Lake Erie Shore Erosion Management Plan

Cedar Point to Vermilion - Reach 01

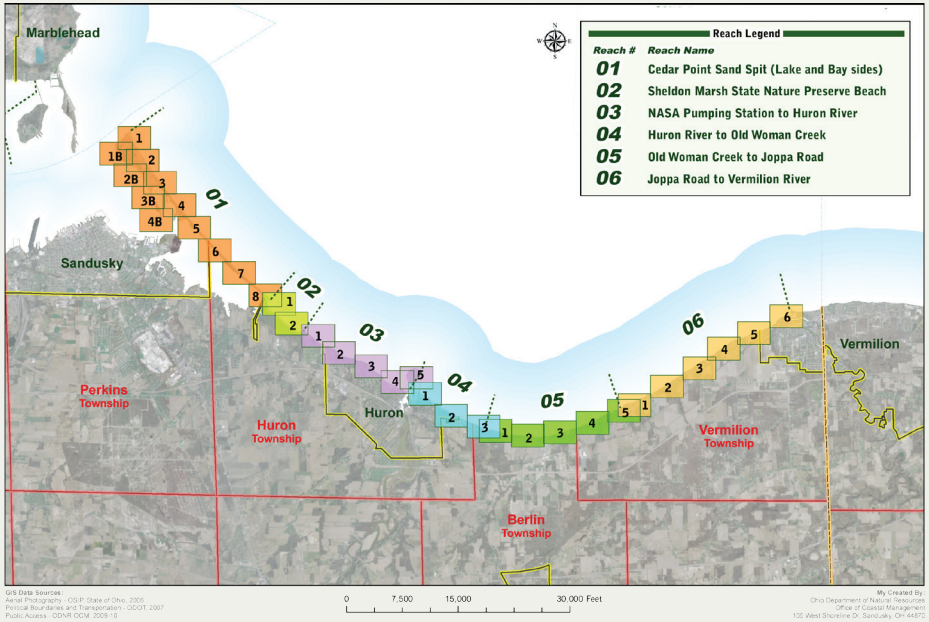
LESEMP

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.

Description

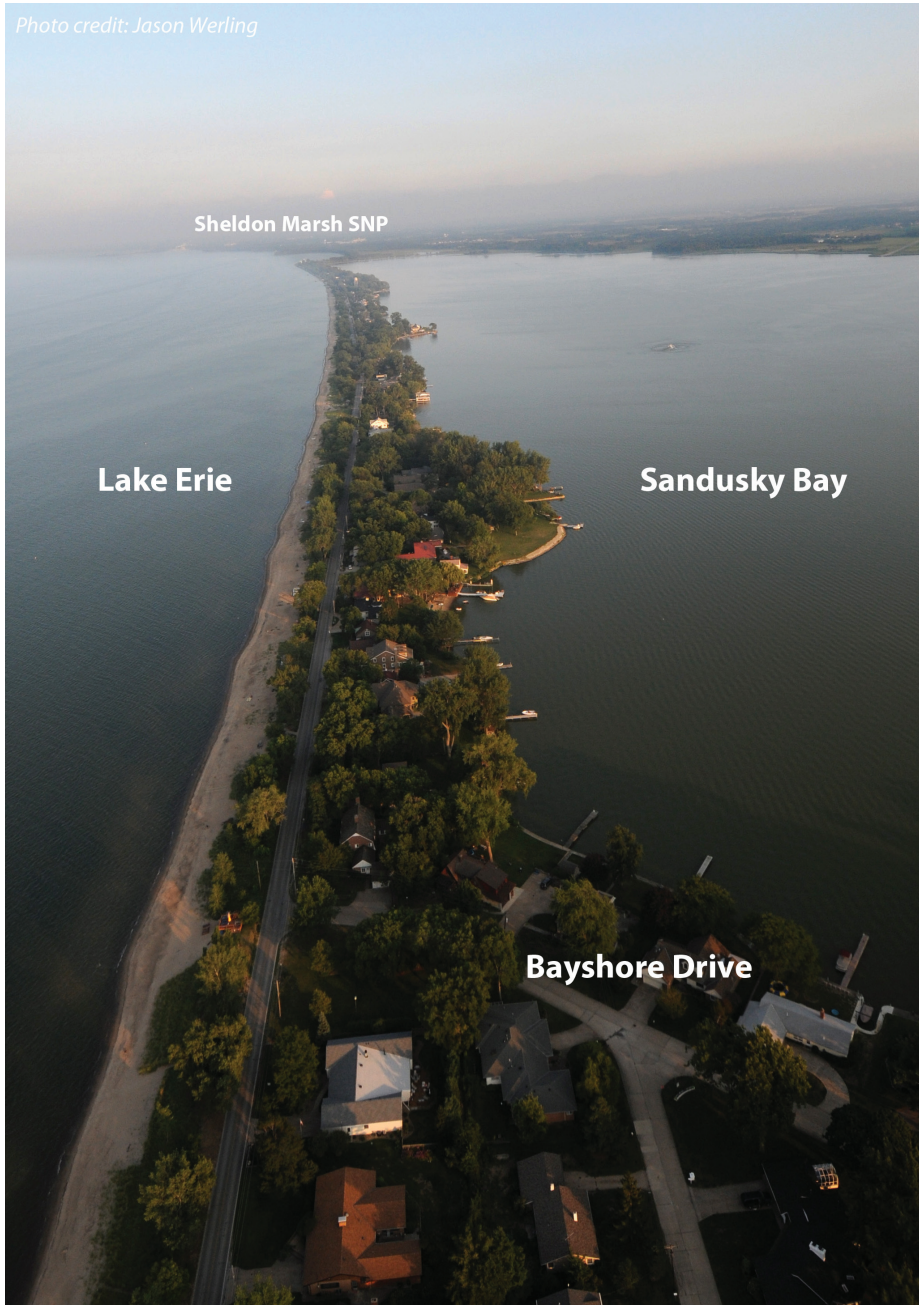
Reach 1 of the Cedar Point to Vermilion Region extends from the Cedar Point federal jetty to the east end of Cedar Point Road (locally known as the Chaussee) in Sandusky. The Cedar Point sand spit includes the land mass between the Lake Erie and Sandusky Bay shores of Cedar Point. This reach contains the Cedar Point amusement park and the residential community along Cedar Point Road. It includes approximately 29,800 feet (5.64 miles) of Lake Erie shore and 41,000 feet (7.77 miles) of Sandusky Bay shore.

