98	20.67	61.85	0.18	0.48	1.43
Eightmile Creek	1.48	3.82	20.81	0.00	0.00	0.00	0.96	2.48	13.53	4.55	11.79	64.16	0.11	0.28	1.51
Sevenmile Creek	1.35	3.49	15.51	0.08	0.20	0.90	2.30	5.96	26.50	4.92	12.75	56.69	0.03	0.09	0.40
Sixmile Creek	0.90	2.33	4.76	0.76	1.96	4.01	11.51	29.80	60.86	5.57	14.42	29.44	0.18	0.45	0.93
Fourmile Creek	1.10	2.86	9.18	0.57	1.47	4.72	7.90	20.45	65.74	2.39	6.19	19.91	0.06	0.14	0.46
Trout Run	2.56	6.64	36.94	0.32	0.82	4.55	3.11	8.05	44.80	0.72	1.86	10.35	0.23	0.60	3.36
Walnut Creek	2.66	6.89	6.99	3.14	8.13	8.25	24.83	64.31	65.27	6.99	18.11	18.38	0.42	1.10	1.11
Elk Creek	7.21	18.68	7.34	5.91	15.31	6.01	64.46	166.94	65.58	18.50	47.92	18.83	2.20	5.70	2.24
Crooked Creek	7.26	18.81	35.84	0.21	0.53	1.02	9.41	24.36	46.41	2.56	6.62	12.61	0.84	2.17	4.13
Raccoon Creek	3.90	10.11	44.73	0.01	0.02	0.09	3.17	8.22	36.37	1.48	3.82	16.92	0.16	0.43	1.89
Turkey Creek	4.73	12.26	59.47	0.07	0.18	0.87	1.43	3.71	17.98	1.64	4.26	20.65	0.08	0.21	1.02
Conneaut Creek	3.69	9.56	2.41	14.00	36.27	9.16	57.42	148.72	37.55	76.32	197.66	49.90	1.50	3.87	0.98
Ashtabula Creek	0.00	0.00	0.00	0.05	0.12	0.57	1.18	3.06	14.41	6.96	18.02	84.79	0.02	0.05	0.22

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Table 5. Forest Cover Area by Major Pennsylvania Lake Erie Sub-watershed

Watershed	Deciduous Forest			Evergreen Forest			Mixed Forest			Total Forest		
	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%
Pennsylvania Lake Erie	192.65	498.95	37.94	6.29	16.29	1.24	4.39	11.36	0.86	203.32	526.60	40.05
Twentymile Creek	0.35	0.92	27.38	0.00	0.00	0.00	0.03	0.07	2.18	0.38	0.99	29.56
Sixteenmile Creek	4.89	12.68	27.22	0.21	0.54	1.15	0.53	1.38	2.95	5.63	14.59	31.32
Twelvemile Creek	3.81	9.87	29.53	0.07	0.19	0.58	0.10	0.25	0.76	3.98	10.32	30.86
Eightmile Creek	1.62	4.20	22.85	0.03	0.07	0.40	0.05	0.12	0.66	1.70	4.39	23.91
Sevenmile Creek	1.87	4.85	21.54	0.03	0.09	0.38	0.07	0.19	0.84	1.98	5.12	22.76
Sixmile Creek	8.35	21.62	44.12	0.42	1.10	2.24	0.28	0.73	1.49	9.05	23.45	47.85
Fourmile Creek	5.17	13.39	43.00	0.21	0.54	1.73	0.21	0.53	1.72	5.58	14.46	46.45
Trout Run	1.92	4.97	27.65	0.03	0.07	0.40	0.11	0.29	1.61	2.06	5.33	29.66
Walnut Creek	11.19	28.97	29.39	0.28	0.73	0.74	0.93	2.41	2.44	12.40	32.11	32.57
Elk Creek	41.98	108.72	42.68	2.18	5.64	2.21	1.35	3.48	1.37	45.50	117.84	46.26
Crooked Creek	9.50	24.61	46.84	0.33	0.85	1.62	0.06	0.15	0.28	9.89	25.61	48.74
Raccoon Creek	4.94	12.80	56.60	0.03	0.08	0.36	0.00	0.00	0.00	4.97	12.88	56.96
Turkey Creek	4.82	12.50	60.57	0.00	0.00	0.00	0.00	0.00	0.00	4.82	12.50	60.57
Conneaut Creek	74.13	192.00	48.42	2.17	5.63	1.42	0.06	0.15	0.04	76.36	197.78	49.88
Ashtabula Creek	3.97	10.29	48.21	0.01	0.02	0.10	0.00	0.00	0.00	3.98	10.32	48.31

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Table 6. Wetland Area by Major Pennsylvania Lake Erie Sub-watershed

	Freshwater emergent wetlands		**Freshwater forested/ shrub wetland**		**Freshwater pond**		**Riverine**		**Other**		**Total Wetland**	
Watershed	*ac*	*%*	*ac*	*%*	*ac*	*%*	*ac*	*%*	*ac*	*%*	*ac*	*%*
Pennsylvania Lake Erie	1123.61	0.35	15243.95	4.69	899.21	0.28	210.21	0.06	10.02	0.00	17487.01	5.38
Twentymile Creek	0.97	0.12	5.73	0.69	4.04	0.49	25.48	3.08	0.00	0.00	36.23	4.38
Sixteenmile Creek	40.13	0.35	172.74	1.50	55.93	0.49	13.78	0.12	2.39	0.02	284.96	2.48
Twelvemile Creek	6.29	0.08	83.02	1.00	27.75	0.34	11.33	0.14	0.95	0.01	129.34	1.57
Eightmile Creek	6.54	0.14	357.10	7.86	9.32	0.21	0.00	0.00	0.00	0.00	372.96	8.21
Sevenmile Creek	15.20	0.27	300.47	5.40	17.39	0.31	0.00	0.00	2.25	0.04	335.31	6.03
Sixmile Creek	37.96	0.31	128.18	1.06	27.94	0.23	3.69	0.03	1.29	0.01	199.06	1.64
Fourmile Creek	3.44	0.04	31.37	0.41	15.00	0.19	0.65	0.01	0.16	0.00	50.63	0.66
Trout Run	22.48	0.51	226.69	5.10	50.10	1.13	0.00	0.00	0.00	0.00	299.27	6.73
Walnut Creek	50.62	0.21	434.42	1.78	70.80	0.29	6.53	0.03	1.25	0.01	563.63	2.31
Elk Creek	61.83	0.10	726.06	1.15	102.31	0.16	70.93	0.11	0.00	0.00	961.13	1.53
Crooked Creek	171.03	1.32	1058.66	8.15	36.82	0.28	0.78	0.01	0.00	0.00	1267.30	9.76
Raccoon Creek	22.97	0.41	904.07	16.18	42.42	0.76	0.00	0.00	0.00	0.00	969.46	17.35
Turkey Creek	40.24	0.79	1861.09	36.51	19.46	0.38	0.00	0.00	0.00	0.00	1920.79	37.68
Conneaut Creek	152.83	0.16	4300.04	4.39	185.48	0.19	74.30	0.08	0.00	0.00	4712.64	4.81
Ashtabula Creek	83.50	1.58	1372.95	26.02	18.31	0.35	0.00	0.00	0.00	0.00	1474.76	27.95

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Table 7. Pennsylvania Lake Erie Watershed Area by County and Municipality

		Total County/Municipal Area			Area within Watershed				Percent of Watershed
County/Municipality	*County*	mi^2	km^2	*ac*	mi^2	km^2	*ac*	*%*	*%*
Erie County	Erie	802.77	2079.17	513773.87	410.18	1062.36	262515.75	51.10	80.91
Crawford County	Crawford	1036.68	2684.99	663474.87	96.80	250.70	61950.22	9.34	19.09
Wesleyville Borough	Erie	0.53	1.38	342.17	0.53	1.38	342.17	100.00	0.11
McKean Township	Erie	37.06	95.97	23715.83	35.35	91.56	22623.84	95.40	6.97
Lake City Borough	Erie	1.81	4.68	1157.69	1.81	4.68	1157.69	100.00	0.36
North East Borough	Erie	1.30	3.37	832.81	1.30	3.37	832.81	100.00	0.26
Platea Borough	Erie	3.34	8.64	2134.84	3.34	8.64	2134.84	100.00	0.66
McKean Borough	Erie	0.58	1.50	369.67	0.58	1.50	369.67	100.00	0.11
Waterford Township	Erie	50.37	130.46	32238.29	2.57	6.66	1646.85	5.11	0.51
Harborcreek Township	Erie	34.13	88.39	21842.31	34.13	88.39	21842.31	100.00	6.73
Girard Borough	Erie	2.36	6.10	1507.32	2.36	6.10	1507.32	100.00	0.46
Frankling Township	Erie	28.70	74.32	18365.45	21.68	56.16	13878.11	75.57	4.28
Washington Township	Erie	45.71	118.38	29253.35	2.55	6.61	1632.47	5.58	0.50
Girard Township	Erie	31.73	82.19	20308.64	31.73	82.19	20308.64	100.00	6.26
Conneaut Township	Erie	43.49	112.63	27830.59	43.49	112.63	27830.59	100.00	8.57
Greene Township	Erie	37.56	97.27	24035.32	13.82	35.79	8844.87	36.80	2.72
Summit Township	Erie	23.73	61.46	15186.95	16.75	43.38	10720.22	70.59	3.30
Fairview Township	Erie	29.20	75.63	18689.59	29.20	75.63	18689.59	100.00	5.76
Venango Township	Erie	43.69	113.17	27964.38	0.84	2.17	537.06	1.92	0.17
Greenfield Township	Erie	34.05	88.19	21792.67	9.35	24.21	5983.08	27.45	1.84
North East Township	Erie	42.42	109.86	27147.13	41.58	107.70	26613.07	98.03	8.20
Elk Creek Township	Erie	34.81	90.16	22278.38	25.32	65.57	16203.78	72.73	4.99
Springfield Township	Erie	37.47	97.04	23980.21	37.47	97.04	23980.21	100.00	7.39
Spring Township	Crawford	45.59	118.07	29176.62	28.53	73.89	18259.82	62.58	5.63
Conneaut Township	Crawford	41.54	107.59	26585.16	6.68	17.31	4276.74	16.09	1.32
Cransville Borough	Erie	0.94	2.42	598.83	0.94	2.42	598.83	100.00	0.18
Lawrence Park Township	Erie	1.83	4.73	1169.36	1.83	4.73	1169.36	100.00	0.36
City of Erie	Erie	19.13	49.55	12243.41	19.13	49.55	12243.41	100.00	3.77
Beaver Township	Crawford	36.55	94.67	23392.40	35.65	92.33	22814.06	97.53	7.03
Springboro Borough	Crawford	0.83	2.15	530.19	0.83	2.15	530.19	100.00	0.16
Summerhill Township	Crawford	25.37	65.71	16237.25	15.84	41.03	10139.93	62.45	3.12
Albion Borough	Erie	1.09	2.82	696.66	1.09	2.82	696.66	100.00	0.21
Summit Township	Crawford	26.01	67.37	16646.82	8.17	21.15	5227.10	31.40	1.61
Conneautville Borough	Crawford	1.10	2.84	702.39	1.10	2.84	702.39	100.00	0.22
Millcreek Township	Erie	31.67	82.02	20267.03	31.67	82.02	20267.03	100.00	6.24

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Table 8. Pennsylvania Lake Erie Watershed Population by Municipality

Municipality	*County*	*Population (2010)[1]*
Wesleyville Borough	Erie	3,341
McKean Township	Erie	4,409
Lake City Borough	Erie	3,031
North East Borough	Erie	4,294
Platea Borough	Erie	430
McKean Borough	Erie	388
Waterford Township	Erie	3,920
Harborcreek Township	Erie	17,234
Girard Borough	Erie	3,104
Frankling Township	Erie	1,633
Washington Township	Erie	4,432
Girard Township	Erie	5,102
Conneaut Township	Erie	4,290
Greene Township	Erie	4,760
Summit Township	Erie	6,603
Fairview Township	Erie	10,102
Venango Township	Erie	2,297
Greenfield Township	Erie	1,933
North East Township	Erie	6,315
Elk Creek Township	Erie	1,798
Springfield Township	Erie	3,425
Spring Township	Crawford	1,548
Conneaut Township	Crawford	1,476
Cransville Borough	Erie	638
Lawrence Park Township	Erie	3,982
City of Erie	Erie	101,786
Beaver Township	Crawford	902
Springboro Borough	Crawford	477
Summerhill Township	Crawford	1,236
Albion Borough	Erie	1,516
Summit Township	Crawford	2,027
Conneautville Borough	Crawford	774
Millcreek Township	Erie	53,515
Total	***Erie &Crawford***	***262,718***

[1] *U.S. Census (2010)*

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Table 9. Pennsylvania Lake Erie Watershed MS4 Communities

Municipality	*County*	*Permit Type*	*Population (2010)*
Wesleyville Borough	Erie	General	3,341
McKean Township[1]	Erie	Waiver	4,409
Lake City Borough	Erie	General	3,031
Harborcreek Township	Erie	Individual	17,234
Girard Borough	Erie	General	3,104
Girard Township	Erie	General	5,102
Greene Township[1]	Erie	Waiver	4,760
Summit Township	Erie	General	6,603
Fairview Township	Erie	Individual	10,102
Lawrence Park Township	Erie	General	3,982
City of Erie	Erie	General	101,786
Millcreek Township	Erie	Individual	53,515

[1] Received waiver

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Table 10. Impervious Cover Area by Major Pennsylvania Lake Erie Sub-watershed

	Watershed Area	***Impervious Cover Area***				
Watershed	*mi²*	*mi²*	*km²*	*ac*	*%*	*Classification*[1]
Pennsylvania Lake Erie	507.72	29.96	77.58	19171.42	5.90	Sensitive-transition
Twentymile Creek	1.29	0.05	0.12	30.37	3.67	Sensitive
Sixteenmile Creek	17.98	1.08	2.81	694.33	6.03	Sensitive - transition
Twelvemile Creek	12.91	0.36	0.92	227.34	2.75	Sensitive
Eightmile Creek	7.10	0.18	0.46	113.85	2.51	Sensitive
Sevenmile Creek	8.69	0.43	1.10	272.77	4.91	Sensitive
Sixmile Creek	18.92	0.62	1.61	398.94	3.30	Sensitive
Fourmile Creek	12.02	1.14	2.95	728.09	9.46	Sensitive - transition
Trout Run	6.94	0.55	1.44	354.94	7.99	Sensitive - transition
Walnut Creek	38.07	4.25	11.01	2720.45	11.17	Impacted
Elk Creek	98.35	2.37	6.13	1513.60	2.40	Sensitive
Crooked Creek	20.29	0.47	1.21	298.92	2.30	Sensitive
Raccoon Creek	8.73	0.20	0.51	126.73	2.27	Sensitive
Turkey Creek	7.97	0.14	0.36	89.21	1.75	Sensitive
Conneaut Creek	153.10	1.58	4.08	1009.38	1.03	Sensitive
Ashtabula Creek	8.24	0.08	0.20	49.02	0.93	Sensitive

[1] *Schueler et al. (2009)*

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Table 11. Roads by Major Pennsylvania Lake Erie Sub-watershed

	Municipal Roads				State Roads				Total Roads			
Watershed	*mi*	*km*	*mi/mi^2*	*km/km^2*	*mi*	*km*	*mi/mi^2*	*km/km^2*	*mi*	*km*	*mi/mi^2*	*km/km^2*
Pennsylvania Lake Erie	1433.07	2306.31	2.82	1.75	800.58	1288.41	1.58	0.98	2233.65	3594.72	4.40	2.73
Twentymile Creek	3.75	6.04	2.90	1.80	3.40	5.48	2.63	1.63	7.16	11.52	5.53	3.44
Sixteenmile Creek	61.34	98.71	3.41	2.12	24.79	39.90	1.38	0.86	86.13	138.61	4.79	2.98
Twelvemile Creek	18.65	30.02	1.44	0.90	26.08	41.97	2.02	1.26	44.73	71.98	3.46	2.15
Eightmile Creek	12.75	20.52	1.80	1.12	12.79	20.58	1.80	1.12	25.54	41.10	3.60	2.24
Sevenmile Creek	25.04	40.30	2.88	1.79	13.49	21.70	1.55	0.96	38.52	62.00	4.43	2.76
Sixmile Creek	39.43	63.46	2.08	1.30	20.80	33.47	1.10	0.68	60.23	96.93	3.18	1.98
Fourmile Creek	49.12	79.05	4.09	2.54	25.68	41.33	2.14	1.33	74.80	120.38	6.22	3.87
Trout Run	24.08	38.76	3.47	2.16	14.50	23.33	2.09	1.30	38.58	62.09	5.56	3.45
Walnut Creek	148.67	239.25	3.91	2.43	96.37	155.08	2.53	1.57	245.03	394.34	6.44	4.00
Elk Creek	187.51	301.77	1.91	1.18	102.77	165.39	1.04	0.65	290.28	467.16	2.95	1.83
Crooked Creek	33.46	53.86	1.65	1.03	30.76	49.50	1.52	0.94	64.22	103.36	3.17	1.97
Raccoon Creek	22.48	36.18	2.58	1.60	14.91	23.99	1.71	1.06	37.39	60.17	4.28	2.66
Turkey Creek	13.79	22.20	1.73	1.08	11.74	18.89	1.47	0.92	25.53	41.09	3.20	1.99
Conneaut Creek	213.54	343.66	1.39	0.87	123.17	198.22	0.80	0.50	336.71	541.88	2.20	1.37
Ashtabula Creek	8.46	13.62	1.03	0.64	7.24	11.66	0.88	0.55	15.70	25.27	1.90	1.18

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Table 12. Pennsylvania Lake Erie Watershed Land Cover Types

Land Cover Category	*Code*	*Description*
Open Water	11	All areas of open water, generally with less than 25% cover or vegetation or soil.
Developed, Open Space	21	Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
Developed, Low Intensity	22	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
Developed, Medium Intensity	23	Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
Developed, High Intensity	24	Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.
Barren Land (Rock/Sand/Clay)	31	Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Deciduous Forest	41	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.
Evergreen Forest	42	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.
Mixed Forest	43	Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.
Shrubs	52	Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Grassland/Herbaceous	71	Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
Pasture/Hay	81	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.
Cultivated Crops	82	Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Woody Wetlands	90	Areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
Emergent Herbaceous Wetlands	95	Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

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Table 13. Land Cover (Reclassified) by Major Pennsylvania Lake Erie Sub-watershed

	Open Water		Developed, Open Space		Developed, Low Intensity		Developed, Medium Intensity		Developed, High Intensity		Barren Land		Forest[1]		Shrub/Grassland[2]		Agriculture[3]		Wetland[4]	
Watershed	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%
Pennsylvania Lake Erie	3.61	0.71	38.80	7.65	37.89	7.47	14.91	2.94	5.55	1.10	0.94	0.19	203.32	40.11	14.91	2.94	160.97	31.76	25.99	5.13
Twentymile Creek	0.04	3.17	0.14	10.79	0.03	2.38	0.06	4.92	0.00	0.00	0.00	0.00	0.38	30.05	0.05	3.73	0.52	40.88	0.05	4.08
Sixteenmile Creek	0.10	0.55	1.96	11.07	0.90	5.10	0.37	2.11	0.13	0.73	0.00	0.00	5.63	31.76	0.27	1.51	7.30	41.15	1.07	6.02
Twelvemile Creek	0.00	0.00	0.95	7.42	0.40	3.12	0.07	0.53	0.00	0.00	0.05	0.36	3.98	31.03	0.53	4.13	6.37	49.59	0.49	3.82
Eightmile Creek	0.01	0.20	0.32	4.51	0.17	2.45	0.18	2.48	0.00	0.00	0.00	0.00	1.70	23.93	0.27	3.87	3.60	50.77	0.84	11.79
Sevenmile Creek	0.00	0.03	0.97	11.15	0.68	7.89	0.22	2.53	0.07	0.83	0.00	0.00	1.98	22.81	0.16	1.81	3.82	44.03	0.77	8.92
Sixmile Creek	0.00	0.00	1.31	7.01	0.85	4.53	0.20	1.08	0.04	0.22	0.05	0.27	9.05	48.34	1.03	5.52	5.54	29.60	0.64	3.43
Fourmile Creek	0.02	0.18	1.41	11.80	1.26	10.55	0.59	4.94	0.15	1.27	0.14	1.14	5.58	46.89	0.24	2.00	2.22	18.65	0.31	2.58
Trout Run	0.08	1.22	0.64	9.24	0.98	14.07	0.44	6.30	0.00	0.00	0.00	0.00	2.06	29.68	0.11	1.53	2.33	33.52	0.31	4.45
Walnut Creek	0.04	0.10	5.42	14.31	5.69	15.03	1.84	4.86	0.89	2.34	0.28	0.74	12.40	32.73	1.95	5.15	7.85	20.72	1.52	4.01
Elk Creek	0.17	0.17	5.54	5.66	3.44	3.52	0.46	0.47	0.15	0.15	0.01	0.01	45.50	46.54	2.48	2.53	37.03	37.87	3.00	3.07
Crooked Creek	0.09	0.44	0.92	4.56	0.74	3.63	0.08	0.42	0.00	0.00	0.00	0.00	9.89	48.77	0.61	3.03	6.51	32.09	1.43	7.05
Raccoon Creek	0.02	0.28	0.59	6.72	0.41	4.69	0.11	1.29	0.03	0.32	0.00	0.00	4.97	57.00	0.15	1.73	2.11	24.13	0.33	3.83
Turkey Creek	0.05	0.58	0.53	6.64	0.35	4.40	0.08	1.07	0.00	0.00	0.00	0.00	4.82	60.87	0.14	1.73	1.04	13.11	0.92	11.60
Conneaut Creek	0.37	0.24	6.00	3.95	2.31	1.52	0.32	0.21	0.08	0.06	0.00	0.00	76.36	50.26	4.94	3.25	52.49	34.55	9.06	5.96
Ashtabula Creek	0.14	1.73	0.32	3.95	0.09	1.12	0.00	0.00	0.00	0.00	0.00	0.00	3.98	49.08	0.18	2.26	2.46	30.31	0.94	11.54

[1] *Includes deciduous forest, evergreen forest, and mixed forest*

[2] *Includes shrubs and grassland/herbaceous*

[3] *Includes pasture/hay and cultivated crops*

[4] *Includes woody wetlands and emergent herbaceous wetlands*

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Table 14. Pennsylvania Lake Erie Watershed Encroachment Types

Encroachment	*Description*
Boat Launch Ramp	Boat Launch Ramps use this sub-facility whether in conjunction with or independent of a docking structure.
Bridge	Used when a structure and its appurtenant works is erected over regulated waters.
Ch. 106 Floodplain Permit	Used for municipal applications as required under Chapter 106.
Channel Work	Used for minor realignment work, channel cleaning around water obstructions or minor channel work that is not covered under another sub-facility code.
Culvert	Used when a structure with appurtenant works that carries a stream under or through an embankment or fill is constructed.
Dock	Used for all types of floating, cantilevered or pile supported structures within regulated waters of the Commonwealth that are constructed for docking purposes of a private, public or commercial nature.
Dredging	Used for activities that remove sand, gravel, mud or other materials from beds of regulated waters.
Flood Levee or Walls	Used for the construction of levees, dikes, flood walls or other such devices for controlling or directing flood waters to a defined area or direction.
Floodway Activity	Used for activities or structures encroaching upon or obstructing the floodway.
Gravel Bar Removal	Used specifically for the removal of gravel bars within channels.
Intake Structure	Used for structures and appurtenant works that convey water from a stream or body of water through a pipe or channel constructed for that purpose.
Other Activities	Used when one of the other sub-facility codes does not adequately cover the activity or structure.
Outfall Structure	Used for structures and appurtenant works that convey water, stormwater or wastewater into a stream or body of water through a pipe or channel constructed for that purpose.
PA Wetland Replacement Project	Used when a contribution is made to the Pennsylvania Wetland Replacement Project fund in lieu of creating/restoring wetlands for compensation of wetland impacts.
Pipeline or Conduit	Used for any pipe or pipeline constructed for the transportation of a gaseous, liquid, liquefiable or slurry substance or, any cable, conduit, line or wire for the transmission of electrical energy, telephone, telegraph, radio or television signals including cathodic corrosion protection placed in, along, under, across or over regulated waters.
Stream Bank Protection	Used for activities or structures authorized individually or in conjunction with other activities or structures that involve rehabilitation or protection of the bank(s) of regulated waters of the Commonwealth against erosion, scour or sloughing by utilizing slope protection, dumped rock, cribbing, walls, channel deflectors or vegetative stabilization techniques.
Stream Enclosure	Used for a structure in excess of 100 feet in length upstream to downstream that encloses regulated waters.
Stream Relocation	Used when a new channel is constructed for the purpose of relocating stream flows from the original (or current) channel.
Stream Restoration	This sub-facility is currently ambiguous and may be modified for clarity. Individual project restoration segments should be represented with their own individual sub-facility.
Temporary Wetland Impact	Used when temporary fill or excavation of a wetland occurs.
Wetland Impact	Used for all permanent wetland impacts regardless of their nature or size.
Wetland Mitigation Bank	A wetland constructed in advance by a private or public entity for use as compensation for authorized wetland impacts.
Wetland Restoration	Used for all wetland creation, replacement or restoration efforts approved or required.

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Table 15. Core Habitat Area by Major Pennsylvania Lake Erie Sub-watershed

	Core Habitat Area				***Supporting Landscape***			
Watershed	*mi²*	*km²*	*ac*	*%*	*mi²*	*km²*	*ac*	*%*
Pennsylvania Lake Erie	37.00	95.83	23679.59	7.29	228.47	591.74	146222.55	45.00
Twentymile Creek	0.36	0.93	229.58	27.73	1.29	3.35	827.78	100.00
Sixteenmile Creek	0.64	1.65	407.13	3.54	2.18	5.65	1395.52	12.13
Twelvemile Creek	0.00	0.00	0.00	0.00	0.07	0.18	44.65	0.54
Eightmile Creek	0.20	0.52	129.18	2.84	1.87	4.84	1195.34	26.32
Sevenmile Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sixmile Creek	1.76	4.56	1127.51	9.31	2.87	7.45	1839.78	15.20
Fourmile Creek	0.80	2.06	509.13	6.62	2.15	5.57	1375.70	17.88
Trout Run	0.29	0.76	188.73	4.25	0.88	2.29	566.18	12.74
Walnut Creek	0.61	1.58	390.48	1.60	2.51	6.51	1608.63	6.60
Elk Creek	4.55	11.78	2911.35	4.63	21.06	54.54	13477.73	21.41
Crooked Creek	1.04	2.68	663.09	5.11	4.85	12.56	3104.38	23.91
Raccoon Creek	1.03	2.66	656.65	11.75	5.19	13.45	3322.57	59.47
Turkey Creek	4.29	11.12	2747.85	53.90	9.75	25.26	6241.99	122.44
Conneaut Creek	13.81	35.77	8839.80	9.02	63.03	14275.29	40337.93	41.17
Ashtabula Creek	1.64	4.25	1049.68	19.89	2.81	7.27	1796.70	34.05

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Table 16. Active River Area by Major Pennsylvania Lake Erie Sub-watershed

	Watershed Area	***Active River Area***			
Watershed	*mi^2*	*mi^2*	*km^2*	*ac*	*%*
Pennsylvania Lake Erie	507.72	172.54	446.87	110424.88	33.98
Twentymile Creek	1.29	0.53	1.38	340.13	41.09
Sixteenmile Creek	17.98	3.72	9.64	2382.02	20.70
Twelvemile Creek	12.91	2.21	5.72	1414.03	17.11
Eightmile Creek	7.10	2.85	7.39	1826.05	40.20
Sevenmile Creek	8.69	2.68	6.94	1714.30	30.83
Sixmile Creek	18.92	1.84	4.76	1175.03	9.71
Fourmile Creek	12.02	1.51	3.91	965.94	12.56
Trout Run	6.94	1.31	3.40	839.79	18.90
Walnut Creek	38.07	11.55	29.91	7391.22	30.34
Elk Creek	98.35	32.02	82.94	20495.68	32.56
Crooked Creek	20.29	8.15	21.10	5215.01	40.17
Raccoon Creek	8.73	4.05	10.50	2594.65	46.44
Turkey Creek	7.97	6.08	15.76	3894.19	76.39
Conneaut Creek	153.10	72.80	188.54	46590.46	47.55
Ashtabula Creek	8.24	0.01	0.01	3.68	0.07

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Table 17. Natural Systems Greenways Area by Major Pennsylvania Lake Erie Sub-watershed

	Exceptional			*High*			*Significant*			*Island*			*Total Greenway*		
Watershed	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%	mi^2	km^2	%
Pennsylvania Lake Erie	73.19	189.57	14.42	8.75	22.67	1.72	30.41	78.75	5.99	3.06	7.92	0.60	115.41	298.91	22.73
Twentymile Creek	0.65	1.69	50.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.69	50.36
Sixteenmile Creek	0.00	0.00	0.00	0.06	0.16	0.35	5.21	13.49	28.97	0.00	0.00	0.00	5.27	13.65	29.32
Twelvemile Creek	0.00	0.00	0.00	0.41	1.07	3.19	0.26	0.67	2.00	0.03	0.07	0.19	0.70	1.80	5.39
Eightmile Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.98	2.55	13.87	0.00	0.00	0.00	0.98	2.55	13.87
Sevenmile Creek	0.00	0.00	0.00	0.00	0.00	0.00	0.58	1.51	6.70	0.00	0.00	0.00	0.58	1.51	6.70
Sixmile Creek	0.00	0.00	0.00	0.00	0.00	0.00	8.06	20.87	42.59	0.00	0.00	0.00	8.06	20.87	42.59
Fourmile Creek	0.00	0.00	0.00	0.00	0.00	0.00	2.45	6.34	20.36	0.00	0.00	0.00	2.45	6.34	20.36
Trout Run	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.55	8.64	0.60	1.55	8.64
Walnut Creek	2.79	7.23	7.33	0.00	0.00	0.00	1.42	3.67	3.72	0.01	0.02	0.02	4.21	10.92	11.07
Elk Creek	5.89	15.26	5.99	4.23	10.95	4.30	2.17	5.61	2.20	0.00	0.00	0.00	12.29	31.82	12.49
Crooked Creek	9.42	24.40	46.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.42	24.40	46.45
Raccoon Creek	4.24	10.99	48.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.24	10.99	48.61
Turkey Creek	4.08	10.56	51.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.08	10.56	51.19
Conneaut Creek	38.39	99.43	25.07	0.25	0.64	0.16	0.00	0.00	0.00	1.82	4.71	1.19	40.45	104.78	26.42
Ashtabula Creek	1.68	4.36	20.42	3.80	9.85	46.13	0.00	0.00	0.00	0.00	0.00	0.00	5.49	14.21	66.55

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Table 18. Non-Attaining Streams by Major Pennsylvania Lake Erie Sub-watershed

	Total Stream Length		***Non-Attaining***			***Attaining***		
Watershed	*mi*	*km*	*mi*	*km*	*%*	*mi*	*km*	*%*
Pennsylvania Lake Erie	1121.35	1804.64	106.07	170.70	9.46	1015.28	1633.94	90.54
Twentymile Creek	4.00	6.44	0.00	0.00	0.00	4.00	6.44	100.00
Sixteenmile Creek	55.18	88.81	8.08	13.00	14.64	47.10	75.81	85.36
Twelvemile Creek	32.67	52.57	0.00	0.00	0.00	32.67	52.57	100.00
Eightmile Creek	22.06	35.50	0.00	0.00	0.00	22.06	35.50	100.00
Sevenmile Creek	27.55	44.34	0.00	0.00	0.00	27.55	44.34	100.00
Sixmile Creek	55.37	89.11	0.00	0.00	0.00	55.37	89.11	100.00
Fourmile Creek	28.87	46.47	0.00	0.00	0.00	28.87	46.47	100.00
Trout Run	11.77	18.95	11.56	18.61	98.20	0.21	0.34	1.80
Walnut Creek	80.27	129.18	37.59	60.50	46.83	42.68	68.68	53.17
Elk Creek	239.95	386.16	0.00	0.00	0.00	239.95	386.16	100.00
Crooked Creek	35.84	57.68	0.00	0.00	0.00	35.84	57.68	100.00
Raccoon Creek	18.17	29.24	0.00	0.00	0.00	18.17	29.24	100.00
Turkey Creek	18.00	28.96	0.00	0.00	0.00	18.00	28.96	100.00
Conneaut Creek	380.14	611.78	4.82	7.76	1.27	375.32	604.02	98.73
Ashtabula Creek	14.23	22.89	1.16	1.86	8.14	13.07	21.03	91.86

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Table 19. Composite Index Score Condition Ratings

	Composite Index Score	
Site Condition Rating	*2nd Order Sites*	*3rd Order Sites*
Optimum	60	60
Very Good	47.5-59.9	50.0-59.9
Good	35.5-47.4	40.0-49.9
Fair	28.1-35.4	31.5-39.9
Slightly Degraded	20.8-28.0	23.0-31.4
Poor	13.4-20.7	14.5-22.9
Very Poor	6.1-13.3	6.1-14.4
Minimum Biotic Diversity	6	6

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Table 20. Composite Index (CI) Scores and Stream Ratings (Campbell 2005)

Site	*Stream*	*CI Score*	*Rating*	*Site*	*Stream*	*CI Score*	*Rating*
20M	Twentymile	51.00	very good	Elk8	Hall's Run	33.00	fair
16M1	Sixteenmile	30.00	slightly degraded	Elk9	Falk Run	48.00	very good
16M2	Sixteenmile	53.30	very good	DR1	Duck Run	33.30	fair
16M3	Sixteenmile	60.00	optimum condition	DR2	Duck Run	27.50	slightly degraded
16M5	Sixteenmile	44.70	good	Cr1	Crooked Creek	37.50	fair
16M4	Baker Creek	19.50	poor	Cr2	Crooked Creek	35.50	fair
12M1	Twelvemile	45.80	good	Cr3	Crooked Creek	31.50	fair
12M2	Twelvemile	52.50	very good	Rac1	Raccoon Creek	42.00	good
7M1	Sevenmile	26.80	slightly degraded	Rac2	Raccoon Creek	37.50	good
7M4	Elliott's Run	25.50	slightly degraded	Con1	Conneaut Creek	48.00	very good
7M2	Sevenmile	37.20	good	Con2	Conneaut Creek	52.00	very good
7M3	Sevenmile	56.00	very good	Con3	Conneaut Creek	46.00	good
6M1	Sixmile	19.00	poor	Con4	Conneaut Creek	28.00	slightly degraded
6M2	Sixmile	20.00	poor	Con5	Conneaut Creek	47.00	good
6M3	Sixmile	13.00	very poor	Con6	Conneaut Creek	44.00	good
4M1	Fourmile	19.50	poor	Con7	Conneaut Creek	46.50	good
4M2	Fourmile	42.00	good	Con8	Conneaut Creek	35.00	fair
4M3	Fourmile	41.00	good	Con9	Conneaut Creek	40.00	good
McD1	McDannel Run	10.00	poor	Con10	Conneaut Creek	48.00	very good
McD2	McDannel Run	10.00	poor				
GR	Garrison Run	6.00	min. biotic diversity				
MC1	Mill Creek	25.60	slightly degraded				
MC1A	Mill Creek	15.00	poor				
MC2	Mill Creek	28.00	slightly degraded				
MC3	West Branch	22.00	slightly degraded				
MC5	Mill Creek	36.25	good				
MC6	Mill Creek	23.00	slightly degraded				
MC8	Mill Creek	28.20	fair				
CC1	Cascade Creek	10.60	very poor				
CC2	Cascade Creek	11.00	very poor				
CC3	Cascade Creek	10.00	very poor				
Wal1	Walnut Creek	39.50	fair				
Wal2	Walnut Creek	28.00	slightly degraded				
Wal3	Walnut Creek	12.00	very poor				
Wal4	Walnut Creek	40.00	good				
Wal5	Walnut Creek	56.00	very good				
ElkM	Elk Creek	30.00	slightly degraded				
Elk1	Elk Creek	33.00	fair				
Elk2	Elk Creek	43.00	good				
Elk3	Elk Creek	44.50	good				
Elk4	Elk Creek	42.70	good				
Elk5	Elk Creek	49.00	very good				
Elk6	Little Elk Creek	46.70	good				
Elk7	Little Elk trib.	55.50	very good				

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Table 21. Conneaut Creek Fish Community Assessment (DER, 1991)

	Sites[1]				
Species	*CC01*	*CC02*	*CC03*	*CC04*	*CC05*
Western Blacknose Dace		x			
Bluntnose Minnow			x	x	x
Central Stoneroller		x	x	x	x
Common Shiner	x	x	x	x	x
Creek Chub	x	x	x		x
Golden Shiner			x	x	x
Redside Dace	x	x			
River Chub					x
Rosyface Shiner			x	x	
Sand Shiner					
Silverjaw Minnow		x	x	x	
Spottail Shiner				x	x
Golden Redhorse				x	x
Northern Hogsucker		x	x	x	x
White Sucker	x	x	x	x	
Stonecat		x			
Brown Trout	x			x	
Rainbow Trout	x				
Green Sunfish			x		
Rock Bass			x	x	x
Smallmouth Bass				x	x
Banded Darter				x	x
Blackside Darter			x	x	
Fantail Darter	x	x			
Greenside Darter			x	x	x
Johnny Darter	x	x			x
Logperch			x		
Rainbow Darter	x	x	x	x	
Species Richness	***9***	***12***	***15***	***17***	***14***

[1] *x indicates species present*

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Table 22. Pennsylvania Lake Erie Watershed Fish Community Assessment (Billingsley and Johns, 1996-98)

			Species[1]																									
Site	*Stream*	*Date*	*W. Blacknose Dace*	*Bluntnose Minnow*	*Central Stoneroller*	*Common Shiner*	*Creek Chub*	*Golden Shiner*	*Longnose Dace*	*River Chub*	*Rosyface Shiner*	*Spottail Shiner*	*Golden Redhorse*	*Northern Hogsucker*	*White Sucker*	*Brown Bullhead*	*Brown Trout*	*Rainbow Trout*	*Mottled Sculpin*	*Bluegill*	*Pumpkinseed*	*Rock Bass*	*Smallmouth Bass*	*Blackside Dace*	*Fantail Darter*	*Johnny Darter*	*Logperch*	*Rainbow Darter*	***Species Richness***
BR-01	Elk Creek	6/7/95	x				x								x		x		x	x	x								***7***
BR-02	Elk Creek	6/7/95	x														x		x										***3***
FR-01	Elk Creek	7/11/94	x		x													x		x	x								***5***
12M-01	Twelvemile Creek	6/21/94	x						x									x	x						x			x	***6***
HR-01	Elk Creek	7/11/94	x	x	x	x	x				x	x		x											x			x	***10***
7M-01	Sevenmile Creek	6/22/94	x				x											x											***3***
7M-02	Sevenmile Creek	6/22/94	x		x		x		x						x			x	x									x	***8***
RC-02	Raccoon Creek	7/6/94		x	x	x	x	x				x			x	x	x	x	x	x	x	x	x			x	x	x	***18***
6M-01	Sixmile Creek	6/23/94			x		x		x						x				x									x	***6***
6M-02	Sixmile Creek	6/23/94	x		x	x	x		x						x				x						x			x	***9***
6M-03	Sixmile Creek	6/23/94	x		x	x	x								x							x			x			x	***8***
GR-01	Elk Creek	7/7/94	x		x		x											x		x	x				x			x	***8***
20M-01	Twentymile Creek	7/14/97	x						x						x			x										x	***5***
20M-02	Twentymile Creek	7/14/97	x		x		x		x	x			x		x		x	x	x		x	x		x	x			x	***15***

[1] *x indicates species present*

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Table 23. Modified Index of Biotic Integrity Metrics (Phillips and Andraso, 2005)

		Scoring Criteria		
Category	*Metric*	*1*	*3*	*5*
Species Richness and Composition	1. Total number of species	< 5	5 to 19	> 19
	2. Number of darter and sculpin species	0	1 to 3	> 3
	3. Number of sunfish species	0	1 to 4	> 4
	4. Number of minnow species	0 to 2	3 to 5	> 5
	5. Number of intolerant species	0 to 1	2 to 5	> 5
	6. % Dace species	≥ 57%	11 to 56%	< 11%
Trophic Composition	7. % Omnivores	≥ 51%	11 to 50%	< 11%
	8. % Insectivores	< 20%	21 to 59%	> 59%
	9. % Top carnivores		0 to 25%	> 25%
Fish Abundance and Condition	10. Catch per hour	< 236	236 to 724	> 724
	11. % Simple lithophils	< 0.1%	0.1 to 22.2%	> 22.2%
	12. % Diseased individuals	> 1.3%	0.1 to 1.3%	< 0.1%

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Table 24. IBI Classifications (Karr et al., 1986)

IBI Score	*Class*	*Attributes*
58 - 60	Excellent (E)	Comparable to the best situations without human disturbance; all regionally expected species for the habitat and stream size, including the most tolerant forms are present with a full array of age classes; balanced trophic structure
53 - 57	E-G	
48 - 52	Good (G)	Species richness somewhat below expectations, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress.
45 - 47	G-F	
40 - 44	Fair (F)	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure; older age classes of top predators may be rare.
35 - 39	F-P	
28 - 34	Poor (P)	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; diseased fish often present.
23 - 27	P-VP	
12 - 22	Very Poor (VP)	Few fish present, mostly introduced or tolerant forms; disease, parasites, fin damage, and anomalies regular.
	No Fish	Sampling finds no fish

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Table 25. Pennsylvania Lake Erie Watershed Fish Community Assessment (Phillips and Andraso, 2005)

Species	Site (number of individuals)																								
	16mc1	16mc2	bc1	12mc1	7mc1	7mc2	7mc3	6mc1	6mc2	4mc1	mr1	mr2	ec1	ec2	ec3	ec4	hr1	lec1	crc1	crc2	crc3	rc1	rc2	coc1	coc2
Sea Lamprey	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0
Rainbow Trout	0	0	0	5	71	0	0	0	0	11	0	0	0	1	2	1	0	0	16	11	14	19	5	0	1
Brown Trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0	0	2
Brook Trout	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Central Mudminnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	1
Muskellunge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Central Stoneroller	141	0	1	7	3	0	0	88	125	2	0	0	6	13	4	15	5	5	1	0	1	1	0	0	2
Redside Dace	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	3	0	0	0	1
Silverjaw Minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0
Bigeye Chub	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0
River Chub	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Striped Shiner	0	0	0	0	0	0	0	3	0	0	0	0	2	1	2	3	4	0	4	7	1	0	2	0	0
Spotfin Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sand Shiner	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	5	9
Bluntnose Shiner	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	7	3	2	4	5	24
Fathead Minnow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0
Blacknose Dace	37	66	43	14	30	30	109	15	71	136	45	35	10	0	1	2	19	39	0	29	9	0	4	1	0
Longnose Dace	20	0	0	16	20	0	0	0	10	42	0	0	0	1	0	0	0	5	2	2	0	0	0	0	0
Creek Chub	23	2	30	2	6	18	29	8	12	67	0	0	9	4	0	0	20	2	1	26	5	0	7	0	0
White Sucker	9	0	0	0	0	0	0	6	27	0	0	0	4	8	0	0	0	0	2	1	12	7	2	0	0
Northern Hogsucker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	8	7	1	2	0	1
Yellow Bullhead	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0
Rock Bass	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	19	14
Pumpkinseed	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	4	12	0	0	0
Green Sunfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Smallmouth Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5	0	0	1	0	0	0	0	0	0
Laregmouth Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	11	1	1	0	0
Black Crappie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Greenside Dace	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	10
Rainbow Darter	0	0	0	51	17	0	0	9	43	0	0	0	8	20	55	41	7	2	1	14	0	4	9	1	0
Fantail Darter	0	0	0	6	10	0	0	3	6	0	0	0	0	7	4	4	12	13	2	2	0	0	3	2	1
Johnny Darter	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	5	0	24	5	14	9	0	1
Mottled Sculpin	1	0	0	3	1	0	0	2	2	3	0	0	0	0	0	5	0	2	1	4	5	5	10	0	0

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Table 26. IBI-Based Fish Community Assessment (Phillips and Andraso, 2005)

Site	*Stream*	*Species Richness*	*IBI Score*	*IBI Class*
16mc1	Sixteenmile Creek	7	40	Fair
16mc2	Sixteenmile Creek	2	20	Very Poor
bc1	Baker Run	3	28	Poor
12mc1	Twelvemile Creek	8	40	Fair
7mc1	Sevenmile Creek	9	42	Fair
7mc2	Sevenmile Creek	2	20	Very Poor
7mc3	Sevenmile Creek	2	22	Very Poor
6mc1	Sixmile Creek	8	38	Fair-Poor
6mc2	Sixmile Creek	11	46	Good-Fair
4mc1	Fourmile Creek	7	32	Poor
mr1	McDannel Run	1	20	Very Poor
mr2	McDannel Run	1	20	Very Poor
ec1	Elk Creek	10	40	Fair
ec2	Elk Creek	11	46	Good-Fair
ec3	Elk Creek	8	44	Fair
ec4	Elk Creek	13	46	Good-Fair
hr1	Hall Run	7	40	Fair
lec1	Little Elk Creek	11	38	Fair-Poor
crc1	Crooked Creek	12	46	Good-Fair
crc2	Crooked Creek	14	46	Good-Fair
crc3	Crooked Creek	20	52	Good
rc1	Raccoon Creek	12	44	Fair
rc2	Raccoon Creek	13	46	Good-Fair
coc1	Conneaut Creek	9	40	Fair
coc2	Conneaut Creek	14	44	Fair

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Table 27. Fourmile Creek Watershed Fish Community Assessment (Andraso et al., 2009)

	Species											
Site	*Rainbow Trout*	*Brown Trout*	*Central Stoneroller*	*Bluntnose Minnow*	*W. Blacknose Dace*	*Longnose Dace*	*Creek Chub*	*Mottle Sculpin*	*Species Richness*	*Total Individuals*	*IBI*	*IBI Class*
4M 1	9	1	25	0	91	23	39	0	6	188	36	Fair-Poor
4M 2	6	1	0	0	18	95	5	0	5	125	34	Poor
4M 3	0	0	0	0	46	9	16	4	4	75	28	Poor
4M 4	0	0	0	0	75	67	7	1	4	150	32	Poor
4M 5	0	0	0	0	40	93	6	6	4	145	32	Poor
4M 6	0	0	0	0	62	66	34	3	4	165	32	Poor
4M 7	0	0	0	0	16	50	22	7	4	95	32	Poor
4M 8	0	0	0	0	25	28	2	2	4	57	30	Poor
4M 9	0	0	0	0	12	0	0	0	1	12	22	Very Poor
4M 10	0	0	0	0	169	0	4	45	3	218	28	Poor
4M 11	0	0	0	2	140	0	12	28	4	182	30	Poor
4M 12	0	0	0	0	48	0	17	1	3	66	28	Poor

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Table 28. High Gradient Stream Habitat Assessment Parameters (Barbour et al., 1999)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <0.3 m/s, deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Bank Vegetative Protection (score each bank**)**	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, under story shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone**)**	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

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Table 29. Pennsylvania Lake Erie Watershed Stream Habitat Assessment (Diz and Powley, 2005)

			Habitat Parameter Scores																
Stream	Site	Date	Epi	Emb	Vel	Dep	Ch Fl	Ch Alt	Riffle	L-Stab	R-Stab	T-Stab	L-Veg	R-Veg	T-Veg	L-Rip	R-Rip	T-Rip	T-Hab	Rating
Racoon Creek	RC 1	7/29/03	14	14	14	2	15	15	11	10	10	20	10	10	20	2	10	12	137	Suboptimal
Racoon Creek	RC 2	7/6/04	15	17	13	9	9	15	17	3	7	10	4	8	12	5	9	14	131	Suboptimal
Racoon Creek	RC 3	7/30/03	16	11	14	3	12	17	15	8	3	11	7	6	13	9	9	18	130	Suboptimal
Crooked Creek	CrC 1	7/28/04	2	19	8	14	12	18	17	3	6	9	6	7	13	2	7	9	121	Suboptimal
Crooked Creek	CrC 2	7/29/04	18	7	16	3	9	19	16	3	8	11	6	7	13	8	9	17	129	Suboptimal
Crooked Creek	CrC 3	8/11/04	16	14	14	9	8	19	16	3	5	8	7	7	14	9	9	18	136	Suboptimal
Crooked Creek	CrC 4	7/29/04	18	8	15	9	12	19	17	3	1	4	7	6	13	9	9	18	133	Suboptimal
Elk Creek	EC 1	7/30/04	12	13	18	15	9	18	17	5	5	10	6	7	13	9	9	18	143	Suboptimal
Elk Creek	EC 2	7/16/03	11	18	17	15	9	13	15	9	7	16	9	9	18	10	7	17	149	Suboptimal
Elk Creek	EC 3	7/14/03	8	19	19	19	7	15	19	9	8	17	10	10	20	8	9	17	160	Optimal
Elk Creek	EC 4	7/17/03	16	17	11	10	14	10	11	8	4	12	10	8	18	9	2	11	130	Suboptimal
Little Elk Creek	LEC 1	7/27/04	7	14	13	9	8	20	9	4	6	10	8	8	16	10	8	18	124	Suboptimal
Little Elk Creek	LEC 2	7/29/03	17	19	9	19	7	15	19	6	3	9	4	5	9	6	9	15	138	Suboptimal
Halls Run (Elk Creek)	HR	7/30/04	9	14	10	12	9	18	19	2	2	4	4	7	11	2	9	11	117	Suboptimal
Walnut Creek	WC	7/7/03	13	12	18	15	11	13	19	7	4	11	9	7	16	10	9	19	147	Suboptimal
McDannel Run	MDR 1	5/29/03	16	18	15	13	15	19	15	8	7	15	9	9	18	4	8	12	156	Suboptimal
McDannel Run	MDR 2	5/29/03	13	11	15	10	14	14	16	8	6	14	5	5	10	4	3	7	124	Suboptimal
McDannel Run	MDR 3	5/28/03	5	16	11	14	17	14	13	5	1	6	2	1	3	2	1	3	102	Marginal
Fourmile Creek	4MC	5/30/03	8	19	9	19	10	12	12	1	2	3	3	5	8	2	2	4	104	Marginal
Sixmile Creek	6MC 1	6/11/03	13	14	17	15	9	20	17	0	2	2	9	6	15	10	4	14	136	Suboptimal
Sixmile Creek	6MC 2	6/23/03	15	13	9	15	7	20	18	7	5	12	8	8	16	7	9	16	141	Suboptimal
Sevenmile Creek	7MC 1	6/6/03	17	19	18	13	15	19	17	7	4	11	7	9	16	9	2	11	157	Suboptimal
Sevenmile Creek	7MC 2	6/10/03	18	14	15	13	18	15	15	8	3	11	6	4	10	6	1	7	136	Suboptimal
Twelvemile Creek	12MC	6/23/03	17	16	14	15	7	10	19	10	9	19	8	7	15	2	3	5	137	Suboptimal
Sixteenmile Creek	16MC 1	6/11/03	15	19	14	16	8	12	14	3	4	7	4	5	9	4	7	11	125	Suboptimal
Sixteenmile Creek	16MC 2	6/10/03	14	19	17	10	11	11	18	3	1	4	5	4	9	1	0	1	114	Suboptimal
Sixteenmile Creek	16MC 3	6/16/03	19	19	9	18	12	18	20	7	9	16	9	9	18	10	10	20	169	Optimal
Baker Creek (Sixteenmile)	BC	6/10/03	2	18	3	17	8	0	19	9	9	18	1	1	2	0	0	0	87	Marginal

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Table 30. Pennsylvania Lake Erie Watershed Streambed Sediment Chemistry Analysis (Diz and Powley, 2005)

			Heavy Metal Concentration (mg/kg)									
Stream	*Site*	*Date*	*Cd*	*Cd PEL*	*Cu*	*CU PEL*	*Pb*	*Pb PEL*	*Ni*	*Ni PEL*	*Zn*	*Zn PEL*
Racoon Creek	RC 1	7/29/03	0.4	< LEL	28.6	> LEL	11.4	< LEL	37.2	> LEL	53.0	< LEL
Racoon Creek	RC 2	7/6/04	0.0	ND	0.0	ND	0.0	ND	0.0	ND	0.0	ND
Racoon Creek	RC 3	7/30/03	0.5	< LEL	19.5	> LEL	5.8	< LEL	17.0	> LEL	42.6	< LEL
Crooked Creek	CrC 1	7/28/04	0.8	> LEL	24.3	> LEL	24.2	< LEL	38.2	> LEL	75.1	< LEL
Crooked Creek	CrC 2	7/29/04	0.8	> LEL	24.5	> LEL	27.6	< LEL	38.1	> LEL	88.1	< LEL
Crooked Creek	CrC 3	8/11/04	2.4	> LEL	17.8	> LEL	16.2	< LEL	45.3	> LEL	63.6	< LEL
Crooked Creek	CrC 4	7/29/04	1.4	> LEL	19.8	> LEL	10.6	< LEL	42.5	> LEL	53.9	< LEL
Elk Creek	EC 1	7/30/04	2.3	> LEL	16.9	> LEL	13.9	< LEL	56.4	> SEL	57.4	< LEL
Elk Creek	EC 2	7/16/03	2.2	> LEL	18.5	> LEL	17.8	< LEL	60.3	> SEL	69.7	< LEL
Elk Creek	EC 3	7/14/03	3.2	> LEL	17.8	> LEL	19.5	< LEL	48.4	> LEL	64.5	< LEL
Elk Creek	EC 4	7/17/03	1.8	> LEL	23.8	> LEL	19.9	< LEL	41.7	> LEL	70.8	< LEL
Little Elk Creek	LEC 1	7/27/04	1.5	> LEL	20.8	> LEL	20.5	< LEL	71.0	> SEL	69.2	< LEL
Little Elk Creek	LEC 2	7/29/03	2.3	> LEL	21.8	> LEL	22.1	< LEL	62.7	> SEL	76.0	< LEL
Halls Run (Elk Creek)	HR	7/30/04	1.5	> LEL	12.5	< LEL	17.2	< LEL	60.6	> SEL	54.9	< LEL
Walnut Creek	WC	7/7/03	1.3	> LEL	20.0	> LEL	27.5	< LEL	69.2	> SEL	103.7	< LEL
McDannel Run	MDR 1	5/29/03	1.6	> LEL	48.4	> LEL	74.8	> LEL	59.0	> SEL	177.5	> LEL
McDannel Run	MDR 2	5/29/03	2.0	> LEL	33.3	> LEL	75.2	> LEL	57.4	> SEL	143.7	> LEL
McDannel Run	MDR 3	5/28/03	1.1	> LEL	28.0	> LEL	39.7	> LEL	68.8	> SEL	118.7	< LEL
Fourmile Creek	4MC	5/30/03	1.3	> LEL	29.5	> LEL	30.9	< LEL	72.2	> SEL	96.9	< LEL
Sixmile Creek	6MC 1	6/11/03	1.1	> LEL	27.6	> LEL	31.2	> LEL	62.9	> SEL	109.7	< LEL
Sixmile Creek	6MC 2	6/23/03	0.3	< LEL	15.4	< LEL	45.3	> LEL	54.4	> SEL	64.4	< LEL
Sevenmile Creek	7MC 1	6/6/03	1.2	> LEL	15.7	< LEL	21.8	< LEL	73.5	> SEL	83.7	< LEL
Sevenmile Creek	7MC 2	6/10/03	1.1	> LEL	18.4	> LEL	25.4	< LEL	44.1	> SEL	98.8	< LEL
Twelvemile Creek	12MC	6/23/03	1.4	> LEL	20.2	> LEL	20.0	< LEL	64.9	> SEL	78.8	< LEL
Sixteenmile Creek	16MC 1	6/11/03	0.4	< LEL	35.7	> LEL	40.1	> LEL	93.8	> SEL	153.3	> LEL
Sixteenmile Creek	16MC 2	6/10/03	1.1	> LEL	26.4	> LEL	27.9	< LEL	88.1	> SEL	110.9	< LEL
Sixteenmile Creek	16MC 3	6/16/03	1.5	> LEL	24.6	> LEL	32.4	> LEL	72.4	> SEL	107.0	< LEL
Baker Creek (Sixteenmile)	BC	6/10/03	2.9	> LEL	102.2	> LEL	62.7	> LEL	77.1	> SEL	168.6	> LEL

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Table 31. Pennsylvania Lake Erie Watershed Water Quality Analysis (Diz and Powley, 2005)

			Analyte[1]					
Stream	*Site*	*Date*	*BOD5 (mg/L)*	*DOC (mg/L)*	*Temp (°C)*	*Cond (mS/cm)*	*DO (mg/L)*	*pH*
Racoon Creek	RC 1	7/29/03	4.5	7.8	19.4	0.5	6.9	6.5
Racoon Creek	RC 2	7/6/04	4.0	12.7	20.5	0.7	9.0	7.8
Racoon Creek	RC 3	7/30/03	ND	ND	20.0	0.7	6.8	ND
Crooked Creek	CrC 1	7/28/04	5.1	6.6	19.6	0.4	9.3	8.2
Crooked Creek	CrC 2	7/29/04	4.5	5.7	16.9	0.2	9.9	8.1
Crooked Creek	CrC 3	8/11/04	3.1	6.6	17.5	0.4	6.6	7.7
Crooked Creek	CrC 4	7/29/04	3.0	7.7	ND	ND	ND	ND
Elk Creek	EC 1	7/30/04	2.4	6.1	20.8	0.4	9.6	8.1
Elk Creek	EC 2	7/16/03	2.1	4.3	25.3	0.7	6.3	8.0
Elk Creek	EC 3	7/14/03	3.0	5.1	24.5	0.7	8.0	8.6
Elk Creek	EC 4	7/17/03	2.5	5.7	24.2	0.7	6.8	7.9
Little Elk Creek	LEC 1	7/27/04	3.2	10.2	21.6	0.5	9.0	8.6
Little Elk Creek	LEC 2	7/29/03	1.8	8.1	19.9	0.5	6.0	7.1
Halls Run (Elk Creek)	HR	7/30/04	2.4	7.0	19.0	0.8	8.9	7.8
Walnut Creek	WC	7/7/03	1.7	7.2	23.8	0.8	6.1	8.2
McDannel Run	MDR 1	5/29/03	3.5	4.4	15.0	1.3	9.0	8.1
McDannel Run	MDR 2	5/29/03	6.7	4.3	13.3	1.4	8.7	8.2
McDannel Run	MDR 3	5/28/03	6.8	6.4	15.3	1.4	13.0	8.4
Fourmile Creek	4MC	5/30/03	4.3	4.8	16.6	0.9	9.6	7.9
Sixmile Creek	6MC 1	6/11/03	2.3	10.8	18.2	0.6	7.5	8.3
Sixmile Creek	6MC 2	6/23/03	5.8	6.4	19.6	0.6	8.3	8.8
Sevenmile Creek	7MC 1	6/6/03	3.3	4.2	17.1	0.8	9.1	8.3
Sevenmile Creek	7MC 2	6/10/03	2.3	7.9	16.6	0.8	7.7	8.0
Twelvemile Creek	12MC	6/23/03	3.5	3.4	16.2	0.7	7.0	8.1
Sixteenmile Creek	16MC 1	6/11/03	3.6	4.9	18.0	0.5	7.1	8.0
Sixteenmile Creek	16MC 2	6/10/03	2.7	4.3	15.9	0.6	8.1	7.5
Sixteenmile Creek	16MC 3	6/16/03	1.5	6.7	14.8	0.7	6.8	ND
Baker Creek (Sixteenmile)	BC	6/10/03	3.5	4.9	16.6	0.7	8.1	8.2

