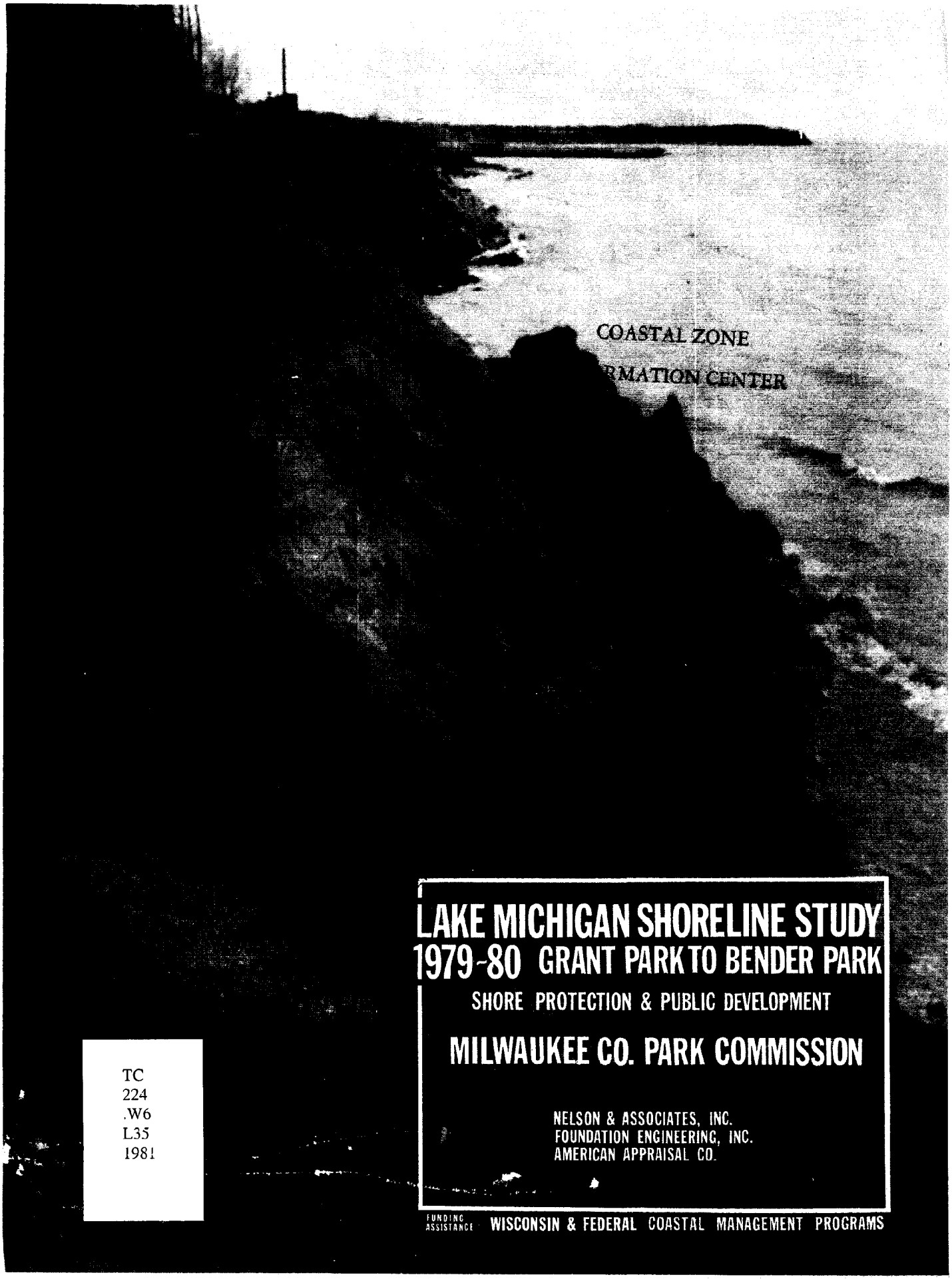

COASTAL ZONE
RMATION CENTER

LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK

SHORE PROTECTION & PUBLIC DEVELOPMENT

MILWAUKEE CO. PARK COMMISSION

NELSON & ASSOCIATES, INC.
FOUNDATION ENGINEERING, INC.
AMERICAN APPRAISAL CO.

FUNDING ASSISTANCE WISCONSIN & FEDERAL COASTAL MANAGEMENT PROGRAMS

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LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK

SHORE PROTECTION & PUBLIC DEVELOPMENT

MILWAUKEE CO. PARK COMMISSION

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FOUNDATION ENGINEERING, INC.

Feasibility Reports No. 1, No. 2, No. 3

AMERICAN APPRAISAL CO.

Report on Riparian Rights

SUMMARY

1. STUDY AREA: A total of 3.5 miles of shoreline along Lake Michigan, extending from the mouth of the Oak Creek in the City of South Milwaukee, to the Oakwood Road in the City of Oak Creek. Some attention has also been given to the half mile south of Oakwood Road to Elm Road, and the Grant Park Shoreline north of the Oak Creek.

2. EXISTING OWNERSHIP: Of the 3.5 miles of shoreline, about 45% is presently in private ownership, and 55% in public. If the half mile between Oakwood and Elm Roads, now owned by WEP Co., becomes public shoreline as proposed, the ratio could become 53% public and 47% private.

3. BLUFF CHARACTER: 50 to 120 feet high above Lake Michigan, 70 to 80 feet in most places. Soils are mostly clays, but layers of sand combined with ground water provide an unstable "layer cake effect". The bluff angle is 44 to 55 degrees of slope.

4. EXTENT AND RATES OF SHORELINE EROSION: Erosion is extensive and present throughout the study area, except at the South Shore Sewage Treatment Plant at Puetz Road, where the shoreline has been stabilized. Virtually no plant growth remains on the bluff face. Erosion has been measured since 1836, and over this 144 year period, the least amount of loss is 87 feet of bluff at Grange Avenue, and the greatest losses are at Ryan and Oakwood Roads, exceeding 370 feet. Thus average loss ranges from 0.5 to 2.6 feet a year. The erosion rate at the Ryan Road the last 15 years has been 5 feet per year.

5. CAUSES OF BLUFF EROSION:

A. Undercutting by wave action of Lake Michigan at the base of the bluff.
B. Groundwater seepage through the bluff from the top, interacting with the unstable soil layers.

Both causes of erosion must be addressed in any shoreline stabilization program.

6. METHODS OF SHORELINE STABILIZATION:

i Slope Grading (to around 20 to 25 degrees) not recommended here because the bluff is higher than 40 feet and because of cost, great loss of top bluff area. Might be suitable in Grant Park if recreational use made of slope.
ii Rubble and Rock Fill recommended, using "once in a lifetime" rock being generated by Metropolitan Milwaukee Sewerage District.
iii Seawalls not recommended here because hillsides have internal seepage layers and would erode above seawall height. Seawall costs are too high.

7. RECREATION/STABILIZATION PLANS:

Scheme A - Minimum Land Fill. Four mile long bike and foot trail in a stabilized bluff and beach zone the entire length, new marina at Bender Park, enlarged marina at South Milwaukee. Assumes all private riparian rights obtainable. Requires 5.5 million cubic yards of fill.

Scheme B - Maximum Land Fill. Same recreational features as A, but more diversity with sheltered lagoons, shoreline extended out 800 - 1000 feet. Assumes all private riparian rights obtainable. Requires 14 million cubic yards of fill, which exceeds MMSD potential unless MMSD returns to earlier plan of large deep tunnels.

Scheme C - Beach and Bluff Stabilization of Public Lands. Assumes private lands or riparian rights not obtainable in useful segments. Stabilizes 4 miles of beach with offshore protection creating many sheltered lagoons, same recreational features as A and B. Stabilizes bluff on public lands, with option to stabilize private bluffs later as public acquisition is agreed. Requires 8 million cubic yards of fill.

8. COSTS: (Placement only, no land purchase, assume free fill)

Scheme A	$33 Million
Scheme B	$72 Million
Scheme C	$48 Million

These costs are assumed to be prohibitive as a park project. Only with MMSD taking on the project as part of its fill disposal program, which it must do one way or another anyway, can the costs be affordable.

9. IMPLEMENTATION: Outside of County government main approval for the plan must come from the US Army Corps of Engineers, who will also involve the US Environmental Protection Agency. The two local municipalities -- City of South Milwaukee and City of Oak Creek -- should also be contacted.

The Corps may need an environmental assessment or statement to reach a decision. That could be most effectively provided by having the MMSD include these project proposals in its comprehensive EIS process already underway.

EXISTING SHORELINE CONDITIONS

STUDY AREA

On the following two pages are a pair of maps which show the enitre study area. Involved are 3.5 miles of Lake Michigan shoreline, from the mouth of the Oak Creek at the southern end of Grant Park in South Milwaukee south to the Oakwood Road.

The northern 1.0 mile is in the City of South Milwaukee, and the southern 2.5 miles is in the City of Oak Creek.

Another 0.5 miles, from Oakwood Road South to Elm Road has for some purposes been included in this study because the shoreline, now owned by the Wisconsin Electric Power Company, is shown under City of Oak Creek plans to become available again for other private and public uses.

SHORELINE OWNERSHIP

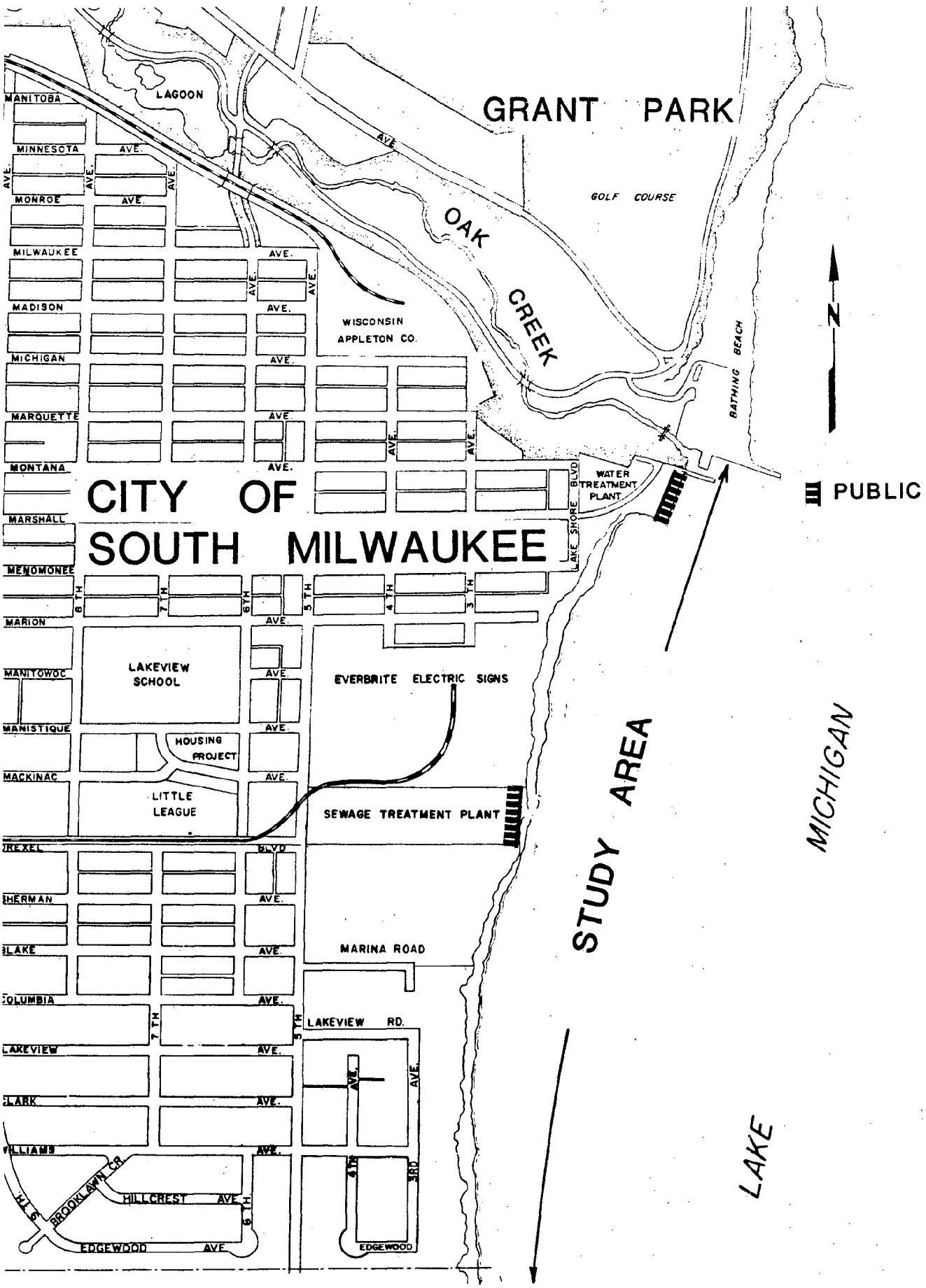
Shoreline ownership falls into two categories, the above water lands, and the submerged lands. Rights to the submerged lands, normally vested in the State, were ceded by the State of Wisconsin in 1935 to Milwaukee County for the first 2400 feet out from the shoreline in the study area giving the County rights to fill these lands above water level for recreational uses. The interaction between the County's right to fill, and the landward owner's riparian rights of access to Lake Michigan, are summarized in the Appendix report by American Appraisal Co.

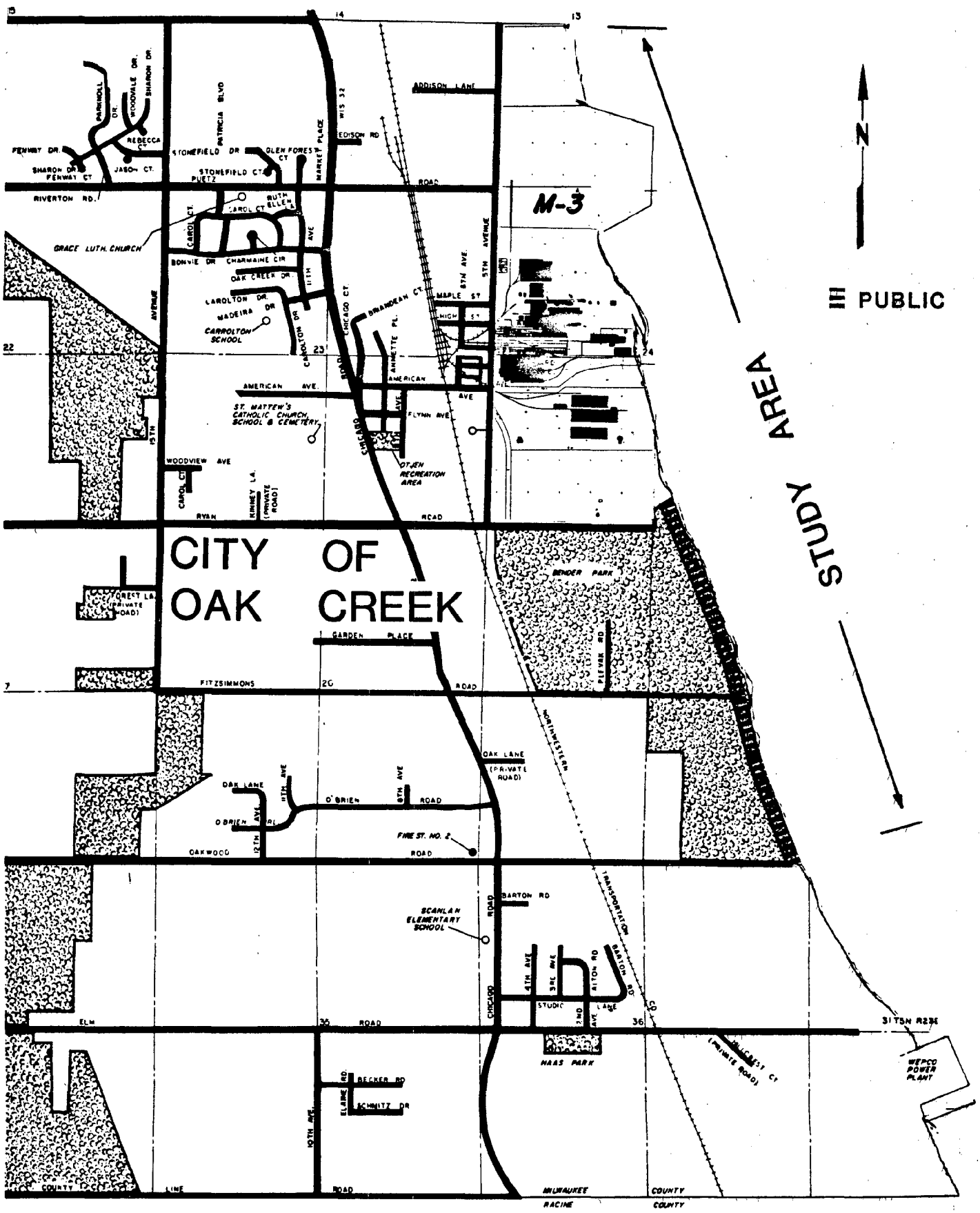
The following two maps show shoreline ownership only in terms of the landward zone giving the stretches of private and public ownership. These are summarized in the table below. More detail on these ownerships are available in the American Appraisal Co. report mentioned above.

STUDY AREA SHORELINE

Percent	Miles	Ownership
	City of South Milwaukee Shoreline	
3.7%	0.13	Public
24.9%	0.87	Private
28.6%	1.00	
	City of Oak Creek Shoreline	
50.0%	1.35	Public
21.4%	0.75	Private
61.4%	2.50	
100.0%	3.50	Total
53.7%	1.90	(Public)
46.3%	1.60	(Private)

Over the entire 3.5 mile shoreline, roughly 45% is private and 55% is public. If the additional half mile that may become surplus from the WEP Co. is included, the ratio could become either 53% public/47% private if that shoreline goes private, or 60% public/40% private if that shoreline goes public. The alternate shoreline plans presented later in this report, based upon concepts contained in City of Oak Creek plans, place the actual shoreline and landfill in public, and the balance of the upper bluff in private.


GRANT PARK
LAGOON
GOLF COURSE
OAK CREEK
WISCONSIN APPLETON CO.
BATHING BEACH
N
PUBLIC
WATER TREATMENT PLANT
LAKE SHORE BLVD.
CITY OF SOUTH MILWAUKEE
MANITOBA
MINNESOTA AVE.
MONROE AVE.
MILWAUKEE AVE.
MADISON AVE.
MICHIGAN AVE.
MARQUETTE AVE.
MONTANA AVE.
MARSHALL
MENOMONEE
MARION AVE.
MANITOWOC
MANISTIQUE
MACKINAC AVE.
LAKEVIEW SCHOOL
HOUSING PROJECT
LITTLE LEAGUE
EVERBRITE ELECTRIC SIGNS
SEWAGE TREATMENT PLANT
STUDY AREA
MICHIGAN
LAKE
DREXEL BLVD.
SHERMAN AVE.
BLAKE AVE.
MARINA ROAD
COLUMBIA AVE.
LAKEVIEW RD.
LAKEVIEW AVE.
CLARK AVE.
WILLIAMS AVE.
BROOKLAWN CR.
HILLCREST AVE.
EDGEWOOD AVE.
EDGEWOOD
8TH
7TH
6TH
5TH
4TH
3RD



CITY OF OAK CREEK
STUDY AREA
M-3
PUBLIC
N
ADDISON LANE
EDISON RD
WIS 32
MARKET PLACE
PATRICIA BLVD
STONEFIELD DR
GLEN FOREST CT
STONEFIELD CT
PUETZ
ROAD
RIVERTON RD.
FENWAY DR.
SHARON DR.
FENWAY CT
JASON CT.
REBECCA CT
PARKNOLL DR.
WOODVALE DR.
SHARON DR.
GRACE LUTH. CHURCH
CAROL CT.
RUTH ELLEN LA.
BONNIE DR
CHARMAINE CIR
OAK CREEK DR
CAROLTON DR.
MADEIRA DR
CARROLTON SCHOOL
CAROLTON DR
11TH AVE
CHICAGO CT
BRIANDEAN CT.
ANNETTE PL.
MAPLE ST
HIGH ST
6TH AVE.
5TH AVENUE
AMERICAN AVE.
AMERICAN AVE
ST. MATTEW'S CATHOLIC CHURCH, SCHOOL & CEMETERY
FLYNN AVE
OTJEN RECREATION AREA
WOODVIEW AVE
CAROL CT
KINNEY LA. (PRIVATE ROAD)
RYAN ROAD
15TH AVENUE
CHICAGO ROAD
BENDER PARK
FOREST LA. (PRIVATE ROAD)
GARDEN PLACE
FITZSIMMONS ROAD
PLEVAK RD
NORTHWESTERN TRANSPORTATION CO
OAK LANE (PRIVATE ROAD)
OAK LANE
11TH AVE
O'BRIEN ROAD
6TH AVE
O'BRIEN PL
12TH AVE
FIRE ST. NO. 2
OAKWOOD ROAD
BARTON RD
SCANLAN ELEMENTARY SCHOOL
4TH AVE
3RD AVE
AITON RD
BARTON RD
STUDIO LANE
2ND AVE
ELM ROAD
31 T5N R23E
HAAS PARK
HILLCREST CT (PRIVATE ROAD)
WEPCO POWER PLANT
BECKER RD
SCHMITZ DR
ELAINE RD
10TH AVE
COUNTY LINE ROAD
MILWAUKEE COUNTY
RACINE COUNTY

LAND USE

The accompanying fold out aerial photograph, taken in 1975 for the Southeastern Wisconsin Regional Planning Commission, shows the basic pattern of land use abutting the shoreline study area.

North of the Oak Creek in the City of South Milwaukee, the features of Grant Park are plainly visible in the upper 4 inches of the aerial map.

Immediately south of Oak Creek's junction with Lake Michigan, the facilities of the South Milwaukee Yacht Club appear, followed by a short stretch of vacant land, and then the Everbrite Sign Company. South of Everbrite is South Milwaukee's own sewage treatment plant, more vacant shoreline, and then the back yards of residences facing 3rd Avenue, south to the South Milwaukee - Oak Creek boundary, which would be Forest Hill extended.

Within Oak Creek, the first three fourths mile (about 2 inches on the aerial) is the Milwaukee Metropolitan Sewerage District's Puetz Road - South Shore Treatment Plant, with its prominent fill out into Lake Michigan. Industrial development on top of the bluff continues for the next half mile southerly and then a quarter mile of vacant private land to Ryan Road extended before reaching Bender Park.

Bender Park extends about one mile, from Ryan Road to Oakwood Road. As of 1975 when this aerial was taken, little actual park - type development had taken place within Bender Park, and that is still largely the case.

South of Oakwood Road, extending to the Wisconsin Electric Power Company's large coal-fired Oak Creek Power Plant at the end of the aerial, is a half mile of natural shoreline. On top the bluff is visible a substantial landfill operation by WEP Co. related to disposal of their fly ash.

