Shabica & Associates, Inc.
WE BUILD BEACHES



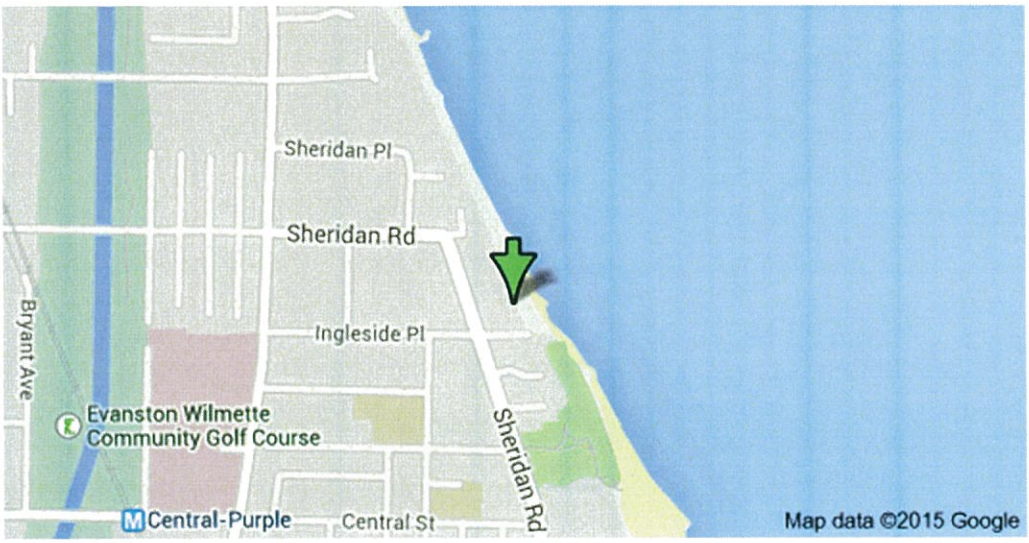
Federal Consistency Coordinator
Illinois Coastal Management Program
Illinois Department of Natural Resources
160 N. LaSalle Street, Suite 700
Chicago, IL 60601

April 29, 2015, Rev. October 2, 2015

To Whom It May Concern:

In compliance with the Illinois Coastal Management Federal Consistency Review Procedures, we provide the following information for a proposed breakwater-protected beach system for the properties located at 2715 and 2719 Sheridan Road, Evanston, Illinois 60201, owned by Kenneth and Lucy Lehman.

**Location of Project**
The proposed breakwater-protected beach system will be built on the lakefront of the property located at 2715 and 2719 Sheridan Road, Evanston, Illinois 60201, owned by Kenneth and Lucy Lehman.




**Project Start Date and Duration**
Work will not begin until all necessary permits have been received. It is anticipated that the project can begin by November 1, 2015. This work will require 10 weeks to complete.

550 Frontage Road • Suite 3735 • Northfield, Illinois 60093 • Tel 847.446.1436 • Fax 847.716.2007
www.shabica.com

**Extent of Work to be Conducted**

The south breakwater will be built starting 2' north of the south property line extending lakeward as a shore parallel structure at 2715 Sheridan Road to help create a stable beach equilibrium. The southwestern steel portion of the breakwater (70') will have a crest elevation of 586' landward tapering to 583' lakeward. At the lakeward end of the steel, a 90' quarrystone breakwater (nominal length) will be constructed with a crest elevation of 583' tapering to 582' at the north end. Stair access (stone) will be constructed over the breakwater to provide pedestrian access. The existing quarrystone revetment will be rebuilt to a crest of 586'using the existing as well as new stone to provide additional defense for extreme stormwaves. The existing deteriorated concrete pier will be demolished. All granular material will be recycled in the core of the new breakwater, while all timber and other undesirable materials will be removed from the site and disposed of properly. The proposed north breakwater crest will be built with the new crest 6' to the south from the current concrete pier location; the new crest will begin entirely on the 2719 property. The proposed breakwater toe will extend 125' lakeward of the existing seawall with a landward crest elevation of 586' tapering down to a lakeward elevation of 583' and curving to the south for approximately 25'. Mitigational sand will be placed in a quantity of 2,600 tons in the system to help the beach reach a safe equilibrium and for the installation of native dune grasses

A letter of authorization from Nanci Tani (2729 Sheridan Road) is included with the full permit submission.

**Contact Information**

All questions pertaining to this project can be submitted to:

Jon Shabica
Shabica & Associates, Inc.
550 Frontage Road, Suite 3735
Northfield, IL 60093
jon@shabica.com
847-446-1436 Tel
847-716-2007 Fax

The proposed activity complies with Illinois' approved Coastal Management Program and will be conducted in a manner consistent with such policies.

Sincerely,

Jon Shabica
Managing Director


2013 Google Earth Photo; see approximate property lines in yellow

Shabica & Associates, Inc.
WE BUILD BEACHES



Ms. Kathy Chernich
East Section Chief, Regulatory Branch
Chicago District
U.S. Army Corps of Engineers
231 S. LaSalle Street, Suite 1500
Chicago, IL 60604

Dear Ms. Chernich:

April 29, 2015, Rev. October 2, 2015

Please find enclosed a permit application for shore protection for the adjacent properties located at 2715 & 2719 Sheridan Road, Evanston, Illinois, 60201, both owned by Kenneth and Lucy Lehman. Proposed work includes: stabilization of an eroding shoreline with a sustainable beach system comprised of two, new quarrystone breakwaters (one with steel), rebuilding of the existing quarrystone revetment, and sandfill as required to reach a stable sand equilibrium. The existing shoreline is erosional with exposed lakebed clay lakeward of the revetment, and is sand starved due to the site's location south of Wilmette Harbor, resulting in vulnerability to stormwaves and fluctuating Lake Michigan water levels. The quarrystone breakwaters are designed to reduce incident wave energy from eroding the sand and lakebed, to create a sustainable sand cover over the clay lakebed which reduces lakebed downcutting (deepening of the water) and helps to improve water quality caused by colloidal fines being suspended in the water during storms. The north neighbor, Ms. Nancy Tani of 2729 Sheridan Road, authorizes the Lehmans to perform the following work on her property: removal of the existing deteriorated concrete pier and construction of a stone breakwater with a spur extension to the south in its place, as well as sandfill per IDNR requirements (see attached letter).

A *Design of Shoreline Erosion Protection* report has been attached to this cover letter as the coastal design specifications component of this permit. All references, photographs and figures referred to in the cover letter and the following report can be found in the Appendix.

The proposed activity complies with the approved Illinois Coastal Management Program and will be conducted in a manner consistent with such policies.

**Project Purpose Statement**

The property owners have retained Shabica & Associates (SA) to design and engineer a shore protection system for their property. This project will be constructed on the lakefront of 2715 & 2719 Sheridan Road, Evanston, where, during higher lake levels, stormwaves overtop the existing concrete seawall, eroding the bluff landward. The beach system has been designed to sit within 125' of shore and will be overfilled with mitigational sand to benefit the regional albeit low amount of long-shore sand sediment transport. This design of the system is consistent with the two sustainable breakwater beach systems permitted and built in south Evanston in 2013. The one-year post construction survey of the south Evanston system showed a net loss of the sand in the regional system of 116 yards of sand as the beaches reached a stable angle of repose.

The October 31, 2014 (Halloween) storm, with storm surges exceeding 2 feet and record winds and waves, did extensive damage to southern Lake Michigan shorelines. With a new understanding of the consequences of climate change, forecasters predict more frequent storms of high intensity and coastal damage. The subject property is located midway between Wilmette Harbor and the Northwestern University landfill (see Photo 2), both of which are complete littoral barriers. While a narrow beach has been present at this site in the past during higher

lake levels, the majority of subject property's beach today is large cobble with little to no sand (see Photos 3 & 4). This condition is due to ongoing lakebed downcutting and the cobble being released from the lakebed clay.

The bluff at this site has a series of timber retaining walls beginning with a concrete seawall and timber deck at the base. Over time and due to erosion and previous high lake levels, a limestone riprap revetment was placed east of the seawall with a breakwater extension to protect the boathouse.

**Project Description**

The south breakwater will be built starting 2' north of the south property line extending lakeward as a shore parallel structure at 2715 Sheridan Road to help create a stable beach equilibrium. The southwestern steel portion of the breakwater (70') will have a crest elevation of 586' landward tapering to 583' lakeward. At the lakeward end of the steel, a 90' quarrystone breakwater (nominal length) will be constructed with a crest elevation of 583' tapering to 582' at the north end. Stair access (stone) will be constructed over the breakwater to provide pedestrian access. The existing quarrystone revetment will be rebuilt to a crest of 586'using the existing as well as new stone to provide additional defense for extreme stormwaves. The existing deteriorated concrete pier will be demolished. All granular material will be recycled in the core of the new breakwater, while all timber and other undesirable materials will be removed from the site and disposed of properly. The proposed north breakwater crest will be built with the new crest 6' to the south from the current concrete pier location; the new crest will begin entirely on the 2719 property. The proposed breakwater toe will extend 125' lakeward of the existing seawall with a landward crest elevation of 586' tapering down to a lakeward elevation of 583' and curving to the south for approximately 25'. Mitigational sand will be placed in a quantity of 2,600 tons in the system to help the beach reach a safe equilibrium and for the installation of native dune grasses.

**Coastal Geology**

This section of coastline has historically lost sand due to large municipal structures such as Gilson Park and Wilmette Harbor as well as ongoing lakebed downcutting especially during prolonged periods of low lake levels. Nearshore sand deposits are minimal to non-existent here (Figure 1, Appendix) and scientists estimate that the rate of lakebed erosion averages 6 inches per year (Nairn, 1997). At the time of the bathymetric survey, there was a section of lakebed with exposed lakebed clay, no sand cover was evident in that location at the time. The net result is similar to the effects of global warming and rising sea level on marine coasts. This includes deeper water nearshore, larger stormwaves and progressively narrower beaches as the nearshore lakebed continues to erode. This has resulted in a cobble beach with minimal sand that is much smaller at historic low lake levels than at higher lake levels of the last decade.

The bathymetric survey shows exposed lakebed clay immediately east of the existing shoreline structures. This is the first bathymetric survey that we have seen with this condition. While a narrow beach has been present at this site in the past during higher lake levels, the majority of subject property's beach today is large cobble with little to no sand. This condition is due to lakebed downcutting and the cobble being released from the lakebed clay. Additionally, stormwaves have scoured the beach at the toe of the seawall and revetment. If these conditions continue, this will lead to the destabilization of the seawall and bluff face causing loss of tableland and infrastructure.

The Illinois Lake Michigan shoreline is considered "sediment starved" by coastal scientists. This is in contrast to East Coast and Gulf Coast open ocean shores where tens of thousands of tons of sand are found in the nearshore system that provide a primary line of defense against stormwaves. On most Great Lakes shores including southern Lake Michigan, natural sand beaches are not able to protect the lakeshore (exceptions may be during very low lake levels like 1964 or 2004-07). Large quantities of sand have been trapped or diverted offshore by municipal structures that extend 900 ft or more into the lake. Today, the main sand supply is wave erosion of the nearshore glacial clay lakebed that contains only about 10% sand (Shabica and Pranschke, 1994). The result is that groins are losing their

effectiveness at holding a sandy beach during average to high lake levels. To retain a sand covering of the shallow lakebed (where downcutting is most active) as well as to protect the revetment and bluff toe, SA has designed a pocket beach system to hold sand as necessary to protect the lakebed and bluff during higher lake levels.

If beach and nearshore sand is lost, degradation of the nearshore ecosystem will result. Meadows et al., (2005) reports an increase in zebra mussels *Dreissena polymorpha*, and a decrease in native zooplankton in waters where the lakebed is eroding clay and rocks. In comparison, a nearshore area with 100% sand cover supports a species-rich community. The report concludes, "it [is] nonetheless clear that sand-based areas were characterized by sufficient shallow water fish CPUE and species richness to suggest that these are important habitats within the context of the Great Lakes Basin and not simply 'wet deserts' as they are often considered."

