Lake Erie Shore Erosion Management Plan

# Western Basin Region Introduction

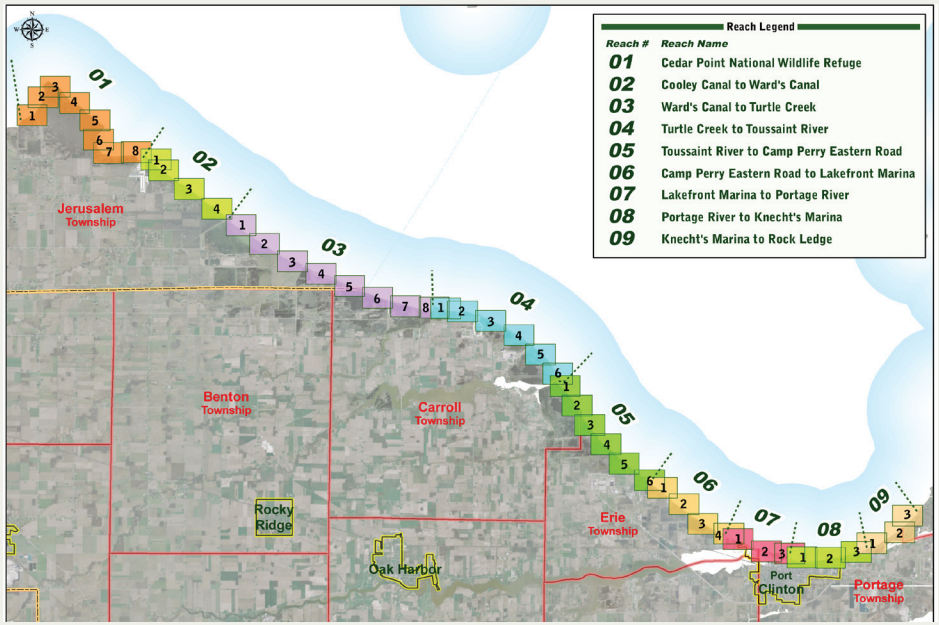
LESEMP

## About the Program

In an on-going effort to assist property owners along Ohio's Lake Erie coast by providing free technical assistance, the *Lake Erie Shore Erosion Management Plan* (*LESEMP*) is being developed by the Ohio Department of Natural Resources through a partnership between the Office of Coastal Management, Division of Wildlife and Division of Geological Survey.

The *LESEMP* identifies the causes of erosion in specific areas called reaches which are stretches of shore with similar site conditions. The *LESEMP* then outlines the most likely means of successful erosion control based on reach-specific erosion issues, geology and habitat. The objective of the reach-based approach to erosion control is to simplify the decision process while enhancing the effectiveness of solutions to erosion related issues.

The *LESEMP* does not contain any regulatory oversight provisions.




*The LESEMP is being developed by the project partners, Ohio Department of Natural Resources Office of Coastal Management, Division of Geological Survey and Division of Wildlife. Federal grant funding for this project is provided by the National Oceanic and Atmospheric Administration.*

## Introduction

Lake Erie is comprised of three distinct geographical basins: the Western, Central and Eastern basins. The Western Basin extends from the Detroit and Maumee rivers to a limestone ridge in the lakebed between Marblehead, Ohio and Point Pelee, Ontario. The Central Basin extends east to a lakebed moraine stretching between Presque Isle, Pa., and Long Point, Ontario. The Eastern Basin extends to Buffalo, N.Y. The LESEMP Western Basin Region includes most of Ohio's Western Basin shore. It extends from the eastern boundary of Mallard Club Marsh State Wildlife Area in Lucas County to the first outcropping of dolomite bedrock, known and herein referred to as Rock Ledge, just east of Port Clinton in Ottawa County.

