



SHORELINE
RECONSTRUCTION
PLANS
FOR CHICAGO

A Summary of
Recommendations for
Chicago Shoreline
Protection from the
U.S. Army Corps of
Engineers Study,
*Illinois Shoreline Erosion
Lake Michigan Interim III
Wilmerte to Illinois/
Indiana State Line*

U.S. ARMY CORPS OF ENGINEERS • CHICAGO PARK DISTRICT • CITY OF CHICAGO

JUNE, 1993

**RECONSTRUCTION PLANS
TO REPAIR CHICAGO'S
SHORELINE FROM EROSION AND
STORM DAMAGE**

A Summary of Recommendations
for Chicago Shoreline Protection from the
U.S. Army Corps of Engineers Study
*Illinois Shoreline Erosion Lake Michigan Interim III
Wilmette to Illinois/Indiana State Line*

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**U.S. ARMY CORPS OF ENGINEERS
CHICAGO PARK DISTRICT • CITY OF CHICAGO
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CHICAGO'S SHORELINE is largely man-made, constructed on landfill an average of 1500 feet wide. Filled in over the course of the last century to create additional land and recreation areas, Chicago's lakefront property requires shore protection to prevent erosion and storm damage. The existing shoreline protection structures, known as revetments, were built between 1910-1931 and have substantially outlived their design life. Because of their deteriorated condition, these revetments no longer provide adequate protection from flood and storm damage.

INTRODUCTION

The continued threat of flooding and storm damage to Lake Shore Drive and several other public facilities prompted Congress, in 1974, to direct the U.S. Army Corps of Engineers (ACOE) to investigate these and related erosion problems along the entire Illinois shoreline of Lake Michigan, a distance of 65 miles. The study was undertaken in four separate "Interim" investigations, each surveying a distinct section of shoreline. The Interim III segment examined the area extending from Wilmette Harbor to the Illinois-Indiana State line. It focused on the 24 miles of publicly owned land managed by the Chicago Park District. This land is fronted by major beaches, held in place by groins, or armored with some type of revetment.

As cooperating agencies, the City of Chicago and the Chicago Park District, have worked on this reconstruction project extensively with the Chicago District Army Corps of Engineers on the preparation of this report.

ACOE's policies and procedures for planning water resource related projects determined how the study process should be employed to develop and evaluate alternative plans and ultimately select a recommended plan. The planning process consists of the following steps:

STUDY METHODS

- identify storm damage and erosion problems
- formulate alternative shore protection plans to address problems
- compare and evaluate effects of alternative plans
- select a recommended plan

The ACOE's, *Illinois Shoreline Erosion Lake Michigan Storm Damage Interim III Report*, consists of a feasibility report and an environmental assessment accompanied by eight appendices (Volumes I and II). The main text includes background information on the study and planning process, and presents conclusions and recommendations. Appendices include:

APPENDIX VOLUME I	APPENDIX VOLUME II
A - Coastal Engineering	D - Economic Analysis
B - Engineering and Design	E - Plan Formulation
C - Geotechnical Engineering	F - Local Sponsor Plan Formulation
	G - Coordination
	H - Real Estate

Through an inventory of public infrastructure, facilities and land in the project study area, economic values and cost of protection were systematically assessed and analyzed to establish a Federal interest in repair of Chicago's shoreline. The City of Chicago, Chicago Park District, and State of Illinois, with the assistance of several other local agencies and organizations, were responsible for compiling this comprehensive inventory.

STUDY PROCESS

The study considered 22 different alternative shore protection strategies to address flooding and storm damage. Of several plans developed and evaluated, two were chosen for detailed analysis. One featured use of low berm rubble mound revetment; the other would reconstruct existing step stone revetment. Both plans assess losses related to transportation and recreational benefits, but only the step stone revetment plan is designed to be consistent with the historic nature of the existing shore protection structures along the rest of the shoreline.

According to ACOE policy and guidelines, the plan which achieves storm damage reduction at the highest ratio of cost to benefit is to be the National Economic Development (NED) plan. The NED plan defines the level of federal financial assistance for constructing the project. Since the rubble plan provides the same amount of storm protection as step stone revetment, but at a lower cost, it was selected as the NED plan.

However, the selected plan must also meet the needs and desires of local communities. Study findings demonstrate that construction of the lowest-cost NED plan would render the lake inaccessible from land and reduce the economic and property values of Chicago's shoreline. Consequently, it does not "meet the needs and desires of the surrounding communities," nor is it consistent with the historical protection systems of Chicago. Therefore, the ACOE report recommends construction of the locally-preferred step stone plan which maintains full use of the lakefront.

Federal funds will cover 65% of the cost to build the NED plan. The remaining 35% of the cost must be paid by local governments from non-federal funds. Whenever cooperating agencies request alternative construction they must pay 100% of any costs beyond the cost to build the NED plan.

Due to the restricted nature of the ACOE's authorization to prevent severe damage from erosion and flooding, the project was limited to protection of those shoreline areas that are in imminent danger. Although the study substantiates the value of Chicago's entire shoreline, the alternatives recommended in this project are not intended to be a comprehensive lakefront development plan. This project is necessary to stop potentially catastrophic collapse of one-third of Chicago's shoreline and presents the opportunity to obtain significant federal financial investment in rebuilding the shoreline.

Taking no action will subject the City to the increasing risk of catastrophic failure along the shoreline. In an emergency, we could lose millions of dollars in valuable facilities, infrastructure, and property. In a crisis, the City would not be in a position to negotiate the type of protection to build. Instead, we would have to accept whatever is available—obviously the fastest and cheapest solution.

Another option is to take advantage of federal funding now to plan for a long-term engineered solution. The least expensive option for Chicago would consist of rubble mound revetments along eight miles of Chicago shoreline which would then be fenced off to restrict public access as well as prevent potential injury. This protection method would require regular maintenance at local expense to resupply the rock piles as they erode from wave action.

The recommended alternative for Chicago is to take advantage of federal funding to rebuild step-stone revetments. This would provide flood and storm damage protection and preserve recreational use in a manner that is consistent with the historic and aesthetic setting of Chicago's existing lakefront. Step stone revetments are relatively maintenance free.

**STUDY
CONCLUSIONS**

The cost benefit analysis concluded that national benefits derived from Chicago's shoreline exceed the Federal costs to protect it, thereby establishing a federal interest in providing financial support to construct this project.

Key study findings include:

- the economic value of the lakefront exceeds costs of protection
- protecting Lake Shore Drive, a federal highway, is sufficient justification for federal participation
- the economic value of Chicago's shoreline facilities and lakefront property exceeds \$5 billion
- left unprotected, large areas of the lakefront will erode at a rate of 20' per year
- areas most subject to damage are deep-water areas
- design of shoreline protection structures can positively or negatively affect the economic value of the lakefront

**ECONOMIC
CONSIDERATIONS**

**THE VALUE OF
CHICAGO'S
SHORELINE**

TO ESTABLISH Federal interest in supporting reconstruction of Chicago's deteriorating shoreline, cooperating agencies ascertained its value via an extensive inventory of public and private property, facilities and infrastructure. The investigation ascribed economic values to facilities, land, beaches, various types of lakefront use, related employment, and annual revenue associated with the study area. In conjunction with the Chicago District ACOE, an assessment was then conducted to determine what would be lost if no reconstruction were undertaken.

For millions of people who annually use the lakefront, major losses will be Lake Shore Drive, a federal highway and major travel route for daily commuters; an airport, located on the lake for ease of access to Chicago's central business district; a water purification plant serving more than 2 million residents in the City and 50 suburbs; several harbors; a wetlands/bird sanctuary; private property; hundreds of public facilities, including some of the largest museums in the U.S. In addition to protecting these, reconstruction of 8 miles of deteriorating shoreline will boost the economy by creating jobs and attracting new businesses.