**Design Options**

The site at 2715 & 2719 Sheridan Road, Evanston has been inspected and options for shore protection were determined using desktop coastal engineering, site conditions from the 2004 and 2013 bathymetric surveys, and several years of observations of the deteriorating shoreline conditions at this site. Given the sand loss over the last several years including during extreme low lake levels, as well as the uncertainty of future lake levels, it is prudent to engineer and design a sustainable beach system that will anticipate greater lakebed downcutting, higher amounts of beach erosion, more extreme storm events with larger waves, and potential loss of land. These six design options were considered:

*OPTION 1*

*Do Nothing –*

The first option of "Do Nothing" results in leaving the currently eroding beach in its existing state. In recent years, the lakefront has been comprised of large cobbles that are dangerous to traverse and narrow in beach form with exposed lakebed clay. During average lake levels the existing shore protection structures are overtopped. The existing stone revetment is limestone that is deteriorating over time. Continued erosion of the exposed lakebed at this site is causing larger waves to impact the shoreline as well as increased deposition of large cobble in lieu of a sand beach.

*OPTION 2*

*Beach Sand Nourishment –*

The concept of regional sand nourishment was explored as a non-structure approach to stabilize the nearshore area. This option is similar to the program in place by the IDNR for shoreline management at Illinois Beach State Park. This option is not sustainable as any sand placed in an open system is susceptible to the extreme lake level fluctuations and stormwaves. There are also environmental impacts with ongoing beach nourishment such as increased sedimentation, safety concerns with extreme fluctuations in near shore bathymetry, associated changes in regional wave action, and the inability to enhance or sustain stable coastal habitat (NOAA Beach Nourishment Report, March 2000).

Additionally, this area is considered sand starved as there is a lack of sustainable nearshore littoral sand. The Corps of Engineers, presenting at the Illinois North Shore Sand Management Strategy sponsored by the IDNR and the Alliance for the Great Lakes, estimated that less than 14,000 cubic yards/year of sand are within the littoral system south of Wilmette Harbor, and therefore beach nourishment would not be cost feasible or sustainable.

*OPTION 3*

*Enhance the Revetment Only –*

The second option considered is to merely enhance the existing revetment. This option provides protection of the bluff at the cost of the following:

1. Continued erosion of the lakebed, which will ultimately destabilize the revetment toe
2. Modification of the revetment crest, raising it to an elevation of about 5 ft higher than the current elevation to adequately protect the toe of the bluff
3. Substantial modification to the lower bluff to maintain the area's functionality (a patio and storage area where access and view of the lake would be reduced)
4. Negative regional impact as the water depth nearshore will continue to increase with lakebed downcutting

Due to the reasons listed above, this option is not recommended.

*OPTION 4*

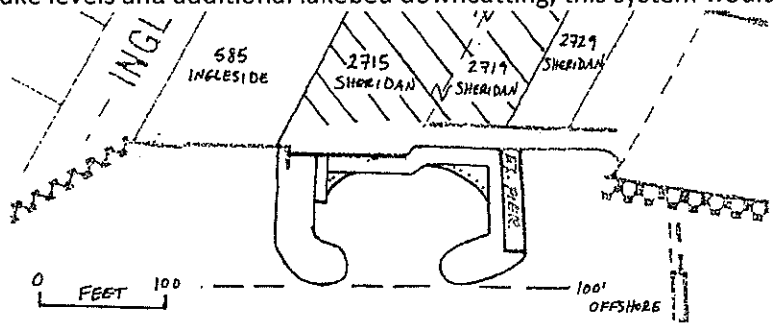
***Preferred Option: Design a Small Pocket System (125 ft offshore) –***

The preferred option is to protect the property with a pocket breakwater system. Based on research of prototypes along the Illinois North Shore, structures that extend less than around 125 ft offshore with a wide gap opening between structures typically do not dissipate enough wave energy to hold a stable beach with fluctuating lake levels. Additionally, the nearshore lakebed elevation plays a large role in holding sand in a pocket beach due to the native sand angle of repose. As this system meets the recommended 125 ft offshore, it will greatly enhance the level of shore protection at this property. The proposed breakwaters will extend east from the seawall approximately 125 ft. This breakwater design will help retain sandfill, provide a stable structure on the north side that will also help the north neighbor's bay retain sand while removing the failing concrete structure, and reduce the gap between the breakwaters to help maintain a more stable beach cell system. The proposed plan will help protect the glacial clay lakebed, as well as the beach and bluff, while allowing safe access to Lake Michigan. This option will help to stabilize the sand on the adjacent beaches by reducing wave energy in the immediate area.

*OPTION 5*

*Design a Smaller Pocket System (Breakwater System 100 ft offshore) –*

Designing a smaller pocket system was reviewed. With the current lake conditions and narrow cobble beach during low lake levels, a smaller cell system will not adequately serve as shore protection. SA explored the option of designing a system with a breakwater that extends 100 ft east of the seawall. Site conditions reveal that there would be no beach and that stormwaves would overtop the seawall elevation during average to high lake levels. In 2005 this design was under permitting review with the state and federal regulators and not issued due to the moratorium placed on all lakefront structures. With the prolonged low lake levels and additional lakebed downcutting, this system would not be sustainable.




OPTION 6

*Design a Larger Beach System –*

The current IDNR regulations state that a shore protection structure cannot extend further than 125' offshore. There are other ways to accommodate a larger system such as building the breakwaters to a higher elevation and closing the gaps between the breakwaters but we feel that these are not in-line with

existing shoreline structures and are extreme for residential shore protection. For this reason, designing a larger beach system is not being considered at this time.

**Public Benefits of Sandy Beaches**

Restoration of the historic sand system of narrow sand beaches and broad nearshore sand plains with regional beach nourishment may be possible for the Illinois Beach State Park shore, but not for the rest of the Illinois lakeshore. This is exemplified by Wilmette Harbor Association's unsuccessful attempts to renourish downdrift beaches by placing thousands of yards of dredged sand close to the downdrift (south) lakeshore (Shabica, 2008). The future of urban Illinois' bluff coast from Waukegan south to Evanston is construction of pocket beaches overfilled with exogenous sand according to Honorary Illinois State Coastal Geologist, Dr. Michael Chrzastowski (Chrzastowski, 2005). Over the last 20 years, more than 23 pocket beach systems have been successfully constructed in Illinois. And with each beach, thousands of tons of new sand is brought in, not only to initially nourish the pocket beach but also to add 20% overfill sand to the adjacent lakeshore. Periodic sand re-nourishment has proven to be a sucessful management tool and provides additional sand for the entire Illinois coastal ecosystem. Planting of native species on the new beaches further improves the terrestrial habitat. On urban coasts, more than 35 years of system monitoring (Shabica et al, 2011) has shown that engineered pocket beaches (aka bay-beaches or attached-breakwater beaches), pre-nourished with sand, have shown a great resilience to changing lake-levels and decreased sediment-supply. After an intense storm, pocket beach recovery is fast. Further, net sand loss and re-nourishment costs are lower than for unprotected beaches on open Great Lakes coasts. And finally, a diverse coastal ecosystem dominated by American Beach Grass and native species like Sea-Rocket has been surprising resilient after severe shore erosion events.

Furthermore, a sandy beach makes a better ecotone (transitional environment) for flora and fauna than seawalls and revetments. Summary arguments supporting a sandy beach system include:

1) Beaches are filters for non-point source runoff.
2) Beaches reduce lakebed downcutting, a source of fine clay pollutants.
3) Beaches support endangered species such as sea rocket, marram grass, and seaside spurge.
4) Beaches make better wildlife habitat than actively eroding bluffs or seawalls.
5) Stone headlands make better fish habitat than eroding lakebed clay.
6) Beaches protect the lakebed from erosion that causes larger stormwaves to impact the shore.
7) Beaches are far safer for swimmers and boaters than a coast lined with seawalls or revetments, especially in an emergency.

**Impacts to Downdrift Properties**

The proposed project will positively impact the property immediately downdrift of the subject property. The adjacent property to the south will be more stable after the construction of the south breakwater is complete and sandfill is placed as shown on the plans. The proposed shore protection system will help to hold sand (mitigational sand placed as part of this project) immediately downdrift by reducing the width of the beach cell and reducing wave energy with the placement of armorstones. The property immediately downdrift is protected by an existing concrete seawall.

**Impact to Littoral Drift System**

The section of Lake Michigan shoreline north and south of 2715 & 2719 Sheridan Road, Evanston is fully engineered with steel groins, piers and seawalls, as well as quarrystone revetments and headlands. About 3,500 ft north of the project site, the MWRD structures at Wilmette Harbor extend approximately 1,400 ft east of the bluff. The nearest structure extending onto the bed of Lake Michigan is about 1,500 ft to the south. It is a steel groin that projects about 550 ft lakeward from the bluff toe. To the south of that and about 3,200 ft south of the project site, the Northwestern University lakefill was constructed in the 1960s. Wilmette Harbor and the Northwestern University

lakefill both pull sand in this regional area between littoral barriers, leaving most of the properties in the center of this cell completely sand starved, with no beaches. The proposed project will help retain sandfill within the project area as well as on adjacent properties.

As the proposed structure will not extend lakeward beyond the existing structure to the south, it will not negatively impact the littoral system after the sandfill is placed (anticipated quantity plus 20% overfill). According to the previous Illinois State Coastal Geologist (Chrzastowski, 2005), "the design to contain placed sand is becoming necessary because of reduced volume of littoral sand in transport." He further states, "beach-cell systems may represent the future for beaches along much of the Illinois bluff coast from Waukegan south to Evanston."

The beach system will be nourished with sand including a 20% overfill placed north and south of the system. The new IDNR regulations for structures that will retain sand require pre- and post-construction surveys, as well as surveys at the one and five-year intervals. This new requirement will help assure that a sand equilibrium is met and that the new project is gaining and losing sand at a similar rate to neighboring properties.

**Impact on Public Uses**
Public access will be maintained as pedestrians will be able to cross the property with stairs over the stone and steel structures at the north and south property lines. The beach will provide a safe place for boaters and swimmers in distress. Fishing will not be impacted negatively, as the underwater area of the quarrystone protection will create an improved fish habitat. Additionally, navigation of water craft will not be impacted, as the proposed construction will not extend further east than the existing structure.

**Impact on Natural Resources**
Quarrystone structures in the nearshore waters of Lake Michigan and sandy beaches improve native species habitat. The LandOwner Resource Centre with support from the Canadian Wildlife Service and the Ontario Ministry of Natural Resources states that, "unstable shorelines can release silt that can choke nearby aquatic habitats." Additionally, underwater structures such as artificial reefs constructed of large boulders and clean riprap material "in large water bodies, such as the Great Lakes . . . are often the best method of creating habitat." As stated above, according to Meadows, et al., 2005, "a nearshore area with 100% sand cover support[s] a species rich community." As the design does not impact the bluff and vegetation, the local terrestrial wildlife will continue to inhabit this property.

Today, excepting Illinois Beach State Park, nearly all of the Illinois shallow water ecosystem including Evanston's is fouled by lakebed clay erosion, choking the most hardy macro and micro benthic fauna and flora. Meadows et al. (2005) report an increase in zebra mussels *Dreissena polymorpha*, and a decrease in native zooplankton in waters where the lakebed is eroding clay. The authors state: "It was nonetheless clear sand-based areas were characterized by sufficient shallow water fish CPUE and species richness to suggest that these are important habitats within the context of the Great Lakes Basin and not simply 'wet deserts' as they are often considered."

**Type of Permit**
The scope of this project requires an individual permit.

**Description and Schedule of Proposed Activity**
All of the proposed shore protection work will be completed by land using a backhoe working on land to place the materials. All materials and machinery will be delivered by truck to the site. Work will not begin until all necessary permits have been received. This work will require approximately 10 weeks to complete.

**Type and Quantity of Fill/Measures Taken to Avoid Impact/Erosion and Sediment Control Plan**

All material will be clean and from inland quarries. Approximately 1,990 tons of new, clean quarried stone will be placed to construct the revetment and breakwater. Approximately 2,600 tons of clean sand will be placed on the existing beach. Acreage of stone placed on the lakebed east of the OHWM is 0.098 acres (or 4,276 square feet).