The LESEMP Western Basin Region includes approximately 32.6 miles of Lake Erie shore or about 10.4 percent of Ohio's 312-mile coast. Approximately 17.3 miles (53 percent) of the coast of the Western Basin Region is publicly owned land, most of which is protected wetlands. The upland on the remaining 15.3 miles is privately owned. The Western Basin Region (from west to east) includes: the Cedar Point National Wildlife Refuge, Reno Beach and Howard Farms Beach communities, Metzger Marsh State Wildlife Area, Ottawa National Wildlife Refuge, Magee Marsh State Wildlife Area, the Sand Beach residential community, the Davis-Besse nuclear power plant, the Navarre Division of the Ottawa National Wildlife Refuge, the Toussaint Shooting Club, the Camp Perry military facilities, the Darby Division of the Ottawa National Wildlife Refuge and the residential, commercial and public access areas along the shore in Port Clinton.

The shore in the Western Basin Region is predominantly oriented in a northwest to southeast direction. The two major exceptions to this generalization are Cedar Point at the west end of the region and the northward curve of the shoreline in Catawba Island Township east of Port Clinton. The most significant features of this stretch of shore are coastal wetlands, low banks and sand beaches. Much of the Western Basin shore has an elevation below normal lake levels and is protected with dikes and levees. The tallest banks in the area are 10 to 20 feet tall at the east end of the region. Historically, beaches have been a prominent feature in several reaches within this region. The most notable beach areas are at Sand Beach and from the

Portage River to Rock Ledge, although beaches are also common up-drift of shore-perpendicular structures throughout the region. Beach widths are generally between 10 to 40 feet wide and vary with sediment supply and water levels. There are two major rivers flowing into Lake Erie in this region: the Toussaint and the Portage. The predominant winds are from the southwest.

Prior to development, the shores of Lake Erie's Western Basin were mainly barrier beaches separating the lake from coastal wetlands. The natural barrier beach system was highly variable and sensitive to changes in water level or lake conditions. Large sand spits like Cedar Point and the earlier Locust Point would naturally migrate with changing environmental conditions. The barrier beaches in the area would accrete, recede or occasionally breach due to natural changes in lake levels, severe storms or flooding in the landward marshes.

As the area was developed, the wetlands were filled and drained to create productive agricultural land. Coastal development near the Portage River and Turtle Creek, and the construction of drainage canals such as Cooley Canal disrupted the natural transport of littoral material – sand – along the coast. However, much of the coastal land was left undeveloped and eventually became protected as a national wildlife refuge or state wildlife area.

Much of the Western Basin Region coast is low-lying and is often at or below common lake levels. Several residential communities including Reno Beach, Howard Beach and Sand Beach were developed at elevations near or below lake levels. As a result these areas are susceptible to flooding as well as erosion.

As development continued, earthen dikes were constructed to control water levels in many of the remaining coastal marshes. Several additional shore-perpendicular structures were also constructed along the Western Basin coast. These structures began to trap littoral material, causing a lack of sand on downdrift barrier beaches. The overall armoring of the Lake Erie shore also led to a decrease of soils eroding into the lake and a reduction of sand available to sustain beaches. These factors, along with periods of high water and severe storms, eventually led to the widespread breaching and erosion of many of the barrier beaches along Lake Erie's Western Basin.

As a result, nearly the entire shore in the Western Basin Region is structurally protected. Earthen dikes armored with rip-rap have been constructed along miles of the Western Basin to protect the remaining coastal marshes and existing residential development along the shore. Most properties in the Sand Beach community and Port Clinton are also protected with a variety of shore structures including seawalls, revetments and small groins stabilizing narrow sand beaches. The largest unarmored areas are the existing barrier beach at the Toussaint Shooting Club, the beach area

*Coastal development near the Portage River (pictured above) and Turtle Creek, and the construction of drainage canals such as Cooley Canal disrupted the natural transport of littoral material – sand – along the coast.*

between the Darby Division of the Ottawa National Wildlife Refuge and Lakefront Marina west of Port Clinton, and the area east of the Portage River jetties between Waterworks Park and Lakeview Park in Port Clinton. Otherwise, unprotected areas are generally limited to individual properties or small gaps between structures.