BASIC TOPOGRAPHY

Later in this report is a series of three fold out maps on which topography is shown in 10 foot contour intervals. Examination of any one of these maps, prepared by the US Geological Survey, shows that most of the land for the first mile and a half inland of the shoreline is about 700 feet above mean sea level, ranging down to elevation 650 at the very top of the shoreline bluff.

The average elevation for Lake Michigan is 580 feet above sea level, so that the bluff throughout the study area averages in the vicinty of 70 feet high above beach level.

These contours also show that surface waters move toward Lake Michigan, but rather slowly in many places given the fairly level nature of much of the land. This movement of surface water, and the lack of extensive storm sewer development, gives maximum opportunity for saturation of subsoils.

BLUFF AND BEACH EROSION RECESSION RATES

Following the fold-out aerial photograph is a series of photographs taken of various sections of the study area shoreline in the fall of 1979. Photography and annotations have been done by John M. Murphy, geologist with Foundation Engineering, Inc.

These photographs show that throughout the study area the shoreline bluff and beach are suffering extensive and continual erosion. Only where the South Shore treatment plant has stabilized the shoreline has erosion ceased.

The extent and causes of this erosion are discussed in more detail in the Foundation Engineering Inc. reports later on, but briefly two causes are at work and should be kept in mind as the photographs are examined:

A. Undercutting of the bluff by Lake Michigan wave action.

B. Groundwater seeping through the top of the bluff, mixing with the "layer cake" of soil types present.

Erosion will continue unless <u>both</u> causes are addressed.

Measurements of the bluff have been kept since 1836, and over the 144 year period to 1980, the bluff has receded the least at Grange Avenue -- 87 feet, and the most at Ryan Road and Oakwood Road -- 370+ feet. The average is 0.5 a foot to 2.6 feet per year. At Ryan Road 74 feet have been lost in just the last 15 years, a rate of 5 feet per year. The photographs show that more erosion is imminent.

Looking West from 6300 S.

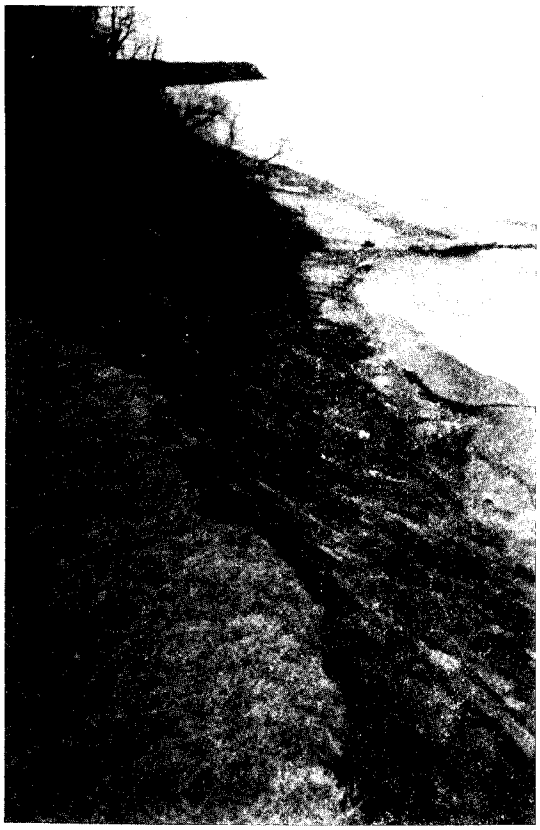
Little or no vegetation, sand layer eroding from middle of bluff (sign at top of bluff warning of cliff)

Looking West from 6350 S. seeing Cudahy Towers

Mud flow, massive erosion even with vegetation, stratification, and erosion of sand layer.

Looking West from 6625 S. (south of creek in Grant Park)

Vertical Bluff, no vegetation, erosion and undercutting of sod, sand layer eroding in bluff, and toe erosion by storm waves even with a beach

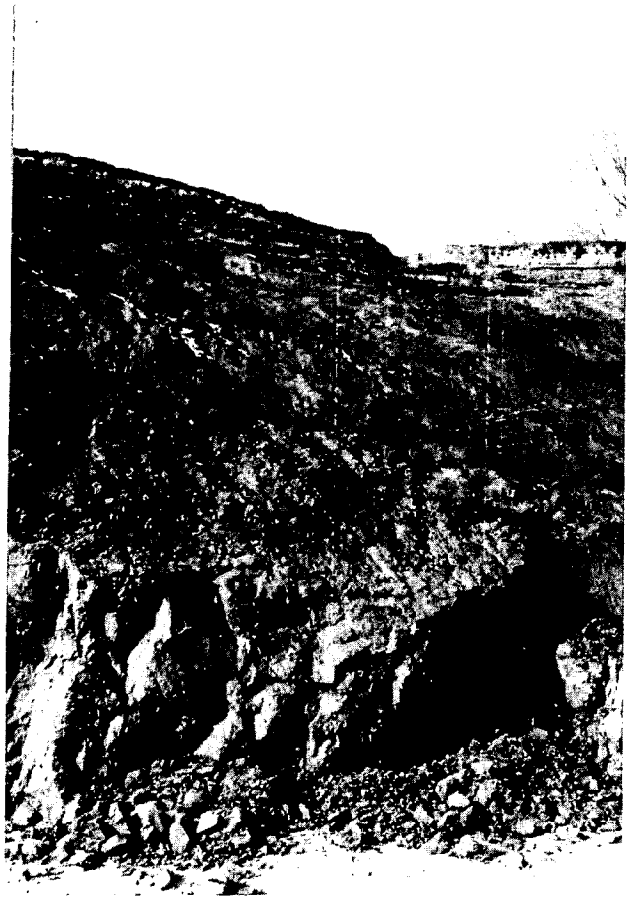


Looking North from 6700 S.

Massive erosion, mud flows, trees falling down the bluff

Looking Northwest from 6700 S.

Example of a more stable bluff



Looking West from 6700 S.

Little or no vegetation on slope, stratification of layers, and toe erosion by storm waves

Looking South from 6700 S.

Extreme erosion of bluff

Looking West from 6775 S.

Private attempt to halt erosion

Looking West from 7100 S.

Classic slumping even with vegetation, and toe erosion by storm waves

Looking West from 7450 S.
Seeing beach pavillion at Grant Park

More stable bluff

Looking South from 7650 S.

Looking West from 7890 S.

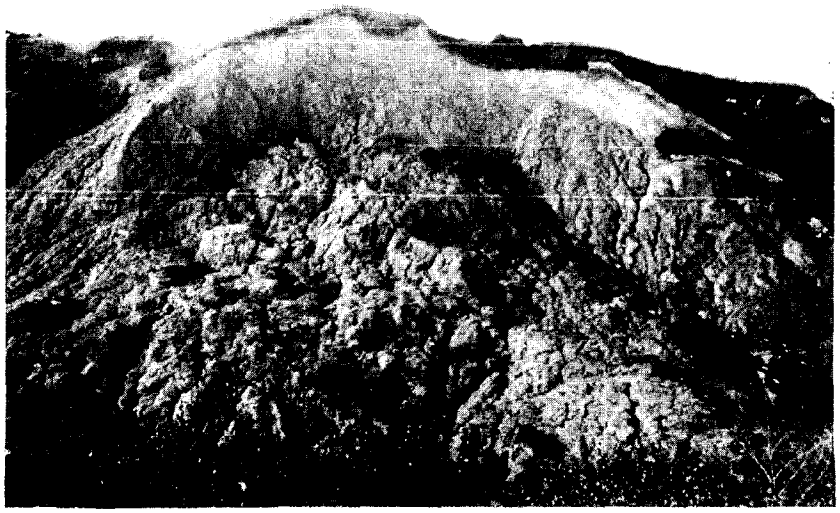
Water seepage out the face of the bluff, rill erosion increased below seepage

Looking South from 8050 S.
seeing Puetz Road Plant

Some beach build up north of plant

Looking West from 9050 S.

Crater-like erosion from slumping



Looking South from 9200 S. seeing Oak Creek Power Plant

Straight shoreline, no beach, steep slope, and no vegetation on bluff

Looking North from 9300 S.

Illustration on mass erosion

Looking down at the lake at 9400 S.

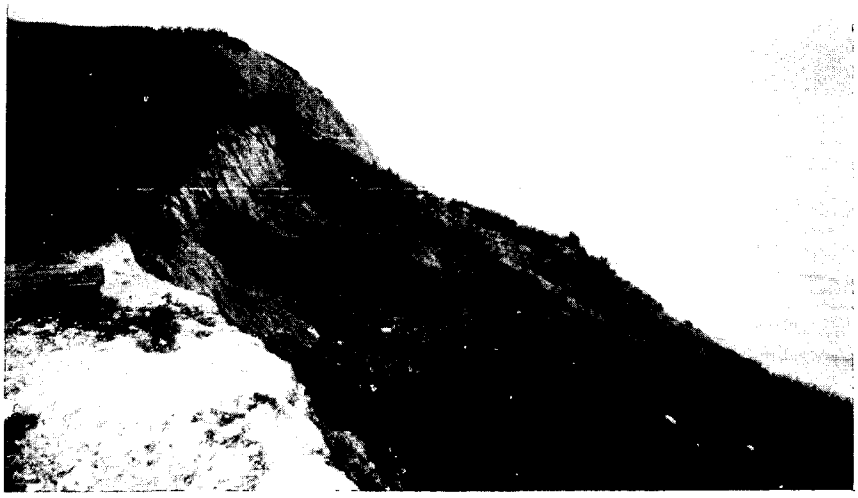
Vertical bluff, no beach, massive toe erosion, undercutting, and surface slumps

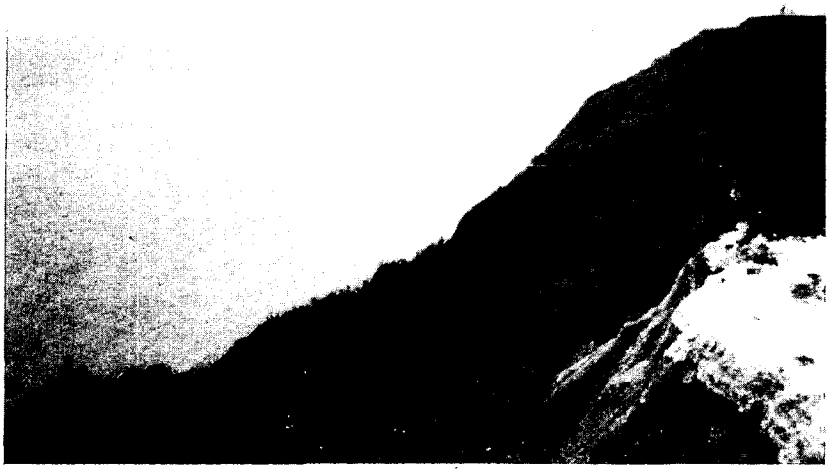
Looking North from 9400 S. seeing Puetz Rd. Plant

Stratification, surface slumping, undercutting at the top, and no beach

Looking North from 9900 S.

Good example of surface slumping at the upper portion of bluff, a more stable area on the right edge of the photo



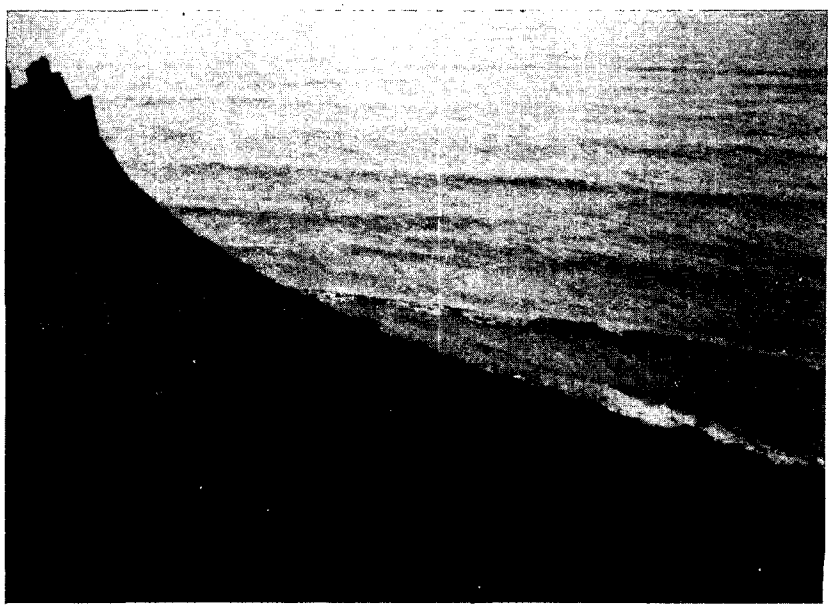


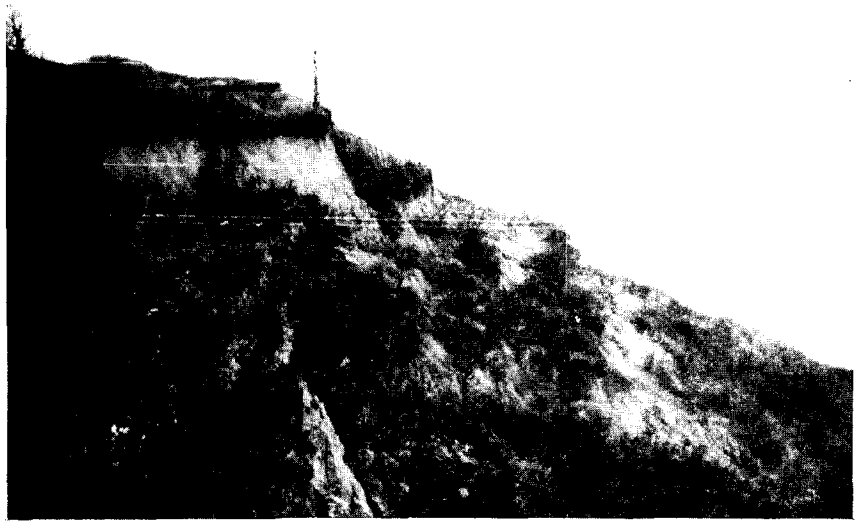
Looking South from 9900 S. seeing Oak Creek Power Plant

Erosion

Looking Northeast from 10000 S.

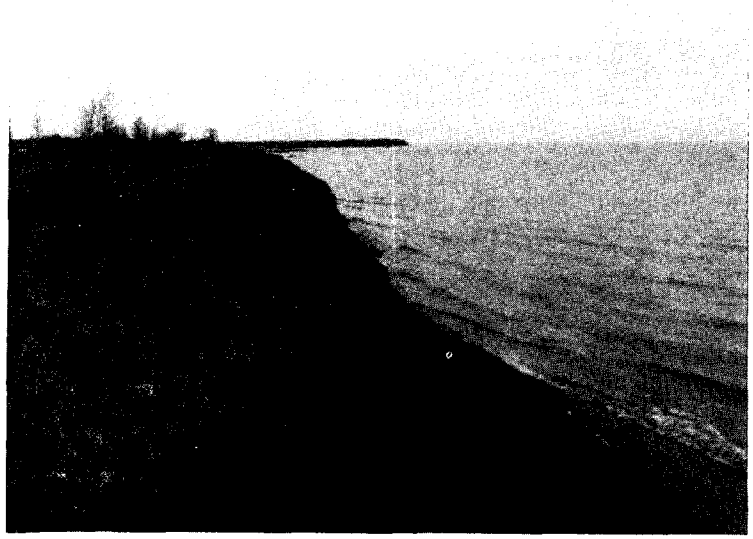
No beach, bad erosion





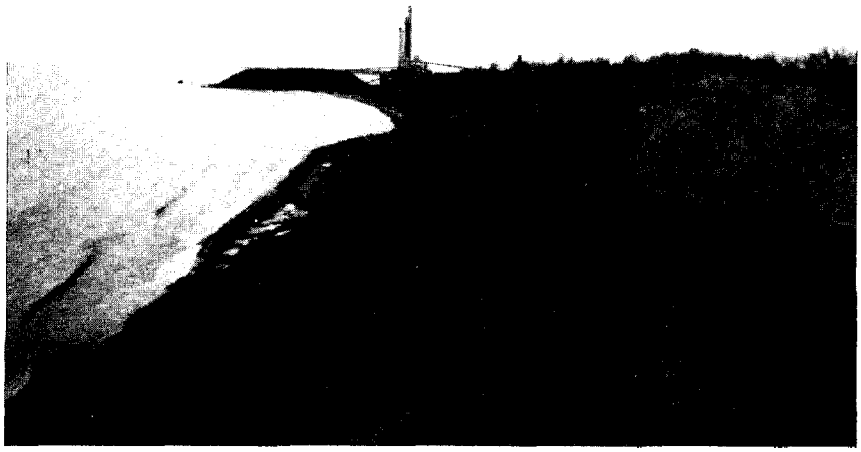
Looking North from 10050 S.

Classic example of the multiple slumping blocks



Looking North from 10200 S.

Decreasing beach and increasing erosion



Looking South from 10300 S. seeing Oak Creek Power Plant

Slumping, some beach build up just North of power plant

SHORELINE EROSION: CAUSES AND CURES

Foundation Engineering, Inc. in connection with this study has produced three reports that address the causes and potential solutions to beach and bluff erosion of the Lake Michigan shoreline within the 3.5 miles of study area shoreline. Since their firm also evaluated Grant Park, their reports cover 1.2 additional miles, or 4.7 miles of total shoreline.

Titled Feasibility Reports Nos. 1, 2 and 3 and issued between January and August 1980, they are reproduced in full in the Appendix of this report.

Feasibility Report No. 1 summarizes samplings of soil taken across the entire bluff face at six locations distributed over the entire study area. The bluff-face analysis shows that conditions between Carrolville and South Milwaukee (stations 11R to 8N) are fairly uniform, but that conditions on either side of this middle zone have substantial differences.

Table 1 at the end of Feasibility Report No. 1 summarizes the conditions at a glance. There are typically half a dozen soil layers that make up the bluff, but the existence of sand layers part way up the bluff reduces the number of significant soil layers to three. Groundwater seepage layers occur at all sites except Carrolville. The bluff face is usually at a slope of 44 to 55 degrees, erosion is recorded at each site, and in three of the six locations no beach or practically no beach remains. In Grant Park bluff vegetation is still present, at least 50% at the sampling site, but at all other sampling sites vegetation is virtually non-existant, reaching only 20% near Forest Hill Avenue.

The prognosis for continued erosion is bleak. Two of the sites are labeled "unstable for full height" of the bluff, and the balance have various degrees of instability.

Feasibility Report No. 2 provides a cross-check to the investigations of the first report, by sampling through test borings of the bluff. Four borings were made -- three in Grant Park and one in Bender Park. One of the three in Grant Park was started at beach level to provide data on the strata below lake level.

At two sites in Grant Park and one in Bender Park groundwater monitoring wells have been left in place for long term evaluation of groundwater fluctuations. Called piezometers, these monitoring wells have been taken over by Milwaukee County's department of public works, who will take the water level readings and maintain logs of the results.

Borings and piezometers at more frequent intervals along the shoreline should be installed as soon as budget permits.

The results of the test borings in Feasibility Report No. 2 confirm the simplified bluff face analysis performed in Report No. 1.

Also shown in Report No. 2 are the results of computer-performed Stability Analyses of the Bender Park bluff, done by geology Ph.D. candidate Robert Sterrett of the University of Wisconsin-Madison. These analyses combine the known conditions of groundwater levels (piezometric surfaces) soil layers, and bluff slope angle, to produce a prediction of whether the bluff face is in a stable or unstable condition.

The stability analyses are performed for various points along the bluff face so that zones of varying degrees of stability can be identified. In the cross section drawings at the end of Report No. 2, these zones are depicted as curves. Where the values read 1.00 or less, instability exists and further erosion will take place.

Mr. Sterrett's work predicts significant additional erosion in Bender Park. However this work also provides the quantitative basis for predicting how much of various types of corrective action need to be taken to achieve a ratio sufficiently above 1.00 to provide stability.

Feasibility Report No.3 takes the results of the bluff face and boring investigations and concludes that the bluffs are generally unstable, and that stabilization will require control of surface storm water infiltration to prevent shallow sliding, and construction of toe-loads to avoid major landslides. Three stabilization methods are outlined:

i Slope Grading
ii Rubble and Rock Fill
iii Seawall

Method (i) slope grading, has been used by MMSD at its South Shore Plant, with toe-loads supplied by the Lake Michigan fill behind sheet steel piling. However, extensive use of this method up and down the shoreline is not recommended because achieving the necessary 20 to 25 degree slope angle will involve moving enormous quantities of earth, and will sacrifice much topland.

Private land would especially find the loss of topland a major drawback. Generally where the bluffs are higher than 40 feet, the economics of slope grading do not prove feasible, and for this reason Foundation Engineering, Inc. in its reports does not pursue this alternative. However withing Grant Park and on the shoreline south of Oakwood Road slope grading might have feasibility if (1) the slope itself is to become a recreational feature such as a downhill ski run, and (2) if in addition to the cost of the grading, costs can be included for construction of the necessary armoring against wave action at beach level with concrete rubble and with 4 to 5 and 5 to 8 ton pieces of limestone rip-rap.

Method iii, the construction of seawalls with proper below grade foundations, has worked well for Milwaukee County Parks in Big Bay Park for over 35 years.

They are, however, extremely expensive. Also, where ground water seepage layers exist in the bluff above seawall height, as it would in this case, drainage facilities must be included to prevent slippage of the slope and ground water action on the landward side of the sea wall. These drainage facilities will require on-going maintenance.

Method ii, Rubble and Rock Fill, is the recommended course of action over most of the study shoreline because of these characteristics:

* Less existing topland has to be sacrificed
* The method is compatible with the kind of surplus material MMSD will be generating
* Construction can take place even where wet soils and surface water are present
* Toe-load fill can be transported by trucks, thus avoiding double handling of the material by earth moving equipment.

As discussed further in Report No. 3, "Rubble can be placed so as to control groundwater and eliminate surface sliding of the hillside soils. Terraces can be constructed, from beach level upward, to eliminate rotational slippage of hillsides, such as are present within the project limits."

Feasibility Report No. 3 concludes with cost estimates for this treatment of the subject area, under each of the three alternate recreation plans developed by Nelson & Associates, Inc.

The next section of this report presents these three recreation plans, and the final chapter presents the costs together with appraisal material related to riparian values within the study area.

RECREATION PLANS WITH SHORELINE STABILIZATION

The following fold-out maps present three alternate plans for the study area from the mouth of the Oak Creek south to the Oak Creek power plant.

All three plans presume the method of rubble and rock fill outlined as method ii in the Foundation Engineering, Inc. reports in the Appendix,and as discussed in the preceeding chapter. The plans vary in three ways -- the quantity of fill required, whether lands that are now private are to be bought and included or not, and the amount of environmental diversity between the plans.

All three plans are offered with the hope of close cooperation between the Parks Department, who would have final jurisdiction over the public lands, and the Milwaukee Metropolitan SewerageDistrict, which may be producing sufficient quantities of fill material in the next few years to make the plans feasible.

SCHEME A, Minimum Land Fill

This plan, by its very title, uses the least fill of the three plans -- 5.5 million cubic yards. As such it falls within the 5 to 8.6 million cubic yards of material the MMSD might be generating from underground tunneling in its expansion program.