The Cedar Point sand spit is oriented from northwest to southeast at the east end of Sandusky Bay. The lake shore is fairly uniform with a slight lakeward facing curvature. The shore along the bay side is much less uniform and includes several peninsulas and embayments. The irregular form of the bayshore is the result natural processes such as sand transported from the barrier beach and manmade structures. Both the lake and bay shores are nearly completely armored, although a beach is present lakeward of the protective structures along much of the Lake Erie-side of the sand spit.

At the west end of the reach, the Cedar Point jetty extends about 5,000 feet (0.95 miles) into the lake at the mouth of the Sandusky Bay. The jetty becomes partially submerged as it wraps around the northern tip of Cedar Point for another 2,000 feet (0.38 miles) into Sandusky Bay. The shore at the mouth of the bay is also protected with a rip-rap revetment. The bay side tip of Cedar Point includes a 150-foot long pier protected by a steel sheet pile breakwater.

Cedar Point Lakeshore

On the lakeshore side of Cedar Point, a wide beach has accumulated updrift of the jetty. The first 200 feet of shore southeast of the jetty is unarmored beach area. The next 550 feet of shore includes a wide sand beach lakeward of a low concrete seawall protecting the Sandcastle Suites resort. The seawall gives way to a rip-rap revetment armoring the natural beach dune for the next 1,900 feet of shore lakeward of the Soak City waterpark. The beach is backed by a concrete seawall for the next 2,500 feet lakeward of the Hotel Breakers and Cedar Point facilities buildings. The next 1,300 feet of shore is sand beach lakeward of the parking area at Cedar Point.



***May 2, 2007**: Looking southeast at the Cedar Point sand spit from about 2.5 miles southeast of the Cedar Point jetty. Sheldon Marsh State Nature Preserve labeled in the background is in Reach 02.*

The next 1,500 feet of lakeshore is the residential area along the west extension of Cedar Point Road. The shore includes a wide beach protected with concrete modules forming a detached breakwater in the nearshore. Most of the homes in this area are also protected with a low seawall or bulkhead landward of the beach.

The remaining approximately 22,500 feet (4.26 miles) of Cedar Point is residential. The beach lakeward of Cedar Point Road typically extends for the next 15,000 feet (2.84 miles) of shore. Nearly the entire shore is armored with a variety of protective structures including seawalls, bulkheads and revetments constructed landward of the beach to protect both Cedar Point Road and residential development. Over the next approximately 1,000 feet of shore, depending on lake levels and sediment supply, sand accumulation gradually decreases and the shore transitions to a rip-rap revetment. The revetment extends to the southeast tip of Cedar Point at the Point Retreat Condominiums. A few properties include a detached breakwater or small stone groin extending into the lake but sand accumulation for the east 6,500 feet (1.23 miles) of Cedar Point is minimal.

The nearshore is mostly comprised of thick sand deposits but littoral processes occasionally uncover underlying glaciolacustrine clay or peat deposits. The net direction of littoral currents is from southeast to northwest. Nearshore sand deposits are generally greater at the west end of the reach as sand is trapped by the Cedar Point jetty. Moderately well defined sand bars occasionally form within the first 100 to 400 feet from shore and generally disperse near the east end of Cedar Point Road. Nearshore slopes in this reach range from about 1 degree for the first 100 feet to about 0.5 degrees farther offshore. Nearshore slopes gradually increase from west to east as sand deposits decrease with distance from the Cedar Point jetty.

Cedar Point Bay Shore

The shore is less uniform on the Sandusky Bay side of Cedar Point. Near the mouth of Sandusky Bay, a 500-foot long rip-rap revetment extends along the shore southwest of the pier at the tip of Cedar Point. The revetment extends for about 2,600 feet (0.5 miles) along Perimeter Road on the southwest side of the amusement park. Approximately 1,200 feet into the revetment there is a U-shaped rip-rap structure extending into the bay at a water intake for the park.

To the southeast, Perimeter Road splits from the bay shore at the base of the northern 1,900-foot long breakwater for the Cedar Point Marina. The marina and seawall along the parking lot are protected with additional 2,600-foot long

(middle) and 1,800-foot long (southern) breakwaters reaching the base of the Cedar Point Causeway. A large portion of the causeway was constructed over natural sand formations stabilized with rip-rap. Southeast of the Cedar Point amusement park the bay shore of the Cedar Point sand spit is completely comprised of residential development.

The lagoon between the causeway and Cedar Point contains 3 smaller sand bars extending as small peninsulas into the bay and separating embayments along the bay shore. The northwestern sand bar (closest to the amusement park) is not developed. The peninsulas forming the east embayment are developed and support Sunset Drive, Willow Drive, Greenbrier Lane and Bayshore Drive. To the east the shore becomes more uniform but contains many small embayments and headlands. The most prominent headlands have been developed about 500 feet southeast of Bayshore Drive and along Lurie Lane. The remaining shore is inconsistent due to its natural form and gaps between protective structures.

Almost the entire bay shore is armored, typically with low revetments, seawalls and bulkheads. Many properties include small pile-supported piers or floating docks extending into the bay.

About 1,000 feet northwest of the southeast tip of the Cedar Point sand spit, the sand spit is connected to shore by Cedar Point Road which connects to Cleveland Road (U.S. Route 6). The road was constructed on fill and is protected with rip-rap. The southeast 1,000 feet of the Cedar Point sand spit contains a marina at the Point Retreat Condominiums.