The shore of Lake Erie's Western Basin contains several areas of converging or diverging littoral currents. For example, the general direction of littoral drift from the Maumee River to the tip of Cedar Point is from west to east. From Cedar Point to the Sand Beach area littoral currents are generally from east to west. Converging littoral currents at Cedar Point are responsible for the formation of the sand spit. From the Sand Beach area to the Port Clinton embayment, the net direction of littoral currents is from west to east. The area from Sand Beach to the mouth of the Toussaint River is generally an area of diverging littoral currents. Because the shoreline bend at Sand Beach is gradual and there is not a specific point where littoral currents split, much of this area experiences variable littoral currents and occasional cross currents. The net direction of littoral drift along the east side of the Port Clinton embayment is from east to west. This causes a convergence and gradual accumulation of littoral material in the Port Clinton embayment. Sand accumulation in this area is amplified by the presence of the Portage River jetties.

## Surficial Geology

Much of the shore at the western end of the region is at or below common lake levels. The low-lying shore is consistent for most of the Western Basin Region from Cedar Point to east of the Toussaint River. From the Toussaint River to the east end of the reach, the relief of the coastline gradually increases from marshes to lake-plain soils and low banks. In the Camp Perry area and at the Darby Division of the Ottawa National Wildlife Refuge, the coast is still predominantly marshland or lake-plain soils. In the Port Clinton area, the relief of the coast begins to steadily increase, particularly at the residential area along Sand Road. At the east end of the reach, banks reach 10 to 20 feet tall. Nearshore slopes are generally about 1 degree for the first few hundred feet before leveling to 0.3 to 0.5 degrees farther offshore. Nearshore slopes are shallowest near the Cedar Point sand spit, the mouth of the Toussaint River and in the Port Clinton embayment.

When Ohio entered statehood in 1803, its northwestern landscape looked considerably different. Settlement and development in the region south of what is now known as the Western Basin was severely delayed due to the 3 million acre Great Black Swamp, a wetland ecosystem composed of 60-foot tall ash, elm, maple and oak forest cover, coastal marshes, poorly-drained soils, pristine spawning areas, lush habitat .

This swamp primarily extended between the Maumee and Sandusky rivers

*Earthen dikes armored with rip-rap have been constructed along miles of the Western Basin to protect the remaining coastal marshes and existing residential development along the shore. In the left photo, the houses are on top of an earthen dike that has Lake Erie on the far side and a drainage ditch on the landward side. In the right photo, houses just west of Ward's Canal are protected with shore structures.*

from the coast inland in a southwest orientation to as far as Fort Wayne, Ind. The remnant of a post-glacial but pre-modern lake (Lake Maumee), the region was essentially an old lakebed, flat-lying and underlain by clayey soils and organic muck. This promoted the poor drainage that lent the area its popular "Great Black Swamp" name. The coastal wetlands were separated from Lake Erie by continuous barrier beaches, similar to much of the East Coast of the United States. Occasionally, these beaches were breached or overtopped by storm waves, but with no development, damage to the wetlands was inconsequential, and the barrier beaches were able to restore themselves naturally.

During the mid-1800s, organized efforts to drain this region and dedicate the land's use to agriculture began. Ditches were dug, forests were cleared, and the lands were tilled and farmed. By the early 1900s, the only large wetlands remaining were at the margin of Lake Erie's Western Basin. Too flood-prone for farming, they were mainly set aside for shooting and trapping.