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Table 32. Pennsylvania Lake Erie Watershed Water Quality Analysis (Diz et al., 2006)

Stream	Site	Air Temp (°C)	Water Temp (°C)	Stream Width (m)	Stream Depth (m)	Surface Velocity (m/s)	pH	DO	Conductivity (µS/cm)	BOD (mg/L)	Total Organic Carbon (mg/L)	Turbidity (ntu)	Total Nitrogen (mg/L)	Total Phosphate (mg/L)	Total Coliforms	E. coli
		Parameter[1]														
Racoon Creek	RC	23.00	19.58	6.02	0.47	0.26	7.75	9.45	321	1.40	6.24	3.86	1.12	0.32	4360	93
Crooked Creek	CrC	23.08	19.74	11.43	0.12	0.38	7.72	9.59	306	1.37	4.39	2.54	1.39	0.27	6426	4080
Elk Creek	EC 1	23.14	22.28	15.67	0.20	0.53	7.80	10.57	377	1.35	4.11	1.66	1.66	0.39	5382	4013
Elk Creek	EC 2	22.60	21.36	21.07	0.27	0.28	7.50	10.93	225	2.11	7.26	16.61	1.32	0.46	8875	5020
Elk Creek	EC 3	26.24	21.94	8.13	0.17	0.36	7.42	7.82	255	1.54	5.09	2.54	0.81	0.27	3494	238
Little Elk Creek	LEC	26.24	24.92	7.10	0.14	0.22	7.82	10.30	247	1.75	5.58	1.20	0.94	0.23	42568	71
Lamson Run	LR	26.24	22.64	4.01	0.15	0.27	7.88	9.24	292	1.22	4.28	1.63	0.59	0.25	3826	229
Godfrey Run	GFR	21.88	16.26	2.96	0.35	0.36	7.94	9.95	362	1.44	2.77	2.92	3.23	0.35	12000	8040
Trout Run	TR	20.34	17.52	5.42	0.38	0.37	7.85	10.25	364	2.11	5.76	15.16	2.77	0.60	8913	774
Walnut Creek	WC 1	20.76	20.30	13.40	0.36	0.37	7.92	9.88	456	1.52	6.19	50.90	1.44	0.55	8623	4580
Walnut Creek	WC 2	28.28	23.32	7.32	0.09	0.28	7.61	8.07	611	2.72	5.84	2.09	1.08	0.28	7810	145
Wilkins Run	WR	22.34	19.96	5.09	0.23	0.42	7.62	9.73	505	1.02	4.96	21.16	2.21	0.35	5485	460
Marshall Run	MR	26.11	17.94	3.41	0.12	0.26	8.06	10.43	613	0.86	4.03	1.21	2.47	0.28	11830	4010
Scott Run	SR	26.11	17.32	2.40	0.20	0.15	7.95	9.31	773	0.93	4.92	6.20	1.50	0.27	3718	15
Cascade Creek	CC 1	25.11	20.88	7.03	0.45	0.16	8.07	9.55	795	1.17	4.54	1.36	2.62	0.27	6016	60
Cascade Creek	CC 2	25.89	17.86	8.38	0.15	0.30	7.89	10.81	665	1.27	3.45	3.26	1.88	0.27	4417	42
Cascade Creek	CC 3	25.89	18.94	2.71	0.28	0.27	7.91	10.14	1037	0.82	3.91	2.76	2.56	0.27	10400	4080
Cascade Creek	CC 4	28.94	18.14	4.47	0.16	0.22	7.21	8.63	981	2.76	3.18	1.35	4.21	0.50	15050	162
Mill Creek	MC 1	25.44	19.40	7.96	0.42	0.00	8.01	8.64	570	5.57	6.95	4.46	2.22	0.43	20000	2690
Mill Creek	MC 2	28.16	21.80	7.87	0.21	0.41	7.36	9.46	500	4.54	4.34	1.69	1.70	0.31	13360	239
Garrison Run	GR	24.78	21.00	4.11	0.10	0.33	7.65	8.20	484	1.56	5.46	3.40	2.40	0.38	9618	390
McDannel Run	MDR	25.00	21.48	4.77	0.04	0.23	8.15	10.03	555	1.78	6.91	2.22	2.85	0.32	9750	50
Fourmile Creek	4MC	25.88	22.60	8.57	0.09	0.30	8.18	9.30	406	3.26	4.60	1.42	1.00	0.21	5529	90
Sixmile Creek	6MC	26.00	23.58	12.01	0.44	0.13	8.40	8.58	273	0.73	4.38	1.07	0.49	0.26	11330	17
Sevenmile Creek	7MC	25.89	21.44	5.64	0.22	0.40	8.19	9.03	353	1.13	4.82	1.71	1.43	0.25	11610	99
Eightmile Creek	8MC	26.22	22.82	8.00	0.18	0.38	8.16	9.45	327	1.01	5.70	4.19	0.91	0.27	11840	4200
Twelvemile Creek	12MC	26.80	22.34	6.10	0.28	0.95	8.27	8.90	294	2.51	3.57	1.18	2.54	0.25	5910	70
Sixteenmile Creek	16MC	26.44	22.76	11.13	0.47	0.35	7.90	9.01	365	2.37	6.92	5.14	1.80	0.48	12900	5090
Baker Creek	BC	27.78	21.96	3.28	0.26	0.52	7.86	8.25	260	0.95	6.07	21.54	0.93	0.65	15440	469
Twentymile Creek	20MC	26.68	24.32	13.25	0.14	0.39	8.15	9.55	260	1.03	3.48	1.40	1.20	0.28	3831	34

[1] values represent mean of five measurements made between May and October 2005

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Table 33. Pennsylvania Lake Erie Watershed Water Quality Rankings (Diz et al., 2006)

		Parameter Rankings[1]									
Stream	*Site*	*Water Temp*	*Conductivity*	*BOD5*	*Total Organic Carbon*	*Total Nitrogen*	*Total Phosphate*	*Total Coliforms*	*E. coli*	*Total Score*	*Overall Rank*
Racoon Creek	RC	22	21	16	5	22	12	26	21	145	8
Crooked Creek	CrC	21	22	17	19	19	22	19	6	145	8
Elk Creek	EC 1	10	15	18	23	15	8	24	8	121	17
Elk Creek	EC 2	16	30	8	1	20	6	16	3	100	21
Elk Creek	EC 3	12	28	13	13	28	24	30	16	164	5
Little Elk Creek	LEC	1	29	11	11	25	29	1	23	130	12
Lamson Run	LR	7	24	20	22	29	26	28	17	173	1
Godfrey Run	GFR	30	18	15	30	2	10	7	1	113	19
Trout Run	TR	28	17	9	9	4	2	15	11	95	24
Walnut Creek	WC 1	19	13	14	6	17	3	17	4	93	26
Walnut Creek	WC 2	4	7	5	8	23	15	18	19	99	22
Wilkins Run	WR	20	10	24	14	11	11	23	13	126	16
Marshall Run	MR	26	6	28	24	8	17	9	9	127	14
Scott Run	SR	29	4	27	15	16	20	29	30	170	3
Cascade Creek	CC 1	18	3	21	18	5	19	20	25	129	13
Cascade Creek	CC 2	27	5	19	28	12	18	25	27	161	6
Cascade Creek	CC 3	24	1	29	25	6	23	12	7	127	14
Cascade Creek	CC 4	25	2	4	29	1	4	4	18	87	28
Mill Creek	MC 1	23	8	1	2	10	7	2	10	63	29
Mill Creek	MC 2	13	11	2	21	14	14	5	15	95	24
Garrison Run	GR	17	12	12	12	9	9	14	14	99	22
McDannel Run	MDR	14	9	10	4	3	13	13	26	92	27
Fourmile Creek	4MC	8	14	3	17	24	30	22	22	140	11
Sixmile Creek	6MC	3	25	30	20	30	25	11	29	173	1
Sevenmile Creek	7MC	15	19	22	16	18	27	10	20	147	7
Eightmile Creek	8MC	5	20	25	10	27	21	8	5	121	17
Twelvemile Creek	12MC	9	23	6	26	7	28	21	24	144	10
Sixteenmile Creek	16MC	6	16	7	3	13	5	6	2	58	30
Baker Creek	BC	11	27	26	7	26	1	3	12	113	19
Twentymile Creek	20MC	2	26	23	27	21	16	27	28	170	3

[1] scored from 1 (lowest quality) to 30 (highest quality)

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Table 34. Low Gradient Stream Habitat Assessment Parameters (Barbour et al., 1999)

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/Available Cover	Greater than 50% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	30-50% mix of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	10-30% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 10% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Pool Substrate Characterization	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Pool Variability	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% <20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yrs.) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. In stream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Channel Sinuosity	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 1 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long distance.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Bank Vegetative Protection (score each bank**)**	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, under story shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone**)**	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE _____ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE _____ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

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Table 35. Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Conneaut Creek	COC 2	10	10	7	15	15	15	11	9	9	18	9	9	18	10	7	17	136	Suboptimal
Conneaut Creek	COC 4	14	15	10	16	17	14	11	9	9	18	9	9	18	10	10	20	153	Suboptimal
Conneaut Creek	COC 5	11	10	10	16	16	15	11	9	9	18	9	9	18	9	2	11	136	Suboptimal
Conneaut Creek	COC 6	11	10	5	16	16	14	6	9	9	18	9	9	18	10	10	20	134	Suboptimal
Conneaut Creek	COC 7	15	15	15	16	19	19	14	9	9	18	9	9	18	9	9	18	167	Optimal
Conneaut Creek	COC 8	14	18	13	18	18	20	19	9	9	18	9	9	18	10	10	20	176	Optimal
Conneaut Creek	COC 9	18	18	18	18	16	18	18	9	9	18	9	9	18	10	10	20	180	Optimal
Conneaut Creek	COC 11	15	16	15	17	18	19	19	9	9	18	9	9	18	9	9	18	173	Optimal
Conneaut Creek	COC 12	15	15	15	16	18	18	15	9	9	18	9	9	18	9	9	18	161	Optimal
Conneaut Creek	COC 18	18	16	16	16	16	16	16	9	9	18	9	9	18	5	9	14	164	Optimal
Conneaut Creek	COC 25	16	12	16	11	13	13	10	6	6	12	7	7	14	5	8	13	130	Suboptimal
Conneaut Creek	COC 26	11	5	11	11	18	14	13	9	9	18	9	9	18	10	10	20	139	Suboptimal
Conneaut Creek	COC 28	11	14	8	11	15	11	7	6	9	15	9	9	18	5	8	13	123	Suboptimal
Conneaut Creek	COC 29	12	5	6	15	19	9	7	9	9	18	9	9	18	8	8	16	125	Suboptimal
Conneaut Creek	COC 30	12	13	11	16	19	14	11	9	9	18	9	9	18	2	4	6	138	Suboptimal
Conneaut Creek	COC 32	11	6	8	16	19	15	7	9	9	18	9	9	18	8	9	17	135	Suboptimal
Conneaut Creek	COC 33	10	10	12	11	16	15	11	8	5	13	9	9	18	9	9	18	134	Suboptimal
Conneaut Creek	COC 34	13	6	10	15	18	15	10	9	9	18	9	9	18	7	7	14	137	Suboptimal
Conneaut Creek	COC 35	15	12	15	16	19	15	17	9	9	18	9	9	18	3	3	6	151	Suboptimal
Conneaut Creek	COC 36	16	10	10	16	19	15	10	5	7	12	9	9	18	9	9	18	144	Suboptimal
Conneaut Creek	COC 37	16	15	16	15	14	15	16	5	5	10	9	9	18	10	10	20	152	Suboptimal
Conneaut Creek	COC 38	15	10	15	11	15	15	10	7	7	14	9	9	18	6	6	12	135	Suboptimal
Conneaut Creek	COC 39	15	7	18	7	16	15	16	7	8	15	7	10	17	6	5	11	137	Suboptimal
Conneaut Creek	COC 40	16	12	15	10	9	15	17	5	3	8	5	6	11	6	8	14	127	Suboptimal
Conneaut Creek	COC 43	20	13	20	14	10	13	18	7	7	14	6	6	12	10	10	20	154	Suboptimal
Conneaut Creek	COC 44	18	14	18	14	15	15	19	8	8	16	9	6	15	10	10	20	164	Optimal
Conneaut Creek	COC 45	17	15	20	16	15	15	15	7	7	14	9	9	18	10	5	15	160	Optimal
Conneaut Creek	COC 46	8	9	14	10	19	15	8	9	7	16	9	8	17	2	2	4	120	Suboptimal
Conneaut Creek	COC 47	15	14	15	19	18	15	15	9	7	16	9	8	17	4	4	8	152	Suboptimal
Conneaut Creek	COC 48	17	10	14	13	9	15	13	7	3	10	6	5	11	10	10	20	132	Suboptimal
Conneaut Creek	COC 49	16	11	15	12	15	15	8	9	9	18	9	7	16	8	8	16	142	Suboptimal
Conneaut Creek	COC 50	15	16	16	14	9	14	19	6	6	12	7	7	14	2	2	4	133	Suboptimal
Conneaut Creek	COC 51	16	15	18	12	9	15	19	8	10	18	8	9	17	9	9	18	157	Suboptimal
Conneaut Creek	COC 52	17	16	19	14	9	11	15	9	3	12	9	3	12	8	5	13	136	Suboptimal
Conneaut Creek	COC 53	16	14	18	18	18	15	8	8	7	15	9	9	18	10	10	20	160	Optimal
Conneaut Creek	COC 54	18	7	16	12	16	15	6	10	8	18	9	9	18	10	10	20	148	Suboptimal
Conneaut Creek	COC 55	12	7	15	12	15	15	5	9	3	12	9	3	12	2	1	3	108	Marginal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Conneaut Creek	COC 56	13	8	14	8	7	11	6	7	4	11	5	4	9	8	8	16	103	Marginal
Conneaut Creek	COC 57	15	14	15	14	9	10	15	3	5	8	7	5	12	2	1	3	115	Suboptimal
Conneaut Creek	COC 58	19	12	20	11	9	14	15	8	6	14	7	7	14	9	6	15	143	Suboptimal
Conneaut Creek	COC 59	16	12	14	14	7	10	18	7	6	13	8	7	15	2	1	3	122	Suboptimal
Turkey Creek	TC 1	15	6	13	8	9	20	8	2	5	7	2	8	10	10	10	20	116	Suboptimal
Turkey Creek	TC 2	15	10	10	10	15	10	6	9	9	18	10	10	20	5	9	14	128	Suboptimal
Raccoon Creek	RC 1	17	8	15	10	10	15	10	7	7	14	9	9	18	10	2	12	129	Suboptimal
Raccoon Creek	RC 2	17	6	15	14	9	14	16	9	2	11	9	6	15	10	10	20	137	Suboptimal
Raccoon Creek	RC 3	19	11	15	10	8	15	18	7	7	14	9	9	18	9	9	18	146	Suboptimal
Raccoon Creek	RC 4	19	9	12	9	9	15	6	3	3	6	7	7	14	10	9	18	118	Suboptimal
Raccoon Creek	RC 5	17	8	15	10	9	15	15	8	9	17	9	10	19	10	10	20	145	Suboptimal
Raccoon Creek	RC 6	15	6	10	6	7	20	10	3	2	5	9	5	14	10	10	20	113	Suboptimal
Raccoon Creek	RC 7	10	5	15	5	15	15	18	7	9	16	9	10	19	10	8	18	136	Suboptimal
Trib 62684	T684 1	12	9	6	5	7	20	10	9	2	11	10	8	18	3	9	12	110	Suboptimal
Trib 62680	T680 1	16	5	7	5	8	15	11	6	9	15	9	9	18	4	4	8	108	Marginal
Crooked Creek	CRC 1	15	8	14	6	8	11	6	10	9	19	4	5	9	2	2	4	100	Marginal
Crooked Creek	CRC 2	7	5	14	6	16	15	19	4	4	8	9	9	18	10	3	13	121	Suboptimal
Crooked Creek	CRC 3	10	10	10	14	15	15	16	9	7	16	2	2	4	2	2	4	114	Suboptimal
Crooked Creek	CRC 4	19	10	15	8	8	20	14	7	2	9	9	9	18	10	10	20	141	Suboptimal
Crooked Creek	CRC 5	8	2	5	10	15	15	10	9	9	18	10	10	20	5	8	13	116	Suboptimal
Crooked Creek	CRC 6	18	6	15	9	8	18	15	3	5	8	9	9	18	10	9	19	134	Suboptimal
Crooked Creek	CRC 7	16	13	10	11	8	20	15	9	8	17	10	10	20	9	8	17	147	Suboptimal
Crooked Creek	CRC 8	15	8	13	10	8	15	9	7	7	14	10	10	20	7	7	14	126	Suboptimal
Crooked Creek	CRC 9	15	8	9	10	13	15	6	2	7	9	3	8	11	8	10	18	114	Suboptimal
Crooked Creek	CRC 10	14	7	10	6	7	14	11	9	9	18	9	9	18	8	8	16	121	Suboptimal
Crooked Creek	CRC 11	16	13	16	15	15	15	16	6	8	14	8	8	16	8	9	17	153	Suboptimal
Crooked Creek	CRC 12	10	10	11	10	10	15	12	5	5	10	5	5	10	9	7	16	114	Suboptimal
Crooked Creek	CRC 13	14	13	16	15	14	17	16	8	6	14	8	8	16	9	9	18	153	Suboptimal
Crooked Creek	CRC 14	15	12	15	11	10	15	16	7	6	13	7	7	14	9	9	18	139	Suboptimal
Crooked Creek	CRC 16	11	7	14	12	14	15	16	7	7	14	8	8	16	9	9	18	137	Suboptimal
Crooked Creek	CRC 17	10	11	13	12	9	16	16	5	4	9	5	5	10	9	9	18	124	Suboptimal
Crooked Creek	CRC 18	10	10	13	11	13	18	16	5	5	10	8	8	16	9	9	18	124	Suboptimal
Crooked Creek	CRC 19	10	12	16	10	10	13	13	6	4	10	6	4	10	9	9	18	122	Suboptimal
Duck Run	DR 1	11	6	11	8	10	10	12	5	5	10	5	6	11	2	2	4	93	Marginal
Duck Run	DR 2	10	13	13	10	10	16	16	5	5	10	5	5	10	5	9	14	122	Suboptimal
Elk Creek	EC 1	16	6	19	10	8	15	15	10	9	19	10	8	18	10	8	18	134	Suboptimal
Elk Creek	EC 2	5	5	9	5	9	14	8	10	10	20	2	10	12	2	1	3	90	Marginal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Elk Creek	EC 3	13	5	19	7	8	15	8	9	8	17	10	9	19	9	9	18	129	Suboptimal
Elk Creek	EC 4	9	7	11	7	6	11	10	7	3	10	10	5	15	2	3	5	91	Marginal
Elk Creek	EC 5	8	10	10	16	16	15	16	8	9	17	9	9	18	9	9	18	144	Suboptimal
Elk Creek	EC 6	10	9	12	9	10	16	15	9	9	18	9	9	18	9	9	18	135	Suboptimal
Elk Creek	EC 7	12	8	10	8	10	16	16	9	9	18	9	9	18	5	9	14	130	Suboptimal
Elk Creek	EC 8	5	14	8	11	10	16	17	8	8	16	9	9	18	9	9	18	133	Suboptimal
Elk Creek	EC 9	9	6	11	15	19	15	6	9	9	18	9	9	18	1	4	5	122	Suboptimal
Elk Creek	EC 10	12	16	15	15	16	16	13	5	9	14	9	9	18	9	9	18	153	Suboptimal
Elk Creek	EC 11	6	5	6	10	16	15	4	9	9	18	9	9	18	9	2	11	109	Marginal
Elk Creek	EC 12	10	10	9	10	7	20	10	4	7	11	6	8	14	9	9	18	119	Suboptimal
Elk Creek	EC 13	14	13	7	11	6	15	5	9	7	16	8	10	18	9	4	13	118	Suboptimal
Elk Creek	EC 14	16	10	14	10	6	15	10	9	9	18	9	8	17	10	10	20	136	Suboptimal
Elk Creek	EC 15	13	13	15	10	8	15	14	9	9	18	5	9	14	10	6	16	136	Suboptimal
Elk Creek	EC 16	14	16	15	10	7	13	17	8	7	15	6	8	14	8	6	14	135	Suboptimal
Elk Creek	EC 17	14	15	15	10	7	19	11	9	9	18	9	9	19	8	10	18	145	Suboptimal
Elk Creek	EC 18	10	10	10	11	8	15	15	9	8	17	9	8	17	10	10	20	117	Suboptimal
Elk Creek	EC 19	10	15	3	15	5	15	3	10	10	20	10	10	20	9	8	17	123	Suboptimal
Elk Creek	EC 20	15	14	7	10	5	15	5	5	5	10	3	5	8	9	9	18	107	Marginal
Elk Creek	EC 21	13	13	12	11	6	13	9	5	2	7	8	5	13	2	2	4	101	Marginal
Elk Creek	EC 22	15	13	19	7	10	19	17	9	6	15	9	6	15	10	3	13	143	Suboptimal
Elk Creek	EC 23	15	14	19	8	10	10	17	9	9	18	7	8	15	7	2	9	135	Suboptimal
Elk Creek	EC 24	17	14	17	16	11	14	16	7	5	12	7	5	12	2	2	4	133	Suboptimal
Elk Creek	EC 25	17	19	18	17	9	15	18	9	9	18	7	9	16	10	10	20	167	Optimal
Elk Creek	EC 26	16	9	10	9	8	15	7	6	6	12	6	6	12	8	8	16	114	Suboptimal
Elk Creek	EC 27	11	8	7	8	7	15	5	5	7	12	5	8	13	6	7	13	99	Marginal
Elk Creek	EC 28	14	8	6	10	12	17	5	9	9	18	9	9	18	2	2	4	112	Suboptimal
Elk Creek	EC 29	14	13	10	10	8	15	14	5	4	9	5	6	11	6	1	7	111	Suboptimal
Elk Creek	EC 30	15	6	16	6	11	15	15	5	9	14	4	9	13	3	4	7	118	Suboptimal
Elk Creek	EC 31	15	6	18	6	10	8	10	8	9	17	4	9	13	3	2	5	108	Marginal
Elk Creek	EC 32	18	14	13	10	8	15	16	6	6	12	7	8	15	4	8	12	133	Suboptimal
Elk Creek	EC 33	16	10	5	10	5	15	5	9	9	18	8	9	17	10	10	20	121	Suboptimal
Elk Creek	EC 34	19	7	18	10	9	15	19	6	9	15	8	10	18	4	4	8	138	Suboptimal
Elk Creek	EC 35	7	8	10	10	11	11	13	6	2	8	2	2	4	2	2	4	86	Marginal
Elk Creek	EC 36	18	9	17	9	15	15	10	8	10	18	10	10	20	2	2	4	135	Suboptimal
Elk Creek	EC 37	18	17	19	10	15	15	18	7	7	14	10	8	18	4	2	6	150	Suboptimal
Elk Creek	EC 38	18	18	15	14	10	12	19	4	5	9	3	3	6	1	2	3	124	Suboptimal
Elk Creek	EC 39	13	20	8	20	19	19	19	8	8	16	8	9	17	8	2	10	158	Suboptimal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Elk Creek	EC 40	20	18	18	16	8	15	19	8	6	14	6	6	12	8	8	16	156	Suboptimal
Elk Creek	EC 41	19	19	10	18	18	15	19	8	8	16	10	10	20	2	7	9	163	Optimal
Elk Creek	EC 42	20	19	18	15	16	15	17	7	10	17	6	10	16	4	4	8	161	Optimal
Elk Creek	EC 43	20	19	20	15	15	15	20	8	6	14	7	7	14	10	10	20	172	Optimal
Elk Creek	EC 44	13	18	5	11	7	10	15	5	8	13	4	8	12	1	2	3	107	Marginal
Elk Creek	EC 45	15	18	17	13	9	14	17	10	9	19	10	10	20	2	2	4	146	Suboptimal
Elk Creek	EC 46	18	18	20	17	19	14	20	7	3	10	9	9	18	3	1	4	158	Suboptimal
Elk Creek	EC 47	16	17	14	17	15	15	19	6	10	16	9	10	19	2	2	4	152	Suboptimal
Elk Creek	EC 48	16	16	14	15	12	15	14	6	9	15	8	10	18	1	2	3	138	Suboptimal
Elk Creek	EC 49	15	18	10	19	7	15	18	10	10	20	10	10	20	9	5	14	156	Suboptimal
Elk Creek	EC 50	20	18	15	13	8	15	18	4	4	8	8	7	15	8	3	11	141	Suboptimal
Elk Creek	EC 51	20	15	20	14	10	15	18	4	9	13	6	10	16	2	5	7	148	Suboptimal
Elk Creek	EC 52	19	16	20	15	9	15	19	8	10	18	8	10	18	3	10	13	162	Optimal
Elk Creek	EC 53	15	12	10	10	10	14	19	7	8	15	8	8	16	2	10	12	133	Suboptimal
Elk Creek	EC 54	13	17	13	14	10	15	13	5	9	14	8	9	17	2	2	4	130	Suboptimal
Elk Creek	EC 55	18	15	16	15	15	15	18	9	9	18	10	10	20	6	8	14	164	Optimal
Elk Creek	EC 56	10	16	15	8	15	16	16	9	9	18	5	5	10	5	5	10	134	Suboptimal
Trib 62490	T490 1	6	5	14	5	6	16	16	9	9	18	9	9	18	9	9	18	122	Suboptimal
Godfrey Run	GFR 1	11	8	14	17	18	17	13	6	8	14	6	6	12	1	1	2	126	Suboptimal
Godfrey Run	GFR3	10	8	14	13	15	13	7	6	6	12	5	5	10	2	2	4	106	Marginal
Godfrey Run	GFR 6	18	14	15	12	15	15	20	2	4	6	2	2	4	9	9	18	137	Suboptimal
Godfrey Run	GFR 7	18	13	17	14	14	14	18	9	9	18	10	10	20	9	2	11	157	Suboptimal
Godfrey Run	GFR 8	10	10	9	12	15	7	15	10	10	20	0	10	10	1	2	3	111	Suboptimal
Trib 62484	T84 1	10	5	8	10	14	15	15	5	7	12	8	10	18	2	7	9	116	Suboptimal
Trib 62483	T83 1	6	5	4	5	7	15	8	4	4	8	9	9	18	8	10	18	94	Marginal
Trout Run	TR 1	14	6	19	5	15	10	14	8	8	16	9	5	14	3	1	4	117	Suboptimal
Trout Run	TR 2	19	14	15	12	11	11	16	3	4	7	3	5	8	7	3	10	123	Suboptimal
Trout Run	TR 3	18	13	16	15	15	15	13	7	9	16	9	9	18	9	6	15	154	Suboptimal
Trout Run	TR 4	16	13	16	13	15	15	12	4	8	12	7	8	15	9	9	18	145	Suboptimal
Trout Run	TR 5	10	6	9	7	15	9	5	9	9	18	6	2	8	2	1	3	90	Marginal
Trib 62476	T76 1	14	8	8	2	15	20	18	5	5	10	8	8	16	10	10	20	131	Suboptimal
Walnut Creek	WC 1	10	13	11	11	11	13	13	8	8	16	7	7	14	9	3	12	124	Suboptimal
Walnut Creek	WC 2	10	10	10	5	8	16	16	5	5	10	5	5	10	10	10	20	115	Suboptimal
Walnut Creek	WC 3	8	9	8	12	10	13	11	6	4	10	6	5	11	9	6	15	107	Marginal
Walnut Creek	WC 4	7	9	9	7	6	16	16	9	9	18	9	9	18	9	9	18	124	Suboptimal
Walnut Creek	WC 5	10	12	11	10	10	15	11	5	8	13	6	6	12	9	9	18	122	Suboptimal
Walnut Creek	WC 6	8	9	8	11	7	16	9	7	7	14	9	9	18	9	9	18	118	Suboptimal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Walnut Creek	WC 7	13	15	10	13	15	14	10	8	8	16	9	8	17	9	7	16	129	Suboptimal
Walnut Creek	WC 8	10	12	11	11	14	8	11	8	8	16	9	9	18	2	6	8	119	Suboptimal
Walnut Creek	WC 9	3	2	2	5	18	13	2	8	8	16	8	8	16	9	3	12	89	Marginal
Walnut Creek	WC 10	10	9	10	10	11	10	13	2	2	4	5	5	10	2	2	4	91	Marginal
Walnut Creek	WC 12	10	10	11	10	11	13	10	8	8	16	7	8	15	5	5	10	116	Suboptimal
Walnut Creek	WC 13	10	15	11	11	11	13	12	9	9	18	9	9	18	9	9	18	137	Suboptimal
Walnut Creek	WC 15	10	8	10	10	10	8	10	6	6	12	7	6	13	5	5	10	101	Marginal
Walnut Creek	WC 16	12	11	10	8	16	16	13	9	10	19	9	9	18	9	9	18	141	Suboptimal
Walnut Creek	WC 17	3	14	2	2	2	14	6	9	9	18	9	9	18	5	3	8	87	Marginal
Walnut Creek	WC 18	16	12	13	9	13	16	7	9	9	18	9	9	18	9	9	18	140	Suboptimal
Walnut Creek	WC 19	17	10	12	6	10	14	13	9	9	18	9	9	18	7	9	16	134	Suboptimal
Walnut Creek	WC 20	10	8	9	12	15	12	11	9	7	16	9	7	16	7	2	9	118	Suboptimal
Walnut Creek	WC 21	11	10	11	12	15	13	10	9	9	18	9	8	17	6	2	8	125	Suboptimal
Trib 62436	T36 1	4	3	6	5	9	6	6	5	5	10	1	1	2	1	1	2	53	Poor
Trib 62436	T36 2	10	5	6	5	8	14	7	5	5	10	5	5	10	2	9	11	86	Marginal
Trib 62436	T36 3	10	6	5	5	8	19	18	7	7	14	9	9	18	8	10	18	121	Suboptimal
Wilkins Run	WR 1	5	7	7	10	15	13	16	9	9	18	9	9	18	7	8	15	124	Suboptimal
Wilkins Run	WR 2	10	10	11	11	10	15	15	5	5	10	7	7	14	9	9	19	124	Suboptimal
Shorehaven	SH 1	6	10	10	13	16	10	16	5	5	10	4	4	8	2	1	3	102	Marginal
Marshall Run	MR 1	18	15	15	14	15	13	17	8	7	15	7	8	15	5	2	7	144	Suboptimal
Marshall Run	MR 2	18	14	15	15	15	19	18	8	8	16	7	10	17	3	9	12	159	Suboptimal
Marshall Run	MR 3	7	6	9	11	15	13	13	4	1	5	2	1	3	1	1	1	84	Marginal
Marshall Run	MR 4	10	6	7	6	9	16	10	7	7	14	7	7	14	2	2	4	96	Marginal
Motch Run	MTR 1	15	4	8	7	9	10	7	3	3	6	8	8	16	1	2	3	85	Marginal
Motch Run	MTR 2	11	15	14	9	6	15	15	2	2	4	3	3	6	10	10	20	115	Suboptimal
Motch Run	MTR 3	9	12	13	12	6	14	18	2	2	4	2	2	4	4	1	5	97	Marginal
Cemetery Run	CR 1	5	18	7	20	12	15	19	9	9	18	9	9	18	2	2	4	136	Suboptimal
McDannel Run	MDR 1	15	19	15	16	9	18	19	7	7	14	7	7	14	9	5	14	153	Suboptimal
McDannel Run	MDR 2	11	16	15	16	10	15	14	2	8	10	1	8	9	1	2	3	119	Suboptimal
Fourmile Creek	4M 1	16	13	19	17	15	19	16	8	9	17	8	9	17	3	8	11	160	Optimal
Fourmile Creek	4M 2	19	19	19	3	8	15	19	3	8	11	7	9	16	2	9	11	140	Suboptimal
Fourmile Creek	4M 3	15	18	19	8	9	6	15	8	8	16	1	6	7	1	3	4	117	Suboptimal
Fourmile Creek	4M 5	15	14	16	6	7	11	16	6	6	12	8	8	16	4	4	8	121	Suboptimal
Fourmile Creek	4M 6	6	15	16	9	8	15	17	4	4	8	3	3	6	9	9	18	118	Suboptimal
Fourmile Creek	4M 7	16	19	15	14	9	15	20	5	5	10	8	8	16	10	2	12	146	Suboptimal
Fourmile Creek	4M 8	20	20	20	15	7	17	20	4	4	8	7	7	14	10	10	20	161	Optimal
Fourmile Creek	4M 9	16	20	20	18	10	20	20	10	10	20	4	4	8	10	10	20	172	Optimal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																	
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Fourmile Creek	4M 10	19	19	18	10	7	14	19	9	9	18	8	8	16	10	10	20	160	Optimal
Fourmile Creek	4M 11	13	13	10	9	6	15	16	8	4	12	5	5	10	6	6	12	116	Suboptimal
Fourmile Creek	4M 12	16	18	20	13	9	15	18	9	9	18	10	9	19	8	3	11	157	Suboptimal
Fourmile Creek	4M 13	16	18	19	18	11	15	18	8	8	16	8	8	16	9	9	18	165	Optimal
Fivemile Creek	5M 0	10	9	17	9	8	18	14	3	3	6	7	7	14	10	8	18	123	Suboptimal
Fivemile Creek	5M 1	12	14	15	14	10	15	16	4	4	8	8	8	16	4	1	5	125	Suboptimal
Fivemile Creek	5M 2	13	13	14	16	15	10	16	8	8	16	6	6	12	1	1	2	127	Suboptimal
Fivemile Creek	5M 3	6	5	7	13	2	8	1	9	9	18	6	6	12	1	1	2	74	Marginal
Fivemile Creek	5M 4	11	12	4	15	4	15	1	9	9	18	9	9	18	2	2	4	102	Marginal
Sixmile Creek	6M 0	14	18	14	10	10	15	8	10	9	19	8	2	10	9	9	18	136	Suboptimal
Sixmile Creek	6M 1	15	16	16	10	12	18	18	2	5	7	5	5	10	2	9	11	133	Suboptimal
Sixmile Creek	6M 2	15	6	19	10	7	15	16	9	9	18	6	6	12	8	2	10	128	Suboptimal
Sixmile Creek	6M 3	11	19	19	6	7	20	20	10	10	20	2	5	7	10	9	19	148	Suboptimal
Sixmile Creek	6M 4	12	17	18	8	10	20	18	9	9	18	5	3	8	2	4	6	135	Suboptimal
Sixmile Creek	6M 5	15	16	13	16	15	15	20	10	8	18	10	10	20	10	8	18	166	Optimal
Sixmile Creek	6M 6	18	15	14	13	14	20	17	6	8	14	9	9	18	8	10	18	161	Optimal
Sixmile Creek	6M 7	18	19	20	15	15	15	20	9	9	18	10	6	16	9	9	18	174	Optimal
Sixmile Creek	6M 8	16	13	17	15	14	15	18	6	6	12	10	10	20	4	4	8	148	Suboptimal
Sixmile Creek	6M 9	17	18	15	14	15	15	19	6	6	12	9	9	18	7	7	14	150	Suboptimal
Sixmile Creek	6M 10	16	18	19	9	8	15	20	6	9	15	8	8	16	8	8	16	152	Suboptimal
Sixmile Creek	6M 11	14	12	16	14	14	15	17	9	9	18	8	9	17	9	3	12	149	Suboptimal
Sixmile Creek	6M 12	16	18	20	17	15	15	20	8	8	16	9	9	18	8	8	16	171	Optimal
Sixmile Creek	6M 13	9	16	10	14	11	15	16	9	7	16	9	9	18	3	3	6	131	Suboptimal
Sixmile Creek	6M 14	16	13	10	17	16	15	16	9	9	18	10	10	20	5	5	10	151	Suboptimal
Sixmile Creek	6M 15	5	13	5	19	5	11	2	10	10	20	10	10	20	8	8	16	116	Suboptimal
Sixmile Creek	6M 16	16	19	15	15	16	15	18	3	10	13	4	8	12	5	9	14	153	Suboptimal
Sixmile Creek	6M 17	18	18	19	15	11	15	19	4	6	10	4	4	8	8	8	16	149	Suboptimal
Sixmile Creek	6M 18	20	19	20	17	15	19	20	7	9	16	8	8	16	10	2	12	174	Optimal
Sevenmile Creek	7M 1	7	8	19	9	9	15	19	8	8	16	9	9	18	2	2	4	124	Suboptimal
Sevenmile Creek	7M 2	5	5	6	7	10	13	3	7	9	16	9	9	18	2	2	4	87	Marginal
Sevenmile Creek	7M 3	6	5	13	6	15	8	14	10	10	20	2	2	4	1	1	2	93	Marginal
Sevenmile Creek	7M 4	14	5	14	5	15	15	13	3	5	8	6	9	15	10	2	12	116	Suboptimal
Sevenmile Creek	7M 5	13	13	9	7	15	15	19	9	9	18	10	10	20	2	2	4	133	Suboptimal
Sevenmile Creek	7M 6	6	5	5	5	7	10	5	9	7	16	7	9	16	1	1	2	77	Marginal
Sevenmile Creek	7M 7	16	18	14	15	15	15	19	5	8	13	5	8	13	2	2	4	127	Suboptimal
Sevenmile Creek	7M 8	15	16	14	13	15	15	19	8	8	16	9	9	18	2	1	3	144	Suboptimal
Sevenmile Creek	7M 9	10	16	13	15	15	15	18	4	7	11	5	8	13	2	2	4	120	Suboptimal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Sevenmile Creek	7M 10	7	15	8	16	15	9	15	7	7	14	3	4	7	1	1	2	108	Marginal
Sevenmile Creek	7M 11	18	18	17	15	15	15	18	9	9	18	9	9	18	5	5	10	162	Optimal
Sevenmile Creek	7M 12	13	16	10	14	15	14	19	6	4	10	9	8	17	10	1	11	126	Suboptimal
Eightmile Creek	8M 1	6	19	17	10	15	20	15	5	5	10	5	5	10	3	9	12	134	Suboptimal
Eightmile Creek	8M 2	16	6	13	5	15	14	15	4	3	7	6	4	10	9	9	18	119	Suboptimal
Eightmile Creek	8M 3	15	16	15	15	15	15	15	2	8	10	2	9	11	1	2	3	130	Suboptimal
Eightmile Creek	8M 4	14	15	10	15	15	12	17	3	3	6	1	1	2	1	1	2	108	Marginal
Eightmile Creek	8M 5	12	16	10	17	15	15	16	9	9	18	9	9	18	2	2	4	126	Suboptimal
Eightmile Creek	8M 6	12	10	9	18	14	13	15	9	9	18	9	9	18	2	2	4	131	Suboptimal
Eightmile Creek	8M 7	15	13	5	15	15	15	19	3	8	11	9	9	18	2	2	4	130	Suboptimal
Eightmile Creek	8M 8	16	18	10	7	8	15	20	3	5	8	9	9	18	5	5	10	130	Suboptimal
Eightmile Creek	8M 9	16	17	14	7	7	15	15	3	3	6	9	9	18	10	5	15	130	Suboptimal
Eightmile Creek	8M 10	13	18	14	13	16	15	19	3	3	6	3	3	6	1	1	2	122	Suboptimal
Eightmile Creek	8M 11	18	14	18	14	15	19	20	6	7	13	7	6	13	7	7	14	158	Suboptimal
Eightmile Creek	8M 12	11	16	15	16	17	13	20	4	8	12	4	8	12	3	5	8	140	Suboptimal
Twelvemile Creek	12M 1	19	11	19	7	9	20	13	8	5	13	9	9	18	2	7	9	138	Suboptimal
Twelvemile Creek	12M 2	16	15	19	10	11	19	16	8	8	16	9	9	18	2	8	10	150	Suboptimal
Twelvemile Creek	12M 3	18	15	15	10	10	15	19	9	8	17	10	10	20	2	9	11	150	Suboptimal
Twelvemile Creek	12M 4	16	16	15	7	7	15	19	5	9	14	9	9	18	4	2	6	133	Suboptimal
Twelvemile Creek	12M 5	18	13	15	10	7	15	14	9	5	14	8	7	15	9	10	19	140	Suboptimal
Twelvemile Creek	12M 6	10	18	15	19	19	11	20	10	10	20	10	10	20	2	1	3	155	Suboptimal
Twelvemile Creek	12M 7	10	14	14	19	19	15	19	10	10	20	9	10	19	2	4	6	155	Suboptimal
Twelvemile Creek	12M 8	18	19	18	6	8	11	20	5	3	8	7	4	11	10	5	15	134	Suboptimal
Twelvemile Creek	12M 9	12	17	7	19	19	15	19	10	10	20	10	10	20	2	2	4	152	Suboptimal
Twelvemile Creek	12M 10	18	17	15	18	18	15	19	8	7	15	8	8	16	7	4	11	162	Optimal
Twelvemile Creek	12M 11	18	18	18	12	15	15	20	9	8	17	9	9	18	4	3	7	158	Suboptimal
Twelvemile Creek	12M 12	17	16	15	18	18	15	20	10	9	19	9	8	17	3	8	11	166	Optimal
Twelvemile Creek	12M 13	16	17	10	18	18	15	20	9	10	19	10	10	20	3	3	6	159	Suboptimal
Twelvemile Creek	12M 14	9	16	5	19	20	15	18	10	10	20	10	10	20	5	9	14	156	Suboptimal
Sixteen Mile Creek	16M 1	8	13	15	11	11	9	16	9	9	18	9	2	11	8	2	10	122	Suboptimal
Sixteen Mile Creek	16M 3	7	16	13	13	17	17	17	9	2	11	9	2	11	9	4	13	135	Suboptimal
Sixteen Mile Creek	16M 4	16	18	18	11	15	6	20	10	10	20	4	4	8	2	2	4	136	Suboptimal
Sixteen Mile Creek	16M 5	15	11	10	13	19	7	6	9	9	18	8	10	18	1	2	3	120	Suboptimal
Sixteen Mile Creek	16M 6	18	13	14	14	15	15	16	7	8	15	8	8	16	2	2	4	140	Suboptimal
Sixteen Mile Creek	16M 7	6	7	11	11	9	4	15	9	9	18	1	1	2	1	1	2	85	Marginal
Sixteen Mile Creek	16M 8	16	15	19	10	9	10	13	7	7	14	5	5	10	2	2	4	120	Suboptimal
Sixteen Mile Creek	16M 9	20	19	20	12	14	20	19	9	9	18	9	9	18	10	8	18	160	Optimal

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Table 35 (continued). Pennsylvania Lake Erie Watershed High Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Sixteen Mile Creek	16M 10	16	16	10	11	5	15	5	7	9	16	9	9	18	10	9	19	131	Suboptimal
Sixteen Mile Creek	16M 11	13	10	13	14	8	15	16	3	5	8	6	6	12	4	2	6	115	Suboptimal
Sixteen Mile Creek	16M 12	16	16	15	15	16	15	19	7	10	17	6	10	16	2	2	4	133	Suboptimal
Sixteen Mile Creek	16M 13	19	15	19	10	14	15	20	8	5	13	5	5	10	8	10	18	153	Suboptimal
Sixteen Mile Creek	16M 14	15	16	19	14	15	15	20	4	7	11	5	9	14	2	6	8	147	Suboptimal
Sixteen Mile Creek	16M 15	18	18	13	16	16	13	20	4	9	13	6	6	12	8	10	18	157	Suboptimal
Sixteen Mile Creek	16M 16	10	16	14	12	18	15	19	7	7	14	4	4	8	2	2	4	130	Suboptimal
Orchard Beach Run	OBR 1	15	19	5	18	18	13	19	10	10	20	9	9	18	10	9	19	164	Optimal
Orchard Beach Run	OBR 2	13	19	5	18	18	14	19	10	10	20	9	6	15	5	5	10	151	Suboptimal
Orchard Beach Run	OBR 4	15	19	8	19	19	14	19	9	8	17	9	9	18	7	7	14	162	Optimal
Orchard Beach Run	OBR 5	6	11	4	14	18	14	16	9	9	18	7	7	14	2	2	4	119	Suboptimal
Woodmere Beach Run	WBR 1	15	15	15	10	11	15	16	5	5	10	2	7	9	5	10	15	131	Suboptimal
Woodmere Beach Run	WBR 2	16	16	14	14	15	16	17	6	6	12	7	7	14	9	5	14	148	Suboptimal
Woodmere Beach Run	WBR 3	14	18	14	18	15	15	19	7	8	15	2	2	4	2	2	4	136	Suboptimal
Peck Run	PR 1	16	9	15	16	18	18	19	9	9	18	9	9	18	5	6	11	158	Suboptimal
Peck Run	PR 2	12	11	16	6	10	11	18	4	4	8	9	9	18	8	8	16	126	Suboptimal
Peck Run	PR 3	10	18	5	15	10	15	18	2	2	4	2	2	4	2	2	4	103	Marginal
Peck Run	PR 5	16	15	15	14	10	14	17	5	9	14	8	8	16	2	5	7	138	Suboptimal
Trib 62254	T54 1	10	14	5	16	15	15	16	9	9	18	8	8	16	2	2	4	129	Suboptimal
Trib 62255	T55 1	5	8	5	10	11	10	16	9	9	18	1	5	6	2	2	4	93	Marginal
Twentymile Creek	20M 1	18	19	19	10	14	19	18	8	8	16	9	9	18	8	10	18	169	Optimal

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Table 36. Pennsylvania Lake Erie Watershed Low Gradient Stream Habitat (Rafferty et al., 2011)

		Habitat Parameter Scores																
Stream	*Site*	*Epi*	*Subst*	*Var*	*Dep*	*Ch Fl*	*Ch Alt*	*Ch Sin*	*L-Stab*	*R-Stab*	*T-Stab*	*L-Veg*	*R-Veg*	*T-Veg*	*L-Rip*	*R-Rip*	*T-Rip*	*T-Hab*	*Rating*
Conneaut Creek	COC 13	18	17	16	15	15	15	6	9	9	18	9	9	18	9	9	18	156	Suboptimal
Conneaut Creek	COC 14	7	10	10	11	10	19	19	5	5	10	7	7	14	9	9	18	128	Suboptimal
Conneaut Creek	COC 15	13	13	13	13	18	15	6	9	9	18	9	9	18	9	9	18	145	Suboptimal
Conneaut Creek	COC 16	16	15	13	13	15	15	12	9	9	18	9	9	18	9	9	18	153	Suboptimal
Conneaut Creek	COC 17	13	15	10	18	18	15	5	9	9	18	9	9	18	8	9	17	147	Suboptimal
Conneaut Creek	COC 19	10	11	11	16	15	15	10	9	9	18	9	9	18	7	9	16	140	Suboptimal
Conneaut Creek	COC 20	2	2	2	16	2	13	5	9	9	18	9	9	18	2	2	4	82	Marginal
Conneaut Creek	COC 21	13	13	13	10	10	13	10	5	8	13	2	2	4	2	4	6	105	Marginal
Conneaut Creek	COC 22	18	15	11	11	16	16	13	9	9	18	9	9	18	9	9	18	139	Suboptimal
Conneaut Creek	COC 23	13	13	14	16	18	15	5	9	9	18	9	9	18	7	7	14	144	Suboptimal
Conneaut Creek	COC 24	13	13	13	11	16	11	10	9	9	18	9	9	18	2	4	6	129	Suboptimal
Conneaut Creek	COC 41	7	6	10	9	18	15	8	9	9	18	10	10	20	10	3	13	124	Suboptimal
Conneaut Creek	COC 42	16	18	16	18	19	15	15	7	7	14	8	8	16	9	3	12	159	Suboptimal
Ashtabula Creek	AC 5	10	10	6	12	15	13	10	7	7	14	9	9	18	9	9	18	126	Suboptimal
Turkey Creek	TC 3	6	6	6	10	11	15	6	2	9	11	3	8	11	2	2	4	76	Marginal
Turkey Creek	TC 4	6	11	8	15	15	12	11	8	5	13	2	2	4	1	1	2	97	Marginal
Duck Run	DR 3	1	6	5	5	13	5	5	8	8	16	8	8	16	2	2	4	76	Marginal
Duck Run	DR 4	5	1	0	16	1	8	5	9	9	18	9	9	18	2	9	11	83	Marginal
Godfrey Run	GFR 2	12	9	5	12	16	15	6	10	10	20	10	10	20	9	8	17	132	Suboptimal
Godfrey Run	GFR 4	5	13	8	17	15	14	7	9	9	18	2	2	4	1	1	2	103	Marginal
Godfrey Run	GFR 5	9	14	5	13	11	15	6	9	9	18	9	9	18	2	2	4	113	Suboptimal

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Table 37. Pennsylvania Lake Erie Watershed Fish Community (Rafferty et al., 2012)

Species		*Total Individuals*	*Sites Found*	*Percent of Total Catch*
Family *Petromyzontidae* (Lampreys)				**0.3973**
American Brook Lamprey	*Lampetra appendix*	94	8	0.3890
Sea Lamprey	*Petromyzon marinus*	2	1	0.0083
Family *Lepisosteidae* (Gars)				**0.0207**
Longnose Gar	*Lepisosteus osseus*	5	4	0.0207
Family *Esocidae* (Pikes)				**0.1366**
Grass Pickerel	*Esox americanus vermiculatus*	33	5	0.1366
Family *Umbridae* (Mudminnows)				**0.0455**
Central Mudminnow	*Umbra limi*	11	6	0.0455
Family *Cyprinidae* (Minnows)				**78.0233**
Bigeye Chub	*Hybopsis amblops*	306	11	1.2665
Blacknose Dace	*Rhinichthys obtusus*	5857	100	24.2405
Bluntnose Minnow	*Pimephales notatus*	910	35	3.7662
Central Stoneroller	*Campostoma anomalum*	5244	64	21.7035
Common Carp	*Cyprinus carpio*	8	4	0.0331
Common Shiner	*Luxilus cornutus*	371	27	1.5355
Creek Chub	*Semotilus atromaculatus*	4001	103	16.5591
Emerald Shiner	*Notropis atherinoides*	1	1	0.0041
Fathead Minnow	*Pimephales promelas*	13	9	0.0538
Golden Shiner	*Notemigonus crysoleucas*	35	13	0.1449
Hornyhead Chub	*Nocomis biguttatus*	1	1	0.0041
Longnose Dace	*Rhinichthys cataractae*	1473	39	6.0963
Mimic Shiner	*Notropis volucellus*	33	7	0.1366
Redfin Shiner	*Lythrurus umbratilis*	1	1	0.0041
Redside Dace	*Clinostomus elongatus*	151	14	0.6249
River Chub	*Nocomis micropogon*	88	11	0.3642
Rosyface Shiner	*Notropis rubellus*	83	6	0.3435
Sand Shiner	*Notropis stramineus*	6	3	0.0248
Silverjaw Minnow	*Notropis buccatus*	142	20	0.5877
Southern Redbelly Dace	*Phoxinus erythrogaster*	24	1	0.0993
Spotfin Shiner	*Cyprinella spiloptera*	5	3	0.0207
Spottail Shiner	*Notropis hudsonius*	4	3	0.0166
Striped Shiner	*Luxilus chrysocephalus*	95	22	0.3932
Family *Catostomidae* (Suckers)				**6.0301**
Golden Redhorse	*Moxostoma erythrurum*	48	9	0.1987
Northern Hogsucker	*Hypentelium nigricans*	405	37	1.6762
White Sucker	*Catostomus commersoni*	1004	58	4.1553
Family Ictaluridae (Catfishes)				**0.2607**
Brown Bullhead	*Ameiurus nebulosus*	28	11	0.1159
Stonecat	*Noturus flavus*	27	12	0.1117
Yellow Bullhead	*Ameiurus natalis*	8	7	0.0331
Family *Salmonidae* (Trout and Salmon)				**1.2954**
Brown Trout	*Salmo trutta*	28	9	0.1159
Golden Rainbow Trout	*Oncorhynchus mykiss*	1	1	0.0041
Rainbow Trout	*Oncorhynchus mykiss*	284	30	1.1754

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Table 37 (continued). Pennsylvania Lake Erie Watershed Fish Community(Rafferty et al., 2012)

Species		*Total Individuals*	*Sites Found*	*Percent of Total Catch*
Family *Gasterosteidae* (Sticklebacks)				**0.0041**
Brook Stickleback	*Culaea inconstans*	1	1	0.0041
Family *Cottidae* (Sculpins)				**1.4527**
Mottled Sculpin	*Cottus bairdi*	351	40	1.4527
Family *Centrarchidae* (Sunfishes)				**3.2696**
Black Crappie	*Promoxis nigromaculatus*	1	1	0.0041
Bluegill	*Lepomis macrochirus*	292	47	1.2085
Green Sunfish	*Lepomis cyanellus*	12	6	0.0497
Largemouth Bass	*Micropterus salmoides*	66	17	0.2732
Pumpkinseed	*Lepomis gibbosus*	125	33	0.5173
Rock Bass	*Ambloplites rupestris*	132	19	0.5463
Smallmouth Bass	*Micropterus dolomieu*	162	20	0.6705
Family *Percidae* (Perches)				**8.8114**
Blackside Darter	*Percina maculata*	32	9	0.1324
Fantail Darter	*Etheostoma flabellare*	193	32	0.7988
Greenside Darter	*Etheostoma blennioides*	185	8	0.7657
Johnny Darter	*Etheostoma nigrum*	368	38	1.5231
Logperch	*Percina caprodes*	391	10	1.6182
Rainbow Darter	*Etheostoma caeruleum*	958	51	3.9649
Yellow Perch	*Perca flavescens*	2	2	0.0083
Family *Gobiidae* (Gobies)				**0.2525**
Round Goby	*Neogobius melanostomus*	61	8	0.2525

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Table 38. Pennsylvania Lake Erie Watershed Fish Community Assessment (Rafferty et al., 2012)

Stream	Site	Richness	Individuals	IBI	Class[1]
Conneaut Creek	COC 9	14	153	42	F
Conneaut Creek	COC 10	15	216	40	F
Conneaut Creek	COC 12	11	274	40	F
Conneaut Creek	COC 18	25	702	54	E-G
Conneaut Creek	COC 25	18	263	48	G
Conneaut Creek	COC 26	19	507	44	F
Conneaut Creek	COC 28	0	0	No Fish	No Fish
Conneaut Creek	COC 34	16	163	50	G
Conneaut Creek	COC 35	16	111	42	F
Conneaut Creek	COC 37	6	143	36	F-P
Conneaut Creek	COC 39	20	363	52	G
Conneaut Creek	COC 43	6	123	36	F-P
Conneaut Creek	COC 44	12	164	36	F-P
Conneaut Creek	COC 45	21	314	52	G
Conneaut Creek	COC 52	19	319	44	F
Conneaut Creek	COC 53	21	533	54	E-G
Conneaut Creek	COC 57	5	244	36	F-P
Conneaut Creek	COC 58	20	171	54	E-G
Turkey Creek	TC1	10	69	38	F-P
Raccoon Creek	RC 1	17	189	44	F
Raccoon Creek	RC 2	21	288	52	G
Raccoon Creek	RC 6	14	154	40	F
Crooked Creek	CRC 1	26	169	52	G
Crooked Creek	CRC 2	16	67	44	F
Crooked Creek	CRC 3	18	140	44	F
Crooked Creek	CRC 4	15	73	40	F
Crooked Creek	CRC 9	13	242	40	F
Crooked Creek	CRC 19	13	128	42	F
Duck Run	DR 1	6	139	28	P
Elk Creek	EC 1	16	213	48	G
Elk Creek	EC-GC 1	7	58	38	F-P
Elk Creek	EC-GC 2	5	79	34	P
Elk Creek	EC 2	7	158	34	P
Elk Creek	EC 3	14	534	42	F
Elk Creek	EC 5	17	198	42	F
Elk Creek	EC 6	9	29	42	F
Elk Creek	EC 7	8	44	38	F-P
Elk Creek	EC 8	5	33	34	P
Elk Creek	EC 10	12	83	44	F
Elk Creek	EC 15	11	155	38	F-P

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Table 38 (cntd). Pennsylvania Lake Erie Watershed Fish Community Assessment (Rafferty et al., 2012)