When compared to the lakeshore, the nearshore of Sandusky Bay is characterized by much shallower water depths and gentler, almost flat slopes, except where navigation channels are present. The bay nearshore is mainly comprised of mud, glaciolacustrine deposits and sand. The wave climate within Sandusky Bay is generally not sufficient to generate consistent littoral currents. Currents in the east end of Sandusky Bay are limited to the mouth of the bay and the channel near Point Retreat when water levels fluctuate during seiche events. Longshore currents along most of the bay shore are negligible.

Recession/Erosion

The ODNR Division of Geological Survey has evaluated the recession of Ohio's Lake Erie shore over three time periods: 1877 to 1973, 1973 to 1990 and 1990 to 2004. Changes in the rates measured during each of the time periods are generally attributed to development along the coast and natural factors such as lake level changes.

Due to the variability of the Cedar Point sand spit before development and the lack of similar geographic features (such as roads or permanent structures) to align the images, the 1877 maps can not be accurately compared to more recent aerial photographs. As a result aerial photographs from 1937 are the earliest data available to determine historic recession for this reach. The tip of Cedar Point was first stabilized with the original construction of the Cedar Point jetty in 1897. The jetty was constructed to prevent migration of the sand spit and reduce sand transport into shipping channels. Sand immediately began accumulating updrift of the structure causing the jetty to be lengthened in 1922. The shoreline has progressed approximately 1,500 feet lakeward as a result of sand accumulated by the structure. From 1937 to 1973 the Cedar Point Sand Spit experienced very low erosion rates on both the lake and bay shores as Cedar Point Road was steadily developed.

By 1973 the Cedar Point sand spit was nearly completely developed and structurally protected on both the lake and bay shores. From 1973 to 1990 average recession rates ranged from 0 feet per year to 5.2 feet per year on the lake side and 0 feet per year to 7.4 feet per year on the bay side. Recession was greatest along the mouth of Sandusky Bay and on the westernmost, undeveloped peninsula extending into the bay. Recession during this time period was extremely localized and limited to small gaps between structures. Overall recession rates were generally less than 0.3 feet per year on both the lake and bay shores. From 1990 to 2004 average recession rates remained low and ranged from 0 feet per year to 0.2 feet per year on the lake side and 0 feet per year to 1.3 feet per year on the bay side. Recession was generally limited to small gaps between structures as the shore is nearly completely armored.

Flooding

This reach is essentially a narrow sand spit that acts as a barrier beach between Lake Erie and Sandusky Bay. The low-lying properties of this reach are susceptible to flooding as well as erosion. Floods have usually been associated with gales from the northeast, such as may occur when tropical storms or the remnants of hurricanes migrate to the northeastern U.S. and southeastern Canada. The resulting winds, rotating counterclockwise around the storm center, may blow over many miles of open lake, piling water in the western basin and leading to overtopping or breaching of shore structures, and have led to occasional breaches of the barrier beaches in this area. If the storm coincides with a period of high water, the effect is intensified. Although the area is extensively armored with

protective structures, the residential development in this reach is often placed extremely close to the shore, making the area especially vulnerable to flooding. During one such storm in 1972, storm waves deposited sand and stone blocks on Cedar Point Road, blocking it. The tongues of sand extending into Sandusky Bay on which Sunset Drive, Greenbrier Lane and Bayshore Drive are developed, are actually remnants of storm deposits that occurred in the distant past, before settlement and development.

Beaches/Sand Supply

This reach consists of a sand spit formed at the mouth of Sandusky Bay. The shores of the reach are naturally sand. A wide beach has also accumulated along the lake shore due to the trapping of longshore transport by the Cedar Point jetty. The occasional formation of sand bars in the nearshore zone demonstrates the availability of sand in this reach. The presence of sand lakeward of vertical seawalls and bulkheads along most of Cedar Point is also an indication of large sand deposits in the area. Vertical structures placed too close to the shore often cause downcutting and scour at the base of the structure. Along this reach the sand bars and shallow nearshore zone often cause waves to break before reaching the structures. Many vertical structures are constructed upland of existing beaches as protection from flooding or severe storms. The beaches further decrease wave energy helping to prevent downcutting. Sand deposits are greatest at the west end of the reach due to accumulation updrift of the jetties. The sand supply generally decreases at the east end of the reach. This is demonstrated by the current lack of beaches for the east 6,500 feet of the reach.

Use of Shore Structures

The most prominent structures in this reach are near the tip of Cedar Point in the area of the amusement park. The 5,000-foot long federal jetty has had the most significant impact on erosion/accumulation in this reach. The marinas and parking areas on the bay side of the amusement park are also protected with a series of long breakwaters.

Along most of Cedar Point a wide variety of erosion control structures have been constructed to protect upland property. The shore in this reach is almost completely armored with only a few small gaps between structures. The most common structures are armor stone revetments, steel sheet pile bulkheads and concrete seawalls. On the lake side many of the seawalls have been constructed upland of the beach to provide protection from severe storms or flooding while preserving the beach.

Summary

The reach from the Cedar Point jetty to the east end of the Cedar Point Sand Spit has generally experienced slow erosion or accretion. The lake shore updrift of the Cedar Point jetty has accumulated sand and progressed lakeward. The remainder of the reach has receded very slowly. Erosion in this area has been limited by extensive residential development and the shore structures constructed to protect it. This reach is nearly completely armored with only a few small gaps between structures. Future erosion will generally be limited to the large sand deposits lakeward of protective structures or small gaps between structures on the bay shore.

The northwest lake shore of the Cedar Point sand spit in an undated photo prior to extensive development which was used in a 1959 report by the National Park Service (left). A 2008 photo looking south with the city of Sandusky in the background (middle). A July 2004 looking southeast along the Cedar Point beach (right).