With low banks of clayey soils and without high bluffs of glacial till, the shore of the Western Basin lacks a widespread and reliable source of sandy material for beach building. It is not known whether the input of sandy material into the littoral zone was greater in the distant past than today, but it seems likely. It is certain that the construction of long jetties, as at the mouth of the Portage River, disrupted the natural littoral transport of sand. *It should be noted that prior to the construction of the jetties, the Portage River flowed farther east behind a coastal wetland barrier beach system before the river entered Lake Erie. References heretofore to the Portage River and recommendations within the LESEMP are based on the current location of the river and its shore structures.*

Long-term changes in lake level have also probably played a role in barrier beach morphology. Whatever the causes, when storm waves in the middle of the 1900s breached some of the barrier beaches and flooded the coastal wetlands behind them (as at Potter's Pond and Metzger Marsh), the beaches were unable to rebuild themselves. Potter's Pond remains open to the lake to this day, a large notch in the western basin coast where a linear barrier beach once lay. With barrier beaches now unable to repair themselves, it is only through the construction and maintenance of dikes that coastal wetlands can be sustained along the Ohio margin of the Western Basin.

Soils along the coast of Lake Erie's Western Basin are often categorized as hydric due to frequent saturation or flooding. Sand deposits are generally fine- to medium-grained sand that is moderately-sorted to well-sorted. Sand deposits extend 500 to 1,000 feet offshore before exposing glacial till and till lag deposits of muddy sand and gravel. Sand deposits are greatest near Cedar Point and in the Port Clinton embayment. From the Portage River to Rock Ledge there are several well defined sand bars present in the nearshore zone. The sand bars are most prominent up-drift of the jetties at the Portage River

*Coastal wetlands may be protected with dikes and levees or fronted by sandy beaches. Both are found at Magee Marsh State Wildlife Area. The above photos were taken near the same spot on the wildlife area's 'birders' beach with the left photo taken looking west and the right photo taken looking east.*

and near the center of the Port Clinton embayment but extend to the end of the reach.

## Habitat

Lake Erie's Western Basin is the shallowest and most biologically productive region in the Great Lakes. Conservation of fish and wildlife habitat, particularly along the nearshore, is a critical component of the LESEMP.

Prior to development, the shores of the Western Basin Region were part of the Great Black Swamp. The shores were comprised of freshwater marshes and fens, with elm-ash swamp forests near the mouths of the Toussaint and Portage rivers. Many species of fish and wildlife thrived in these coastal wetlands, using both wetland and nearshore Lake Erie habitats during different stages of their life. The coastal wetlands were separated from the lake by dynamic system of barrier beaches. Due to at least seasonal connectivity, coastal wetlands provided essential spawning and nursery habitat for many species common to the Lake Erie nearshore fish community, particularly esocids (northern pike and muskellunge) and centrarchids (largemouth bass, bluegill, crappie). In addition to the vegetated wetlands, the shallow sandy nearshore lakebed was productive habitat and spawning grounds for several native fish species, including walleye. In addition, soft sediments provide for an extensive macroinvertebrate community, particularly for mayflies, which spend most of their lives as larvae in the lakebed. Today, the shores of the Western Basin Region have been extensively armored with structural protection to prevent shoreline recession, aid navigation and protect residential and commercial development. The armoring has altered coastal habitats and displaced species dependant on access to wetlands.

Habitats along the shore of the Western Basin Region can be characterized as nearshore, beaches, coastal wetlands and low banks.

### *Nearshore*

The nearshore habitat of Lake Erie's Western Basin is fairly consistent. The lake bottom is predominately glaciolacustrine clay and glacial till, covered by significant sand deposits closer to shore. These two substrates provide feeding, spawning, and nursery habitats to fish and wildlife. The nearshore and offshore glacial till deposits in the Sand Beach area and near the mouth of the Toussaint River provide the Lake Erie's most significant spawning habitat for walleye and other native species. The sandy nearshore along

*Prior to development, the shores of the Western Basin Region were part of the Great Black Swamp, remnants of which are found throughout the region still.*

the entire Western Basin Region is identified as walleye nursery habitat. In addition to walleye, the Western Basin nearshore also provides habitat for several other species including yellow perch, smallmouth bass, spottail and emerald shiners.