Scheme A assumes acquisition of all riparian rights from private land owners in the study area, including the half mile from Oakwood Road to Elm Road, and would stabilize the entire area south of Grant Park.

Recreational uses would be confined to 100 to 200 feet of area at the base of the bluff except for the two nodes represented by the expanded South Milwaukee marina, and a new marina to be built at Bender Park. The feasibility and sizes for these two marinas has not been independently studied in this report, that having already been done by the US Army Corps of Engineers in its 1974 report "Lake Michigan Recreational Boating Survey and Analysis." Reference to "star moorings" in the marinas relates to the system being used on Chicago's lake-front to achieve higher denisty boat storage at less cost than an all fixed system.

Given the narrow corridor of recreation land that results under a minimum fill plan, the most prominent recreational use would be linear in nature -- bicycle and foot paths. The route through the Puetz Road sewage treatment plan is feasible, staff of the MMSD has reported.

The steep bluffs in the study area have restricted the number to 5 places that a lake-level path system could be connected to the top of the bluff. These five are:

1. South Milwaukee Yacht Club Area
2. E. American Avenue extended (City of Oak Creek water department road)
3. Ryan Road to Marina Drive
4. Oakwood Road to Marina Drive
5. Elm Road

SCHEME B-Maximum Land Fill

This plan requires 14 million cubic yards, or almost triple the amount of Scheme A. It exceeds by some 6 million cubic yards what the MMSD would have available, unless the MMSD were to return to the extensive deep tunnel storm overflow storage plan it once considered.

The plan has all the features and access points as Scheme A, but by filling out 800 to 1000 feet to match the South Shore Treatment Plant and the WEP Co. plant fills, opportunity is introduced for sheltered lagoons and larger play spaces.

Actually a plan was drafted that brought the shoreline uniformly out to the South Shore Treatment and power plant fills, but the quantities so exceeded what might be available, that the plan was dropped at an early stage. The concern was that the shoreline be returned to as uniform a beachline as possible, to minimize scouring and deposition action of the lake current that appears to take place when man-made intrusions are placed out from the shoreline.

Again, as with Scheme A, all shoreline from Grant Park to the Oak Creek power plant would be stabilized, requiring the acquisition of all private riparian rights.

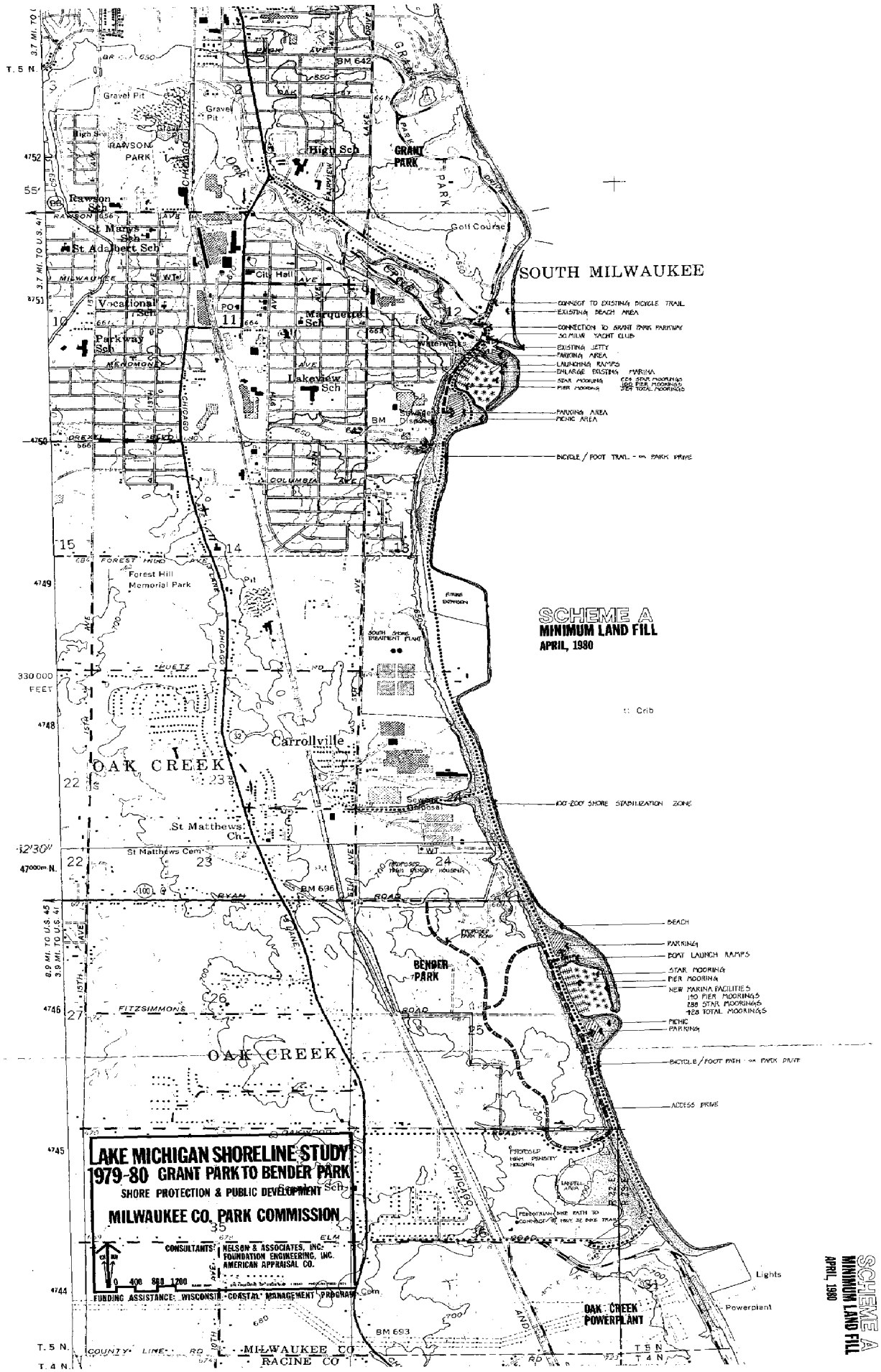
Also, as with Scheme A, the plan assumes the MMSD would be able to carry out its plan of expanding the South Shore Treatment site into Lake Michigan northerly of its present fill up to the South Milwaukee city limits. As of the writing of this report that fill plan has failed to receive the necessary approval from the Wisconsin Department of Natural Resources. Perhaps as the total opportunities for bluff stabilization, lakefront recreation, and the need for sewerage treatment space are explored with DNR all factors can be related and resolved to everyone's satisfaction.

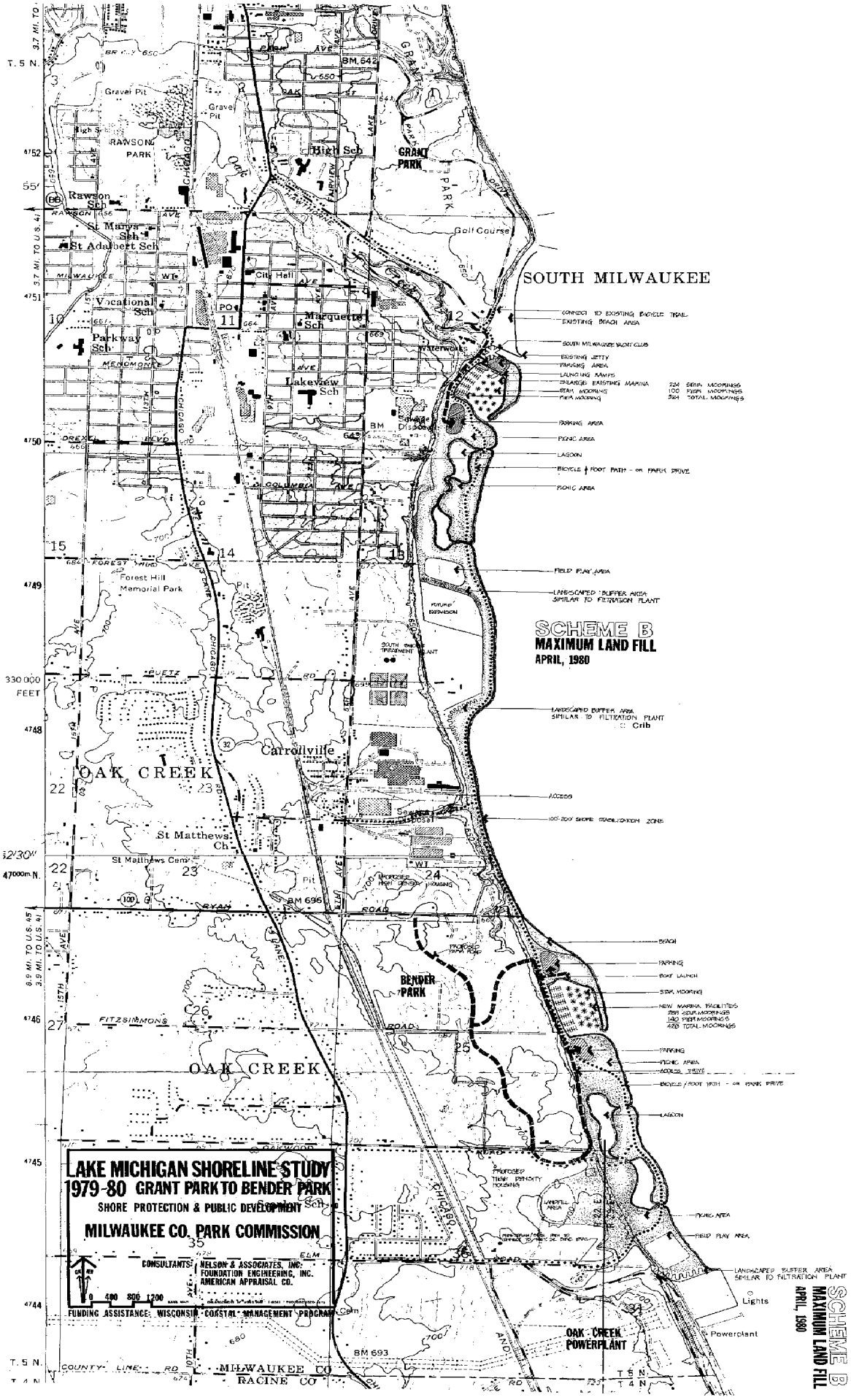
SCHEME C - Beach and Bluff Stabilization of Public Lands

Until actual negotiations are opened with private land owners in the study area, it is not known how many are actually in favor of selling their riparian rights, and possibly also full title to their shoreline lands. Since the Park Commission has no condemnation power unless endorsed by the local municipality, should some private owners refuse to sell, that may block public action in whole segments of the present private areas. As discussed by Foundation Engineering, Inc. in their reports in the Appendix, stabilization has to be done in meaningful chunks, otherwise the non-stabilized areas lead to undermining of the treated areas.

Scheme C has been prepared assuming that some, or even all, presently private lands would not be treatable by the public on terms suitable to the public. Only public shore lands would be stabilized under Scheme C. Therefore bluff stabilization of private lands would be left totally in the hands of present private owners.

Beach stabilization along stretches of private lands would be done by the public with off-shore fill. The fill would be placed beyond the extent of private riparian


SCHEME A
MINIMUM LAND FILL
APRIL, 1980
LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK
SHORE PROTECTION & PUBLIC DEVELOPMENT
MILWAUKEE CO. PARK COMMISSION
CONSULTANTS: NELSON & ASSOCIATES, INC.
FOUNDATION ENGINEERING, INC.
AMERICAN APPRAISAL CO.
FUNDING ASSISTANCE: WISCONSIN COASTAL MANAGEMENT PROGRAM
SOUTH MILWAUKEE
OAK CREEK
Carrollville
GRANT PARK
BENDER PARK
OAK CREEK POWERPLANT
Powerplant
Lights
Golf Course
Forest Hill Memorial Park
St Matthews Ch
St Matthews Cem
Rawson Park
Rawson Sch
St Marys Sch
St Adalbert Sch
Vocational Sch
Parkway Sch
Marquette Sch
Lakeview Sch
High Sch
City Hall
Gravel Pit
Crib
MILWAUKEE CO
RACINE CO
BEACH
PARKING
BOAT LAUNCH RAMPS
STAR MOORING
PIER MOORING
NEW MARINA FACILITIES
110 PIER MOORINGS
288 STAR MOORINGS
428 TOTAL MOORINGS
PICNIC
PARKING
BICYCLE/FOOT PATH - on PARK DRIVE
ACCESS DRIVE
100-200' SHORE STABILIZATION ZONE
CONNECTION TO EXISTING BICYCLE TRAIL
EXISTING BEACH AREA
CONNECTION TO GRANT PARK PARKWAY
SO MILW YACHT CLUB
EXISTING JETTY
PARKING AREA
LAUNCHING RAMPS
ENLARGE EXISTING MARINA
STAR MOORING
PIER MOORING
PARKING AREA
PICNIC AREA
BICYCLE / FOOT TRAIL - on PARK DRIVE
SCHEME A
MINIMUM LAND FILL
APRIL, 1980



SOUTH MILWAUKEE
GRANT PARK
BENDER PARK
OAK CREEK
OAK CREEK POWERPLANT
Carrollville
Forest Hill Memorial Park
Rawson Sch
St Marys Sch
St Adalbert Sch
Vocational Sch
Parkway Sch
Marquette Sch
Lakeview Sch
High Sch
City Hall
Golf Course
Gravel Pit
RAWSON PARK
Lights
Powerplant
MILWAUKEE CO
RACINE CO
T. 5 N.
T. 4 N.
330 000 FEET
47000m N.
SCHEME B
MAXIMUM LAND FILL
APRIL, 1980
LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK
SHORE PROTECTION & PUBLIC DEVELOPMENT
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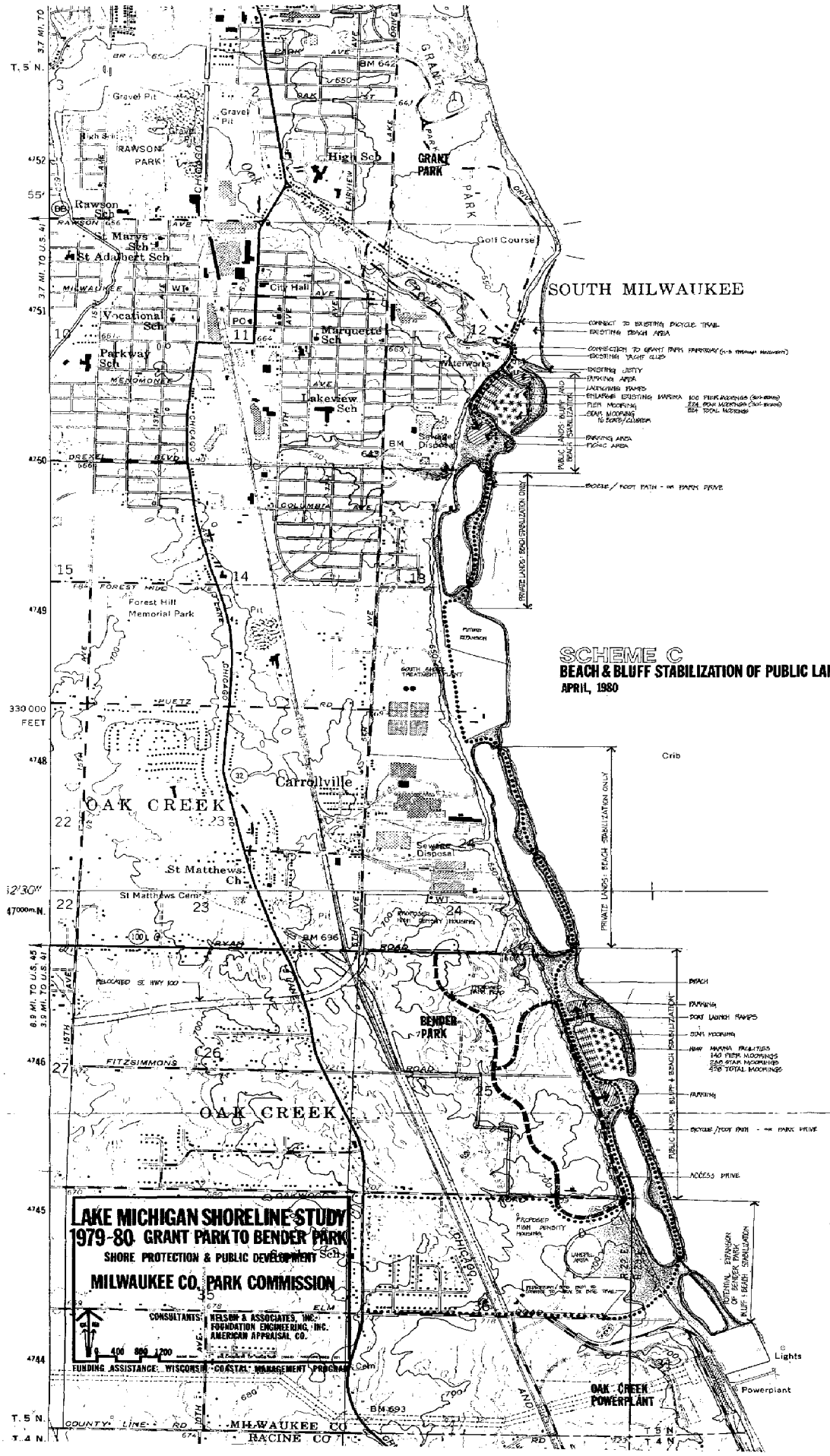


SCHEME C
BEACH & BLUFF STABILIZATION OF PUBLIC LANDS
APRIL, 1980

rights by utilizing part of the 2400 foot wide band of "submerged land rights" given by the State of Wisconsin to the County of Milwaukee under Chapter 194, the Law of 1935. The resulting lagoons, with access to the balance of Lake Michigan, would preserve private riparian rights of water access to the Lake.

As blocks of private owners later decided to sell their lands to the public, or to at least sell their riparian rights, bluff stabilization could proceed on the shore side of the lagoons, assuming fill and public funds are available at that time.

Thus Scheme C is intended to be flexible should the response of private landowners be quite variable.

The off-shore approach of Scheme C has another important basis -- it achieves the restoration of a fairly uniform lakeward shoreline from the point at Grant Park to the fill by WEPCo. on the Racine County Line.

Finally Scheme C has one of the desirable features of Scheme B -- environmental diversity in the shoreline treatment, with sheltered lagoons, and opportunities for some fish and waterfowl habitat improvement, etc.

The key access point at American Avenue is omitted since it cannot be reached without traversing private beachland. This omission leaves a stretch of shoreland of two miles between emergency vehicle access points, a drawback for Scheme C.

Scheme C will require about 8 million cubic yards of fill assuming no treatment of bluffs presently in private ownership other than the WEP Co. lands south of Oakwood Road which might become public if Oak Creek's city plans are realized.

Armor stone weighing at least 5 to 8 tons each would be the highest cost on this plan due to the need to shield both sides of the outer lagoon breakwater:

Scheme	Armor Stone, Lineal Feet
A	32,000
B	32,500
C	45,600

This report is limited to the above three schemes because of the budgetary restraints of this particular study. However it is possible to take parts of each scheme and combine them into further variations. These additional variations can be assembled and evaluated at such time as the MMSD is able to express its interest in undertaking such a program as the method for disposing of its fill, and as private landowners give expression to their interest in sale of their lands, or at least of their riparian rights, to the public.

Since the values of riparian rights are only rarely evaluated separately from the full value of a shoreline property, the Appendix of this report contains a

study by the American Appraisal Company's headquarters office in Milwaukee which pursues the concept of riparian values separate from all other values (such as the rest of the lot, the improvements thereon, mineral rights, air rights, etc.). The study concludes that nominal to $100 per foot of shoreline is the general range of riparian value alone, which can become the basis for negotiation with property owners in the study area. However, since the least expensive plan, Scheme A, costs some $1800 per foot as discussed in the next chapter, it is possible the net value of riparian rights, possibly even of full title rights, are negative, that is worth less than the cost to protect them from erosion.

IMPLEMENTATION AND COSTS

Achieving any one of the plans presented in the preceding chapter will be a complicated and costly undertaking.

Normally the cost alone, discussed below, would be discouraging for Milwaukee County. What makes the whole concept worth considering is the possible contribution by the Milwaukee Metropolitan Sewerage District of the rock and earth fill they will be generating anyway in the treatment expansion mandated upon them by the DNR, and by the federal court lawsuit brought by Illinois.

Participation by MMSD would thus be a double blessing on top of the basic water quality improvement the MMSD expansion program is to achieve:

*water quality improvement from lessened land erosion into Lake Michigan.

*improved shoreline esthetics, recreation, and environmental diversity.

Thus the initial step of implementation by the County Parks depends greatly upon the enthusiasm MMSD shows toward this kind of a use for its excess rock rubble and earth fill.

In addition to MMSD participation, the County Parks in pursuing approval of this plan will have to obtain a "404" permit from the US Army Corps of Engineers. The permit application to the Corps (for permission to fill in a navigable body of water) will automatically involve other related Federal agencies such as the Environmental Protection Agency, and the US Fish & Wildlife Services.

In the event that the Corps should later need an Environmental Impact assessment or statement of the project, the MMSD can be of great help by including this project in its EIS process already underway for its entire program.

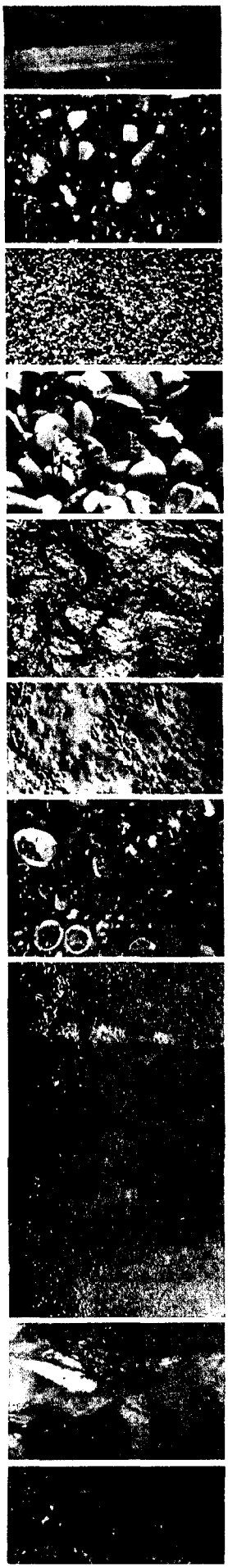
In addition to this Federal approval, consultation and possibly approvals will also be necessary with the two municipalities -- the City of South Milwaukee and the City of Oak Creek, plus of course negotiations with private owners.

For the remaining discussion of this chapter - costs - reference is made to Foundation Engineering Inc.'s Feasibility Report No.3 in the appendix. It must be stressed that this very cursory study has not generated enough geotechnical data for definitive cost estimates. As outlined on Page 13 of Report No.3, from a quarter to over a half million dollars of additional geotechnical studies have to be performed to adequately address all the design and construction issues.