GIS Data Sources:
Aerial Photography - OSIP, State of Ohio, 2006
Political Boundaries and Transportation - ODOT, 2007
Public Access - ODNR OCM, 2009-10

Created By:
Ohio Department of Natural Resources
Office of Coastal Management
105 West Shoreline Dr, Sandusky, OH 44870

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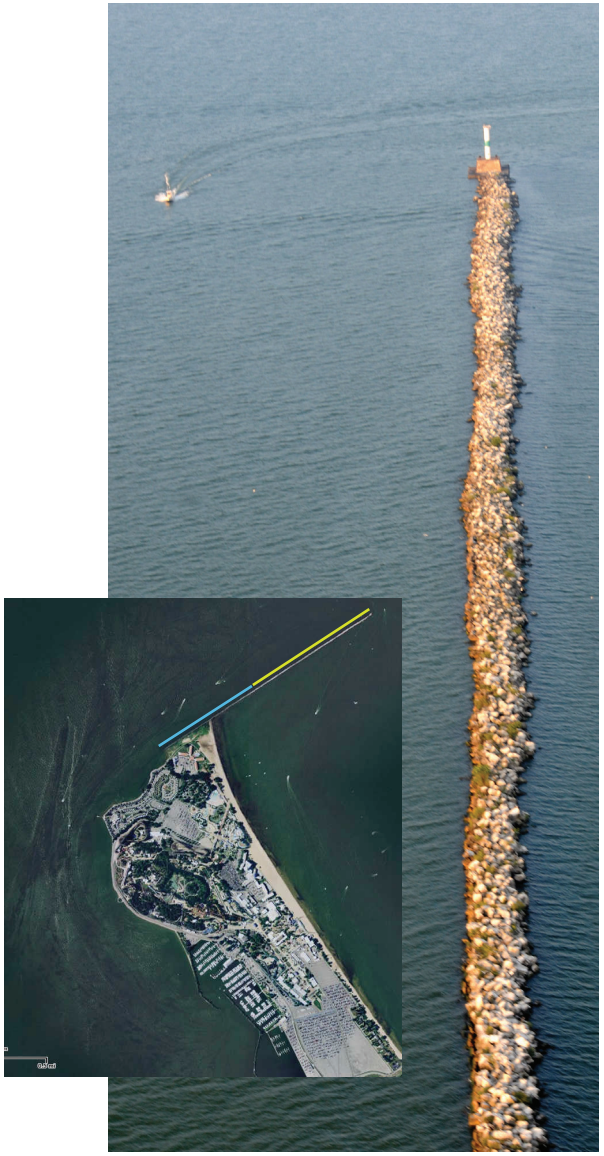

The large map at left shows the first ~2,200 feet of the nearly mile long Cedar Point jetty. This is the portion outlined in blue in the above aerial image. The aerial picture at right shows the most northeast portion of the jetty which is highlighted in green but not shown on the map at left.

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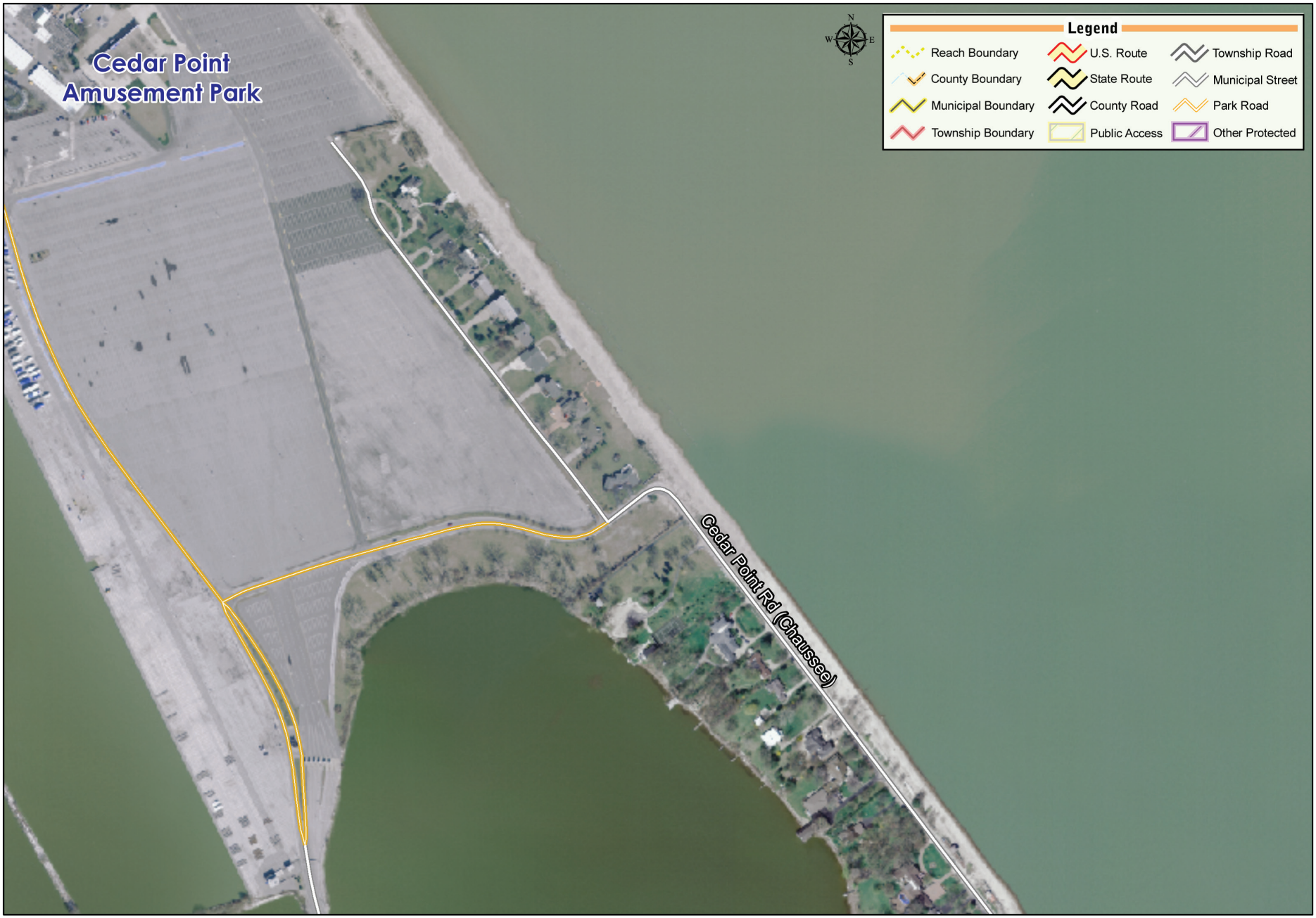

