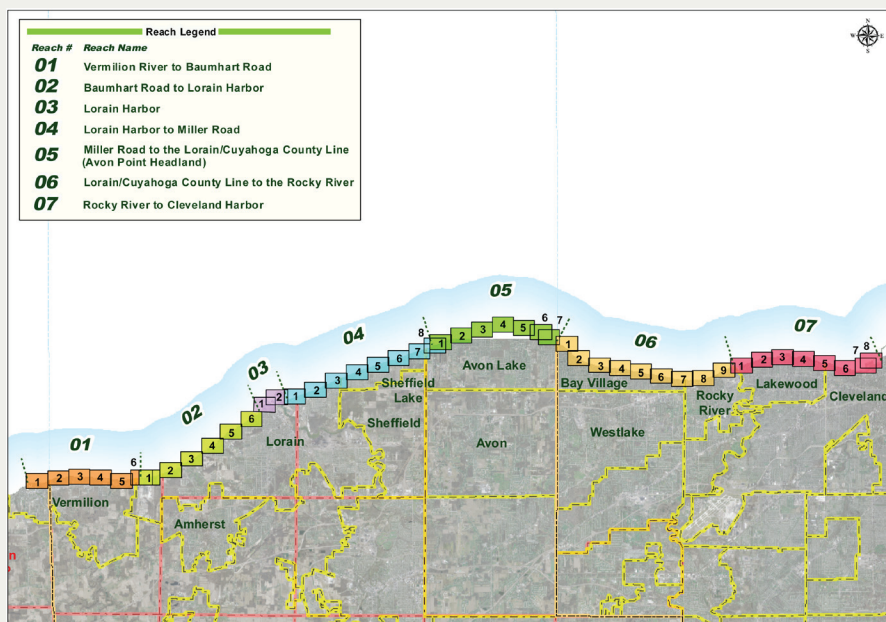


About the Program

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.

Description

The *LESEMP* Vermilion to Cleveland Harbor Region includes the Lake Erie shoreline from the mouth of the Vermilion River to the east end of the sand beach at Edgewater Park in Cleveland. The region includes the eastern end of Erie County, the entire Lake Erie shore in Lorain County and the western end of Cuyahoga County.

The Vermilion to Cleveland Harbor Region includes approximately 37.8 miles of Lake Erie shore which is about 12 percent of Ohio's 312-mile coast. The region (from west to east) includes the Lake Erie shore along the east side of the city of Vermilion, the entire shore in the cities of Lorain, Sheffield Lake, Bay Village, Rocky River and Lakewood, and the shore at the west end of Cleveland.

The Vermilion to Cleveland Harbor Region is centered on the natural headland at Avon Point; however, as viewed from above the shore from Vermilion River to Cleveland Harbor is generally wavelike. Smaller, broad headlands are present at the east end of Vermilion and along the shore of Lakewood. The breakwaters at Lorain Harbor also form an artificial headland at the mouth of the Black River.

The prominent headland at Avon Point is generally an area of diverging littoral currents. West of Avon Point, littoral currents flow west toward Cedar Point in Erie County. East of Avon Point, littoral currents flow along the Ohio shore to the east toward Conneaut. The gradual curve of Avon Point and the small scale headlands and embayments encompassing the shore make littoral currents at Avon Point variable and difficult to predict. Weaker, sometimes variable littoral currents are also common along the shore of Vermilion at the west end of the reach and in the vicinity of Lorain Harbor. Littoral currents east of Avon Point are generally more consistent.

In general, sand resources are greater at the west end of the region and gradually decrease to the east. The distribution of sand resources in this region is due to the composition of the bluff and direction of littoral currents. The bluffs in the western end of the region contain larger amounts



The largest beaches in Vermilion to Cleveland Harbor Region are in areas where sand accumulation is supported by significant shore structures such as the groins at Huntington Reservation in Bay Village (top) or the detached breakwaters at Lakeview Park in Lorain (middle) and east of the jetties at the mouth of the Vermilion River (bottom).