In 1992 almost three-quarters of Chicago's households (74%) visited parks on Lake Michigan, making this the second most popular outdoor

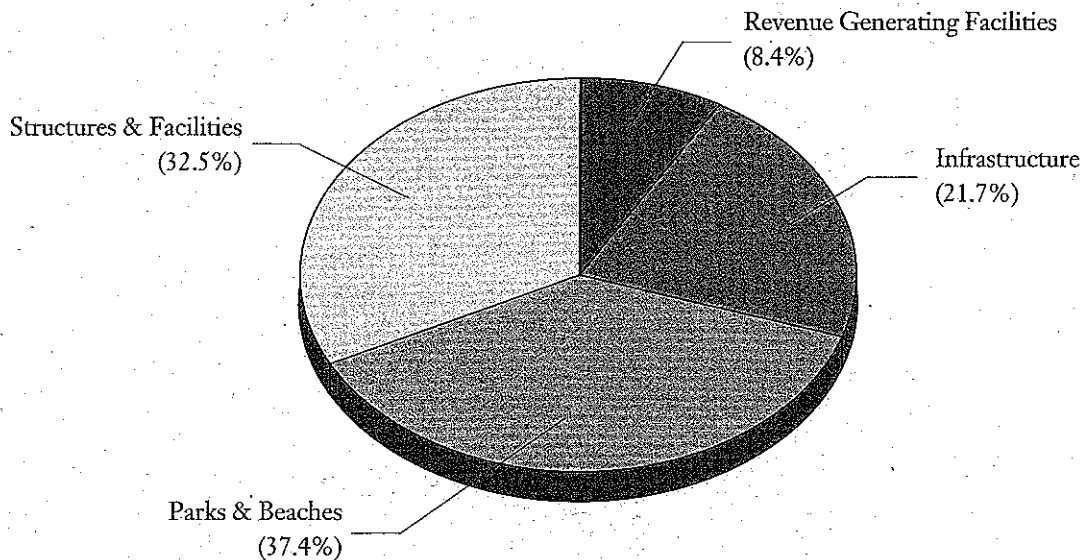
recreational activity within the city, second only to visiting local neighborhood parks. The shoreline and associated activities support more than 8,500 jobs providing \$287,000,000 in lakefront-generated revenue and sales.

The Illinois Department of Commerce and Community Affairs (DCCA) documented that in 1990 35 million people visited Illinois contributing \$14 billion to the State's economy. Illinois travel-related businesses employed 208,000 persons with a payroll of \$3.4 billion generating \$1.9 billion in taxes. Of all Illinois visitor dollars, two-thirds are spent in the Chicago area. Of the 1,393,000 foreign visitors to Illinois, 1,000,000 visit Chicago. Illinois' number one and number two attractions for visitors are on Chicago's lakefront—Lincoln Park Zoo and the Museum of Science and Industry.

Based on their study, DCCA concluded: "...the protection of Chicago's magnificent Lake Michigan shoreline is vital to the future economic growth of the Chicago metropolitan region and the entire State of Illinois." The lakefront significantly enhances the quality of life in Chicago and is a major reason why new businesses locate here.

The replacement value of the public lakefront facilities and property exceeds \$5 billion. These facilities and related activities support not only the local economy but also provide a revenue resource for the state and the nation.

**COMPONENTS OF CHICAGO SHORE
PUBLIC PROPERTY VALUE
TOTAL REPLACEMENT VALUE = \$5 BILLION (1989\$)**



BENEFITS

Table 1 below shows the relative benefits to be derived from the two plans. Although both plans protect the shoreline from further erosion, the rubble mound plan eliminates access to the shore edge. The step stone revetment plan, by restoring the original design, affords safe access and continued recreational use. Consequently, additional recreational benefits are provided under the step stone preferred plan.

SUMMARY OF ANNUAL BENEFITS

	RUBBLE MOUND	STEP STONE PLAN
Transportation/Road Loss	\$19,394,852	\$19,394,852
Transportation/Flooding	307,359	307,359
Facilities & Infrastructure	7,707,552	7,707,552
Recreation Benefits	8,409,119	12,569,733
Sub-Total	\$35,818,882	\$39,979,496
Emergency Maintenance Cost Avoided	509,967	509,967
Total	\$36,328,849	\$40,489,463

TABLE 1**CURRENT PROBLEM**

Existing step stone revetments, which make up the majority of Chicago's shoreline, are supported by wood pilings. Because of deterioration, many pilings no longer are able to adequately support the heavy stones which rest upon them. This alone accounts for over half of the collapsing shoreline. Once the wood pilings holding these structures in place break down, land will erode at an estimated average rate of 20 feet per year, destroying valuable public infrastructure, park land, park facilities, and eventually private property.

Approximately eight miles, about one-third, of Chicago's shoreline is in danger of collapse. Areas most critically affected and most vulnerable are:

- Montrose Harbor to Fullerton Avenue
- Northerly Island/Meigs Field
- 27th Street to Promontory Point at 55th Street
- South Water Purification Plant at 79th Street

Just as important is the major flooding of Lake Shore Drive which occurs at Fullerton Avenue.

Calculations were completed to estimate what the value of loss would be if erosion were to begin. Utilizing erosion rates ranging from 13 feet to 26 feet per year the value of loss was determined to be as follows:

**WHAT WOULD BE LOST?
EROSION RATE SENSITIVITY ANALYSIS
FOR RUBBLE MOUND PLAN**

STORM DAMAGE REDUCTION CATEGORY	EROSION RATE 13 FT/YR	EROSION RATE 26 FT/YR
Transportation Road Loss	\$12,593,000	\$22,466,000
Facilities and Infrastructure	5,005,000	8,928,000
Incidental Recreation	6,044,000	9,066,000
Total Average Annual Benefits	23,642,000	40,461,000
Total Average Annual Costs	\$15,445,000	\$15,444,000
Benefit to Cost Ratio	1.5	2.6

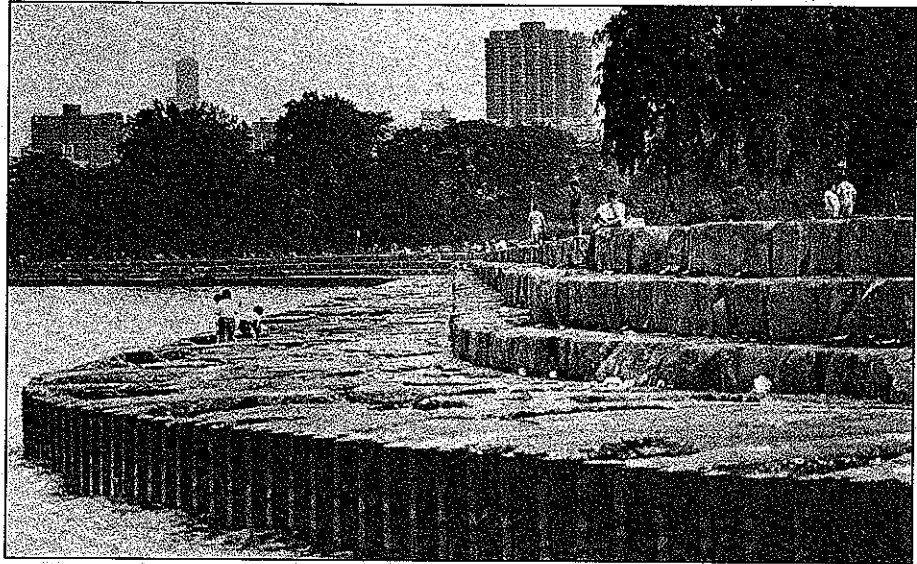
TABLE 2

SHORELINE PROTECTION SYSTEMS

Because of varying water depth and shore composition, four different types of protection systems have been used for more than 50 years to support Chicago's shoreline and prevent erosion. All four types were considered in this study as possible solutions.

They are step stone revetments, rubble mound revetments, beaches and groins, and offshore breakwaters

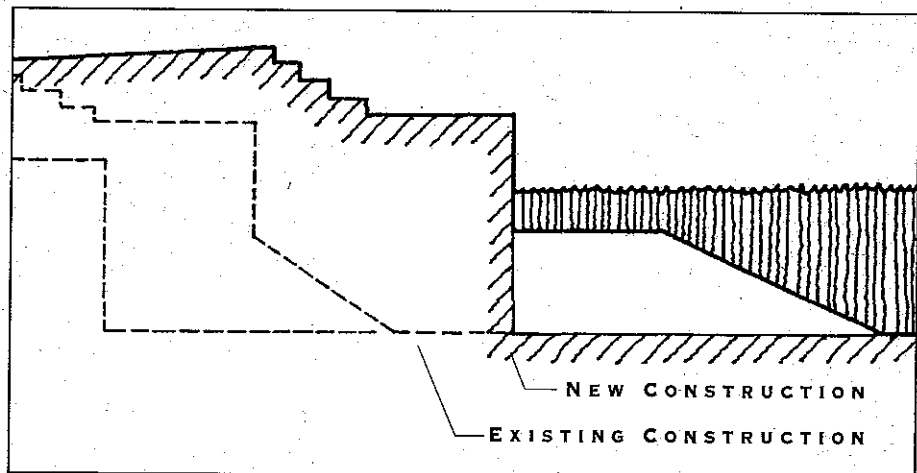
STEP STONE REVETMENT



Most of Chicago's original shoreline has this type of protection system. It is a part of the long standing history and beauty of the city. Step stone revetments provide easy and safe access to the water's edge and are relatively maintenance free.