### *Beaches*

Much of Lake Erie's Western Basin shore was historically comprised of dynamic barrier beaches protecting the coastal wetlands or narrow beaches fronting lake plain or low banks. The overall development and structural protection of Lake Erie's shore and the construction of navigation aids at rivers and channels have limited beaches in this area. Beaches are generally present up-drift of large shore-perpendicular structures or front protective structures where sufficient sand deposits are present. As a result, natural beach habitats have been limited. Beaches provide important yet fragile habitat supporting both flora and fauna. Supplementing beach flora with native vegetation is recommended throughout this region both to improve habitat and for erosion management to help stabilize the beach.

### *Coastal Wetlands*

The remaining coastal wetlands along Lake Erie's Western Basin are protected state and national wildlife areas. The coastal wetlands are generally separated from Lake Erie by earthen dikes armored with rip-rap. The wetlands often include several interior earthen dikes controlling water levels in separate ponds. Water levels are regulated to prevent intrusion from Lake Erie to provide a variety of habitats for both aquatic and terrestrial species including shallow waters, wooded wetlands, coastal wetlands, shrublands and grasslands. However, this disconnect with the lake impairs the use of these wetlands by open-lake fish species. The Lake Erie marshes provide habitat for up to 300 species of resident or migratory birds including warblers, waterfowl, shorebirds, wading birds, owls and raptors. The south shore of the Western Basin is designated as an important bird area by Audubon Ohio.

### *Low Banks*

Low banks are present in the eastern end of the region, particularly along Sand Road east of Port Clinton. The banks generally increase from west to east and are often fronted by narrow beaches. Historically, the low banks have supported varied vegetation from grasses and sedges to herbaceous shrubs and trees. The bank vegetation provided habitat for both resident and migratory bird populations. Due to extensive armoring with concrete seawalls, steel sheet pile bulkheads and stone revetments, there is little natural bank habitat remaining. Vertical structures such as seawalls and bulkheads provide very little habitat. Stone revetments can provide suitable habitat for water snakes, small animals and fish habitat on submerged stones, although this habitat may appeal more to invasive species (i.e. round goby, white perch) than to natives.

## Coastal Erosion

Erosion along Lake Erie's Western Basin is primarily due to wave action,

*Coastal wetlands in the Western Basin Region of the Lake Erie Shore Erosion Management Program include those found at Ottawa National Wildlife Refuge.*

rather than mass-wasting. Wave action causes erosion in several ways. The constant motion of waves has a scouring effect on the shore. Sand and gravel suspended in waves can abrade (rub or wear away by friction) materials making up the shore, especially softer materials such as clays. The impacts of waves also release energy that dislodges material from the shore and forces water into voids, creating hydraulic pressure that can widen voids and force materials apart. Waves also cause both alongshore and cross-shore littoral currents responsible for the erosion and accretion of beach sand and fine materials.

Surface water runoff and weathering, including wind and freeze-thaw processes, are also important factors contributing to erosion in the Western Basin Region. Because of the low bluff heights and generally uniform bank compositions, mass wasting (slumping and collapsing) plays less of a role in erosion in the Western Basin than the Central Basin.

Erosion rates along Lake Erie's Western Basin vary drastically by geographic locations and time periods. On average the Western Basin Region has experienced slow to moderate recession. (Note, however, that even these slow to moderate rates could be regarded as intolerable if the region were more densely developed.) Long term recession has been most severe along the barrier beaches fronting the coastal marshes in this region. Beaches and other sand formations have also been particularly susceptible. For example, the Cedar Point sand spit in Lucas County has receded nearly 2,000 feet since the 1870s, although most of this recession could be described as simply shifting of the sands, rather than a permanent loss of land. Some areas in the Western Basin Region have also experienced long term accretion. The center of the embayment at Port Clinton in Ottawa County has accreted several hundred feet up-drift of the Portage River jetties. This is due both to a convergence of littoral currents in the Port Clinton embayment and the trapping of littoral material by the Portage River jetties.