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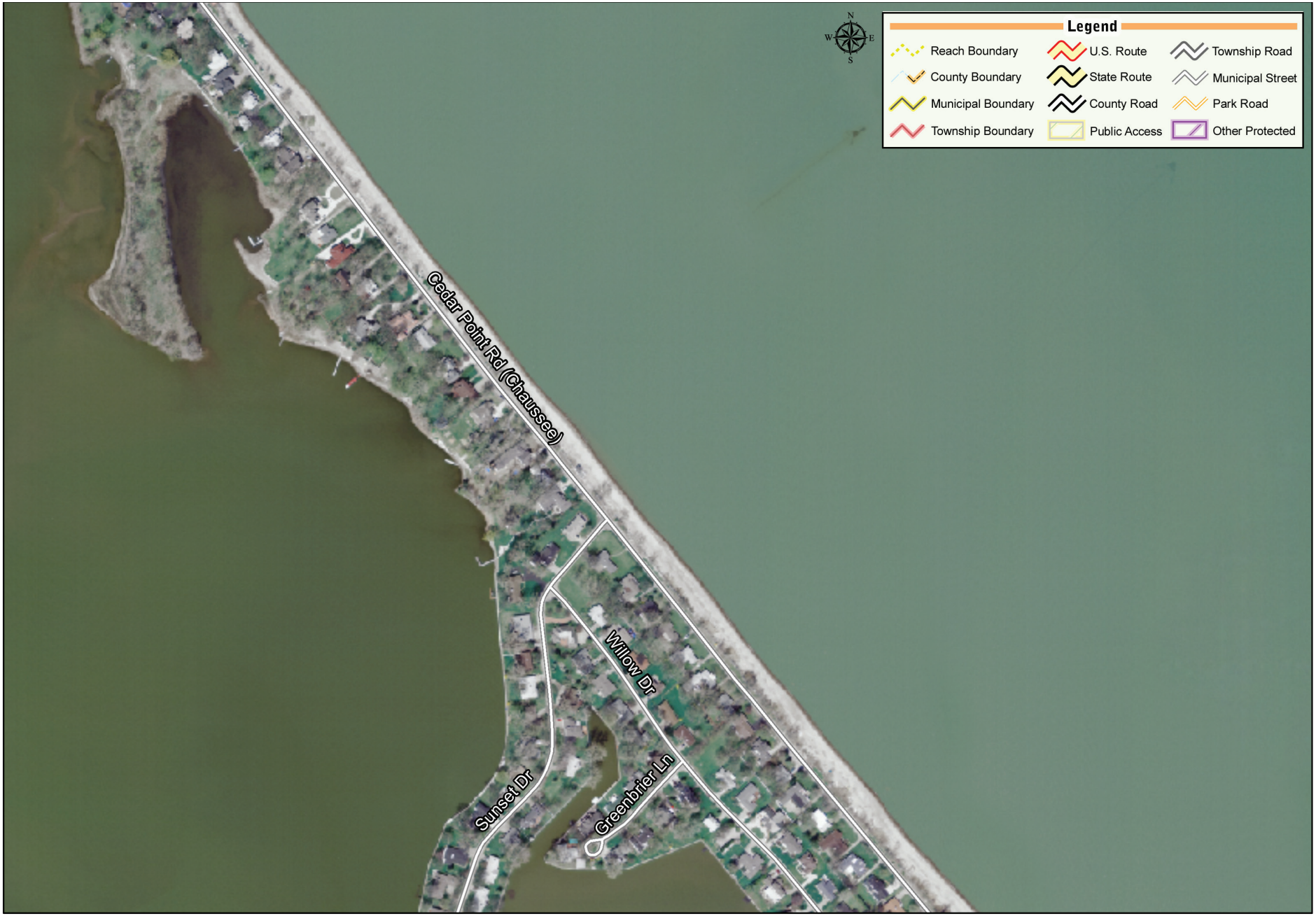