of till and glaciolacustrine deposits and produce a larger amount of sand when eroded than the primarily shale bluffs at the east end of the reach. This effect can also be seen at a smaller scale in the eastern portion of the reach in areas such as Bay Village and Rocky River where bluffs composed of unconsolidated materials are more likely to have beaches present than surrounding areas with shale bluffs. The direction of littoral currents and presence of shore-perpendicular structures also impact sand resources throughout the region. The largest beaches in the Vermilion to Cleveland Harbor Region are updrift of the Vermilion River, near the Beaver Creek jetties, at Lakeview Park and Lorain Harbor in Lorain, Miller Road Park adjacent to the Avon Lake power plant, at Huntington Reservation, east of the Rocky River jetty, and at Edgewater Park in Cleveland. These beaches are all stabilized by large shore structures such as jetties, harbor structures or detached breakwaters.

In addition to the Vermilion River at the west end of the region, the shore from Vermilion to Cleveland Harbor is intersected by the Black River and the Rocky River. The shore is also intersected by several creeks and smaller tributaries including Brownhelm Creek, Beaver Creek, Martin Run, Quarry Creek, Schumacher Ditch, Heider Creek, Gable Ditch, Porter Creek, Cahoon Creek, Sperry Creek, Tuttle Creek, Wischmeyer Creek, as well as an unnamed creek just east of the pier at Bradstreet's Landing in the City of Rocky River.

Description

At the west end of the Vermilion to Cleveland Harbor Region the east jetty at the mouth of the Vermilion River extends approximately 600 feet into the lake. The structures at the mouth of the Vermilion River were originally constructed in 1836 and have caused a wide beach to accrete along about 3,700 feet of shore east of the structures. East of the beach, the shore transitions to 20 to 30-foot high bluffs composed of shale capped in till. The next approximately 3.2 miles of shore is generally residential development. Much of the shore in this area is protected by shore structures, primarily armor stone revetments.

The next 3.8 miles of shore to the east is protected by a long, nearly continuous armor stone revetment lakeward of the Norfolk Southern Railway. The revetment is split near the midpoint by the jetties at the mouth of Beaver Creek. The remains of several submerged wood-pile groins can also be seen in the nearshore lakeward of the revetment. East of the Norfolk Southern Railway revetment, the shore leading up to Lorain Harbor is

generally characterized by 15 to 30-foot high bluffs composed of till and glaciolacustrine deposits. This area is primarily residential development and the bluffs in this area are protected by a variety of shore structures.

Approximately 1,200 feet west of the Lorain Harbor Breakwaters, a series of detached breakwaters stabilize about 1,500-foot long beach of considerable width at the east end of Lakeview Park. The breakwaters at Lakeview Park, constructed in 1977 by the U.S. Army Corps of Engineers, were the first detached breakwaters constructed for the purpose of beach stabilization in Ohio. The breakwaters were constructed approximately 450 feet lakeward of the toe of the bluff and help support a wide salient beach at the park. A narrow beach extends along the shore between Lakeview Park and Lorain Harbor. The beach gradually widens as sand accumulates near the landward end of the harbor breakwaters.

At the mouth of the Black River, Lorain Harbor is bounded by a series of breakwaters and confined disposal facility. The west breakwater extends



A nearly continuous armor stone revetment protects almost 4 miles of shore lakeward of the Norfolk Southern Railway at the east end of the City of Vermilion and the west end of the City of Lorain (top). The revetment is split near the center by the jetties at the mouth of Beaver Creek (bottom).

approximately 4,000 feet (0.75 miles) to the Lorain Harbor lighthouse at the lakeward end. Two breakwaters, one 2,200-foot long and one 2,000-foot long, protect the harbor basin from waves from the north and northeast. The east end of the harbor is bounded by a 2,300-foot long breakwater. A 58-acre D-shaped confined disposal facility was constructed along the northeast side of the east breakwater to store sediments dredged from the harbor's shipping channels. The harbor houses the city of Lorain's public boat ramp, public fishing pier, water treatment facility, the mouth of the Black River, the city of Lorain's wastewater treatment plant, the U.S. Coast Guard Station Lorain (www.uscg.mil/d9/sectdetroit/lorain.asp) and the marina at Lakeside Landing

The shore from Lorain Harbor to Miller Road Park in Avon Lake is primarily residential development fronted by 15 to 25-foot high bluffs composed of till, shale and glaciolacustrine deposits. The bluffs in this area are most commonly protected by concrete block seawalls or steel sheet pile bulkheads.