Stream	Site	Richness	Individuals	IBI	Class[1]
Elk Creek	EC 21	8	601	38	F-P
Elk Creek	EC 22	15	186	46	G-F
Elk Creek	EC 23	16	1927	46	G-F
Elk Creek	EC 25	5	88	38	F-P
Elk Creek	EC 26	2	97	26	P-VP
Elk Creek	EC 28	3	55	26	P-VP
Elk Creek	EC 30	17	240	50	G
Elk Creek	EC 43	4	342	30	P
Elk Creek	EC 51	19	429	50	G
Elk Creek	EC 52	9	147	40	F
Tributary 62490	T490 1	4	8	32	P
Godfrey Run	GFR 6	2	10	26	P-VP
Godfrey Run	GFR 8	3	369	28	P
Tributary 62483	T83 1	1	4	26	P-VP
Trout Run	TR 1	2	48	30	P
Trout Run	TR 3	5	111	36	F-P
Trout Run	TR 5	10	376	38	F-P
Tributary 62476	T76 1	1	70	24	P-VP
Walnut Creek	WC 1	20	282	46	G-F
Walnut Creek	WC 2	8	409	40	F
Walnut Creek	WC 3	14	422	42	F
Walnut Creek	WC 4	15	183	44	F
Walnut Creek	WC 12	11	219	40	F
Walnut Creek	WC 16	11	216	36	F-P
Walnut Creek	WC 19	12	259	42	F
Tributary 62436	T36 1	2	2	36	F-P
Tributary 62436	T36 2	3	60	24	P-VP
Wilkins Run	WR 1	5	12	36	F-P
Marshall Run	MR 1	11	90	44	F
Marshall Run	MR 3	1	23	26	P-VP
McDannel Run	MDR 1	1	42	22	VP
Fourmile Creek	4M 1	12	37	40	F
Fourmile Creek	4M 5	4	65	30	P
Fourmile Creek	4M 6	4	207	32	P
Fourmile Creek	4M 9	4	63	32	P
Fourmile Creek	4M 12	3	49	26	P-VP
Fourmile Creek	4M 13	3	87	26	P-VP
Fivemile Creek	5M 0	3	156	30	P
Fivemile Creek	5M 1	3	64	26	P-VP
Fivemile Creek	5M 3	0	0	No Fish	No Fish
Sixmile Creek	6M 0	18	907	46	G-F

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Table 38 (cntd). Pennsylvania Lake Erie Watershed Fish Community Assessment (Rafferty et al., 2012)

Stream	*Site*	*Richness*	*Individuals*	*IBI*	*Class*[1]
Sixmile Creek	6M 1	9	268	38	F-P
Sixmile Creek	6M 4	11	933	40	F
Sixmile Creek	6M 7	11	484	40	F
Sixmile Creek	6M 18	8	179	40	F
Sevenmile Creek	7M 1	7	54	38	F-P
Sevenmile Creek	7M 2	3	19	24	P-VP
Sevenmile Creek	7M 3	9	288	38	F-P
Sevenmile Creek	7M 6	5	100	34	P
Sevenmile Creek	7M 11	2	57	22	VP
Sevenmile Creek	7M 12	2	44	22	VP
Eightmile Creek	8M 1	7	85	30	P
Eightmile Creek	8M 2	7	195	36	F-P
Eightmile Creek	8M 3	8	689	38	F-P
Eightmile Creek	8M 4	3	441	32	P
Eightmile Creek	8M 10	2	11	22	VP
Eightmile Creek	8M 11	0	0	No Fish	No Fish
Twelvemile Creek	12M 1	20	431	46	G-F
Twelvemile Creek	12M 2	5	115	32	P
Twelvemile Creek	12M 3	2	174	24	P-VP
Twelvemile Creek	12M 4	3	59	24	P-VP
Twelvemile Creek	12M 5	3	114	26	P-VP
Twelvemile Creek	12M 8	4	142	26	P-VP
Twelvemile Creek	12M 12	2	25	26	P-VP
Sixteenmile Creek	16M 1	16	353	46	G-F
Sixteenmile Creek	16M 2	12	341	42	F
Sixteenmile Creek	16M 5	3	313	26	P-VP
Sixteenmile Creek	16M 7	1	4	26	P-VP
Sixteenmile Creek	16M 9	3	133	34	P
Sixteenmile Creek	16M 10	3	109	30	P
Sixteenmile Creek	16M 12	3	106	30	P
Sixteenmile Creek	16M 13	1	2	26	P-VP
Orchard Beach Run	OBR 5	2	209	24	P-VP
Woodmere Beach Run	WBR 1	3	93	28	P
Woodmere Beach Run	WBR 3	2	228	24	P-VP
Peck Run	PR 1	2	59	26	P-VP
Peck Run	PR 3	2	44	22	VP
Peck Run	PR 5	4	119	28	P
Twentymile Creek	20M 1	10	175	46	G-F

[1] Excellend-Good (E-G); Good (G); Good-Fair (G-F); Fair (F); Fair-Poor (F-P); Poor (P); Poor-Very Poor (P-VP); Very-Poor (VP)

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Table 39. Trout Run and Godfrey Run Water Quality Analysis (2010)

	Concentration (mg/L)[1]												
Site	*Total Phosphorus*	*Dissolved Orthophosphate*	*Total Orthophosphate*	*Dissolved Phosphorus*	*Nitrite*	*Total Suspended Solids*	*Ammonia*	*Carbonaceous Biochemical Oxygen Demand*	*Biochemical Oxygend Demand*	*Alkalinity*	*Total Nitrogen*	*Total Dissolved Solids*	*Nitrate*
Sampled April 29, 2010													
TR 1	0.013	< 0.01	< 0.01	< 0.01	< 0.01	12	< 0.02	1.5	4.8	128	0.42	340	< 0.04
TR 2	0.015	< 0.01	<0.01	< 0.01	< 0.01	< 5	< 0.02	1.2	< 0.02	134.4	0.34	312	< 0.04
TR 3	0.054	< 0.01	< 0.01	< 0.01	< 0.01	84	< 0.02	< 0.02	7.7	132.8	0.96	352	0.15
TR 4	0.014	< 0.01	< 0.01	< 0.01	< 0.01	< 5	< 0.02	1.8	< 0.02	146	1.42	352	1.14
TR 5	0.017	< 0.01	< 0.01	< 0.01	< 0.01	< 5	< 0.02	0.9	1.4	146.6	1.72	352	1.42
TR 6	0.022	< 0.01	0.01	<0.01	< 0.01	8	0.03	0.83	1.9	144	1.6	346	1.39
GR 1	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	< 5	0.02	0.26	0.8	178.2	3.13	312	2.9
GR 2	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	< 5	< 0.02	0.8	0.7	180.8	3.68	320	3.53
GR 3	0.01	< 0.01	< 0.01	<0.01	< 0.01	12	0.02	< 0.2	< 0.2	163	2.39	320	2.24
GR 4	0.132	< 0.01	0.012	0.012	0.01	24	0.04	2	1.3	161.8	1.41	356	1.06
GR 5	< 0.01	< 0.01	< 0.01	<0.01	< 0.01	28	< 0.02	< 0.2	0.9	109.4	5.95	296	5.59
GR 6	0.019	< 0.01	< 0.01	<0.01	< 0.01	16	< 0.02	0.38	1.3	151	2.27	294	2.13
Sampled August 25, 2010													
TR 1	0.013	< 0.01	< 0.01	< 0.01	< 0.01	8	< 0.02	2.2	ND	173.6	3.51	356	0.09
TR 2	0.019	< 0.01	0.013	< 0.01	< 0.01	18	0.02	2.7	ND	174.8	0.29	348	0.06
TR 3	0.025	0.012	0.015	0.016	< 0.01	14	0.04	1.6	ND	172	0.43	380	0.25
TR 4	0.018	< 0.01	0.013	0.011	< 0.01	6	< 0.02	1.7	ND	186	2.09	464	1.92
TR 5	0.03	0.015	0.019	0.018	0.02	< 5	0.04	2.6	ND	172.4	2.05	388	1.86
TR 6	0.036	0.036	0.04	0.041	0.01	6	< 0.02	1.8	ND	166.8	2.28	386	2.17
GR 1	0.011	< 0.01	< 0.01	< 0.01	< 0.01	< 5	< 0.02	1.5	0.9	178.6	3.84	316	1.75
GR 2	0.01	< 0.01	< 0.01	0.012	< 0.01	< 5	0.08	1.7	1.3	194.2	2.93	328	2.75
GR 3	0.021	< 0.01	< 0.01	< 0.01	0.01	6	0.02	2.2	0.8	177.4	2.11	318	1.89
GR 4	0.024	0.017	0.021	0.019	0.02	6	0.05	2.9	0.8	177.4	1.03	414	0.83
GR 5	0.021	0.014	0.018	0.016	0.02	< 5	0.04	1.9	ND	168.4	1.79	350	1.66
GR 6	0.02	< 0.01	0.016	< 0.01	0.01	28	< 0.02	2.1	ND	165.8	1.98	328	1.93

[1] *ND = no data*

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Table 40. Walnut Creek Fish Community Assessment (O'Kelly, 1972)

	Site (Number of Individuals)				
Species	*WC (Stat 1) 6/19/1972*	*WC (Stat 2) 8/15/1972*	*WC (Stat 3) 7/12/1972*	*WC (Stat 4) 6/19/1972*	*WC (Stat 5) 7/12/1972*
W. Blacknose Dace	10	22	32	40	70
Bluntnose Minnow	0	0	0	16	0
Central Stoneroller	40	102	20	43	30
Common Shiner	8	23	11	29	45
Creek Chub	0	16	10	110	16
Emerald Shiner	1	0	0	0	0
Fathead Minnow	0	0	0	42	0
Longnose Dace	50	57	48	73	36
Redside Dace	0	0	0	9	9
River Chub	1	1	5	0	0
Rosyface Shiner	20	0	0	0	5
Northern Hogsucker	0	11	2	0	1
White Sucker	1	17	0	11	3
Brindled Madtom	12	0	0	0	0
Stonecat	0	0	2	0	0
Rainbow Trout	1	5	1	0	0
Rock Bass	3	0	0	0	0
Smallmouth Bass	0	6	0	0	0
Fantail Darter	1	4	2	3	6
Johnny Darter	2	0	0	0	1
Logperch	874	0	0	0	0
Rainbow Darter	10	15	27	7	10
Species Richness	***15***	***12***	***11***	***11***	***12***
Total Individuals	***1034***	***279***	***160***	***383***	***232***

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Table 41. Walnut Creek Fish Community Assessment (DEP, 2007)

Species	*Site (abundance)* [1]																					
	WC 1	*WC 2*	*WC 7*	*WC 8*	*WC 9*	*WC 11*	*WC 12*	*WC 13*	*WC 14*	*WC 15*	*WC 16*	*WC 17*	*WC 18*	*WC 19*	*WC 20*	*WC 21*	*WC 22*	*WC 23*	*WC 24*	*TM 25*	*EC 26*	*GR 27*
Rainbow Trout (stock)				R		R		C	C					P	P		P	P	P	C	R+	P
Rainbow Trout (wild)									C	R	R			C			A	C	C	A	P	C
Brown Trout (lake run)																		R	P	R		
Brown Trout (wild)																	P					
Creek Chub	VA	C	C	A		C	A	A	P	P	P	C	A	C		A	P	P	C	C	C	C
River Chub							R									R		C	P	C	P	
W. Blacknose Dace	VA	C	A	A		VA	A	A	C	C	C	A	C	C		A	C	C	C	P	C	VA
Longnose Dace			P	A		C		P	P				P	C		C	P	C	P	C	C	R
Redside Dace		C	C			C	C															C
Central Stoneroller		P	A	VA		VA	P	A	C	C	C		A	C		VA	P	VA	VA	C	VA	P
Northern Hogsucker		P	P			C		P					P	P		A		C	P	P	P	C
White Sucker		P	C	P		A	P	P	P				P	P		P		P	C	P	P	
Common Shiner		C	P			A		A	P				P	P		A		C	P	P	C	
Rainbow Darter	R	C	P					C	A	P	P		P	C		P	P	A	A	A	VA	
Banded Darter						P												P				
Fantail Darter		P	C	P				R	R	R	R		R	R		P		P	P	C	P	
Johnny Darter		P	R			R																
Mottled Sculpin		P	P					C	P	P	P	C	P	R			C	R	R	R		
Stonecat																		C	P	P	P	
Smallmouth Bass																			R	P	C	
Largemout Bass												R	P						R			
Yellow Perch																					R	P
Logperch																			P			
Pumpkinseed									R	R	R			R					P		P	P
Bluegill							R	R	P	P	P							R	P	R+	P	P
Rount Goby				R															C	P		
Species Richness	***3***	***11***	***12***	***7***	***0***	***11***	***7***	***11***	***12***	***9***	***9***	***4***	***11***	***12***	***1***	***10***	***8***	***16***	***20***	***17***	***16***	***11***

[1] *Very Abundant (>100 individuals); Abundant (26-99 individuals); Common (10-25 individuals); Present (3-9 individuals); and Rare (<3 individuals)*

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Table 42. Criteria for Characterizing the Biological Condition of Walnut Creek (DEP, 2007)

% Comparison to Reference Scores[1]	*Biological Condition Category*	*Attributes*
> 83%	Non-Impaired	Comparable to the best situation to be expected within an ecoregion. Balanced trophic structure. Optimum community structure (composition and dominance) for stream size and habitat quality.
54-79%	Slightly Impaired	Community structure less than expected. Composition (species richness) lower than expected due to loss of some intolerant forms. Percent contribution of tolerant forms increases.
21-50%	Moderately Impaired	Fewer species due to loss of most intolerant forms. Reduction in EPT index
<17%	Severely Impaired	Few species present. If high densities of organisms, then dominated by one or two taxa.

[1] Percentage values obtained that are intermediate to the above ranges require subjective judgement as the correct placement.

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Table 43. Walnut Creek Macroinvertebrate-Based Biological Condition Assessment (DEP, 2007)

		Metric							
Site	*Reference Site*	*Biological Condition Score*	*Percent Comparability to Reference Site*	*Biological Condition Category*	*Taxa Richness*	*Total Individuals*	*Hilsenhoff Biotic Index*	*Shannon Diversity Index*	*Number of EPT Taxa*
WC 1	GR 27	20	67	Slightly Impaired	48	2154	3.19	1.88	20
WC 2	GR 27	14	47	Moderately Impaired	38	1519	4.66	2.28	15
WC 7	EC 26	20	67	Slightly Impaired	24	732	5.74	1.37	8
WC 8	EC 26	24	80	Non Impaired	26	1093	5.32	0.95	10
WC 9	GR 27	2	7	Severely Impaired	8	147	6.17	0.96	1
WC 11	EC 26	16	53	Slightly Impaired	22	759	5.82	1.24	6
WC 12	GR 27	2	7	Severely Impaired	12	229	6.68	1.06	0
WC 13	EC 26	16	53	Slightly Impaired	23	816	5.99	1.47	5
WC 14	GR 27	12	40	Moderately Impaired	30	561	4.77	1.56	15
WC 16	EC 26	16	53	Slightly Impaired	22	654	6.02	0.89	5
WC 17	GR 27	12	40	Moderately Impaired	33	2628	4.95	1.63	10
WC 18	GR 27	10	33	Moderately Impaired	30	1278	5.76	0.93	8
WC 19	GR 27	8	27	Moderately Impaired	26	829	4.73	1.65	6
WC 20	GR 27	0	0	Severely Impaired	4	2251	7.49	0.81	0
WC 21	EC 26	12	40	Moderately Impaired	13	214	5.77	0.79	3
WC 22	GR 27	18	60	Slightly Impaired	31	2050	2.18	1.63	12
WC 23	EC 26	14	47	Moderately Impaired	16	506	5.85	0.83	6
WC 24	EC 26	10	33	Moderately Impaired	10	84	5.55	0.90	3
EC 26		30	0	Reference	25	802	5.37	2.11	11
GR 27		30	0	Reference	36	4122	1.74	1.57	20

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Table 44. Walnut Creek Stream Habitat Assessment (DEP, 2007)

	Habitat Parameter Scores													
Site	*Cover*	*Epi*	*Emb*	*Vel*	*Dep*	*Ch Fl*	*Ch Alt*	*Riffle*	*T-Stab*	*T-Veg*	*V-Graze*	*T-Rip*	*T-Hab*	*Rating*
WC 1	15	15	12	14	12	12	15	16	10	13	13	12	159	Suboptimal
WC 2	16	15	15	14	13	16	16	13	11	16	16	12	173	Suboptimal
WC 7	10	8	10	11	9	15	15	9	13	14	17	14	145	Suboptimal
WC 8	12	9	12	15	12	12	17	16	15	8	12	12	157	Suboptimal
WC 9	9	9	11	13	11	11	7	12	6	11	12	6	118	Marginal
WC 11	15	15	13	17	11	12	13	16	8	8	11	7	146	Suboptimal
WC 12	6	7	4	11	5	13	7	16	2	2	2	1	66	Poor
WC 13	13	12	11	15	12	13	15	15	7	14	15	12	154	Suboptimal
WC 14	14	16	16	16	14	11	20	16	13	19	19	19	193	Optimal
WC 16	13	12	12	13	13	12	16	16	11	17	18	16	154	Suboptimal
WC 17	12	12	12	15	10	16	15	15	11	10	9	10	147	Suboptimal
WC 18	14	13	12	15	13	16	20	16	11	16	16	16	176	Suboptimal
WC 19	12	9	11	15	11	11	20	12	6	18	18	15	158	Suboptimal
WC 20	14	12	10	15	11	15	11	15	12	15	13	10	153	Suboptimal
WC 21	13	9	11	18	11	18	19	15	5	12	15	15	161	Suboptimal
WC 22	14	13	12	18	12	14	19	15	8	16	16	16	178	Suboptimal
WC 23	13	11	11	15	12	11	16	12	8	13	13	12	147	Suboptimal
WC 24	12	10	10	14	12	15	7	15	6	7	14	3	125	Marginal

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Table 45. Low Flow-Cold Water Analysis (DEP, 2007)

Parameter	WC 1	WC 2	WC 3	WC 4	WC 5	WC 6	WC 7	WC 8	WC 9	WC 10	WC 11	WC 12	WC 13	WC 14	WC 15	WC 16	WC 17	WC 18	WC 19	WC 20	WC 21	WC 22	WC 23	WC 24	TM 25	EC 26	GR 27
Field Parameters																											
pH	7.08	7.93	8.38	7.24	7.3	7.45	7.47	7.82	7.93	7.64	8.78	7.52	7.81	8.09	8.07	8.37	7.9	8	8.12	7.77	7.6	8.15	8.12	8.97	7.68	8.26	7.28
Temp (Celsius)	7.62	11.5	17.1	14.1	14.4	12	8.79	11	10.6	10.1	13.9	11.4	9.24	11.8	14.8	10.5	9.04	10.3	7.98	11.2	9.65	9.77	9.41	13.4	9.9	9.01	7
Alkalinity (mg/L)	40	68	150	140	75	130	100	120	125	80	82	114	120	92	156	106	98	96	112	222	90	130	120	110	60	90	35
Conductivity (umhos/cm)	82	162	303	741	321	326	275	322	1264	2709	532	633	411	646	615	602	578	687	557	896	344	259	620	420	237	194	123
Dissolved Oxygen (mg/L)	12.6	13.8	9.18	9.18	11.9	10.1	11.4	11.1	11.1	10.7	12.6	10.8	11.6	12.2	11.3	13.7	13.7	12.2	13.3	11.6	11.9	12	13	11.1	12	13.7	12.3
Dissolved Oxygen (%)	106	127	89.3	89.3	117	94	97.9	100	100	95.6	122	97.3	101	113	112	123	119	109	113	106	105	106	114	106	106	114	101
Laboratory Parameters																											
Fecal Coliforms (cfu/100 mL)	< 20	20	20	20	140	20	100	20	10	20	20	60	140	610	40	80	230	40	80	< 20	60	40	20	60	< 20	20	< 20
pH	8	8.1	8.4	7.9	7.6	7.9	8	8.4	8.3	8	8.3	8.2	8	8.3	8.3	8.5	8.5	8.5	8.5	8.1	8.4	8.4	8.4	8.4	8.3	8.2	7.5
Alkalinity (mg/L)	45	92	100	118	63	107	106	92	189	271	103	196	120	106	187	117	109	121	126	222	125	177	135	132	77	88	34
Sulfate (mg/L)	13	12	102	69	17	21	22	23	90	23	29	46	33	26	52	33	24	25	28	49	37	45	41	42	25	21	21
Residue, Total (mg/L)	98	178	334	660	262	310	300	290	176	2544	390	574	480	428	530	402	338	416	320	652	420	312	402	392	186	188	126
Settable Solids (mg/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
T. Suspended Solids (mg/L)	< 2	< 2	2	28	4	58	12	< 2	10	9	6	< 2	2	18	2	4	< 2	4	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2	2
Nitrite-N (mg/L)	0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Nitrate-N (mg/L)	0.19	0.12	< 0.04	0.11	0.06	0.07	0.06	< 0.04	0.5	0.87	0.08	0.22	0.16	0.19	0.28	0.17	0.23	0.12	0.14	2.32	0.22	0.38	0.27	0.31	0.2	0.31	0.38
Total Nitrogen (mg/L)	0.43	0.31	0.31	0.71	0.33	0.35	0.24	0.14	0.64	1.03	0.3	0.37	0.32	0.35	0.42	0.28	0.36	0.26	0.42	2.37	0.34	0.41	0.35	0.44	0.28	0.46	0.45
TOC (mg/L)	2.9	3.1	4.39	7.25	5.19	3.5	3.42	3.03	2.35	1.54	3.05	3.64	3.06	2.59	3.38	2.87	3.12	3.46	2.79	1.26	2.74	2.04	2.69	2.7	2.06	3.09	2.95
Ammonia (mg/L)	< 0.02	< 0.02	< 0.02	0.06	0.05	0.05	0.03	< 0.02	< 0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02
SPC @ 25 C (umhos/cm)	147	302	456	1052	408	431	453	478	2370	3630	614	902	745	644	787	675	541	613	543	906	631	509	616	619	267	300	201
TDS @ 105 C (mg/L)	98	178	332	632	258	252	288	290	1746	2536	384	574	478	410	528	398	338	412	320	652	420	312	402	392	186	186	124
Total Hardness (mg/L)	58	112	203	254	95	142	143	129	535	528	158	289	191	153	271	182	142	178	162	329	193	242	200	200	105	116	55
Total Phosphorus (mg/L)	0.05	0.02	0.02	0.04	0.03	0.03	0.02	0.01	< 0.01	< 0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.01
Chloride (mg/L)	8	32.6	21.2	234	79.6	58.9	68	82.6	656	978	124	156	156	135	123	136	89.8	119	83.2	140	112	33.6	94.8	94.4	20.1	27.7	26.1
COD (mg/L)	23.8	24.1	25.9	25.4	20.2	19.1	28.4	16.6	32.9	37	26.5	21.9	32.9	21.9	23	22.4	18.8	24.2	15.4	16.8	19.7	23.9	40	20.9	20.3	19.8	22.7
BOD5 (mg/L)	0.66	0.69	1.4	0.82	0.68	0.84	0.7	0.45	0.46	< 0.2	0.33	0.72	0.71	0.65	0.59	0.66	0.96	0.92	0.65	< 0.2	< 0.2	< 0.2	< 0.2	0.57	< 0.2	0.93	< 0.2
Turbity (NTU)	3.43	1.62	2.72	9.44	2.23	16.7	9.19	1.28	2.03	6.52	< 1	3.2	1.27	2.49	< 1	< 1	< 1	1.01	< 1	1.25	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Iron (ug/L)	172	378	172	791	376	874	907	116	180	1413	72	910	231	223	97	50	173	146	83	109	42	89	42	56	22	40	< 20
Aluminum (ug/L)	< 200	< 200	< 200	358	< 200	278	203	< 200	< 200	380	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Nickel (ug/L)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Calcium (ug/L)	17	33.4	58.1	64.4	28.7	42.9	42.9	39.1	156	156	47.2	86.2	57.2	46.5	81.6	54.5	42.5	52.2	47.5	98.5	57	70.9	58.9	58.6	32.1	35.3	16.3
Copper (ug/L)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Chromium (ug/L)	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Manganese (ug/L)	12	77	73	145	131	180	146	< 10	174	273	< 10	140	45	12	27	10	15	31	15	71	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Cadmium (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Lead (ug/L)	< 1	< 1	< 1	1.1	< 1	< 1	< 1	<1.0	< 1	2.5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mercury (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Zinc (ug/L)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	29	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Magnesium (mg/L)	3.75	6.9	13.9	21.7	5.74	8.33	8.59	7.47	35.1	33.6	9.79	17.9	11.7	8.81	16.3	11.1	8.7	11.6	10.6	20	12.3	15.8	12.7	13	5.9	6.72	4.92
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	< 5	7.2	< 5	5.1	< 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5	NA

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Table 46. High Flow-Cold Water Analysis (DEP, 2007)

Parameter	WC 1	WC 2	WC 3	WC 4	WC 5	WC 6	WC 7	WC 8	WC 9	WC 10	WC 11	WC 12	WC 13	WC 14	WC 15	WC 16	WC 17	WC 18	WC 19	WC 20	WC 21	WC 22	WC 23	WC 24	TM 25	EC 26	GR 27
Site																											
Field Parameters																											
pH																											
Temp (Celsius)																											
Alkalinity (mg/L)																											
Conductivity (umhos/cm)																											
Dissolved Oxygen (mg/L)																											
Dissolved Oxygen (%)																											
Laboratory Parameters																											
Fecal Coliforms (cfu/100 mL)	1700	13000	3200	43000	12000	10000	2100	580	3100	360	2600	8000	4600	3500	11000	5600	7000	4400	2800	3600	2600	1800	1000	1300	180	2100	2900
pH	7.4	7.9	7.9	7.9	7.5	8	7.9	7.6	7.5	7.1	7.8	7.6	7.4	7.6	7.5	7.9	7.7	7.6	8	7.7	8.1	8.2	8.1	8.2	8.2	8	7.5
Alkalinity (mg/L)	64	97	124	119	59	98	125	51	35	10	39	44	54	45	72	109	83	83	108	87	121	147	124	126	82	90	41
Sulfate (mg/L)	15	12	90	73	15	34	22	15	13	6	14	12	18	11	16	31	19	20	24	28	40	41	43	42	21	31	26
Residue, Total (mg/L)	446	254	564	1404	344	1612	456	314	552	136	516	370	702	248	380	1084	364	1096	490	1556	658	360	418	450	156	282	202
Settable Solids (mg/L)	0.4	0.4	< 0.2	1.2	1.2	< 0.8	1.2	0.8	0.8	0.4	1.2	0.8	1.6	0.8	1.6	8	0.8	1.2	1.6	0.4	2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
T. Suspended Solids (mg/L)	254	28	236	360	124	1236	118	128	264	68	290	264	138	72	158	632	62	602	206	974	240	8	30	12	< 2	24	4
Nitrite-N (mg/L)	0.03	< 0.01	0.03	0.03	0.03	0.03	< 0.01	0.01	0.02	< 0.01	0.01	0.03	0.03	< 0.01	0.02	0.02	0.01	0.02	0.01	0.04	0.02	0.01	< 0.1	< 0.1	< 0.1	< 0.01	0.01
Nitrate-N (mg/L)	0.78	0.36	0.58	0.26	0.3	0.42	0.1	0.45	0.44	0.24	0.37	0.61	0.49	0.21	0.49	0.46	0.45	0.68	0.42	0.97	0.42	0.58	0.38	0.5	0.21	0.55	1.02
Total Nitrogen (mg/L)	2.34	0.81	1.34	1.59	1.6	1.68	0.72	1.32	2.1	0.85	1.73	2.98	2.03	0.94	1.91	2.41	1.36	2.67	1.15	2.11	1.17	0.81	0.93	0.81	0.28	0.97	1.48
TOC (mg/L)	6.87	15.7	15	7.25	16.6	16	6.88	9.57	11.6	5.07	11.2	20.6	16.5	10.8	17.4	15.3	14.5	23.5	9.73	9.72	9.97	6.78	6.36	5.7	2.74	6.09	7.41
Ammonia (mg/L)	0.12	0.1	0.05	0.06	0.17	0.28	0.05	0.24	0.37	0.35	0.32	0.61	0.39	0.05	0.14	0.09	0.1	0.26	0.07	0.09	0.04	0.05	0.04	0.05	0.03	0.06	0.05
SPC @ 25 C (umhos/cm)	211	355	487	1167	351	475	518	413	328	79	306	211	387	299	306	635	516	402	406	400	601	445	558	561	266	330	250
TDS @ 105 C (mg/L)	192	226	328	1044	220	376	338	230	288	68	226	106	564	176	222	452	302	494	284	582	418	352	388	438	156	258	198
Total Hardness (mg/L)	82	126	218	320	96	226	168	95	93	23	89	78	120	59	100	213	113	153	152	180	209	203	189	191	110	126	71
Total Phosphorus (mg/L)	0.53	0.08	0.12	0.308	0.19	0.504	0.11	0.13	0.33	0.08	0.27	0.58	0.39	0.12	0.24	0.39	0.13	0.557	0.15	0.528	0.13	0.02	0.04	0.03	< 0.01	0.05	0.05
Chloride (mg/L)	13.6	45.5	25.4	286.3	63.2	75.5	78.4	84.9	71.8	11.5	60	27	74	58.1	39.8	128	99	64	48.4	54.6	92.4	28.5	76.8	78.5	19	27.8	31.5
COD (mg/L)	37.1	33.4	67.5	56.9	55.6	54.9	24.6	41.9	38.1	22.1	51.3	91.6	48.1	27.2	60.7	36.7	49.6	58.2	38.4	16.4	28.8	41.2	35	34.7	10.6	43.1	47.9
BOD5 (mg/L)	10.9	3.3	10.4	10.3	13.8	6.8	3.9	10.6	11.3	5.5	11.4	21.6	17.1	2	11.3	12	7.5	9.5	6.1	5.8	7.5	5	4.2	3.5	2.1	3.5	3.3
Turbity (NTU)	119	34.5	65.7	494.5	76.6	1062	59.9	107	123	47.6	111	101	346	80.5	62.5	194	50.1	887.5	168	230.6	40.6	9.59	20.3	19	1.26	40	23.1
Iron (ug/L)	5029	1797	3660	18600	4330	43000	6315	4642	11200	2444	7120	7270	20100	4289	6648	18200	2408	43700	6144	58600	4760	435	1801	942	48	2002	906
Aluminum (ug/L)	3544	746	1590	7890	2430	21200	3788	2614	5215	1735	3760	2790	8791	3508	3486	8480	1619	26400	3600	25900	2210	< 200	958	440	< 200	1476	878
Nickel (ug/L)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	51	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Calcium (ug/L)	24	37.7	63	76.1	27.8	60.3	48.9	28.2	27.4	6.9	26.6	23.3	33.9	17.6	29.7	62.1	33.6	39.6	44.4	46.3	62.2	59.7	55.8	56.3	34.3	37.2	20.1
Copper (ug/L)	< 10	< 10	< 10	33	< 10	37	< 10	15	21	< 10	15	23	30	< 10	14	22	< 10	45	12	66	< 10	< 10	13	< 10	< 10	< 10	< 10
Chromium (ug/L)	< 4	< 4	< 4	12	< 4	18.3	< 4	6.5	18.4	5.9	14	16.4	20.2	< 4	< 4	15.4	< 4	14.9	5.2	16	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Manganese (ug/L)	255	176	498	667	896	956	752	168	976	142	615	383	685	220	814	833	502	1059	387	671	246	39	91	46	< 10	78	26
Cadmium (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	<0.2	<0.2	<0.2
Lead (ug/L)	4.4	2	2.6	23.5	3.8	27.7	3.2	5.8	14.7	10.4	11	8.8	16.6	3.5	4.7	20	2.3	38.1	93.2	18.1	3.5	< 1	3.4	< 1	< 1	1.3	< 1
Mercury (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Zinc (ug/L)	31	12	33	113	32	129	15	58	178	101	124	160	160	31	39	94	15	142	42	186	29	< 10	< 10	< 10	< 10	< 10	< 10
Magnesium (mg/L)	5.33	7.63	14.8	31.5	6.32	18.3	11.2	6.03	6.04	1.51	5.43	4.79	8.67	3.55	6.3	14.1	7.1	13.1	9.9	15.5	13.1	39	12.1	12.1	5.91	7.94	4.92
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5	< 5	< 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5	NA

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Table 47. Low Flow-Warm Water Analysis (DEP, 2007)

Parameter	Site																										
	WC 1	WC 2	WC 3	WC 4	WC 5	WC 6	WC 7	WC 8	WC 9	WC 10	WC 11	WC 12	WC 13	WC 14	WC 15	WC 16	WC 17	WC 18	WC 19	WC 20	WC 21	WC 22	WC 23	WC 24	TM 25	EC 26	GR 27
Field Parameters																											
pH	7.8	7.8	7.9	7.9	7.4	7.8	8	8.7	8.3	8	8.6	8.1	8.3	7.8	8.3	8.6	8.3	8.3	8.5	8.2	8.6	8.4	8.4	8.3	8.2	8.3	8.1
Temp (Celsius)	14.3	14.3	15.8	14.54	16	16.12	16.6	17.1	15	15.5	18.2	16.9	18.4	16.1	16.4	17.7	17.5	16.38	15.4	15.77	19.4	15.2	16.2	16.4	22.3	19.4	16.8
Alkalinity (mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Conductivity (umhos/cm)	205	359	419	616	571	503	522	523	1725	1457	711	1049	715	692	766	658	505	629	515	815	621	456	551	558	347	330	298
Dissolved Oxygen (mg/L)	9.89	8.3	9.45	8.26	3.59	7.13	10.1	13.2	10.1	9.05	12.7	9.93	13	8.23	10.4	12.7	12.1	10.12	11	10.11	11.2	10.5	12.2	11.5	10.3	9.96	8.84
Dissolved Oxygen (%)	96.6	81.2	95.8	81.3	66.7	72.7	104	138	100	91.2	135	103	138	84	107	134	127	103.5	110	102.3	122	104	125	118	118	108	90.6
Laboratory Parameters																											
Fecal Coliforms (cfu/100 mL)	500	160	320	500	360	1000	160	260	480	120	370	220	240	80	500	140	160	180	280	600	80	100	140	80	< 20	280	260
pH	7.8	7.8	7.9	7.9	7.4	7.8	8	8.7	8.3	8	8.6	8.1	8.3	7.8	8.3	8.6	8.3	8.3	8.5	8.2	8.6	8.4	8.4	8.3	8.2	8.3	8.1
Alkalinity (mg/L)	79	141	115	116	102	152	147	121	222	233	126	238	140	162	251	127	150	157	158	240	125	193	132	131	104	91	57
Sulfate (mg/L)	18	14	105	54	29	33	34	36	83	155	43	55	41	21	56	40	29	31	32	52	44	52	49	48	35	27	38
Residue, Total (mg/L)	176	266	370	580	420	394	404	396	1604	1098	524	782	504	526	616	476	322	466	412	624	446	378	402	434	202	212	214
Settable Solids (mg/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
T. Suspended Solids (mg/L)	< 2	< 2	2	6	< 2	2	< 2	< 2	2	4	2	< 2	4	6	< 2	< 2	< 2	2	< 2	2	< 2	< 2	< 2	< 2	6	8	22
Nitrite-N (mg/L)	< 0.1	< 0.01	< 0.01	< 0.01	0.01	< 0.1	< 0.1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Nitrate-N (mg/L)	0.62	0.12	0.24	0.32	0.27	0.08	0.13	0.05	0.82	0.33	< 0.04	0.13	0.13	0.16	0.12	0.04	0.18	0.09	0.14	1.48	< 0.04	0.32	< 0.04	0.05	0.11	0.48	0.85
Total Nitrogen (mg/L)	0.86	0.29	0.46	0.73	0.69	0.32	0.48	0.29	1.05	0.55	0.22	0.26	0.28	0.31	0.23	0.15	0.31	0.22	0.24	1.63	0.15	0.38	0.15	0.19	0.22	0.75	1.17
TOC (mg/L)	3.94	3.44	3.83	5.68	4.93	4.26	4.65	4.13	4	5.25	4.02	3.04	3.21	3.57	3.43	3.22	2.33	3.54	2.77	1.29	3.13	1.66	2.66	2.72	1.98	3.06	3.36
Ammonia (mg/L)	< 0.2	0.03	0.03	0.04	0.06	0.07	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.02	0.02	0.03
SPC @ 25 C (umhos/cm)	246	425	480	726	671	565	582	577	1986	1667	764	1155	854	773	848	713	549	701	590	918	649	536	616	622	358	368	350
TDS @ 105 C (mg/L)	176	266	368	574	420	392	404	396	1602	1094	522	782	500	520	616	476	320	464	412	622	446	378	402	434	196	204	192
Total Hardness (mg/L)	101	163	225	225	162	208	190	172	527	364	211	359	226	220	338	202	187	220	207	344	194	253	212	205	148	122	96
Total Phosphorus (mg/L)	0.17	0.02	0.02	0.051	0.04	0.037	0.02	0.01	0.02	0.02	< 0.01	0.02	0.01	0.02	0.02	< 0.01	0.02	0.017	0.01	0.012	< 0.01	< 0.01	0.01	0.01	< 0.01	0.01	0.02
Chloride (mg/L)	15.7	44	21.3	140.5	140	72.4	79.9	92.2	493	335	151	213	173	147	110	141	72.1	120.7	79.9	135.4	115	33.3	93	92.6	29.3	41.7	48.5
COD (mg/L)	27.2	20.6	32.7	36.5	36.9	23.6	22.9	27.9	48.1	54.7	21.1	22.7	24.3	23	28.9	35.1	25	15.9	34.9	24.8	21.2	10.1	20.8	23.2	23.6	16.9	34.1
BOD5 (mg/L)	1.6	1.9	< 0.2	2.3	2.4	2.1	1.8	1.7	1.8	1.9	1.9	1.9	1.8	1.6	1.5	2.3	2.1	1.8	1.5	2.1	2	1.9	1.7	1.5	2.2	2.3	1.9
Turbity (NTU)	1.73	3.39	5.9	10.36	6.85	11.23	5.91	< 1	< 1	1.84	< 1	3.83	< 1	1.34	< 1	< 1	< 1	1.26	< 1	1.08	< 1	< 1	< 1	< 1	< 1	< 1	1.34
Iron (ug/L)	140	684	568	2680	1110	1350	681	51	28	230	< 20	636	55	315	193	31	40	163	76	78	37	46	33	36	< 20	30	270
Aluminum (ug/L)	< 200	< 200	225	1320	< 200	376	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200	< 200
Nickel (ug/L)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Calcium (ug/L)	30.4	48.8	67.2	58.7	48.7	61.6	56.2	51.3	157	109	62.7	109	67.8	66.8	102	60.1	55.7	64.6	60.8	104	55.9	73.9	61.2	59.6	46	35.4	29
Copper (ug/L)	12	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	23	< 10	< 10	< 10	< 10
Chromium (ug/L)	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Manganese (ug/L)	27	207	358	291	505	221	91	< 10	< 10	147	< 10	120	22	168	38	< 10	24	46	13	56	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Cadmium (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Lead (ug/L)	< 1	< 1	< 1	3	< 1	1.2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Mercury (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Zinc (ug/L)	< 10	< 10	< 10	16	15	21	< 10	< 10	11	23	< 10	< 10	< 10	< 10	< 10	< 10	25	< 10	< 10	< 10	< 10	< 10	15	< 10	< 10	< 10	< 10
Magnesium (mg/L)	6	10	13.8	18.9	9.7	13.1	12	10.7	32.7	22.1	13.2	21.1	13.8	12.9	20.2	12.5	11.7	14.1	13.3	20.4	13.1	16.5	14.2	13.6	8.1	8.2	5.8
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5	< 5	< 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5

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Table 48. High Flow-Warm Water Analysis (DEP, 2007)

Parameter	WC 1	WC 2	WC 3	WC 4	WC 5	WC 6	WC 7	WC 8	WC 9	WC 10	WC 11	WC 12	WC 13	WC 14	WC 15	WC 16	WC 17	WC 18	WC 19	WC 20	WC 21	WC 22	WC 23	WC 24	TM 25	EC 26	GR 27
Field Parameters																											
pH																											
Temp (Celsius)																											
Alkalinity (mg/L)																											
Conductivity (umhos/cm)																											
Dissolved Oxygen (mg/L)																											
Dissolved Oxygen (%)																											
Laboratory Parameters																											
Fecal Coliforms	45000	18000	15000	30000	9900	37000	45000	30000	5200	500	37000	11000	18000	8100	5600	14000	30000	19000	14000	26000	18000	11000	24000	16000	14000	54000	51000
pH	7.7	7.6	7.8	7.9	7.7	7.9	8	7.9	8.1	8.1	7.9	8	8	7.8	7.9	7.8	7.8	8.1	8.1	7.8	8	8.1	8	7.9	7.9	8	7.8
Alkalinity (mg/L)	47	38	51	77	71	78	81	77	91	191	72	98	72	63	70	65	67	85	81	54	62	83	66	65	55	94	39
Sulfate (mg/L)	15	18	108	37	24	46	43	36	31	131	32	19	27	16	17	21	23	25	25	14	24	24	24	23	25	30	28
Residue, Total (mg/L)	210	144	448	556	276	410	592	420	360	1732	472	250	334	226	166	364	290	440	428	420	406	206	496	612	288	466	148
Settable Solids (mg/L)	< 0.2	0.4	< 0.2	< 0.2	< 0.2	< 0.2	0.8	< 0.2	< 0.2	< 0.2	0.4	< 0.2	2.4	< 0.2	< 0.2	0.2	< 0.2	0.4	0.4	0.4	0.4	0.4	0.8	3.2	0.8	1	< 0.2
T. Suspended Solids (mg/L)	< 2	16	284	52	24	170	350	216	< 2	2	246	22	132	22	2	124	48	114	118	328	204	30	310	418	224	208	4
Nitrite-N (mg/L)	0.01	< 0.01	0.01	0.03	0.01	0.02	0.02	< 0.01	< 0.01	< 0.01	0.02	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	0.03	< 0.01	0.01	0.01	0.01	< 0.01	< 0.01	< 0.01
Nitrate-N (mg/L)	0.61	0.12	0.38	0.28	0.38	0.43	0.48	0.44	0.44	0.6	0.45	0.85	0.42	0.25	0.37	0.41	0.26	0.59	0.51	0.42	0.47	0.64	0.52	0.5	0.5	0.67	1.23
Total Nitrogen (mg/L)	1.51	2.2	0.86	0.76	1.35	1.14	1.4	1.23	0.76	0.93	1.17	1.63	1.03	0.71	0.85	1.07	1.1	1.46	1.33	1.02	1.21	1.39	1.42	1.64	1.39	1.68	1.67
TOC (mg/L)	10.6	19.4	4.13	5.15	12.3	11	13.8	10.2	5.9	7.63	9.66	8.95	7.98	6.57	7.24	5.4	13.5	11.8	12.2	8.18	5.52	10.3	8.88	11.3	9.52	7.77	7.03
Ammonia (mg/L)	0.03	0.04	< 0.02	< 0.02	0.03	0.03	0.04	< 0.02	< 0.02	0.02	0.03	0.04	0.03	< 0.02	0.02	0.03	0.03	0.06	0.03	0.06	0.03	0.02	0.04	0.04	< 0.02	< 0.02	< 0.02
SPC @ 25 C (umhos/cm)	219	196	366	344	482	367	372	361	631	1443	351	351	349	352	251	315	432	579	510	200	317	274	321	294	215	391	242
TDS @ 105 C (mg/L)	210	128	246	504	252	240	242	204	360	1730	226	228	202	204	164	240	242	326	310	92	202	176	186	194	64	258	144
Total Hardness (mg/L)	76	60	176	141	78	140	137	122	122	283	113	106	99	83	82	87	73	103	99	79	95	116	109	108	87	167	67
Total Phosphorus (mg/L)	0.22	0.14	0.13	0.176	0.15	0.176	0.226	0.164	0.05	0.02	0.204	0.13	0.13	0.08	0.06	0.12	0.16	0.179	0.16	0.258	0.17	0.12	0.217	0.28	0.14	0.148	0.06
Chloride (mg/L)	27.3	24.8	10.5	38	91.2	36.5	39	43	127	277	44.5	36.9	46.6	59.5	25.5	47.3	79.2	119.1	92.9	19.5	45.8	18.7	42.9	38.8	15	47.1	28
COD (mg/L)	119	103	55.2	58.4	77.6	68	76.1	109.8	40.5	80.4	47.5	67.3	81.8	103	75.5	17.3	143.1	38.7	87.9	56.3	72.4	152	55.9	157	58.2	71	46.2
BOD5 (mg/L)	1.7	17.3	3.9	3.9	17.6	19.65	4.9	10.8	6.4	3.4	9.65	3.3	4.6	18.8	1.2	1.8	11.1	12.45	27.3	17.1	8.3	11.4	23.4	2.2	18.1	22.2	14.8
Turbity (NTU)	38.1	4.19	163	310	27.8	145.8	233	185.3	5.37	1.15	234.5	17.9	96.8	11.2	5.24	91.6	29.35	62.7	50.2	321.5	120	23.6	188.8	200	96.8	47.85	10.4
Iron (ug/L)	2850	230	10800	12700	1827	7614	13400	11500	419	272	11900	706	3981	1280	402	1758	2190	4520	3024	11500	8650	2180	14100	9702	4108	3604	479
Aluminum (ug/L)	1560	< 200	4570	6900	1218	4165	6660	5807	< 200	< 200	6150	331	2188	548	203	1342	1480	2382	1578	5385	4390	919	6700	6912	2512	1900	323
Nickel (ug/L)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Calcium (ug/L)	22.5	17.7	51.9	41.7	23.6	41.6	39	35.8	38.8	87.8	33.1	33.2	30.3	25.2	25.5	27	22.3	31	30	23.3	27.8	34.6	32	32.1	26	52.9	19.8
Copper (ug/L)	< 10	< 10	13	17	< 10	10	15	11	< 10	< 10	11	< 10	< 10	< 10	< 10	13	< 10	< 10	< 10	15	11	< 10	15	< 10	< 10	< 10	< 10
Chromium (ug/L)	< 4	< 4	5.2	8.1	< 4	< 4	4.9	4.4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Manganese (ug/L)	100	50	162	168	153	259	361	287	33	70	364	47	205	93	32	244	232	298	272	151	314	154	494	501	186	222	13
Cadmium (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Lead (ug/L)	2.4	< 1	4.6	8.9	2.1	3.7	5.9	4.9	< 1	1.7	6.1	< 1	3.6	< 1	< 1	6	1.9	48	4.9	3.1	7.1	1.3	9.5	12.8	2.9	3.3	< 1
Mercury (ug/L)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Zinc (ug/L)	19	29	65	45	17	25	51	36	12	73	46	13	28	11	< 10	27	11	19	20	47	50	15	69	50	21	17	< 10
Magnesium (mg/L)	4.85	3.86	11.3	8.86	4.53	8.652	9.55	7.976	6.09	15.5	7.369	5.66	5.6	4.84	4.4	4.7	4.2	6.2	5.8	5	6.26	7.1	7.1	6.7	5.3	8.5	4.3
Oil and Grease	NA	NA	NA	NA	NA	< 5	NA	< 5	< 5	< 5	< 5	< 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 5	< 5	< 5

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Table 49. Parks and Recreation Space, and Trails within the Pennsylvania Lake Erie Watershed

Park and Recreation Space	*ac*	*mi²*	*km²*
Passive Park	776.230	1.213	3.141
Multi-Use Park	2297.500	3.590	9.298
Athletic Field	99.808	0.156	0.404
Playground	11.674	0.018	0.047
Beach[1]	4.091	0.006	0.017
Pool	3.871	0.006	0.016
Golf Course	2778.235	4.341	11.243
Campground	412.407	0.644	1.669
Camp	1048.437	1.638	4.243
State Property	294.188	0.460	1.191
Total	7726.441	12.073	31.268
Trail	*mi*	*km*	
Hiking	1.307	2.104	
Biking	68.475	110.200	
Multi-Use	32.276	51.943	
Total	***102.058***	***164.247***	

[1] *Does not include Presque Isle State Park*

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Table 50. PFBC Access Points by Major Pennsylvania Lake Erie Sub-watershed

Watershed	*Number of Access Points*
Pennsylvania Lake Erie	64
Twentymile Creek	3
Sixteenmile Creek	1
Twelvemile Creek	1
Eightmile Creek	1
Sevenmile Creek	0
Sixmile Creek	1
Fourmile Creek	2
Trout Run	2
Walnut Creek	5
Elk Creek	22
Crooked Creek	3
Raccoon Creek	4
Turkey Creek	1
Conneaut Creek	2
Ashtabula Creek	0
Other	16

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Table 51. Potential Stream Impairment Factors to Guide Restoration

Factor	*Description*
Land Cover/Land Use	Dominant land cover/use type(s) surrounding the site (based on reclassified 2011 National Land Cover Dataset). Types include: developed, forest, shrub/grassland, agriculture, wetland, and other (i.e. water and barren land).
Eroding Streambank	Streambank stability is an active process and while erosion does occur naturally, human-related activities often accelerate erosion. The presence or absence of erosion was recorded during the site visits.
Riparian Buffer	Riparian buffers serve as a link between stream environments and their terrestrial surroundings. The presence or absence of a protected or impaired riparian buffer was recorded during the site visits.
Impediments	Natural or human created obstacles that can impede the movement of fish, including natural waterfalls, concrete waterfalls, culverts, and sediment deposition at the mouth of the stream. The presence or absence of impediments was recorded during the site visits.
Livestock	The presence of livestock along streams can result in pollutants being discharged to the stream, resulting in negative impacts to the stream ecosystem as well as negatively impacting receiving waters. The presence or absence of livestock was recorded during the site visits.
Invasive Species	The evaluation of invasive species focused primarily on assessing the presence of aquatic invasive plants and terrestrial invasive plants. The presence or absence of invasive species was recorded during the site visits.
Wastewater Treatment	Malfunctioning or improperly functioning sewage disposal systems, regardless of type, can pose a serious threat to public health and the environment. The type of sewage disposal system was identified for each site, including public treatment system, private treatment system, and onlot (septic) treatment system.

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Table 52. Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors						
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Stream-Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
COC 20	Conneaut Creek	High	8.47	0.00	32.41	21.99	37.14	0.00	Stable	Impaired	Absent	Present	Present	Treatment Plant
COC 21	Conneaut Creek	High	8.81	0.00	37.27	22.77	22.76	8.39	Stable	Protected	Absent	Present	Present	No Data
TC 3	Turkey Creek	High	0.00	14.39	45.68	7.92	0.00	32.01	Eroding	Impaired	Absent	Absent	Present	Septic
TC 4	Turkey Creek	High	0.00	60.80	21.69	0.29	17.22	0.00	Eroding	Impaired	Absent	Absent	Absent	Septic
COC 55	Conneaut Creek	High	0.00	46.15	26.58	12.63	14.64	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
COC 56	Conneaut Creek	High	0.00	9.29	44.43	0.79	45.43	0.06	Eroding	Impaired	Absent	Absent	Present	Septic
EC 4	Elk Creek	High	0.00	16.01	72.86	0.00	11.13	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 11	Elk Creek	High	0.00	56.39	31.38	0.00	12.23	0.00	Stable	Protected	Absent	Absent	Absent	Treatment Plant; Septic
EC 20	Elk Creek	High	0.00	14.55	66.00	0.00	19.46	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 27	Elk Creek	High	0.00	12.02	41.01	0.00	46.97	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 31	Elk Creek	High	0.00	41.60	5.95	0.00	48.34	4.11	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
EC 35	Elk Creek	High	0.00	9.29	26.32	0.00	64.39	0.00	Eroding	Impaired	Absent	Absent	Present	No Data
EC 44	Elk Creek	High	0.00	63.70	15.85	0.00	20.45	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
WC 9	Walnut Creek	High	0.00	4.04	1.15	0.00	94.12	0.69	Stable	Impaired	Absent	Absent	Absent	Septic
WC 10	Walnut Creek	High	0.00	49.89	5.77	0.00	44.34	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
WC 15	Walnut Creek	High	0.00	87.28	12.72	0.00	0.00	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
WC 17	Walnut Creek	High	0.00	58.28	31.38	3.04	7.30	0.00	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
7M 10	Sevenmile Creek	High	0.00	24.31	18.79	0.00	56.90	0.00	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
COC 13	Conneaut Creek	Medium	0.00	9.29	49.26	9.20	18.45	13.80	Stable	Protected	Absent	Absent	Present	No Data
COC 14	Conneaut Creek	Medium	0.00	0.00	87.79	0.00	0.00	12.21	Eroding	Protected	Absent	Absent	Absent	No Data
COC 15	Conneaut Creek	Medium	0.00	0.00	50.75	16.45	3.12	29.69	Stable	Protected	Absent	Absent	Present	No Data
COC 16	Conneaut Creek	Medium	0.00	2.17	32.49	27.81	0.00	37.53	Stable	Protected	Absent	Absent	Present	No Data
COC 17	Conneaut Creek	Medium	0.00	1.92	81.12	0.00	16.96	0.00	Stable	Protected	Absent	Absent	Present	No Data
COC 19	Conneaut Creek	Medium	0.00	0.00	54.70	14.49	18.81	12.00	Stable	Protected	Absent	Absent	Present	No Data
COC 22	Conneaut Creek	Medium	0.00	0.00	43.26	0.00	56.74	0.00	Stable	Protected	Absent	Absent	Present	No Data
COC 23	Conneaut Creek	Medium	0.00	0.00	9.85	5.91	84.24	0.00	Stable	Protected	Absent	Absent	Present	No Data
COC 24	Conneaut Creek	Medium	0.00	7.48	14.78	0.49	77.26	0.00	Stable	Impaired	Absent	Absent	Present	No Data
COC 41	Conneaut Creek	Medium	0.00	0.00	37.50	0.00	49.75	12.75	Stable	Protected	Absent	Absent	Present	No Data
COC 42	Conneaut Creek	Medium	0.00	0.12	37.06	0.00	50.20	12.62	Eroding	Protected	Absent	Absent	Present	No Data
AC 5	Ashtabula Creek	Medium	0.00	0.00	77.79	2.98	18.39	0.84	Stable	Protected	Absent	Absent	Present	Septic
COC 2	Conneaut Creek	Medium	0.00	9.29	65.37	8.10	16.06	1.19	Stable	Protected	Absent	Absent	Present	Septic
COC 4	Conneaut Creek	Medium	0.00	0.00	86.96	0.00	6.68	6.36	Stable	Protected	Absent	Absent	Present	Septic
COC 5	Conneaut Creek	Medium	0.00	9.29	65.12	0.00	9.75	15.84	Stable	Protected	Absent	Absent	Present	No Data
COC 6	Conneaut Creek	Medium	0.00	9.29	50.37	2.79	18.70	18.84	Stable	Protected	Absent	Absent	Present	No Data

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 52 (cntd). Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors					
Site	Sub-watershed	Priority	O	D	F	S/G	A	W	Bank	Riparian Buffer	Impediment	Livestock	Invasive Species	Wastewater Treatment
COC 30	Conneaut Creek	Medium	0.00	0.65	61.27	0.00	38.08	0.00	Stable	Protected	Absent	Absent	Present	No Data
COC 32	Conneaut Creek	Medium	0.00	9.81	55.66	0.00	16.47	18.06	Eroding	Protected	Absent	Absent	Present	No Data
COC 33	Conneaut Creek	Medium	0.00	21.23	39.21	0.00	29.82	9.74	Eroding	Protected	Absent	Absent	Present	No Data
COC 36	Conneaut Creek	Medium	0.00	22.80	37.35	0.18	39.67	0.00	Eroding	Protected	Absent	Absent	Present	No Data
COC 38	Conneaut Creek	Medium	0.00	19.74	35.05	8.70	29.13	7.37	Eroding	Protected	Absent	Absent	Present	No Data
COC 40	Conneaut Creek	Medium	0.00	9.29	50.94	0.00	39.76	0.00	Eroding	Protected	Absent	Present	Present	No Data
COC 46	Conneaut Creek	Medium	0.00	0.49	61.98	0.00	35.48	2.05	Eroding	Impaired	Absent	Absent	Present	Septic
COC 47	Conneaut Creek	Medium	0.00	0.00	48.20	0.00	51.80	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
COC 48	Conneaut Creek	Medium	0.00	11.87	52.06	0.00	36.07	0.00	Eroding	Protected	Absent	Absent	Present	Septic
COC 49	Conneaut Creek	Medium	0.00	14.79	68.13	0.00	17.07	0.00	Stable	Impaired	Absent	Absent	Present	Septic
COC 50	Conneaut Creek	Medium	0.00	29.38	9.67	7.80	50.04	3.11	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
COC 51	Conneaut Creek	Medium	0.00	22.90	24.99	0.00	39.11	13.01	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
COC 54	Conneaut Creek	Medium	0.00	11.93	65.28	13.40	9.29	0.10	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
COC 59	Conneaut Creek	Medium	0.00	76.42	10.05	0.00	13.53	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant
TC 2	Turkey Creek	Medium	0.00	6.39	87.26	0.00	0.00	6.35	Stable	Protected	Absent	Absent	Present	Septic
RC 3	Raccoon Creek	Medium	0.00	0.00	93.37	0.00	0.00	6.63	Eroding	Protected	Absent	Absent	Absent	Septic
RC 4	Raccoon Creek	Medium	0.00	19.16	39.29	0.00	41.55	0.00	Eroding	Protected	Absent	Absent	Present	Septic
RC 5	Raccoon Creek	Medium	0.00	0.00	93.41	0.00	6.59	0.00	Eroding	Protected	Absent	Absent	Present	Septic
RC 7	Raccoon Creek	Medium	0.00	27.06	39.51	4.55	18.72	10.17	Eroding	Protected	Absent	Absent	Present	Septic
CRC 5	Crooked Creek	Medium	0.00	7.23	17.75	0.50	67.96	6.55	Stable	Protected	Absent	Absent	Present	Septic
CRC 6	Crooked Creek	Medium	0.00	15.27	52.86	9.29	16.01	6.56	Eroding	Protected	Absent	Absent	Present	Septic
CRC 7	Crooked Creek	Medium	0.00	9.44	54.77	9.29	17.21	9.29	Eroding	Protected	Absent	Absent	Present	Septic
CRC 8	Crooked Creek	Medium	0.00	2.19	42.41	0.00	53.75	1.65	Eroding	Protected	Absent	Absent	Present	Septic
CRC 10	Crooked Creek	Medium	0.00	1.34	53.88	0.00	44.78	0.00	Stable	Protected	Present	Absent	Present	Septic
CRC 11	Crooked Creek	Medium	0.00	24.60	63.57	8.55	3.28	0.00	Eroding	Protected	Absent	Absent	Present	Septic
CRC 12	Crooked Creek	Medium	0.00	4.81	47.51	0.00	40.02	7.65	Eroding	Protected	Absent	Absent	Present	Septic
CRC 13	Crooked Creek	Medium	0.00	5.88	49.65	0.00	38.05	6.41	Eroding	Protected	Absent	Absent	Present	Septic
CRC 14	Crooked Creek	Medium	0.00	6.41	43.38	0.00	41.44	8.77	Eroding	Protected	Absent	Absent	Present	Septic
CRC 16	Crooked Creek	Medium	0.00	43.45	0.00	0.00	56.55	0.00	Eroding	Protected	Absent	Absent	Present	Septic
CRC 17	Crooked Creek	Medium	0.00	4.50	50.05	0.00	45.45	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
CRC 18	Crooked Creek	Medium	0.00	4.41	36.92	0.00	49.10	9.57	Eroding	Protected	Absent	Absent	Present	Septic
EC 9	Elk Creek	Medium	0.00	15.08	52.64	5.41	26.87	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 12	Elk Creek	Medium	0.00	3.59	74.41	0.35	21.65	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 13	Elk Creek	Medium	0.00	8.97	78.44	0.00	12.59	0.00	Eroding	Protected	Absent	Absent	Present	Septic