Every year millions of visitors bike, jog, sun bath, run, fish, picnic, and relax atop their large capstones (large smooth cut stones used to create steps). It is the preferred system of shore protection in deep water areas.

Capstones in many areas are falling into the lake as deteriorated timber piling that once held them in place are collapsing. Newly constructed step stone revetments would use steel sheet piles to anchor the step stones.



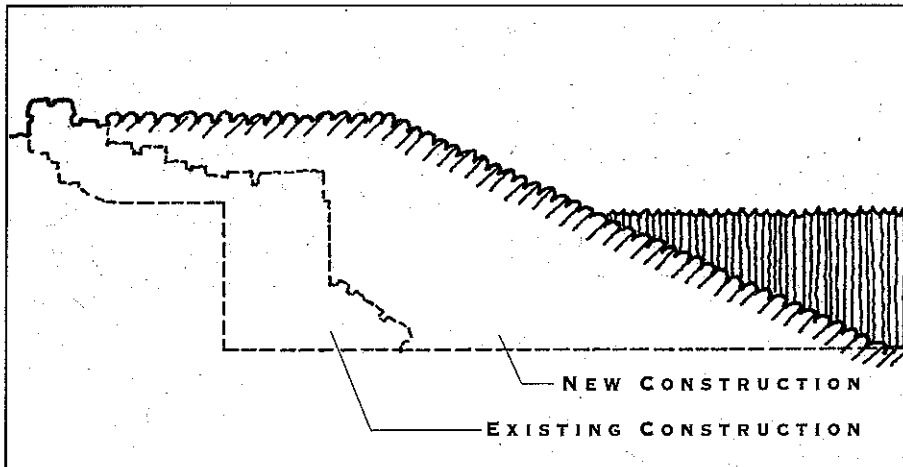
This cross section through a typical step stone revetment shows the profiles of steps as they approach the water's edge from the shore. As a cost saving measure, plans include using existing stones as fill when reconstructing the new revetments. In non-swimming areas more rubble stone below the water level than has been used in the past is recommended to assist in wave dissipation and ensure resistance to future storm damage.

LOW BERM RUBBLE MOUND REVETMENT



Low berm rubble mound revetments consist of large stones piled on shore to take the impact of wave action. There are very few permanently installed low berm rubble mound revetments in Chicago. It is not considered appropriate for public sections of the shoreline because it creates a safety hazard for those who choose to climb over the stones to reach the edge of the water. Most shore edge activities are eliminated with this type of revetment.

This revetment has the lowest cost to construct but a higher maintenance cost since shifting stones periodically have to be realigned and replaced.



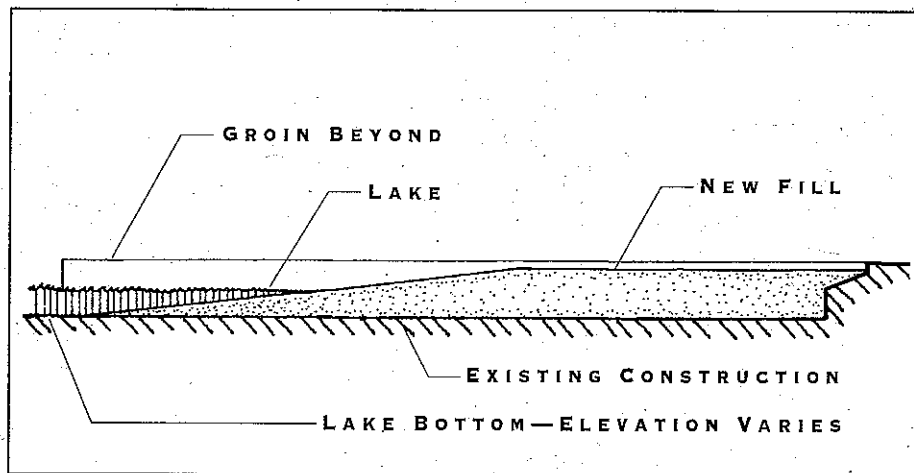
This drawing shows a cross section through a typical low berm rubble mound revetment. Rough, jagged, and uneven surfaces provide unsafe access to the water. If the ACOE were to replace step stone revetments with low berm rubble mound revetments in areas of public use, fences with warning signs, advising visitors of the danger, would have to be installed.

BEACH AND GROIN



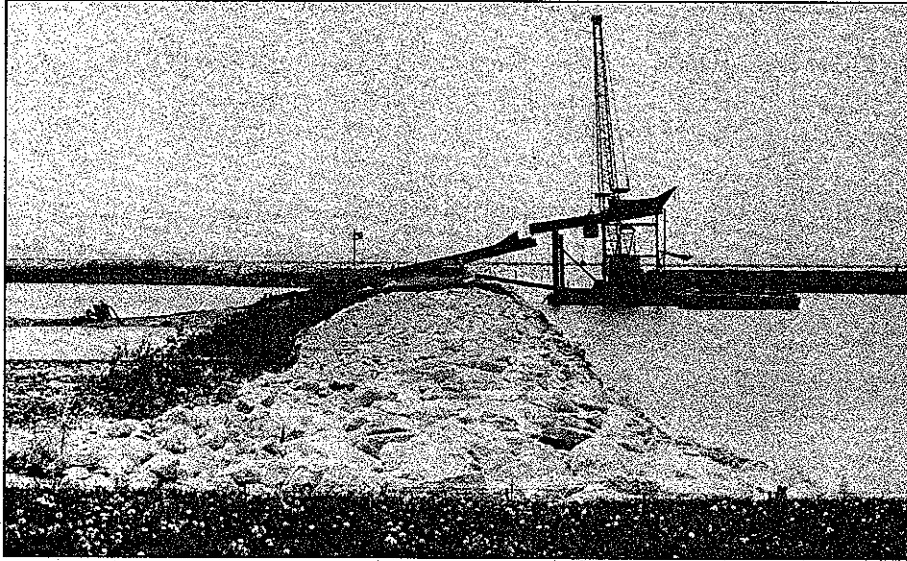
Where the lake is shallow a beach and groin is the preferred shoreline protection system. Though beach sand must be replenished periodically, the groin, a wall connected to the shore and extending out into the water, helps to secure and capture drifting sand and reduce erosion. Beaches have a higher value of use than other revetment types.

Every year millions of visitors use Chicago's beaches not only for swimming and sunbathing but also for a variety of activities including company picnics, volleyball tournaments and sand castle building.

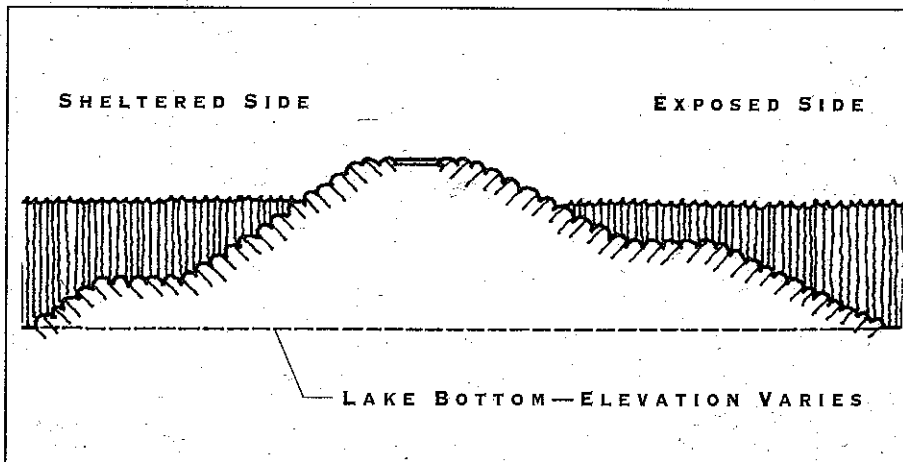


This cross section shows the construction of a typical beach. A steel sheet pile groin is the stabilization device which helps to keep sand in place.

RUBBLE MOUND BREAKWATER



A rubble mound breakwater consists of natural stone or concrete rubble, placed in a pile on the lake bed, to a engineered height above the normal water level. Such breakwaters help to dissipate strong waves that come ashore in deep water. This protection system is recommended to protect the South Water Purification Plant at 79th Street.