Lorain Harbor is protected by a series of breakwaters and a confined disposal facility for storing material dredged from the harbor channels. The Lorain Harbor Lighthouse is located at the lakeward end of the western breakwater (top). The CDF is located at the east end of the harbor (bottom).



The breakwaters at Miller Road Park and the Avon Lake power plant help stabilize the beach along the shore between the structures (top and middle). The shore of Avon Point consists of shale bluffs along several small headlands separated by narrow embayments (bottom).

Shore-perpendicular structures are also common in this area. Many residential properties are fronted by small groins in the area east of Lorain Harbor. As sand resources gradually decrease to the east, the shore-perpendicular structures found in the nearshore transition from predominantly groins intended for beach stabilization to lake access structures.

Miller Road Park's shore includes a boat ramp protected by two shore-connected breakwaters. East of Miller Road Park the shore of the GenOn Avon Lake Generating Station (Avon Lake power plant) includes a series of shore-perpendicular breakwaters protecting the power plant water intake and outlets. The breakwaters at Miller Road Park and the Avon Lake power plant help stabilize approximately 1,500 feet of beach between the structures.

East of the Avon Lake power plant the shale bluffs along the shore continue to the northeast before gradually turning to the southeast along the shore of Avon Point. Because Avon Point is a gradual headland made up of several small headlands and embayments, the point of diverging currents is highly dependent on constantly changing wind and wave directions. Localized currents can converge or diverge along the shore of the individual landforms, contributing to the formation of the irregular shoreline at Avon Point. As a result, this area experiences frequent cross currents and littoral currents that are highly variable and difficult to predict. Much of the shale bluffs in this area are unarmored; however, shore protection, such as armor stone revetments or concrete block seawalls, are common in several of the narrow embayments in the shale bluff.

To the east the shore gradually curves from facing northeast to facing northwest along the broad, shallow embayment between Avon Point and Lakewood Park. The shore in this area is consistently fronted by 50 to 60-foot high bluffs with the exception of the floodplain near the mouth of the Rocky River. The shore contains alternating areas of shale bluffs and bluffs composed of unconsolidated materials such as till, clay silt and sand. In areas with fairly erosion resistant shale bluffs long stretches of unarmored bluff are common. In areas where the bluff is composed of unconsolidated materials the bluff is mostly armored. The most common shore structures in this area are concrete block seawalls and armor stone revetments. Lake access structures such as piers are also common.

The area between Lakewood Park and Cleveland Harbor primarily contains unarmored shale bluffs; however a large amount of fill has been placed lakeward of the bluffs at Lakewood Park, near the original Bramley estate along Harborview Drive at the west end of Cleveland.

Surficial Geology

The shore of the Vermilion to Cleveland Harbor Region generally contains lakefront bluffs varying in elevation from about 15 to 60 feet. The shore in this area is composed of varying amounts of shale, till, clay and glaciolacustrine deposits. The nearshore is typically composed of either till or shale covered by a narrow layer of sand along the shore. Sand resources are variable throughout the reach due to the composition of the bluff, direction of littoral currents and impacts of artificial structures.

The shore at the west end of the reach includes a beach fronting the Vermilion River floodplain. At the east end of the floodplain shale becomes exposed at the toe of the bluff. The bluffs gradually transition from shale covered with a varying layer of till to till covered with glaciolacustrine deposits along the shore east of Showse Park. The shore fronted by the Norfolk Southern Railway revetments is primarily 15 to 20-foot high till bluffs but transitions to exclusively glaciolacustrine deposits near the Beaver Creek floodplain. The glaciolacustrine bluffs extend along the shore until just east of Lorain Harbor. The nearshore at the west end of the reach is primarily shale in areas with shale bluffs (west of Showse Park in Vermilion) and till in areas where the bluff is composed of till or glaciolacustrine deposits. While sand deposits increase in the areas of the Vermilion River jetties, Beaver Creek jetties and Lorain Harbor breakwaters, sand resources are generally limited. Nearshore slopes in this area are generally less than 1 degree but can reach up to 8 degrees within the first 100 feet of shore. Nearshore slopes can be variable in areas where shale is present in the

nearshore and west of the Beaver Creek jetties where sand bars are present.