**Summary**
All of the above described activities and plans will follow IPP terms and conditions. All of the proposed work adheres to the guidelines prescribed by the Illinois Environmental Protection Agency and its Anti-Degradation Assessment. U.S. Fish & Wildlife Service and the Illinois Historic Preservation Association will be updated on all relevant correspondence.

If you have any questions please feel free to call me at the phone number below.

Sincerely,

Jon Shabica
Vice President

CC: IDNR (Casey)
IEPA (Heacock)
U.S. Fish & Wildlife Service
Illinois Historic Preservation Agency (Haaker)
Kenneth & Lucy Lehman

## DESIGN OF SHORELINE EROSION PROTECTION

### Introduction

The following report summarizes assumptions and design criteria for a quarrystone breakwater system, a quarrystone revetment and sandfill mitigation to help provide access, reduce erosion and protect the properties located at 2715 and 2719 Sheridan Road, Evanston IL, 60201. The design is based on the drawings included in the permit application to the U.S. Army Corps of Engineers dated April 29, 2015.

The site lies within a fully engineered section of urban lakeshore that is typically protected with revetments, seawalls, impermeable piers and steel sheetpile groins that may hold narrow beaches. There are no naturally eroding bluffs in the area.

This section of coast is sand-starved due to municipal structures (littoral barriers) constructed over the past 100 years that extend lakeward beyond the littoral zone and reduce sand bypass. Although there is currently an exposed sandy beach due to extreme low lake levels, the beach width varies greatly due to the vulnerability of this location. According to the Illinois State Geological Survey, there is almost no sand moving along this section of coast. All structures in the area have been steadily losing their effectiveness at holding beach sand. This problem is exacerbated by lakebed erosion. In many cases where all the sand has been lost, the adjacent bluffs have begun to erode. To provide adequate protection for the upland property, solutions have typically been of two types: breakwater- or groin-anchored beaches to protect the bluffs, or large quarrystone revetments placed against the toe of the bluff that prevent stormwave erosion but at the expense of the beach.

### Project Description

Construction of a quarrystone breakwater system, a quarrystone revetment and sandfill mitigation are proposed that fulfill the design requirements of 20-year stormwave erosion protection. The existing limestone breakwater at this site has deflated and only provides minimal protection for the boathouse. The proposed system is designed for all lake level conditions.

### Summary Specifications

Using the Army Corps of Engineers Shore Protection Manual (1984), performance of nearby prototypes and other sources, the following specifications were developed for this site (elevations are based on IGLD 1985):

| **Stone Breakwater Specifications** | |
|---|---|
| Lakeward Crest Elevation: | 582 ft |
| Toe of Structure: | 574 ft (average) |
| Crest Width: | 7 ft |
| Average Armor Size: | 2.5 tons |
| "B" Stone | 200 lbs to 800 lbs |
| Slope: | 1:1.5 |
| Tons/linear ft: | 10 tons |

| **Assumptions** | |
|---|---|
| • Design High Water (DHW): | 582.5 ft * |
| • Design Water Level: | 580.0 ft |
| • Design Low Water (DLW): | 577.5 ft * |
| • Existing clay till elevation at breakwater toe: | 574.0 ft |
| • 20-yr lakebed erosion at toe of breakwater: | 3 ft** |
| • Design wave height: | Hs = 5.7 ft |

**Assumptions (continued)**

- Nearshore Slope: ± 1:66
- Design Wave Period (T): 9.5 s ***
- Depth at Structure Toe DHW (Ds): 6'
- Design Deepwater Wave (Ho): 18.0'
- Design Wave Length (Lo): 501.8'
- Structure Porosity: 30%

* DHW includes 2 ft storm setup; DLW is equivalent to Low Water Datum
** 2.5 ft sand and gravel (thickness varies) plus 2 ft clay till, Nairn, 1997
*** Resio & Vincent, 1976

**Stone Revetment Stability, Armorstone**

The proposed quarrystone breakwaters have one layer of 1 to 4 ton armorstone built on a 1.5H:1V slope. Overtopping of the structure is expected during storms and higher water levels. Design conditions include:

* Revetment crest elevation 0.5 ft below DHW, 4.5 ft above DLW
* Depth-limited breaking waves will break on the stone breakwater and sand beach
* Depth at the toe of the structure is 8.5 ft (574 ft) at design high water
* Incident wave directions: NE, E and SE
* Wave period for DHW T = 9.5 seconds
* Wave period for average conditions T = 6 seconds

For a quarrystone breakwater, structural integrity may depend on the ability of the foundation to resist the erosive scour by the highest waves. Therefore, it is suggested that the selected design wave height $H_s$ for such structures be based on the design wave height H being the average height of the top 10 percent of waves expected during an extreme event. Based on the deepwater significant wave height $H_s$ corrected for refraction and shoaling.

The stability coefficient ($K_d$) varies primarily with the shape of armor units, roughness of armor unit surface, sharpness of edges and degree of interlocking obtained in placement.

The equation below is Hudson's formula and is used to determine the armor stone weight needed to support a particular structure.

$$W = (W_r * H_s^3)/(K_d([W_r/W_w]-1)^3 * \cot(\beta))$$

W = weight of individual armor units in lbs
$W_r$ = Unit weight of armor units
$W_w$ = unit weight of water
$H_s$ = the design wave height for the structure
$K_d$ = the design stability coefficient for rubble and toe protection
$\beta$ = the angle of incline of the structure

Quartzite or Dolomitic Limestone armorstone is recommended as it is highly durable and is locally available in most gradations under 6 tons. Hudson's formula was used to estimate armorstone size using 168#/cubic foot. As the lakeward face of the breakwater will be built random placement, an armorstone of 1.1 tons is predicted for special placement stonework based on the design conditions.

**Bathymetry**
Bathymetric profiling for the design of this project was performed in 6/12/2013. Six transects were completed in the project area. The profiles extend up to 400 ft offshore from the revetment toe. Tolerances were 6 inches vertical. The survey was performed using a robotic electronic total station with a diver in the water and a licensed survey crew on land. Elevations were related to hourly water level data from NOAA weather buoys.

**Project Supporting Data**
To help facilitate project review, SA offers the following supporting data based on standard coastal engineering practices:

1. **Sediment Transport Around Structure** The structure is designed to lie within the surf zone (zone of breaking waves), therefore allowing sediment transport around the structure. The range of breaking wave heights is from 7.4 ft based on a 6-second wave with a wave length of 184 ft (using 1/25 Lo) to 18 ft based on a 9.9-second wave with a wave length of 501.8 ft (Resio and Vincent, 1976). The commonly accepted zone of sediment transport is to 18 ft (depth of closure) in this section of Lake Michigan, which is a function of the design wave parameters. Based on this data, once the structure has been filled with sand, it will continue to bypass littoral drift sand. Rod and transit survey monitoring will be conducted, as required by the IDNR, to assure that the system performs as designed.

   The IDNR requires sand fill in areas where sediment will be trapped by the new system. Sand volume quantities have been calculated as shown in the permit drawings. As required by the IDNR, a 20% overfill will be added to the calculated volume. Additionally, the new pre- and post-construction monitoring will be performed and submitted to the IDNR to verify the impacts to the system.

2. **Effect on Adjacent Shorelines** A wave diffraction diagram (Figure 3, Appendix) has been overlain on the proposed shore protection system. Using a refracted incident wave angle of 90 degrees (USACE, Shore Protection Manual), with average and design waves, there will be a decrease in wave energy on adjacent properties. The wave diffraction pattern shows that the coefficient of diffraction (K) reduces the wave energy to a distance of about ½ the wave length downdrift and does not have an impact further downdrift. For the average 6-second wave, that distance of reduced wave energy is about 90 ft and for the design wave, the protected distance is about 250 ft. This protected area close to the structure has diminished wave energy that will in turn reduce erosion in the area.

3. **Wave Reduction in Rubble-Mound Structures** The Iribarren number ($\xi$), or surf similarity number, is used to determine the wave reflection coefficient. For rubble-mound structures, wave reflection (and wave energy) is reduced by one half or more (0.2 to 0.53) (Figure 4, Appendix). For example, a wave reflection of 0.25 means that the wave energy is reduced by 75%. The range of wave reflection for beaches peaks at about 0.44. The range for plane slopes, however, quickly rises to 0.5 and peaks at .91. This illustrates that rubble-mound structures reduce wave energy almost as well as beaches.

**Lakebed Erosion**
Lakebed erosion, active in water depths of 10 ft or less, is a design component of this plan. This section of Evanston lakeshore is considered sediment-starved. Sand deposits were measured near this site (Isabella Street, Evanston) from the backshore to a depth of 15 ft. Sand deposits were thin to non-existent for the entire profile (Shabica & Pranschke, 1994). Also, the site is underlain by highly-erodable, cohesive glacial clay-till. This condition increases the rate of irreversible lakebed erosion that causes deepening of the water and larger waves to impact the shoreline. According to Robert Nairn, approximately 200 $m^3$ of sand cover per meter of lakeshore (out to a depth of 4 m) is necessary to protect the underlying cohesive profile from lakebed erosion under most

conditions. Sand and coarser sediments represent typically less than 15% of the material eroding from the lakebed and bluffs.

Using the historic rate of lakebed downcutting of 0.15 ft/yr (Nairn, 1997), an irreversible lowering of the nearshore lakebed clay of approximately 3.0 ft over a 20-year period is predicted in unprotected areas. With the stone breakwater, revetment and sandfill installed, the lakebed erosion will be reduced.

**Project Monitoring**

As the performance of shore protection structures cannot be predicted with absolute certainty, the shore protection system for 2715 & 2719 Sheridan Road, Evanston will be inspected as required by IDNR guidelines. This includes topographic and hydrographic surveys beginning at an elevation of 581.5 ft (IGLD 1985) and progressing to 300 ft lakeward of the lakeward end of the project, within the north and south property lines. Additionally, all structures should be inspected to assure that they continue to meet design specifications.

**References**

Anglin, C.D., and K. J. Macintosh, *Southport Marina, Kenosha, Wisconsin: Design and Construction of Breakwaters, in Coastal Engineering for the Great Lakes*, a short course, University of Wisconsin, March 11-13, 1991.

W.F Baird & Associates and Warzyn Engineering, 1986, *Shoreline Development at Forest Park, Lake Forest, Illinois, Model Studies*, Unpublished Final Report to the City of Lake Forest.

Chrzastowski, M.J. and C.B. Trask, 1995, Illinois State Geological Survey, Open File Series, 1996-7, 57 p. plus eight appendices.

Chrzastowski, M.J. and C.B. Trask, 1996, *Review of the City of Lake Forest Final Report for the 1995 beach and nearshore monitoring program, Forest Park Beach, Lake Forest, Illinois*: Illinois State Geological Survey, Open File Series, 1996-6, 57 p. plus eight appendices.

Chrzastowski, M.J., 2005, *Chicagoland Geology and the Making of a Metropolis*, Illinois State Geological Survey Open File Series OFS 2005-9.

Johnson, Charles, 1997, USACE, Chicago, personal communication.

LandOwner Resource Centre, Canadian Wildlife Service, Ontario Ministry of Natural Resources, 1999, *Improving Fish Habitat,* Extension Notes: Ontario, LRC 45.

Meadows, Guy; Mackay, S.; Goforth, R.; Mickelson, D.; Edil, T.; Fuller, J.; Guy, D.; Meadows, L.; Brown, E.; Carman, S.; Liebenthal, D.; 2005, *Cumulative Habitat Impacts of Nearshore Engineering,* Journal of Great Lakes Research; vol.31, Supplement 1, 2005, pp.90-112.

Nairn, Robert B., 1997, *Cohesive Shores,* Shore & Beach Vol. 65 No. 2: 17-21.

National Oceanic & Atmospheric Administration, 2000, *State, Territory, and Commonwealth Beach Nourishment Programs*, Beach Nourishment Report, March 2000, pp. 4.

Resio, Donald T. and Charles L. Vincent, 1976, *Design Wave Information For The Great Lakes: Technical Report 3, Lake Michigan*.