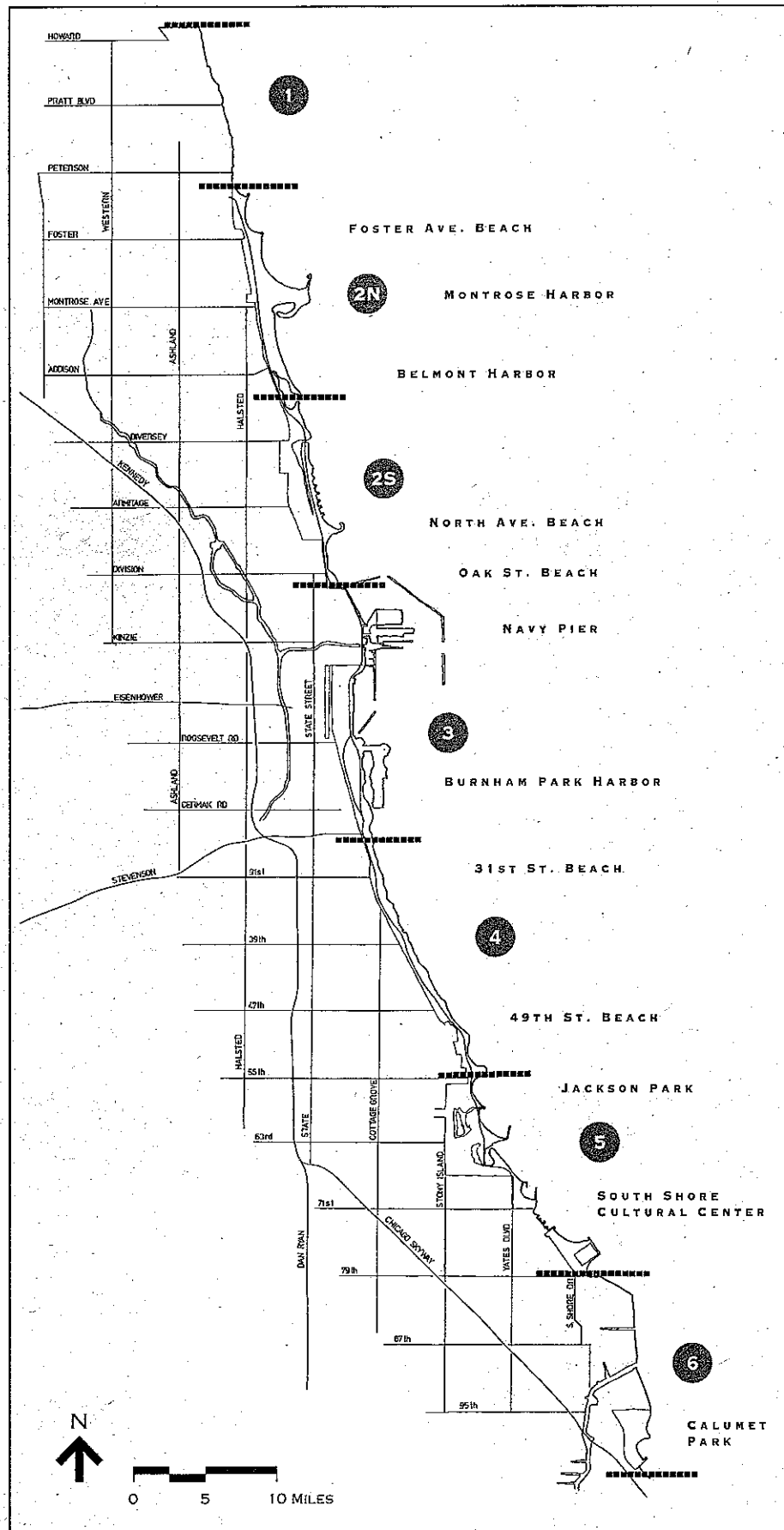
This cross section of a rubble mound breakwater shows the breakwater's design that serves to dissipate wave energy away from the shore by effectively reducing wave action before it hits the shoreline.

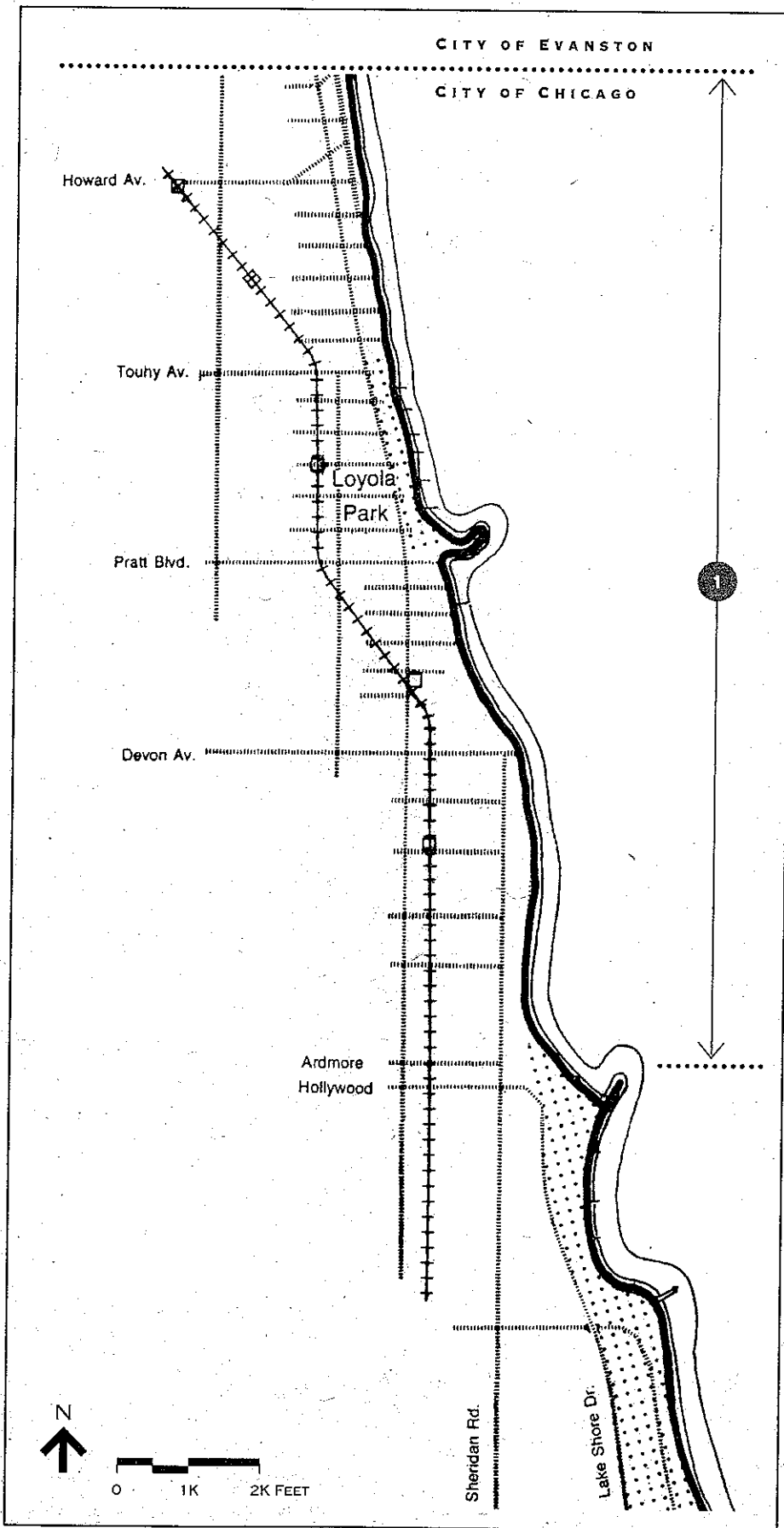
STUDY AREA

REACHES

- 1 Northern city boundary to Ardmore
- 2N Ardmore to Belmont
- 2S Belmont to Oak Street
- 3 Oak Street to 26th Street
- 4 26th Street to 55th Street
- 5 55th Street to 79th Street
- 6 79th Street to the Indiana State line

Note: The designation of reach boundaries was established by the Mayor's Shoreline Protection Commission in 1986 and have been used as a convenience by both the Corps of Engineers and the cooperating agencies in dividing the study into workable zones. The proposed shore protection treatments for each reach are described in the following section.