East of Lorain Harbor the shore is characterized by 15 to 25-foot bluffs containing two layers of till separated by a layer of glaciolacustrine deposits. Shale begins to be exposed at the base of the bluff near the west end of Sheffield Lake. To the east the bluff transitions to primarily shale at the west end of Avon Lake. Bluff heights gradually increase to nearly 50 feet as the bluffs become entirely shale near the tip of Avon Point. Due to the shale bluffs and diverging littoral currents near Avon Point, sand deposits in this area are thin and discontinuous. Narrow, transient beaches occasionally



Much of the shore from Vermilion to Cleveland Harbor is fronted by fairly erosion resistant shale bluffs. The 15 to 20-foot high bluffs near the west end of the region are composed of shale covered with a layer of till of varying thickness (left and top right). The layer of shale at the base of the bluff gradually increases in elevation along the shore of Sheffield Lake. The bluffs are primarily shale by the west end of Avon Lake. The eastern portion of the region includes long stretches of unarmored bluffs.

form at the toe of the bluff, in small gaps between shore structures or other embayments along the shore; however sand accumulation is transitory. Nearshore slopes are generally less than 1 degree throughout the reach, however offshore profiles can be irregular as the nearshore transitions from till to shale near Sheffield Lake.

East of Avon Point the 40 to 50-foot bluffs transition from shale to glaciolacustrine silts and clays capped in sand. The transition occurs near the Lorain/Cuyahoga county line with several shale headlands separated by broad embayments where the bluffs are composed of glaciolacustrine deposits. The silt, clay and sand bluffs extend along the shore at the west end of Bay Village until the mouth of Porter Creek. Shale bluffs front the shore from Porter Creek to Sperry Creek (near the east end of Bay Village) where the bluff composition transitions back to till and glaciolacustrine silts and clays capped in sand. Shale extends into the nearshore throughout most of the area from Avon Point to the mouth of the Rocky River; but the



The shore transitions from bluffs composed silt clay and sand to shale bluffs at the mouth of Porter Creek at the east end of Huntington Reservation (top right). The eastern portion of the region is generally characterized by 40 to 60-foot shale bluffs (right). The shale bluffs just west of the Rocky River mouth are shown above.

shale is generally covered with sand in areas where the bluff is composed of unconsolidated deposits.

From just west of the Rocky River to Cleveland Harbor the shore is generally characterized by 40 to 60-foot shale bluffs. The only exceptions are the floodplain just east of the Rocky River and a small area with till bluffs near Edgewater Park just west of Cleveland Harbor. There are several sites in this area where a large amount of fill has been placed along the shore lakeward of the shale bluffs (such as Lakewood Park and the former Bramley estate along Harborview Drive at the west end of the City of Cleveland). Nearshore slopes near the east end of the Vermilion to Cleveland Harbor Region are variable due to the presence of shale in the nearshore. Average slopes are generally less than 1 degree but can reach 6 degrees along the shore.



Habitat

Conservation of fish and wildlife habitat, particularly along the nearshore, is a critical component of the LESEMP. Prior to development, the shore from the mouth of the Vermilion River to Cleveland Harbor contained a variety of complex habitats. Today the Vermilion to Cleveland Harbor Region contains a variety of habitats along the nearshore, beaches and bluffs.

Nearshore

The nearshore habitat of the Vermilion to Cleveland Harbor Region is fairly consistent. The lake bottom typically consists of shale bedrock or glacial till, covered by variable sand deposits. These substrates provide important habitat for adult walleye and perch. Smallmouth bass are also common in the area from the mouth of the Vermilion River to Avon Point and from the mouth of the Rocky River to Cleveland Harbor.

Beaches

Beaches along the Vermilion to Cleveland Harbor Region provide important yet fragile habitat. Beaches wide enough to support vegetation are generally limited to areas where they are supported by shore structures. Supplementing existing beach flora with additional native vegetation is recommended throughout this region both to improve habitat and for erosion management to help stabilize the beach.