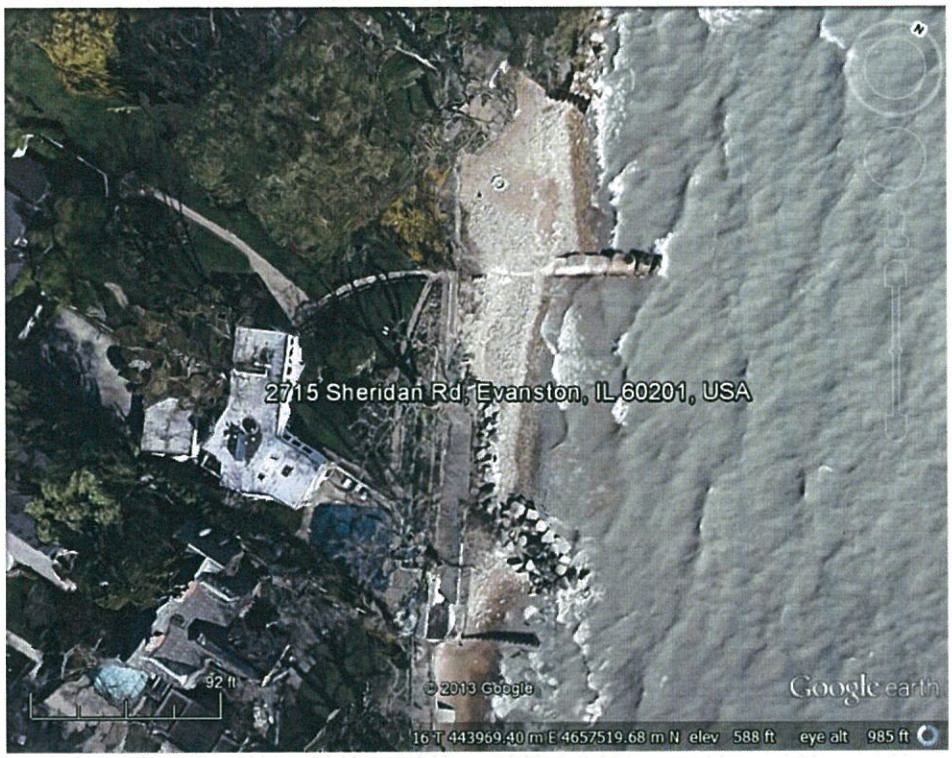
Shabica, C.W., F. Pranschke and M. Chrzastowski, 1991, *Survey of Littoral Drift Sand deposits Along the Illinois Shore of Michigan from Fort Sheridan to Evanston*, Illinois/Indiana Sea Grant Program, IL-IN-SG-R-91-3.

Shabica, C.W., F. Pranschke, 1994, *Survey of Littoral Drift Sand Deposits Along the Illinois and Indiana Shores of Lake Michigan*, U.S. Geological Survey Symposium Volume, Journal of Great Lakes Research, vol. 20, no.1, pp 61-72.

Shabica, Charles and Assoc., 1997, *Lake Bluff Beach Monitoring and Mitigation Report 5*, US Army Corps of Engineers, Chicago District.

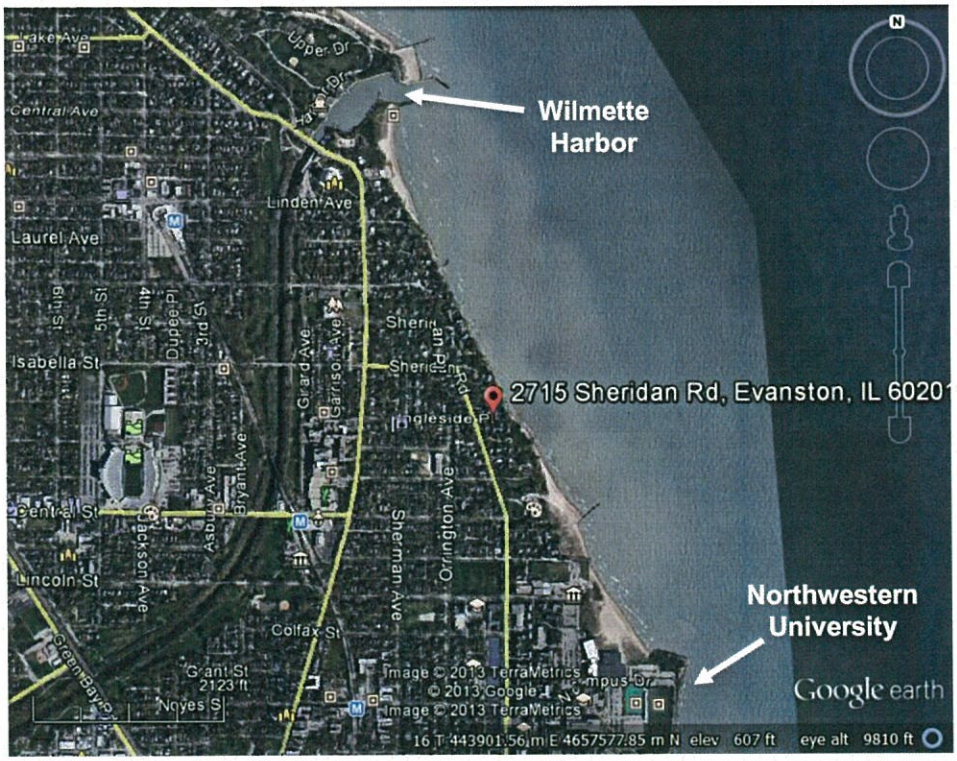
US Army Corps of Engineers, 1984, *Shore Protection Manual*, Coastal Engineering Research Center, Vicksburg, Mississippi.

**PHOTO 1**




2013 Google Earth Aerial Photo

**PHOTO 2**




2013 Google Earth Aerial Vicinity Photo; note littoral barriers Wilmette Harbor and Northwestern University landfill, respectively to the north and south

**PHOTO 3**

August 3, 2007 Photo taken by homeowner south of the existing concrete pier (to be removed); note the small amount of native sand is in the beach system
Lake Michigan level at 577.43' (IGLD 1985)

**PHOTO 4**

May 2013 Photo taken by SA; note the lack of sand on the beach and the Wilmette Harbor breakwater in the distance (yellow arrow)
Lake Michigan level at 577.20' (IGLD 1985)

**PHOTO 5**

June 10, 2015 photo looking south at the adjacent shoreline

**PHOTO 6**

Existing deteriorating concrete pier to be removed as part of the breakwater installation

# FIGURE 1

Evanston North Date:06/27/89 Time:

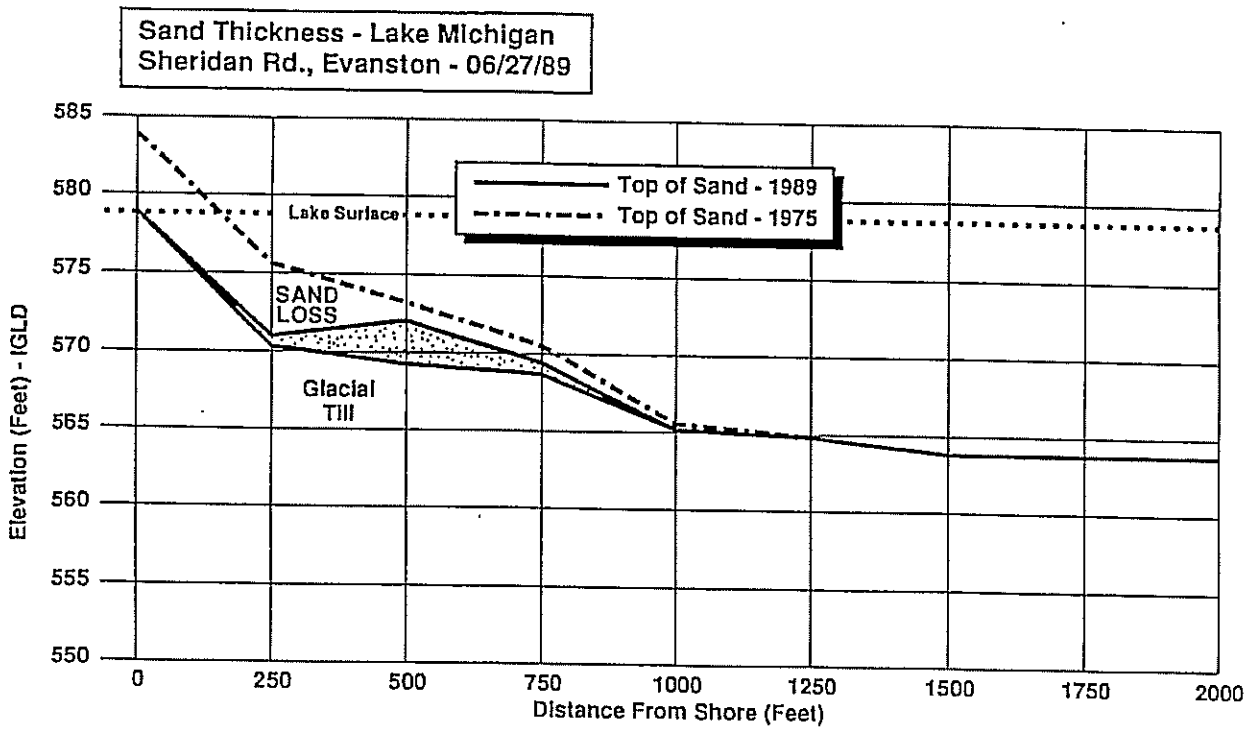
Enter lake surface 578.90 elevation for tine of survey

| Enter Graph: | | DATA A | DATA B | | DATA C | | | |
|---|---|---|---|---|---|---|---|---|
| Enter Dist. From Shore | Enter Water Depth | Enter Sand Thick ness | Top of Sand Elev. 1990 | Bottom of Sand Elev. 1990 | Enter Sand Thick. 1975 | Top of sand 1975 | Enter Hard- pan Type | Sand Volume Cu.Yd. Per ft. 1975 | 1990 |
| 0.0 | 0.0 | 0.0 | 578.9 | 578.9 | | 578.9 | | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 578.9 | 578.9 | | 578.9 | | 0.0 | 0.0 |
| 25.0 | 0.0 | 0.0 | 578.9 | 578.9 | | 578.9 | rocks | 0.0 | 0.0 |
| 50.0 | 3.0 | 1.6 | 575.9 | 574.3 | | 574.3 | | 0.0 | 2.2 |
| 100.0 | 2.4 | 2.1 | 576.5 | 574.4 | | 574.4 | | 0.0 | 4.0 |
| 153.0 | 6.4 | 1.8 | 572.5 | 570.7 | | 570.7 | | 0.0 | 5.0 |
| 250.0 | 8.1 | 0.0 | 570.8 | 570.8 | | 570.8 | rocks | 0.0 | 0.0 |
| 500.0 | 6.9 | 2.9 | 572.0 | 569.1 | | 569.1 | | 0.0 | 26.7 |
| 747.0 | 9.7 | 0.4 | 569.2 | 568.8 | | 568.8 | | 0.0 | 3.7 |
| 1001.0 | 13.5 | 0.0 | 565.4 | 565.4 | | 565.4 | clay&rock | 0.0 | 0.0 |
| 1248.0 | 13.9 | 0.0 | 565.0 | 565.0 | | 565.0 | clay&rock | 0.0 | 0.0 |
| 1504.0 | 15.2 | 0.0 | 563.7 | 563.7 | | 563.7 | clay&rock | 0.0 | 0.0 |
| 1745.0 | 15.2 | 0.0 | 563.7 | 563.7 | | 563.7 | clay&rock | 0.0 | 0.0 |
| 2003.0 | 15.1 | 0.0 | 563.8 | 563.8 | | 563.8 | clay&rock | 0.0 | 0.0 |
| 2250.0 | 14.8 | 0.0 | 564.1 | 564.1 | | 564.1 | clay&rock | 0.0 | 0.0 |
| 2510.0 | 15.0 | 0.0 | 563.9 | 563.9 | | 563.9 | clay&rock | 0.0 | 0.0 |
| 3000.0 | 15.2 | 0.0 | | | | | clay&rock | | |
| 3250.0 | | | | | | | | 0.0 | 41.6 |
| Note all measurements in feet | | | | | | | | CuYd/ft 1975 | CuYd/ft 1990 |