As nearly the entire Western Basin Region shore is armored with structural protection, manmade structures have played an important role in erosion in the region. The earliest structures in the area were shore-perpendicular jetties to aid navigation at the mouth of the Portage River and to stabilize the outlets of canals constructed to drain the Great Black Swamp. These structures immediately began disrupting the flow of littoral material. The structures caused sand accumulation up-drift but prevented sand from reaching downdrift beaches. The construction of additional structures, at the mouths of creeks and to stabilize beaches lakeward of residential development, further disrupted the littoral drift. This had a destructive

*Storm driven waves role onshore at Magee Marsh (top) and Metzger Marsh state wildlife areas (bottom).*

impact on the barrier beaches fronting the coastal marshes along most of the Western Basin Region. As sand needed to sustain the barrier beaches was increasingly trapped by up-drift structures, the beaches were breached and eroded by periods of high water and severe storm events. More importantly, they were unable to restore themselves in the calm periods between storms. In most cases the barrier beaches have been replaced with earthen dikes armored with rip-rap. While preventing further shoreline recession, the manmade structures have significantly altered coastal habitats.

Erosion has also increased due to an overall reduction in material available to sustain beaches. Steady development along Lake Erie's shores has led to considerable armoring for structural protection and erosion prevention. The widespread prevention of erosion, however, reduces the amount of sand that enters the littoral system through mass-wasting. Transport of eroded soils into the lake from upland by rivers and streams is a second significant source of sand. This source, however, has been reduced due to damming and dredging for the maintenance of navigation. For this reason, sandy dredge material should be placed in the littoral system when possible. Unfortunately, contamination from industrial and agricultural sources often requires dredge material to be placed offshore or in confined disposal facilities, permanently removing it from the littoral system.

The widespread armoring of the shore has resulted in a significant overall reduction in recession rates. From 1990 to 2004, shoreline recession in the Western Basin Region averaged from 0 feet per year to 4.9 feet per year. Recession was greatest in unarmored beach areas such as the barrier beach at the Toussaint Shooting Club or pockets of beaches lakeward of the dikes at the Cedar Point National Wildlife Refuge. As most of the shore is armored, average recession rates from 1990 to 2004 were 0 feet per year for much of the coast and were generally less than 0.5 feet per year.

With adequate maintenance of the existing shore structures in this reach, future erosion will likely be limited to small unprotected areas or gaps between structures.

## Flooding

Lake-based flooding is often a greater concern along the coast of Lake Erie's Western Basin than the gradual recession due to erosion. Flooding in the Western Basin Region has at times produced dramatic property loss.

Floods have usually been associated with gales from the northeast, which may occur when tropical storms and the remnants of hurricanes eventually reach areas northeast of Lake Erie. The resulting winds, rotating counterclockwise around the storm center, may blow over many miles of open lake, piling water in the Western Basin. (GRAPHS) If the storm coincides with a period of high water, the effect is intensified. One such storm in November 1972 caused widespread flooding along the southern margin of Lake Erie's Western Basin. Damage was extensive in areas with residential development very close to the shore. For example, the floods breached existing dikes and destroyed several homes in the Reno Beach and Howard Farms areas. This led to the construction of the Operation Foresight Dike by the U.S. Army Corps of Engineers in 1973. (PICTURE)

*Port Clinton's City Beach is found within this region in Reach 08. The beach is pictured above looking west (left) and east (right).*

The flooding problem is exacerbated in the Western Basin Region by the area's natural history as a wetland. The widespread lacustrine clay soils in the area are not conducive to drainage, allowing floodwaters to remain several feet deep for days after a storm.

Controlling water levels is a primary reason for the construction of structural protection along much of the Western Basin shore. For example, the dikes fronting the coastal marshes in this region were constructed to manage water levels for habitat protection. Many of the dikes were originally constructed with earthen fill within the marshes before being armored with rip-rap to control wave action and prevent further recession as the barrier beaches were breached and eroded. Another example of shore structures primarily constructed to control flooding are the seawalls and revetments along the Port Clinton embayment. Many of these structures were constructed immediately adjacent to upland structures, landward of existing beaches. Since waves in this area generally break on nearshore sand bars or on the beach, these structures are intended as protection from flooding during periods of high water or severe storm events.