Bluffs

Bluffs are present along most of the shore of the Vermilion to Cleveland Harbor Reach. While habitat is limited on the nearly vertical shale bluffs fronting most of the reach, areas with bluffs composed of till and glaciolacustrine deposits support a variety of vegetation ranging from grasses and sedges to herbaceous shrubs and trees. The vegetation along the bluff face provides important habitat for both resident and migratory bird populations. Vegetation also provides several benefits for bluff stabilization and is recommended throughout the region.

Upland

Mixed temperate forests dominated the west end of the region along the shore east of the Vermilion River. The mixed temperate forests gave way to beech forests in the area between Beaver Creek and the Black River. Mixed oak forests spanned much of the remaining shore of the Vermilion to Cleveland Harbor Region, particularly the areas fronted by shale bluffs. The mixed oak forests extended from the Black River to about 2 miles east of the



Planting native vegetation along the beach helps stabilize the beach by encouraging sand accumulation and dune formation and provides important habitat for resident and migratory bird populations.

Rocky River before shifting back to temperate forests at the east end of the region. As the area was developed the mixed oak and mesophytic forests were cleared for agriculture and eventual development.

Coastal Erosion

The Vermilion to Cleveland Harbor Region is susceptible to a variety of types of erosion depending on the characteristics of the shoreline. The shale bluffs along most of the reach are fairly erosion resistant but are prone to collapses and rock falls if undercut. Areas of the region with bluffs composed of till and glaciolacustrine deposits are susceptible to erosion from wave action, surface and ground water and mass wasting. Beach areas are primarily susceptible to erosion from wave action and weathering by wind, rain and ice.

The vertical shale bluffs fronting most of the Vermilion to Cleveland Harbor Region generally erode in episodes of collapsing, rather than by the gradual removal of soil. This means a shale bluff may appear stable for many years before suddenly experiencing a loss of several feet. This is generally the result of wave action at the base of the bluff. Erosion of the shale bluffs by wave action is due both to the significant forces as waves impact the bluff

and by the motion or water or suspended sand and gravel scouring the base of the bluff. The waves breaking on the shore also releases energy that dislodges material from the shore and forces water into existing voids, widening the voids and forcing materials apart. The shale bluffs can also be damaged by ice forces both from ice floes in the lake and from freeze/thaw processes due to ground water in the bluff face. These factors eventually cause cracks in the shale and can lead to rockfalls, particularly in undercut areas.

Areas with bluffs composed of till, and glaciolacustrine deposits will generally erode from a combination of wave action, surface water run-off, ground water seepage and mass wasting. Waves impacting the bluff can cause scour at the toe of the bluff and displacement of loose materials. This leads to slumping of unsupported material higher on the bluff face. Erosion between layers within the bluff due to groundwater seepage can also result in mass wasting (slumping and collapsing). Surface water run-off and weathering, including wind and freeze-thaw processes, are also important factors contributing to erosion of the bluffs in this region.

On sandy shores waves cause both alongshore and cross-shore littoral currents responsible for the erosion and accretion of beach sand and fine



The vertical shale bluffs fronting most of the reach are fairly erosion resistant but are susceptible to wave based erosion at their base. If the bluff is undercut the upper portion of the bluff may collapse (left). Surface water run-off can cause rills to erode along the face of bluffs composed of till or glaciolacustrine deposits (right).

materials. This is particularly apparent near large shore-perpendicular structures such as the jetties at the mouth of Beaver Creek, the breakwaters surrounding Lorain Harbor and the groin field at Huntington Reservation.

Erosion and accretion along the shore of the Vermilion to Cleveland Harbor Region has been considerably impacted by the development of the region. During the time period from 1876 to 1973 average recession rates in this region typically ranged from 0 to 3.1 feet per year. In general, recession rates were greater in areas where the bluff is composed of unconsolidated deposits as compared to areas with shale bluffs. Recession rates were also greater early in the time period and gradually decreased due to the widespread development of protective structures throughout the region. There were also localized areas that experienced accretion during this time period, particularly in areas impacted by the construction of large shore-perpendicular structures. The original jetties at the mouth of the Black River were constructed in 1829 and the Vermilion River jetties were originally constructed in 1836. These structures, and the larger harbor structures that were eventually built, have caused wide beaches to accumulate updrift of the Vermilion River and in the area of Lorain Harbor.