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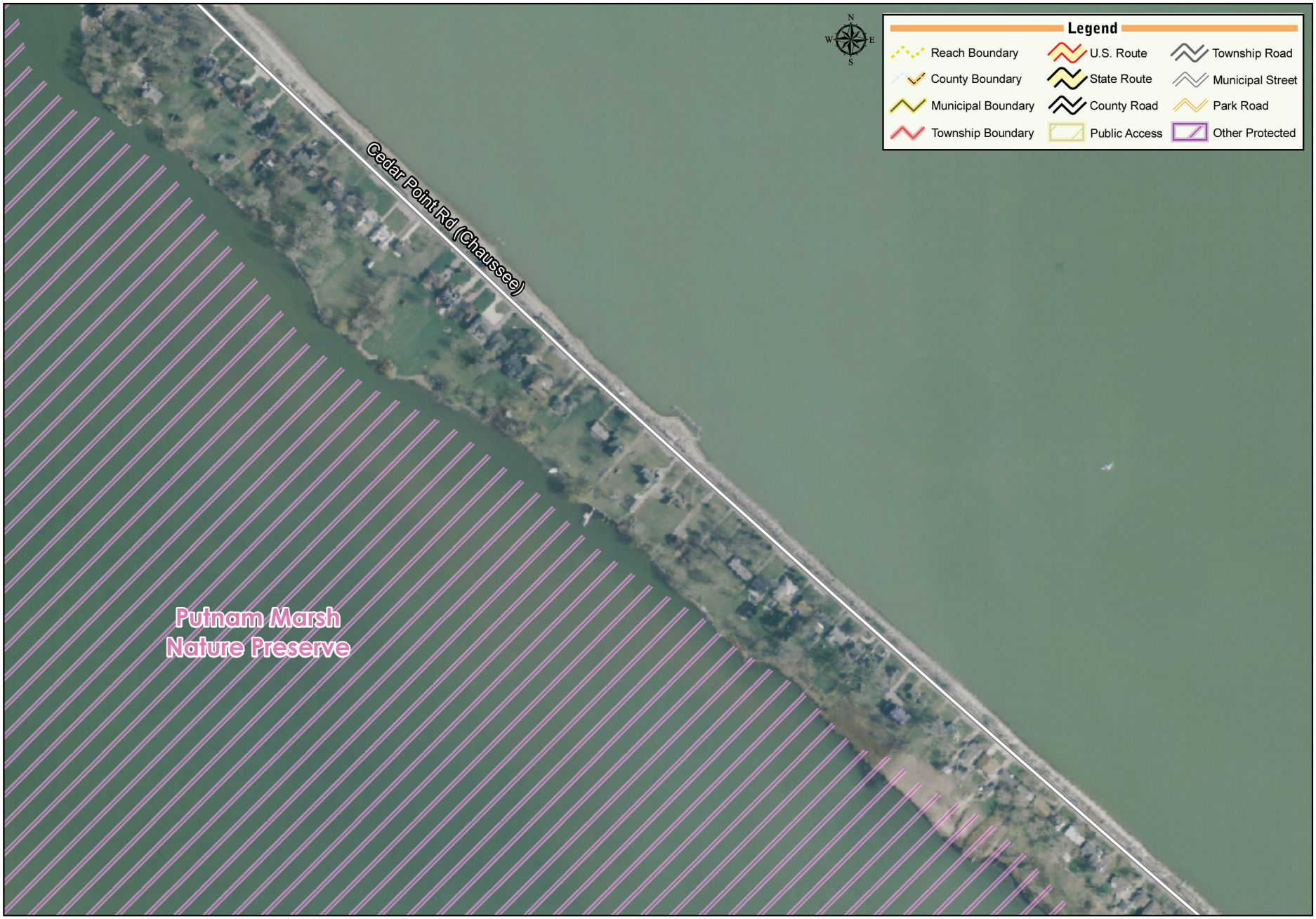

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May 2012: *The above photos show the view of the shore that corresponds to the aerial map at right. The top photo is taken looking north from where the breakwater turns from running east-to-west to running north-to-south. The middle photo was taken looking east along the shore from near where the bridge is shown in the bottom photo. The bridge in the bottom photo is just north of where the words "Cedar Point Dr" are on the map at right.*

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Ohio Department of Natural Resources
Office of Coastal Management
105 West Shoreline Dr, Sandusky, OH 44870

GIS Data Sources:
Aerial Photography - OSIP, State of Ohio, 2006
Political Boundaries and Transportation - ODOT, 2007
Public Access - ODNR OCM, 2009-10

May 2012: *The above photos show the view of the shore that corresponds to the aerial map at left. The top photo is of the land that bulges westward from Cedar Point Drive. The middle photo was taken looking at the pocket of sand just to the south of the bulge. The bottom photo was taken looking south along the shore from near where the middle photo was taken.*

Recommendations

The recommendations included below are options that may be applicable within this reach and should only be used for planning purposes. Based upon the above physical characteristics, the following recommendations are suggested for the Cedar Point Sand Spit reach. Each recommendation includes a brief overview of the solution prior to addressing areas within the reach where the recommendation is best suited. For more information on any of the items listed below, please refer to the Glossary and Appendix A: Erosion Control Solutions.

In addition to the recommendations listed below, a "do nothing" alternative should also be considered. This may be a viable, and even favorable, alternative for much of Ohio's Lake Erie shore. The Cedar Point Sand Spit reach generally has a stable shore and has low erosion rates. In areas where the shore is protected with effective structures additional protection might not be necessary. In these areas attention should be focused on monitoring and maintaining the structures. In other areas, particularly those with a natural shoreline and low erosion rates, the best option may be to hold development back from the shore and allow natural erosion/accretion processes to occur. This is a favorable option for the few undeveloped areas of this reach such as the westernmost peninsula extending into the bay, just east of Cedar Point Drive.

For the Lakeshore

Sand Management:

1. <u>Conserve Sand Resources</u>: Conserve sand resources within the shore and nearshore areas. Sand is a limited resource in constant fluctuation. Avoid removing sand from the system; sand moved or excavated during construction along the shore should be placed in the nearshore, not on the upland and should not be incorporated into the construction project.

While there is sand available in the littoral system this recommendation should be considered throughout this reach. The sand available in the nearshore zone is relied on to provide beach material and prevent waves from breaking on structures. A reduction of sand in the littoral system would decrease the effectiveness of many protective structures, leaving residential properties vulnerable to erosion and flooding.

2. <u>Beach Nourishment</u>: Supplement the current sand supply with beach nourishment, also known as beach fill or pre-fill. Beaches protected by groins and detached breakwaters will benefit from initial nourishment (pre-fill during or directly after construction) and periodic re-nourishment. The sand used in these projects should be acquired from an upland source.

This recommendation is applicable throughout the reach. The addition of beach nourishment would be especially beneficial if added to sites with existing beach stabilization structures or as part of new construction for detached breakwaters. Beach nourishment may also be beneficial in areas with limited sand supply near the southeast end of Cedar Point.