REACH 1

Reach 1 extends from the Northern border of the City to Ardmore Avenue. This area received extensive emergency assistance from the State of Illinois and federal government to protect public and private property during high water levels and storms in the 1980s. These flood and storm damage reduction measures included beach nourishment and construction of rubble mound breakwaters and revetments.

Analysis conducted by the ACOE determined that currently there are no serious flooding or erosion problems within this reach which qualify for treatment under this study.

REACH 2 N

Problem:

Shoreline protection along this entire reach, from Montrose to Belmont, is moderately to severely damaged, especially the south face of Montrose Harbor.

This is the second most seriously damaged portion of shoreline in the study area.

Nearly all capstones are tilted forward, misaligned or missing.

Estimated Failure Date: 2008

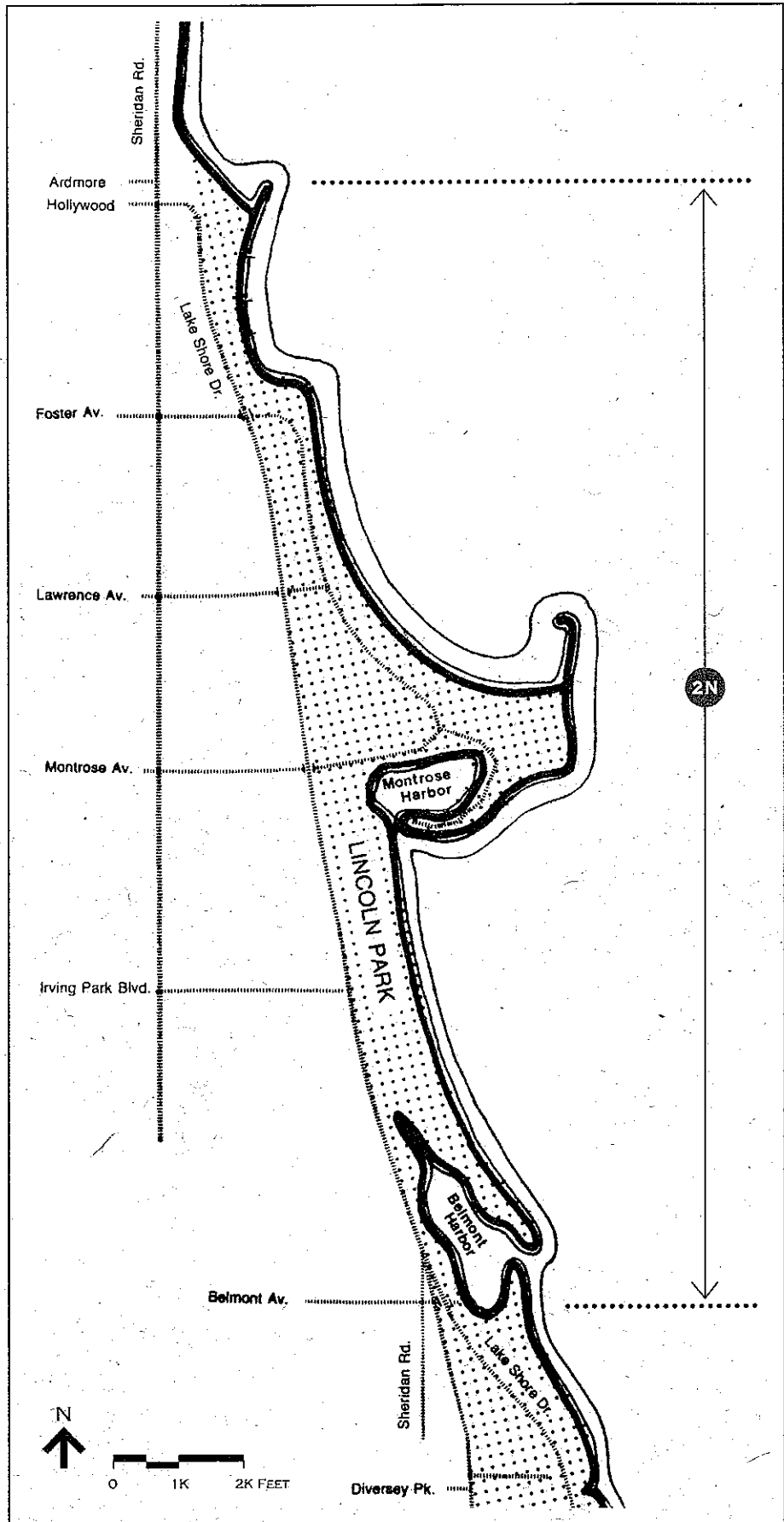
Construction Start Date

Harbor area: 1996

Shoreline: 2005

Recommended Plan:

Reconstruct Montrose Harbor area and step stone revetment from Montrose to Belmont Avenue.



REACH 2 S

Problem:

From Belmont Ave. to North Ave. step stone revetments are either collapsing or capstones are covering large caverns that have been created from wash out underneath them.

From Fullerton Ave. to North Ave. there exists a manmade perched beach system held in place by 6 groins. The northern two groin bays no longer retain beach sand. Lake Shore Drive floods because the revetment just landward of the beach is not stable and there is only a narrow strip of walkway between the shore and the Drive. Lake Shore Drive also floods between North Ave. and Oak Street.

Estimated Failure Date: 2008

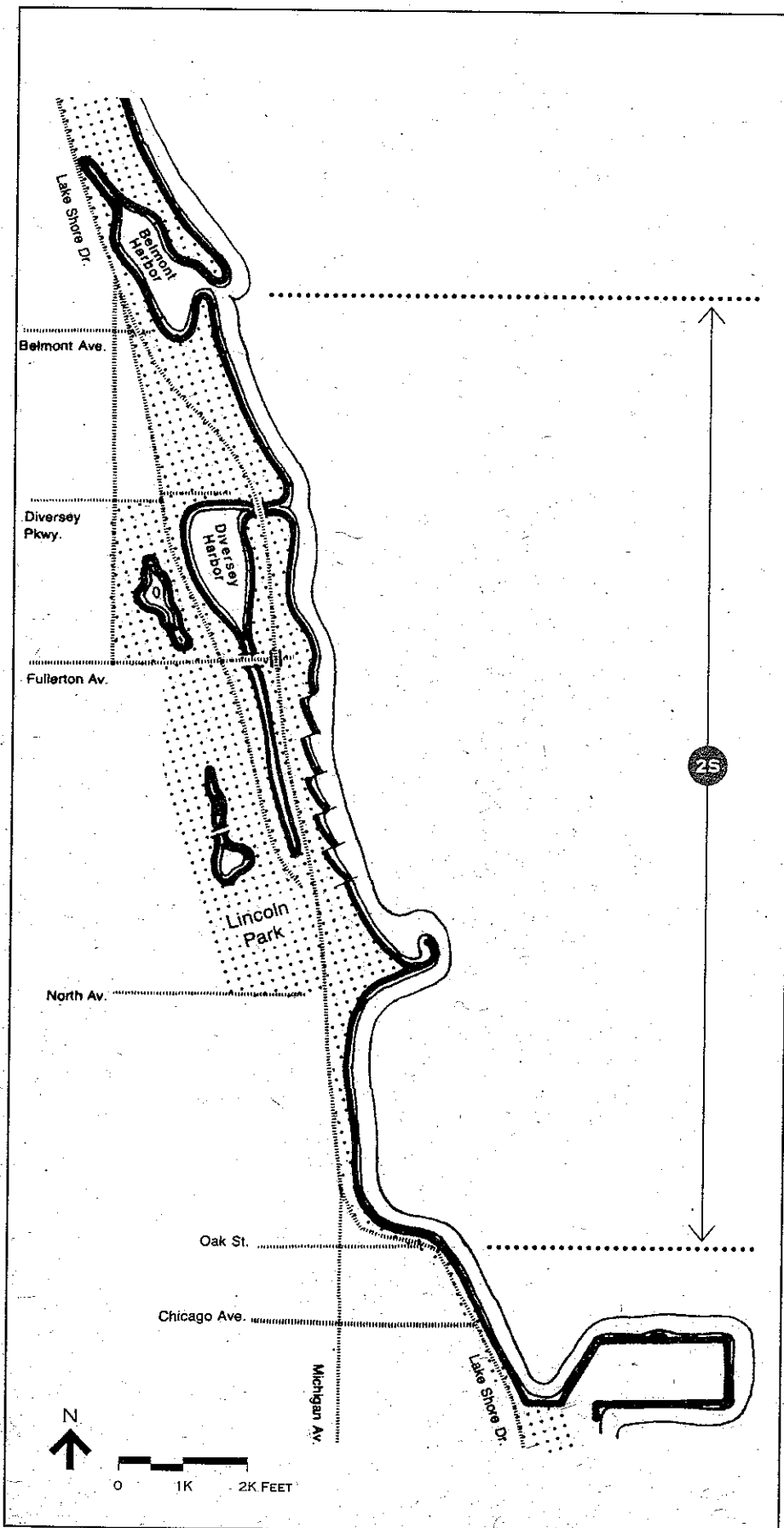
Construction Start Date: 2002

Recommended Plans:

Reconstruct step stone revetment from Belmont Ave. to Fullerton Ave. Partially fill the two northern beach groins south of Fullerton Avenue with rock, gravel and sand. Make other structural modifications to stabilize beaches and raise walkway.