Flood conditions as a result of high water levels and wave buildup in the Western Basin Region are certain to occur again. The property damage associated with widespread flooding may be lessened due to the extensive armoring of the shore.

# *Needs Assessment*

A needs assessment was performed in 2006 and 2007 to gather information from coastal property owners and local officials about their knowledge and perceptions of Lake Erie coastal erosion. The needs assessment included focus groups and mail/internet surveys.

Three focus groups were held in Bay Village, Painesville and Port Clinton. There were ten participants at the Port Clinton meeting. Several participants were from the LESEMP Western Basin Region. Overall, the meeting participants were understanding of the effects of erosion and in favor of technical assistance or written best management practices to better inform those affected.

Written surveys were sent to public officials and lakefront property owners. Statewide 243 property owners and 140 public officials responded to the survey. Survey respondents were asked to provide their zip code to help identify the erosion characteristics and needs of their community. Nine public officials and 13 property owners responded from the zip codes included in the Western Basin Region (43452, 43449 and 43412). It should be noted that the Port Clinton zip code (43452) includes portions of Catawba Island Township that are east of the LESEMP Western Basin Region.

To supplement information gained from the initial LESEMP needs assessment several meetings were held in the Western Basin Region. Public officials from Lucas and Ottawa counties and all of the municipalities included in the Western Basin Region were invited to participate. Additional a meeting was scheduled for the general public with all lakefront property owners within the region boundaries invited to attend.

## Top Priorities for Shoreline Property Owners

The most notable concerns from property owners in the Western Basin Region include:

1. Shoreline property owners showed concern about sediment transport and availability in the Western Basin Region. A particular area of concern was the Sand Beach residential area.
2. Property owners had questions and comments about specific erosion control methods. Several property owners provided valuable insight on what works regionally based on personal experiences.
3. Shoreline property owners were conscious of the wide range of environmental conditions along the Ohio's Western Basin coast. Several property owners mentioned site specific technical assistance as a valuable asset in planning erosion control projects.

*Rock Ledge in Ottawa County is at the eastern end of this region.*

## Top Priorities of Local Public Officials

According to public officials along Lake Erie's Western Basin, the following are their top priorities with regards to erosion issues and control measures:

1. Communicating to the public that erosion is a constant process and does not just occur during storm events.
2. Explaining sediment transport along Ohio's Western Basin shore. A concise and understandable explanation of sediment sources, transport and sinks would be helpful for those living in the region.
3. Providing definable options and practical solutions for erosion protection.

# *Recommendations*

To better provide recommendations for the various coastal conditions within the Western Basin, the region has been segmented into nine reaches. Each reach contains introductory material on the coastal setting of the reach, followed by a set of recommendations specific to the reach. For more information on the recommendations, please refer to Appendix Erosion Control Methods.

The reaches for the Western Basin Region are as follows:

- Reach WB01: Eastern boundary of Mallard Club Marsh State Wildlife Area to Cooley Canal
- Reach WB02: Cooley Canal to Wards Canal at Metzger Marsh
- Reach WB03: Wards Canal at Metzger Marsh to Turtle Creek
- Reach WB04: Turtle Creek to Toussaint River
- Reach WB05: Toussaint River to Camp Perry Eastern Road
- Reach WB06: Camp Perry Eastern Road to Lakefront Marina in Port Clinton
- Reach WB07: Lakefront Marina in Port Clinton to Portage River
- Reach WB08: Portage River to east of Knecht's Marina
- Reach WB09: Knecht's Marina to Rock Ledge

The sections for each reach are designed so that they can be read individually or as part of this chapter. Additionally, the reaches do not have to be read in any order as they do not reference information from other reaches.

*Port Clinton's waterfront as viewed from the Portage River's east jetty.*

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## *Learn More:*

**LESEMP Webpages:** ***ohiodnr.com/tabid/20501.default.aspx***

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