July 2012: *The shore along East Sandusky Bay has a very low profile and contains a mixture of native wetland vegetation, invasive species and small private docks. In some spots, vegetation or grass abuts the water while at other places low-profile shore structures are present. Photos from the 230 to 150 block of Cedar Point Road.*

3. <u>Dune Construction</u>: Natural sand dunes prevent erosion by providing protection to the landward areas from waves and wind while acting as a sand reserve for the beach and nearshore areas. With sufficient sand supply beaches will naturally form dunes as sand accretes on the beach during calm wave conditions and is eventually piled along the shore by wind. The sand formations are gradually stabilized by vegetation and provide natural protection to the shore. The formation of mature sand dunes requires excess sediment supply for a considerable time period and is rare along Ohio's Lake Erie coast. An effective dune system can be created through dune construction by beach nourishment and vegetation. Dune ladders, sand bags and snow fences are also commonly used to hold sand and aid the formation of sand dunes. An artificial dune system will require regular monitoring and occasional maintenance through the addition of sand or planting of vegetation.

This recommendation applies to the wide beaches updrift of the Cedar Point jetty at the west end of the reach. Snow fences and other artificial dune stabilization techniques can also be beneficial in keeping beach sand from blowing onto upland property. This would be beneficial in preventing sand from being removed from the littoral system and reducing maintenance for property owners and at the Cedar Point amusement park.

4. <u>Vegetation</u>: Encourage growth of native vegetation on the back beach. Beach vegetation encourages the formation of a dune system by holding sand in place and providing protection from wind. It is also possible to simply allow the natural succession of native plant species to grow along the beach.

Native vegetation on the beaches in this reach would be beneficial to help encourage dune formation and would assist in stabilizing the shore. Beach vegetation also provides protection from wind and can help prevent sand from blowing onto upland areas or onto Cedar Point Road. This recommendation would be most beneficial on the wider beaches at the west end of the reach, particularly the beach fronting the less accessible areas lakeward of Cedar Point amusement park.

August 12, 2010 aerial looking northwest at the northern half of the Cedar Point sand spit.

Toe Protection:

5. <u>Detached Breakwaters</u>: Detached breakwaters may be useful in areas where beaches are present or likely to form. Detached breakwaters aid in retaining a beach by limiting the wave energy reaching the shore causing sediment to settle out and be deposited. As opposed to groins which trap sand moving along the shore, properly designed and constructed detached breakwaters are intended to allow alongshore movement of sand. An initial beach nourishment (pre-fill) and periodic re-nourishment will often be advantageous to creating and retaining the beach landward of the breakwater while limiting impacts to neighboring shorelines. Some regulatory agencies may require pre-fill and periodic nourishment as one of the design components for a project that includes detached breakwaters.

Detached breakwaters would function well in the shallow water throughout the reach and would be particularly effective near the west end of the reach. The west extension of Cedar Point Road is already protected with concrete modules in the nearshore acting as a detached breakwater. The beach in this area exhibits a salient formation demonstrating the effectiveness of the structures in reducing wave energy on shore. A few properties near the east end of the reach have detached breakwaters that have been less effective due to the small length of the projects, the hardened shoreline in the area, and the reduced amount of sand in the littoral system.

Beach nourishment or sand pre-fill should be included in the design of a detached breakwater to prevent the structure from trapping littoral material and increasing the risk of erosion on adjacent properties. A beach monitoring and sand bypassing plan should also be included in the design of the detached breakwaters to prevent excessive sand accumulation during periods of unanticipated environmental conditions.

6. <u>Revetments</u>: Revetments along the toe of a bank will aid in protecting against wave-based erosion. In areas without beaches, a structural measure may be necessary to protect the toe of the bank. The low-relief banks within this reach have relatively gradual slopes, which are ideal for revetment development. In essence the revetments form a stable bank slope, providing protection to the soil underneath while breaking up wave attacks. Since material eroded off the bank is one source of beach-building sand, some regulatory agencies may require that one of the design components for a revetment be the inclusion of sand pre-filling in the amount equal to that which would have been added to the system over the life of the structure.

Revetments are common throughout this reach and are the primary coastal feature for much of the lakeshore at the east end of the reach. The revetments in this area have been effective at stabilizing the dynamic barrier beach.

Several properties at the west end of the reach are protected with seawalls or bulkheads. If these structures need maintenance or replacement, revetments should be considered. Many of the seawalls and bulkheads were constructed immediately lakeward of upland structures to allow existing beaches to remain. A revetment will provide similar protection against storm waves and flooding but has the advantage of dissipating wave energy rather than reflecting it into the nearshore zone. This reduces the risk of downcutting and would help prevent erosion of the beaches fronting the structures.

In winter, ice accumulates along the shore preventing wave action from reaching the shore. The waves push the ice into piles until/unless the lake freezes as shown on the Jan. 24, 2011 (left). Nearly the same angle is shown in the Oct. 13, 2011 photo at right. Photos taken y Scott Duncan near the 1500 block of Cedar Point Road.

For the Bay Shore

Toe Protection:

*7. **Revetments**: Revetments along the toe of a bank will aid in protecting against wave-based erosion. A revetment forms a stable bank slope, providing protection to the soil underneath while breaking up wave attacks. Since material eroded off the bank is one source of beach-building sand, some regulatory agencies may require that one of the design components for a revetment be the inclusion of sand pre-fill in the amount equal to that which would have been added to the system over the life of the structure.*

Revetments are common along the bay shore of the Cedar Point sand spit and have been effective at stabilizing the shore. While used throughout the reach, revetments are particularly recommended in areas subject to considerable wave energy. The shore near the mouth of the Sandusky Bay can experience large lake waves directly from the north. The bay shore to the west of the Cedar Point Causeway is also exposed to waves from the west with a long fetch down Sandusky Bay. This area is protected with an armor stone revetment wrapping around the tip of Cedar Point and continuing along Perimeter Road. The armor stone breakwaters protecting the Cedar Point Marina and parking areas armor the rest of the shore up to the Cedar Point Causeway.