At the north end of the beach, construct a breakwater extending from the shore eighty feet into the lake.

Along Lake Shore Drive between Oak Street and North Avenue, install highway-standard concrete barrier wall, designed to accept flashboards during periods of high water level and storms.



REACH 3

Problem:

This reach protects Lake Shore Drive adjacent to the main business area of the City of Chicago. Between Shedd Aquarium and the Adler Planetarium the revetment has severe capstone spauling and cracking. There is evidence that large caverns exist beneath the revetment.

Estimated Failure Date: 1998

Construction Start Date: 1997

The area from 12th St. beach to 26th St. is subject to storm damage and erosion. Revetment along the central section of Meigs Field is severely deteriorated and does not provide protection. The airfield parking lot floods.

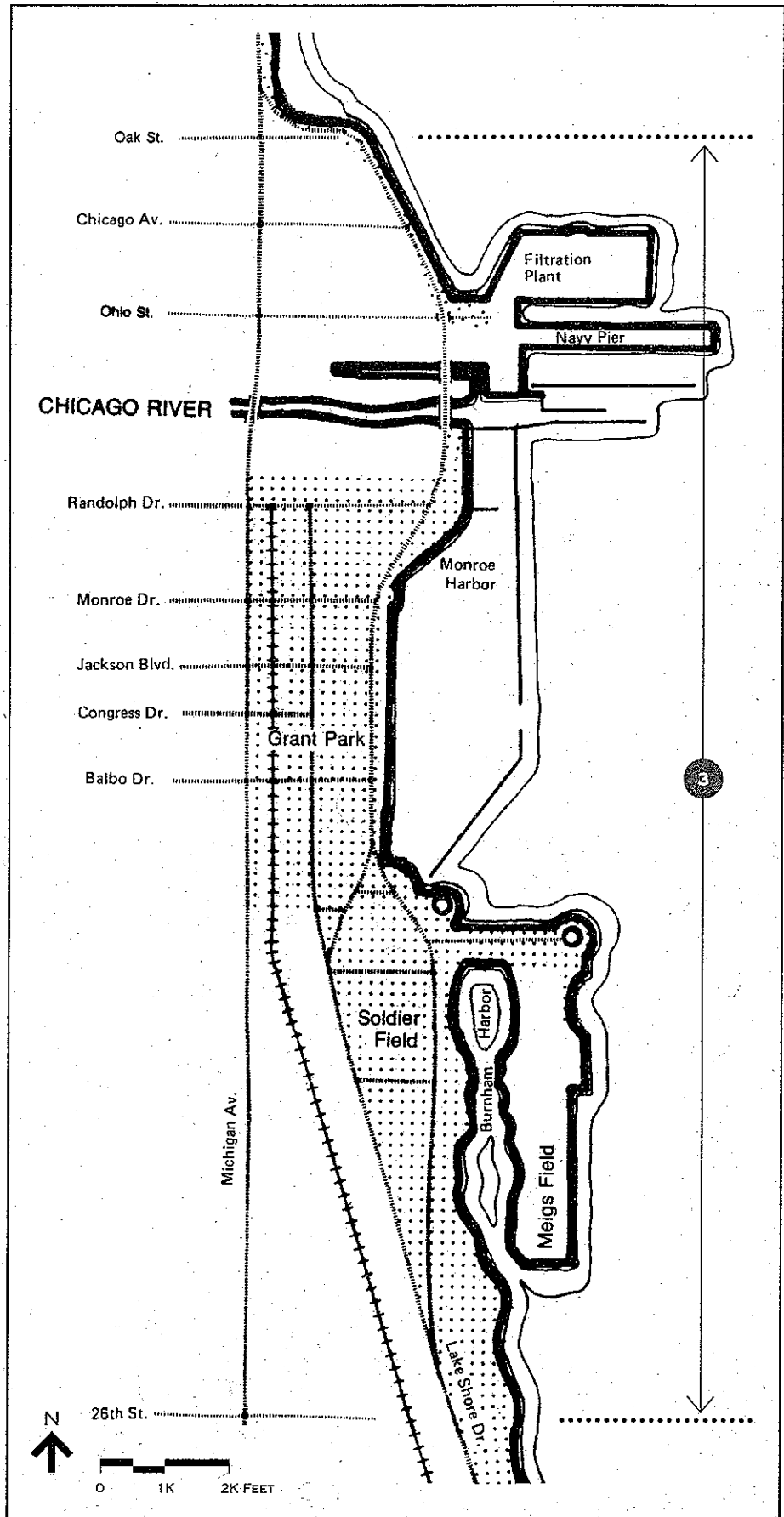
Estimated Failure Date: 2003

Construction Start Date: 2002

Recommended Plans:

Reconstruct failed step stone revetment along the north side of the east-west isthmus of Northerly Island.

Construct 1,200 foot rubble mound revetment near the center of the eastern edge of Meigs Field.



REACH 4

Problem:

This area has sustained the most serious damage in the study area. 80% of all step stones have fallen into the lake. There are large caverns extending beneath the first and second step stone tiers throughout the area.

In the most deteriorated area from 49th St. to 55th St., all that remains of the step stone revetment is stone debris.

Large caverns exist under step stones near Hyde Park Blvd.

South of Hyde Park Blvd. to 55th St. the revetment is in general disarray; capstones and step stones have fallen into the lake.