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 52 (cntd). Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors					
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
EC 14	Elk Creek	Medium	0.00	0.00	98.32	0.00	1.68	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 16	Elk Creek	Medium	0.00	30.09	52.87	0.00	17.04	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 17	Elk Creek	Medium	0.00	27.80	38.56	2.34	31.30	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 18	Elk Creek	Medium	0.00	28.26	43.82	2.88	25.04	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 19	Elk Creek	Medium	0.00	15.65	68.63	0.00	15.54	0.18	Stable	Protected	Absent	Absent	Present	Septic
EC 24	Elk Creek	Medium	0.00	0.00	7.08	0.00	92.92	0.00	Eroding	Impaired	Present	Present	Present	Septic
EC 29	Elk Creek	Medium	0.00	4.26	19.51	0.00	76.10	0.12	Eroding	Impaired	Absent	Present	Present	Septic
EC 32	Elk Creek	Medium	0.00	3.62	13.65	0.00	79.30	3.43	Eroding	Protected	Absent	Absent	Present	Treatment Plant
EC 33	Elk Creek	Medium	0.00	2.50	91.22	0.00	4.05	2.23	Stable	Protected	Absent	Absent	Present	Septic
EC 34	Elk Creek	Medium	0.00	0.00	47.50	17.99	32.69	1.83	Eroding	Protected	Absent	Absent	Present	Septic
EC 36	Elk Creek	Medium	0.00	41.27	30.13	6.87	14.98	6.75	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
EC 37	Elk Creek	Medium	0.00	24.53	4.82	9.29	55.53	5.82	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
EC 38	Elk Creek	Medium	0.00	9.29	51.23	0.00	30.26	9.22	Eroding	Impaired	Absent	Absent	Present	Septic
EC 39	Elk Creek	Medium	0.00	9.29	51.92	0.00	29.49	9.29	Eroding	Protected	Absent	Absent	Present	Septic
EC 40	Elk Creek	Medium	0.00	0.00	61.52	5.95	15.89	16.64	Eroding	Protected	Absent	Absent	Present	Septic
EC 45	Elk Creek	Medium	0.00	0.00	11.49	0.00	88.51	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 46	Elk Creek	Medium	0.00	4.63	3.78	0.00	91.59	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 47	Elk Creek	Medium	0.00	0.07	6.36	0.00	93.56	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 48	Elk Creek	Medium	0.00	5.95	5.93	9.29	78.83	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 49	Elk Creek	Medium	0.00	10.78	27.18	8.18	53.67	0.20	Stable	Protected	Absent	Absent	Present	Septic
EC 50	Elk Creek	Medium	0.00	17.45	32.85	1.64	48.06	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 53	Elk Creek	Medium	0.00	6.42	65.00	0.33	21.89	6.36	Eroding	Impaired	Absent	Absent	Present	Septic
EC 54	Elk Creek	Medium	0.00	2.51	12.05	0.00	79.49	5.95	Eroding	Impaired	Absent	Present	Present	Septic
EC 56	Elk Creek	Medium	0.00	0.00	63.05	4.72	24.29	7.95	Eroding	Protected	Absent	Absent	Absent	Septic
TR 2	Trout Run	Medium	0.00	63.26	28.82	0.00	7.92	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
TR 4	Trout Run	Medium	18.61	16.18	33.51	5.64	26.06	0.00	Eroding	Protected	Absent	Absent	Present	Septic
WC 5	Walnut Creek	Medium	0.00	20.74	59.91	11.85	7.50	0.00	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
WC 6	Walnut Creek	Medium	0.00	4.11	42.85	0.00	53.04	0.00	Eroding	Protected	Absent	Absent	Present	Septic
WC 7	Walnut Creek	Medium	0.00	19.72	30.27	0.00	47.40	2.61	Eroding	Protected	Absent	Absent	Present	Septic
WC 8	Walnut Creek	Medium	0.22	0.00	20.84	9.29	65.50	4.15	Stable	Impaired	Absent	Absent	Present	Septic
WC 13	Walnut Creek	Medium	0.00	37.82	50.42	0.00	0.00	11.76	Stable	Protected	Absent	Absent	Present	Septic
WC 18	Walnut Creek	Medium	0.00	15.67	25.67	22.06	18.02	18.58	Stable	Protected	Absent	Absent	Present	Septic
WC 20	Walnut Creek	Medium	0.00	69.67	23.38	0.00	0.49	6.46	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
WC 21	Walnut Creek	Medium	0.00	15.68	77.09	6.44	0.80	0.00	Stable	Protected	Absent	Absent	Present	Treatment Plant

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 52 (cntd). Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors					
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
4M 2	Fourmile Creek	Medium	0.00	100.00	0.00	0.00	0.00	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant
4M 3	Fourmile Creek	Medium	0.00	100.00	0.00	0.00	0.00	0.00	Eroding	Impaired	Present	Absent	Present	Treatment Plant
4M 7	Fourmile Creek	Medium	0.00	22.61	65.04	9.29	3.06	0.00	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
4M 11	Fourmile Creek	Medium	0.00	13.56	82.10	0.00	4.34	0.00	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
6M 2	Sixmile Creek	Medium	11.55	66.33	0.00	0.00	12.52	9.60	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
6M 3	Sixmile Creek	Medium	14.57	42.86	29.54	0.00	3.31	9.71	Stable	Protected	Present	Absent	Present	Treatment Plant; Septic
6M 8	Sixmile Creek	Medium	0.00	34.02	52.12	0.00	2.22	11.63	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
6M 9	Sixmile Creek	Medium	0.00	8.15	56.70	20.02	15.14	0.00	Eroding	Protected	Present	Absent	Present	Septic
6M 10	Sixmile Creek	Medium	0.00	15.08	34.26	9.35	41.31	0.00	Eroding	Protected	Absent	Absent	Present	Septic
6M 11	Sixmile Creek	Medium	0.00	9.29	60.39	0.00	30.32	0.00	Eroding	Protected	Absent	Absent	Present	Septic
6M 13	Sixmile Creek	Medium	0.00	1.08	79.86	0.00	19.06	0.00	Eroding	Impaired	Absent	Present	Present	Septic
6M 14	Sixmile Creek	Medium	0.00	0.00	68.62	0.00	31.38	0.00	Stable	Protected	Absent	Absent	Present	Septic
6M 15	Sixmile Creek	Medium	0.00	19.28	14.31	0.00	66.40	0.00	Stable	Protected	Absent	Present	Present	Septic
6M 16	Sixmile Creek	Medium	0.00	17.89	34.17	5.09	42.85	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
6M 17	Sixmile Creek	Medium	0.00	17.51	33.95	5.78	42.75	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
7M 4	Sevenmile Creek	Medium	0.00	8.60	18.79	0.00	36.94	35.67	Eroding	Protected	Absent	Absent	Present	Septic
7M 5	Sevenmile Creek	Medium	0.00	15.97	0.00	0.00	71.15	12.88	Stable	Impaired	Absent	Absent	Present	Septic
7M 7	Sevenmile Creek	Medium	0.00	7.59	0.00	0.00	88.75	3.66	Eroding	Impaired	Absent	Absent	Absent	Septic
7M 8	Sevenmile Creek	Medium	0.00	3.10	9.29	0.00	83.31	4.30	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
7M 9	Sevenmile Creek	Medium	0.00	3.53	7.60	0.00	85.74	3.13	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
8M 5	Eightmile Creek	Medium	0.00	0.00	0.00	2.24	97.76	0.00	Stable	Impaired	Absent	Absent	Absent	Septic
8M 6	Eightmile Creek	Medium	0.00	2.03	1.63	5.95	90.40	0.00	Stable	Impaired	Absent	Absent	Absent	Septic
8M 7	Eightmile Creek	Medium	0.00	6.99	11.09	0.00	77.89	4.03	Eroding	Impaired	Absent	Absent	Present	Septic
8M 8	Eightmile Creek	Medium	0.00	6.36	24.57	3.22	65.85	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
8M 9	Eightmile Creek	Medium	0.00	5.31	55.96	13.63	24.47	0.63	Eroding	Impaired	Absent	Absent	Present	Septic
8M 12	Eightmile Creek	Medium	0.00	14.50	74.05	2.16	9.29	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
12M 6	Twelvemile Creek	Medium	0.00	54.18	0.00	16.69	29.13	0.00	Stable	Impaired	Absent	Absent	Absent	Septic
12M 7	Twelvemile Creek	Medium	0.00	1.03	5.53	11.15	82.28	0.01	Stable	Impaired	Absent	Absent	Absent	Septic
12M 9	Twelvemile Creek	Medium	0.00	0.00	0.15	0.00	89.33	10.52	Stable	Protected	Absent	Absent	Present	Septic
12M 11	Twelvemile Creek	Medium	0.00	5.95	8.06	15.24	70.75	0.00	Eroding	Protected	Absent	Absent	Present	Septic
12M 13	Twelvemile Creek	Medium	0.00	8.55	38.85	0.00	43.30	9.29	Stable	Protected	Absent	Absent	Present	Septic
12M 14	Twelvemile Creek	Medium	0.00	13.05	29.14	4.43	53.37	0.00	Stable	Protected	Absent	Absent	Present	Septic
16M 3	Sixteenmile Creek	Medium	0.00	65.53	12.66	0.00	21.81	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
16M 4	Sixteenmile Creek	Medium	0.00	6.26	58.26	0.00	35.47	0.00	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 52 (cntd). Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors					
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
16M 6	Sixteenmile Creek	Medium	0.00	56.07	10.40	0.00	33.44	0.08	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
16M 8	Sixteenmile Creek	Medium	0.00	49.72	5.95	0.00	44.33	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
16M 11	Sixteenmile Creek	Medium	0.00	12.20	27.96	10.24	23.58	26.01	Eroding	Impaired	Absent	Absent	Absent	Septic
16M 14	Sixteenmile Creek	Medium	0.00	5.95	27.53	0.00	45.59	20.93	Eroding	Impaired	Absent	Absent	Present	Septic
16M 15	Sixteenmile Creek	Medium	0.00	0.10	47.68	0.00	52.22	0.00	Eroding	Protected	Present	Absent	Present	Septic
16M 16	Sixteenmile Creek	Medium	0.00	26.99	0.60	0.00	58.22	14.19	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
COC 7	Conneaut Creek	Low	0.12	0.00	80.79	4.83	14.19	0.07	Stable	Protected	Absent	Absent	Present	No Data
COC 8	Conneaut Creek	Low	5.94	0.00	67.55	0.00	0.02	26.49	Stable	Protected	Absent	Absent	Present	No Data
COC 11	Conneaut Creek	Low	0.00	0.00	51.13	0.00	0.81	48.06	Stable	Protected	Absent	Absent	Present	No Data
EC 41	Elk Creek	Low	0.00	0.00	52.75	5.79	22.88	18.58	Eroding	Impaired	Absent	Absent	Present	Septic
EC 42	Elk Creek	Low	0.00	4.71	36.38	0.00	50.22	8.69	Eroding	Protected	Absent	Absent	Present	Septic
EC 55	Elk Creek	Low	0.00	6.86	46.63	0.00	30.79	15.72	Stable	Protected	Absent	Absent	Present	Septic
4M 8	Fourmile Creek	Low	0.00	22.89	75.43	0.00	1.68	0.00	Eroding	Protected	Absent	Absent	Absent	Treatment Plant; Septic
4M 10	Fourmile Creek	Low	0.00	39.88	57.83	1.33	0.00	0.97	Stable	Protected	Present	Absent	Present	Treatment Plant; Septic
6M 5	Sixmile Creek	Low	0.00	0.00	67.00	0.00	33.00	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
6M 6	Sixmile Creek	Low	0.00	18.84	6.06	0.24	72.05	2.81	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
6M 12	Sixmile Creek	Low	9.29	5.71	74.82	2.33	7.86	0.00	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
12M 10	Twelvemile Creek	Low	0.37	1.46	1.01	0.00	88.70	8.46	Eroding	Protected	Absent	Absent	Present	Septic

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 53. Restoration Priorities by Sub-watershed for the Habitat-Based Restoration Model

	Number of Sites			
Sub-Watershed	*High Priority*	*Medium Priority*	*Low Priority*	*Total*
Twentymile Creek	0	0	0	0
Sixteenmile Creek	0	8	0	8
Twelvemile Creek	0	6	1	7
Eightmile Creek	0	6	0	6
Sevenmile Creek	1	5	0	6
Sixmile Creek	0	11	3	14
Fourmile Creek	0	4	2	6
Trout Run	0	2	0	2
Walnut Creek	4	8	0	12
Elk Creek	27	7	3	37
Crooked Creek	0	12	0	12
Raccoon Creek	0	4	0	4
Turkey Creek	2	1	0	3
Conneaut Creek	4	30	3	37
Ashtabula Creek	0	1	0	1
Total	***38***	***105***	***12***	***155***

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Table 54. Habitat and Fish Community-Based Restoration Model Site Rating Criteria

Metric	*Rating*	*Score*
Habitat	High Priority	5
	Medium Priority	3
	Low Priority	1
Fish Community	High Priority	5
	Medium Priority	3
	Low Priority	1
Habitat and Fish	High Priority	8, 10
	Medium Priority	6
	Low Priority	2, 4

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Table 55. Restoration Priorities for Sites Assessed using the Habitat and Fish Community-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors						
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Stream-Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
COC 28	Conneaut Creek	High	0.00	0.00	34.25	16.67	49.07	0.00	Eroding	Protected	Absent	Absent	Present	No Data
EC 2	Elk Creek	High	0.00	39.85	8.82	0.00	51.34	0.00	Stable	Impaired	Absent	Absent	Absent	Septic
EC 8	Elk Creek	High	0.00	11.72	73.79	0.00	14.49	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 21	Elk Creek	High	0.00	4.48	44.99	0.00	50.53	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 26	Elk Creek	High	9.40	0.00	43.48	0.00	46.69	0.43	Eroding	Protected	Absent	Absent	Present	Septic
EC 28	Elk Creek	High	0.00	0.57	39.48	0.72	45.92	13.32	Stable	Impaired	Absent	Absent	Present	Septic
TR 5	Trout Run	High	0.00	81.95	18.05	0.00	0.00	0.00	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
TR 1	Trout Run	High	0.00	33.65	48.61	11.29	0.00	6.45	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
WC 3	Walnut Creek	High	0.00	23.87	44.63	9.29	22.20	0.00	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
4M 5	Fourmile Creek	High	0.00	93.74	6.25	0.00	0.01	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
4M 6	Fourmile Creek	High	0.00	19.86	48.20	4.37	27.56	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
4M 12	Fourmile Creek	High	3.88	30.74	65.36	0.00	0.00	0.02	Stable	Impaired	Present	Absent	Present	Septic
7M 2	Sevenmile Creek	High	0.00	78.92	2.69	0.00	18.39	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
7M 3	Sevenmile Creek	High	0.00	24.57	21.21	0.76	33.56	19.90	Stable	Impaired	Absent	Absent	Present	Septic
7M 6	Sevenmile Creek	High	0.00	45.85	0.00	0.00	47.24	6.91	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
7M 12	Sevenmile Creek	High	0.00	23.27	50.89	4.72	19.63	1.50	Eroding	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
8M 1	Eightmile Creek	High	26.47	0.00	0.20	0.00	25.06	48.27	Eroding	Protected	Present	Absent	Present	Septic
8M 4	Eightmile Creek	High	0.00	0.20	6.36	3.83	86.56	3.05	Eroding	Impaired	Absent	Absent	Absent	Septic
8M 10	Eightmile Creek	High	0.00	5.95	15.72	11.86	66.47	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
8M 11	Eightmile Creek	High	0.00	14.47	73.99	2.25	9.29	0.00	Eroding	Protected	Absent	Absent	Present	Septic
12M 2	Twelvemile Creek	High	0.00	13.71	29.44	4.12	52.73	0.00	Stable	Impaired	Absent	Absent	Present	Septic
12M 3	Twelvemile Creek	High	0.00	6.36	0.00	0.00	93.64	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
12M 4	Twelvemile Creek	High	0.00	6.00	2.47	6.00	83.75	1.78	Eroding	Impaired	Present	Absent	Present	Septic
12M 5	Twelvemile Creek	High	0.00	22.75	42.30	0.00	16.37	18.58	Eroding	Protected	Absent	Absent	Absent	Septic
12M 8	Twelvemile Creek	High	0.00	7.28	34.54	1.72	56.47	0.00	Eroding	Impaired	Absent	Absent	Absent	Septic
12M 12	Twelvemile Creek	High	0.00	14.61	23.18	0.00	62.22	0.00	Stable	Protected	Absent	Present	Present	Septic
16M 5	Sixteenmile Creek	High	0.00	94.43	5.57	0.00	0.00	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
16M 7	Sixteenmile Creek	High	0.00	18.92	4.90	0.00	72.12	4.06	Stable	Impaired	Absent	Absent	Absent	Treatment Plant; Septic
16M 10	Sixteenmile Creek	High	0.00	9.26	39.37	9.23	14.29	27.85	Eroding	Protected	Absent	Absent	Present	Septic
16M 12	Sixteenmile Creek	High	0.00	69.51	11.23	0.00	19.26	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
16M 13	Sixteenmile Creek	High	0.00	16.44	32.90	0.00	41.30	9.35	Eroding	Protected	Absent	Absent	Present	Septic
COC 26	Conneaut Creek	Medium	0.00	17.12	36.95	0.00	45.94	0.00	Stable	Protected	Absent	Absent	Present	No Data
COC 35	Conneaut Creek	Medium	0.00	53.26	17.53	9.29	10.63	9.29	Stable	Protected	Absent	Absent	Present	No Data
COC 37	Conneaut Creek	Medium	0.00	0.00	44.08	0.00	55.92	0.00	Eroding	Protected	Absent	Absent	Present	No Data

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 55 (cntd). Restoration Priorities for Sites Assessed using the Habitat and Fish Community-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors					
Site	Sub-watershed	Priority	O	D	F	S/G	A	W	Stream-Bank	Riparian Buffer	Impediment	Livestock	Invasive Species	Wastewater Treatment
COC 43	Conneaut Creek	Medium	0.00	18.11	62.71	0.00	9.56	9.63	Eroding	Protected	Absent	Absent	Present	No Data
COC 52	Conneaut Creek	Medium	0.00	32.07	39.82	16.01	12.10	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
COC 57	Conneaut Creek	Medium	0.00	5.75	85.89	0.00	6.32	2.03	Eroding	Impaired	Absent	Present	Present	Septic
RC 1	Raccoon Creek	Medium	6.16	0.00	93.84	0.00	0.00	0.00	Eroding	Protected	Absent	Absent	Present	Septic
RC 6	Raccoon Creek	Medium	0.00	14.43	56.86	0.00	19.76	8.95	Eroding	Protected	Absent	Absent	Present	Septic
CRC 1	Crooked Creek	Medium	2.55	42.97	27.37	26.62	0.49	0.00	Stable	Impaired	Absent	Absent	Absent	Septic
CRC 2	Crooked Creek	Medium	1.46	14.35	56.91	11.01	11.01	5.25	Eroding	Protected	Absent	Present	Present	Septic
CRC 3	Crooked Creek	Medium	0.33	14.67	57.56	12.00	12.00	3.45	Eroding	Impaired	Absent	Absent	Absent	Septic
CRC 4	Crooked Creek	Medium	0.00	17.85	58.16	0.00	9.58	14.41	Eroding	Protected	Absent	Absent	Present	Septic
CRC 9	Crooked Creek	Medium	0.00	9.73	30.64	0.00	59.63	0.00	Eroding	Protected	Absent	Absent	Present	Septic
CRC 19	Crooked Creek	Medium	0.00	9.61	53.04	0.00	37.35	0.00	Eroding	Protected	Absent	Absent	Present	Septic
EC 3	Elk Creek	Medium	0.00	0.00	31.90	3.27	64.83	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 5	Elk Creek	Medium	0.00	0.51	41.34	3.70	54.45	0.00	Stable	Protected	Absent	Absent	Present	Septic
EC 6	Elk Creek	Medium	0.00	31.04	45.96	9.29	13.12	0.58	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
EC 7	Elk Creek	Medium	0.00	26.58	48.26	9.29	15.86	0.00	Stable	Protected	Present	Absent	Absent	Treatment Plant; Septic
EC 10	Elk Creek	Medium	0.63	36.44	28.92	15.16	18.85	0.00	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
EC 15	Elk Creek	Medium	0.00	0.00	95.12	0.00	4.88	0.00	Stable	Protected	Present	Absent	Present	Septic
EC 43	Elk Creek	Medium	0.00	14.37	54.90	3.02	21.97	5.74	Eroding	Protected	Absent	Absent	Present	Septic
TR 3	Trout Run	Medium	0.00	37.39	27.18	0.00	35.43	0.00	Eroding	Protected	Absent	Absent	Present	Septic
WC 2	Walnut Creek	Medium	0.00	34.71	35.78	23.51	6.00	0.00	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
WC 4	Walnut Creek	Medium	0.00	27.07	45.00	9.29	18.64	0.00	Eroding	Protected	Absent	Absent	Absent	Treatment Plant; Septic
WC 12	Walnut Creek	Medium	0.00	52.45	21.88	18.58	5.57	1.52	Eroding	Protected	Absent	Absent	Present	Treatment Plant; Septic
WC 16	Walnut Creek	Medium	0.00	79.74	13.83	0.00	6.43	0.00	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
WC 19	Walnut Creek	Medium	0.00	61.95	14.45	0.00	12.33	11.28	Stable	Protected	Absent	Absent	Absent	Treatment Plant; Septic
4M 9	Fourmile Creek	Medium	0.00	25.82	73.75	0.00	0.42	0.00	Stable	Protected	Absent	Absent	Absent	Treatment Plant; Septic
4M 13	Fourmile Creek	Medium	0.00	12.39	47.37	0.00	40.24	0.00	Eroding	Protected	Absent	Absent	Absent	Septic
6M 1	Sixmile Creek	Medium	3.06	60.41	16.00	0.00	9.52	11.01	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
6M 4	Sixmile Creek	Medium	4.13	38.86	33.03	0.00	15.94	8.04	Stable	Impaired	Present	Absent	Present	Treatment Plant; Septic
7M 1	Sevenmile Creek	Medium	1.79	0.00	54.24	13.62	11.95	18.41	Eroding	Impaired	Absent	Absent	Present	Treatment Plant; Septic
7M 11	Sevenmile Creek	Medium	0.00	30.39	17.20	0.00	52.41	0.00	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
8M 2	Eightmile Creek	Medium	0.00	1.24	4.42	9.02	27.06	58.26	Eroding	Protected	Absent	Absent	Present	Septic
8M 3	Eightmile Creek	Medium	0.00	0.00	15.69	0.00	50.52	33.80	Eroding	Impaired	Absent	Absent	Present	Septic
16M 9	Sixteenmile Creek	Medium	0.00	0.00	76.10	0.00	17.96	5.95	Stable	Protected	Absent	Absent	Absent	Septic
COC 9	Conneaut Creek	Low	5.52	0.00	52.38	0.00	0.00	42.11	Stable	Protected	Absent	Absent	Present	No Data

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 55 (cntd). Restoration Priorities for Sites Assessed using the Habitat and Fish Community-Based Restoration Model

			Land Cover (%)[1]						Restoration Factors						
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*	*Stream-Bank*	*Riparian Buffer*	*Impediment*	*Livestock*	*Invasive Species*	*Wastewater Treatment*
COC 12	Conneaut Creek	Low	0.00	0.00	87.01	0.00	6.66	6.33	Stable	Protected	Absent	Absent	Absent	No Data
COC 18	Conneaut Creek	Low	0.00	17.71	48.30	5.19	10.22	18.58	Stable	Protected	Absent	Absent	Present	Septic
COC 25	Conneaut Creek	Low	0.00	5.22	13.65	0.56	69.56	11.01	Eroding	Impaired	Absent	Absent	Present	No Data
COC 34	Conneaut Creek	Low	0.00	0.00	82.71	0.00	8.58	8.72	Stable	Protected	Absent	Absent	Present	No Data
COC 39	Conneaut Creek	Low	0.00	8.45	19.02	0.00	67.79	4.74	Eroding	Protected	Absent	Present	Present	No Data
COC 44	Conneaut Creek	Low	0.00	2.24	78.12	0.06	17.45	2.13	Eroding	Protected	Absent	Absent	Present	No Data
COC 45	Conneaut Creek	Low	0.00	9.29	66.30	1.78	2.75	19.88	Eroding	Protected	Absent	Present	Present	No Data
COC 53	Conneaut Creek	Low	0.00	36.59	37.78	0.00	17.23	8.39	Eroding	Protected	Present	Absent	Present	Septic
COC 58	Conneaut Creek	Low	0.00	0.00	0.00	8.07	88.22	3.71	Eroding	Protected	Absent	Present	Present	Septic
RC 2	Raccoon Creek	Low	0.00	14.39	33.88	8.15	22.37	21.22	Eroding	Protected	Present	Absent	Present	Septic
EC 1	Elk Creek	Low	0.00	20.47	58.86	0.00	20.54	0.13	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
EC 22	Elk Creek	Low	0.00	3.54	66.39	0.00	25.32	4.75	Eroding	Protected	Absent	Absent	Present	Septic
EC 23	Elk Creek	Low	0.00	18.81	20.38	1.05	59.77	0.00	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
EC 25	Elk Creek	Low	0.00	29.26	40.27	9.29	21.18	0.00	Stable	Protected	Present	Absent	Present	Septic
EC 30	Elk Creek	Low	0.00	0.00	31.90	3.27	64.83	0.00	Eroding	Impaired	Absent	Present	Present	Treatment Plant; Septic
EC 51	Elk Creek	Low	0.00	13.77	38.11	1.93	46.19	0.00	Eroding	Impaired	Absent	Absent	Present	Septic
EC 52	Elk Creek	Low	0.00	6.19	59.63	0.00	27.82	6.36	Eroding	Protected	Absent	Absent	Present	Septic
WC 1	Walnut Creek	Low	0.00	99.04	0.96	0.00	0.00	0.00	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
4M 1	Fourmile Creek	Low	21.60	78.40	0.00	0.00	0.00	0.00	Eroding	Impaired	Absent	Absent	Present	Treatment Plant
6M 7	Sixmile Creek	Low	0.00	51.69	24.44	0.00	12.84	11.03	Stable	Protected	Absent	Absent	Present	Treatment Plant; Septic
6M 18	Sixmile Creek	Low	0.00	4.24	87.61	8.12	0.03	0.00	Stable	Impaired	Absent	Absent	Present	Septic
16M 1	Sixteenmile Creek	Low	33.12	1.17	20.24	0.00	45.46	0.00	Stable	Impaired	Absent	Absent	Present	Treatment Plant; Septic
20M 1	Twentymile Creek	Low	10.66	22.65	15.87	0.00	50.83	0.00	Stable	Protected	Absent	Absent	Present	Septic

[1] *O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland*

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Table 56. Restoration Priorities by Sub-watershed for the Habitat and Fish Community-Based Restoration Model

	Number of Sites			
Sub-Watershed	*High Priority*	*Medium Priority*	*Low Priority*	*Total*
Twentymile Creek	0	0	1	1
Sixteenmile Creek	5	1	1	7
Twelvemile Creek	6	0	0	6
Eightmile Creek	4	2	0	6
Sevenmile Creek	4	2	0	6
Sixmile Creek	0	2	2	4
Fourmile Creek	3	2	1	6
Trout Run	2	1	0	3
Walnut Creek	1	5	1	7
Elk Creek	5	7	7	19
Crooked Creek	0	6	0	6
Raccoon Creek	0	2	1	3
Turkey Creek	0	0	0	0
Conneaut Creek	1	6	10	17
Ashtabula Creek	0	0	0	0
Total	***31***	***36***	***24***	***91***

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Table 57. High Priority Conservation Sites Identified using the Habitat-Based Conservation Model

			Land Cover (%)[1]					
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*
COC 7	Conneaut Creek	High	0.12	0.00	80.79	4.83	14.19	0.07
COC 8	Conneaut Creek	High	5.94	0.00	67.55	0.00	0.02	26.49
COC 11	Conneaut Creek	High	0.00	0.00	51.13	0.00	0.81	48.06
EC 41	Elk Creek	High	0.00	0.00	52.75	5.79	22.88	18.58
EC 42	Elk Creek	High	0.00	4.71	36.38	0.00	50.22	8.69
EC 55	Elk Creek	High	0.00	6.86	46.63	0.00	30.79	15.72
4M 8	Fourmile Creek	High	0.00	22.89	75.43	0.00	1.68	0.00
4M 10	Fourmile Creek	High	0.00	39.88	57.83	1.33	0.00	0.97
6M 5	Sixmile Creek	High	0.00	0.00	67.00	0.00	33.00	0.00
6M 6	Sixmile Creek	High	0.00	18.84	6.06	0.24	72.05	2.81
6M 12	Sixmile Creek	High	9.29	5.71	74.82	2.33	7.86	0.00
12M 10	Twelvemile Creek	High	0.37	1.46	1.01	0.00	88.70	8.46

[1] O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland

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Table 58. High Priority Conservation Sites Identified using the Habitat and Fish Community-Based Conservation Model

			Land Cover (%)[1]					
Site	*Sub-watershed*	*Priority*	*O*	*D*	*F*	*S/G*	*A*	*W*
COC 9	Conneaut Creek	Low	5.52	0.00	52.38	0.00	0.00	42.11
COC 12	Conneaut Creek	Low	0.00	0.00	87.01	0.00	6.66	6.33
COC 18	Conneaut Creek	Low	0.00	17.71	48.30	5.19	10.22	18.58
COC 25	Conneaut Creek	Low	0.00	5.22	13.65	0.56	69.56	11.01
COC 34	Conneaut Creek	Low	0.00	0.00	82.71	0.00	8.58	8.72
COC 39	Conneaut Creek	Low	0.00	8.45	19.02	0.00	67.79	4.74
COC 44	Conneaut Creek	Low	0.00	2.24	78.12	0.06	17.45	2.13
COC 45	Conneaut Creek	Low	0.00	9.29	66.30	1.78	2.75	19.88
COC 53	Conneaut Creek	Low	0.00	36.59	37.78	0.00	17.23	8.39
COC 58	Conneaut Creek	Low	0.00	0.00	0.00	8.07	88.22	3.71
RC 2	Raccoon Creek	Low	0.00	14.39	33.88	8.15	22.37	21.22
EC 1	Elk Creek	Low	0.00	20.47	58.86	0.00	20.54	0.13
EC 22	Elk Creek	Low	0.00	3.54	66.39	0.00	25.32	4.75
EC 23	Elk Creek	Low	0.00	18.81	20.38	1.05	59.77	0.00
EC 25	Elk Creek	Low	0.00	29.26	40.27	9.29	21.18	0.00
EC 30	Elk Creek	Low	0.00	0.00	31.90	3.27	64.83	0.00
EC 51	Elk Creek	Low	0.00	13.77	38.11	1.93	46.19	0.00
EC 52	Elk Creek	Low	0.00	6.19	59.63	0.00	27.82	6.36
WC 1	Walnut Creek	Low	0.00	99.04	0.96	0.00	0.00	0.00
4M 1	Fourmile Creek	Low	21.60	78.40	0.00	0.00	0.00	0.00
6M 7	Sixmile Creek	Low	0.00	51.69	24.44	0.00	12.84	11.03
6M 18	Sixmile Creek	Low	0.00	4.24	87.61	8.12	0.03	0.00
16M 1	Sixteenmile Creek	Low	33.12	1.17	20.24	0.00	45.46	0.00
20M 1	Twentymile Creek	Low	10.66	22.65	15.87	0.00	50.83	0.00

[1] O = Other; D = Developed; F = Forest; S/G = Shrub/Grass; A = Agriculture; W = Wetland

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Table 59. Metrics included in the Guidance Criteria for Evaluating the Ecological Value of Potential Conservation Properties

Metric	*Description*
Stream	The Pennsylvania integrated water quality assessment reports on the condition of the waters in Pennsylvania. Attaining streams are those segments where all four water uses are met (aquatic life, fish consumption, recreation, and potable water supply). A stream segement is considered impaired or Non-Attaining if any of the four uses are not met. Further, streams with excellent water quality may be designated High Quality Waters (HQ) or Exceptional Value Waters (EV). Refer to *Sections 4.4.4 and 4.4.5*.
Forest Cover	Forest cover in the Pennsylvania Lake Erie watershed is comprised of deciduous forest, evergreen forest, and mixed forest. Watersheds with a high proportion of forested land and wetlands are effective at filtering out contaminants and trapping sediments (Postel and Thompson, 2005). Postel and Thompson (2005), based on analysis of 27 water suppliers in the United States, suggest that treatment costs for drinking water derived from watersheds comprised of at least 60% forest cover were half of those derived from watersheds with 30% forest cover, and one-third of the cost of treating water from watershed with 10% forest cover. Refer to *Section 4.1.6*.
Impervious Cover	There is a strong relationship between the imperviousness of a watershed and the health of its receiving stream; generally, as impervious coverage increases, stream health decreases. Schueler *et al.* (2009) divides streams into four management categories based on the general relationship between impervious cover and stream quality, including: 1) sensitive streams (0-10% impervious cover); 2) impacted streams (10-25% impervious cover); 3) non-supporting streams (25-60% impervious cover); and urban drainages (60-100% impervious cover). Schueler *et al.* (2009) also developed three transitional categories: 1) 5-10% (transitioning to impacted); 2) 20-25% (transitioning to non-supporting); and 3) 60-70% (transitioning to urban drainage). Refer to *Section 4.2.4*.
Protected Riparian Buffer	Riparian buffers serve as a link between stream environments and their terrestrial surroundings. Prior to the enactment of Act 162 in 2014, Title 25 Pennsylvania Code Chapter 102 (025 Pa. Code § 102.14) required average minimum widths for riparian buffers: 1) A total of 100 feet of riparian forest buffer along all streams; and 2) a total of 150 feet of riparian forest buffer along high quality and exceptional value streams. Refer to *Section 4.1.9*.
Wetland	Wetlands are important elements of a watershed because they serve as the link between land and water resources. Mitch and Gosselink (2000) suggest that an ideal amount of wetlands be around 3-7% in watersheds to optimize the landscape for their ecosystems values such as flood control and water quality enhancement. Refer to *Sections 2.2.8 and 4.1.7*.
Natural Heritage Area	The Pennsylvania Natural Heritage Program, through the Natural Heritage Inventory process, identifies Core Habitat of Biological Diversity Areas and Supporting Landscapes. Core Habitat areas identify the essential habitat of the species of concern or natural community that can absorb very little activity or disturbance without substantial impact to the natural features. Supporting Landscape areas directly connect to Core Habitat and maintain vital ecological processes and/or secondary habitat that may be able to withstand some lower level of activity without substantial negative impacts to elements of concern. *Refer to Sections 2.3.4 and 4.4.1*.

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Table 59 (continued). Metrics included in the Guidance Criteria for Evaluating the Ecological Value of Potential Conservation Properties

Metric	*Description*
Active River Area	The Active River Area framework, developed by The Nature Conservancy, provides a comprehensive view of rivers that includes both the channels and the riparian lands most significant to the physical and ecological processes within a river system (Smith *et al.* 2008). The model identifies areas within a watershed that are essential to key natural processes, including floodplains, riparian wetlands, and headwater and steep-sloped areas that are important sources of organic material, nutrients, and habitat-forming sediment to the river system. Refer to *Section 4.4.2*.
Natural Systems Greenways	Natural Systems Greenways are corridors whose primary function is preservation of unique natural infrastructure including habitats, such as wetlands, steep slopes, floodplains, and exceptional value water-quality streams, high-value natural areas identified by the County Natural Heritage Inventory, interior forests, important bird areas, and important mammal areas (Pashek Associates 2010). Each greenway corridor is broken down by its sensitivity level and designated as having exceptional, significant, or high value based on scoring criteria described by Pashek Associates (2010). Islands refer to those areas that were evaluated by are not part of a Greenway Corridor. Refer to *Section 4.4.3*.
Stream Habitat	The EPA's Rapid Bioassessment Protocol (Barbour et al. 1999) provides guidance for the visual based habitat assessment of streams. The Protocol evaluates and scores 10 parameters on a range of 0 to 20. The individual parameter scores are then summed to get a total habitat score for each location. Total habitat scores are then classified as optimal (160-200), suboptimal (110-159), marginal (60-109), or poor (< 60). Refer to *Sections 4.4.11 and 4.4.15*.
Stream Fish Community	The IBI, first introduced by Karr (1981), uses the characteristics of fish assemblages to evaluate the biological integrity and includes scoring 12 metrics related to species composition, trophic composition, and fish abundance and condition. The sum of the 12 metrics yields an overall site score that characterizes the biotic integrity of the site. Sites are then classified according to Karr et al. (1986) as excellent (E), excellent-good (E-G), good (G), good-fair (G-F), fair (F), fair-poor (F-P), poor (P), poor-very poor (P-VP), or very poor (VP). Refer to Sections *4.4.9, 4.4.10, and 4.4.16*.
Species of Concern	Species of concern are endangered, threated, or rare plant and animal species. Pennsylvania Endangered Species are species in imminent danger of extinction or extirpation throughout their range in Pennsylvania if the deleterious factors affecting them continue to operate. Pennsylvania Threatened Species are species that may become endangered within the foreseeable future throughout their range in Pennsylvania unless the casual factors affecting the organism are abated. Pennsylvania Rare Species are species which are uncommon within the Commonwealth because they may be found in restricted geographic areas or in low numbers throughout Pennsylvania. Refer to PNHP (2012; 2008) for more information.
Nearest Public Land	Public lands include municipal parks, athletic fields, playgrounds, beaches, state parks, and state gamelands. An emphasis is placed on conserving properties adjoining public lands. Refer to *Section 4.5*.
Nearest Conserved Land	Land conservation is a tool designed to help communities protect their watersheds. Lands are conserved when open space and development rights are acquired from property owners through fee simple purchase, conservation easements, and/or donations. An emphasis is placed on placed on conserving properties adjoining already conserved lands. Refer to *Section 2.2.11*.
Parcel Size	Parcels refer to a track of land owned by someone or some entity. The parcel size criteria are arbitrary but are intended to prioritize conserving large tracts of land.

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Table 60. Guidance Criteria for Evaluating the Ecological Value of Potential Conservation Properties

		Evaluation Criteria		
Metric	*0*	*1*	*3*	*5*
Stream[1]	Non-Attaining		Attaining	High Quality
Forest Cover	< 30%	30 - 40%	40 - 60%	> 60%
Impervious Cover	> 15%	10 - 15%	5 - 10%	0 - 5%
Protected Riparian Buffer[1]	< 25 feet	25 - 50 feet	50 - 100 feet	> 100 feet
Wetland		Not Present	Present (< 3%)	Present (> 3%)
Natural Heritage Area		Not Designated	Supporting Habitat	Core Habitat
Active River Area		Not Present		Present
Natural Systems Greenways		Islands	High/Significant	Exceptional
Stream Habitat[1]	Poor	Marginal	Sub-Optimal	Optimal
Stream Fish Community[1]	VP, No Fish	F-P, P, P-VP	G-F, F	E, E-G, G
Species of Concern		Not Present	Present in Sub-watershed	Present on Site
Nearest Public Land		Not Adjoining		Adjoining
Nearest Conserved Land		Not Adjoining		Adjoining
Parcel Size		< 5 acres	5 - 20 acres	> 20 acres

[1] *Exclude if no stream is present on the parcel being evaluated*

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Table 61. PALE IWRM Plan Long-term Monitoring and Data Needs

	Year									
Action	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*
Develop an interactive, web-based map service to host the watershed characterization data.[1]	X	X								
Develop a web-based geospatial database to track the implementation of restoration, protection, and management efforts within the watershed		X								
Evaluate the Pennsylvania Lake Erie watershed habitat, water quality, sediment quality, and fish and macroinvertebrate communities every 10 years at the same sites assessed by Rafferty *et al.* (2011),							X			
Develop a riparian buffer shapefile (100-foot and 150-foot buffers)										
Acquire updated ortho-imagery, LiDAR, and impervious cover data					X					X
Evaluate historical changes in land cover/land use		X								
Provide a PALE IWRM Plan Update							X			

[1] *Currently in progress.*

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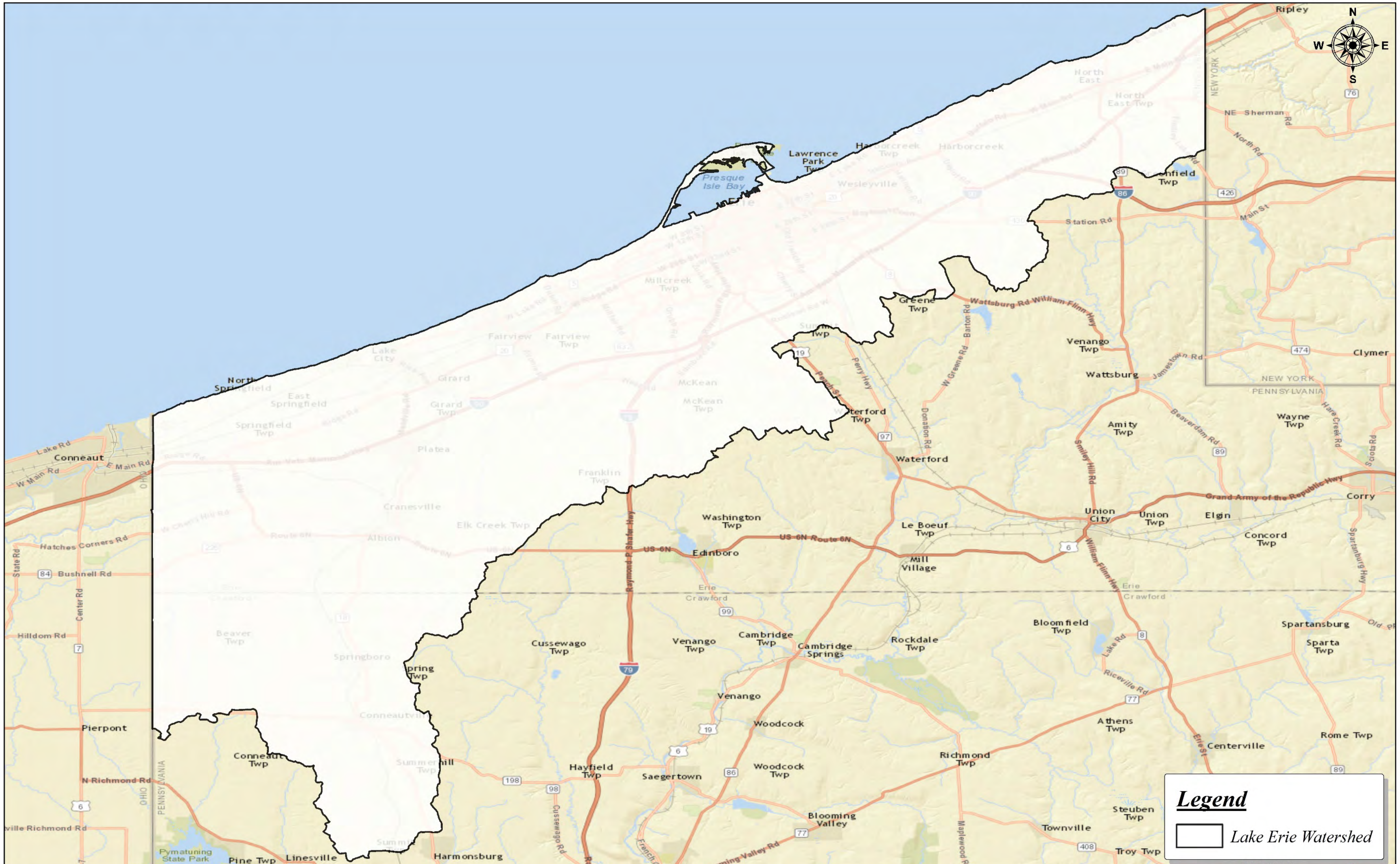
APPENDIX B: MAPS

Map 1. Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the

0 10 Miles

Data Source: Pennsylvania Sea Grant

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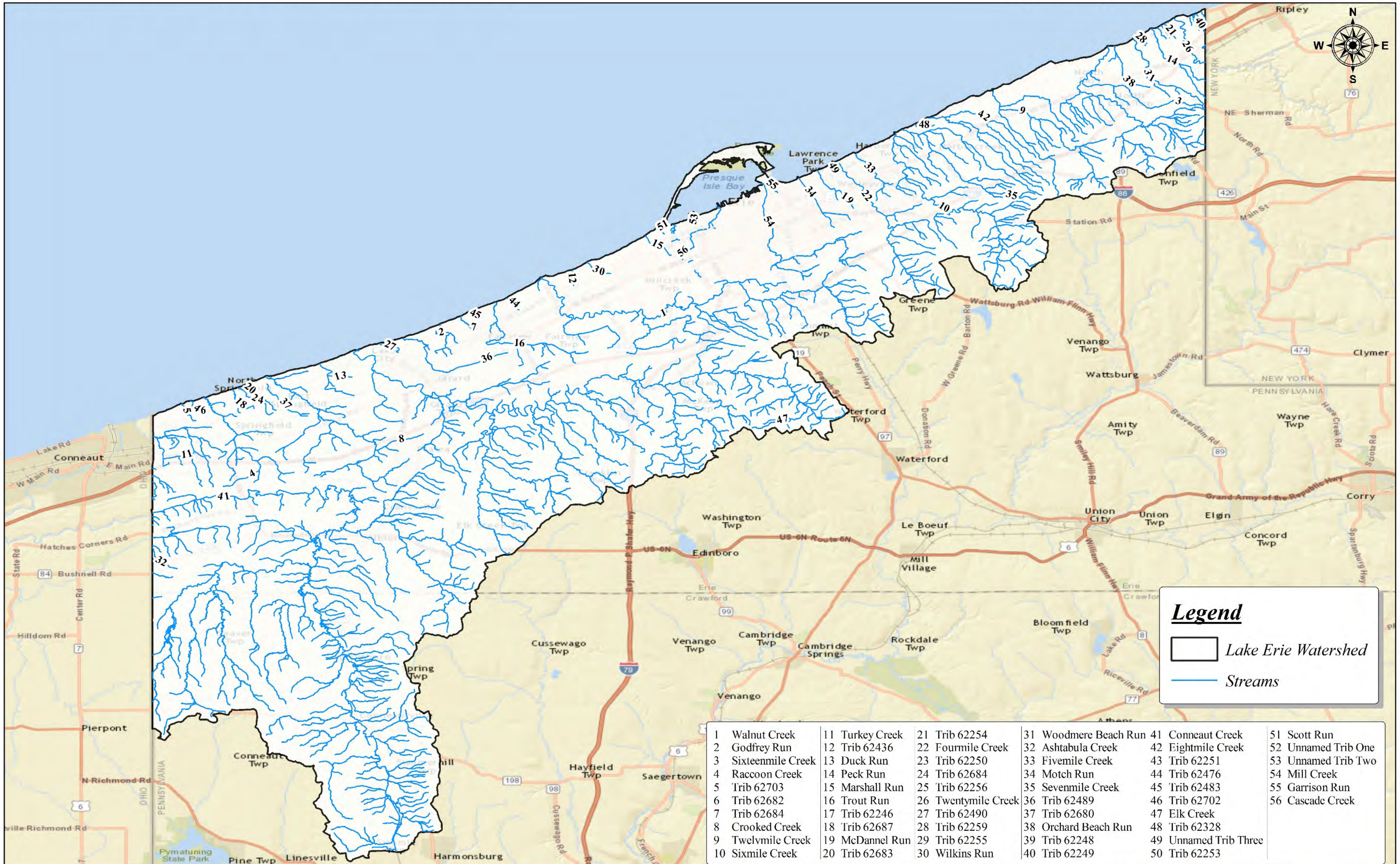
Map 2. Streams within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: USGS NHD

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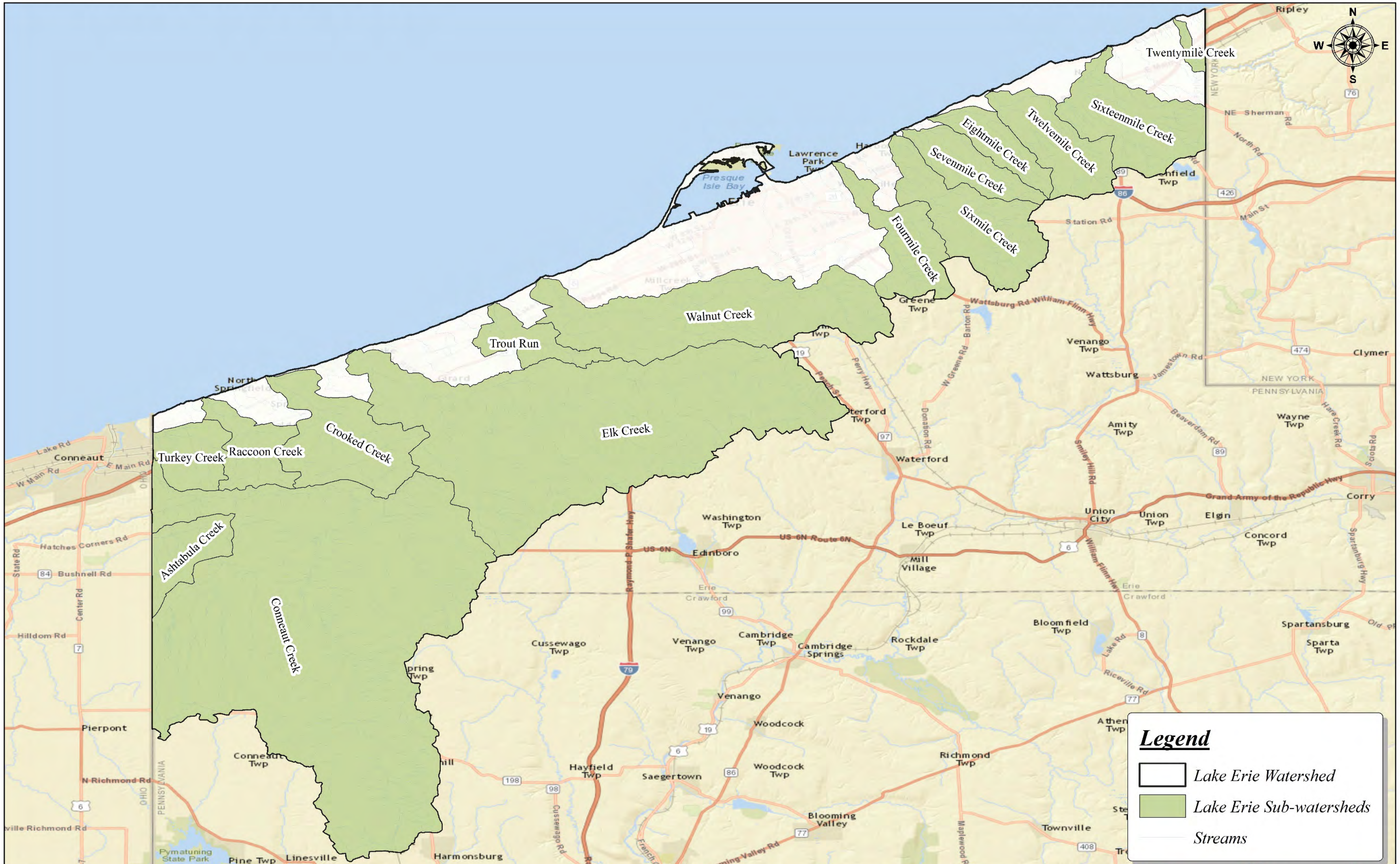
Map 3. Major Pennsylvania Lake Erie Sub-watersheds

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: PA DEP

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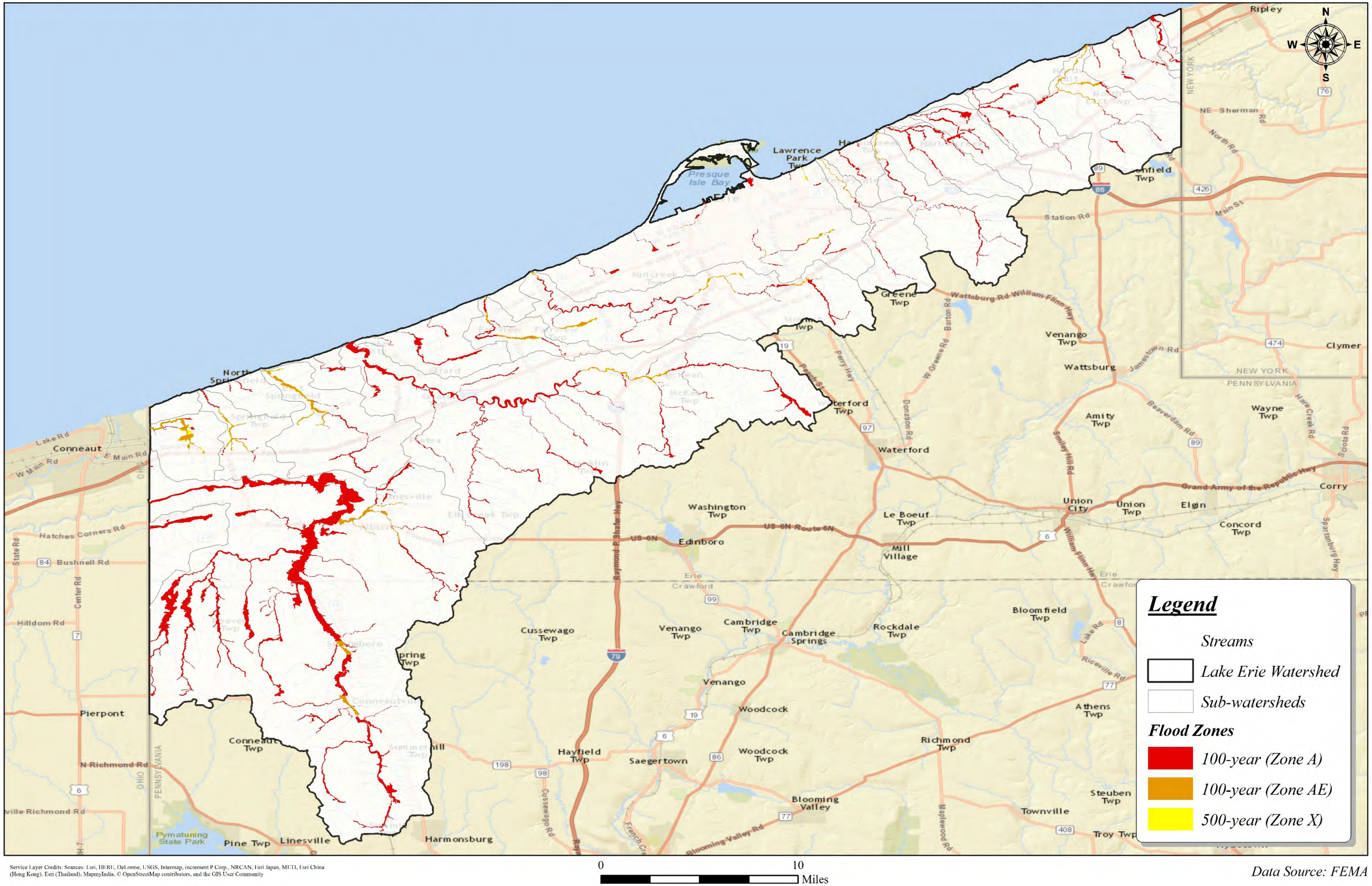
Map 4. Flood Zones within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: FEMA

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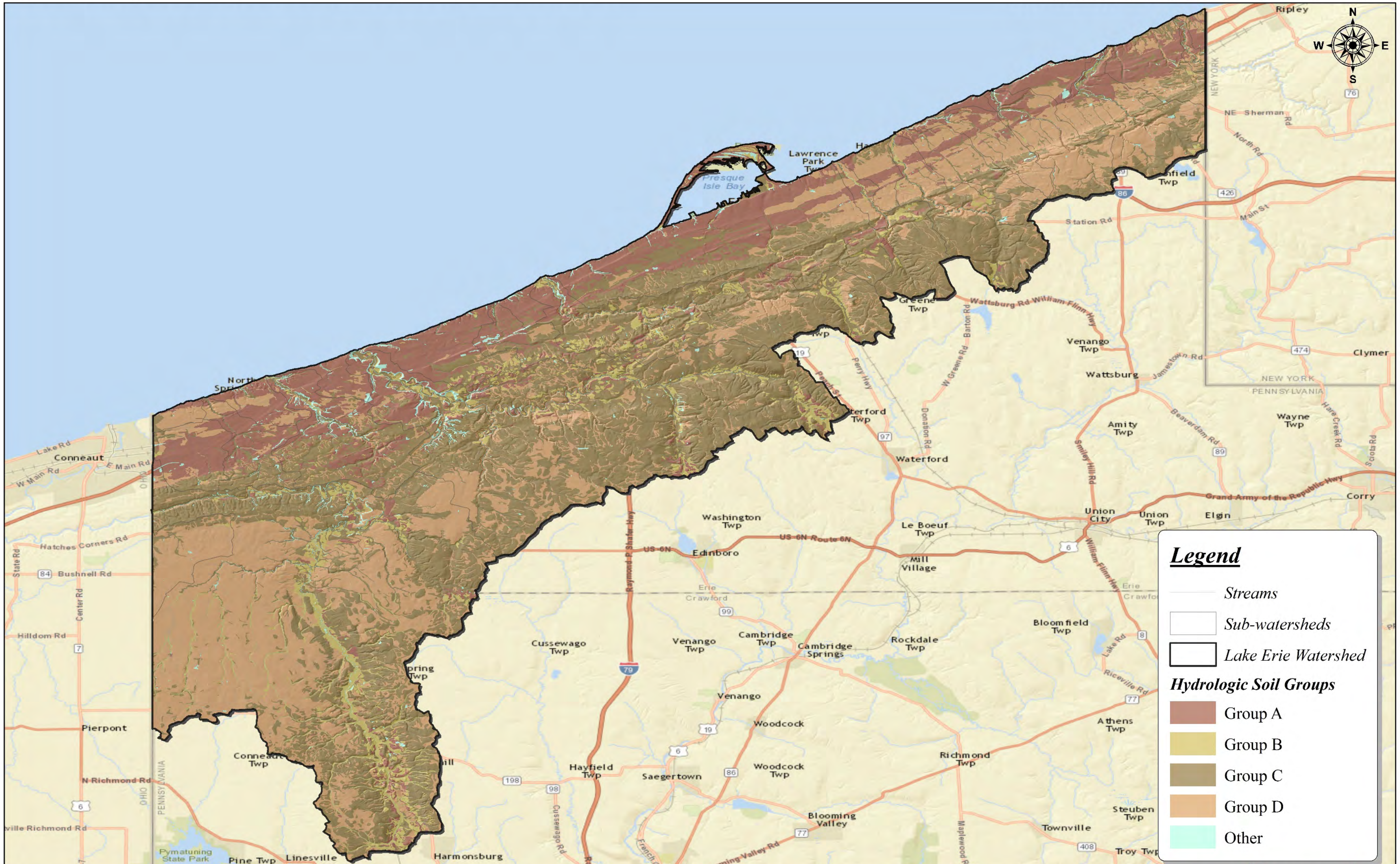
Map 5. Hydrologic Soil Groups within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: USDA, Pennsylvania Sea Grant