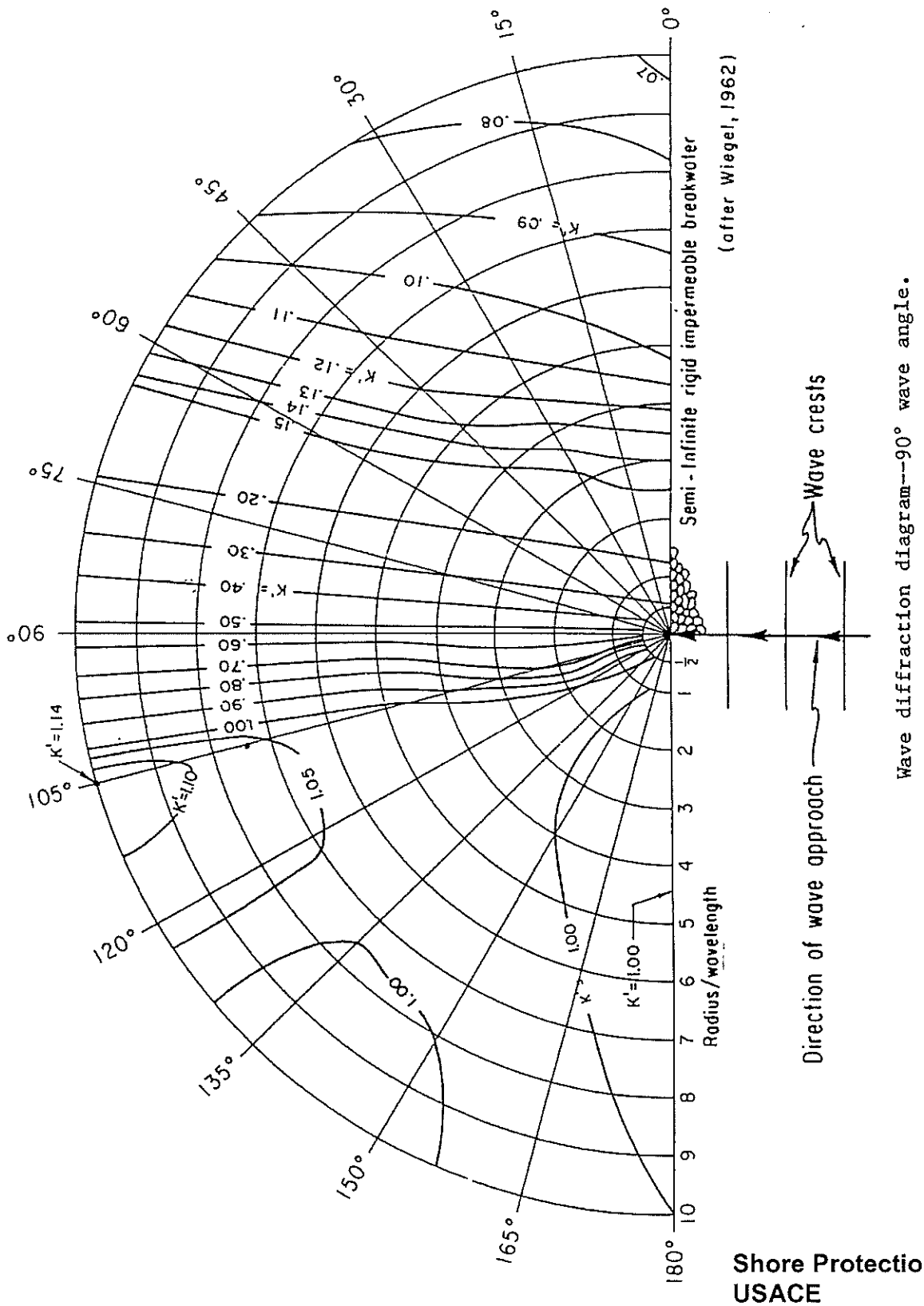
Field Worksheet from 1989 Lakefront Sand Thickness Survey at street end of 2735 Sheridan Road, Evanston (approximately 200 ft north of this application's subject property)

# FIGURE 2

Figure 7

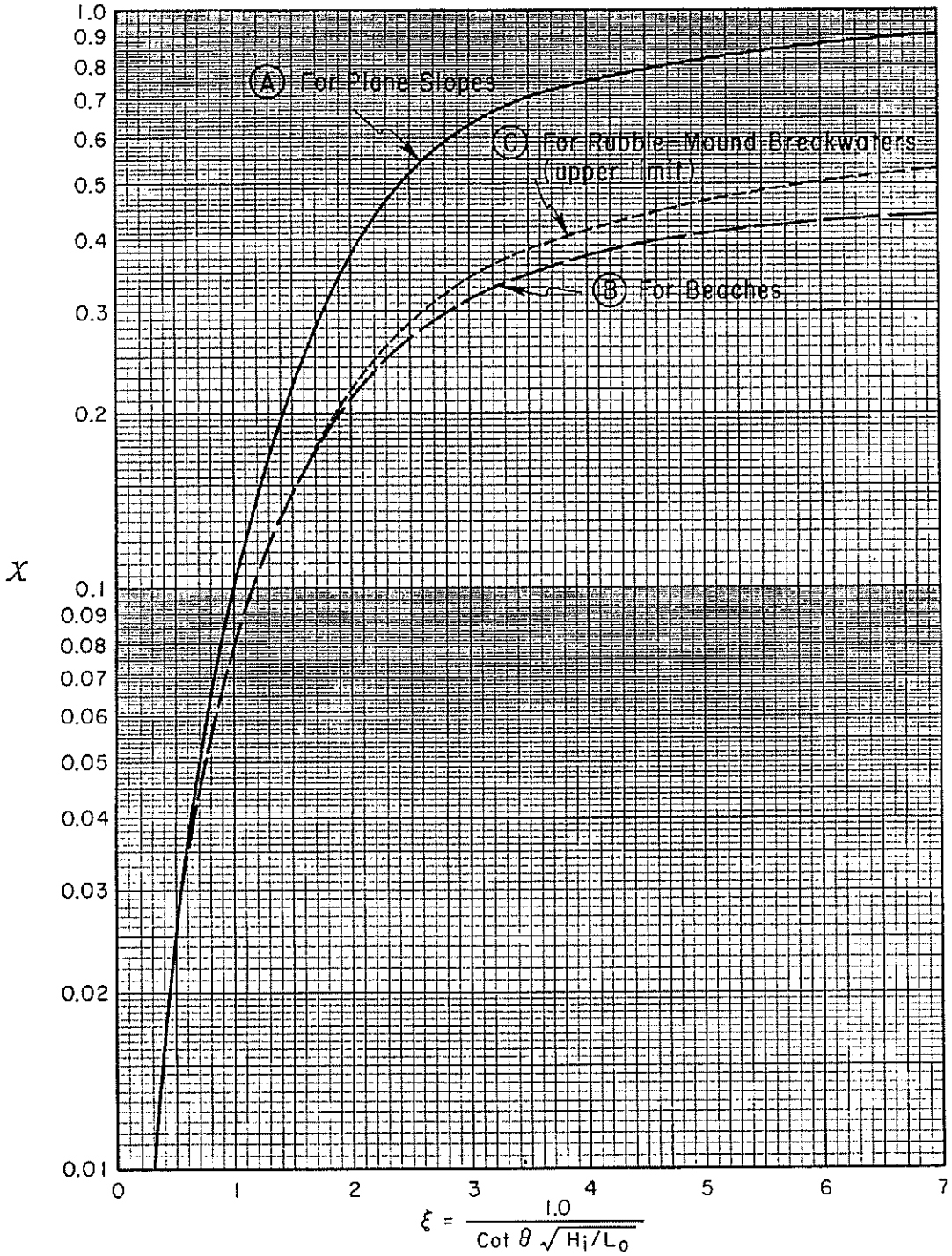


# FIGURE 3




**Shore Protection Manual**
**USACE**

# FIGURE 4




Wave reflection coefficients for slopes, beaches, and rubble-mound breakwaters as a function of the surf similarity parameter $\xi$ .

**Shore Protection Manual**
**USACE**

# JOINT APPLICATION FORM FOR ILLINOIS

ITEMS 1 AND 2 FOR AGENCY USE

| 1. Application Number | 2. Date Received |
|---|---|
| | |

3. and 4. (SEE SPECIAL INSTRUCTIONS) NAME, MAILING ADDRESS AND TELEPHONE NUMBERS

| 3a. Applicant's Name: | 3b. Co-Applicant/Property Owner Name (if needed or if different from applicant): | 4. Authorized Agent (an agent is not required): |
|---|---|---|
| Kenneth & Lucy G. Lehman | | Jon Shabica |
| Company Name (if any): | Company Name (if any): | Company Name (if any): Shabica & Assoc., Inc. |
| Address: 2715 Sheridan Road Evanston, Illinois 60201 | Address: | Address: 550 Frontage, Rd. Suite 3735 Northfield, IL 60093 |
| Email Address: | Email Address: | Email Address: jon@shabica.com |
| Applicant's Phone Nos. w/area code | Applicant's Phone Nos. w/area code | Agent's Phone Nos. w/area code |
| Business: | Business: | Business: 847-446-1436 |
| Residence: | Residence: | Residence: |
| Cell: | Cell: | Cell: |
| Fax: | Fax: | Fax: 847-716-2007 |

***STATEMENT OF AUTHORIZATION***

I hereby authorize, Shabica & Associates to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

Applicant's Signature

4/21/2015
Date

5. ADJOINING PROPERTY OWNERS (Upstream and Downstream of the water body and within Visual Reach of Project)

| Name | Mailing Address | Phone No. w/area code |
|---|---|---|
| a. (See Attached List) | | |
| b. | | |
| c. | | |
| d. | | |

6. PROJECT TITLE:
Lehman Shoreline Erosion Protection Project

7. PROJECT LOCATION:
Shoreline at 2715 & 2719 Sheridan Road, Evanston, Il

| LATITUDE: 42.06655 °N | UTMs |
|---|---|
| LONGITUDE: -87.67670 °W | Northing: 443970.12 Easting: 4657508.69 |

| STREET, ROAD, OR OTHER DESCRIPTIVE LOCATION | LEGAL DESCRIPT | QUARTER | SECTION | TOWNSHIP NO. | RANGE |
|---|---|---|---|---|---|
| 2715 & 2719 Sheridan Road, Evanston, IL | | SE 6 | 42N | 14E | 3rd. |

☒ IN OR ☐ NEAR CITY OF TOWN (check appropriate box)
Municipality Name: Evanston

| COUNTY | STATE | ZIP CODE | WATERWAY | RIVER MILE (If applicable) |
|---|---|---|---|---|
| Cook | IL | 60201 | Lake Michigan | |

Revised 2010

☐ Corps of Engineers ☐ IL Dep't of Natural Resources ☐ IL Environmental Protection Agency ☐ Applicant's Copy

8. PROJECT DESCRIPTION (Include all features):

The south breakwater will be built starting 2' north of the south property line extending lakeward as a shore parallel structure at 2715 Sheridan Road to help create a stable beach equilibrium. The southwestern steel portion of the breakwater (70') will have a crest elevation of 586' landward tapering to 583' lakeward. At the lakeward end of the steel, a 90' quarrystone breakwater (nominal length) will be constructed with a crest elevation of 583' tapering to 582' at the north end. Stair access (stone) will be constructed over the breakwater to provide pedestrian access. The existing quarrystone revetment will be rebuilt to a crest of 586'using the existing as well as new stone to provide additional defense for extreme stormwaves. The existing deteriorated concrete pier will be demolished. All granular material will be recycled in the core of the new breakwater, while all timber and other undesirable materials will be removed from the site and disposed of properly. The proposed north breakwater crest will be built with the new crest 6' to the south from the current concrete pier location; the new crest will begin entirely on the 2719 property. The proposed breakwater toe will extend 125' lakeward of the existing seawall with a landward crest elevation of 586' tapering down to a lakeward elevation of 583' and curving to the south for approximately 25'. Mitigational sand will be placed in a quantity of 2,600 tons in the system to help the beach reach a safe equilibrium and for the installation of native dune grasses.