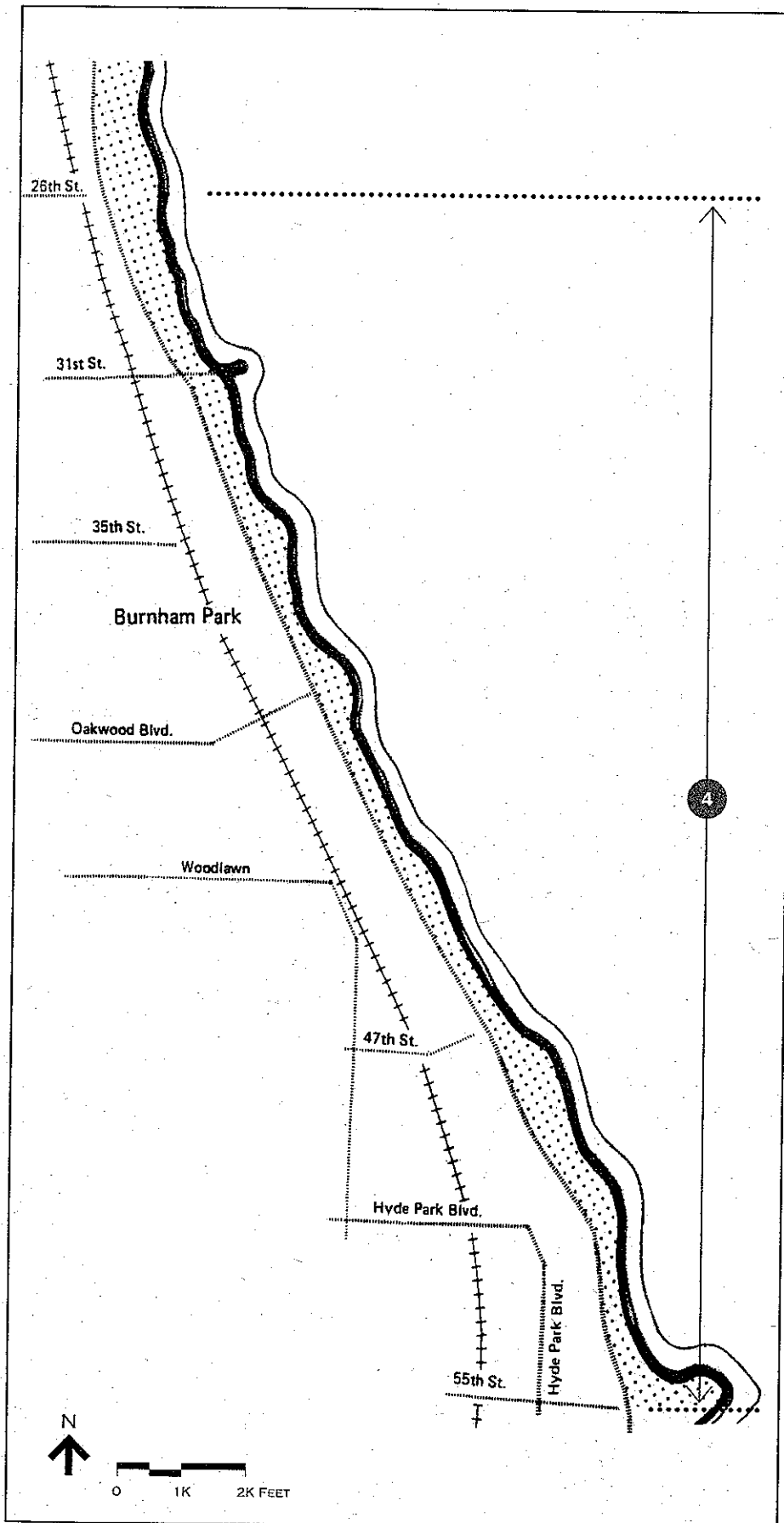
Estimated Failure Date: 2003

Construction Start Date: 1999

Recommended Plans:

Reconstruct step stone revetment along the entire reach including 900 feet into Reach 5.

Replenish sand at 31st Street Beach.



REACH 5

Problem:

The 2,500 foot breakwater, located 900 feet offshore from the South Water Purification Plant at 79th Street, is near collapse. The breakwater crest has either settled or been displaced by wave action to an elevation below water level. Portions have been breached, especially on the north end of the breakwater.

Damage at Casino Pier at 63rd Street is being addressed separately by the ACOE in the Illinois Shoreline Erosion Interim II study and is not considered in this report.

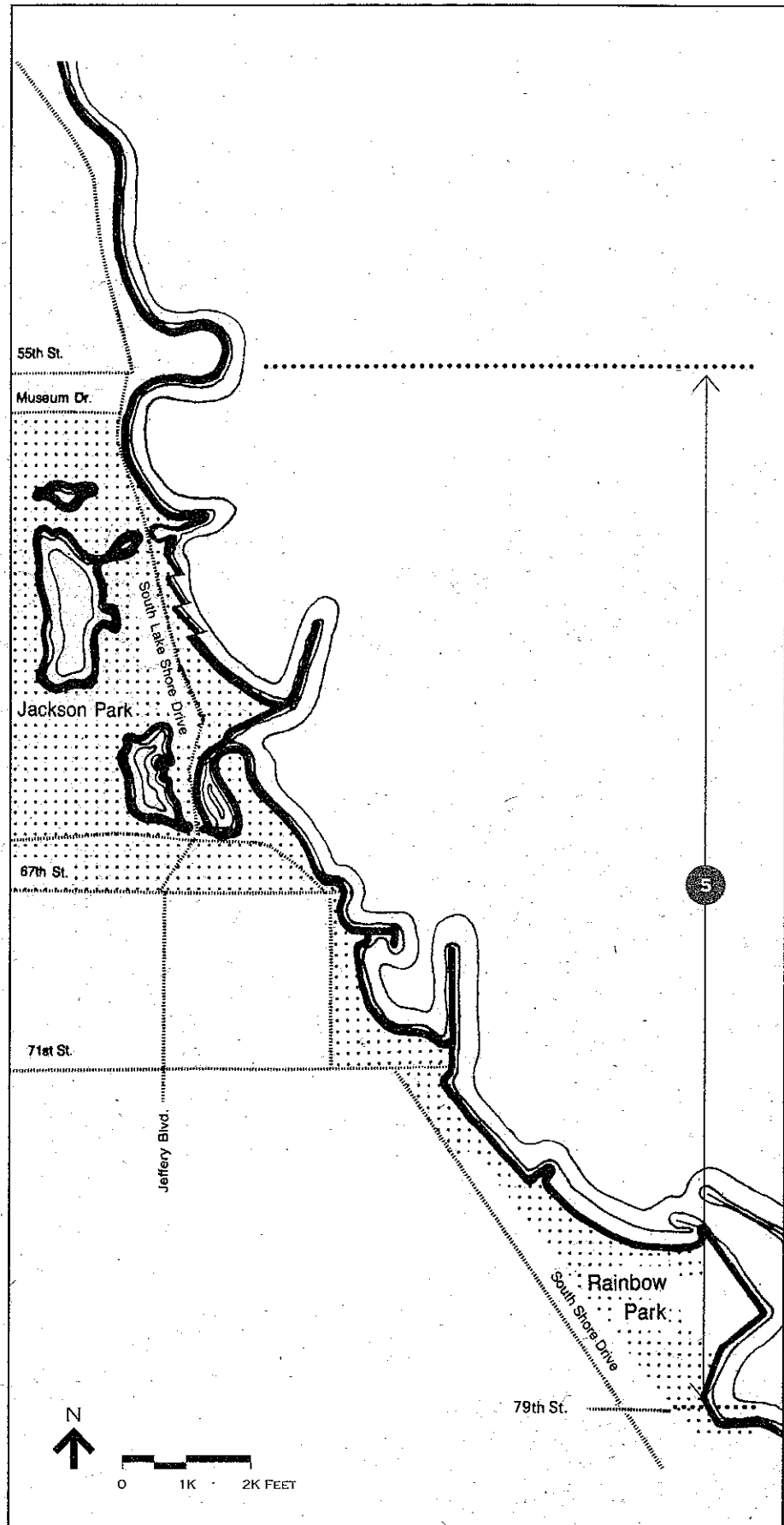
Estimated Failure Date: 2003

Construction Start Date: 1999

Recommended Plans:

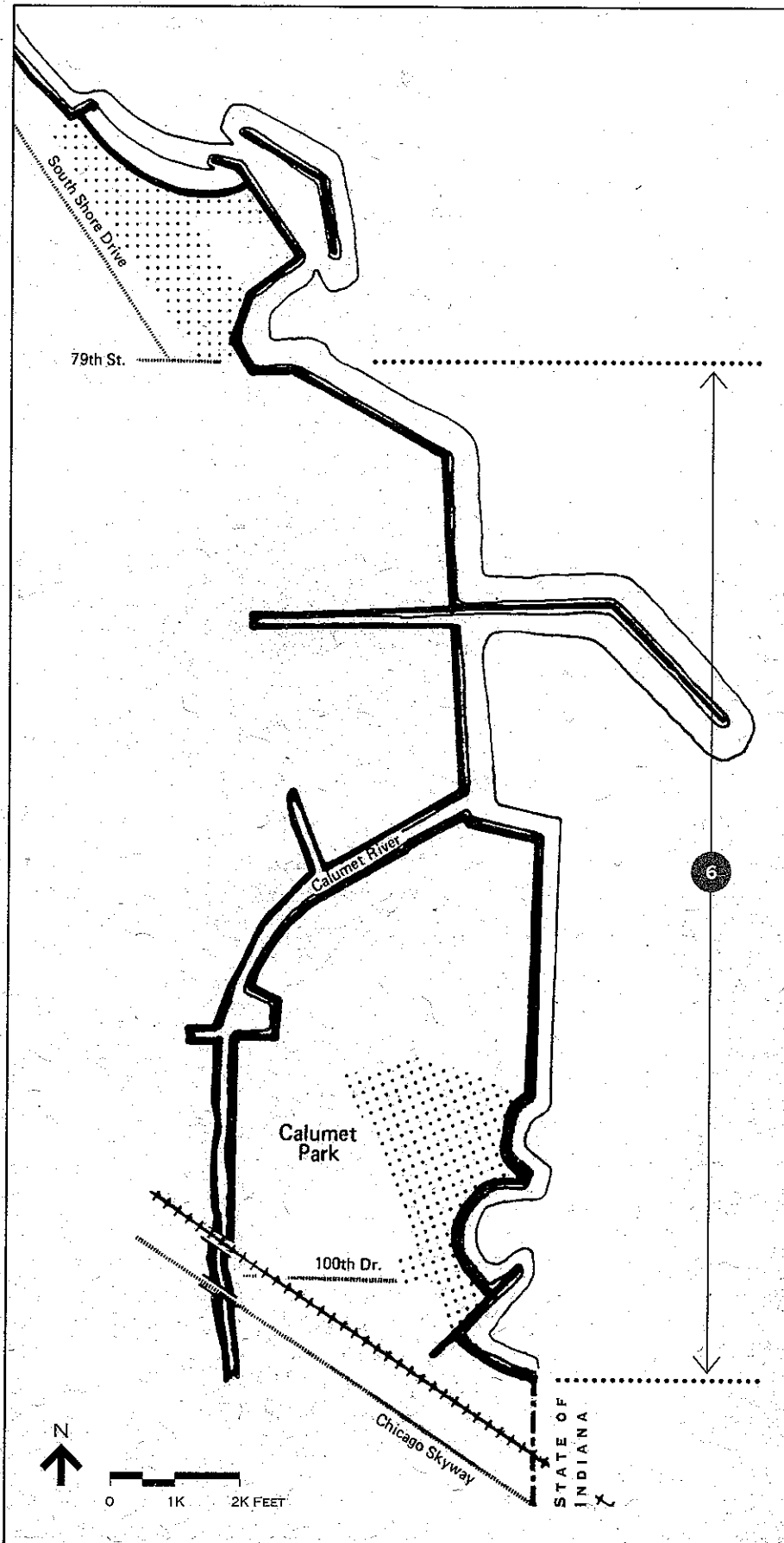
Reconstruct step stone revetment along north 900 feet of the reach.