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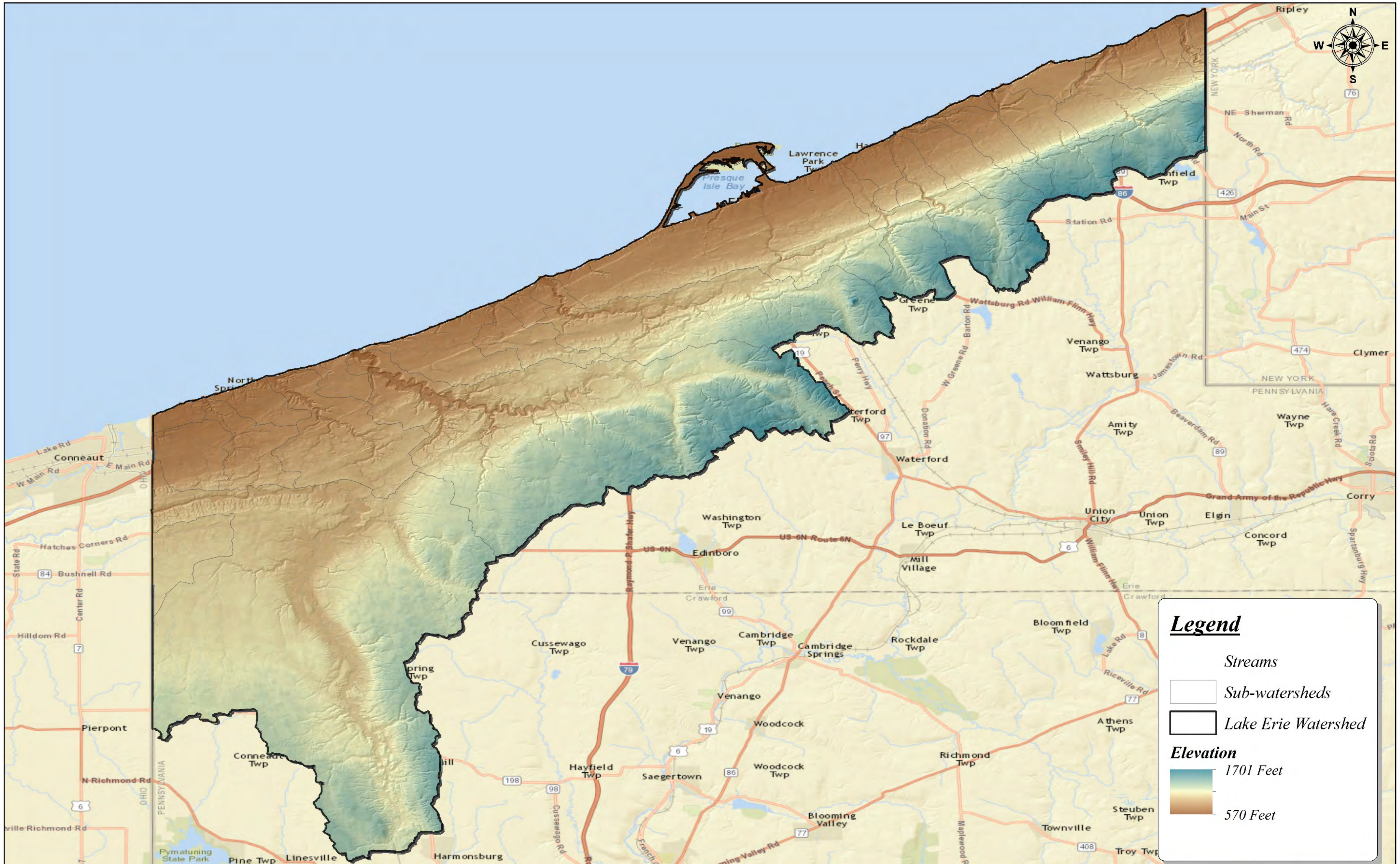
Map 6. Pennsylvania Lake Erie Watershed Elevation

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Pennsylvania Sea Grant

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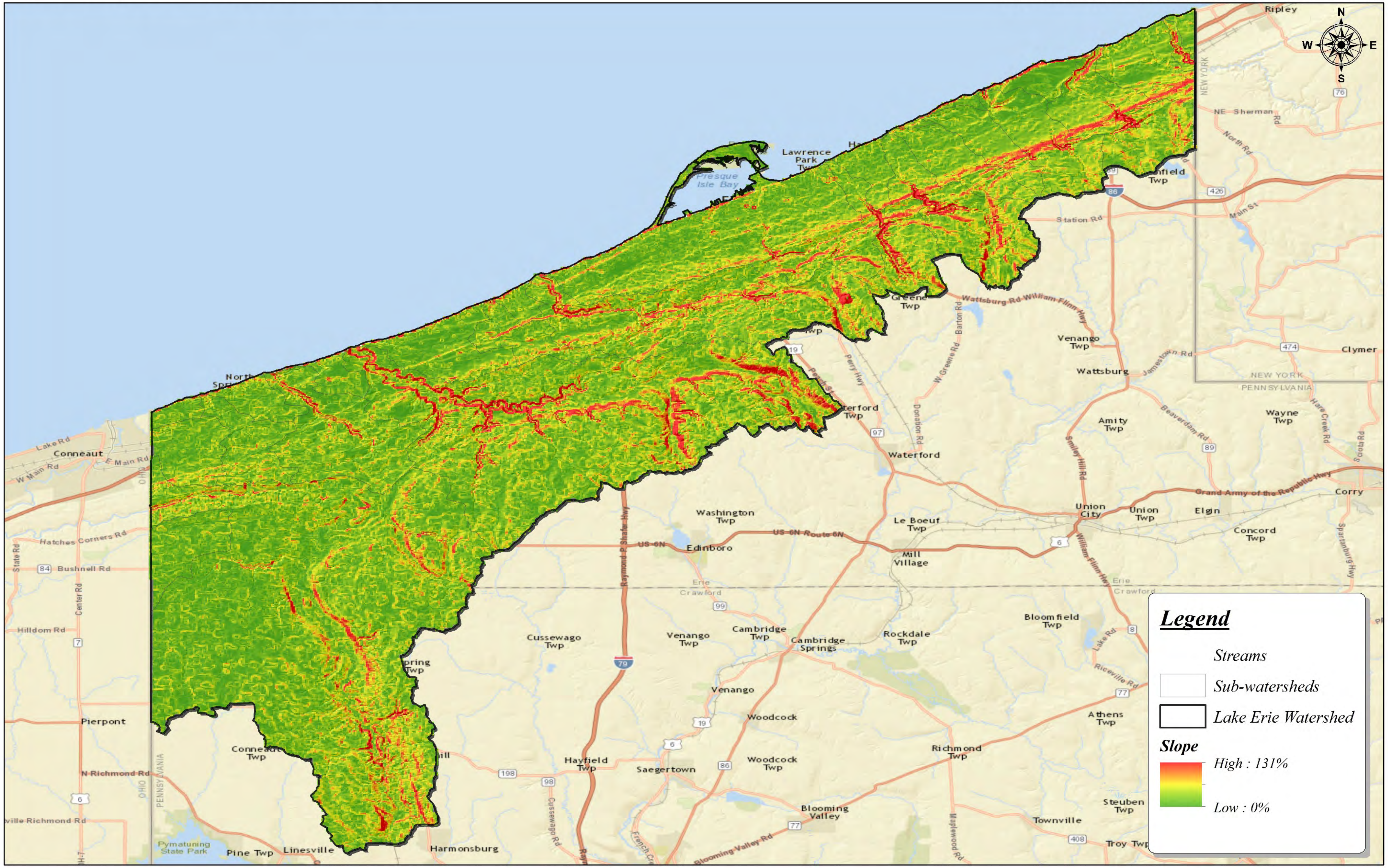
Map 7. Pennsylvania Lake Erie Watershed Slope

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Pennsylvania Sea Grant

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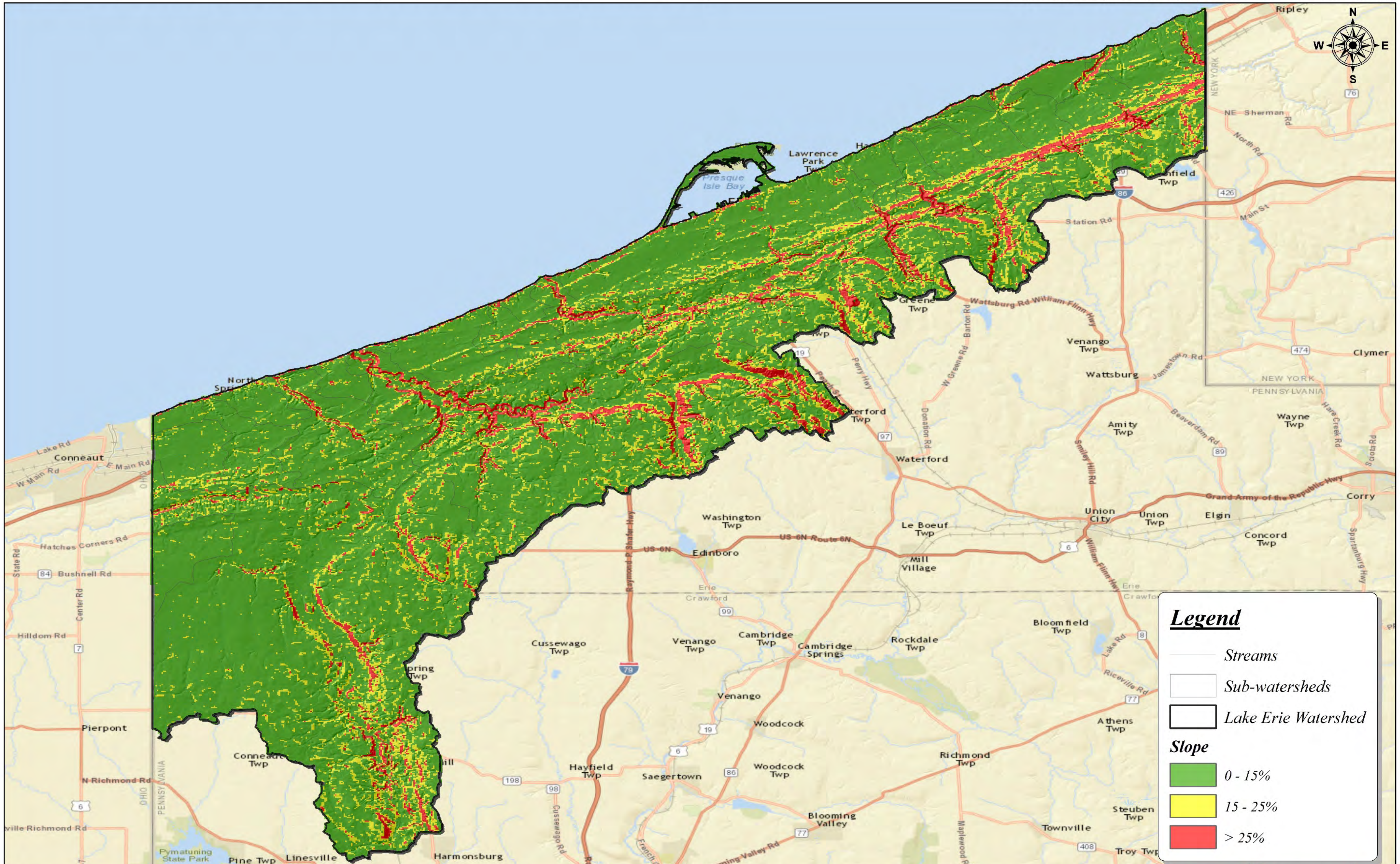
Map 8. Pennsylvania Lake Erie Watershed Slope Reclassified According to Arendt (1999)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Pennsylvania Sea Grant

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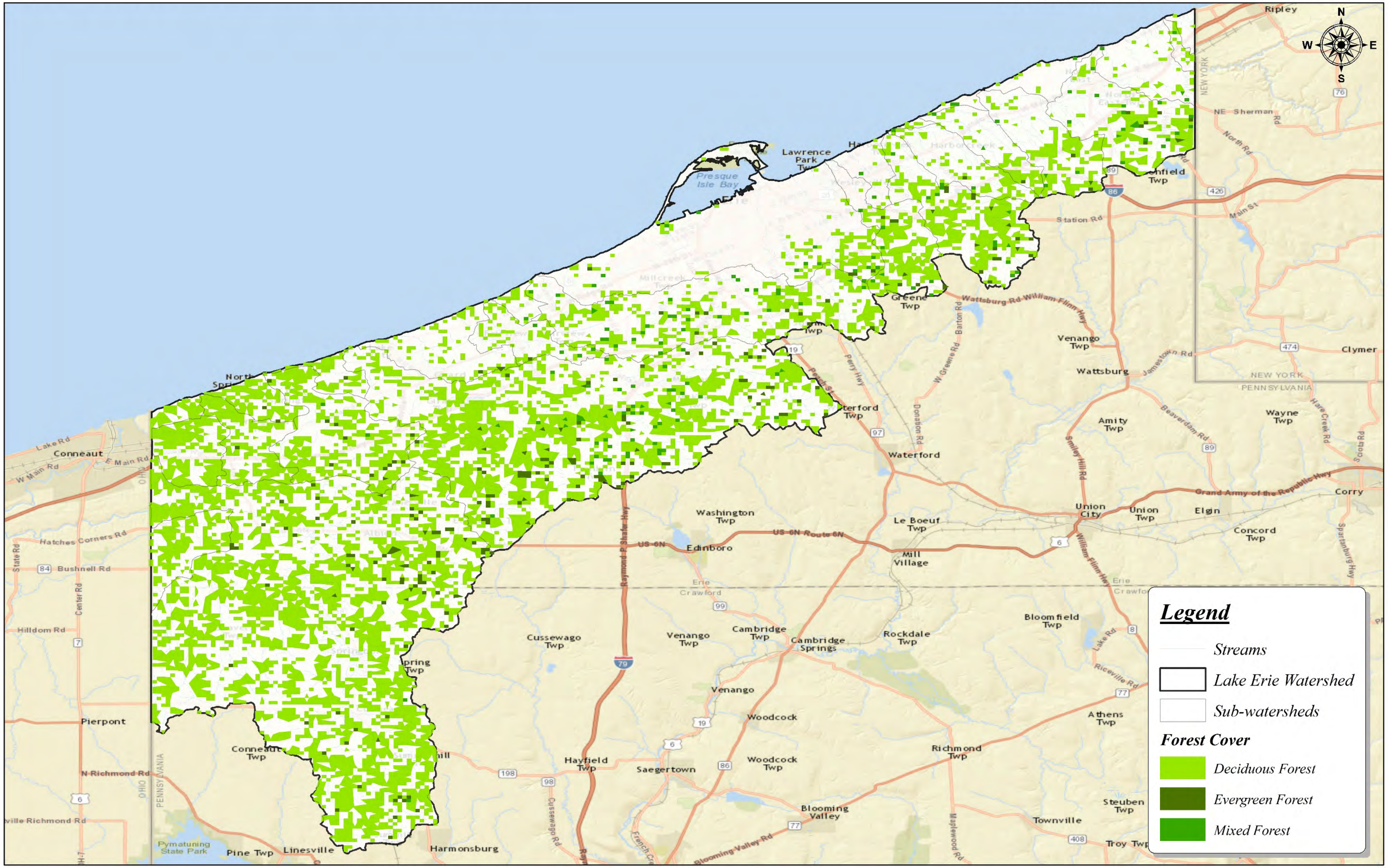
Map 9. Forest Cover within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: USGS, NLCD 2011

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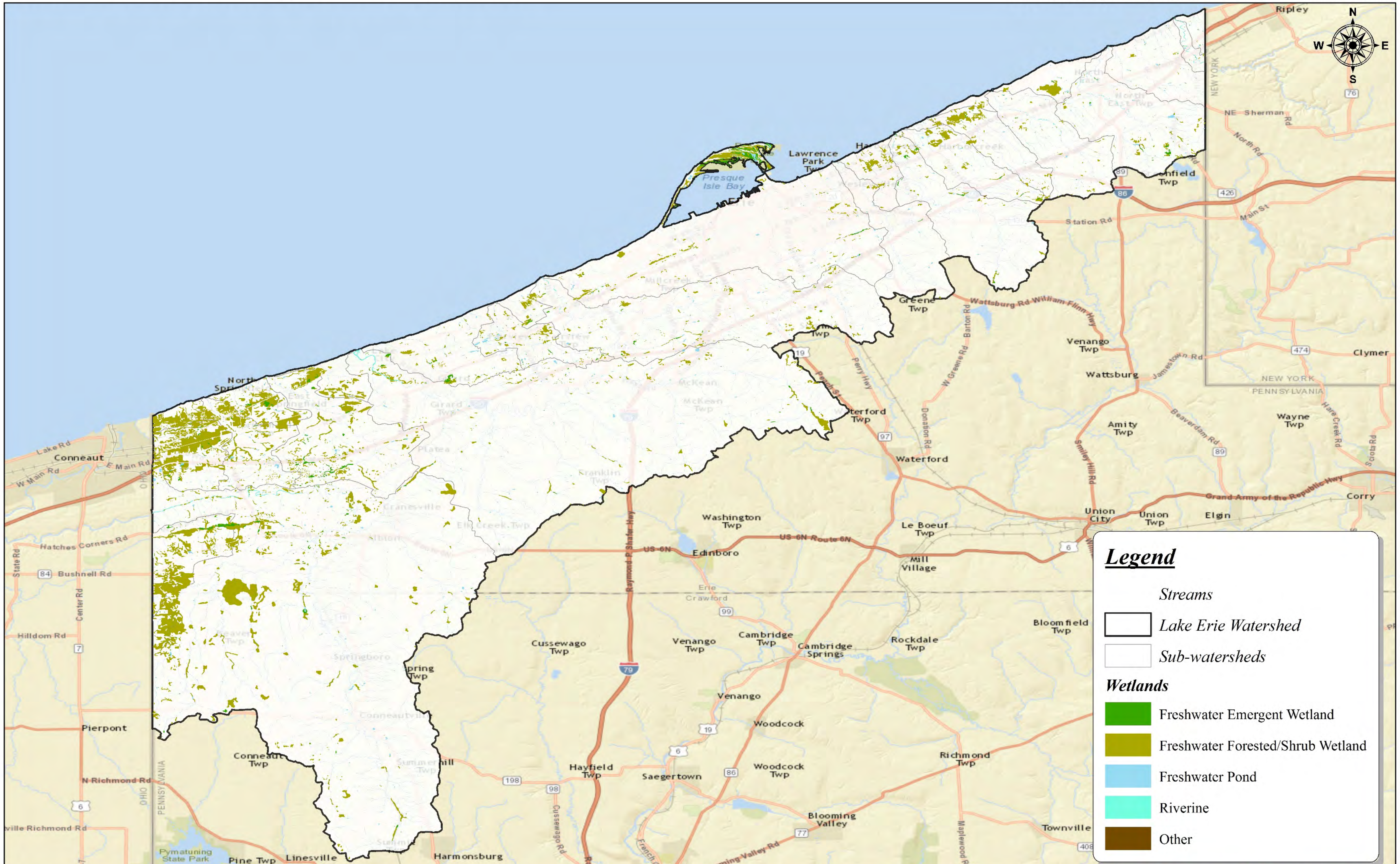
Map 10. Wetlands within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: USFWS

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Map 11. Pennsylvania Lake Erie Watershed Orthoimagery

Map Produced by Pennsylvania Sea Grant (Penn State University)

Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Woolpert, Inc.; Pennsylvania Sea Grant

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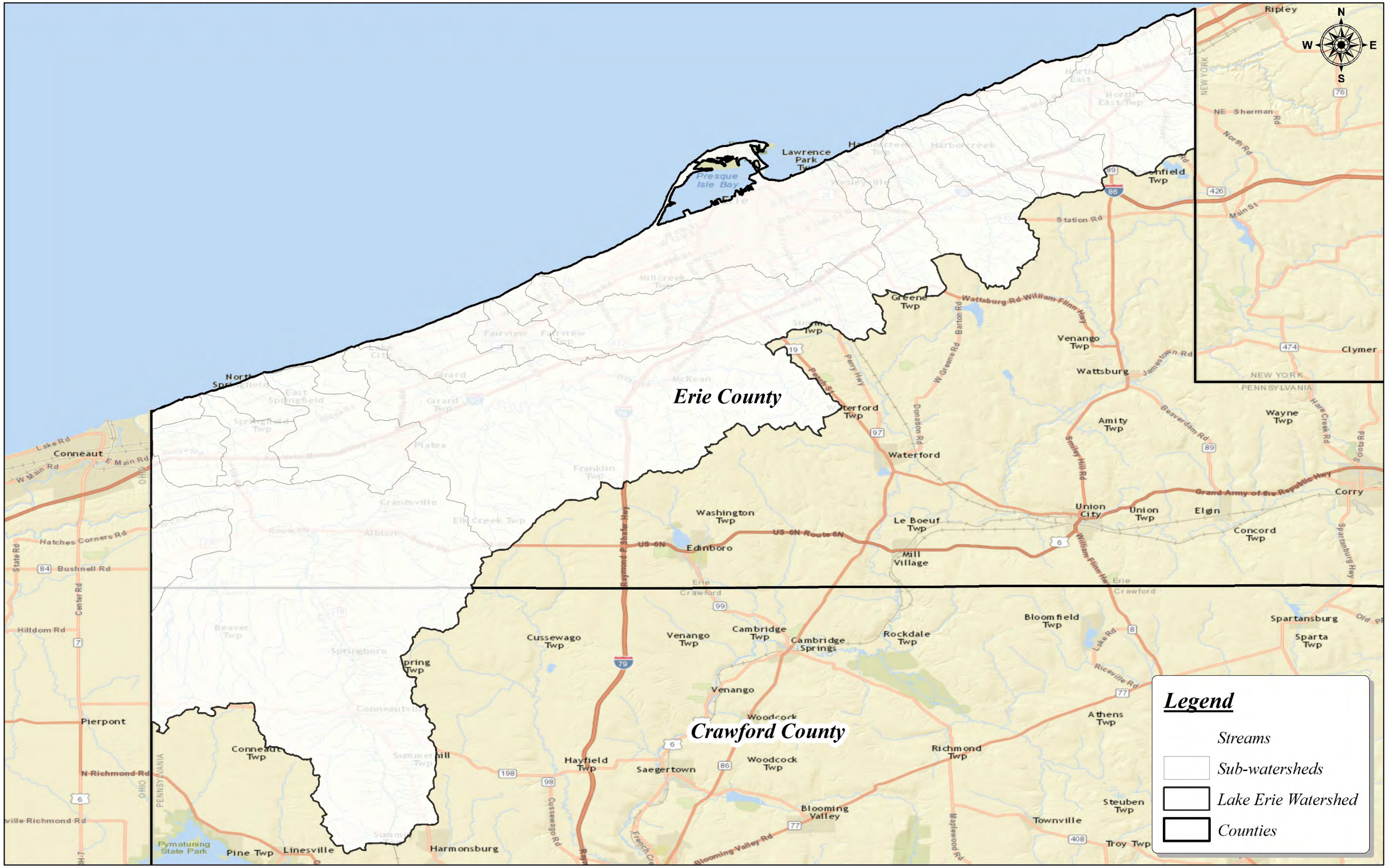
Map 12. Counties Intersecting the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PennDOT

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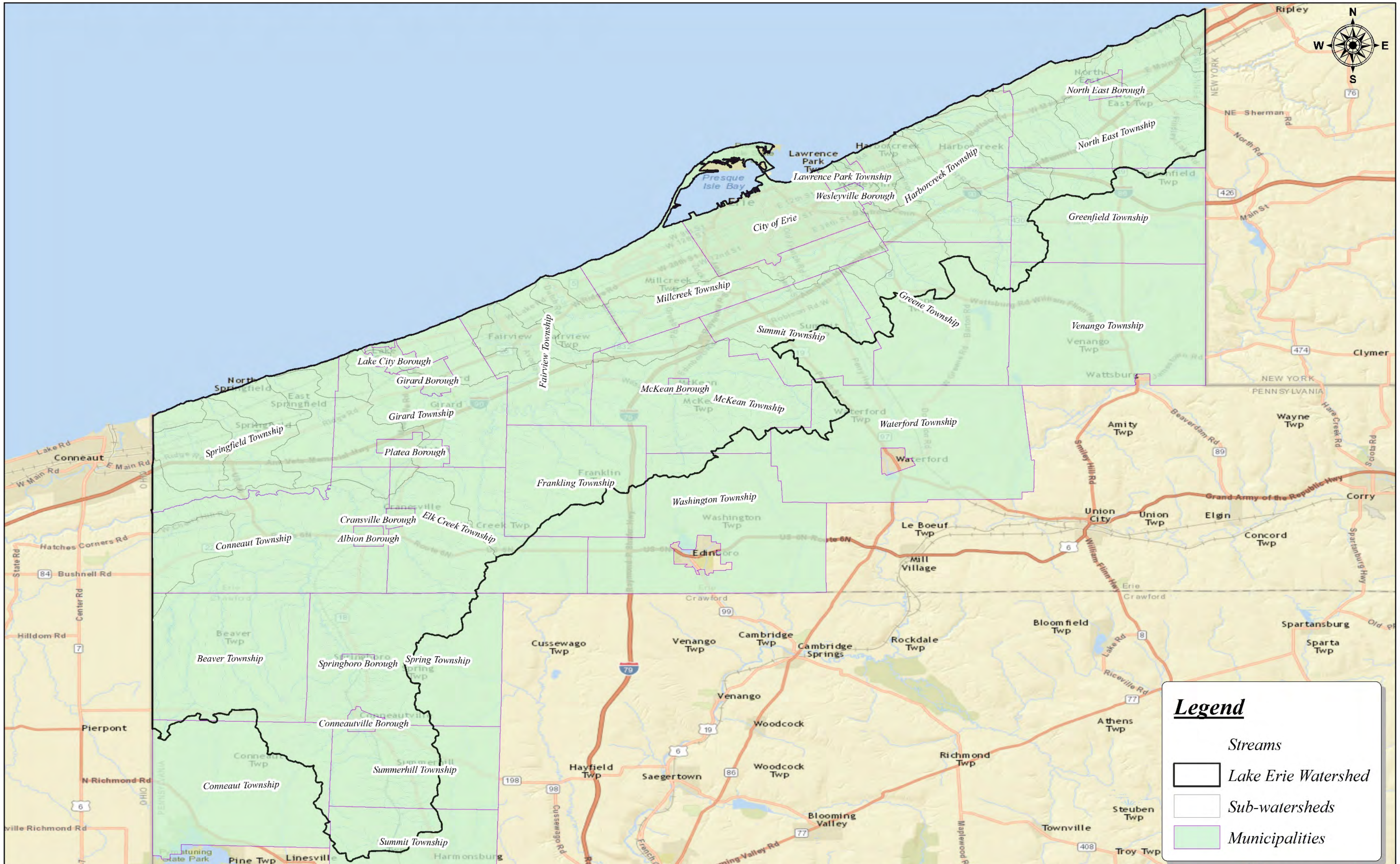
Map 13. Municipalities Intersecting the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: PennDOT

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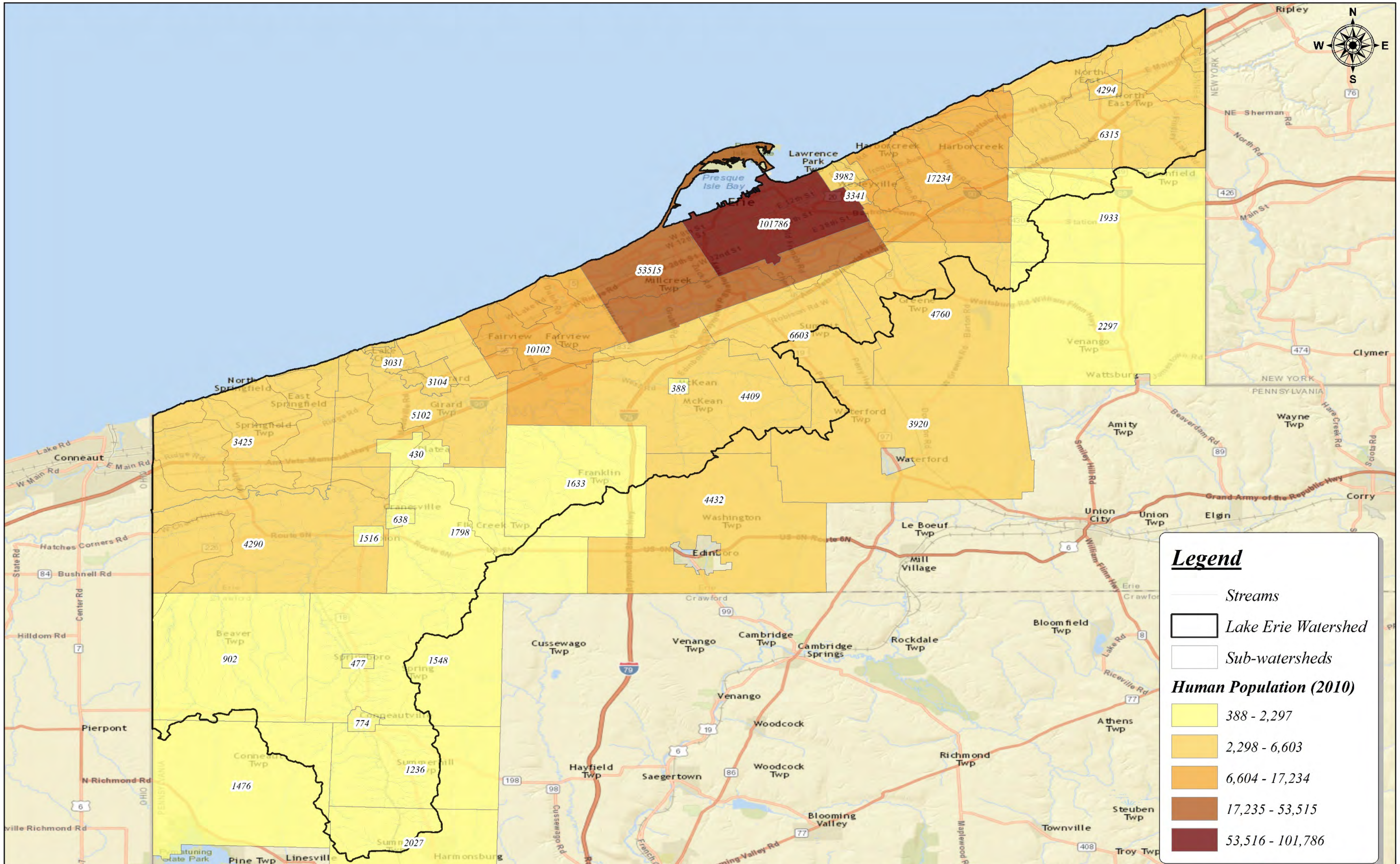
Map 14. Human Population within Municipalities Intersecting the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: U.S. Census Bureau (2010)

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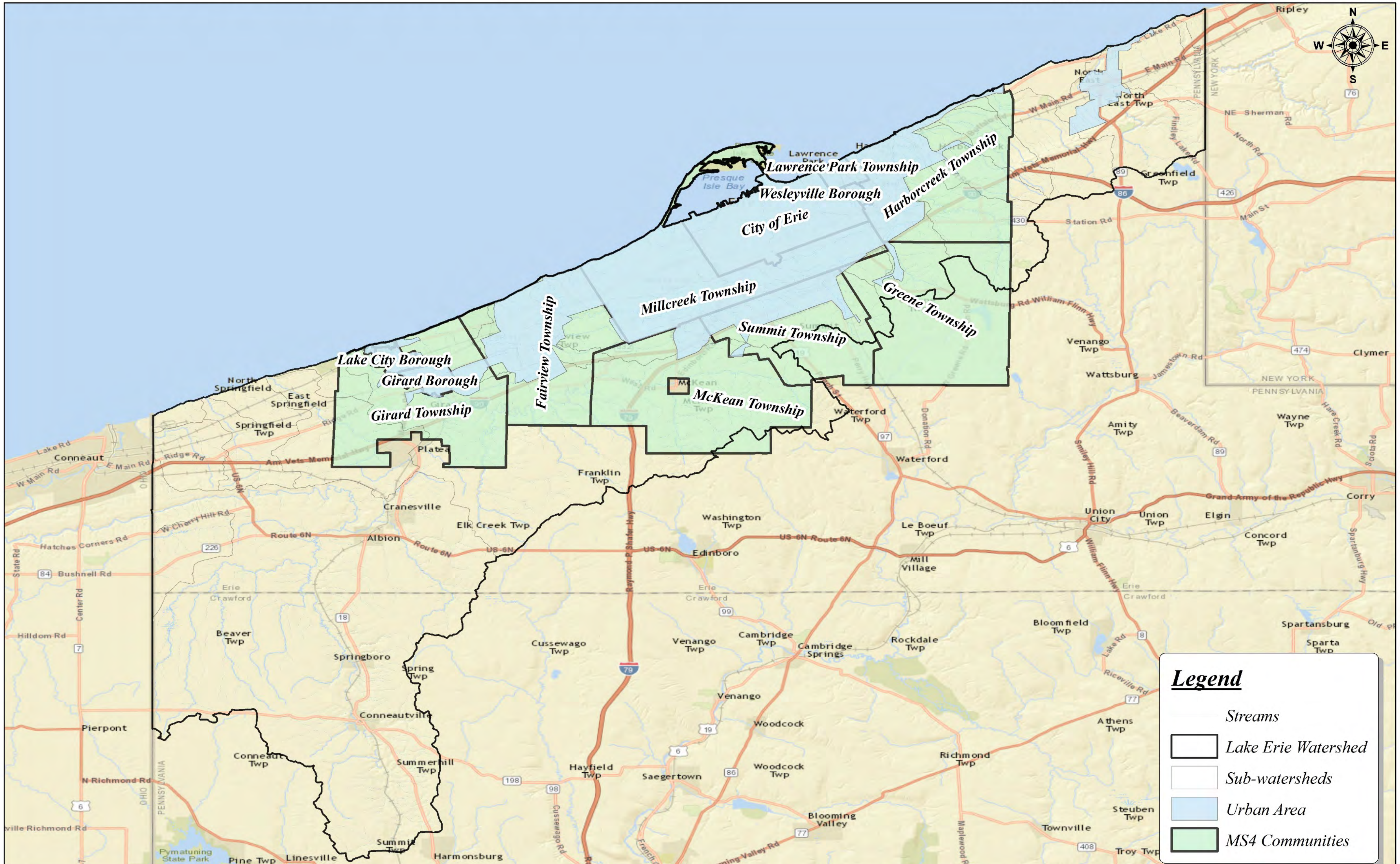
Map 15. Urban Area and MS4 Communities within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DEP; PennDOT

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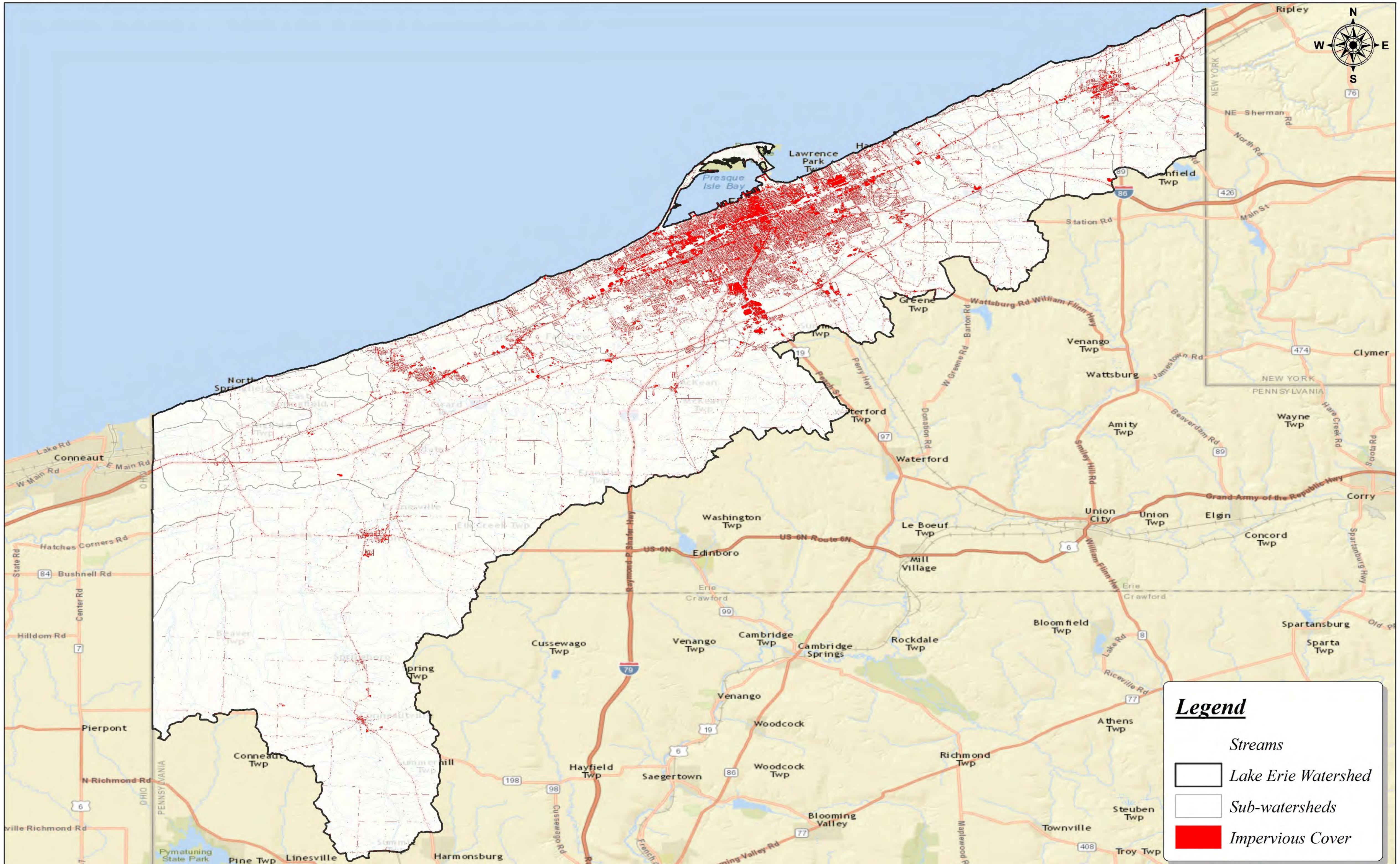
Map 16. Impervious Cover within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: Woolpert, Inc.; Pennsylvania Sea Grant

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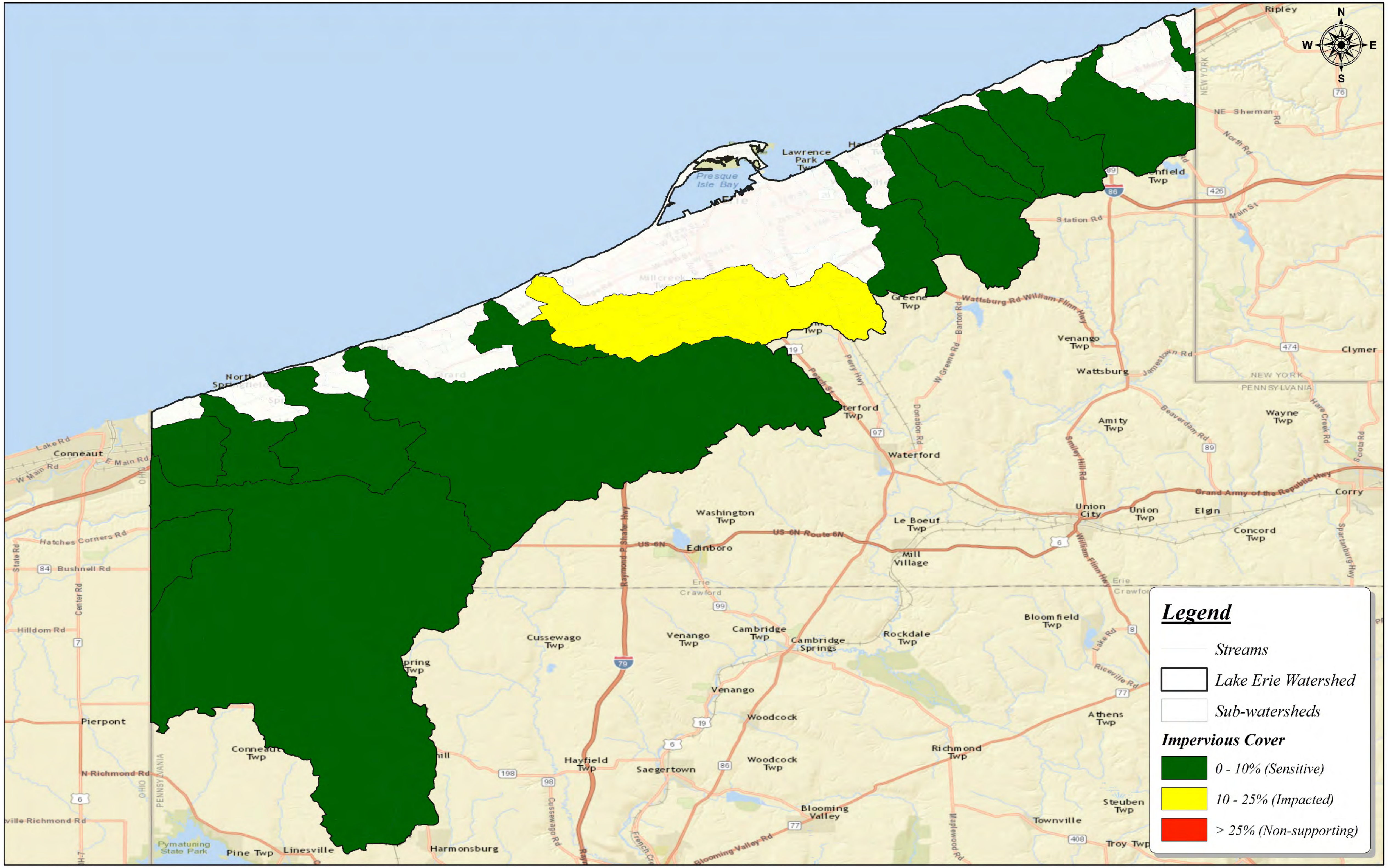
Map 17. Impervious Cover within the Pennsylvania Lake Erie Watershed Classified According to Schueler (1994)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Pennsylvania Sea Grant

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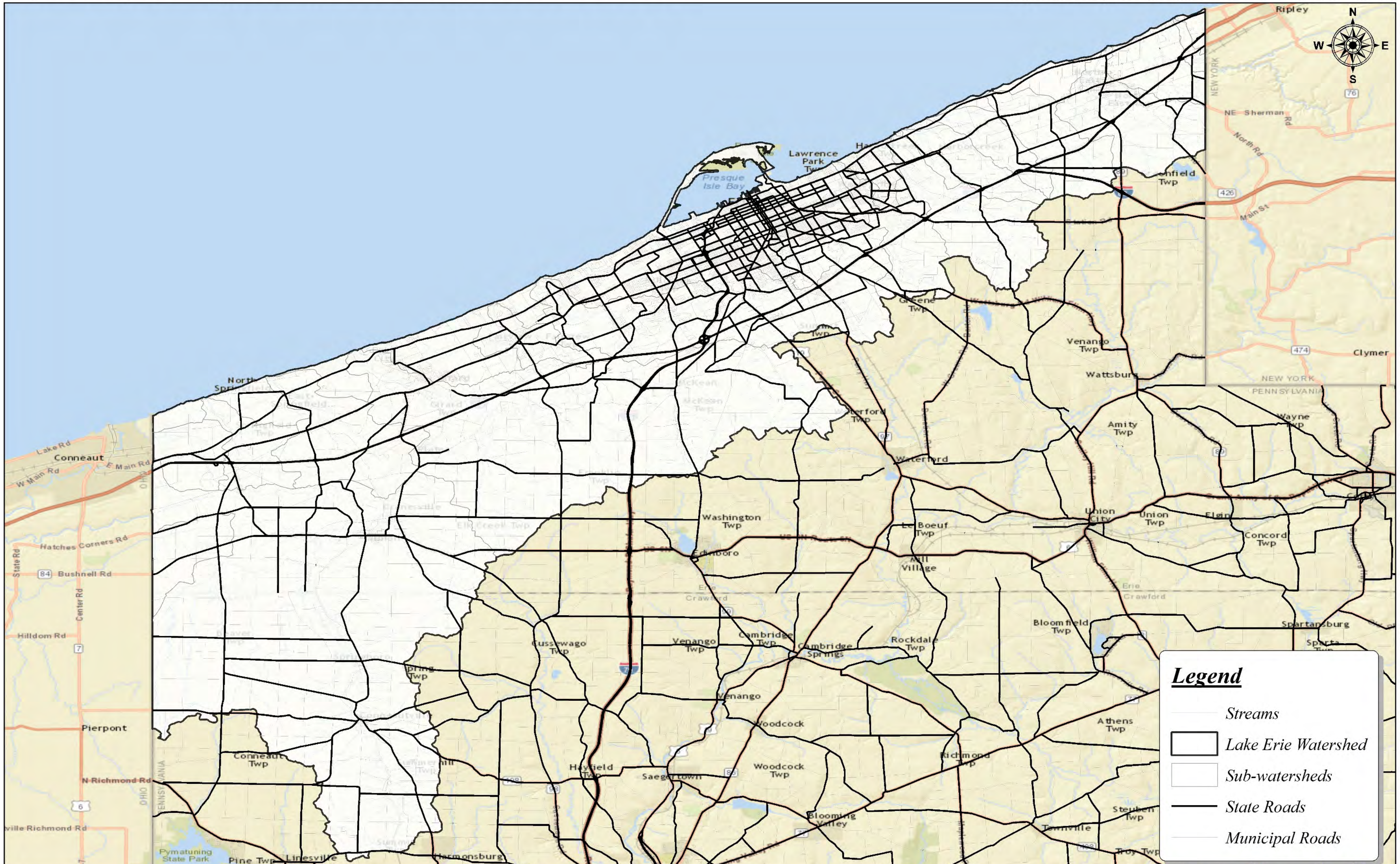
Map 18. Transportation Infrastructure within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PennDOT

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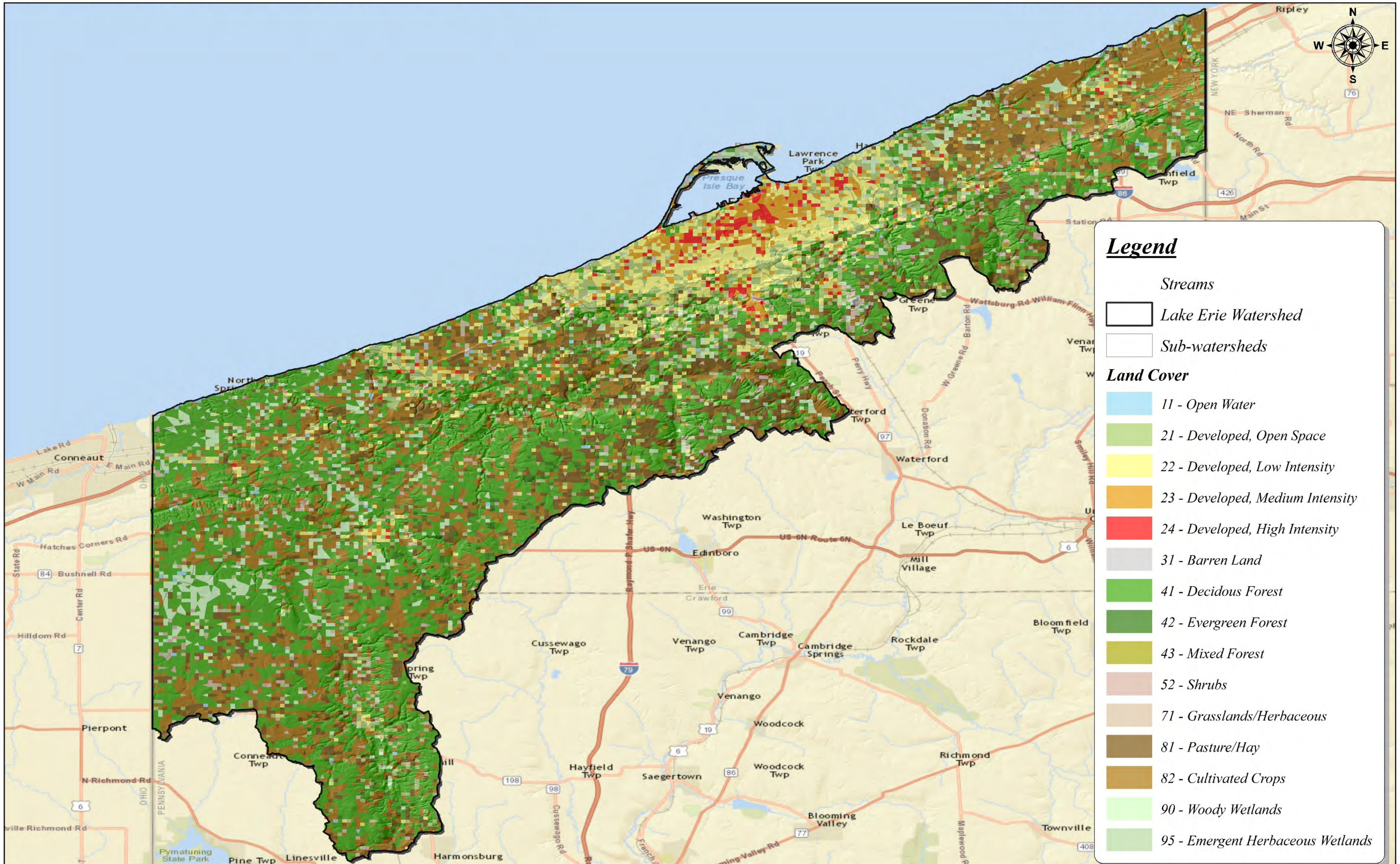
Map 19. Land Cover within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: USGS, NLCD 2011

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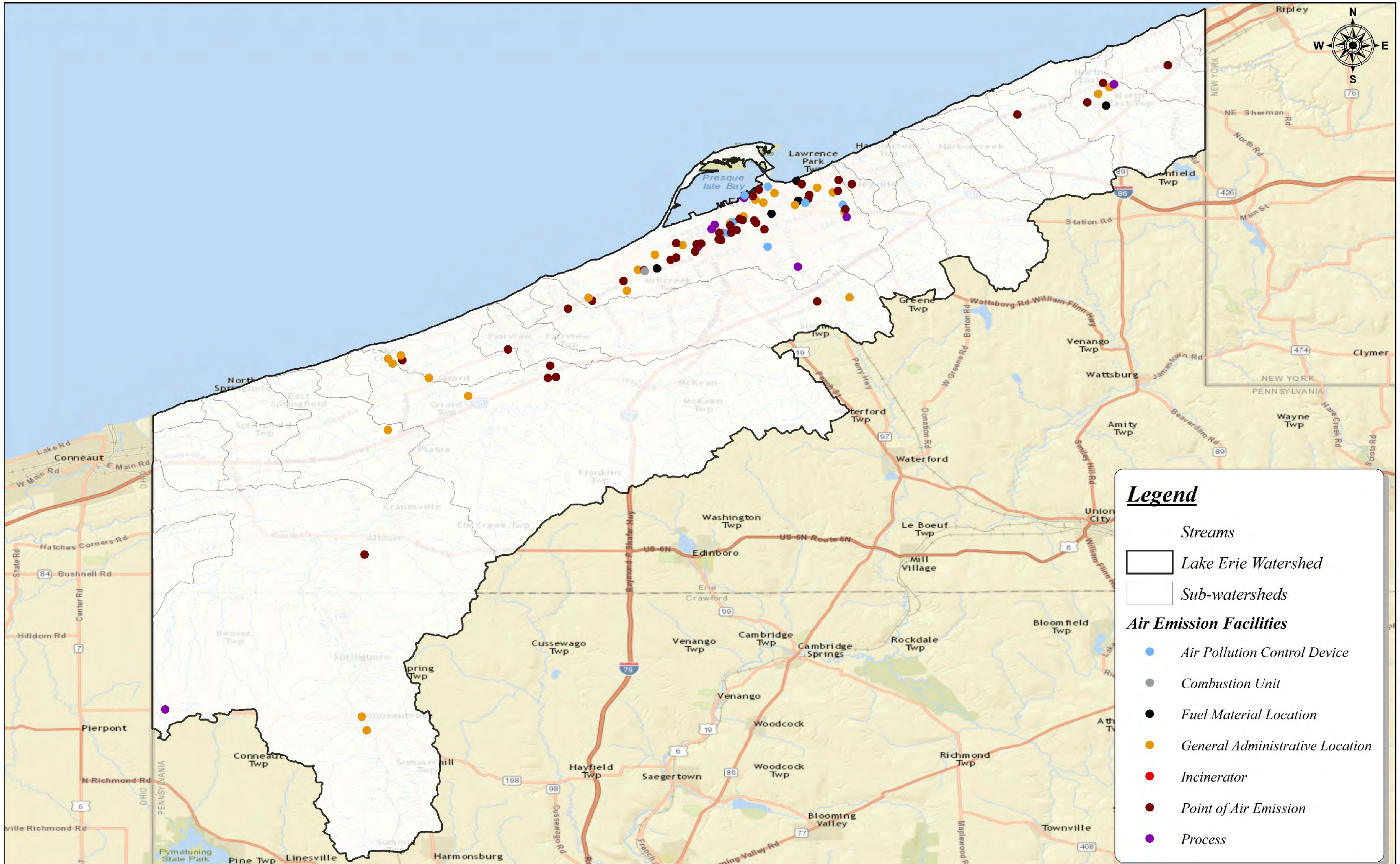
Map 20. Air Emission Facilities within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: PA DEP

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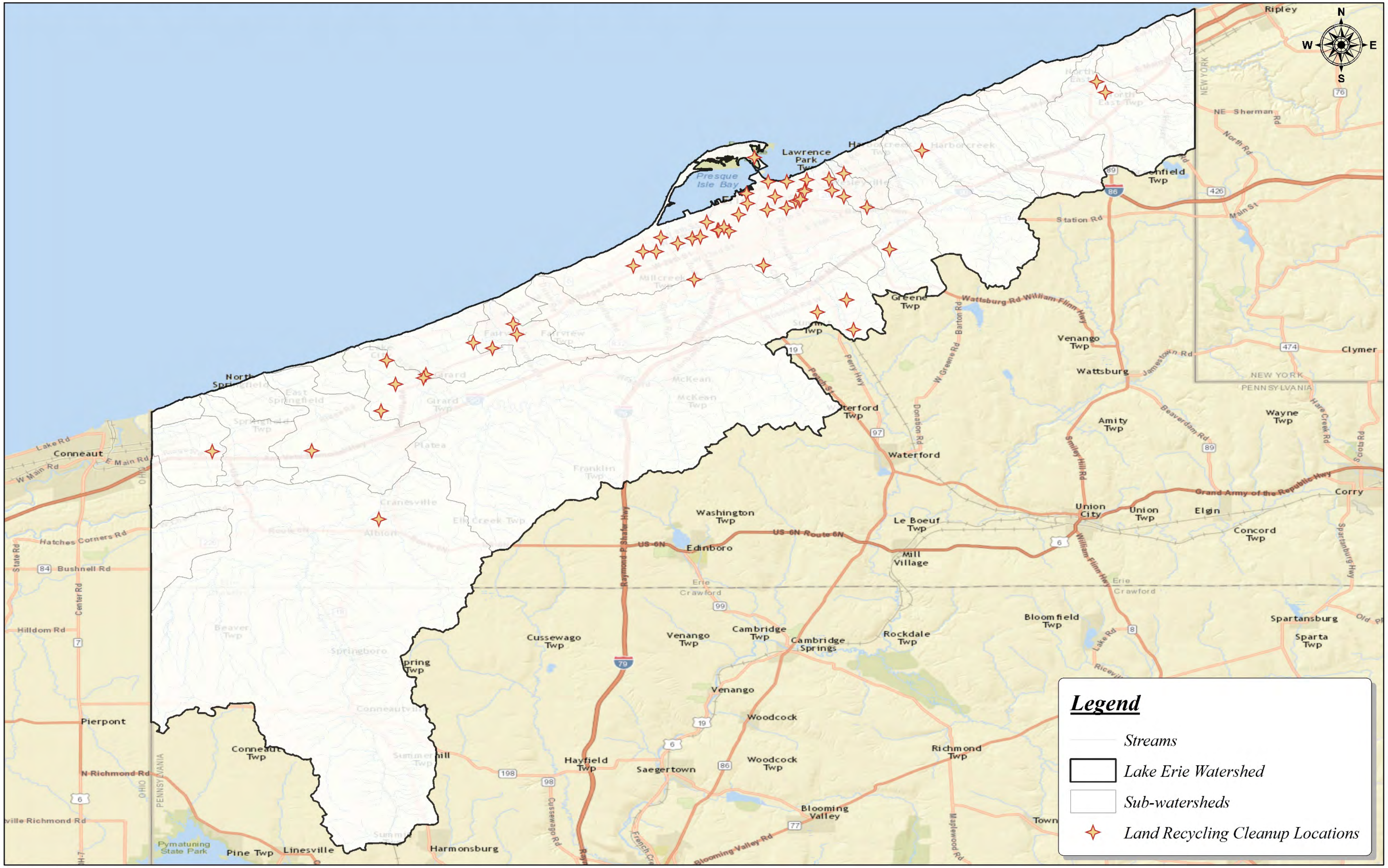
Map 21. Land Recycling Cleanup Locations within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DEP