9. PURPOSE AND NEED OF PROJECT:

This section of coastline has exposed clay lakebed with a beach of exposed cobble. This project will provide a higher level of shore protection and help protect the lakebed clay.

**COMPLETE THE FOLLOWING FOUR BLOCKS IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED**

10. REASON(S) FOR DISCHARGE:

Shore protection in the form of a breakwater-protected beach

11. TYPE(S) OF MATERIAL BEING DISCHARGED AND THE AMOUNT OF EACH TYPE IN CUBIC YARDS FOR WATERWAYS:

TYPE: Stone/sand

AMOUNT IN CUBIC YARDS:

Stone 870 cu. yds. / Sand 2,073 cu. yds.

12. SURFACE AREA IN ACRES OF WETLANDS OR OTHER WATERS FILLED (See Instructions)

<0.1 (4,355 cubic feet)

13. DESCRIPTION OF AVOIDANCE, MINIMIZATION AND COMPENSATION (See instructions)

A steel sheetpile wall is part of this plan in order to minimize the footprint of the structures in this beach system.

| | | | | |
|---|---|---|---|---|
| 14. Date activity is proposed to commence<br>November 1, 2015 | | | Date activity is expected to be completed<br>January 15, 2016 | |
| 15. Is any portion of the activity for which authorization is sought now complete?<br>Month and Year the activity was completed | Yes | ☐ | No | ☒ NOTE: If answer is "YES" give reasons in the Project Description and Remarks section.<br>Indicate the existing work on drawings. |

16. List all approvals or certification and denials received from other Federal, interstate, state, or local agencies for structures, construction, discharges or other activities described in this application.

| Issuing Agency | Type of Approval | Identification No. | Date of Application | Date of Approval | Date of Denial |
|---|---|---|---|---|---|
| | | | | | |

17. CONSENT TO ENTER PROPERTY LISTED IN PART 7 ABOVE IS HEREBY GRANTED. Yes No

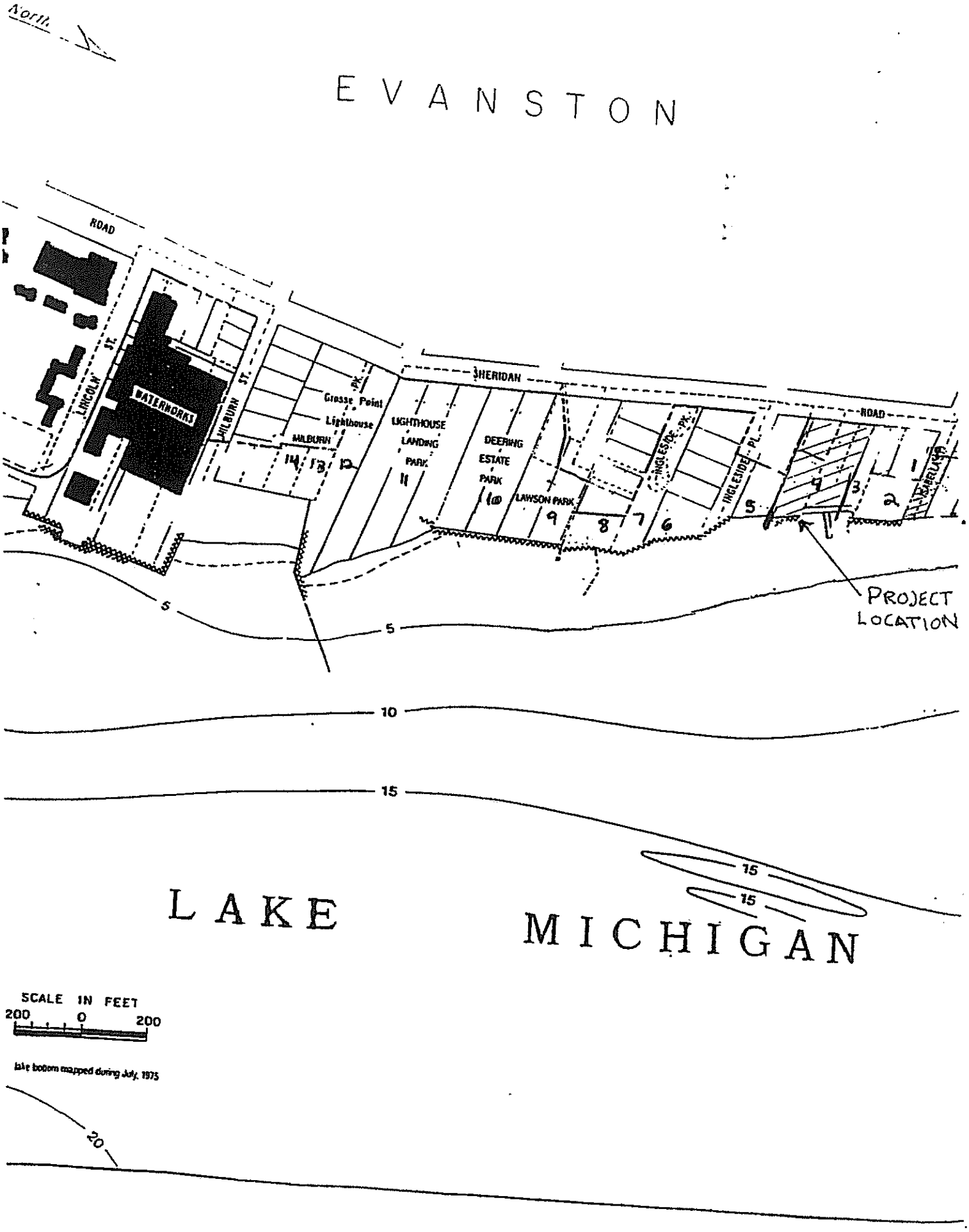
18. APPLICATION VERIFICATION (SEE SPECIAL INSTRUCTIONS)

Application is hereby made for the activities described herein. I certify that I am familiar with the information contained in the application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities

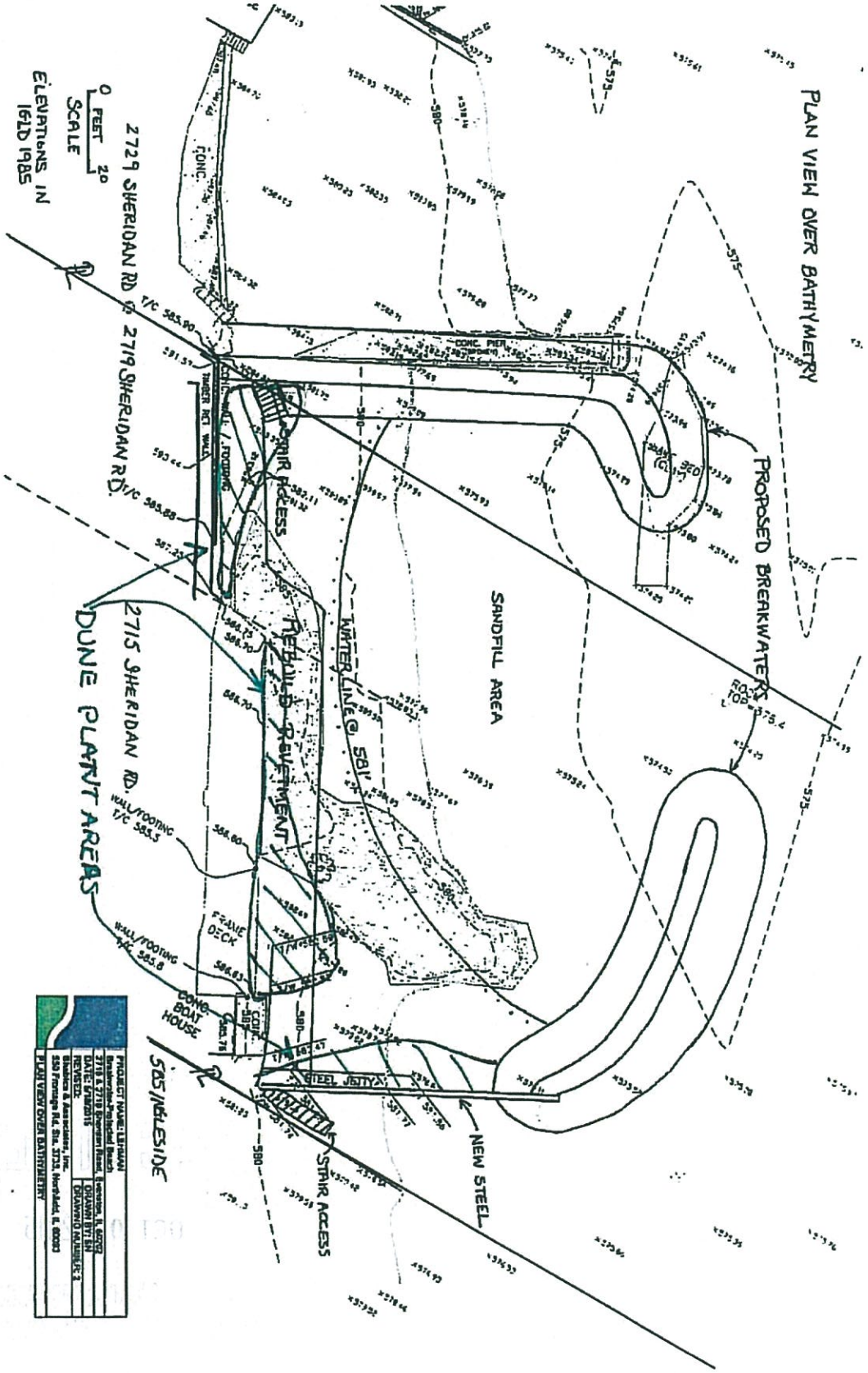
| | |
|---|---|
| Signature of Applicant or Authorized Agent | 9/7/2015<br>Date |
| Signature of Applicant or Authorized Agent | Date |
| Signature of Applicant or Authorized Agent | Date |

☐ Corps of Engineers Revised 2010 ☐ IL Dep't of Natural Resources ☐ IL Environmental Protection Agency ☐ Applicant's Copy