*8. **Seawalls**: Vertical shore structures such as seawalls and sheet pile bulkheads provide protection to the shore without limiting water access. Vertical structures do not dissipate as much wave energy as revetments causing energy to be reflected into the nearshore zone. Waves breaking on the structure can cause excessive spray over the structure or downcutting and scour of the structure toe. As a result, seawalls and bulkheads are most effective in areas with relatively deep water and a mild wave climate. Because seawalls prevent material from eroding into the nearshore some regulatory agencies may require sand pre-fill as part of the design.*

Seawalls and steel sheet pile bulkheads are the most common structures along the bay shore of the Cedar Point sand spit and are recommended along the bay shore of this reach. In most applications seawalls have been effective at stabilizing the bay shoreline. While their popularity in Sandusky Bay is primarily due to their advantages in water access there are several characteristics of the bay shore that make seawalls particularly effective. Seawalls are most effective in areas with mild wave climates because wave reflection, over spray and downcutting are minimal. Wind driven waves along the bay shore east of the Cedar Point Causeway are limited due to the shallow water depths and limited fetch. Vertical shore structures have been particularly successful in areas with reduced wave climates such as the protected embayments between Sunset Drive and Bayshore Drive. The lack of sediment supply and littoral transport along the bay shore of the Cedar Point sand spit reduces the potential negative impacts of scour at the base of the vertical structures. Seawalls also have the advantage of a reduced project footprint. In an appropriate wave climate they often have less of an impact on nearshore habitats because they cover less lakebed.

July 26, 2011: Photos taken along the bay shore of the Cedar Point sand spit show a variety of structures. The water tower present in the photos is located in the 730 block of Cedar Point Road.

For the Lake and the Bay Shores

Bank Modifications:

9. <u>Surface Water Management and Flood Protection</u>: Low lying areas should be protected from excess surface water and flooding from the lake and from upland runoff. In areas prone to flooding erosion protection should include surface water management design elements such as collection areas, retaining structures, and drainage ditches or culverts. Surface water should be routed away from the face of the bank. In areas where gullies or rills are forming, surface water is slowly eroding the face of the bank. Where possible, re-route water away from the bank toward a planned collection area and drainage system.

This reach is comprised of a sand spit barrier beach with extensive residential and commercial development. Much of this reach has been stabilized with seawalls and other shore structures to protect upland development very close to the shore. As a result, surface water flows, including storm water outflows, can cause extreme localized erosion. Surface water collecting on roadways, residential roofs, parking areas or driveways near the shore should be routed away from the bank or beach whenever possible. This recommendation is of particular importance when considering storm water runoff in the large paved areas at the Cedar Point amusement park.

10. <u>Vegetation</u>: Encourage growth of vegetation along the bank slope. Where possible plant vegetation, preferably native species, along the bank to remove excess ground water while retaining soil strength. It is also possible to simply allow the natural succession of native plant species to grow along the bank.

Planting native vegetation on the upland above the seawalls, revetments and other shore structures in this reach would reduce excess surface water and help stabilize the low banks. Vegetation should be closely monitored on the structures as vegetation growing on a rip-rap or armor stone revetment could damage the structure by causing stones to be broken or displaced.

Management and Monitoring:

11. <u>Bank-Top Management</u>: Keep heavy materials, equipment or structures well back from the edge of the bank-top. Any structure (concrete decks, stone walls) or heavy object (vehicles or construction equipment) placed near the bank edge will increase the stress within the soil and can lead to slope failure.

This recommendation applies to the low banks and structure crests throughout this reach. Many residential structures in this reach have been placed immediately landward of seawalls or bulkheads. Further development near the crest of these structures could cause damage. Care should be taken when maintaining shore structures or accessing the area with vehicles or other equipment to prevent damage.

***September 29, 2009**: The three bottom photos are of the bay shore during lower water levels caused by a storm pushing water east. The photos are of the bay shore as viewed from the portion of Cedar Point Road the crosses East Sandusky Bay looking northwest (left and middle) and looking at he bay shore side of Point Retreat Condos (right). The top right photo from September 21, 2004 shows more normal water levels.*

12. <u>Coordination of Projects</u>: Continuation of similar erosion control measures along a stretch of shore will often yield more effective protection than the installation of multiple types of structures adjacent to one another. Most erosion control measures function better when utilized over large areas of the shore.

This recommendation is applicable throughout this reach. In residential areas, shoreline property is often divided into parcels as small as 50 feet wide with each property owner responsible for their own shore protection. This leads to a mix of structures with varying designs, construction quality and condition. The interaction between these structures often limits their effectiveness and at times can increase erosion at the site or on adjacent properties. This is best avoided by coordinating projects over a length of shore. There are stretches in this reach where several properties are protected by one continuous structure. When these structures require maintenance or replacement, coordinating projects to retain or increase the continuity of structures should be considered. Coordinating projects between neighbors can also allow some engineering and construction expenses to be spread over several properties.

When structures can not be continued across multiple properties, conditions at the ends of the structure should be carefully considered in the design. The structures should be designed to prevent intersections causing increased wave energy or gaps between structures where erosion is likely.

13. <u>Shore Structure Management-Monitoring</u>: Monitor and maintain shore structures. Routine monitoring of shore structures will allow for early detection of any potential failures. Smaller repairs performed more frequently will be less costly and can often increase how long the structure will be effective at controlling erosion. Should removal of an aged or deteriorating structure be necessary, consider the above recommended items as potential future solutions.

Many of the structures in this reach were constructed over 30 years ago. The condition of the structures should be closely monitored and repairs should be made when necessary. If new erosion control measures are installed, the recommendations listed above should be considered. A combination of recommendations may be the most effective solution. For example, to further protect upland structures fronted by an existing beach, a revetment landward of the beach or detached breakwaters with sand pre-fill may be considered.

The lighthouse at the end of the nearly mile long Cedar Point jetty is seen in this photo from July 18, 2007.

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