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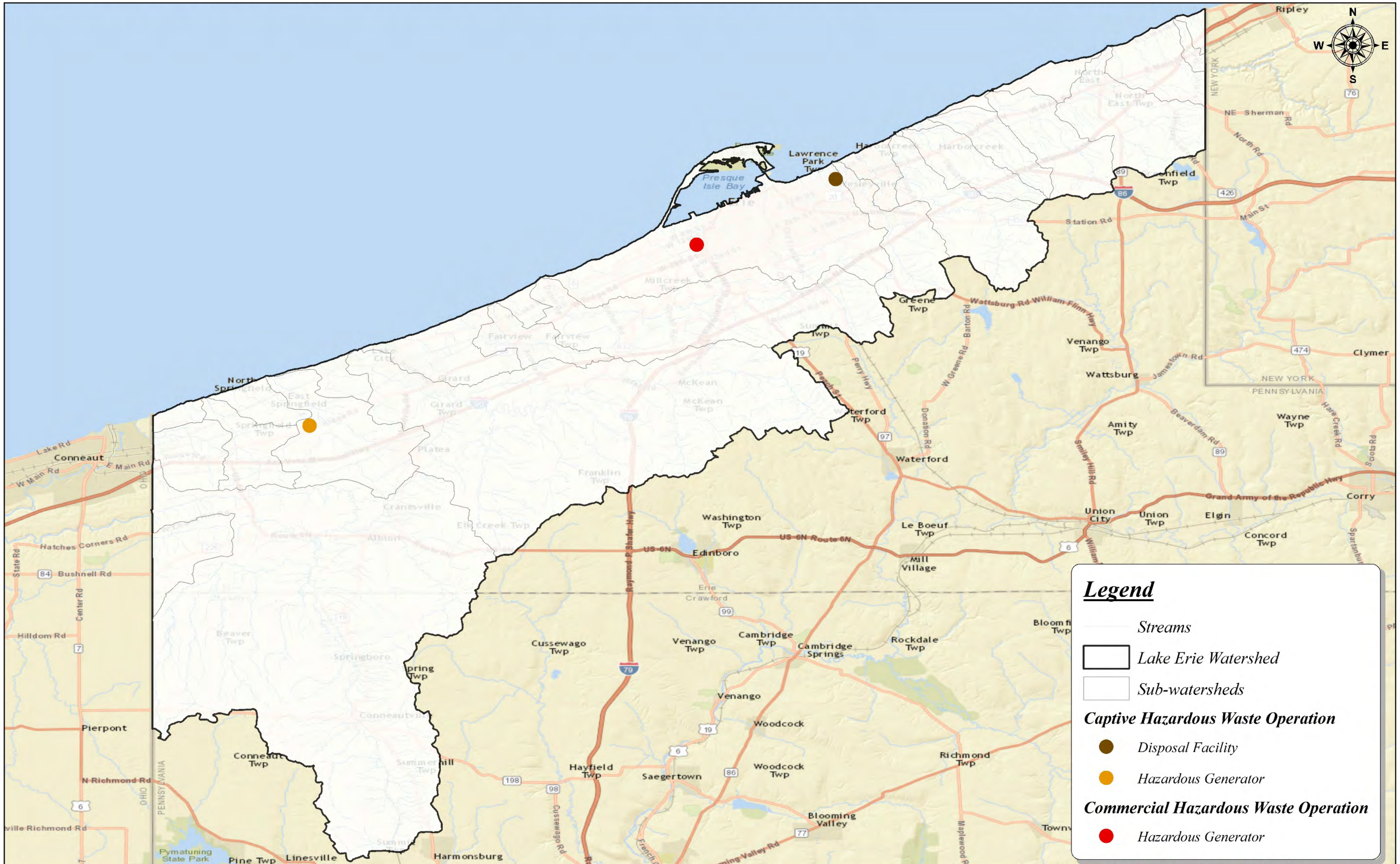
Map 22. Captive and Commercial Hazardous Waste Operations within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DEP

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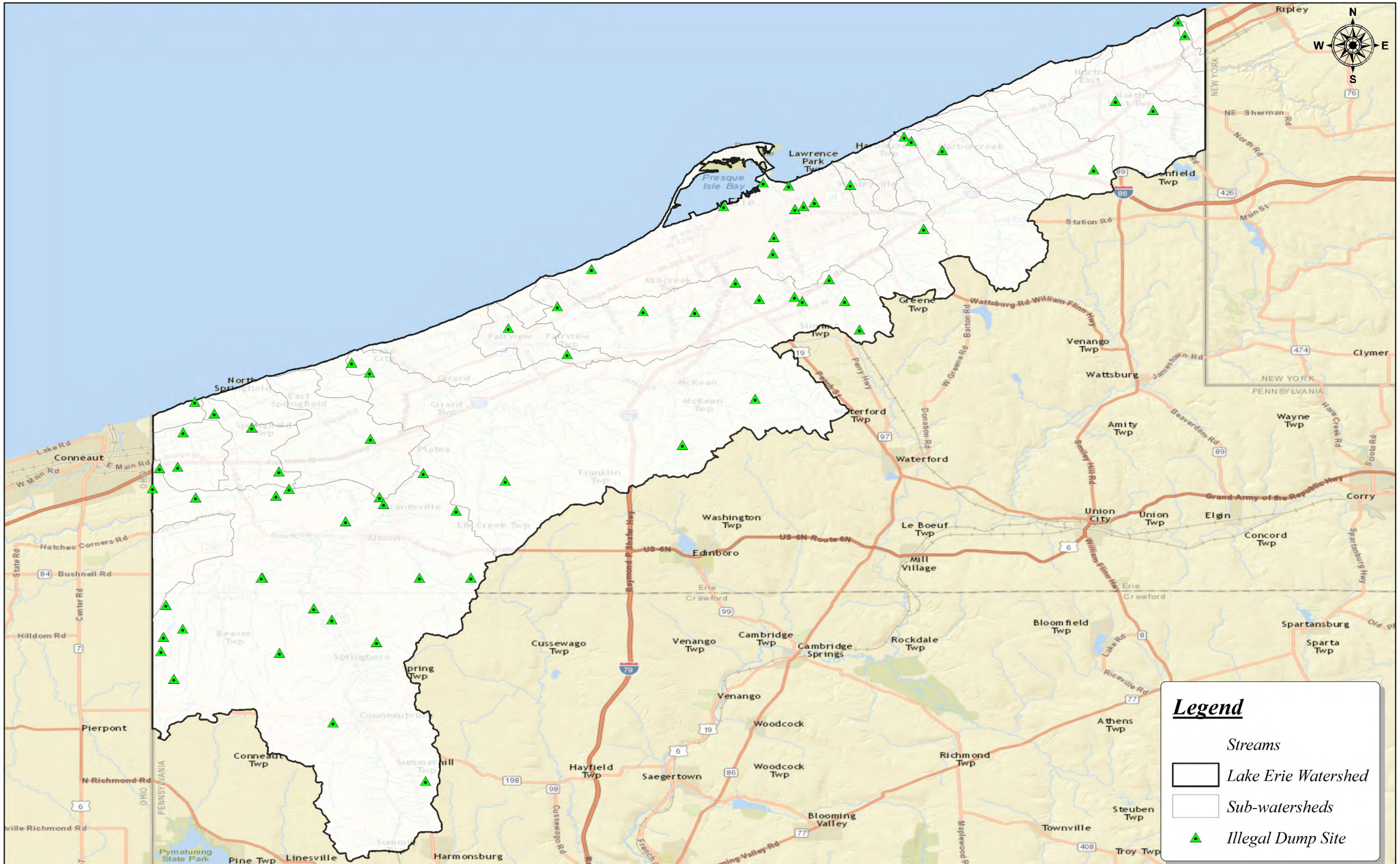
Map 23. Illegal Dump Sites within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Keep Pennsylvania Beautiful

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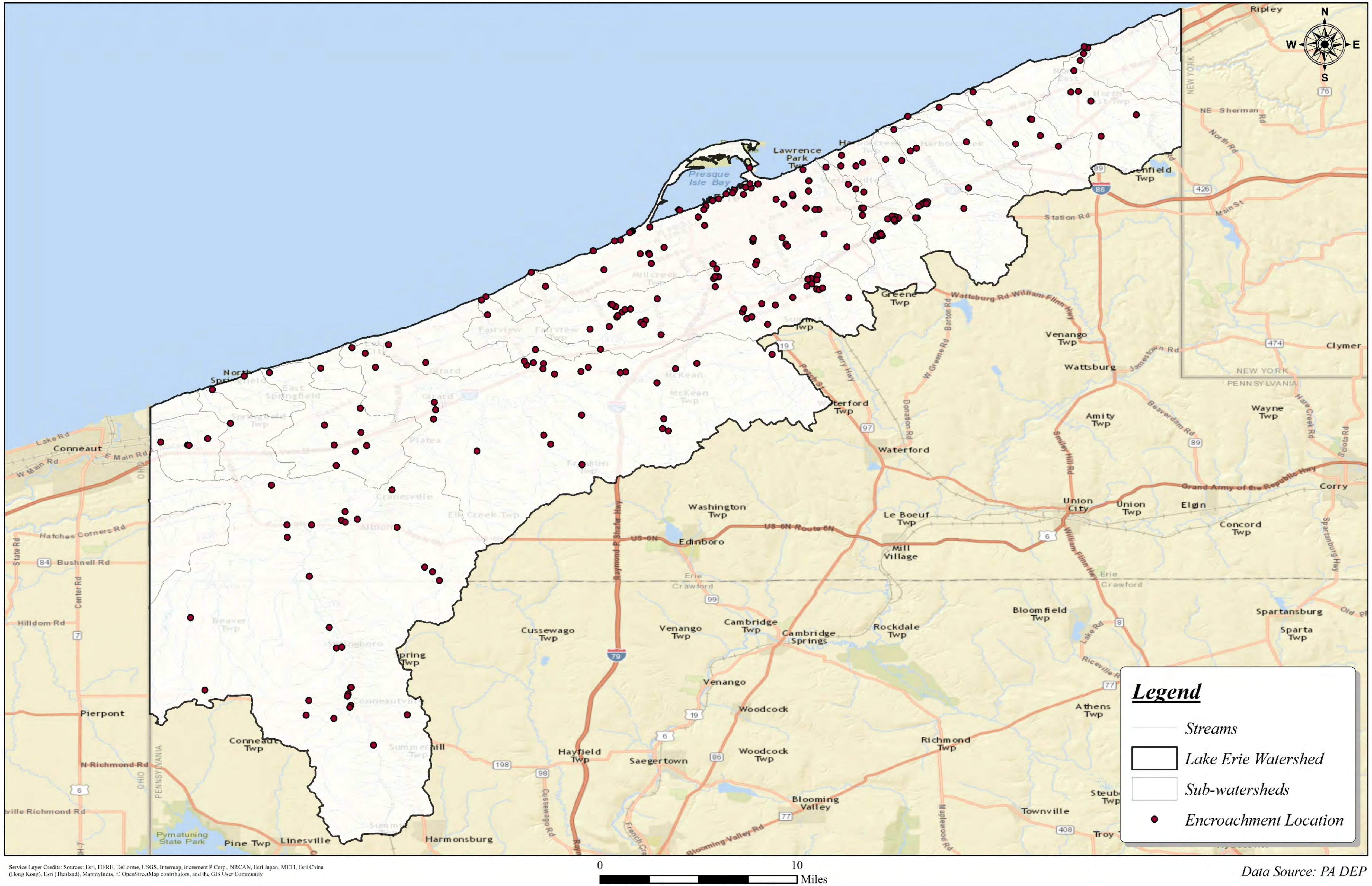
Map 24. Encroachment Locations within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: PA DEP

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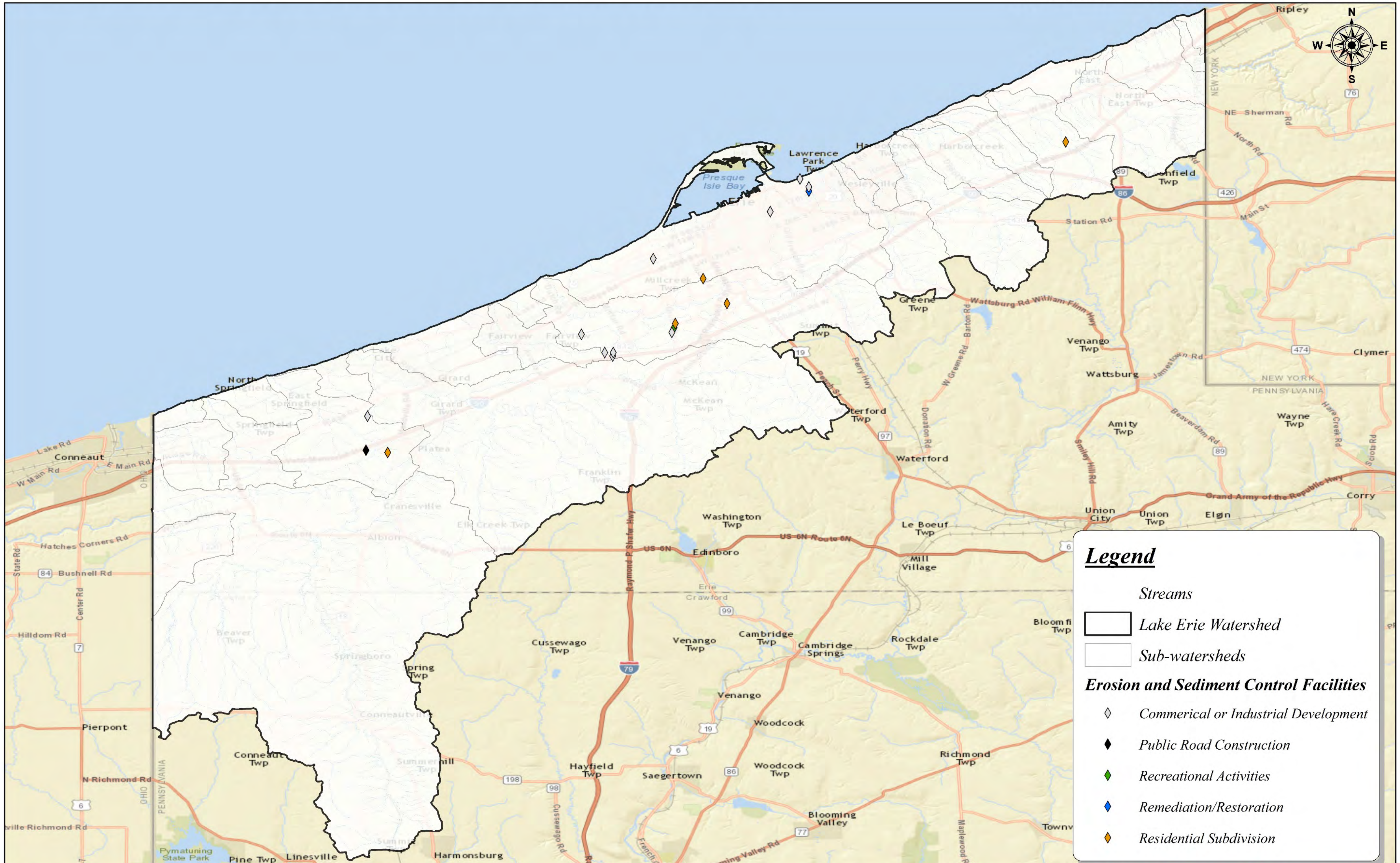
Map 25. Erosion and Sediment Control Facilities within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: PA DEP

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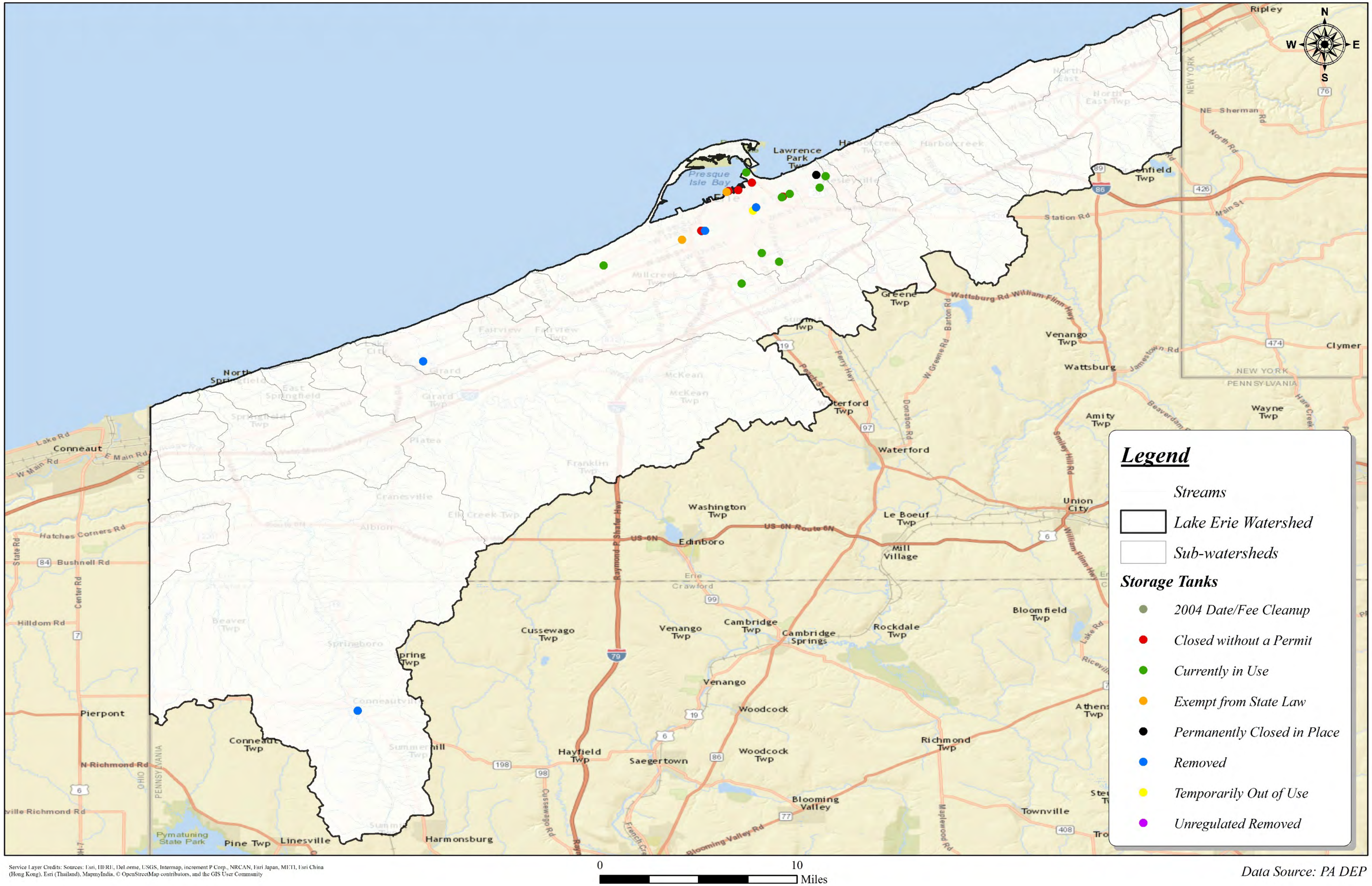
Map 26. Storage Tanks within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: PA DEP

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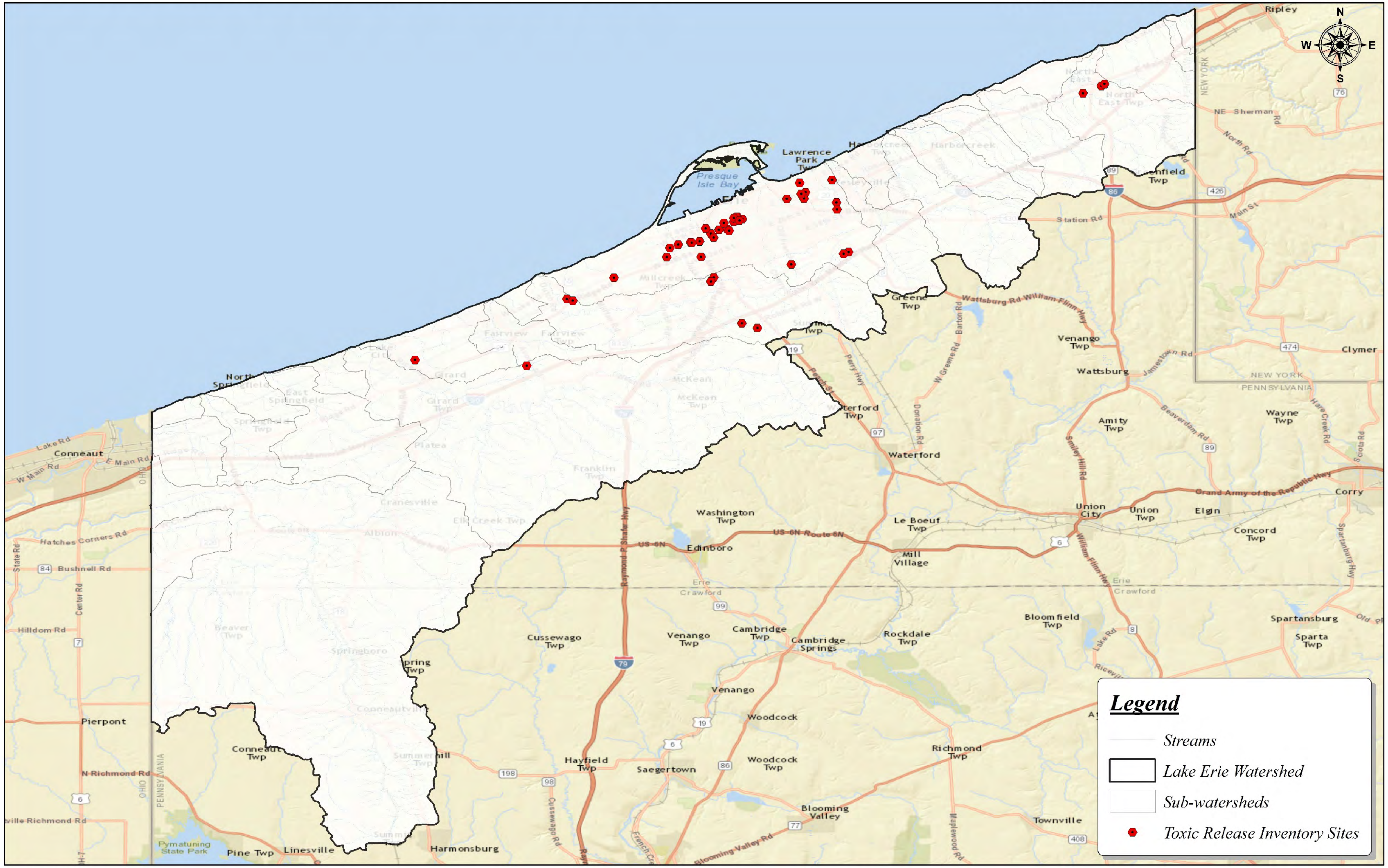
Map 27. Toxic Release Inventory Sites within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: US EPA

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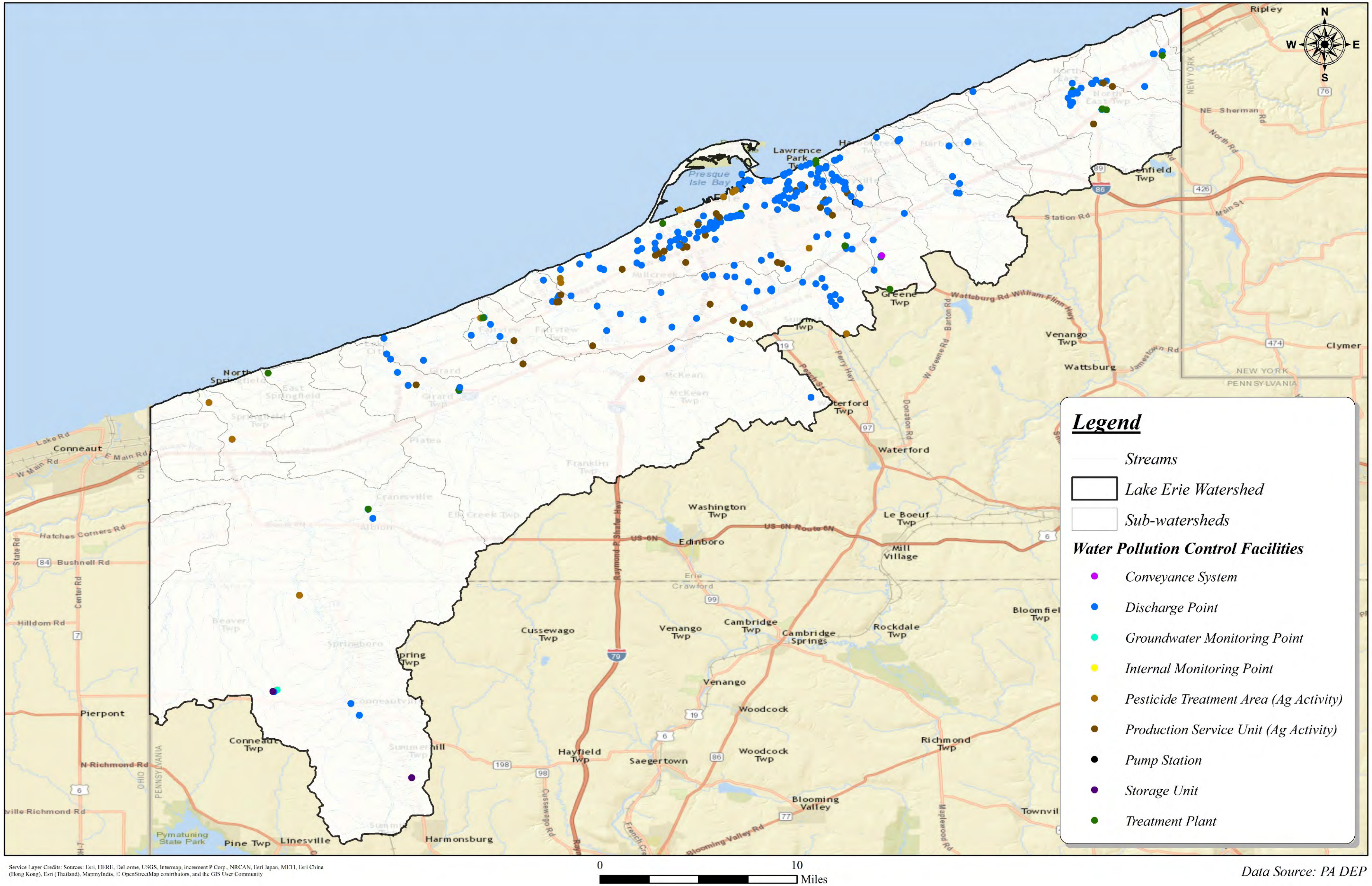
Map 28. Water Pollution Control Facilities within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: PA DEP

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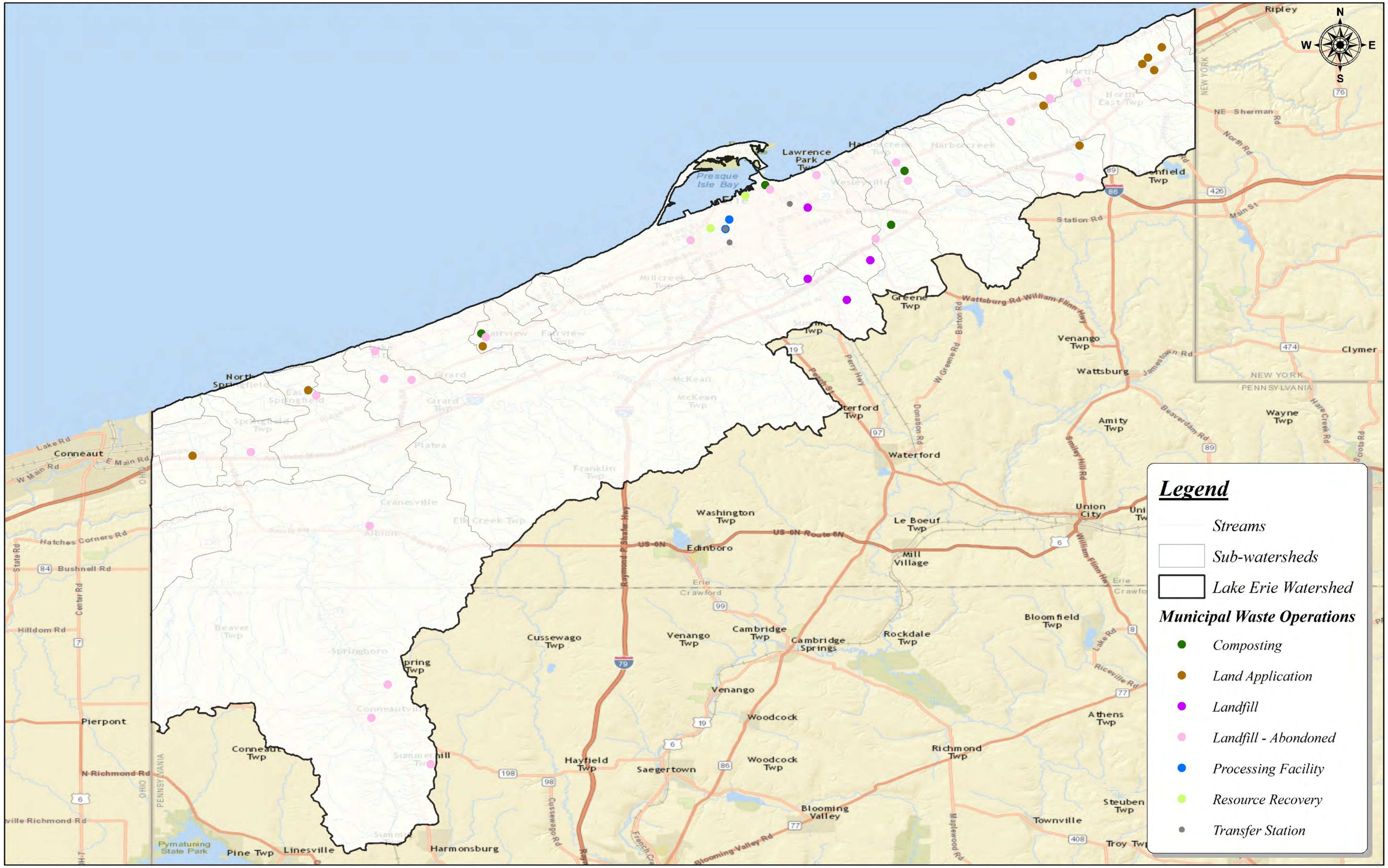
Map 29. Municipal Waste Operations within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: PA DEP

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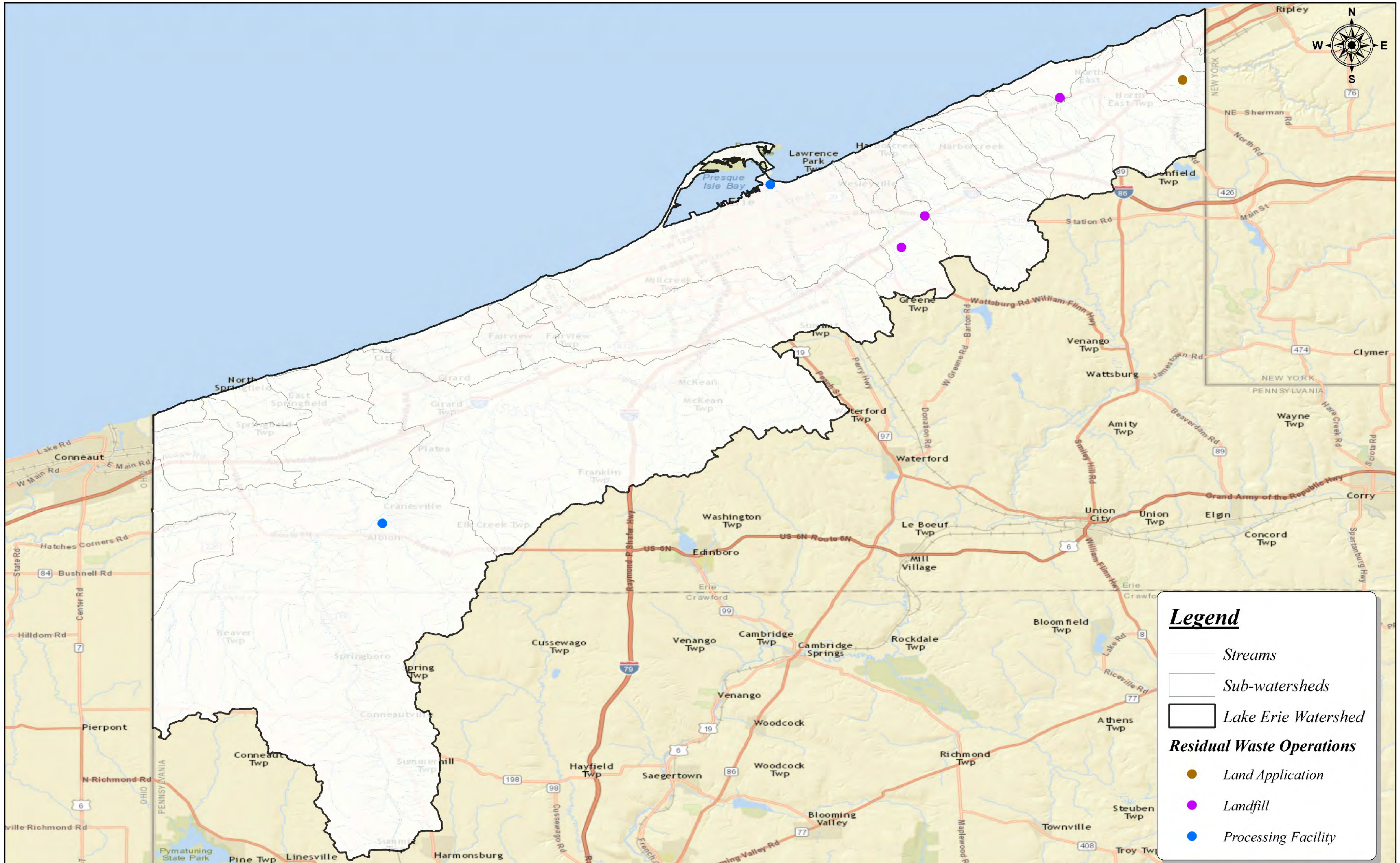
Map 30. Residual Waste Operations within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DEP

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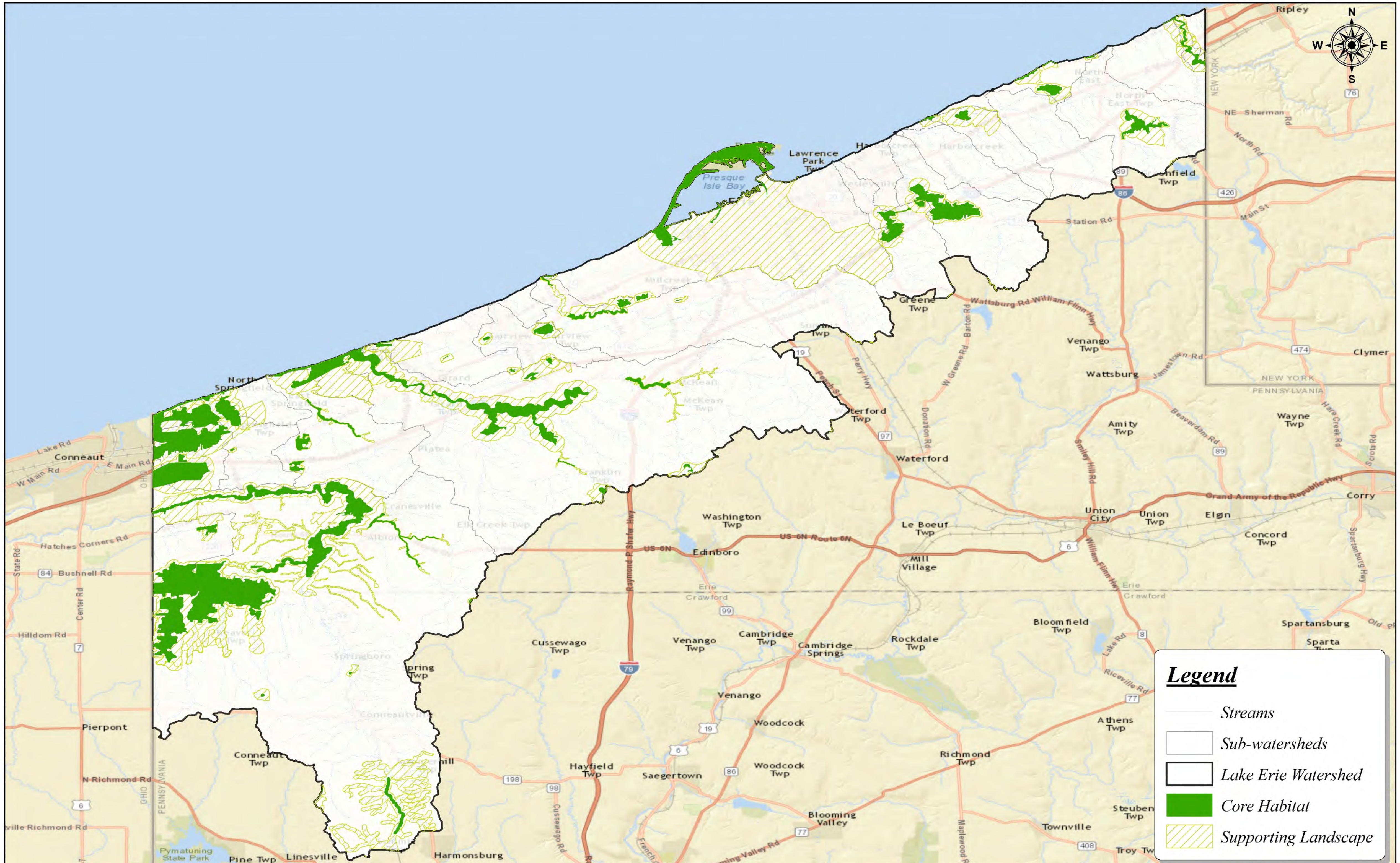
Map 31. Core Habitat of Biological Diversity Areas and Supporting Landscapes within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: PNHP

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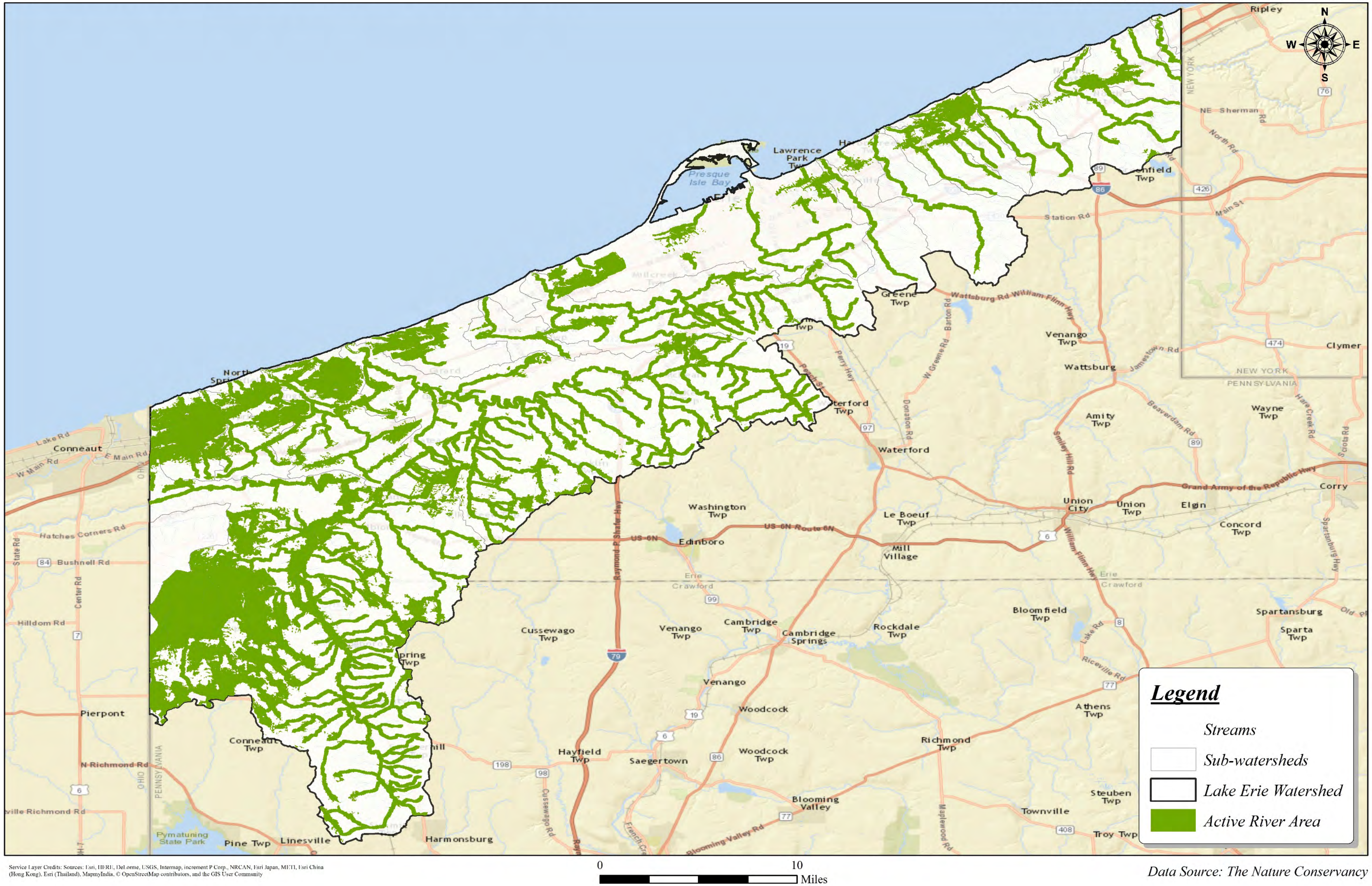
Map 32. Active River Area within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: The Nature Conservancy

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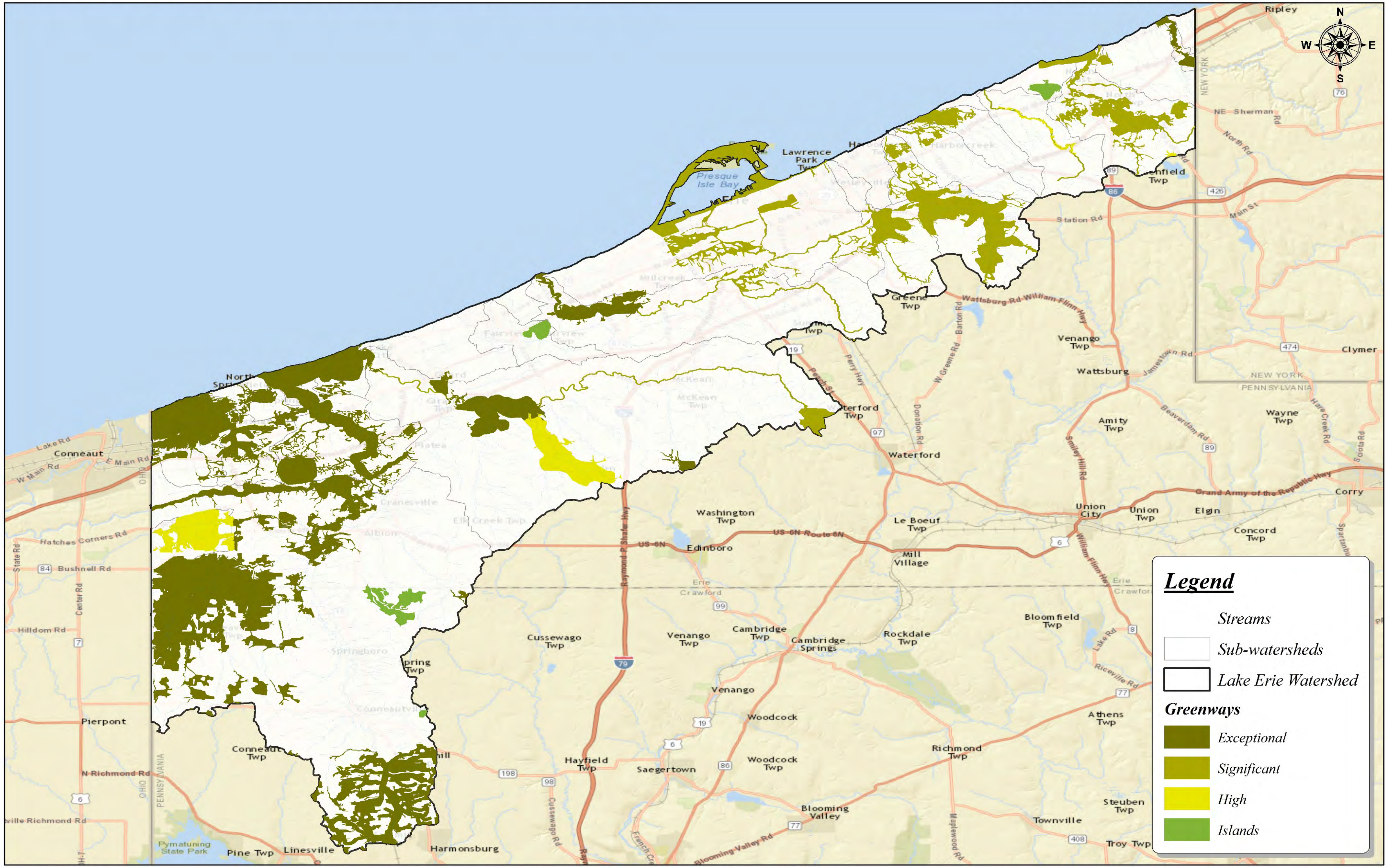
Map 33. Natural Systems Greenways within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Pashek Associates

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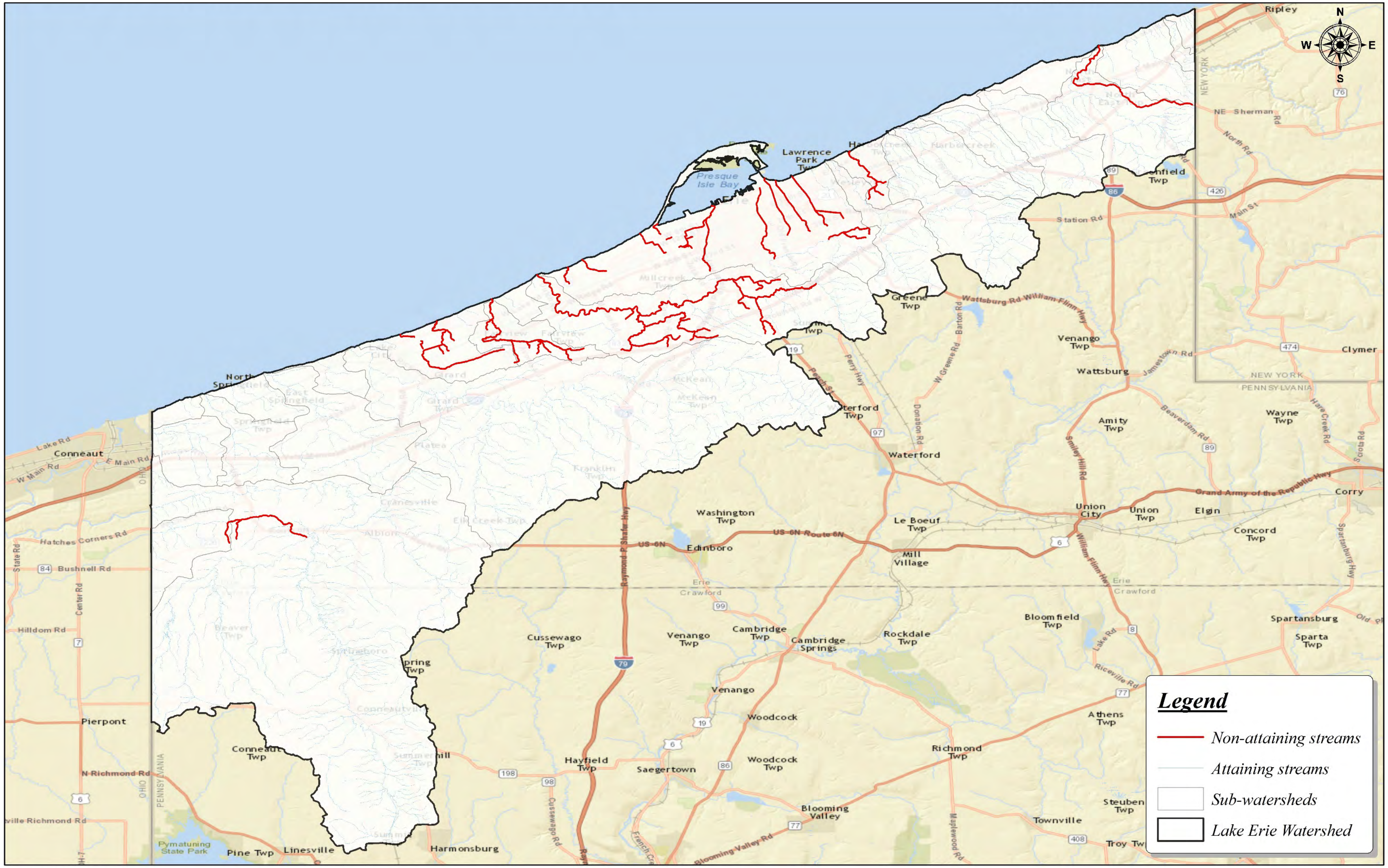
Map 34. Non-Attaining Streams within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DEP

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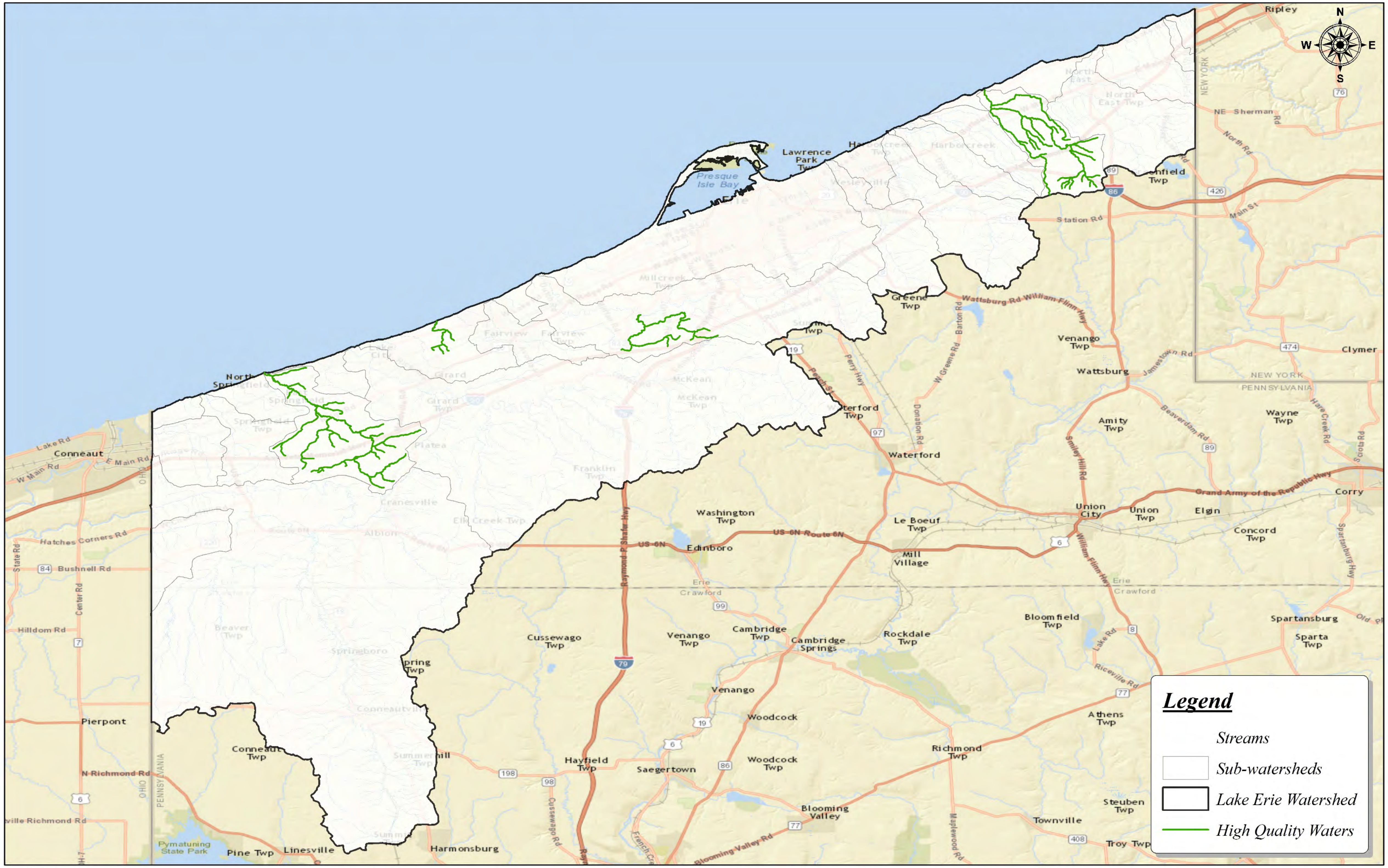
Map 35. High Quality Waters within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: USGS, NHD

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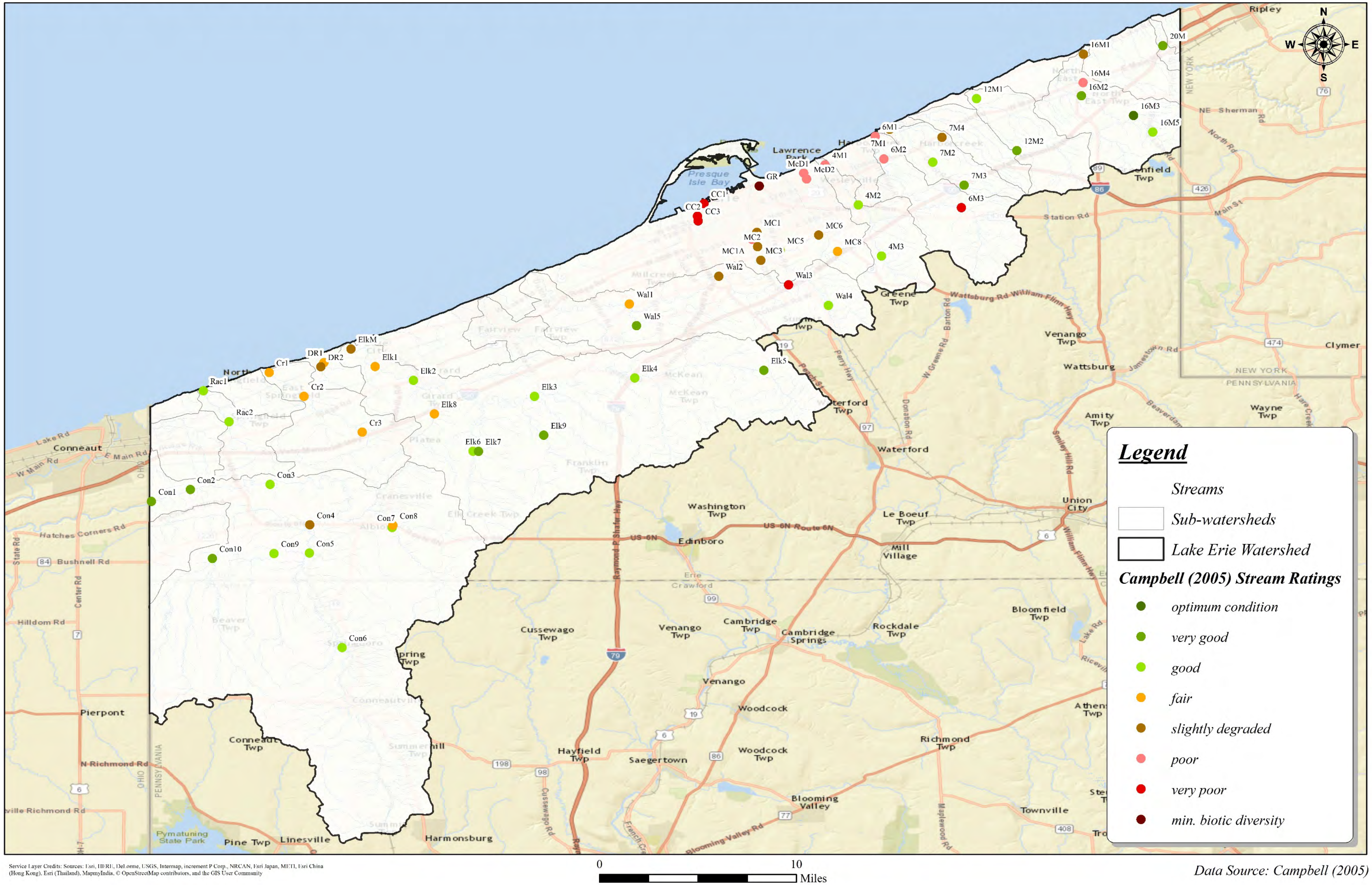
Map 36. Pennsylvania Lake Erie Watershed Macroinvertebrate Community-Based Stream Ratings (Campbell, 2005) *Map Produced by Pennsylvania Sea Grant (Penn State University)*