Nevertheless, using a very broad-brush approach, and relying upon its experience in similar work, Foundation Engineering, Inc. has estimated costs of $33 million for Scheme A, $72 million for Scheme B, and $48 million for Scheme C. These costs do not include the marina facilities, though they do include the protective-landfills that form the marina area.

These costs assume free fill, but include all trucking costs, plus armor stone. To the extent that MMSD were to take over the responsibility for the project's construction, the accounting for these costs may change. Reductions may be possible through the transfer of the costs from the project, to the disposal function which MMSD or its contractors must achieve in any case.

APPENDIX



FOUNDATION ENGINEERING, INC

SOIL—ROCK CONSULTANTS

FEASIBILITY REPORT NO. 1

LAKE MICHIGAN SHORELINE STUDY 1979 - 1980

GRANT PARK TO BENDER PARK

COASTAL MANAGEMENT PROGRAM - CONTRACT 79102-8.2

PREPARED FOR

MILWAUKEE COUNTY PARKS COMMISSION

REPORT NO. FE7997

JANUARY 29, 1980

2116 WEST CORNELL STREET • MILWAUKEE, WISCONSIN 53209 • TELEPHONE 414-445-6672

FEASIBILITY REPORT NO. 1

LAKE MICHIGAN SHORELINE STUDY 1979 - 1980

GRANT PARK TO BENDER PARK

INTRODUCTION

The purpose of the investigative study by Foundation Engineering, Inc. is to ascertain the feasibility of using recycled rubble and rock materials for stabilization of the Lake Michigan shoreline between Grant Park and Bender Park. Our firm is undertaking three sequences of work. Sequence 1 is described in this report and includes bluff inspections, geological review, field soil sampling, preparation of geological profiles and laboratory soil classification tests.

Sequence 2 of the study will include four test borings for two bluff sites where major erosion is occurring. Piezometers will be installed at these sites to define groundwater levels and refined laboratory tests and stability calculations will be performed to ascertain the quantities and configurations of fill needed for stabilization.

Sequence 3 will include preparation of schematic drawings and cross-sections of the two sites which will show proposed fill design and construction proposals. Also, preliminary cost estimates will be developed in relation to available sources of rubble and rock in this study sequence.

SEQUENCE 1 STUDY

A. Sources of Information

The study area includes 4.7-miles of shoreline extending from the southern limit of Bender Park to the northern end of Grant Park. It is apparent that the geological conditions vary significantly along this distance, and therefore,

we have utilized as much test boring data as possible from previously existing sources as an aid to preparing the soils interpretations. We emphasise that more test borings are required, beyond those planned for Sequence 2, to fully evaluate stabilization treatment of the 4.7-miles of shoreline.

We have explored the following sources of geological information:

1. Foundation Engineering, Inc. - Job Files 1959 - 1979
2. University of Wisconsin, Milwaukee - Geol. Dept., Prof. N. Lasca
3. Milwaukee Expressway Commission - Files
4. Milwaukee City Engineer's Office
5. Milwaukee Metropolitan Sewerage District (M.M.S.D.)
6. U.S. Coast & Geodetic Survey - Files
7. Southeastern Wisconsin Regional Planning Commission (SEWRPC)
8. Wisconsin Coastal Zone Management Committee
9. Wisconsin Electric Power Company
10. City of Oak Creek - Engineering Dept.
11. City of South Milwaukee - Engineering Dept.
12. Marquette University - Dept. of Engineering, Prof. W. Murphy
13. University of Wisconsin, Milwaukee - Library
14. Milwaukee Central Public Library

Technical Publications

15. "Shoreline Erosion & Bluff Stability Along Lake Michigan & Lake Superior Shorelines of Wisconsin", Appendix 3, Appendix 8 Wisconsin Coastal Management Shore Erosion Study - February, 1977
16. "Stratagraphic & Engineering Study of the Lake Michigan Shore Zone Bluffs in Milwaukee County, Wisconsin" Master of Science Thesis by Robert H. Klauk - 1978

Only a few of these sources yielded pertinent test boring information. We were helped by the City of Oak Creek Engineer and the City of South Milwaukee Engineer, who supplied logs of test borings for their respective sewer and

water treatment plants. Also, we have purchased two sets of U.S. Geological Survey maps of the area to ascertain bluff elevations and cross-sections of field sampling sites and future drilling sites. We have also prepared cross-sections through the bluffs based upon the above-referenced technical publications

B. Bluff Inspection

Initial reconnaissance of the bluffs was made at lake level by traversing the study area from the north end. South of Ryan Road, hillside inspection was made from the top of the bluff due to the absence of beach or lower hill. Photographs were taken to identify severe shore erosion areas and general notations were recorded of seepage layers, slump blocks, general site conditions, and locations suitable for drilling or field sampling.

Field sampling sites were selected where the entire height of the bluff is accessible, as shown on Drawing FE7997-1. The sites are referenced 1A, 4F, 7L, 8N, 11R and 12V. Field sampling was performed at all prominent soil interfaces evident from top to bottom of the bluffs and each layer was given an alpha-numerical notation, as shown on Drawing FE7997-2. A summary of the important site statistics is given in Table 1.

Bag samples of each soil layer were returned to our laboratory for testing, which included natural water contents, liquid limits, plastic limits and sieve analyses. From these tests each soil was classified according to the Unified Soil Classification System. All soil data are reported on Drawing FE7997-1, and a simplified subsoil profile has been prepared on Drawing FE7997-2. The depth of each stratum in the profile has been determined by measuring the length of the stratum of the bluff (L) times the sine of the angle of the

stratum to the horizontal (Θ), i.e. Depth = L sine Θ.

The altitude of the bluff at each location has been estimated from the U.S. Geological Survey maps of the area. Correlations of the strata in the subsoil profile are based on the physical properties and color as determined by the soil classification tests. Correlation was also aided by technical publications 15 and 16, referred to in the previous section of the report.

C. Simplified Subsoil Profile

The subsoils in the study area consist of clay tills, glacial lacustrine clays and silts, glacial outwash sands and gravels, with intermittent layers and lenses of loess. Altitudes of the bluffs range from Elevation 650.0 at sampling site 1A to 630.0 at site 7L and rise to Elevation 700.0 at site 12V. Between sites 1A and 7L the subsoils are predominantly sands and silts which are probably glacial outwash. From site 7L south to 12V the soils consist predominantly of glacial till with lenses of loess and there are no significant layers of outwash sand and gravel. Topsoil cover to the shoreline study area ranges in thickness from 1-foot to 5-feet. No data are available at this time on the groundwater levels in the bluffs, but some guide is available from the seepage observations recorded in Table 1.

The simplified subsoil profile will be supplemented with future test boring information. Test borings will be drilled within Sequence 2 of our work in Grant Park and Bender Park. As part of this drilling program, piezometers will be installed and soil strength tests will be made.

FOUNDATION ENGINEERING, INC.

John M. Murphy
Geologist

William T. Painter, Ph.D., P.E.
President

LAKE MICHIGAN SHORELINE STUDY

1979-80 GRANT PARK TO BENDER PARK

SHORE PROTECTION & PUBLIC DEVELOPMENT

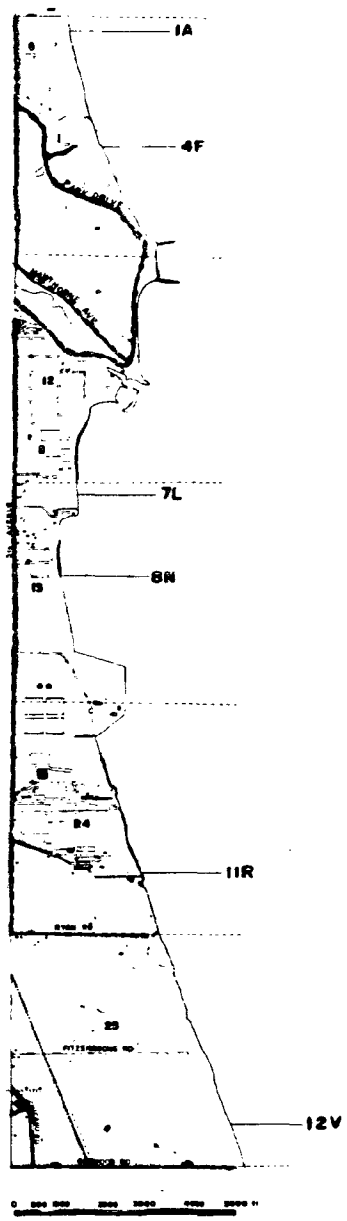
MILWAUKEE CO. PARK COMMISSION

SOIL DATA SUMMARY TABLE

SITE	LAYER	W_L	W_P	W_I	W%	SIEVE ANALYSIS GRAVEL	SAND	FINES	SAMPLE ID
12V	T1	—	—	—	—	—	—	—	—
12V	C2	27.2	14.7	12.5	15.5	—	—	—	12V1
12V	C3	27.1	14.3	12.8	15.2	—	—	—	12V2
12V	C4	26.8	13.1	13.7	14.8	—	—	—	12V3
12V	C4	25.6	13.7	11.0	15.4	—	—	—	12V4
12V	C4	31.0	15.1	15.9	19.8	—	—	—	12V5
12V	M5	—	—	—	16.1	0	42.4	57.6	12V6
12V	C4	25.0	12.5	12.5	11.1	—	—	—	12V7
12V	C4	31.3	15.3	16.0	18.9	—	—	—	12V8
12V	S6	—	—	—	—	0	99.2	.8	12V9
12V	C7	20.0	12.8	7.2	12.3	—	—	—	12V10
12V	C8	28.0	13.1	14.9	16.4	—	—	—	12V11
11R	T1	—	—	—	—	—	—	—	—
11R	C2	27.5	16.1	11.4	19.6	—	—	—	11R1
11R	C3	23.5	12.8	10.7	12.1	—	—	—	11R2
11R	C3	21.0	13.2	7.8	13.5	—	—	—	11R3
11R	C4	25.3	11.0	14.3	14.1	—	—	—	11R4
11R	C4	28.0	15.0	13.0	20.0	—	—	—	11R5
8N	T1	—	—	—	—	—	—	—	—
8N	M17	—	—	—	19.8	0	6.6	93.4	8N1
8N	C2	31.6	16.7	14.9	20.1	0	21.7	78.3	8N1A
8N	C4	30.2	13.9	16.6	19.2	—	—	—	8N2
7L	T1	—	—	—	—	—	—	—	—
7L	C9	29.9	16.3	13.6	6.2	—	—	—	7L1
7L	S10	—	—	—	—	41.6	58.4	0	7L2
7L	CM11	18.3	11.4	6.9	11.9	—	—	—	7L3
7L	C4	24.1	13.1	11.0	9.9	—	—	—	7L4
4F	T1	—	—	—	—	—	—	—	—
4F	S10	—	—	—	—	0	81.1	18.9	4F1
4F	S10	—	—	—	—	10.8	88.0	1.2	4F2
4F	C12	36.8	17.2	19.6	22.6	—	—	—	4F3
4F	M13	—	—	—	21.1	0	29.9	70.1	4F4
4F	S14	23.0	12.2	10.8	19.1	2.8	95.1	2.1	4F5
4F	C4	35.5	17.8	17.7	18.8	—	—	—	4F6
1A	S10	—	—	—	6.1	15.1	84.5	0	1A1
1A	CM15	22.7	15.8	6.9	21.7	—	—	—	1A2
1A	S16	—	—	—	13.7	0	81.1	18.9	1A3
1A	S14	22.8	13.9	8.9	—	0	98.8	1.2	1A4
1A	C4	22.1	15.9	6.2	20.4	0	—	—	1A5
1A	S18	22.2	19.5	2.7	20.4	0	54.8	45.2	1A6

LEGEND

W_L - PER CENT LIQUID LIMIT
W_P - PER CENT PLASTIC LIMIT
W_I - PER CENT PLASTIC INDEX
W% - PER CENT NATURAL WATER CONTENT
SEE DRAWING FE 7997-2 FOR LOCATION OF THE SOIL LAYERS IN THE SHORELINE BLUFFS



NOTE:
SAMPLES WERE RECOVERED BY HAND-SAMPLING METHODS FROM SHORELINE BLUFFS WHERE ACCESS PERMITTED. ALL SOIL TEST WERE PERFORMED AT FOUNDATION ENGINEERING INC. LABORATORY ON DISTURBED SAMPLES.

THIS IS FIGURE 1 OF TWO FIGURES

LOCATIONS OF SAMPLING SITES AND SUMMARY OF SOIL CLASSIFICATION MILWAUKEE SOUTH SHORELINE

FOUNDATION ENGINEERING INC.
2116 W. CORNELL STREET
MILWAUKEE, WISCONSIN 53209

SCALE: 1" 1000' | DRAWN BY: J MURPHY | CHECKED BY: | DRAWING: FE 7997-1

TABLE 1. SAMPLING SITE STATISTICS

SAMPLING SITE (See Drawing FE7997-1)	1A	4F	7L	8N	11R	12V
Elevation at top of bluff	650.0	640.0	630.0	660.0	660.0	700.0
Number of soil layers visible	6	7	6	6	7	11
Seepage layer(s) (See Drawing FE7997-2)	S14	M13 S14	CM11	M17	None	M5 S6
Elevation of seepage(s)	628.0	619.5 605.0	610.0	652.0 620.0	-	658.0 640.0
Approximate average hillside slope	52°	43°	55°	47°	44°	70°
Slope condition	lower 50-ft slumped	rapid sheet erosion	slow sheet erosion	mud-flows slumps	slumped faulted	rapid erosion sheet flow slump
Wave erosion	some storm waves	all storm waves	all storm waves	all waves	all waves	storm waves
Beach width	40-ft.	20-ft.	10-ft.	5-ft.	0	20-ft.
Vegetation	50% grass trees	none	20% grass	5% grass	none	5% grass
Notes	some instability	running sand layers	some instability	concrete rubble at base	unstable for full height	unstable for full height

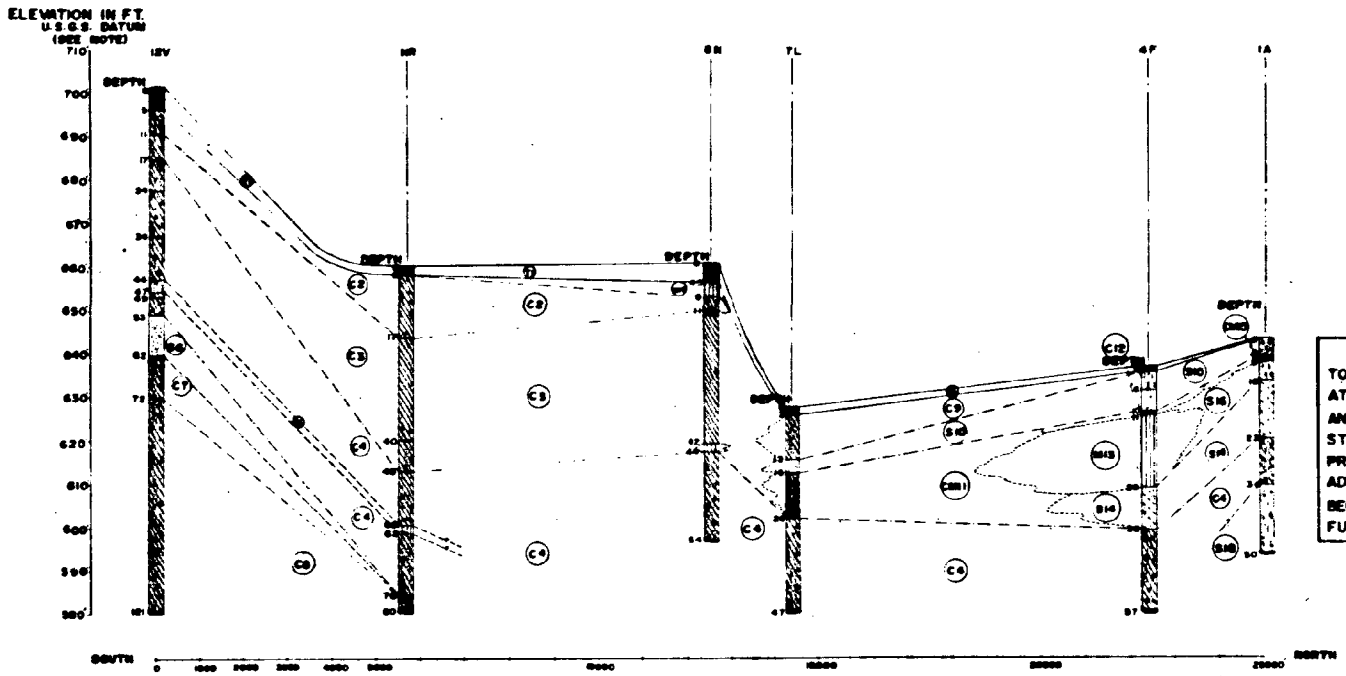
LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK

SHORE PROTECTION & PUBLIC DEVELOPMENT

MILWAUKEE CO. PARK COMMISSION

NOTE:
DATUM IS MEAN SEA LEVEL ACCORDING TO THE U.S.G.S. QUADRANGLE MAPS OF S. MILWAUKEE & RACINE-NORTH. ALL SOIL CLASSIFICATIONS ARE IN ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM.

NOTE:
THIS IS A PRELIMINARY SIMPLIFIED SUBSOIL PROFILE FOR APPROXIMATELY 4.7 MILES OF LAKE MICHIGAN SHORELINE AND AS SUCH SHOULD NOT BE USED FOR DESIGN OR GENERAL ENGINEERING PURPOSES. HAND-SAMPLING SITES INCLUDED IN THIS PROFILE RANGE FROM 2650 FEET TO 6000 FEET APART. PREVIOUS GEOLOGICAL SURVEYS HAVE BEEN AN AID TO PROFILE PREPARATION.



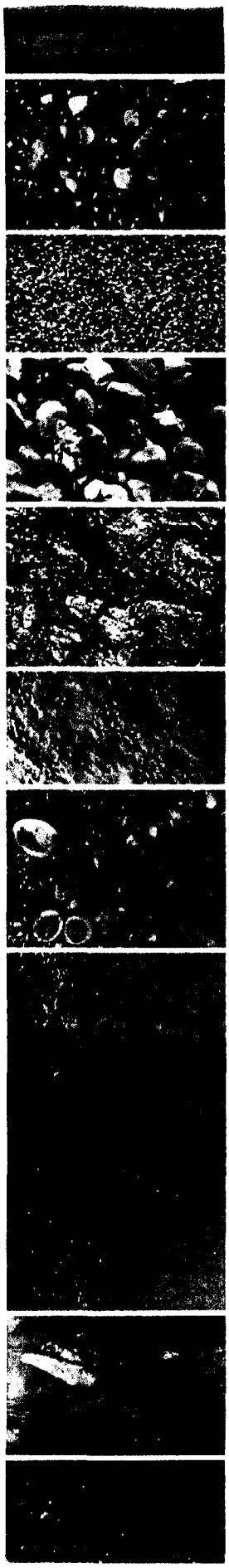
TEST BORINGS ARE PLANNED TO FULLY DEFINE SOIL STRATA AT SITES BETWEEN 12V AND 1R, AND, 7L AND 4F, FOR SLOPE STABILITY COMPUTATIONS. THE PROFILE WILL BE AMENDED AS ADDITIONAL SOIL BORING DATA BECOMES AVAILABLE FROM FUTURE STUDIES.

- T1 TOPSOIL
- C2 BROWN TO GRAYISH BROWN SILTY CLAY, TRACE OF GRAVEL (CL)
- C3 GRAYISH BROWN SILTY CLAY (CL)
- C4 BLOCKY BROWN TO GRAY ROCKY SILTY CLAY (CL)
- M5 BROWN NON-PLASTIC "LOESS"
- S6 WELL GRADED SAND (SW)
- C7 BROWNISH GRAY SILTY CLAY, TRACE OF GRAVEL (CL)
- C8 BLOCKY GRAY ROCKY SILTY CLAY WITH SEAMS OF SILT, SAND, & GRAVEL (CL)
- C9 BROWN & RED VARVED-LIKE SILTY CLAY (CL)
- S10 WELL TO POORLY GRADED SAND AND SILTY SAND (SW,SM,SP)
- CM11 GREEN, GRAY, RED, AND BROWN GRAVELLY SILTY CLAY & CLAYEY SILT (CL-ML)
- C12 BROWN SILTY CLAY (CL)
- M13 SILT WITH SMALL CLAY, SAND, & GRAVEL SEAMS (ML)
- S14 POORLY GRADED SAND & CLAYEY SAND (SP-SC)
- CM15 DARK BROWN SILTY CLAY & CLAYEY SILT (CL-ML)
- S16 BROWN SILTY SAND (SM)
- M17 BROWN NON-PLASTIC "LOESS"
- S18 SILTY SAND (SM)

PRELIMINARY SIMPLIFIED SUBSOIL PROFILE LAKE MICHIGAN SHORELINE — GRANT PARK TO BENDER PARK

FOUNDATION ENGINEERING INC.
2116 W. CORNELL STREET
MILWAUKEE, WISCONSIN 53209

HORIZ. SCALE: 1"=1000'	VERT. SCALE: 1"=10'	DRAWN BY: J.MURPHY	CHECKED BY: WTP	DRAWING: FE79SP-3



FOUNDATION ENGINEERING, INC

SOIL—ROCK CONSULTANTS

FEASIBILITY REPORT NO. 2

LAKE MICHIGAN SHORELINE STUDY 1979 - 1980

GRANT PARK TO BENDER PARK

COASTAL MANAGEMENT PROGRAM - CONTRACT 79102-3.2

PREPARED FOR

MILWAUKEE COUNTY PARKS COMMISSION

REPORT NO. FE7997

MARCH 26, 1980

2116 WEST CORNELL STREET • MILWAUKEE, WISCONSIN 53209 • TELEPHONE 414-445-6672

FEASIBILITY REPORT NO. 2

LAKE MICHIGAN SHORELINE STUDY 1979 - 1980

GRANT PARK TO BENDER PARK

INTRODUCTION

This report describes Sequence 2 of the soil investigation required to ascertain the feasibility of using recycled rubble and rock materials for stabilization of the Lake Michigan shoreline between Grant Park and Bender Park.

Sequence 2 includes four test borings to further define geological conditions in the Grant Park area; installation of two piezometers to observe groundwater fluctuations in two of these borings; survey profiles of the bluffs made by Milwaukee County personnel; UW-Madison preliminary stability analyses of the Bender Park shoreline bluffs, and a description of tentative construction planning and proposals.

SEQUENCE 2 STUDY

A. Soil Borings

Four test borings, numbered B1 through B4, were drilled to depths of 25-feet, 80-feet, 45-feet and 45-feet respectively, at the locations shown in Figure 1. The borings were advanced with 3.25-inches I.D. hollow-stem augers, using a CME 55 rotary rig, and standard penetration tests were made generally at 5-feet intervals within the augers, according to ASTM Specification D-1586, for recovery of soil samples and to define relative consistency and density of the soil strata. A log for each borehole is enclosed in this report.