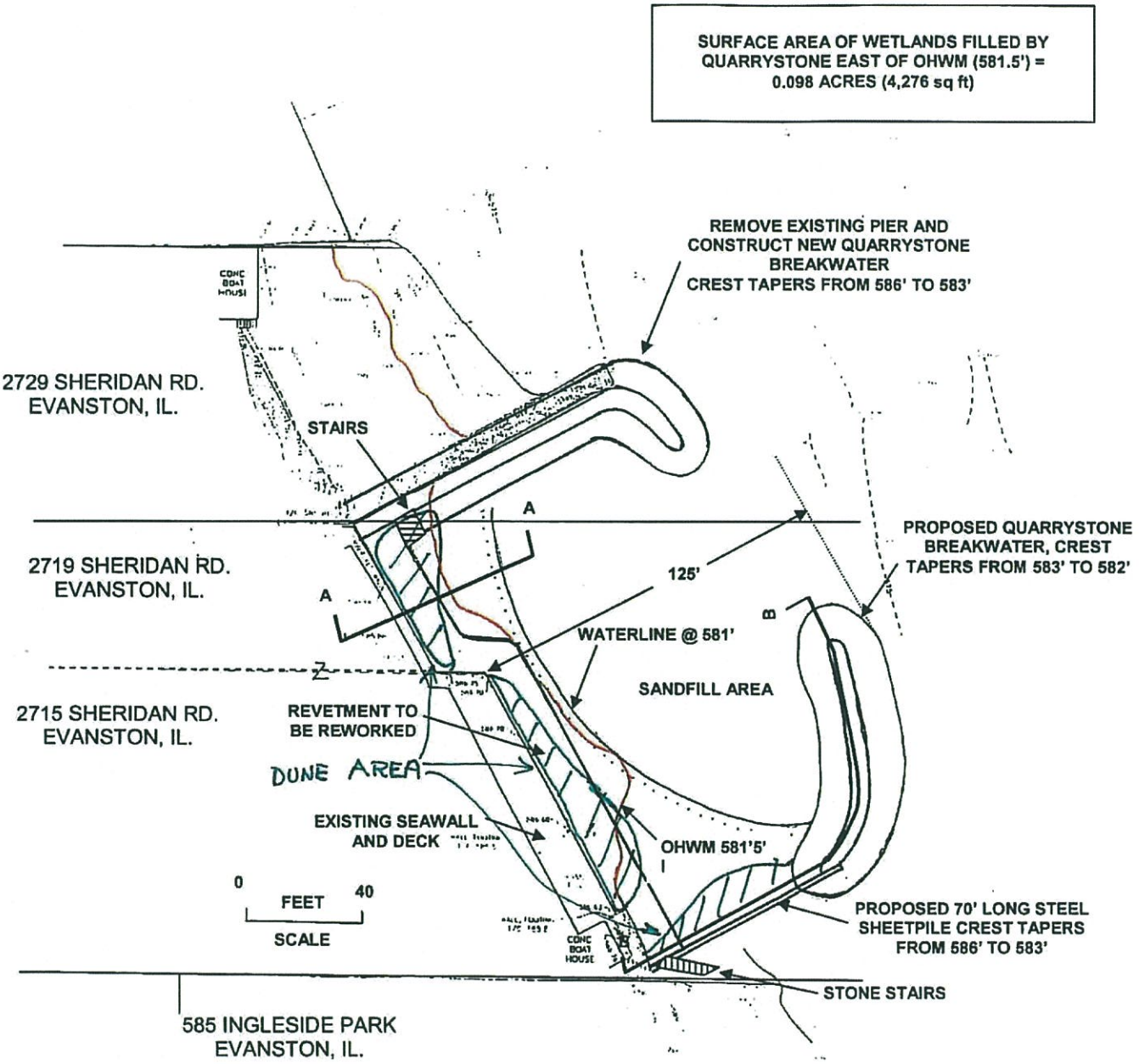
SEE INSTRUCTIONS FOR ADDRESS


North
EVANSTON
ROAD
LINCOLN ST.
WATERWORKS
MILBURN ST.
MILBURN
Grosse Point Lighthouse
PK.
LIGHTHOUSE LANDING PARK
SHERIDAN
DEERING ESTATE PARK
LAWSON PARK
INGLESIDE PK.
INGLESIDE PL.
ROAD
PROJECT LOCATION
5
10
15
15
15
LAKE
MICHIGAN
SCALE IN FEET
200 0 200
lake bottom mapped during July, 1975
20

## PLAN VIEW OVER BATHYMETRY



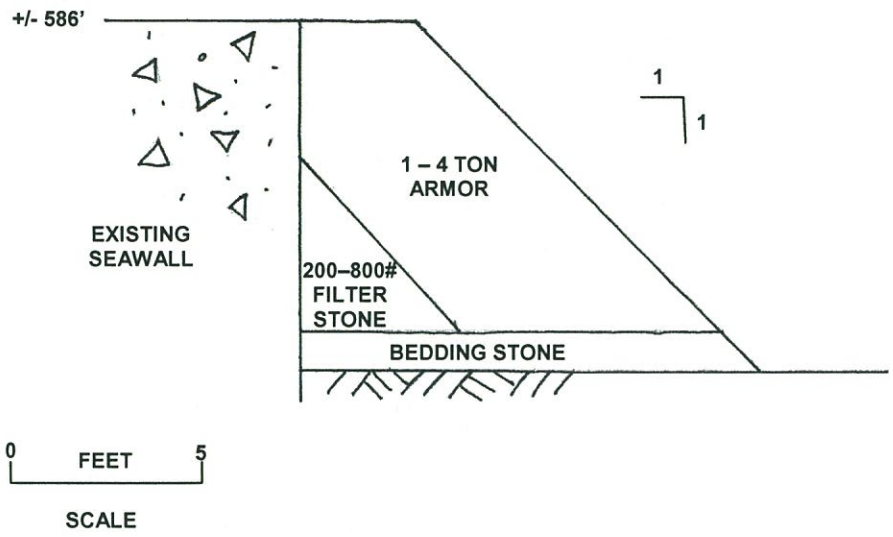
## PLAN VIEW



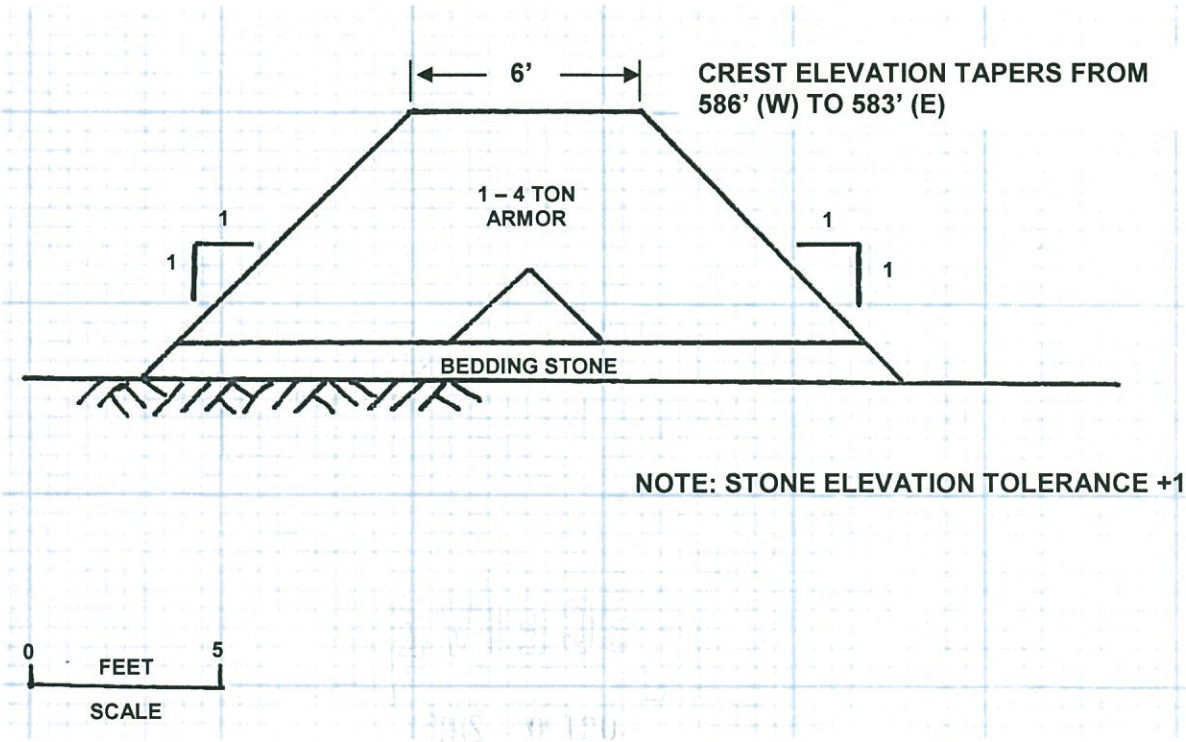

**ELEVATIONS IGLD 1985**

| | |
|---|---|
| PROJECT NAME: LEHMAN Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013 | DRAWN BY: SN |
| REVISED: 1/19/2015 | DRAWING NUMBER: 2A |
| **Shabica & Associates, Inc.** 550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| PLAN VIEW | |

## CROSS SECTION AA: REVETMENT



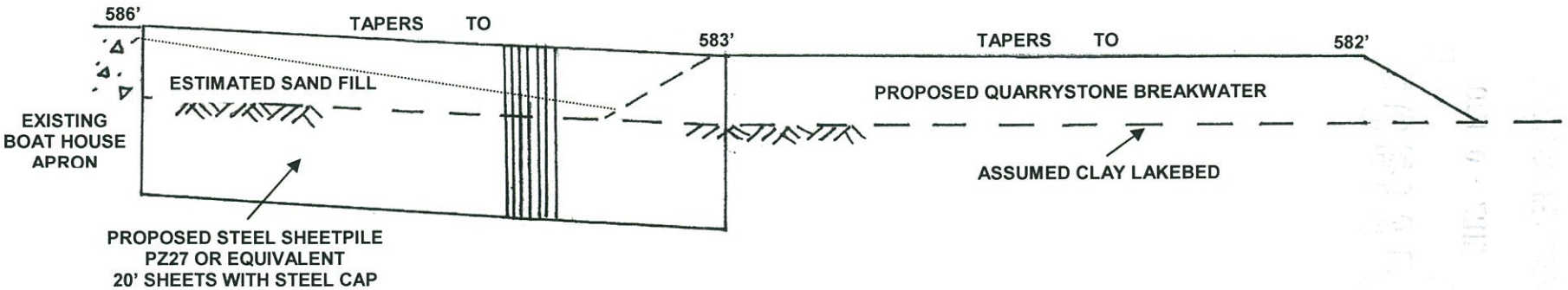

## TYPICAL CROSS SECTION NORTH BREAKWATER E/W ARM




ELEVATIONS IGLD 1985

| | |
|---|---|
| PROJECT NAME: LEHMAN<br>Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013<br>REVISED: 7/17/2015 | DRAWN BY: SN<br>DRAWING NUMBER: 3 |
| **Shabica & Associates, Inc.**<br>550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **CROSS SECTION AA:REVETMENT & NORTH ARM** | |

## CROSS SECTION BB: BREAKWATER

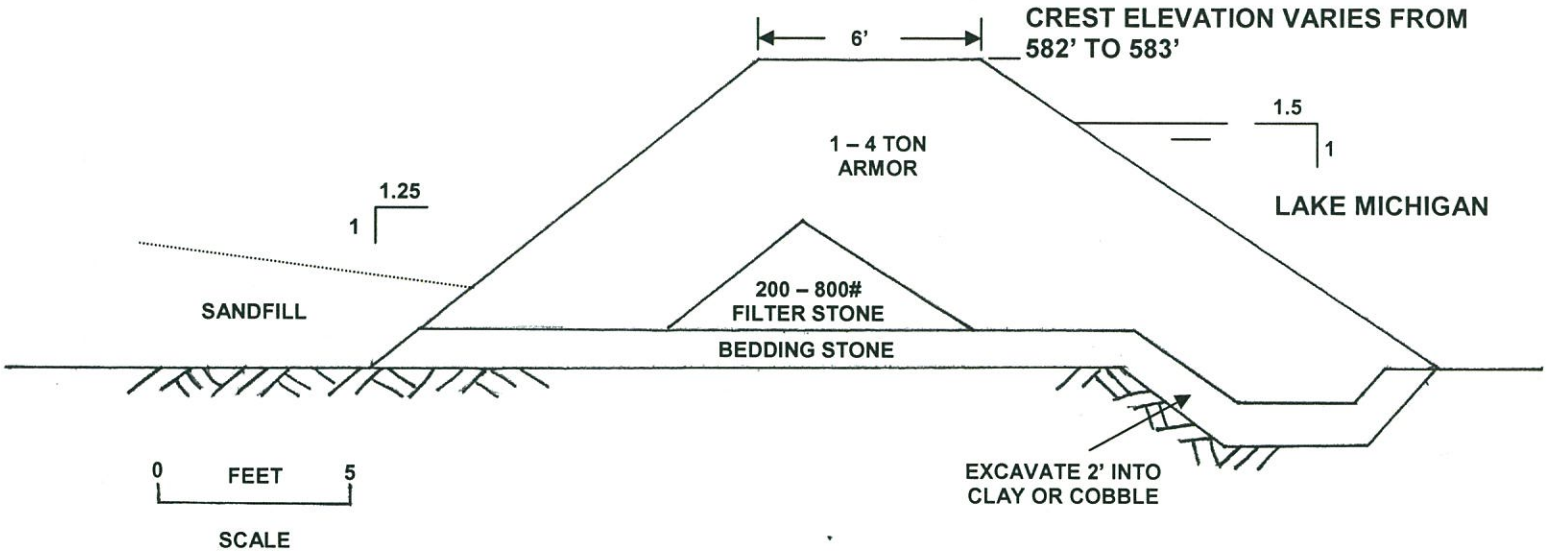



**NOTE: STONE ELEVATION TOLERANCE +1'**

**ELEVATIONS IGLD 1985**

| | |
|---|---|
| PROJECT NAME: LEHMAN<br>Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013<br>REVISED: | DRAWN BY: SN<br>DRAWING NUMBER: 4 |
| **Shabica & Associates, Inc.**<br>550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **CROSS SECTION CC: BREAKWATER** | |