Reconstruct failed breakwater protecting South Water Purification Plant.



REACH 6

The ACOE has determined Reach 6 is not qualified for assistance under this study at this time.



IMPLEMENTATION

WHEN AUTHORIZED by the U.S. Congress, this project will be constructed under the direction of the ACOE. In advance of construction, detailed engineering and design specifications will be prepared. Cooperating agencies will review and approve all plans and specifications prior to construction. At this time, cooperating agencies will request the ACOE consider local design alternatives which provide equivalent erosion and flood protection as well as additional recreational and aesthetic enhancements. Under the current cost sharing formula all costs associated with improvements above the level of the NED plan could be the financial responsibility of the cooperating agencies.

Areas most at risk are targeted for the earliest reconstruction. Estimated construction dates are as follows:

CONSTRUCTION SCHEDULE

REACH	PLAN FEATURE	START DATE	COMPLETION DATE
2N Lincoln Park	Step Stone	March 2005	Nov 2008
2S Oak Street Beach	Flood Protection	March 1996	Nov 1998
2S Fullerton	Flood Protection	March 2002	Nov 2003
3 Solidarity Dr.	Step Stone	March 1997	Nov 1998
3 Meigs Field	Rubble Mound	March 2002	Nov 2003
4 27th St. to 55th St	Step Stone	March 1999	Nov 2003
5 55th St. to 76th St	Step Stone	March 1999	Nov 2003
5 S. Water Purification Plant	Breakwater	March 1996	Nov 1998

TABLE 3

The step stone plan is the ACOE recommended plan for storm damage reduction and recreation and is the plan preferred by cooperating agencies. Total estimated construction cost is \$187,418,800. The federal government will pay 65% of the cost to build the rubble mound or NED plan. Cooperating agencies pay 35% of costs to build the NED plan plus 100% of all extra costs associated with building the recommended plan. A cost breakdown is shown in Table 4.

ESTIMATED COST SHARE (\$THOUSANDS)

REACH	PLAN FEATURE	RECOM- MENDED STEP STONE PLAN	FEDERAL COSTS (65% of Least Cost NED Rubble Mound plan)	LOCAL COSTS (35% of Least Cost NED Rubble Mound plan)	Plus EXTRA COSTS Associated with Step Stone Plan	TOTAL LOCAL COSTS
2N Lincoln Park	Step Stone	\$71,821.5	\$40,967.3	\$22,059.3	\$ 8,794.9	\$ 30,854.2
2S Oak Street Beach	Flood Protect.	833.5	541.8	291.7	—	291.7
2S Fullerton	Flood Protect.	1,456.3	946.6	509.7	—	509.7
3 Solidarity Dr.	Step Stone	4,097.4	2,663.3	1,434.1	—	1,434.1
3 Meigs Field	Rubble Mound	2,016.5	1,310.7	705.8	—	705.8
4 27th St. to 55th St	Step Stone	95,439.0	47,220.5	25,426.4	22,792.1	48,218.5
5 55th St. to 76th St	Step Stone	4,066.2	2,053.9	1,106.0	906.3	2,012.3
5 S. W. Purification Plt.	Breakwater	7,688.4	4,997.5	2,690.9	—	2,690.9
Total		\$187,418.8	\$100,701.6	\$54,223.9	\$32,493.3	\$ 86,717.2

TABLE 4

Estimated annual federal and local costs are shown below. Costs are budgeted on an annual basis and correlate to projected construction dates (see Table 3).

PROJECTED PAYMENT SCHEDULE (\$THOUSANDS)

FUND SOURCE	1996	1997	1998	1999	2000	2001
Federal Share	\$1,847	\$3,834	\$3,834	\$9,855	\$9,855	\$9,855
Local Share	663	2,064	2,064	10,047	10,047	10,047
Total	\$2,500	\$5,998	\$5,998	\$19,902	\$19,902	\$19,902

FUND SOURCE	2002	2003	2005	2006	2007	2008
Federal Share	\$10,328	\$10,328	\$10,242	\$10,242	\$10,242	\$10,242
Local Share	10,702	10,702	7,713	7,713	7,713	7,713
Total	\$21,030	\$21,030	\$17,955	\$17,955	\$17,955	\$17,955

TABLE 5

MAJOR RECONSTRUCTION of collapsing structures is needed to preserve the integrity of Chicago's shoreline. This project is designed to prevent further storm damage and loss of valuable land, infrastructure and facilities. The recommended step stone plan will also maintain safe access to the shoreline while preserving its historical and aesthetic value.

If no action is taken, land and facility loss will be rapid and severe; including loss of critical features such as sections of Lake Shore Drive and the South Water Purification Plant. Economic impacts could be immense including the loss of 8,538 jobs, nearly \$3 million in annual revenue and sales, and more than \$5 billion dollars in assets.

After substantial analysis the ACOE has determined that there is a federal interest in assisting in restoration of those sections of Chicago's shoreline that are in the most imminent danger of collapse.

This federal study and recommendation for federal participation provides an opportunity for local action. Without federal financial assistance, local resources are insufficient to provide badly needed protection. Although this reconstruction project is not a long term strategic plan for Chicago's shoreline, it is a means to restore what has been lost and forestall ongoing destruction.

GLOSSARY

BREAKWATER: a structure, usually detached from the shoreline, protecting a shore area, harbor, anchorage or basin from waves.

EROSION: the wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, littoral currents or wind.

GROIN: a structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore. Groins on the western shoreline of Lake Michigan are usually placed south of beaches to retain sand drifting from the north.

JETTY: on an open coast, a structure extending into a body of water, and designed to prevent build-up of littoral materials in a channel. Jetties are built at the mouth of harbors or other navigable waterways.

LITTORAL DRIFT: the movement of sediments, caused by wave action, along the coastline. On the western shoreline of Lake Michigan, littoral drift carries sediments from the north to the south

PERCHED BEACH: a sand beach retained above the otherwise normal profile level by an off-shore submerged dike or bulkhead. Perched beaches are constructed where a beach is desired but the water depth is too deep and profile too steep to fill with sand. Examples are the beaches south of Fullerton Avenue.

REBUILD: either dismantle the existing structure and recreate or, if infeasible or impractical, reconstruct at a point further out into the lake (15' to 20' out).

REPAIR: selective removal of pieces of a structure and replacement or partial reconstruction.

REVEMENT: any hardened shoreline to protect softer land behind it. Revetments may be constructed of steel sheet piling, stone, concrete, wood or a combination of these.

RUBBLE: rough irregular fragments of broken rock.

SHEETPILE: interlocking steel piles driven vertically through the sand and into harder clay lake bottom.

STEP-STONE: large stone or concrete blocks placed or stacked along the shoreline. Provides convenient pedestrian access.

SUBMERGED BULKHEAD: an underwater structure designed to retain sand or landfill to the shore side. The lake bottom on the lake side is deeper. Submerged bulkheads are used to create plateaus or perched beaches.