Soil strata at each test location were found to be in general accordance with the soil classified in the preliminary simplified subsoil profile

presented on drawing FE7997-2, given in our Feasibility Report No. 1, dated January 29, 1980.

B. Piezometers

Piezometers consisted of 1.25-inch diameter Schedule 40 PVC pipe connected to 5-foot long slotted screens wrapped with Typar filter cloth, and were installed at depths of 20-feet and 25-feet at boring locations B2 and B4 respectively. Details of subsurface installation are shown in Figures 2 and 3. Groundwater levels will be recorded in the piezometers by Milwaukee County personnel. We advise that readings are taken each two weeks or following heavy rainstorms from hereon. Both piezometers have been protected with steel pipe vandal covers with screw tops.

C. Survey Profiles

Two bluff profiles, referenced A-A and B-B, have been prepared by the Milwaukee County Architectural-Engineering Division for the locations shown in Figure 1. Two additional profiles are required for future stability analyses of the Grant Park shoreline at the positions of borings B1 and B4. Profiles A-A and B-B are presented in Figures 4 and 5, respectively.

D. Bender Park Stability Analyses

Figures 6, 7, 8, and 9 give the results of slope stability analyses for Bender Park - Profile No. 1, prepared by Robert Sterrett as part of his UW-Madison Ph.D. thesis work. These studies are considered suitable for preliminary decisions relating to construction planning along the Bender Park shoreline. In view of this study, our stability analyses will be made for Grant Park only, under Sequence 3 of the feasibility investigation.

Tentative Construction Planning

Enquiries have revealed that approximately 5-million cubic yards of rock and earth spoils could be available from the sewer tunnel construction projects planned by the Milwaukee Metropolitan Sewerage Commission. Precise descriptions of the type, quantity and size of spoils expected, will be delineated when we have meetings with the Sewerage Commission next month. Tentative construction plans for breakwaters and shoreline protection are being developed by ourselves in conjunction with Nelson and Associates, and are expected to be available for the meetings.

FOUNDATION ENGINEERING, INC.

William T. Painter, Ph.D., P.E.
President

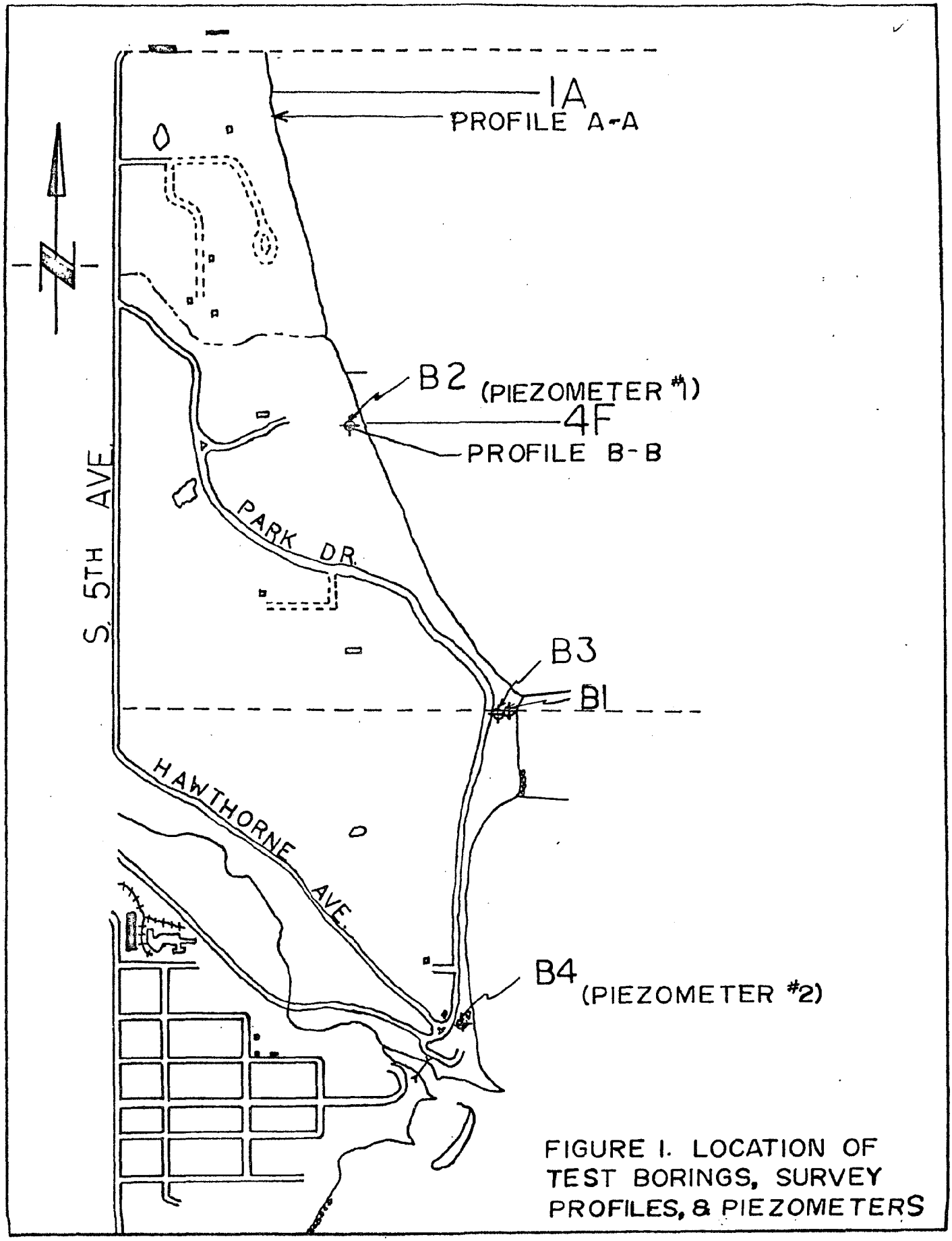


FIGURE 1. LOCATION OF TEST BORINGS, SURVEY PROFILES, & PIEZOMETERS

FOUNDATION ENGINEERING, INC. - CONSULTING ENGINEERS

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	1-24-80
LOCATION		BORING NO.	B1
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
					Fine SAND (SP) (firm moist)					
1A	SS	1.0	16	1.5				6.8		
1B	SS	1.5			Coarse SAND (SP) (firm - moist)			9.1		
2	SS	3.5	12	3.0	Fine silty SAND (SP - SM) (firm - wet)			17.9	NP	NP
3	SS	5.5	17	5.0	SAND with clay layers (SP) (firm - moist to wet)			20.4		
4A	SS	7.5	21					14.6		
4B	SS	8.5	21					21.6		
5	SS	9.5	19	9.0	Brownish-grey silty CLAY (CL - CH) (very stiff to extremely stiff - moist)		4.5+	17.7	46.5	23.1
6	SS	14.5	50 4"	10.0	Grey silty CLAY, traces of gravel with black organic seams of clay (CH)		4.5+	1.2	50.0	20.9
7	SS	19.5	37	15.0	Grey silty CLAY, some gravel (CL)		4.5+	17.3	27.0	13.5
8	SS	24.5	39	25.0			8.1	23.6	22.3	12.2

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: Mudbug - 3¼" ID hollow stem augers	qu - Unconfined Strength	SS - Split Spoon	At Drilling: 2' 9"
	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	Cave-in @ 3' 4"
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W. T. Painter	N-SPT Blows/Ft.		Scale: 1" = 4'

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	2-25-80
LOCATION		BORING NO.	B2
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
						640.0				
				0.5	Topsoil	639.5				
					Fine SAND & SILT					
				3.0	Silty SAND, some clay, traces of gravel (firm - moist)	637.0				
1	SS	4.5	10							
				8.0	Fine silty gravelly SAND (firm - moist)	632.0				
2A	SS	9.5	13							
2B	SS	10.0	13	9.75	Slightly mottled greyish-brown silty CLAY*	630.25				
				10.25	(stiff - moist)	629.75				
					Stratified SILT, SAND & silty CLAY (firm - moist)					
3	SS	14.5	16							
				15.0	Greyish-brown gravellly CLAY (very stiff - moist)	625.0				
4A	SS	19.5	25							
4B	SS	20.0	25	19.5	Coarse SAND (firm - moist)	620.5				
				22.0	Grey very silty CLAY, traces of gravel (stiff - moist)	618.0				
5	SS	24.5	9							
1	ST	26.5	-							
6	SS	29.5	12							

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - Power Wagon - 3¼" ID hollow stem augers	qu - Unconfined Strength	SS - Split Spoon	At Drilling:
	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W. T. Painter	N-SPT Blows/Ft.		Scale: 1" = 5'

*possible sand seam or layer at tip

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	2-25-80
LOCATION		BORING NO.	B2(contd)
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
					Grey very silty CLAY (stiff - moist)					
2	ST	37.0	-	37.0		603.0				
					Grey silty CLAY (very stiff - moist)					
7	SS	39.5	17							
3	ST	46.5	-							
8	SS	49.5	17							
9	SS	54.5	23							
10	SS	59.5	26							
				63.0		577.0				

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - Power	qu - Unconfined Strength	SS - Split Spoon	At Drilling:
Wagon - 3¼" ID hollow	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
stem augers	LL - Liquid Limit	A - Auger	
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W. T. Painter	N-SPT Blows/Ft.		Scale: 1" = 5'

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE 2-25-80	
LOCATION		BORING NO. B2(contd)	
BORING POSITION	See Plan	JOB NO. FE7997	

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
11	SS	64.5	42		Fine grey very silty sandy CLAY (hard - moist)					
				66.0		574.0				
					Grey silty CLAY (very stiff to hard - moist)					
12	SS	69.5	28							
13	SS	74.5	22							
14	SS	79.5	31							
				80.0		560.0				

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 Power	qu - Unconfined Strength	SS - Split Spoon	At Drilling:
Wagon - 3½" ID hollow	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
stem augers	LL - Liquid Limit	A - Auger	
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W. T. Painter	N-SPT Blows/Ft.		Scale: 1" = 5'

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	3-03-80
LOCATION		BORING NO.	B3
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
						665.0				
					Light brown mottled silty CLAY, traces of gravel (very stiff - very dry)					
1	SS	4.5	10							
2	SS	9.5	26							
3A 3B	SS	14.5	21							
				18.0		647.0				
					Light brown fine SAND, traces of gravel (dense - moist)					
4	SS	19.5	34							
5	SS	24.5	20	25.0		640.0				

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - 3¼" ID	qu - Unconfined Strength	SS - Split Spoon	At Drilling:
hollow stem augers	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	2 wks. after drilling -
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	cave-in @ 15'
Engineer: W. T. Painter	N-SPT Blows/Ft.		Scale: 1" = 4'

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	3-03-80
LOCATION		BORING NO.	B3 (contd)
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
					Brown gravelly SAND (firm - moist)					
				27.0		638.0				
					Fine SAND, some silt (dense - dry)					
6	SS	29.5	49							
7	SS	34.5	44							
8	SS	39.5	37							
				41.6		623.5				
					Grey clayey SILT (hard - dry)					
9	SS	44.5	50 11"							
				45.0		620.0				

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - 3¼" ID	qu - Unconfined Strength	SS - Split Spoon	At Drilling:
hollow stem augers	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	2 wks after drilling -
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	cave-in @ 15'
Engineer: W.T. Painter	N-SPT Blows/Ft.		Scale: 1" = 4'

FOUNDATION ENGINEERING, INC. - CONSULTING ENGINEERS

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	3-19-80
LOCATION		BORING NO.	B4
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
						640.0				
					Topsoil & brown gravelly silty CLAY					
				2.0		638.0				
					Brown fine sandy SILT (stiff - moist)					
1	SS	4.5	14							
2	SS	9.5	26	9.0		631.0				
					Mottled brown clayey GRAVEL (very stiff - moist)					
				11.5		628.5				
					Brown medium SAND (loose - moist)					
3	SS	14.5	8							
				17.0		623.0				
					Stratified brown CLAY and SAND & GRAVEL (firm - moist)					
4	SS	19.5	17							
5	SS	24.5	14							

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - 3½" ID hollow stem augers	qu - Unconfined Strength	SS - Split Spoon	At Drilling: None
	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W.T. Painter	N-SPT Blows/Ft.		Scale: 1" = 4'

LOG OF TEST BORING

PROJECT	Milwaukee County - South Shoreline Study	DATE	3-19-80
LOCATION		BORING NO.	B4 (contd)
BORING POSITION	See Plan	JOB NO.	FE7997

SAMPLE NO.	TYPE	DEPTH TO CENTER (Ft.)	N	DEPTH OF STRATA (Ft.)	SOIL DESCRIPTION	ELEV. (Ft.)	LABORATORY RESULTS qu TSF	W %	LL %	PL %
					Stratified brown CLAY and SAND & GRAVEL (firm - moist)					
				28.5		611.5				
6	SS	29.5	17		Grey silty CLAY, little gravel (very stiff - moist)					
7	SS	34.5	20							
8	SS	39.5	17							
9	SS	44.5	23							
				45.0		595.0				

PROJECT DATA	NOTATIONS		WATER LEVEL OBSERVATIONS
Drill Rig: CME 45 - 3¼" ID	qu - Unconfined Strength	SS - Split Spoon	At Drilling: None
'hollow stem augers	w - Water Content	ST - Shelby Tube	Hrs. After Drilling
	LL - Liquid Limit	A - Auger	
Driller: S. Tromp	PL - Plastic Limit	NR - No Recovery	
Engineer: W.T. Painter	N-SPT Blows/Ft.		Scale: 1" = 4'