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Data Source: Campbell (2005)

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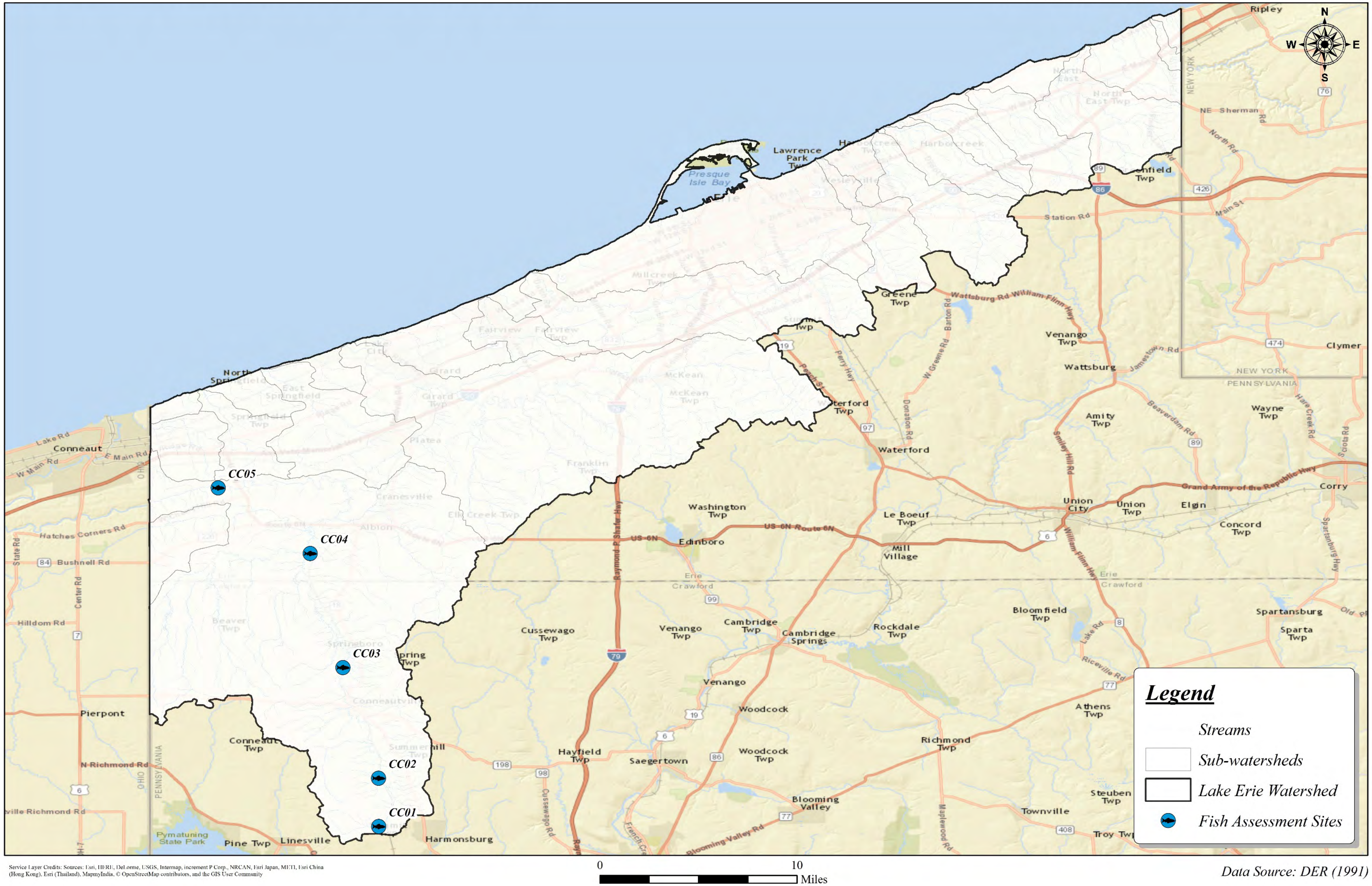
Map 37. Conneaut Creek Fish Community Assessment (DER, 1991)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: DER (1991)

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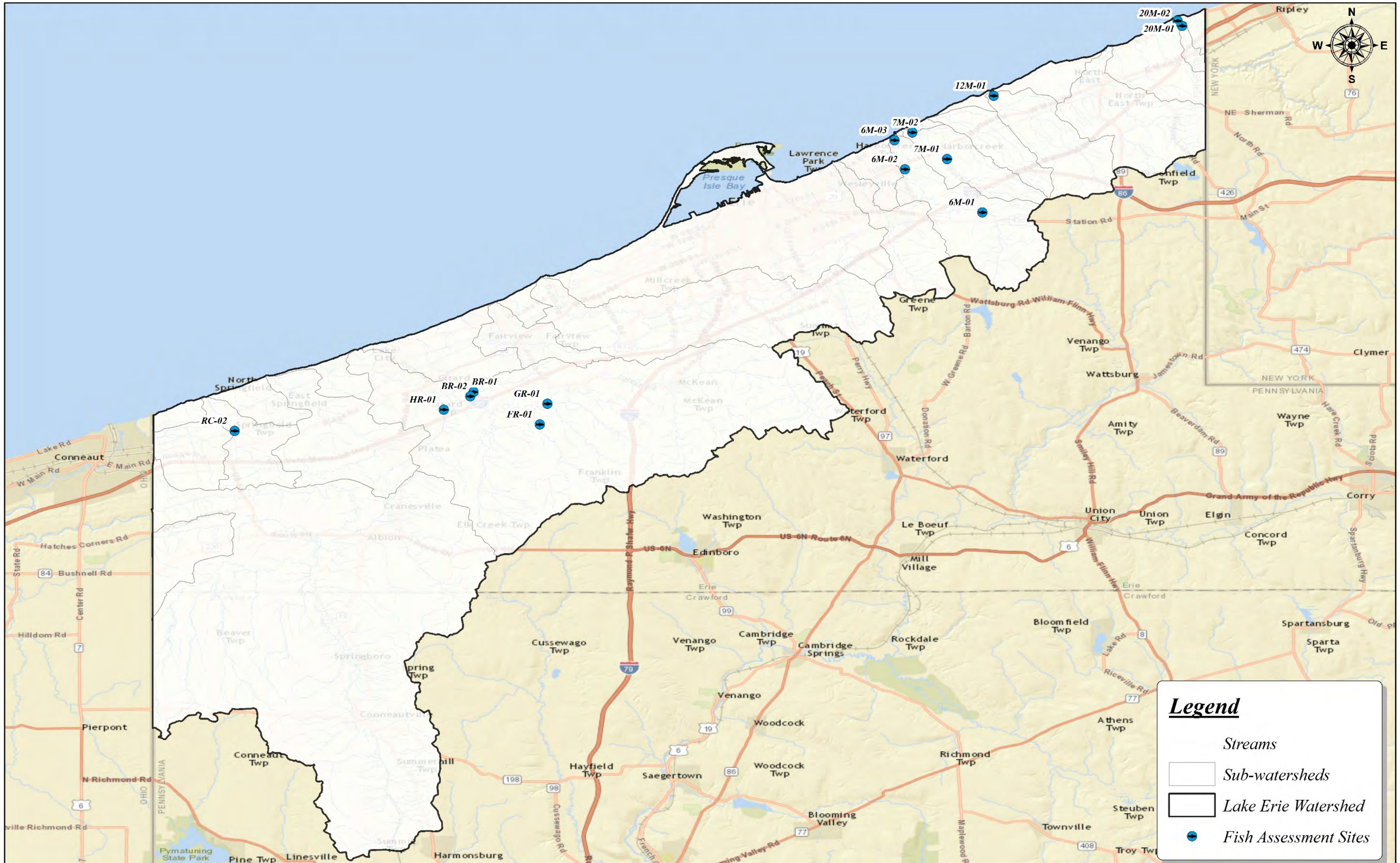
Map 38. Pennsylvania Lake Erie Watershed Fish Community Assessment (Billingsley and Johns, 1996-98)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Billingsley and Johns (1996-98)

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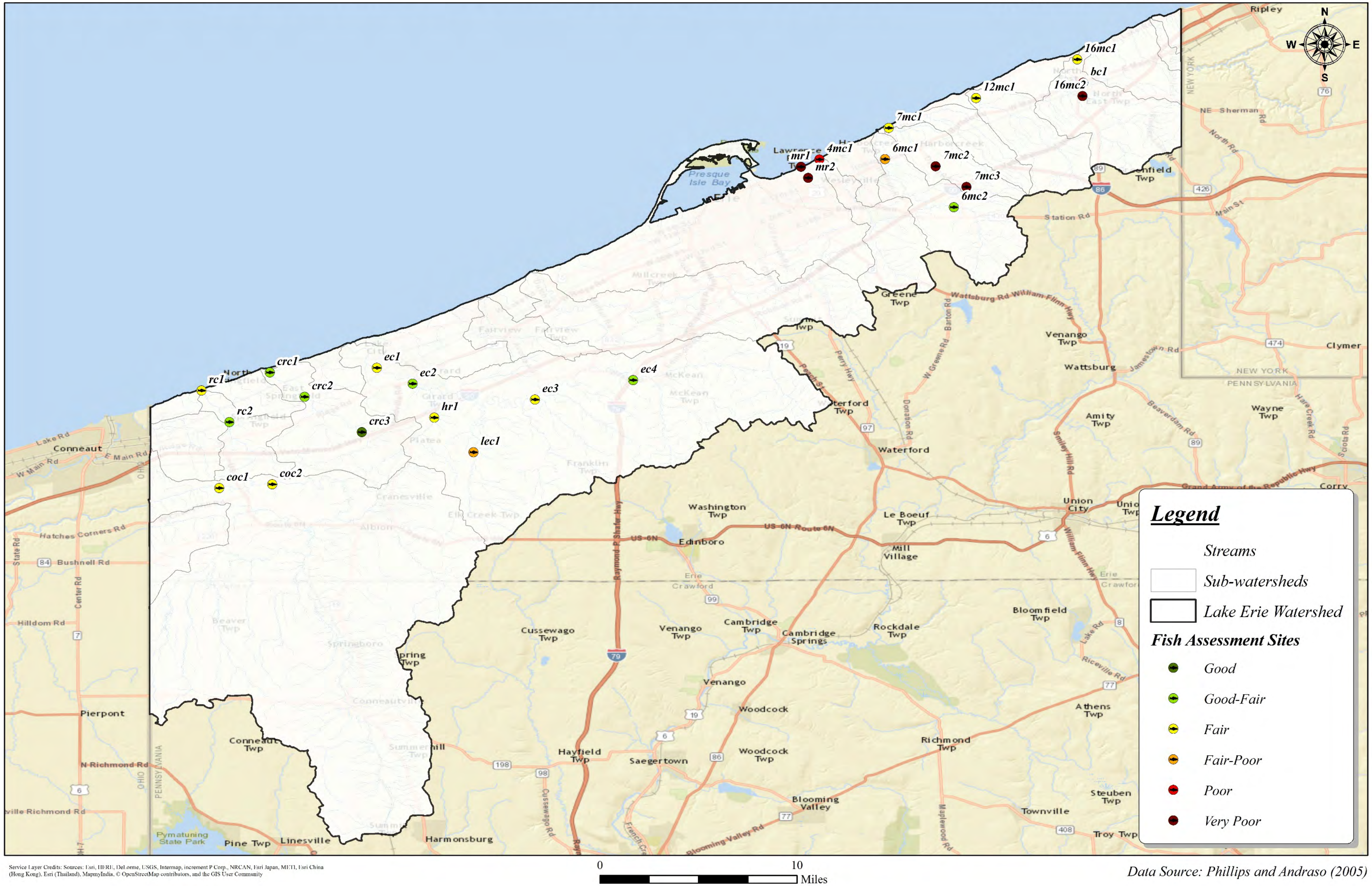
Map 39. IBI-Based Pennsylvania Lake Erie Watershed Fish Community Assessment (Phillips and Andraso, 2005)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Phillips and Andraso (2005)

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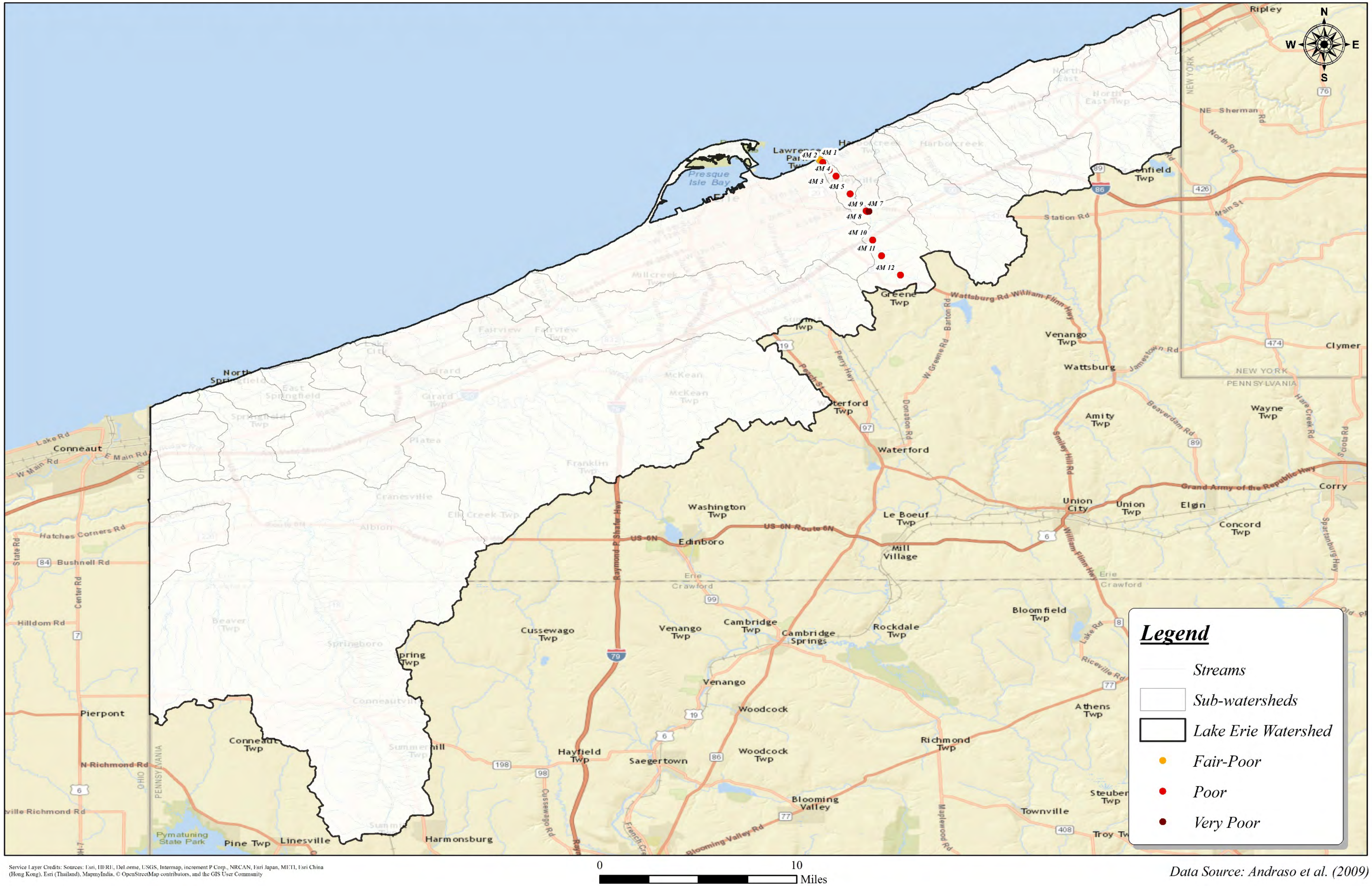
Map 40. Fourmile Creek Watershed IBI-Based Fish Community Assessment (Andraso et al., 2009)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Data Source: Andraso et al. (2009)

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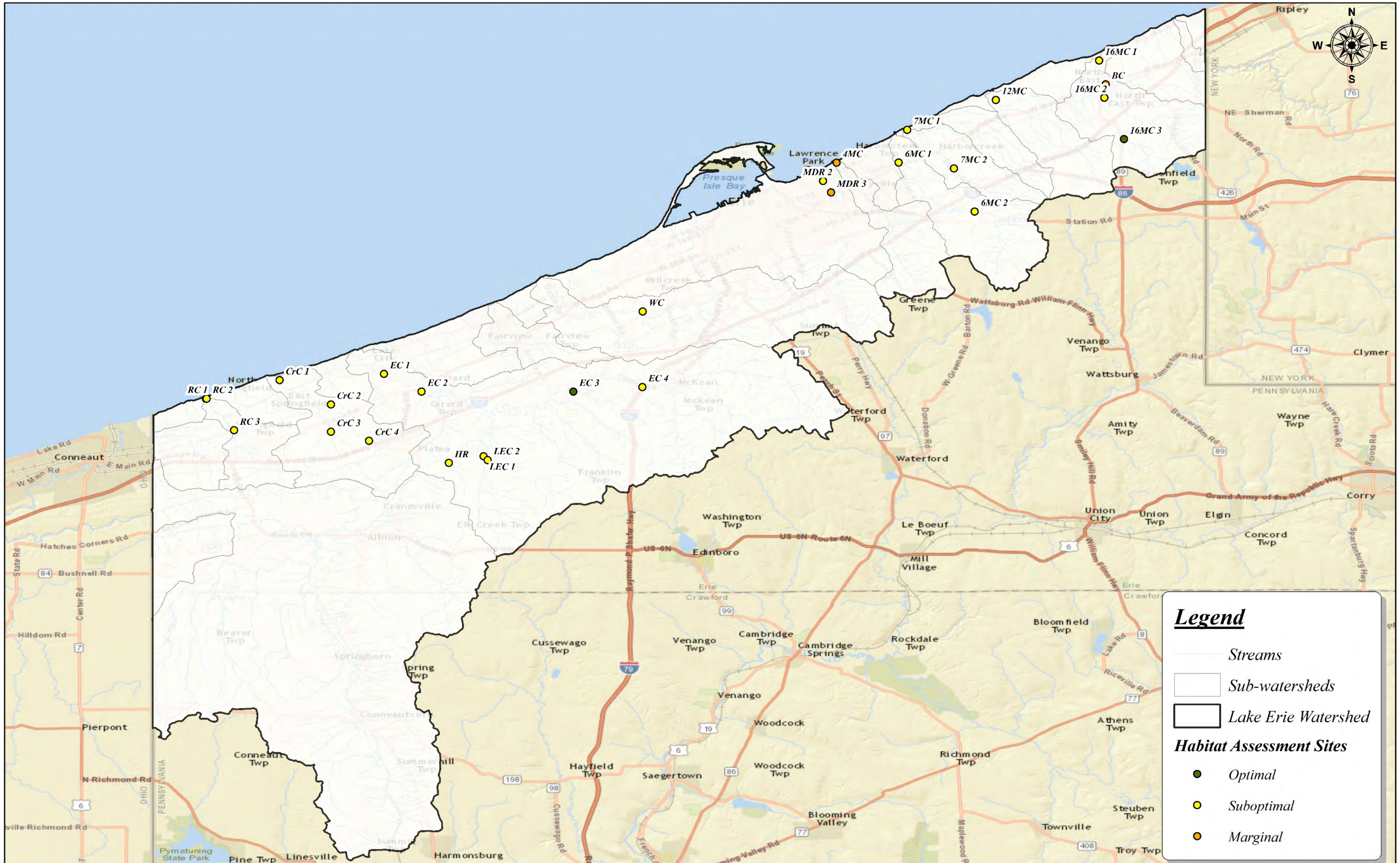
Map 41. Pennsylvania Lake Erie Watershed Stream Habitat Assessment (Diz and Powley, 2005)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Diz and Powley (2005)

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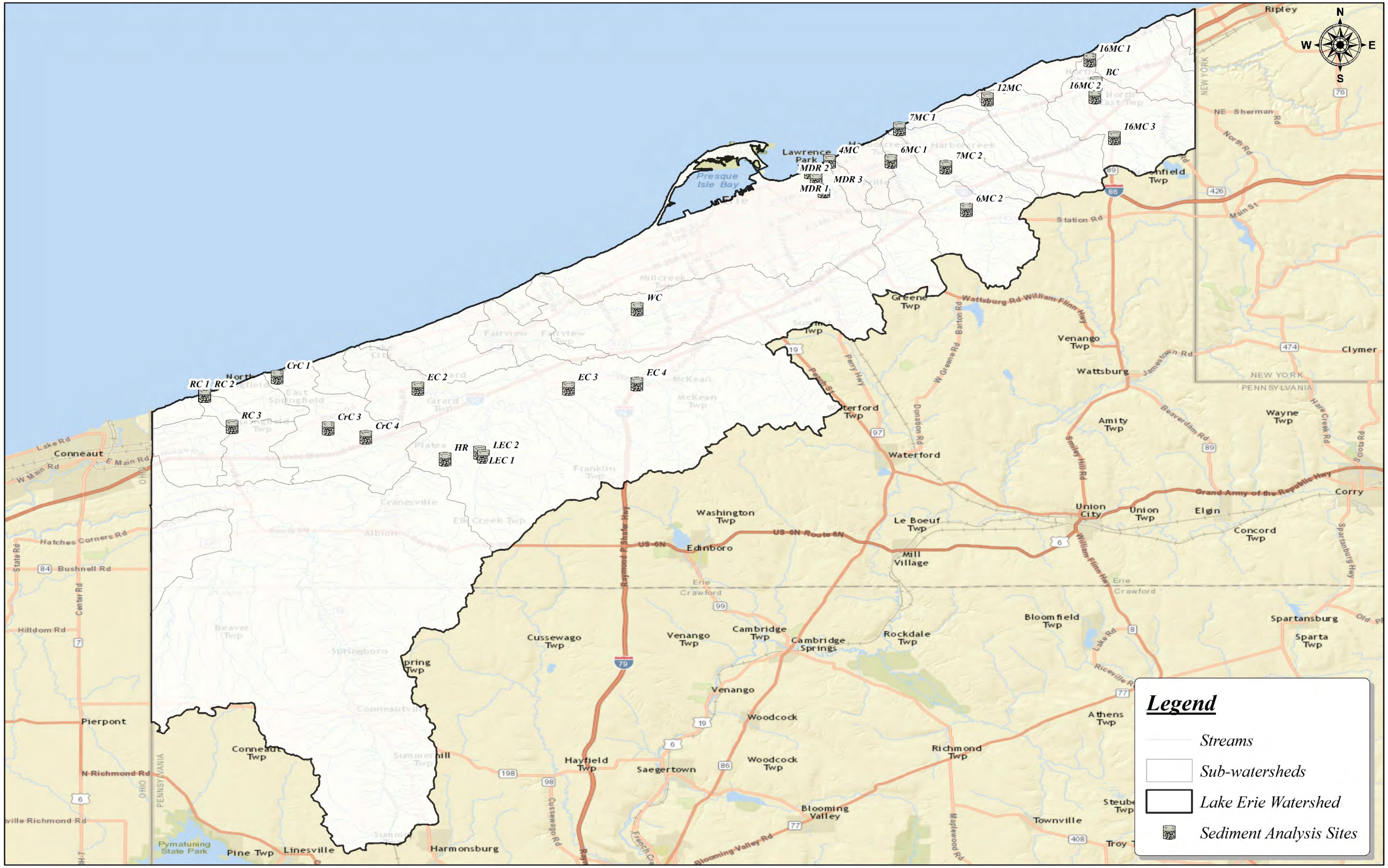
Map 42. Pennsylvania Lake Erie Watershed Stream Sediment Analysis (Diz and Powley, 2005)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Diz and Powley (2005)

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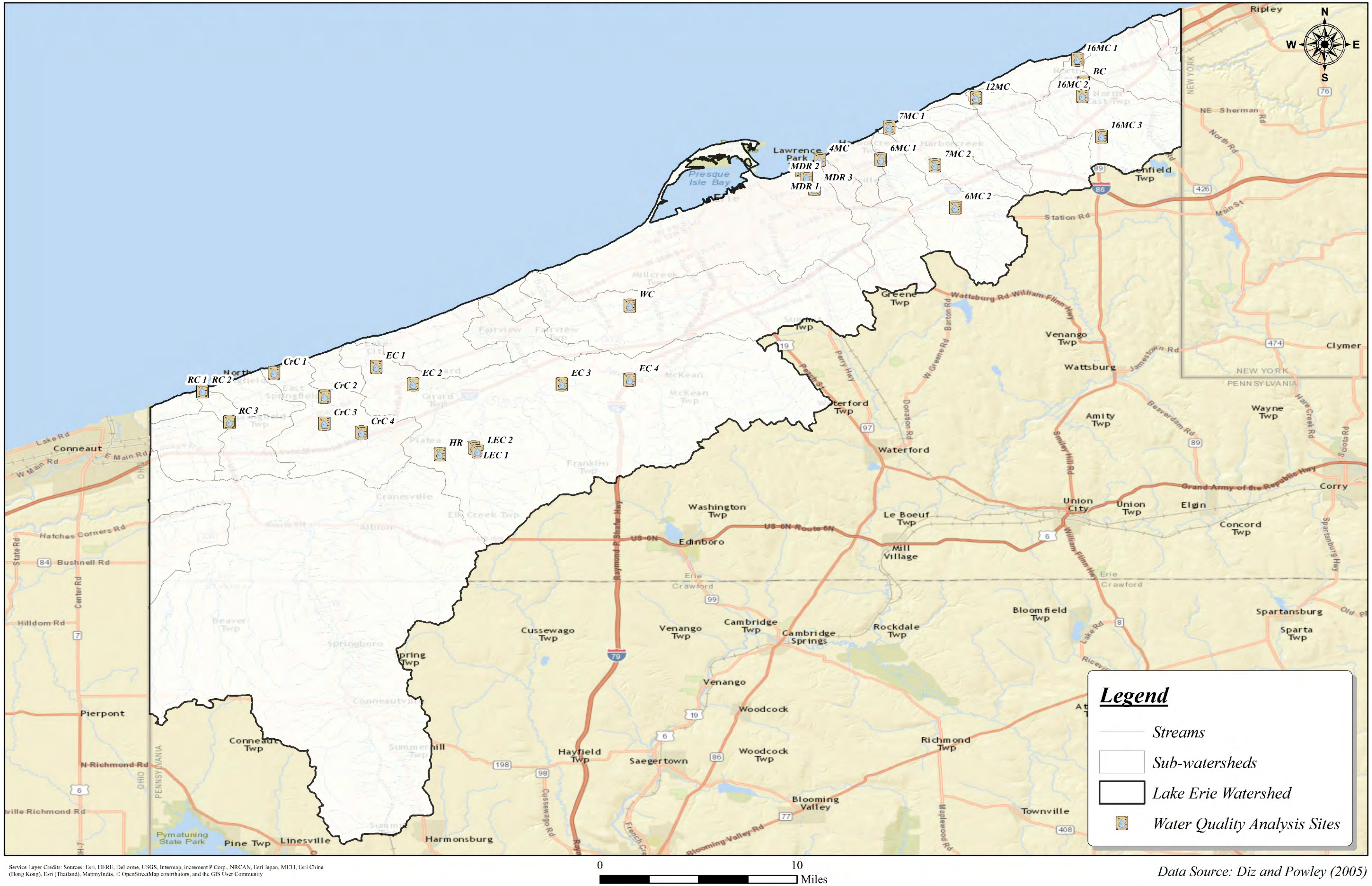
Map 43. Pennsylvania Lake Erie Watershed Stream Water Quality Analysis (Diz and Powley, 2005)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Diz and Powley (2005)

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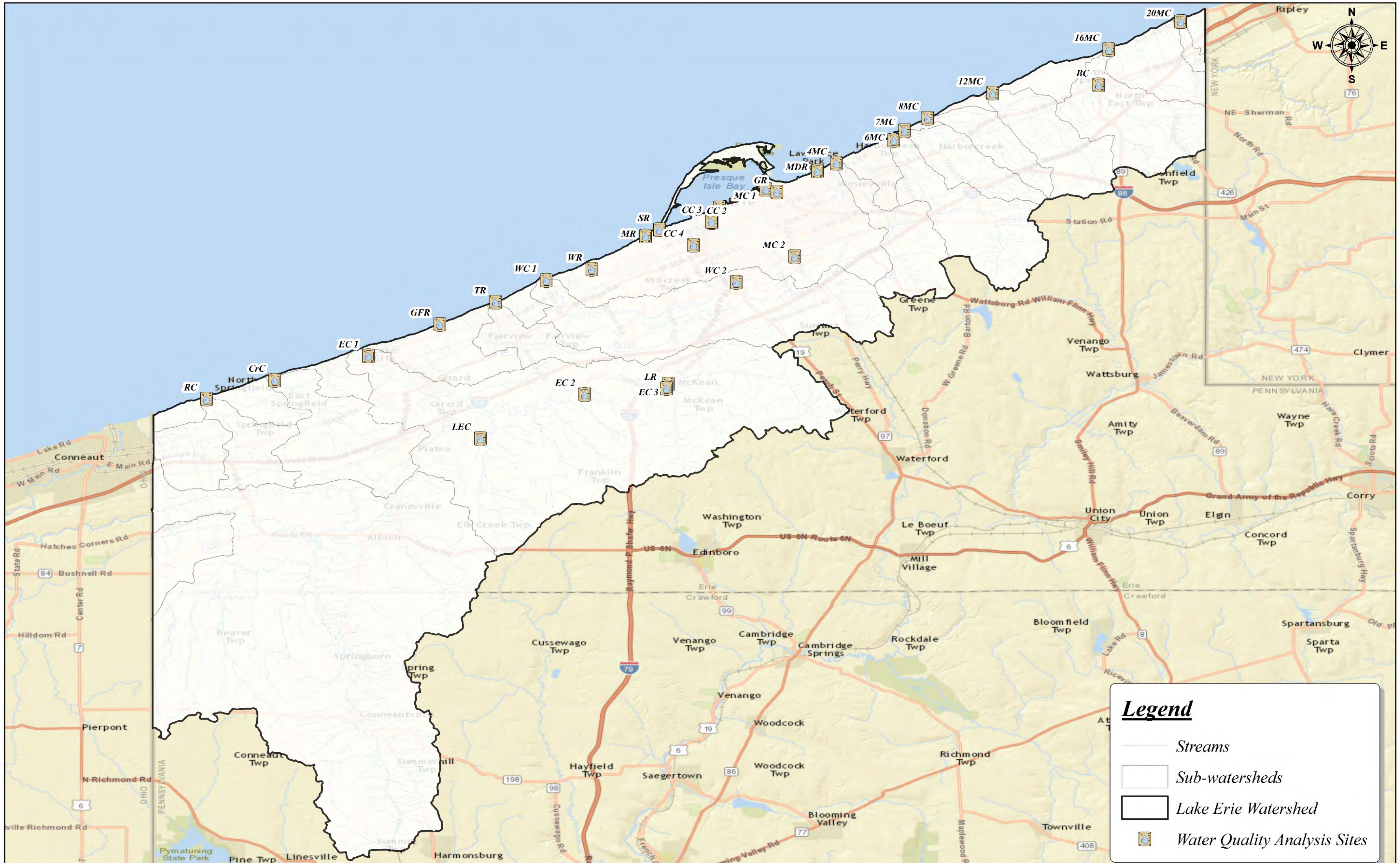
Map 44. Pennsylvania Lake Erie Watershed Stream Water Quality Analysis (Diz et al., 2006)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Diz et al. (2006)

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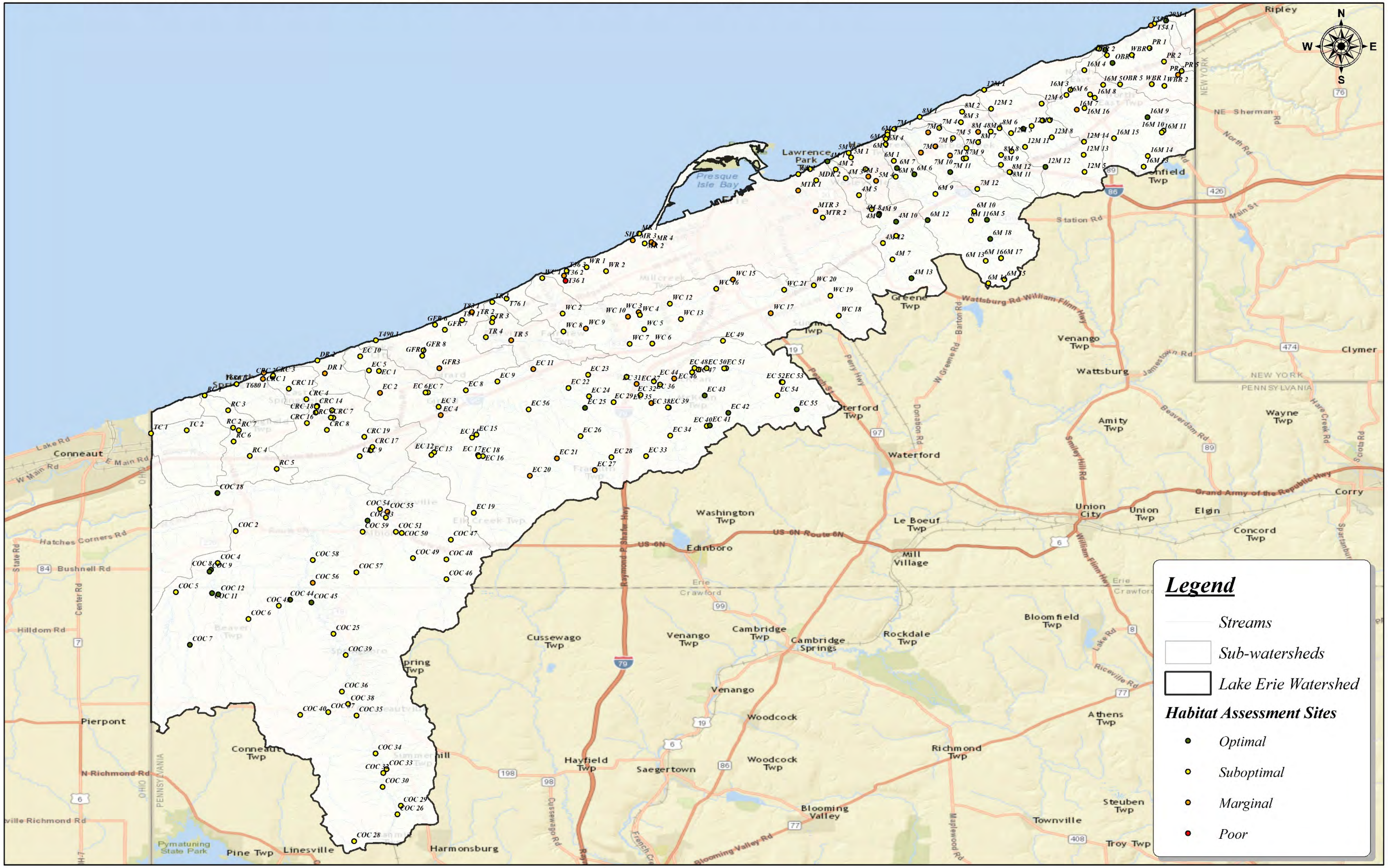
Map 45. Pennsylvania Lake Erie Watershed High Gradient Stream Habitat Assessment (Rafferty et al., 2011)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Rafferty et al. (2011)

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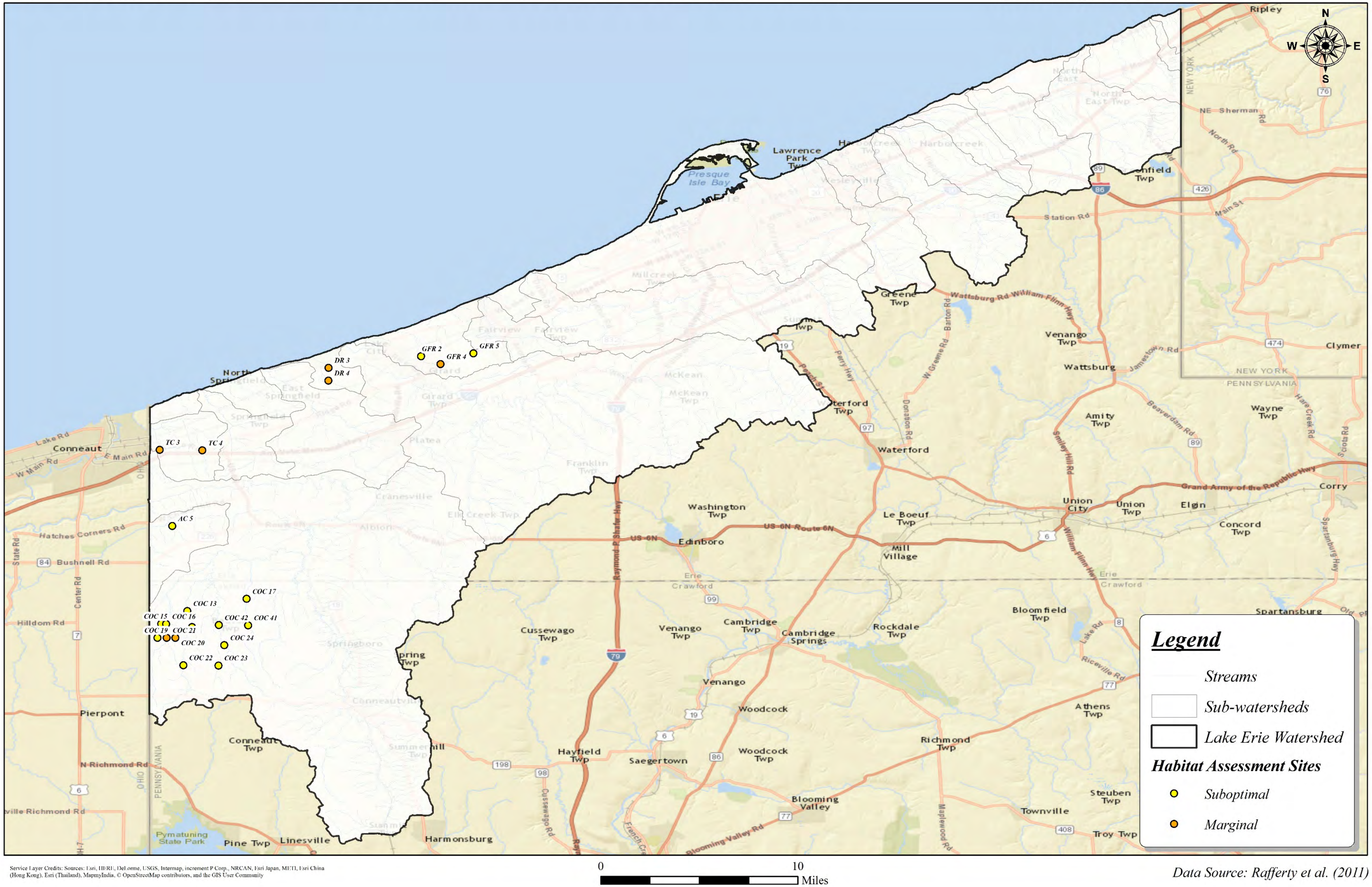
Map 46. Pennsylvania Lake Erie Watershed Low Gradient Stream Habitat Assessment (Rafferty et al., 2011)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Rafferty et al. (2011)

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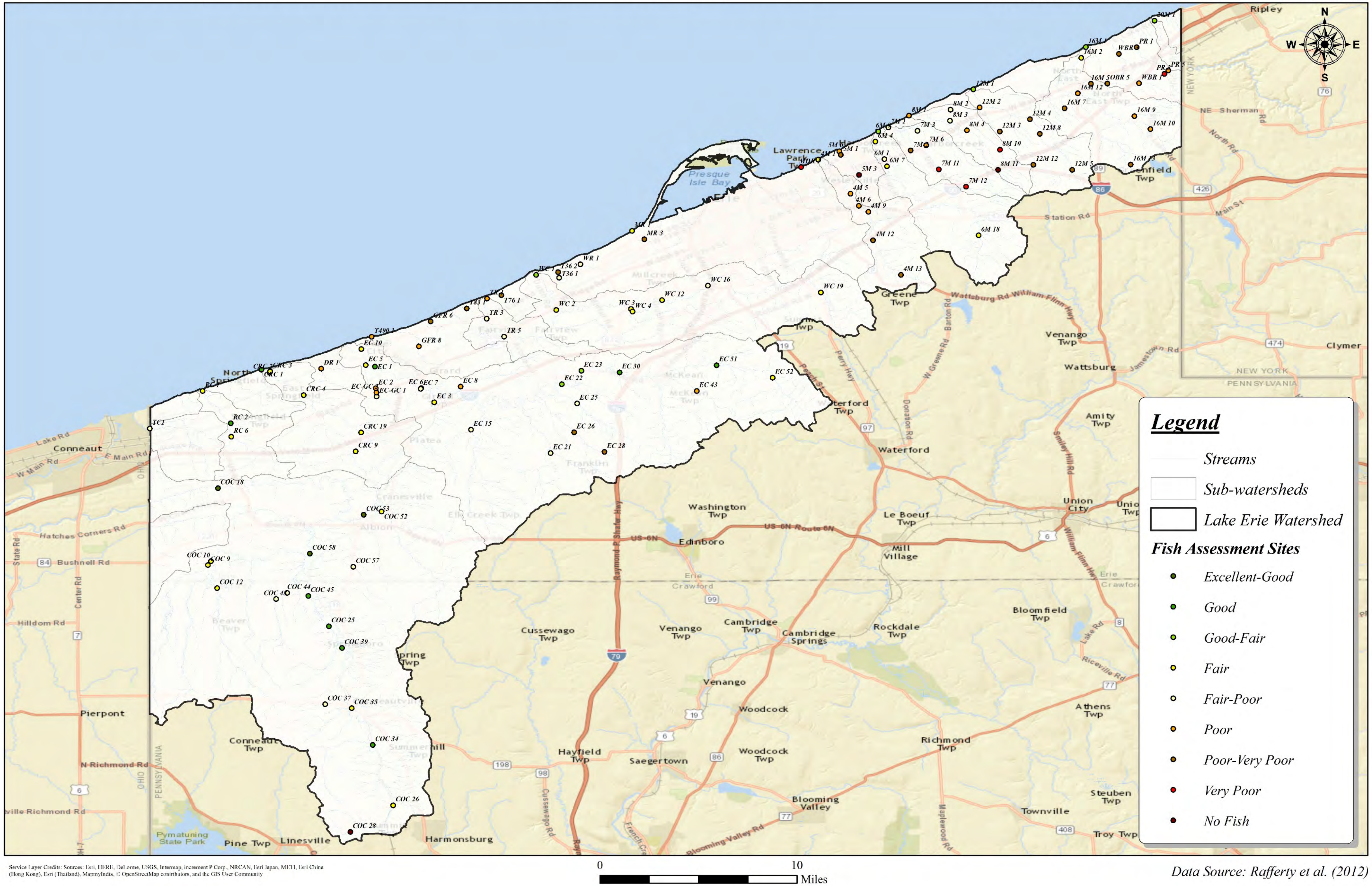
Map 47. IBI-Based Pennsylvania Lake Erie Watershed Fish Community Assessment (Rafferty et al., 2012)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Rafferty et al. (2012)

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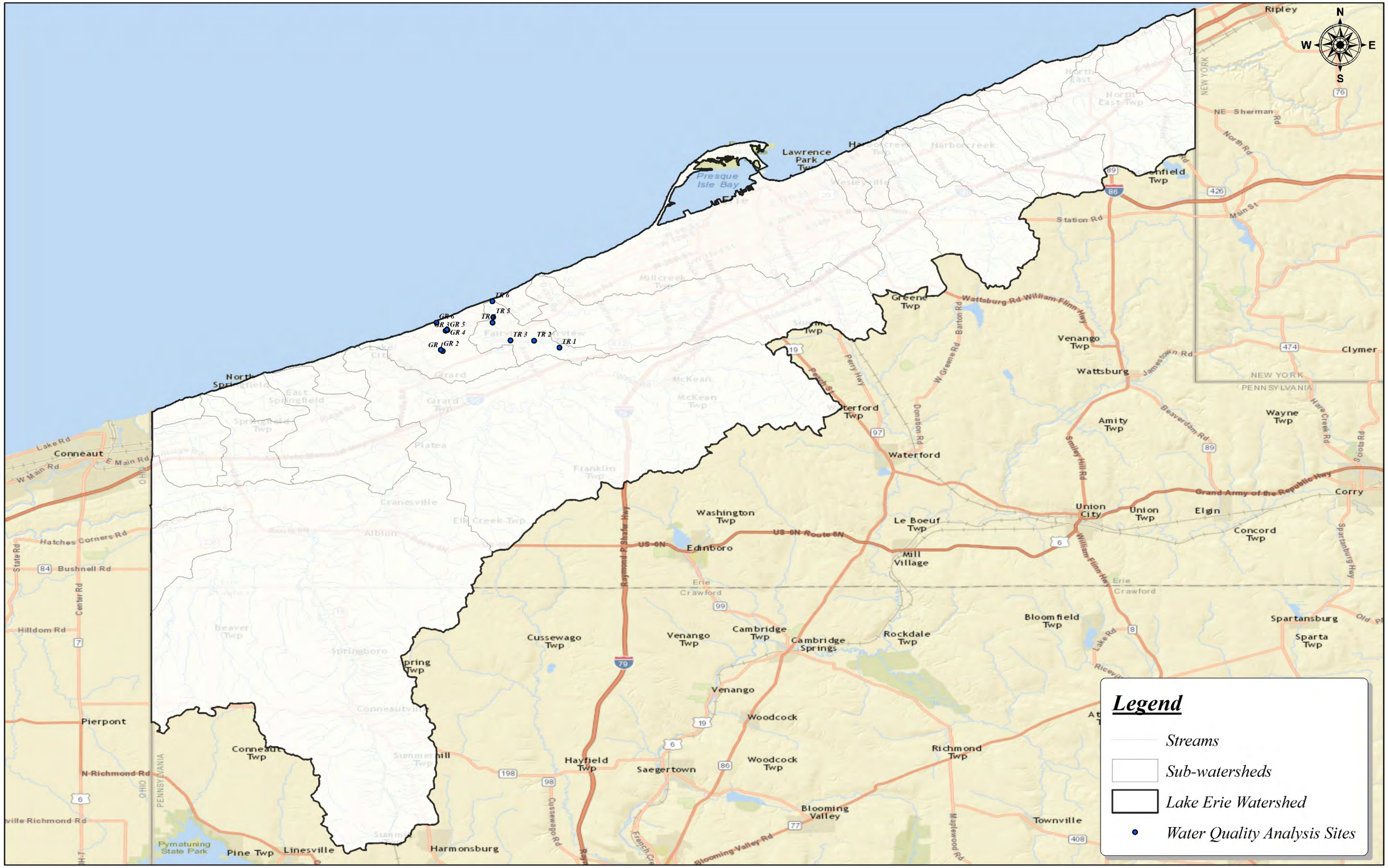
Map 48. Trout Run and Godfrey Run Water Quality Analysis (April and August 2010)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: ECCD; PA DEP

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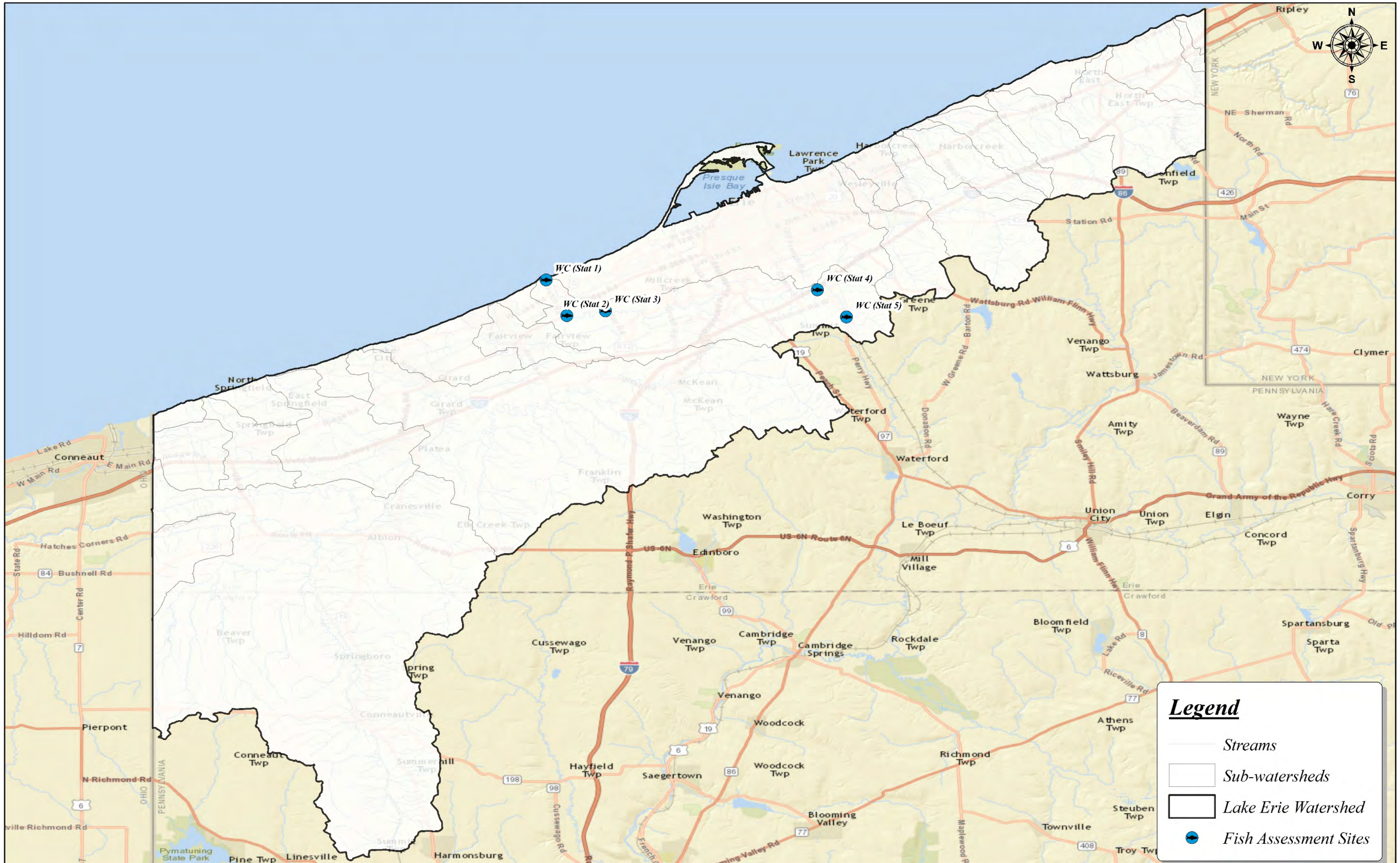
Map 49. Walnut Creek Fish Community Assessment (O'Kelly, 1972)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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Data Source: O'Kelly (1972)

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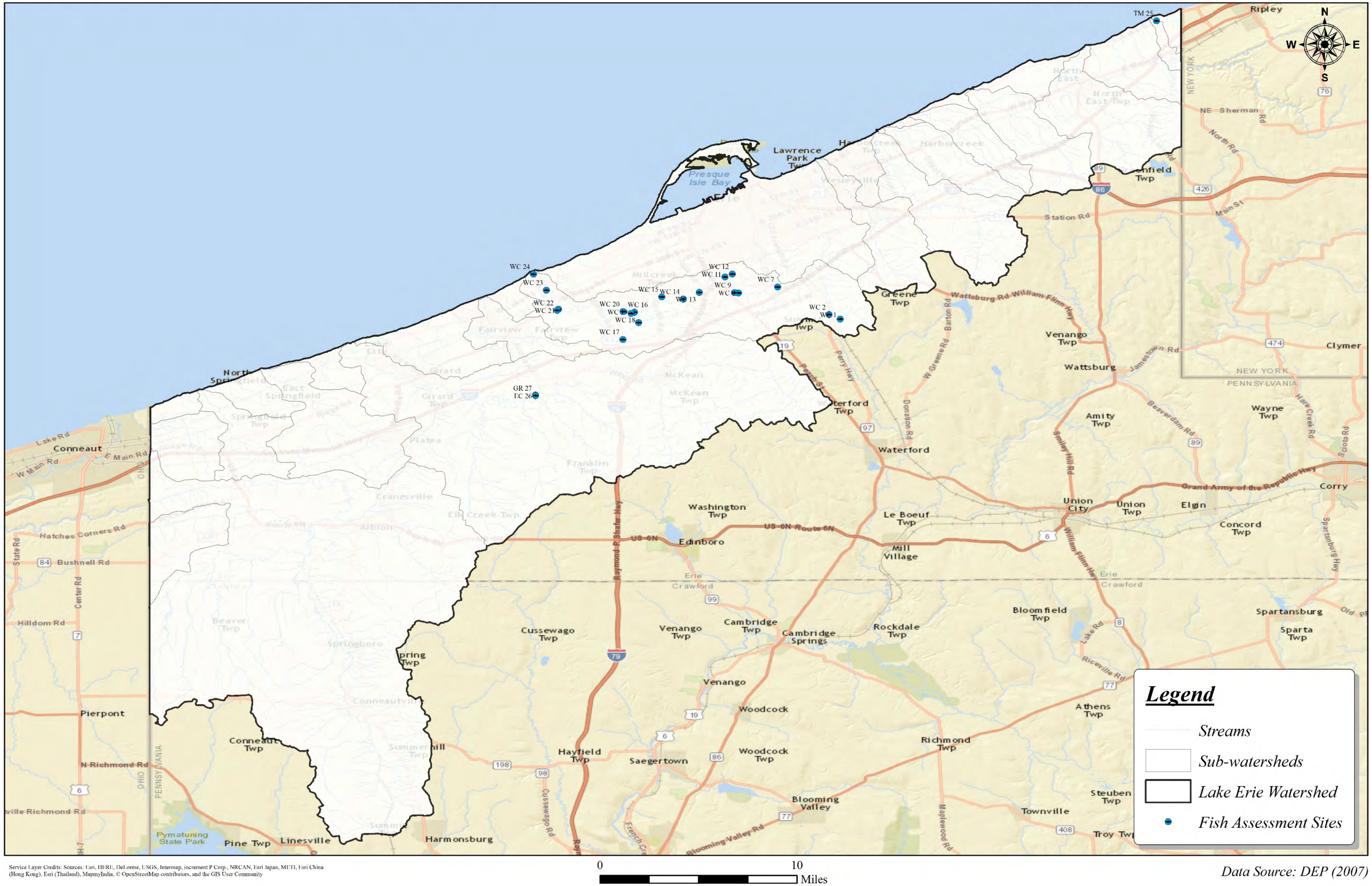
Map 50. Walnut Creek Fish Community Assessment (DEP, 2007)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Data Source: DEP (2007)

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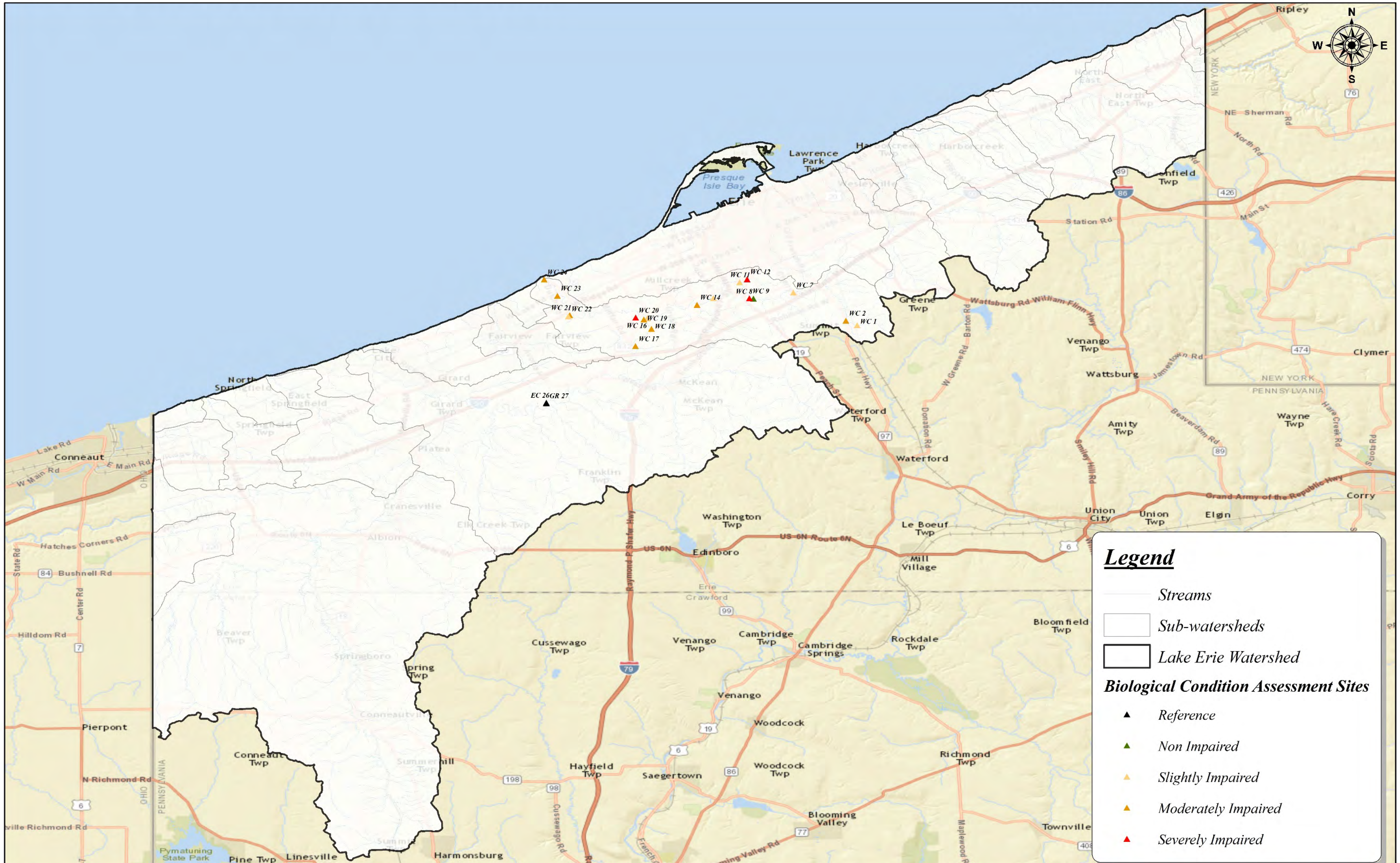
Map 51. Walnut Creek Biological Condition Assessment (DEP, 2007)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: DEP (2007)