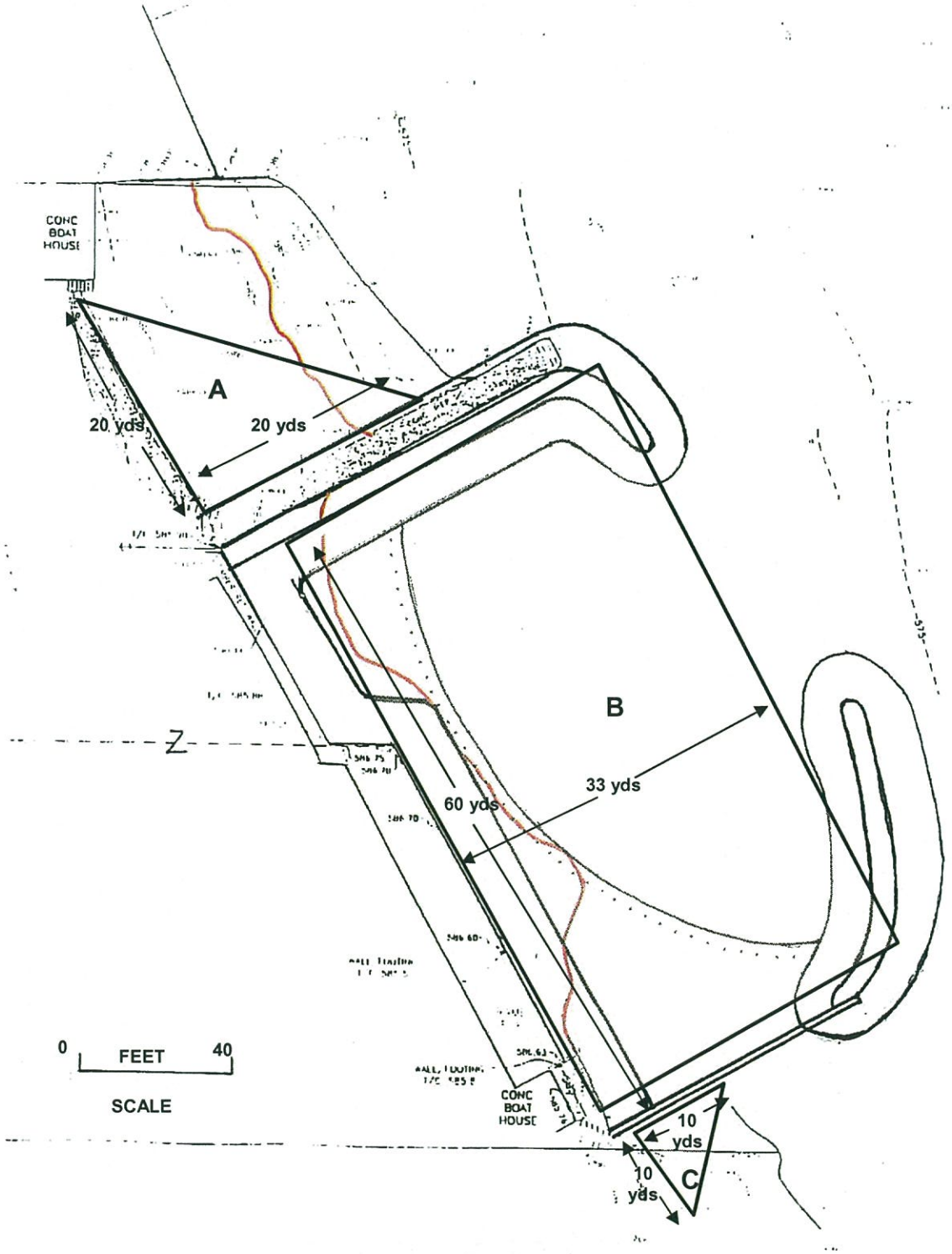
# TYPICAL CROSS SECTION: BREAKWATER




**ELEVATIONS IGLD 1985**

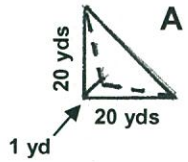
| | |
|---|---|
| PROJECT NAME: LEHMAN<br>Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013<br>REVISED: 1/19/2015 | DRAWN BY: SN<br>DRAWING NUMBER: 5 |
| **Shabica & Associates, Inc.**<br>550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **TYPICAL CROSS SECTION: BREAKWATER** | |

## SAND PLAN VIEW

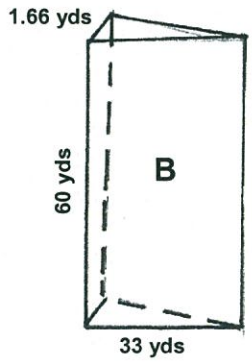



| | |
|---|---|
| PROJECT NAME: LEHMAN<br>Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013<br>REVISED: | DRAWN BY: SN<br>DRAWING NUMBER: 6 |
| **Shabica & Associates, Inc.**<br>550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **SAND PLAN VIEW** | |

## SAND CALCULATIONS




$$\text{VOL A: } \frac{20 \text{ yds} \times 20 \text{ yds} \times 1 \text{ yd}}{6} = 67 \text{ yds}^3$$




$$\text{VOL B: } \frac{60 \text{ yds} \times 33 \text{ yds} \times 1.66 \text{ yd}}{2} = 1,644 \text{ yds}^3$$


$$\text{VOL C: } \frac{10 \text{ yds} \times 10 \text{ yds} \times 1 \text{ yd}}{6} = 17 \text{ yds}^3$$

**SUBTOTAL:**

$67 + 1,644 + 17 = 1,728 \text{ yds}^3$

$1,728 \text{ yds}^3 \times 1.25 \text{ yds/ton} = 2,160 \text{ tons}$

$2,160 \text{ tons} \times 20\% \text{ overfill} = 432 \text{ tons}$

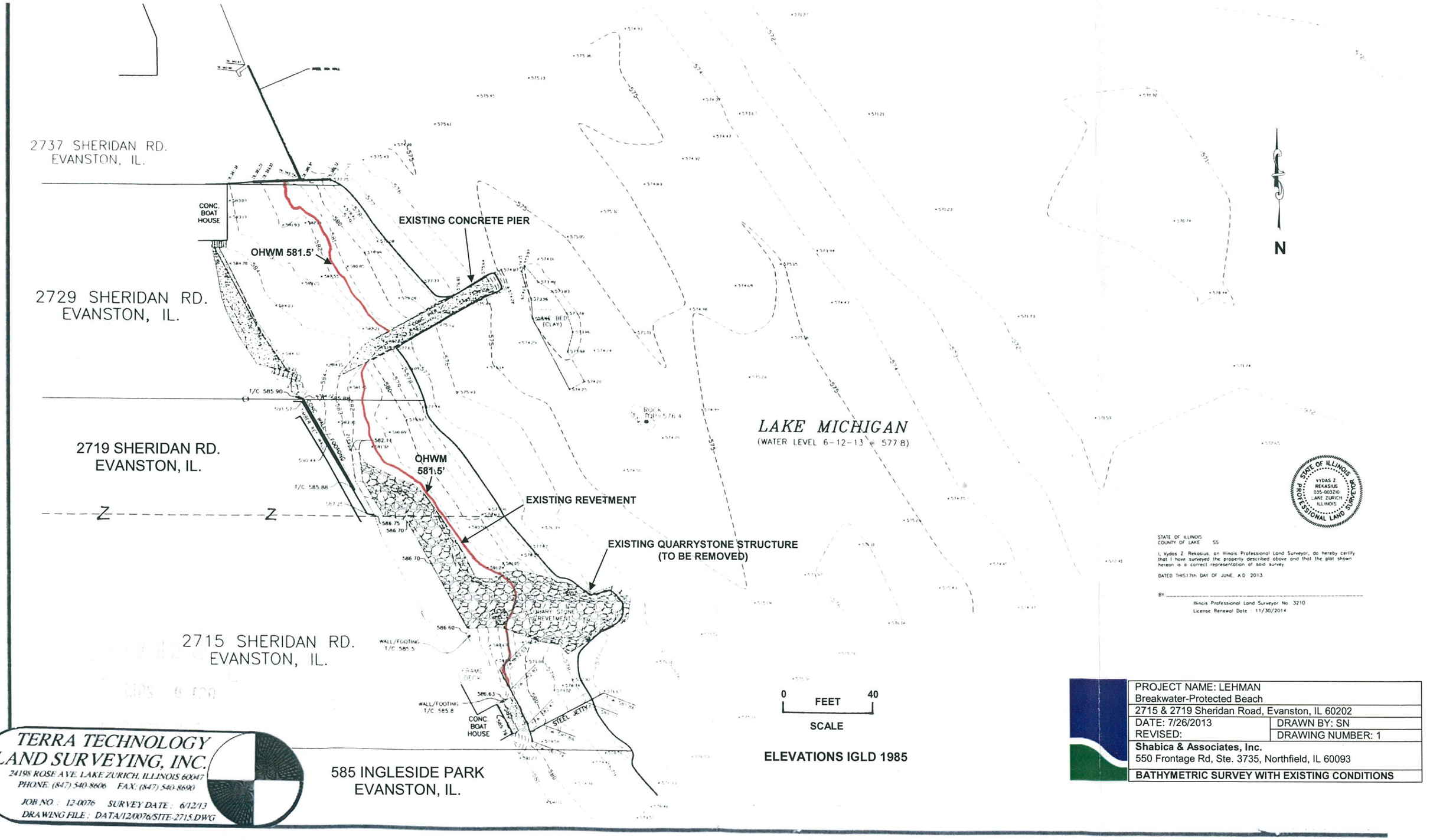
**TOTAL:**

$2,160 \text{ tons} + 432 \text{ tons} = 2,592 \text{ tons}$

**2,600 Tons Clean Sand To Be Placed**

| | |
|---|---|
| PROJECT NAME: LEHMAN Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013 | DRAWN BY: SN |
| REVISED: | DRAWING NUMBER: 7 |
| **Shabica & Associates, Inc.** 550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **SAND CALCULATIONS** | |

## BATHYMETRIC SURVEY WITH EXISTING CONDITIONS




STATE OF ILLINOIS
VYDAS Z. REKASIUS
035-003210
LAKE ZURICH
ILLINOIS
PROFESSIONAL LAND SURVEYOR

STATE OF ILLINOIS
COUNTY OF LAKE SS

I, Vydas Z. Rekasius, an Illinois Professional Land Surveyor, do hereby certify that I have surveyed the property described above and that the plat shown hereon is a correct representation of said survey

DATED THIS 17th DAY OF JUNE, A.D. 2013.

BY _____
Illinois Professional Land Surveyor No. 3210
License Renewal Date : 11/30/2014


TERRA TECHNOLOGY
LAND SURVEYING, INC.
24198 ROSE AVE. LAKE ZURICH, ILLINOIS 60047
PHONE: (847) 540-8606 FAX: (847) 540-8690


JOB NO : 12-0076 SURVEY DATE : 6/12/13
DRAWING FILE : DATA/12/0076/SITE-2715.DWG

| | |
|---|---|
| PROJECT NAME: LEHMAN Breakwater-Protected Beach | |
| 2715 & 2719 Sheridan Road, Evanston, IL 60202 | |
| DATE: 7/26/2013 | DRAWN BY: SN |
| REVISED: | DRAWING NUMBER: 1 |
| **Shabica & Associates, Inc.** 550 Frontage Rd, Ste. 3735, Northfield, IL 60093 | |
| **BATHYMETRIC SURVEY WITH EXISTING CONDITIONS** | |