B2

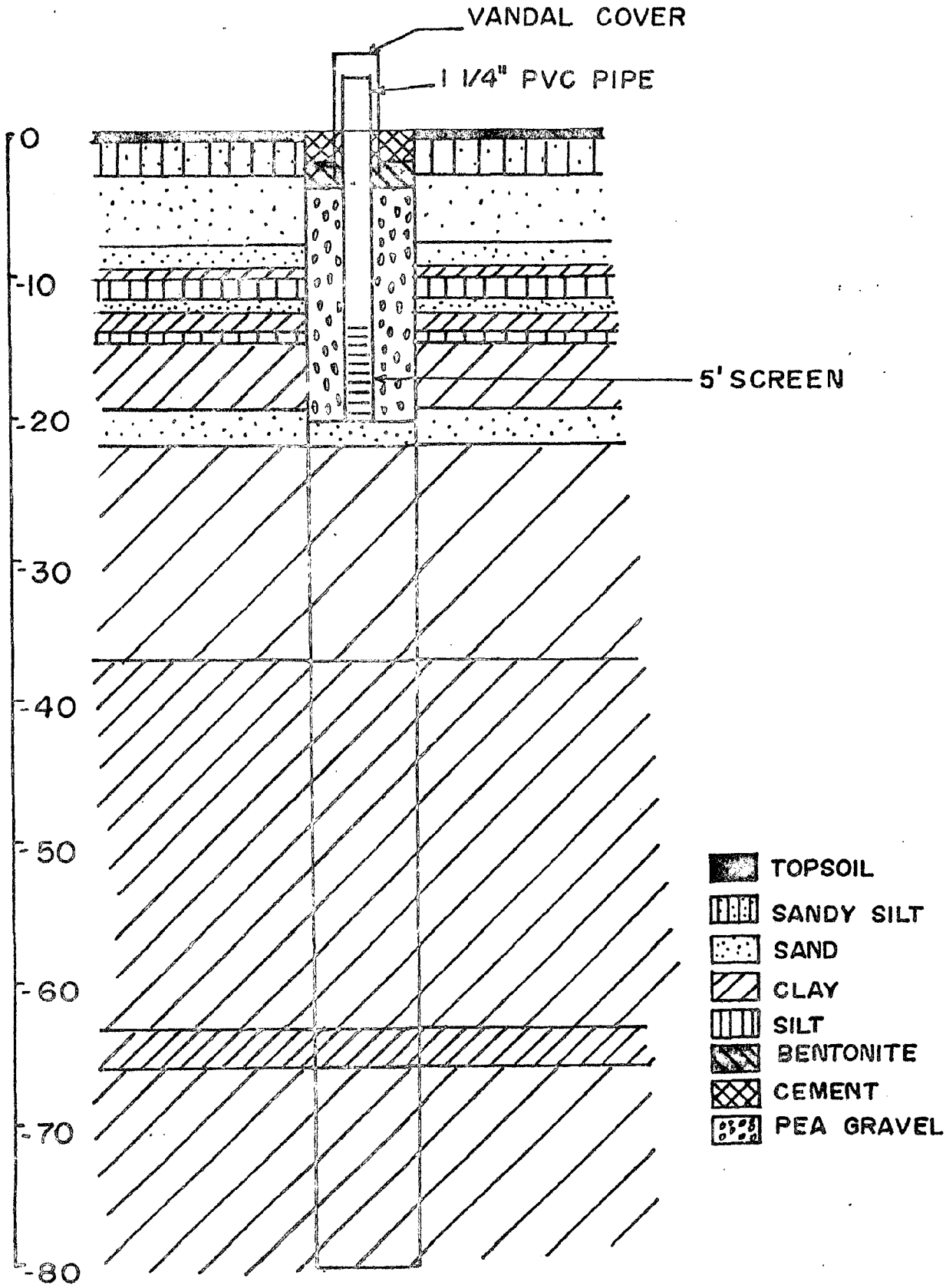


FIGURE 2. DETAILS OF PIEZOMETER #1

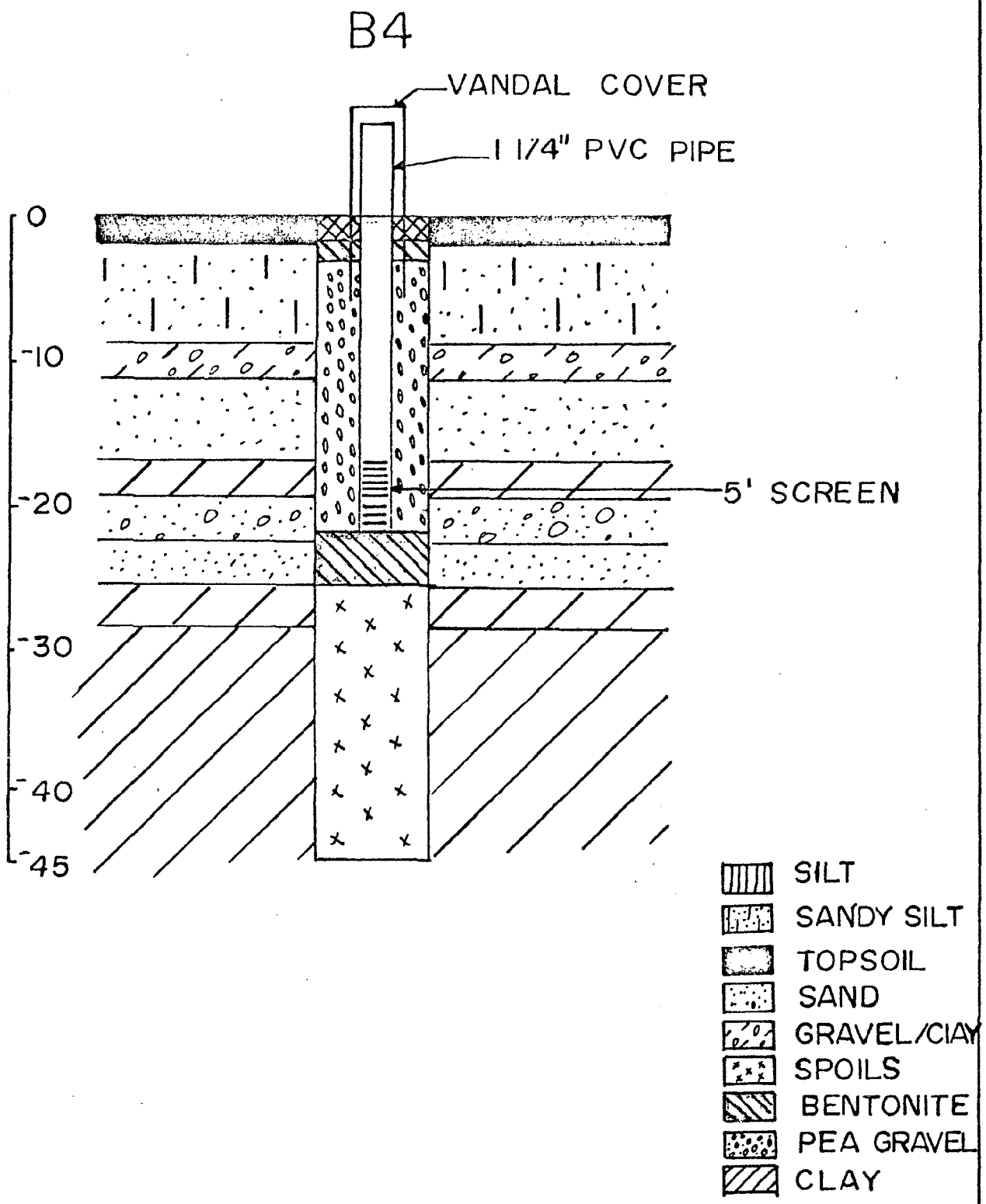


FIGURE 3. DETAILS OF PIEZOMETER #2

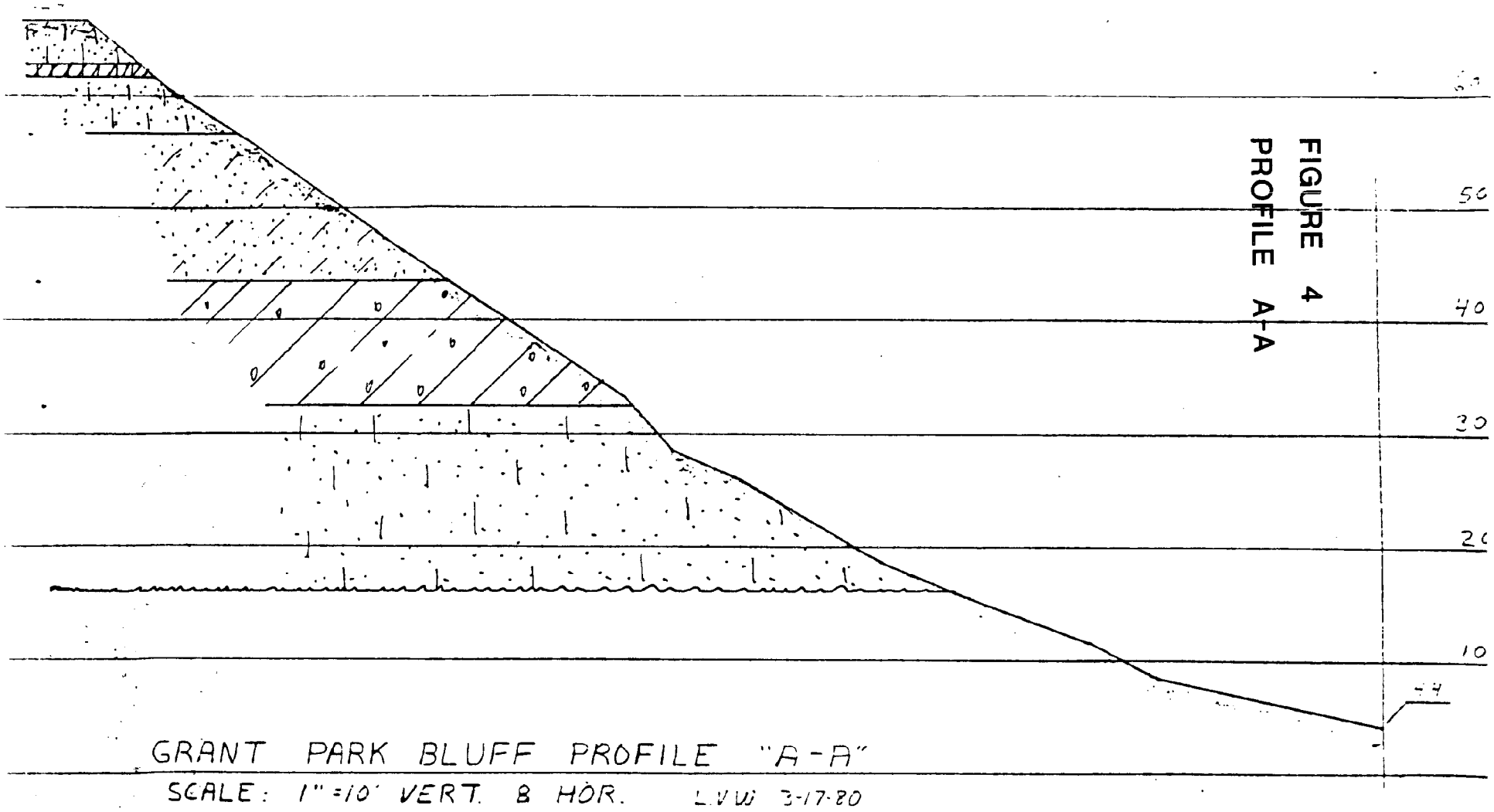


FIGURE 4
PROFILE A-A

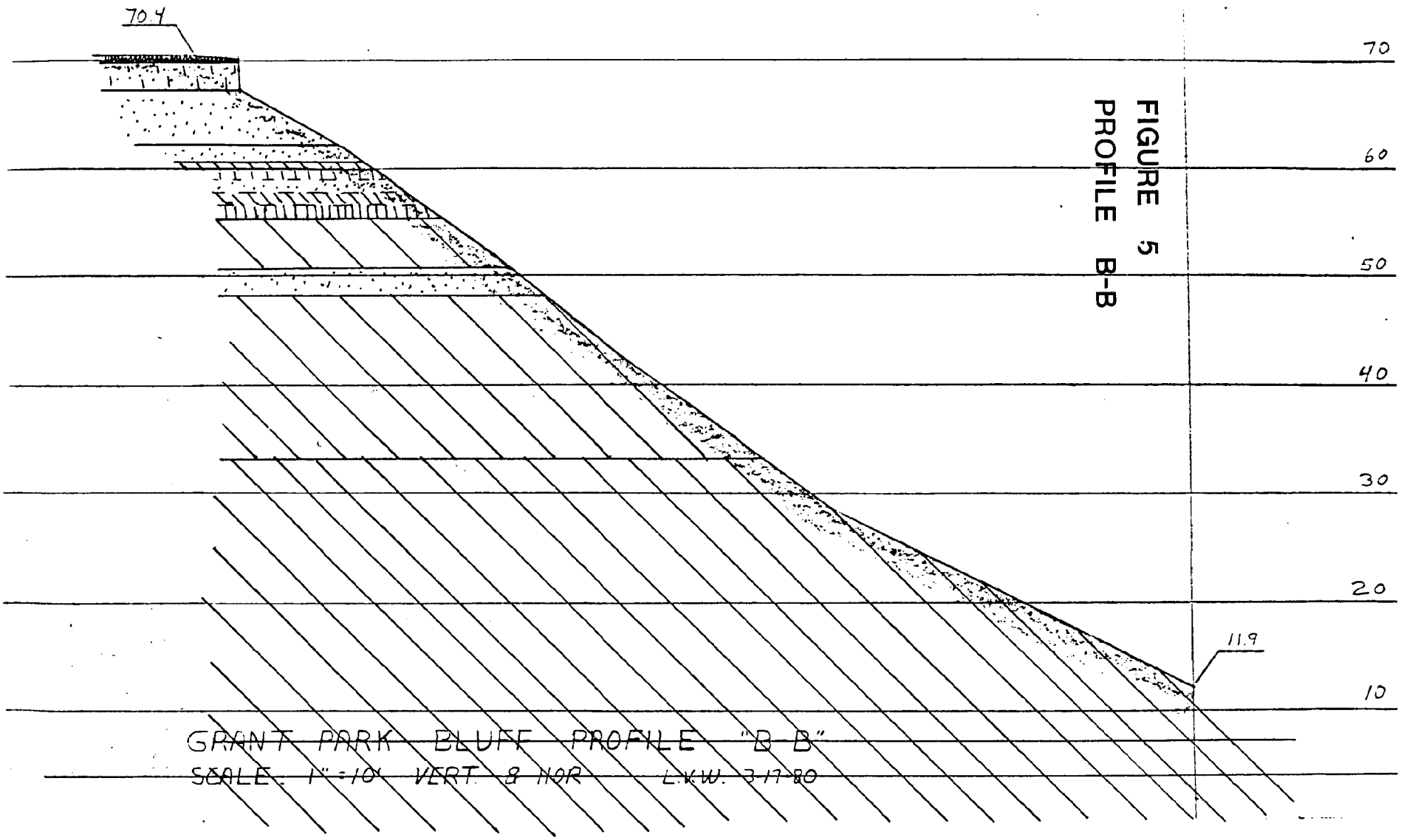


FIGURE 5
PROFILE B-B

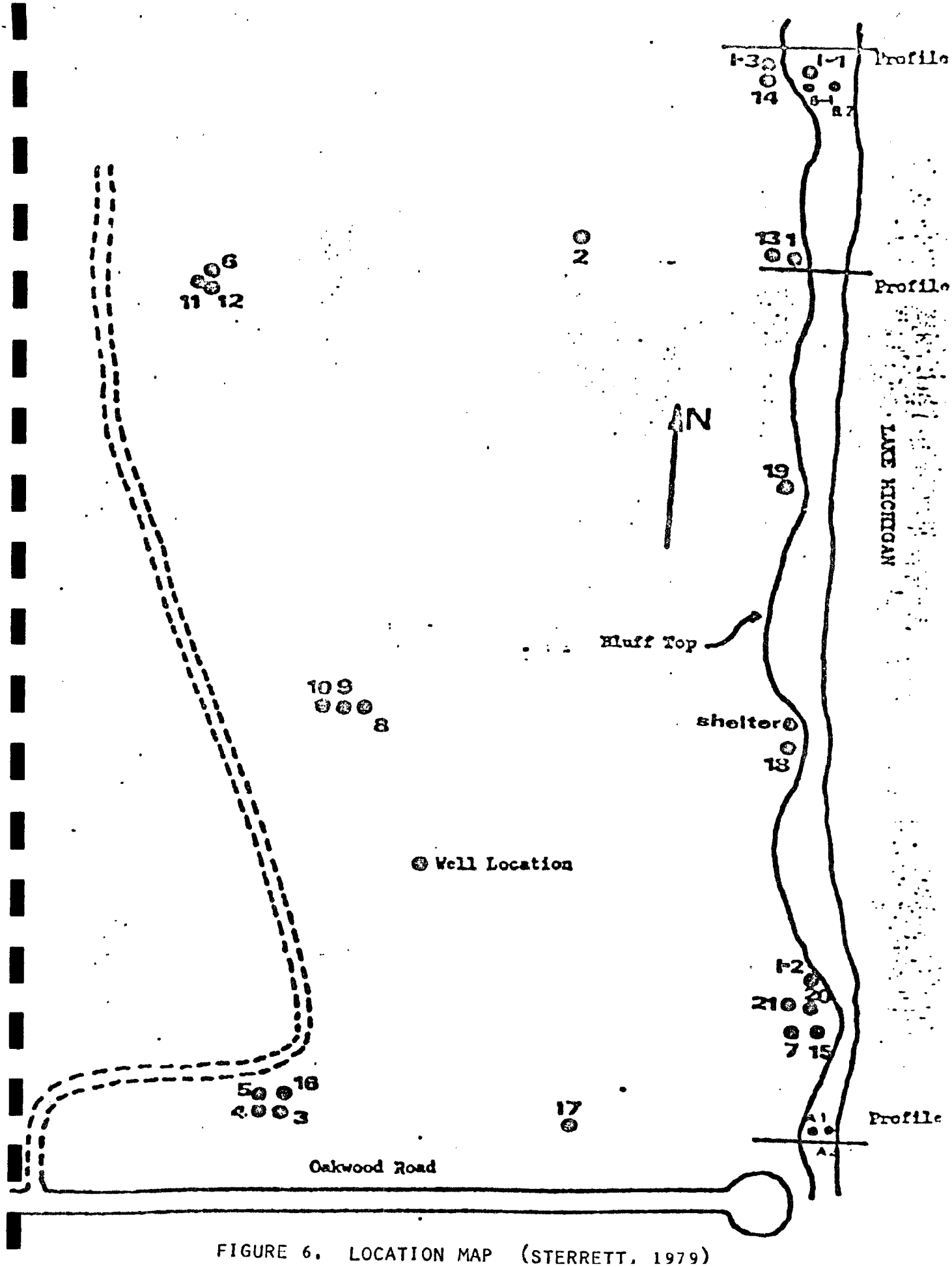


FIGURE 6. LOCATION MAP (STERRETT, 1979)

Figure 3.13 - Bender Park Field Pore Pressures

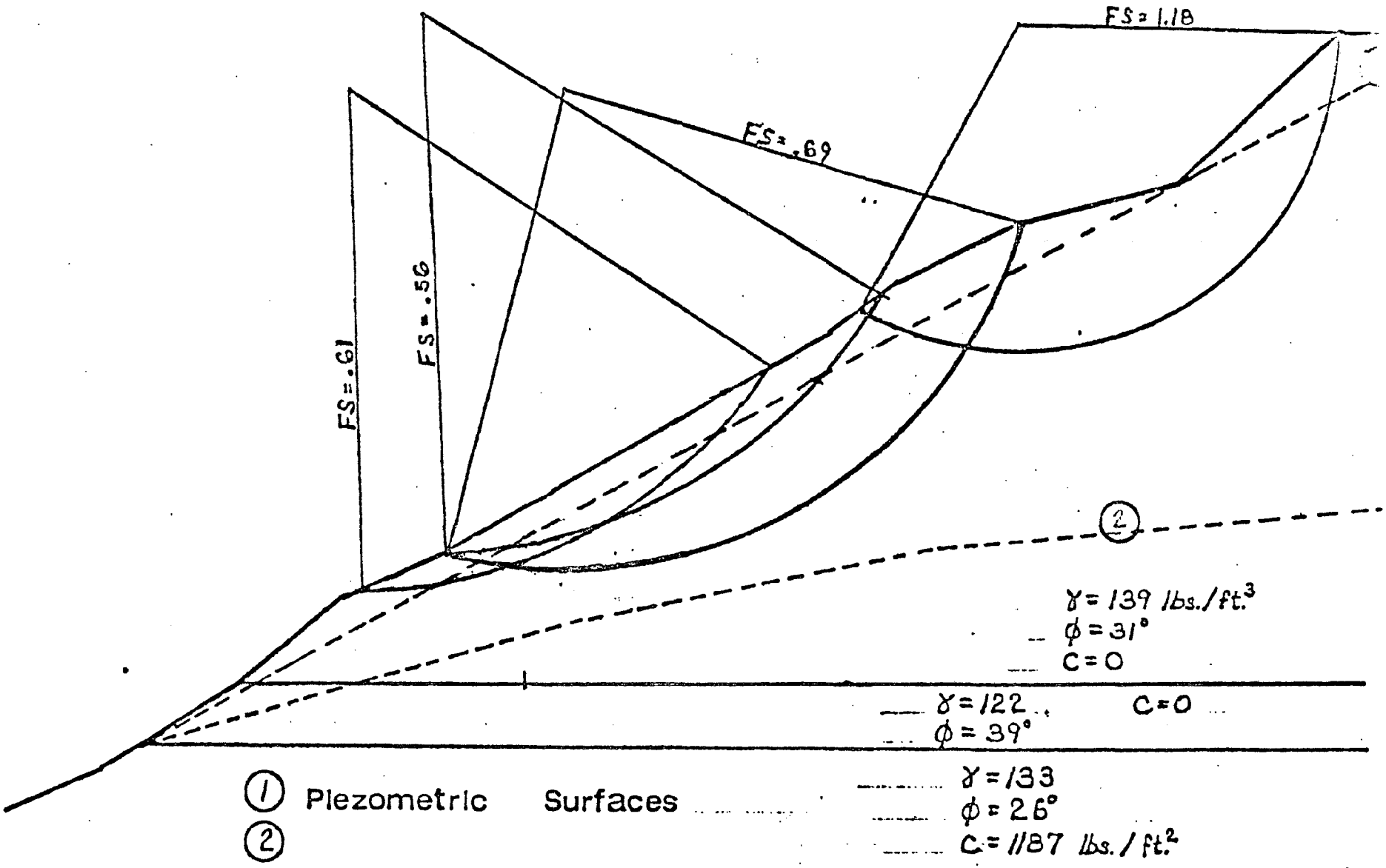


FIGURE 7. PROFILE NO.1. STABILITY ANALYSIS - BENDER PARK (STERRETT, 1979)

Figure 3.14 BENDER PARK PROFILE #1 (6-4-79)

Revised Pore Pressure

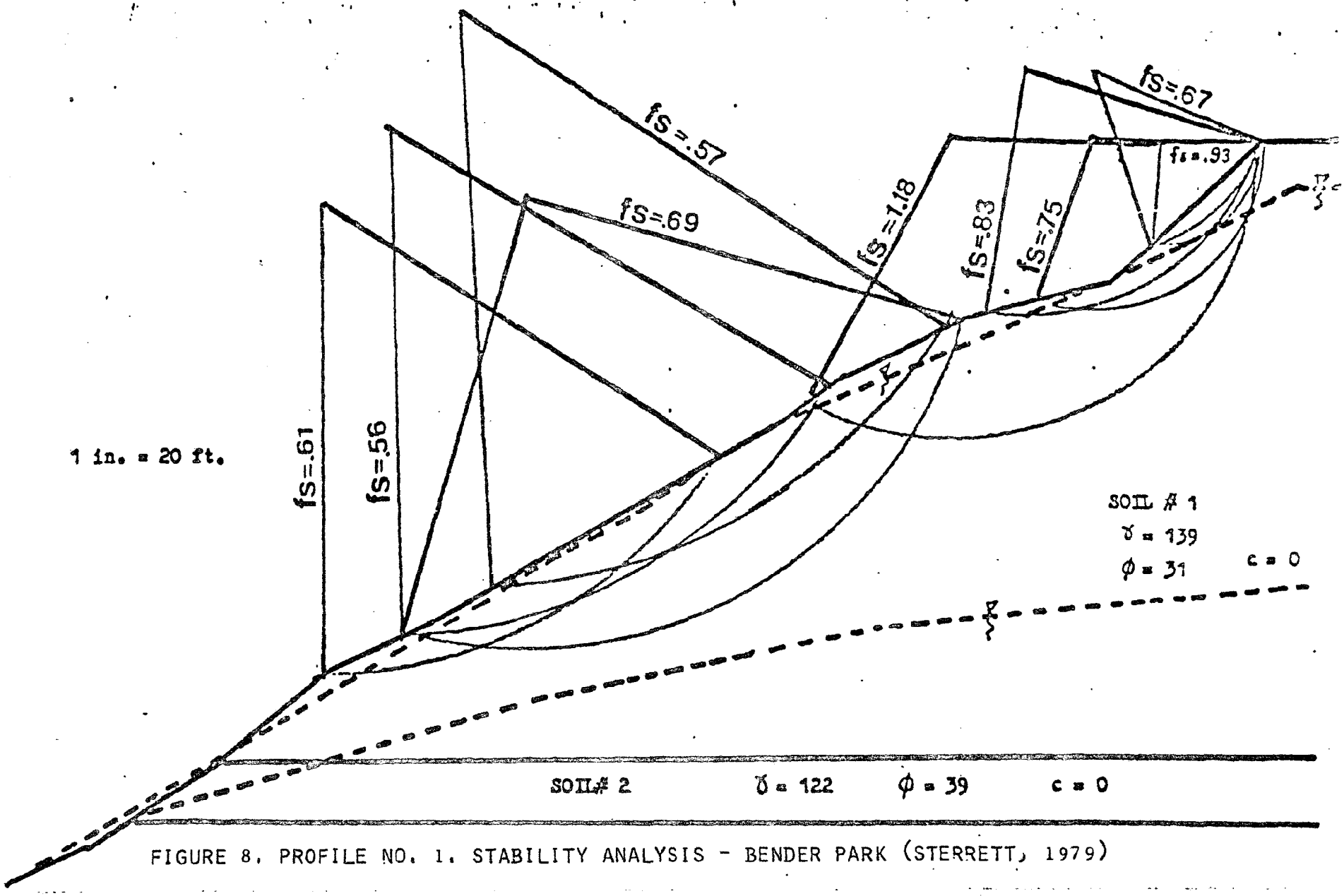


FIGURE 8. PROFILE NO. 1. STABILITY ANALYSIS - BENDER PARK (STERRETT, 1979)

Figure 3.12

Bender Park Static Case

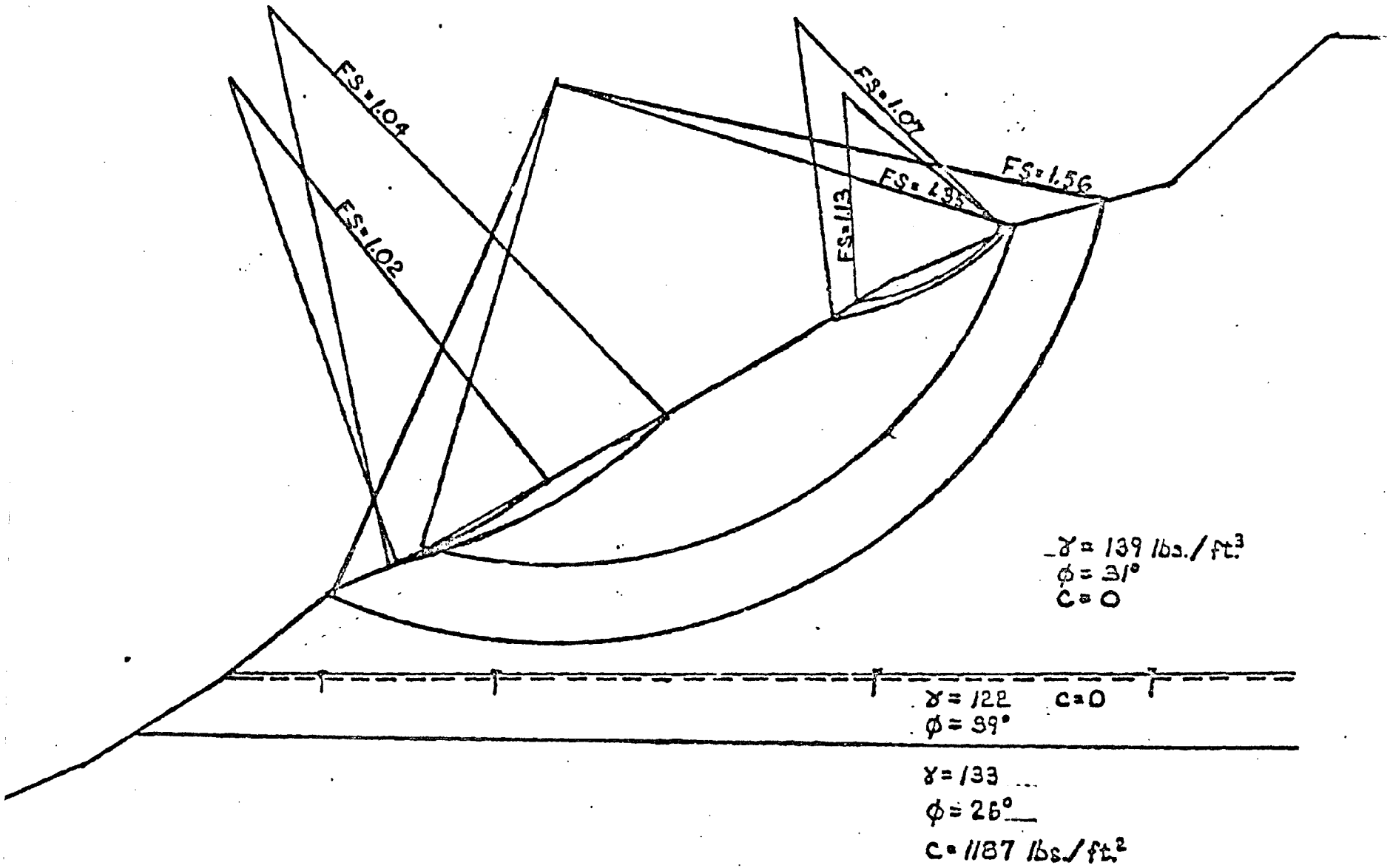
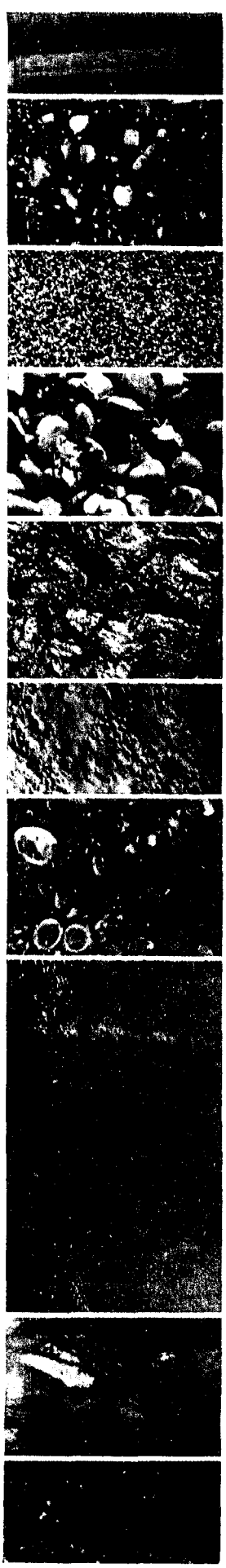


FIGURE 9. PROFILE NO. 1. STABILITY ANALYSIS - BENDER PARK (STERRETT, 1979)



FOUNDATION ENGINEERING, INC

SOIL—ROCK CONSULTANTS

FEASIBILITY REPORT NO. 3

LAKE MICHIGAN SHORELINE STUDY, 1979 - 1980

GRANT PARK TO BENDER PARK

COASTAL MANAGEMENT PROGRAM - CONTRACT 79102-8.2

PREPARED FOR

MILWAUKEE COUNTY PARKS COMMISSION

REPORT NO. FE7997

AUGUST 8, 1980

2116 WEST CORNELL STREET • MILWAUKEE, WISCONSIN 53209 • TELEPHONE 414-445-6672

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FEASIBILITY REPORT No. 3

LAKE MICHIGAN SHORELINE STUDY, 1979 - 1980

GRANT PARK TO BENDER PARK

INTRODUCTION

This report describes Sequence III of the geotechnical investigation required to ascertain the feasibility of using recycled rubble and rock materials for stabilization of the Lake Michigan shoreline between Grant Park and Bender Park. The studies included in this report were completed between May and August, 1980.