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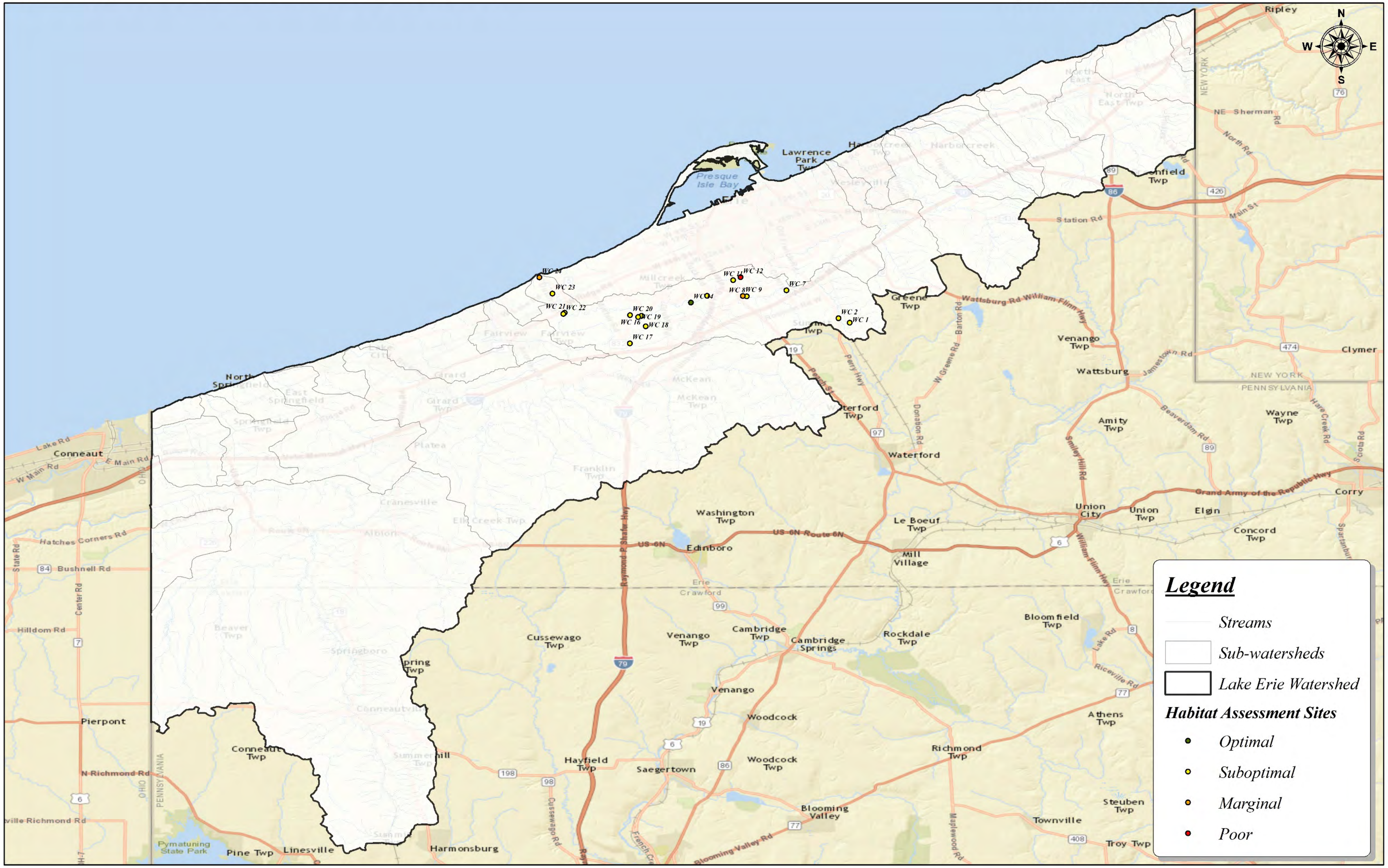
Map 52. Walnut Creek Stream Habitat Assessment (DEP, 2007)

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: DEP (2007)

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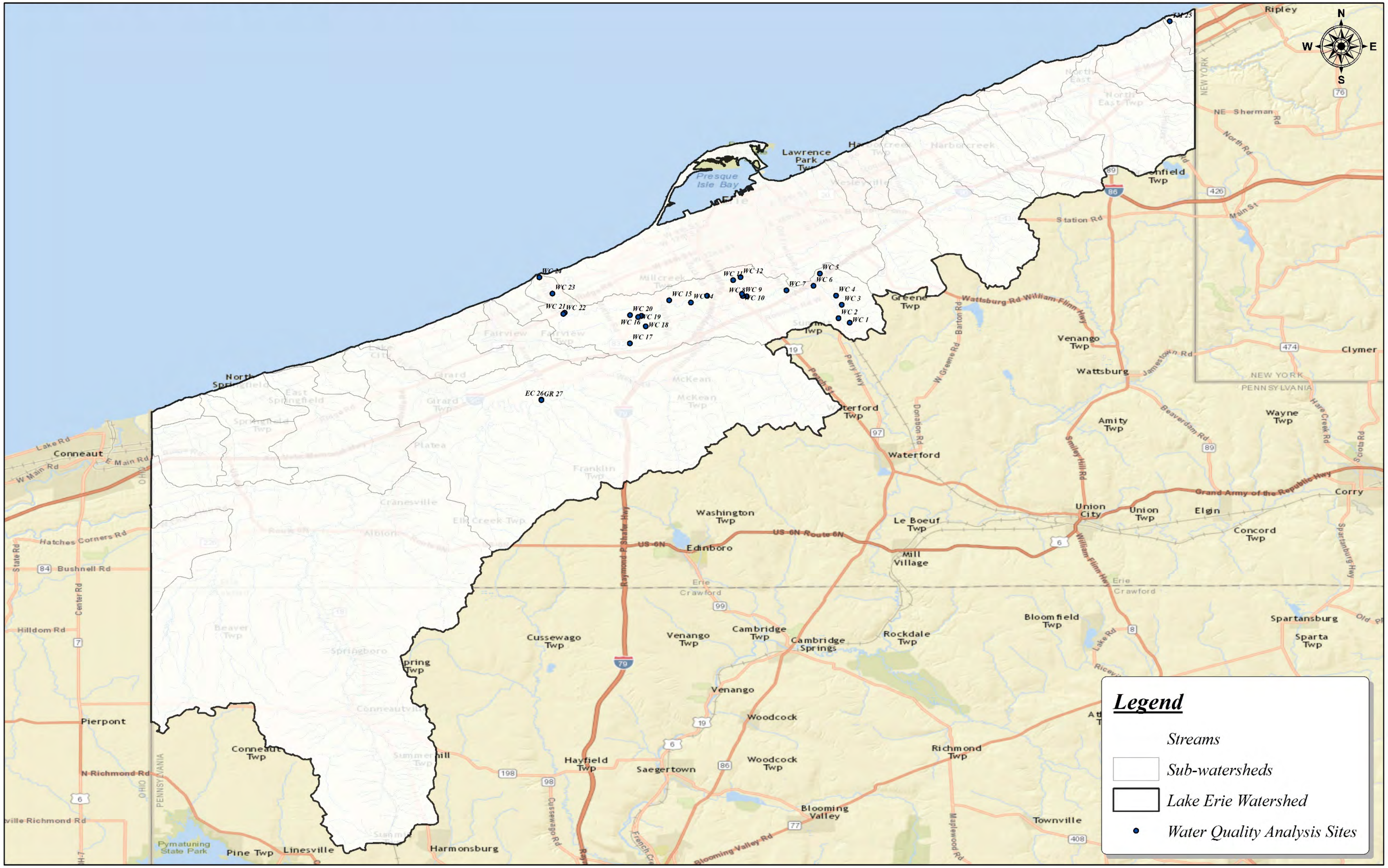
Map 53. Walnut Creek Water Quality Analysis (DEP, 2007)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: DEP (2007)

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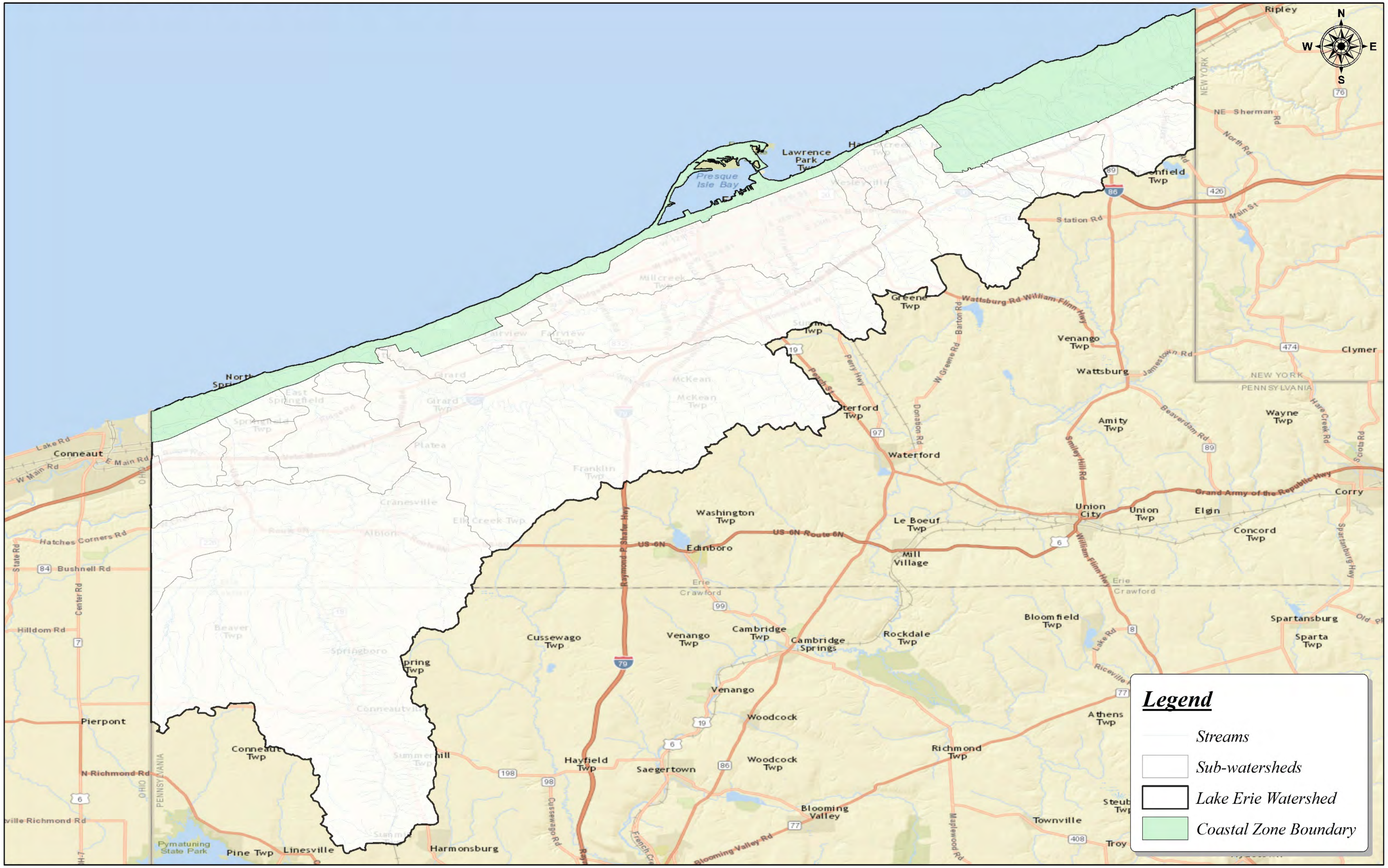
Map 54. Pennsylvania Lake Erie Coastal Zone Boundary

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA CRM

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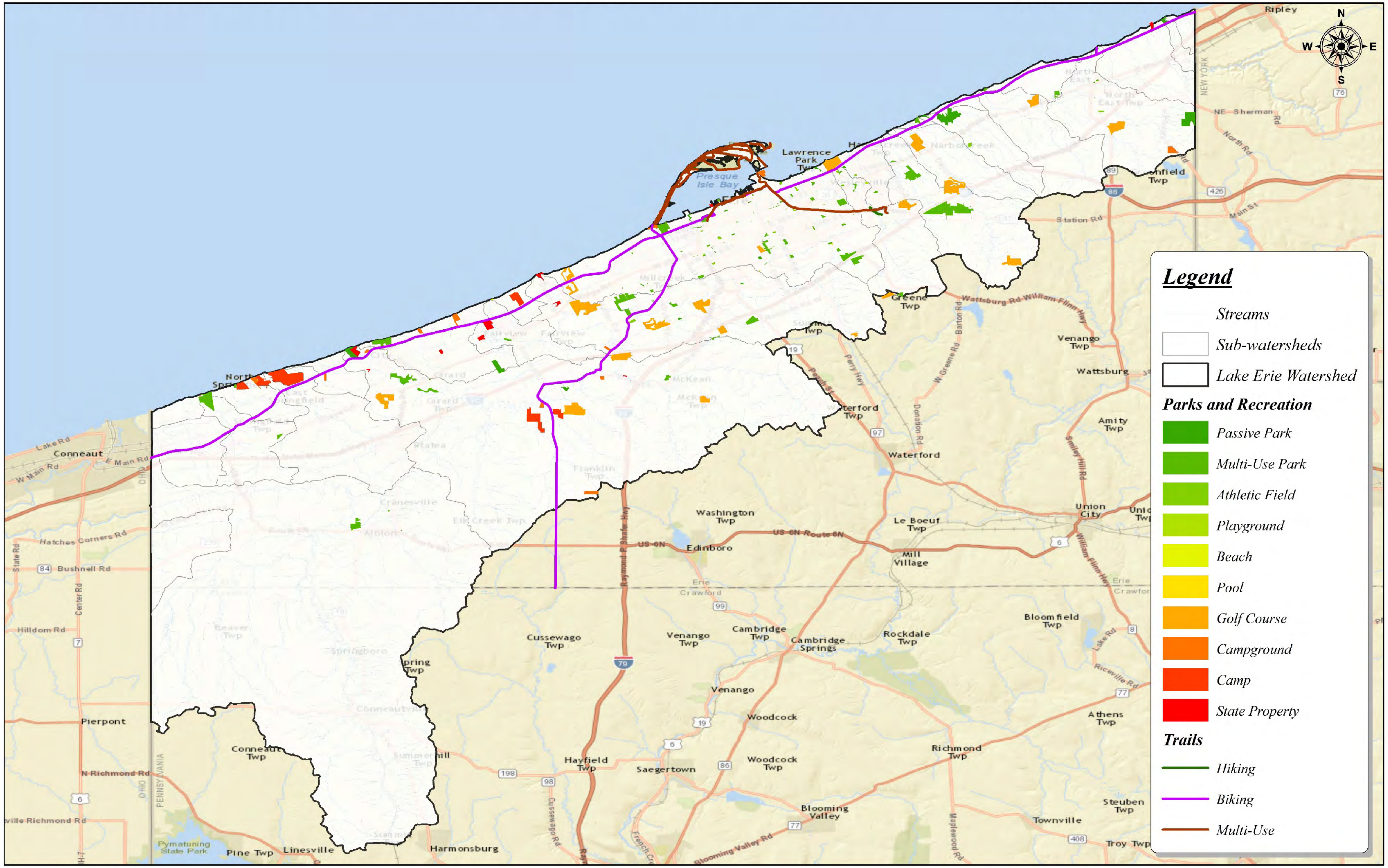
Map 55. Parks and Recreation Space, and Trails within the Pennsylvania Lake Erie Watershed (Erie County)

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Erie County Department of Planning

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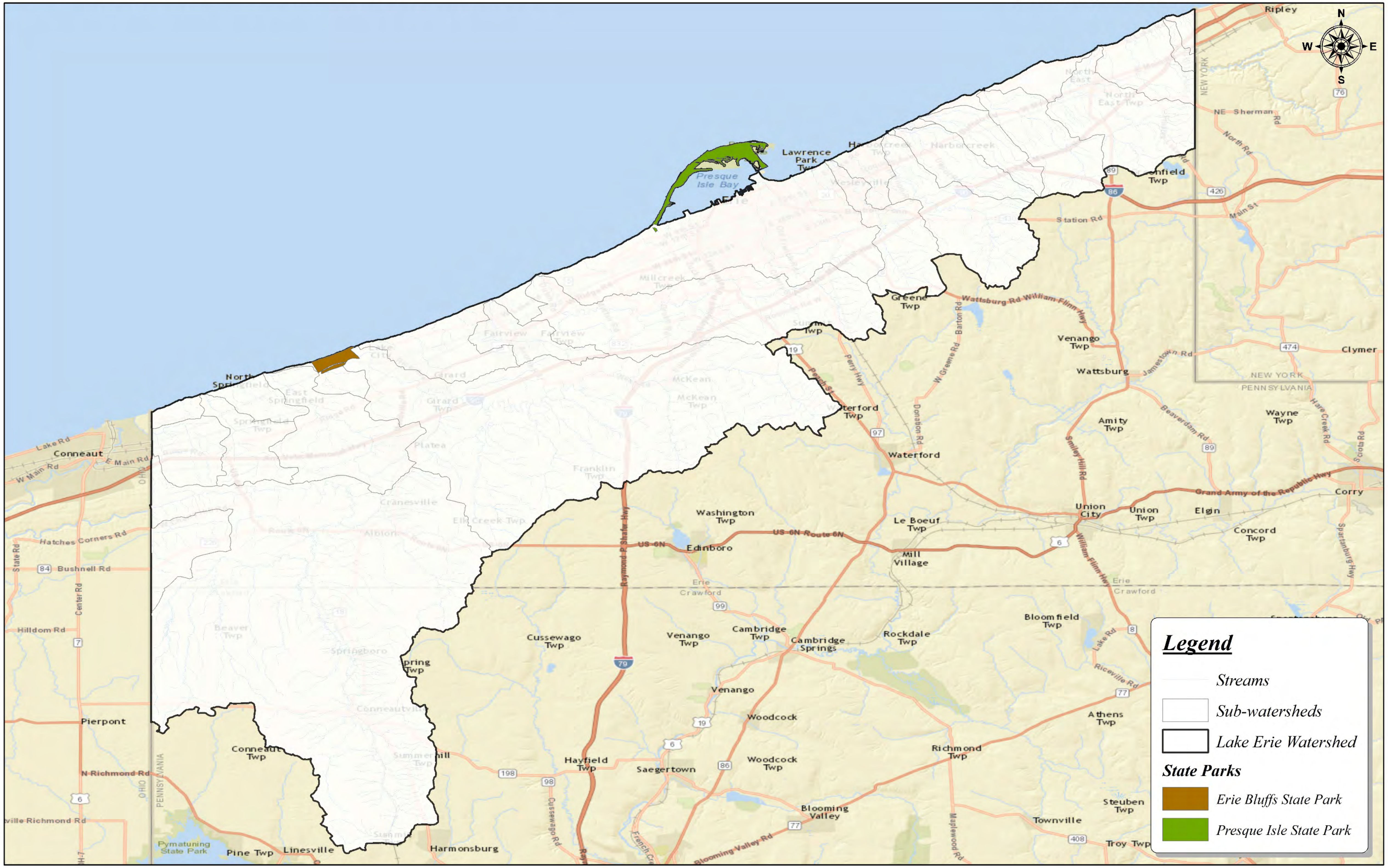
Map 56. State Parks within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: PA DCNR

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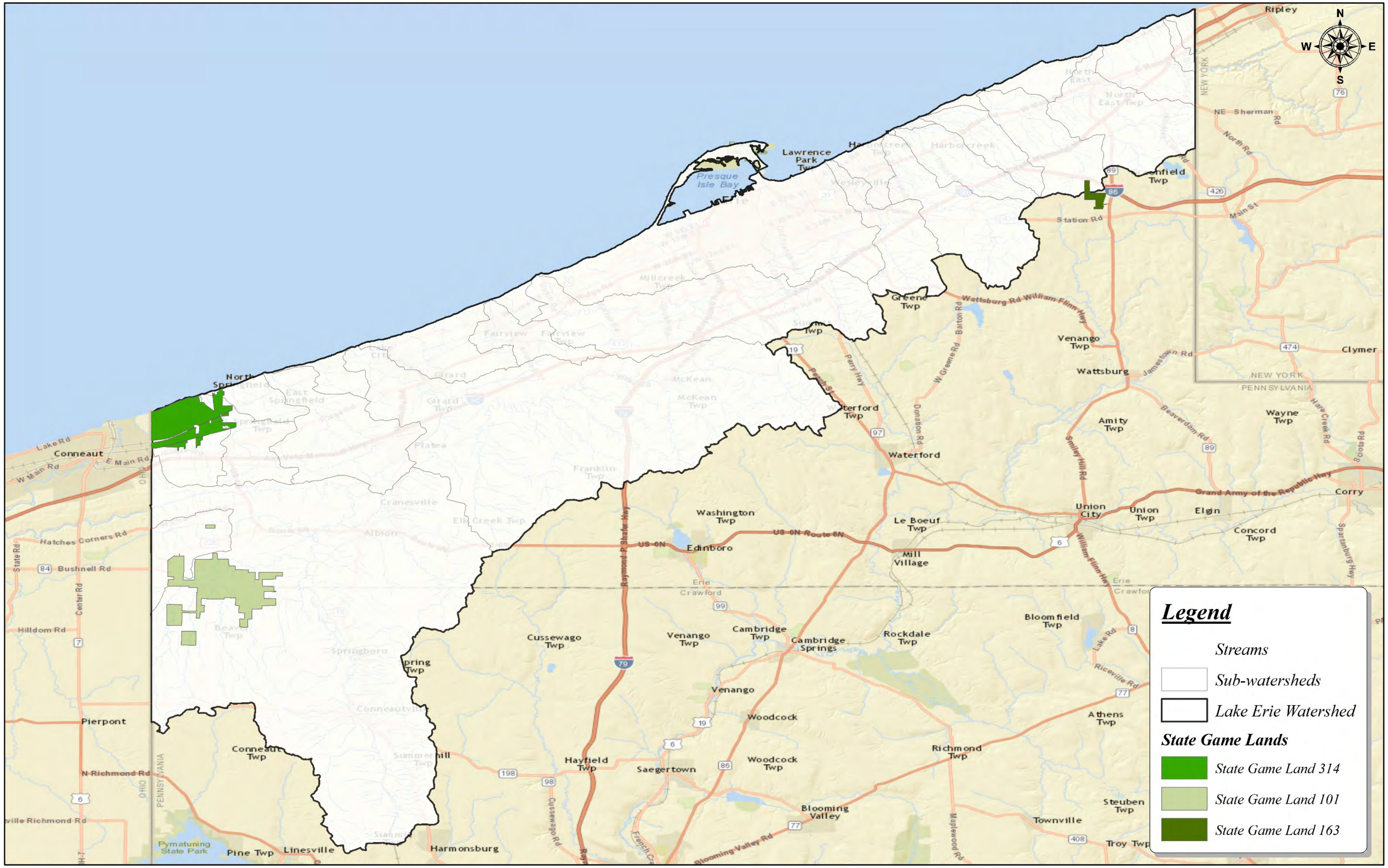
Map 57. State Game Lands within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: PGC

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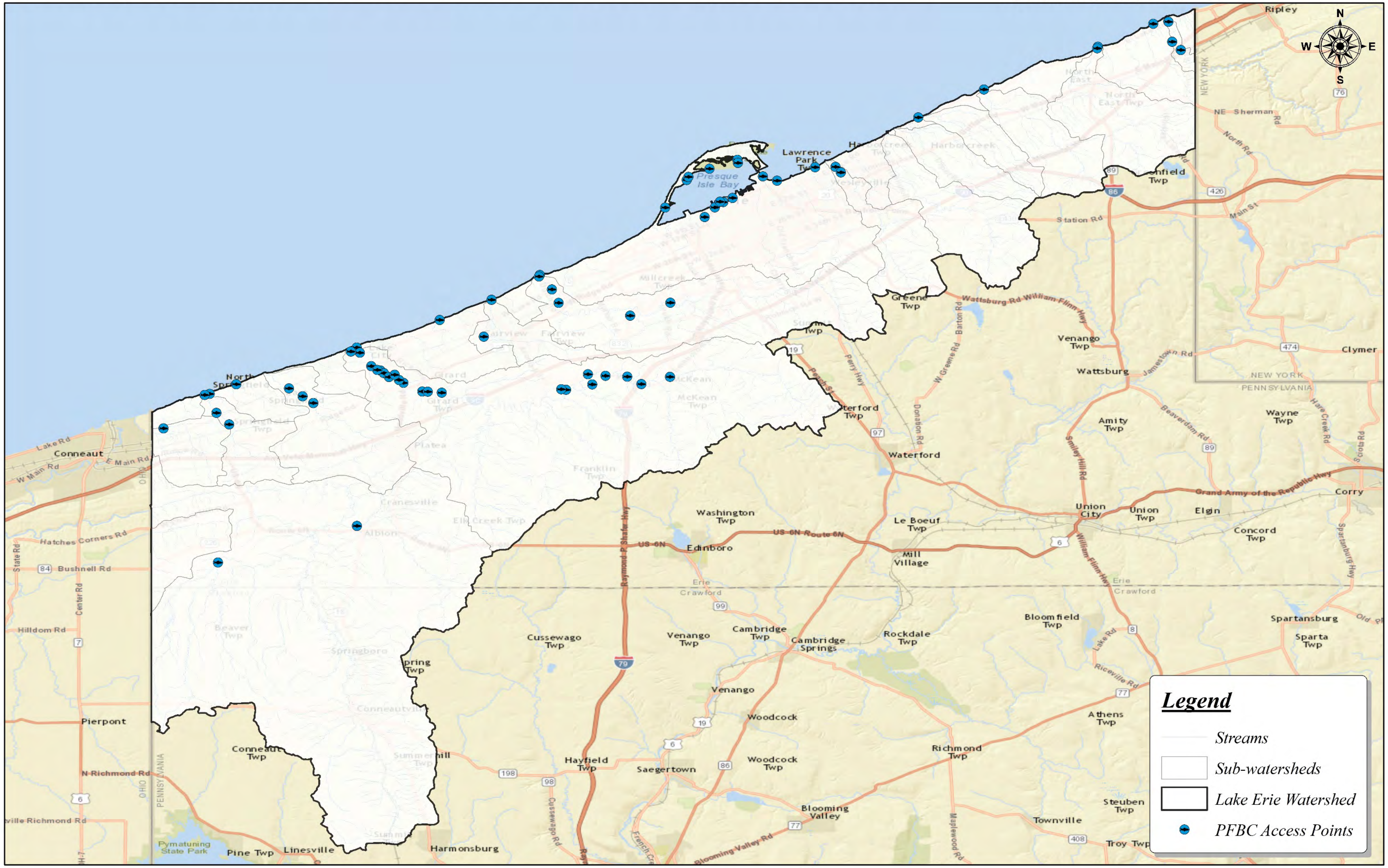
Map 58. Pennsylvania Fish and Boat Commission Public Access Points within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: PFBC

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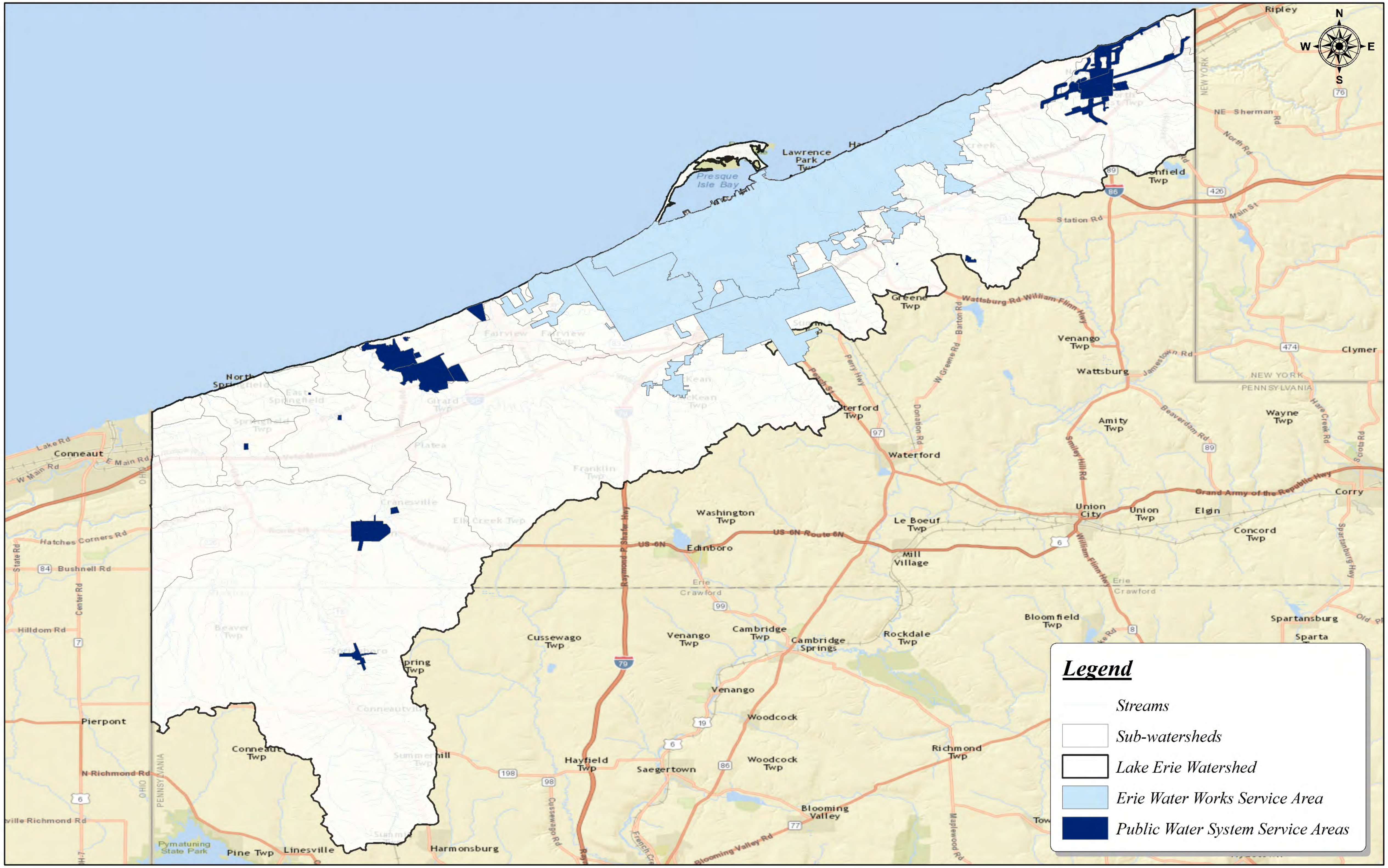
Map 59. Public Water System Service Areas within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Erie Water Works; PA DEP

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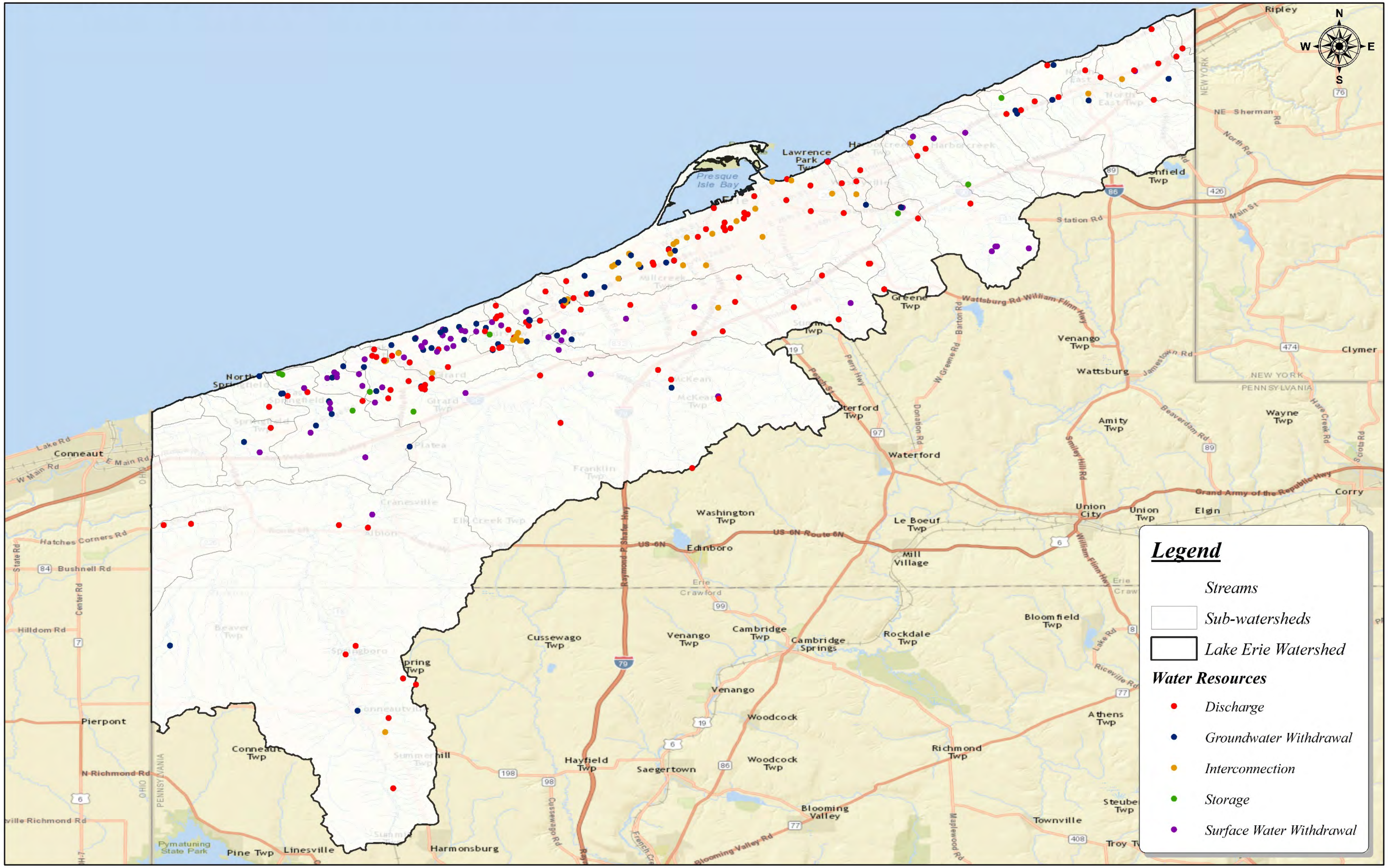
Map 60. Water Resources within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: PA DEP

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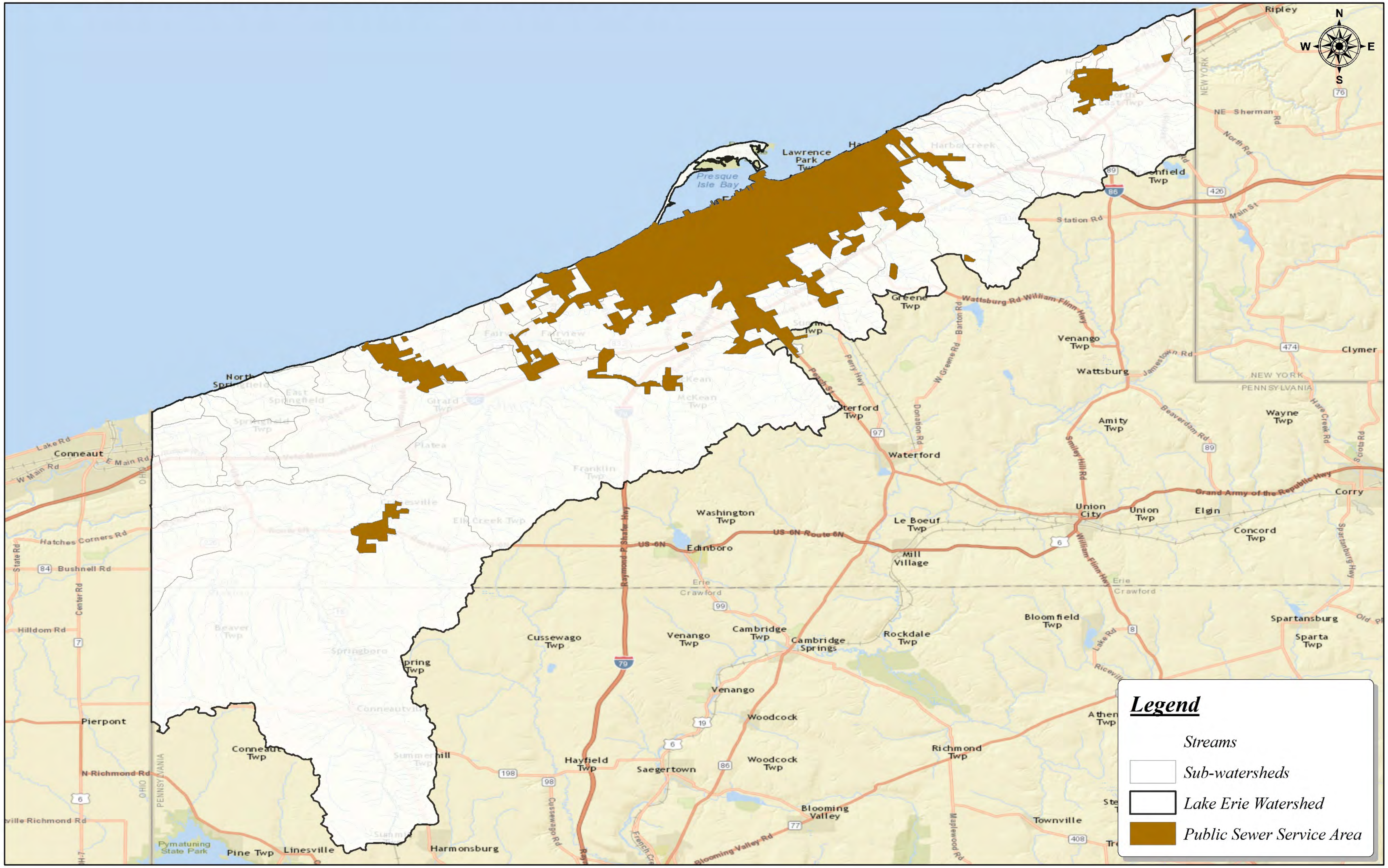
Map 61. Sanitary Sewer Service Area within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: EWWTP

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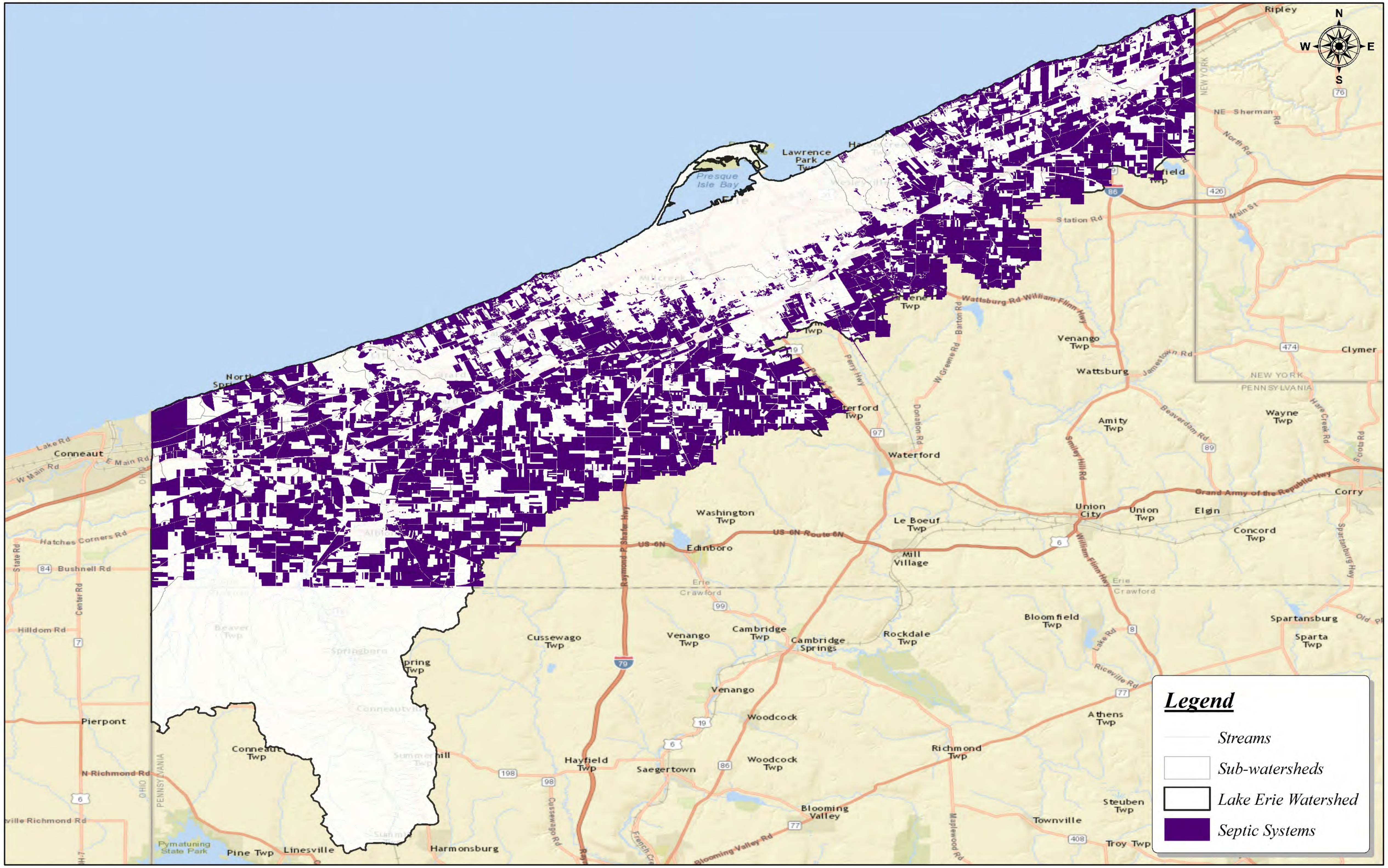
Map 62. Onsite Wastewater Treatment Systems within the Pennsylvania Lake Erie Watershed

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

0 10 Miles

Data Source: Erie County Department of Planning

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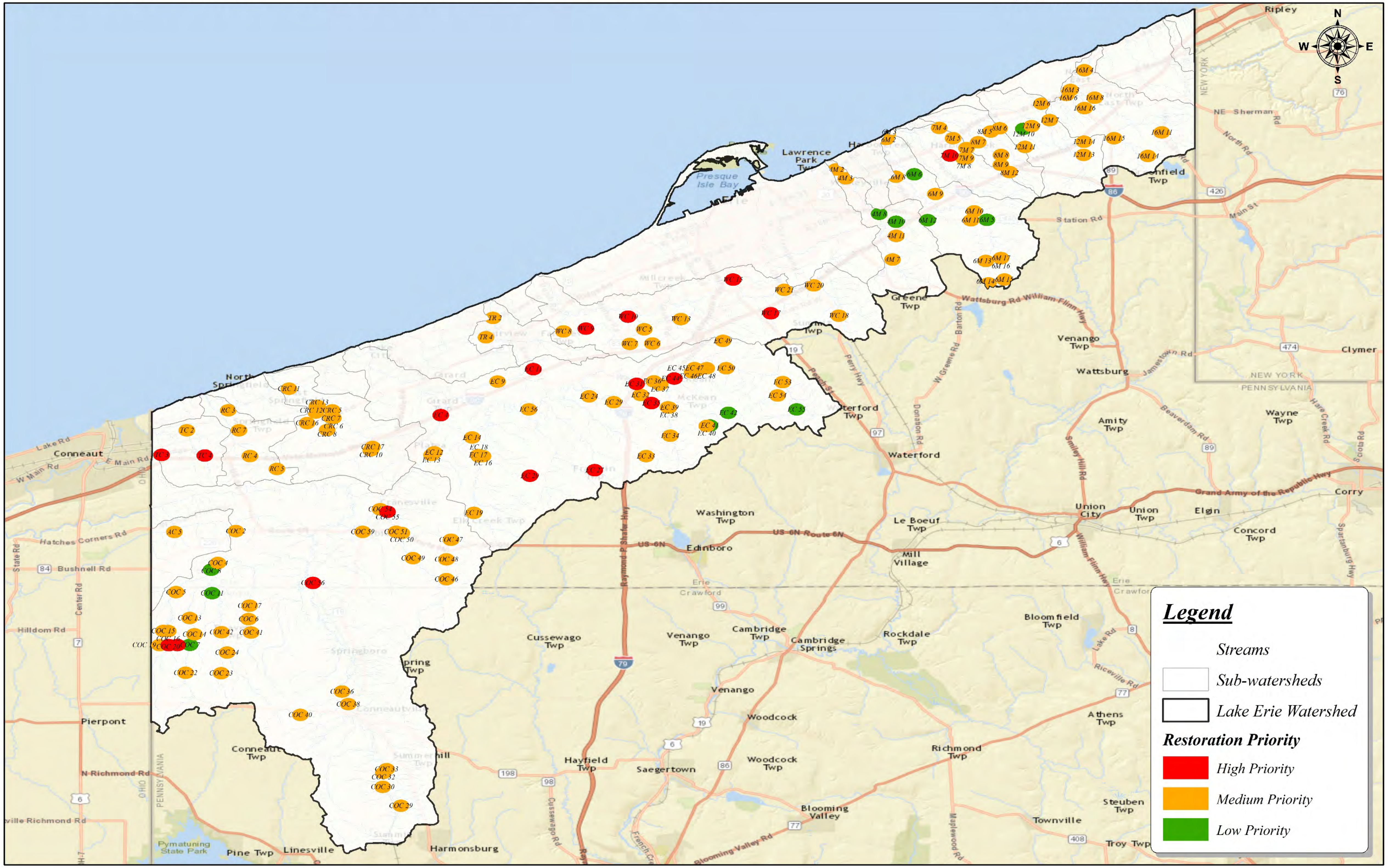
Map 63. Restoration Priorities for Sites Assessed using the Habitat-Based Restoration Model

Map Produced by Pennsylvania Sea Grant (Penn State University)



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0 10 Miles

Data Source: Pennsylvania Sea Grant

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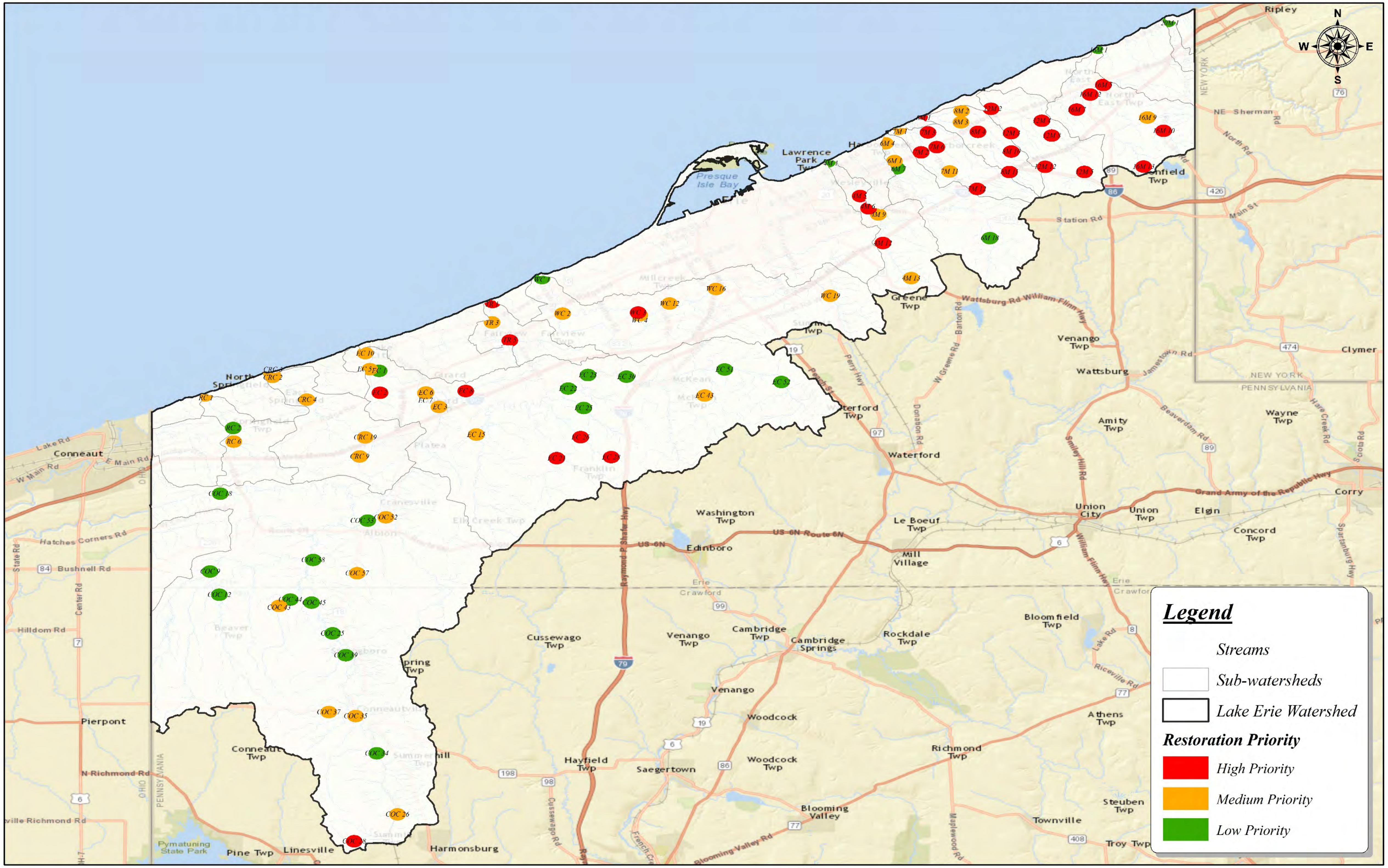
Map 64. Restoration Priorities for Sites Assessed using the Habitat and Fish Community-Based Restoration Model

Map Produced by Pennsylvania Sea Grant (Penn State University)



Service Layer Credits: Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Data Source: Pennsylvania Sea Grant

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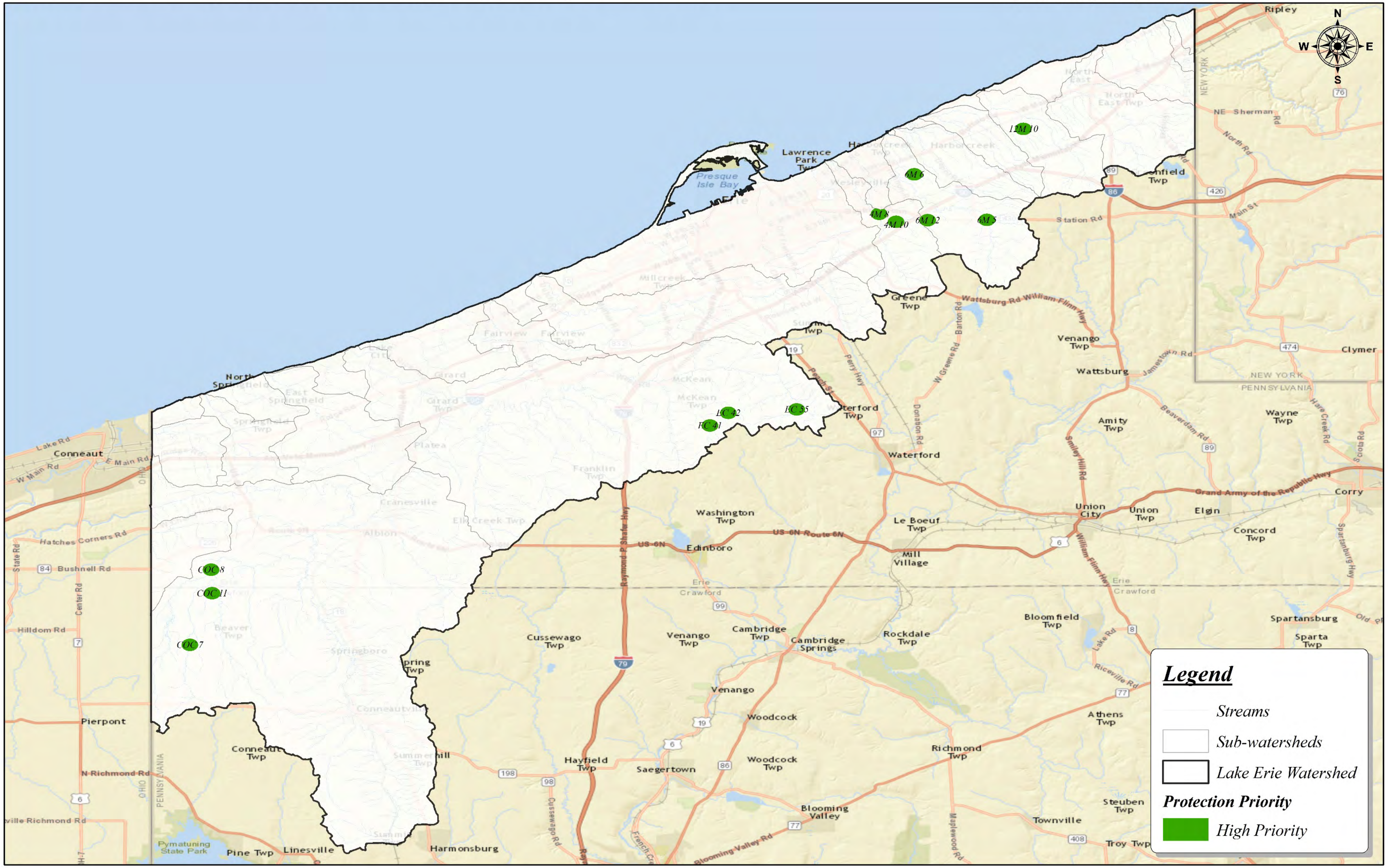
Map 65. Protection Priorities for Sites Assessed using the Habitat-Based Protection Model

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Pennsylvania Sea Grant

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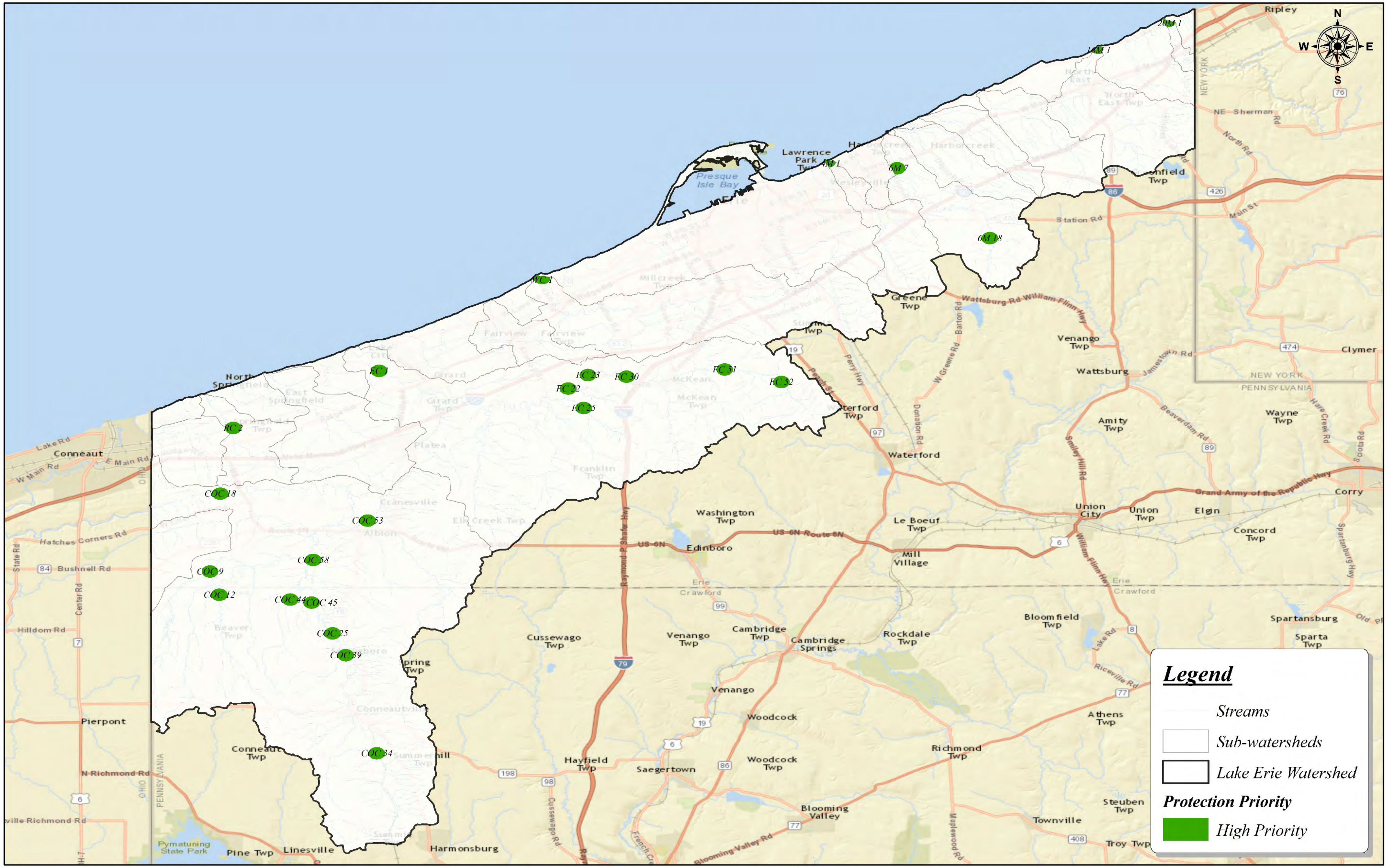
Map 66. Protection Priorities for Sites Assessed using the Habitat and Fish Community-Based Protection Model

Map Produced by Pennsylvania Sea Grant (Penn State University)



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Data Source: Pennsylvania Sea Grant

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