From 1973 to 1990 average recession rates ranged from 0 to 4.9 feet per year, although average recession rates were typically less than 3 feet per year throughout the region. Recession was greatest along the shore just east of Showse Park at the east end of Vermilion. This area is fronted by bluffs primarily composed of glaciolacustrine deposits. Overall, recession during this time period was generally limited to unarmored areas fronted by unconsolidated bluffs, compared to the shale bluffs fronting most of the region.

As stretches of this region with bluffs composed of unconsolidated materials continued to be armored, average recession rates continued to decrease from 1990 to 2004. Average recession rates ranged from 0 to 2.5 feet per year throughout the region. Recession was greatest along the unarmored beach near the Beaver Creek jetties. Future erosion along most of the Vermilion to Cleveland Harbor Region will likely be limited as most areas with till, clay or glaciolacustrine deposits near the toe of the bluff are heavily armored with protective structures. Future erosion will likely be limited to small unprotected areas or gaps between structures or the slow recession of the long stretches with fairly erosion resistant shale bluffs. With adequate maintenance of the existing shore structures in this reach, future recession rates should be low along most of the region.

Flooding

In addition to the gradual recession due to erosion, the threat of flooding is a concern along the low-lying areas in the flood plains near the mouths of the Vermilion and Rocky rivers. Flooding in these areas is often attributed to a combination of high lake levels and flooding of the rivers. If flooding occurs, it generally happens during the spring due to snow melt and upland run-off, particularly at the mouth of the Vermilion River where the harbor structures sometimes collect ice and obstruct the flow of water from the river.

The risks attributed to flooding are also increased in heavily developed, low-lying areas such as the Vermilion Lagoons area. Many residential structures in this area are constructed very close to the shore, increasing the threat of property damage from lake-based flooding.

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 mail and internet surveys, and focus groups.

Written surveys were sent to both 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. Twenty-four public officials and 54 property owners responded from the zip codes included in the Vermilion to Cleveland Harbor Region (44089, 44052, 44012, 44140, 44116, 44107, 44113). It should be noted that the Vermilion (44089) and Cleveland (44113) zip codes extend beyond Vermilion River at the west end of the region and into Cleveland Harbor at the east end of the region. An additional 7 public officials responded from inland zip codes near the shore of this region including LaGrange (44050), Elyria (44035), Lorain (44055), Brookpark (44142) and Cleveland (44130).

Three focus groups were held in Bay Village, Painesville and Port Clinton. Based on meeting proximity, it is expected that property owners or officials from the Vermilion to Cleveland Harbor Region participated in the Bay Village meetings. Overall, the meeting participants understood the effects of erosion and were in favor of technical assistance or written best management practices to better inform those affected.

Recommendations

To better provide recommendations for the various coastal conditions within the Vermilion to Cleveland Harbor Region, the region has been segmented into seven 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 the Erosion Control Methods Appendix.

The reaches for the Vermilion to Cleveland Harbor Region are as follows:

- Reach 1: Vermilion River to Baumhart Road
- Reach 2: Baumhart Road to Lorain Harbor
- Reach 3: Lorain Harbor
- Reach 4: Lorain Harbor to Miller Road
- Reach 5: Miller Road to Lorain/Cuyahoga County Line
- Reach 6: Lorain/Cuyahoga County Line to Rocky River
- Reach 7: Rocky River to Cleveland Harbor

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.



From 1990 to 2004 average recession rates were greatest along the unarmored beach downdrift (west) of the jetties at the mouth of Beaver Creek.

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ODNR Office of Coastal Management

105 West Shoreline Drive, Sandusky OH 44870

419.626.7980 | coastal@dnr.ohio.gov | coastal.ohiodnr.gov

ODNR Division of Wildlife wildlife.ohiodnr.gov

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