Feasibility Report No. 3 summarizes bluff recession rates within project limits; preliminary stability analyses of the bluffs; and includes evaluations and tentative cost estimates for potential Construction Schemes A, B, and C, from Grant Park to Bender Park, developed by Nelson and Associates, Inc. in consultation with ourselves. We have described various methods of shoreline stabilization, and the report concludes with a summary of the main findings of the geotechnical investigation and describes the additional study required before the chosen construction scheme can be implemented. Estimated costs for the additional study are included in Appendix "A".

SEQUENCE III STUDY

A. Bluff Recession Rates

In cooperation with Mr. Thomas Borgwardt of the Milwaukee County Architectural and Engineering Division, we have summarized recession rates between 1836 and 1980 for the proposed project limits. The recession data are incomplete but clearly indicate the magnitude of erosion that has occurred along the south shoreline.

The measurements are reported in the enclosed Drawing 7997-4, and have been obtained from the sources noted on the drawing.

In a period of 144-years, the maximum recession of the top of the bluff has been 375-feet, for an average of 2.6-feet per year, at Oakwood Road. The minimum recession has been 87-feet, for an average of 0.6-feet per year, at Grange Avenue.

B. Bluff Stability Analyses

Drawing 7997-3 summarizes the stability analyses for six bluff profiles, numbered I through VI, between ordinate 6300 South and ordinate 10200 South, as located on Drawing 7997-4.

The stability analyses are based on the method according to Bishop (1955) using effective shear strength parameters and variable groundwater conditions. Trial slip circles have been assumed for each profile and factors of safety against sliding have been calculated. A factor of safety of 1.00 indicates incipient failure. For design of new hillside profiles for stabilization, a minimum factor of safety of 1.5 is required.

The results of these preliminary analyses confirm the generally

unstable nature of the surface hillside soils and marginal stability of the bluffs against major rotational slippage. In other words, stabilization of this shoreline will require control of surface groundwater, or surface stormwater, to prevent shallow sliding, and construction of toe-loads to avoid major landslides.

To formulate future landfill profiles to achieve stabilization, stability analyses must be made using computer programs into which the geometric and geological parameters are incorporated for each variable section of the bluff. Further survey and drilling work is required in this regard.

C. Methods Of Stabilization

1. Slope Grading

In certain circumstances, hillside slopes can be stabilized by cutting the topland to a stable angle to create a continuous slope from top to bottom, or a terraced slope. Such technique requires the use of heavy earth-moving equipment and, therefore, the height and geological conditions in the hillside become of paramount importance. Sections of shoreline bluff, which have layers of wet silts, sands or gravels, cannot be treated this way unless dewatering of the layers can be accomplished within economical means, as was done by MMSD at Puetz Road.

Where the hillsides consist of soil materials, such as those present within this shoreline project, the required angle of slope is 20 to 25 degrees to the horizontal. Therefore, much topland has to be sacrificed when the bluffs are 60 to 110-feet in height.

Regraded soils, cut from the top of the hill, are not sufficient to withstand wave action at beach level, and must, therefore, be armored with concrete rubble and 4 to 5-ton pieces of limestone rip rap.

In our experience, slope grading is only practical for Lake Michigan bluffs a maximum of 40-feet high, but can be used in conjunction with rubble and rock fill for higher bluffs.

ii. Rubble and Rock Fill

Stabilization using rubble and rock fill has the distinct advantage that no existing land is lost and it is easier to accomplish construction even where wet soils and hillside surface water is present.

Access roads are built with the fill between the topland and the beach. Toe-load fill can then be transported by trucks to its required dumping spot, thus avoiding double-handling of the material by earth-moving equipment. Rubble can be placed so as to control groundwater and eliminate surface sliding of the hillside soils. Terraces can be constructed, from beach level upward, to eliminate the rotational slippage of hillsides such as present within the project limits.

iii. Sea Walls

Where shoreline hillsides have no internal seepage layers, stabilization can be achieved by using concrete sea walls. Such walls, when properly constructed, provide excellent shoreline protection from wave action, and also act as a retaining structure for the hillside soils.

A successful example of sea wall protection is that built by

Milwaukee County Parks Commission, along Big Bay Park in Whitefish Bay. This wall has a step configuration and has performed very satisfactorily for more than thirty-five years.

Sea walls must have sufficiently deep foundations below beach level to avoid underscouring by wave action. Neglect of this requirement has led to the collapse of many sea walls constructed in Milwaukee County on private land. Also, sea walls require engineered backfill and wing walls to avoid flanking and loss of hillside land behind them. Steel sheet piling, of marine quality, is also suitable for sea wall construction, and has been used frequently in Milwaukee County for harbor, dock and breakwater protection.

D. Potential Construction Schemes

Consultations with our co-consultants, Nelson and Associates, Inc., have led to the development of three potential construction schemes for public utilization of the shoreline between Grant Park and Bender Park. These three schemes provide for extra marinas, additional recreational area, access to beach level and means of protection and stabilization of the bluffs.

Each construction plan requires the use of concrete rubble and rock fill, such as commonly available from razing of buildings, highway restoration, excavations for new construction, or spoil from sewer tunneling. These recycled materials will not, however, be sufficient on their own to complete the proposed facilities. Fill used for bluff stabilization will have to be protected at beach level with armor stone or sea walls, both

for aesthetic appearances and wave protection. Likewise, marinas, access roadways and breakwaters constructed off-shore, will require such wave protection.

On May 12, 1980, a meeting was held at the Milwaukee Metropolitan Sewerage District (MMSD) to explore their future tunneling plans and probable types and quantities of spoil which may be available for shoreline stabilization. It was learned that specific tunneling plans have not been finalized, but it is expected that a separated storm and sanitary sewer system will be adopted. This construction scheme will probably generate 5 to 8.6-million cubic yards of gravel-sized rock and roadway rubble. It is not anticipated that any large 4 to 10-ton blocks of limestone, required for beach stabilization and breakwater protection, will be available.

On the basis of our experience with lakeshore stabilization during the last six years, it is realistic that recycled rubble can be generated at the rate of 150,000 cubic yards per construction season. Sewer construction could double this quantity per year. Although the fill itself can usually be acquired free of cost, trucking charges will be relatively high because of the distance to the south shore from the Milwaukee metropolitan area.

The primary features of the three potential construction schemes are as follows:

1. <u>Scheme A.</u>

Construction Scheme A will require 5.5-million cubic yards of

landfill and approximately 32,000 linear feet of armor stone construction. The scheme allows for expansion of existing marina facilities south of Grant Park, landfill and toe-load construction for creation of public beach access adjoining private and public lands, and a new marina adjoining Bender Park.

This scheme has the advantage of requiring the least amount of landfill of the three potential schemes, but has the disadvantage that riparian rights must be acquired from private landowners.

ii. Scheme B

Scheme B requies 14-million cubic yards of landfill and approximately 32,500 linear feet of armor stone. Plans incorporate two marinas, and substantial additional park space near lake level, bathing pools and vehicular access to lake level. Acquisition of riparian rights will be necessary, but substantial park expansion could result.

iii. Scheme C

Construction Scheme C does not include stabilization of lakeshore bluffs on private lands, and there should be no need to purchase riparian rights. Marina proposals match those of Schemes A and B; additional park space will result; public beach access and beach usability will also be expanded. The required quantity of landfill is approximately 8-million cubic yards, and approximately 45,600 linear feet of armor stone will be needed to protect both sides of each off-

shore breakwater and each marina.

iv. Construction Costs

Assuming that all rubble is acquired free of cost from within a 25-mile radius of the project site, combined costs for trucking and placement of the rubble are estimated at $3.00 per ton. Armor rock will be required in 4 to 5-ton sizes, for protection of landfills against wave action, and in 8 to 10-ton sizes for harbor and breakwater construction.

It is anticipated that 4 to 5-ton limestone rock will cost $55.00 per ton for acquistion and placement, and it is available within 30-miles of the project site. The 8 to 10-ton rock will require shipment from the Manitowoc area and it is estimated to cost $100.00 per ton for acquistion and placement.

Using the estimated quantities of rubble and armor rock depicted in potential Construction Schemes A, B and C, preliminary construction costs are given in Table 1.

E. Required Additional Study

Additional geotechnical studies will be needed whichever construction scheme is adopted. For feasibility study purposes, we investigated the general geological strata along the shoreline bluff and and have three pertinent bluff stability analyses only, i.e. Profiles II, V and VI. Additional test borings, laboratory soil tests, groundwater measurements and computerized stability analyses will be required

for Bender Park, the south end of Grant Park and all shoreline lands which are to be stabilized.

Expansion of the marina facilities will require off-shore test borings and soil testing programs to define the pertinent lakebed geology and formulate landfill construction. Designs for fills which will be placed in the lake and the creation of harbors cannot be accomplished until the geotechnical data are available. Off-shore test borings are also required so that designs can be formulated for the breakwaters connecting the marina facilites and public lands.

Programs have been devised for the additional exploratory work, and preliminary costs are included in Appendix "A". The additional geotechnical studies allow for test borings on a 500-foot grid pattern for each of Schemes A, B and C. Piezometers will be required in land borings at 1,000-foot intervals. Bluff profiles must be surveyed at 500-foot intervals and computerized stability analyses will be needed also at 500-foot intervals, where the shoreline is to be stabilized by rock and rubble fill.

Off-shore marinas, park areas or breakwaters, will require borings from barges. Soil tests will include shear strength, general classification, consolidation and permeability measurements. A complete breakdown of all test requirements will be given when the favored construction scheme is selected.

CONCLUSIONS

1. The feasibility study performed by ourselves and co-consultants

has led to the development of three ambitious, but realistic, schemes for utilization of the south shoreline for public facilites and recreation. Costs of the respective schemes range from $32.6-million to $71.4-million, assuming that the work is undertaken without MMSD participation or financial assistance.

2. The geological studies, although performed with a limited budget, have clearly demonstrated that the public shoreline areas can be stabilized using rock and rubble fill so as to arrest erosion and provide access to the lake over a distance of almost five miles. Estimated quantities of construction material are within reasonable limits so that construction schedules can be planned over a six to twelve year period. A major fraction of the required materials could be obtained from MMSD projects, provided that construction can be co-ordinated with sewer excavation.

3. Additional test borings, soils analyses, and landfill designs are required before the chosen construction scheme can be implemented. Costs of this work could range from $298,000.00 to $576,000.00. The additional geotechnical work would take from twelve to eighteen months to accomplish. The required investigations can be scheduled according to the priorites placed upon the respective components of the construction scheme. For example, it may be decided to begin the additional marinas as a first priority and investigations could be undertaken for these facilities first of all. Likewise, construction of the chosen scheme can be divided into several parts, each being assigned a given priority.

4. Permits will be required from the U.S. Army Corps of Engineers, the Environmental Protection Agency, Wisconsin Department of Natural Resources, individual City agencies and private landowners. Choice of the construction scheme must take account of whether or not riparian rights are to be acquired for private lands. Such requirement can be eliminated by avoiding shoreline stabilization on the private lands. Off-shore breakwaters, such as included in Construction Scheme C, will afford wave protection for the private lands without eliminating lake access from such lands.

FOUNDATION ENGINEERING, INC.

William T. Painter, Ph.D., P.E.

John M. Murphy, Geologist, C.S.T.

APPENDIX "A"

ESTIMATED COSTS FOR

GEOTECHNICAL STUDIES

CONSTRUCTION SCHEMES A, B & C

APPENDIX "A"

ESTIMATED COSTS FOR
GEOTECHNICAL STUDIES
CONSTRUCTION SCHEMES A, B & C

SUMMARY OF COSTS FOR GEOTECHNICAL STUDIES FOR IMPLEMENTATION OF CONSTRUCTION

SCHEME	A	B	C
LAND BORINGS	$ 80,625.	$ 80,625.	$ 33,750.
PIEZOMETERS	$ 3,870.	$ 3,870.	$ 1,620.
STABILITY ANALYSES	$ 86,000.	$ 86,000.	$ 36,000.
LAKE BORINGS	$ 12,500.	$207,500.	$125,000.
LABORATORY SOIL TESTS	$139,500.	$189,000.	$102,000.
ESTIMATED TOTAL COSTS	$322,495.	$566,995.	$298,370.

Costs include all geological interpretation and geotechnical calculations and reports.

REFERENCES

Bishop, A.W. (1955) "The Use of the Slip Circle in the Stability Analysis of Slopes"
Geotechnique Vol. 5, No. 1, 1955., p.17

LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK
SHORE PROTECTION & PUBLIC DEVELOPMENT

MILWAUKEE CO. PARK COMMISSION

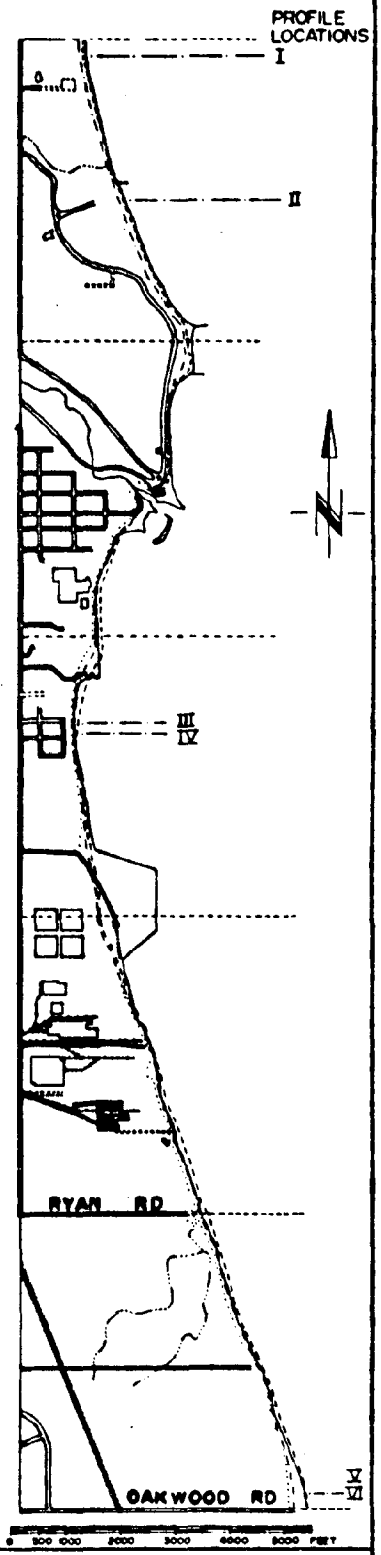
RECORD OF RECESSION OF TOP OF BLUFF ALONG SOUTH SHORELINE

LOCATION	MEASUREMENT TO TOP OF BLUFF FROM U.S. SURVEY CORNERS					RECESSION OF TOP OF BLUFF									
						1836 to 1874		1874 to 1944		1944 to 1965		1965 to 1980		1836 to 1980	
	1836	1874	1944	1965	1980	TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL
GRANGE	1823	—	1819	1790	1736	—	—	—	—	29	1.4	54	3.6	87	0.6
COLLEGE	1049	950	898	900	900	99	2.6	52	0.7	—	—	—	—	149	1.03
RAWSON	3010	2937	2873	2773	2884	73	1.9	64	0.9	100	4.8	—	—	126	.88
DREXEL	1422	—	1360	—	1297	—	—	—	—	—	—	—	—	125	0.9
PUETZ	1403	—	1332	—	—	—	—	—	—	—	—	—	—	—	—
RYAN	888	—	700	590	516	—	—	—	—	110	5.2	74	4.9	372	2.6
OAKWOOD	2640	—	2298	2285	2285	—	—	—	—	10	0.5	0	0	375	2.6
SO. COUNTY	2158	2000	1951	—	—	158	4.2	49	0.7	—	—	—	—	—	—

NOTE: MEASUREMENTS ARE IN FEET

NOTE:

1836 SURVEY MEASUREMENTS FROM ORIGINAL GOVERNMENT SURVEY 1836
1874 SURVEY MEASUREMENTS FROM CHAMBERLIN'S GEOLOGY OF WISCONSIN
1944 SURVEY MEASUREMENTS FROM MILWAUKEE COUNTY REGIONAL PLANNING DEPARTMENT
1965 & 1980 SURVEY MEASUREMENTS FROM MILWAUKEE COUNTY DEPARTMENT OF PUBLIC WORKS - ARCHITECTURAL & ENGINEERING DIVISION
1980 SURVEY OF BLUFF TOP
1944 SURVEY OF BLUFF TOP
1836 SURVEY OF BLUFF TOP
LAKE LINE



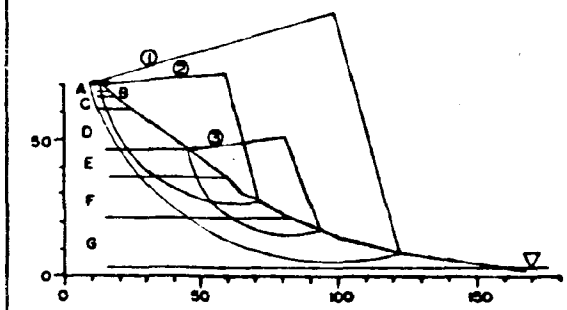
LAKE BLUFF RECESSION FROM 1836 TO 1980 MILWAUKEE SOUTH SHORELINE

FOUNDATION ENGINEERING INC.
2116 W. CORNELL STREET
MILWAUKEE, WISCONSIN 53209

SCALE: 1"=1000' | DRAWN BY: J. MURPHY | CHECKED BY: W. PAINTER | 7997-4

PROFILE I

LOCATION: 6300 SOUTH

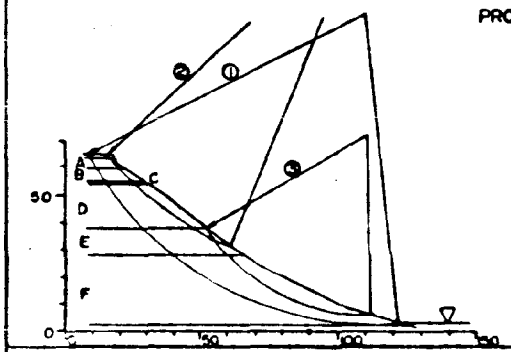


FAILURE SURFACE	SAFETY FACTOR SATURATED	SAFETY FACTOR DRY
1	1.29	2.06
2	1.11	1.99
3	1.82	2.91

LAYER	γ	C	Ø
A	124	0	38
B	110	200	33.5
C	124	0	38
D	124	0	38
E	129	720	26
F	135	0	38
G	129	720	26

PROFILE II

LOCATION: 7000 SOUTH

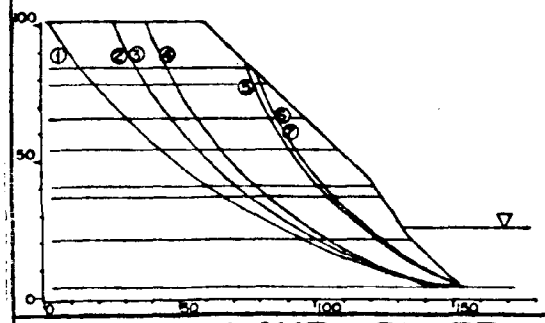


FAILURE SURFACE	SAFETY FACTOR SATURATED	SAFETY FACTOR DRY
1	1.05	1.78
2	.48	1.30
3	3.28	4.04

LAYER	γ	C	Ø
A	124	0	38
B	124	0	38
C	110	200	33.5
D	110	20	36.5
E	124	0	38
F	129	720	26

PROFILE III

LOCATION: 8200 SOUTH

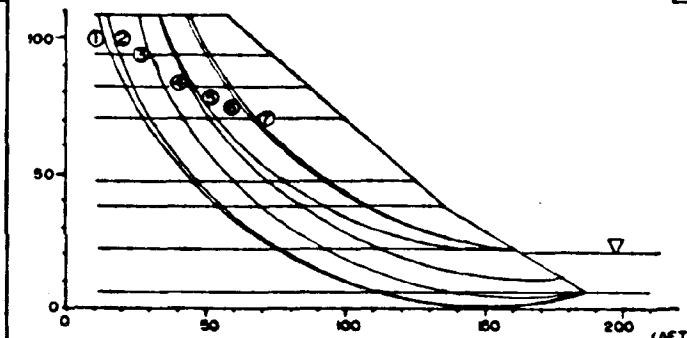


FAILURE SURFACE	SAFETY FACTOR
1	1.04
2	1.85
3	1.52
4	.87
5	.64
6	.35
7	.73

(AFTER GILES ENGINEERING ASSOCS., 1979)

PROFILE IV

LOCATION: 8200 SOUTH

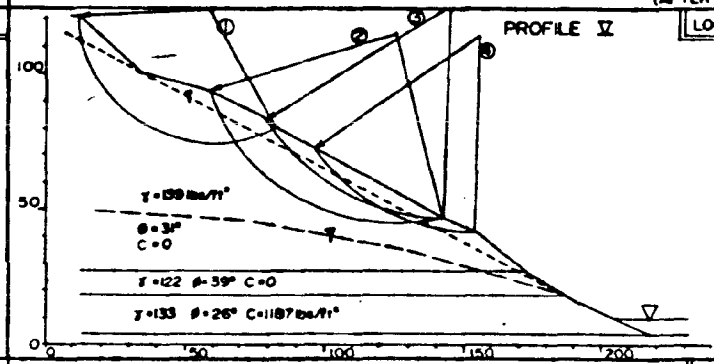


FAILURE SURFACE	SAFETY FACTOR
1	1.88
2	2.29
3	1.04
4	1.05
5	.98
6	1.00
7	.64

(AFTER GILES ENGINEERING ASSOCS.,

PROFILE V

LOCATION: 10200 SOUTH

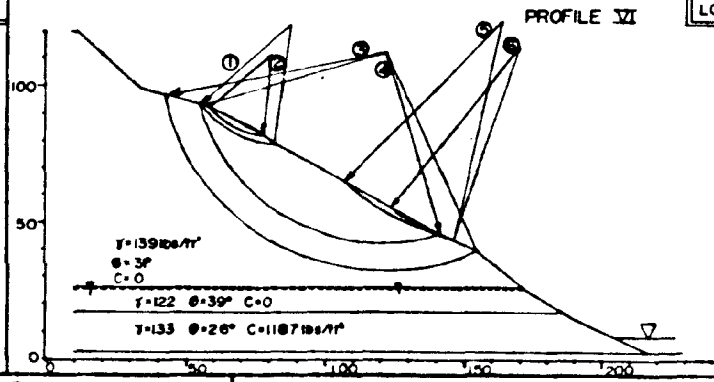


FAILURE SURFACE	SAFETY FACTOR
1	1.18
2	.69
3	.56
4	.61

(AFTER BOB STERRETT, 1980

PROFILE VI

LOCATION: 10200 SOUTH



FAILURE SURFACE	SAFETY FACTOR
1	1.07
2	1.13
3	1.56
4	1.35
5	1.04
6	1.02

(AFTER BOB STERRETT, 19

LAKE BLUFF STABILITY ANALYSIS
LAKE MICHIGAN SHORELINE STUDY
1979-80 GRANT PARK TO BENDER PARK

SHORE PROTECTION & PARK DEVELOPMENT

MILWAUKEE CO. PARK COMMISSION

FOUNDATION ENGINEERING INC.
2116 W. CORNELL STREET
MILWAUKEE, WISCONSIN 53209
ROCK-SOIL CONSULTANTS

DRAWN BY: J. MURPHY	VERTICAL SCALE: 1"=20'	HORIZONTAL SCALE: 1"=20'
CHECKED BY: W.T. PAINTER	DATE: 5/29/80	DRAWING NUMBER: 7997-3

TABLE 1

PRELIMINARY CONSTRUCTION COSTS

POTENTIAL CONSTRUCTION SCHEMES A, B & C

SCHEME	RUBBLE (TONS)	PLACEMENT COSTS	4-5 TON ARMOR ROCK (TONS)	PLACEMENT COSTS	8-10 ARMOR ROCK (TONS)	PLACEMENT COSTS	EST. TOTAL COST
A	8.25×10^6	$24.75million	60,000 tons	$3.3million	45,000 tons	$4.5million	$32.6 million
B	21×10^6	$63million	70,500 tons	$3.9million	45,000 tons	$4.5million	$71.4 million
C	12×10^6	$36million	97,500 tons	$5.4million	70,000 tons	$7 million	$48.4 million

REPORT ON RIPARIAN RIGHTS

Milwaukee County Park Commission

Milwaukee County, Wisconsin

July 1980

AMERICAN APPRAISAL

THE AMERICAN APPRAISAL COMPANY Corporate Headquarters, Milwaukee, Wisconsin

AMERICAN APPRAISAL

THE AMERICAN APPRAISAL COMPANY Corporate Headquarters 525 East Michigan Milwaukee, Wis. 53201 Area 414:271-7240

INVESTIGATIONS • VALUATIONS • REPORTS

August 4, 1980

Nelson & Associates, Inc.
Milwaukee, Wisconsin

Gentlemen:

We have made an investigation of the Lake Michigan shoreline, from Grant Park to Bender Park, Milwaukee County, Wisconsin, for the purpose of developing the conceptual framework of value-related aspects of a proposed project to develop public recreational lands and in the process stabilize the beach and bluff in this area. At this time, our involvement has been only on a theoretical basis, and no actual appraisals of individual properties have been made. The appraisal is as of July 1980.

The proposed project encompasses approximately 3.66 miles of Lake Michigan shoreline in the southeastern part of metropolitan Milwaukee. The northerly limit of the proposed project is the mouth of Oak Creek at the southeasterly corner of Grant Park in the city of South Milwaukee. The southerly limit of the proposed project is at Oakwood Road at the southeasterly corner of Bender Park in the city of Oak Creek. Land uses along the shoreline are mixed and include marinas, improved residences and vacant lots, industrial properties, municipal and public utility facilities, and parkland.

At the present time, we have considered the following:

1. Identification and ownership of property along the shoreline segment based on public records

2. Definition of the rights of property ownership, including riparian rights

3. Methods of valuing riparian rights

4. The relationship of value and possible costs of riparian rights considering different land uses

5. Alternatives in the acquisition process

6. Value of created land to the municipality

Theory of Property Ownership

The ownership of real property is occasionally expressed as the Bundle of Rights Theory. This theory holds that property ownership may be compared to a bundle of sticks wherein each stick represents a distinct and separate right or privilege of ownership. These rights are inherent in ownership of real property and are guaranteed by law but are subject to certain limitations and restrictions. Rights under this theory are:

1. The right to occupy and use real property

2. The right to sell it in whole or in part

3. The right to lease it wherein the rights of use and occupancy are transferred to another party for a specified time

4. The right to enter it

5. The right to give it away

6. The right to refuse to exercise any of these rights

Although the legal definition of land implies complete ownership of land and everything attached to it, under it, and over it, legal title to land, in fact, does not convey absolute fee simple title to real property and the unrestricted exercise of the entire bundle of rights. Limitations and restrictions to these rights include governmental restrictions and legal private agreements. The four powers of government are the power of taxation; the power of eminent domain wherein private property is acquired for public benefit after payment of just compensation; the police power wherein private property is regulated to promote public safety, health, morals, and general welfare; and the power of escheat wherein the ownership of private property returns to the state if the owner dies leaving no will and no known or ascertainable heirs. Some of the legal private agreements include deed restrictions, easements, and right-of-way agreements.

Riparian Rights are defined as rights and privileges which are incidental to the ownership of land fronting on a body of water. These rights generally include:

1. The exclusive right of access to and from the upland to navigable waters

2. The right of accretion, being the gradual accumulation of land out of the body of water caused by the washing up of sand and soil or the recession of the body of water from its usual water mark

3. The right to the flow of water undiminished in quality and quantity

4. The right of ownership to the middle of the body of water (in the instance of river riparian rights) subject to the public rights of navigation

5. The right to construct walls, abutments, and protective embankments to prevent loss of soil by the process of erosion

6. The right to erect piers, wharves, landings, etc.

In some states, the common law doctrine of riparian rights has been superseded by the doctrine of beneficial use which holds that the water resources of the state must be put to the most beneficial use of which they are capable.

In Doemel vs. Jantz, 180 Wis. 225 (1923), the Supreme Court set out the following rules of law regarding riparian rights in the state of Wisconsin:

"1. The rights of a riparian owner are based upon his title to the ownership of the banks or the uplands.

2. Such ownership gives him exclusive privileges of the shore for the purposes of access to his land and the water.

3. These privileges are valuable privileges incident to his title to the land, of which he cannot be deprived for any private use, and which the public can only acquire from him by purchase, prescription, or by the exercise of the right of eminent domain.

4. That such rights include the right of using the shore for the purposes of building piers, wharves, harbors, or booms in aid of navigation, and of

building walls or other protection so as to prevent loss of soil by the process of erosion. He obtains the right and title to the soil formed by accretions and relictions.

5. The title to the soil under water in inland navigable meandered lakes is held by the state in trust for the benefit of the public for navigation purposes and its various incidents.

6. Insofar as the structures erected by the riparian owner into the water interfere with the public rights of navigation and its incidents, he takes and holds such rights subject to the public rights.

7. When the waters in the lake recede to low-water mark, the public has the privilege to use the water up to the water line, and, when they extend to the ordinary high-water mark, such rights in the public are extended accordingly."

This case dealt with property on Lake Winnebago. We have not been advised of any court decisions regarding riparian rights for property abutting Lake Michigan, but it would seem that the same conclusions would hold.

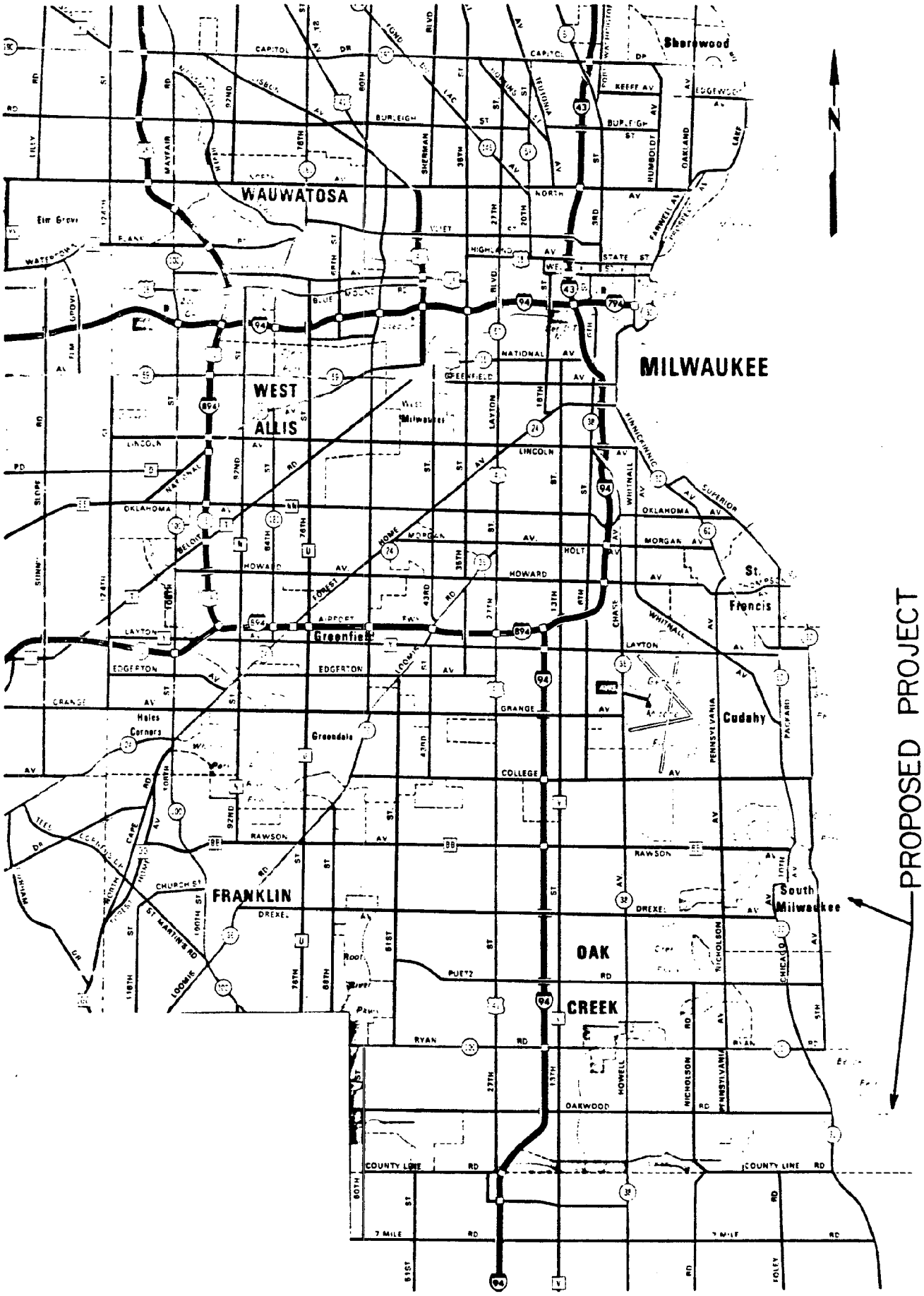
The State of Wisconsin has deeded the submerged lands along the Lake Michigan shoreline within the Milwaukee County limits to Milwaukee County.

It follows that the riparian rights of the owners within this project area have been modified due to the rights of Milwaukee County to the submerged lands.

Description of the Proposed Project

The proposed project encompasses the westerly shoreline of Lake Michigan, from Grant Park to Bender Park. The location begins approximately 6 miles southeast of the central business district of Milwaukee.

More specifically, the proposed project encompasses approximately 3.66 miles of shoreline. The northerly limit of the proposed project is the mouth of Oak Creek at the southeasterly corner of Grant Park in the city of South Milwaukee. Shoreline to the north for approximately 2 miles includes Grant Park and Sheridan Park. The southerly limit of the proposed project is at Oakwood Road at the southeasterly corner of Bender Park in the city of Oak Creek. Shoreline to the south as far as the Racine County line includes the large Wisconsin Electric Power Company Oak Creek Power Station and abutting buffer land.


WAUWATOSA
MILWAUKEE
WEST ALLIS
FRANKLIN
OAK CREEK
Sherewood
Elm Grove
Greenfield
Greendale
Hales Corners
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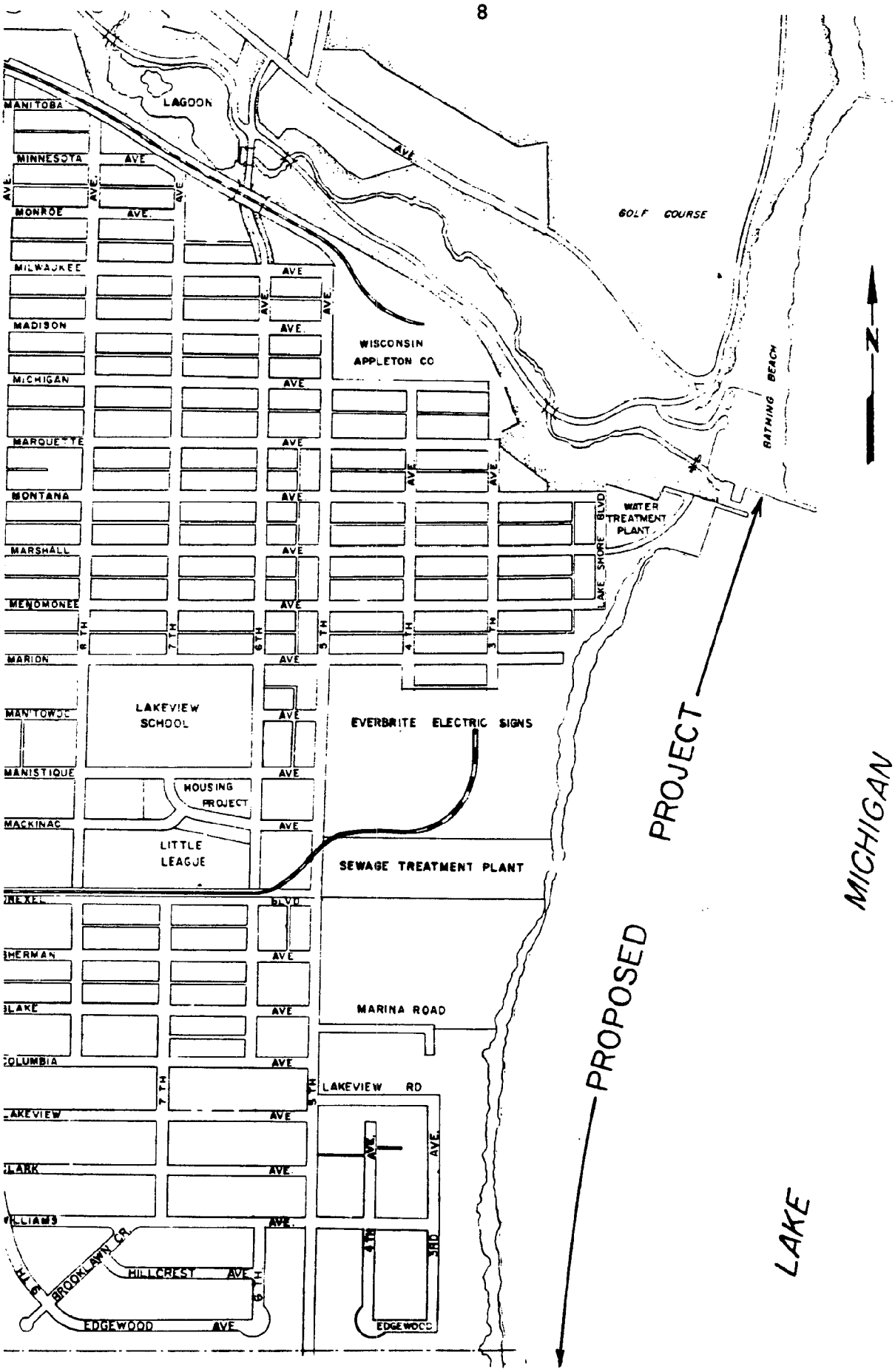
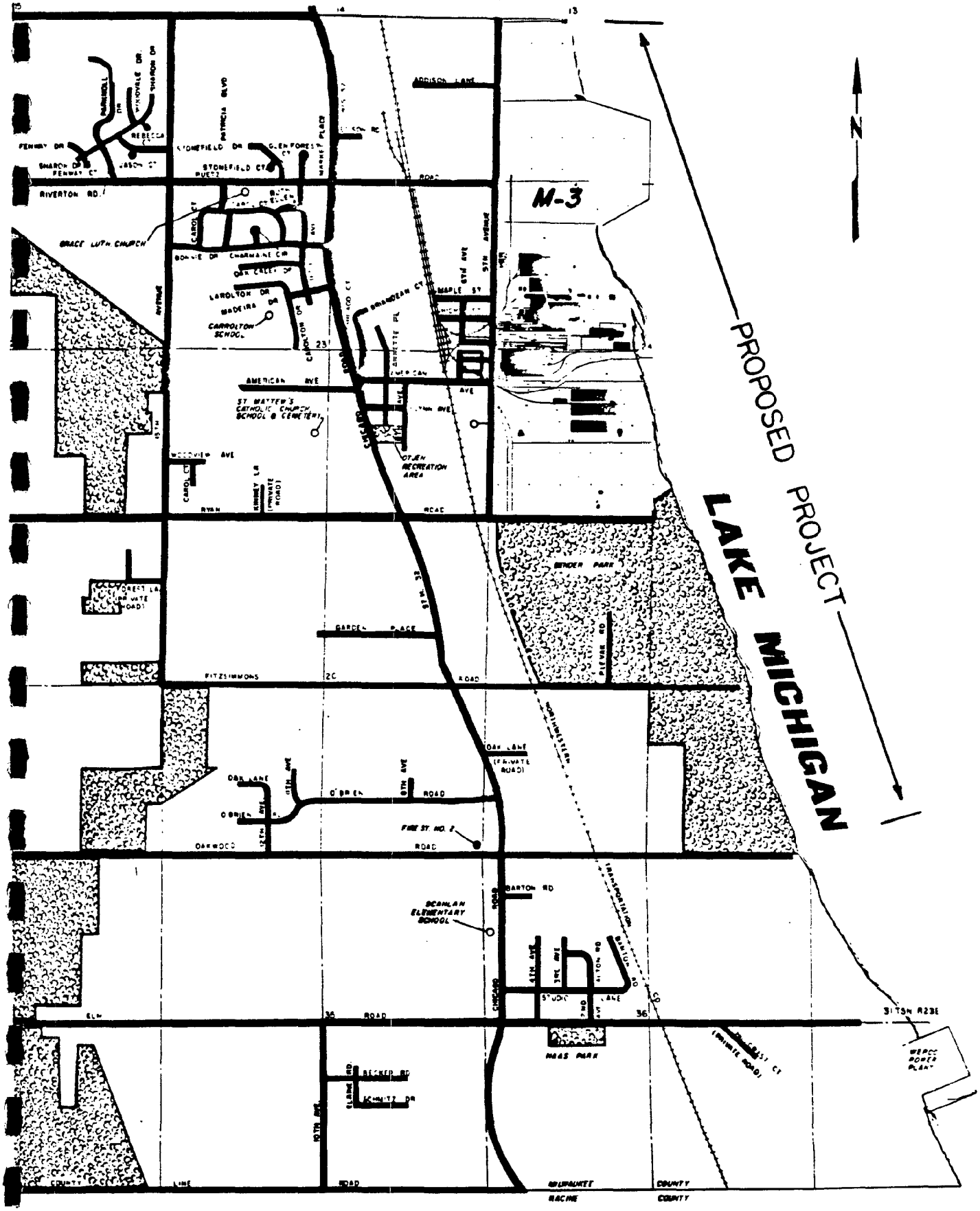
Cudahy
South Milwaukee
CAPITOL DR
BURLEIGH
NORTH AV
VLIET
STATE ST
NATIONAL AV
GREENFIELD AV
LINCOLN AV
OKLAHOMA AV
MORGAN AV
HOWARD AV
LAYTON
EDGERTON
GRANGE AV
COLLEGE AV
RAWSON AV
DREXEL
PUETZ RD
RYAN RD
OAKWOOD RD
COUNTY LINE RD
7 MILE RD
PROPOSED PROJECT


LAGOON
MANITOBA
MINNESOTA AVE
MONROE AVE.
MILWAUKEE AVE
MADISON AVE.
MICHIGAN AVE
MARQUETTE AVE
MONTANA AVE
MARSHALL AVE
MENOMONEE AVE
MARION AVE
MANITOWOC AVE
MANISTIQUE AVE
MACKINAC AVE
NEXEL BLVD
SHERMAN AVE
BLAKE AVE
COLUMBIA AVE
LAKEVIEW AVE
CLARK AVE
WILLIAMS AVE
HILLCREST AVE
EDGEWOOD AVE
BROOKLAWN CR.
8TH
7TH
6TH
5TH
4TH
3RD
LAKE SHORE BLVD
WISCONSIN APPLETON CO
WATER TREATMENT PLANT
LAKEVIEW SCHOOL
HOUSING PROJECT
LITTLE LEAGUE
EVERBRITE ELECTRIC SIGNS
SEWAGE TREATMENT PLANT
MARINA ROAD
LAKEVIEW RD
GOLF COURSE
BATHING BEACH
N
PROPOSED PROJECT
LAKE MICHIGAN


PROPOSED PROJECT
LAKE MICHIGAN
M-3
N
RIVERTON RD.
GRACE LUTH. CHURCH
CARROLTON SCHOOL
ST. MATTHEW'S CATHOLIC CHURCH SCHOOL & CEMETERY
OTJEN RECREATION AREA
ADDISON LANE
AMERICAN AVE
RYAN ROAD
BENDER PARK
GARDEN PLACE
FITZSIMMONS ROAD
OAK LANE (PRIVATE ROAD)
O'BRIEN ROAD
OAKWOOD ROAD
FIRE ST. NO. 2
BARTON RD
SCANLAN ELEMENTARY SCHOOL
ELM ROAD
MAS PARK
WEPCO POWER PLANT
BECKER RD
SCHMITZ DR
MILWAUKEE COUNTY
RACINE COUNTY

Land uses along the shoreline are mixed but are summarized by type as follows:

Occupant	Approximate Linear Feet of Shoreline	Percent of Total
City of South Milwaukee - water filtration plant, yacht club marina, and sewerage treatment plant	950	4.9
Privately Held Residential		
Improved - 5 parcels	499	2.6
Vacant Land - 9 parcels	2,648	13.7
Privately Held Industrial		
Improved - 5 parcels	4,350	22.5
Vacant Land - 1 parcel	860	4.5
Privately Owned Marina - 1 parcel	150	0.8
City of Oak Creek - water intake and storm water drainage ditch	460	2.4
Metropolitan Sewerage Commission - sewerage treatment plant	3,290	17.0
Milwaukee County Park Commission - Bender Park	6,100	31.6
Total	19,307	100.0

A detailed summary of ownership and corresponding plats are contained in an exhibit section at the end of this report.

The South Milwaukee water treatment plant and the South Milwaukee Yacht Club are at the mouth of Oak Creek, at the north end of the proposed project. The location is immediately south of a boat ramp facility at the southeasterly corner of Grant Park.

The only industrial facilities in the shoreline project area within the city of South Milwaukee are the large Everbrite Electric Sign Company plant and the South Milwaukee sewerage treatment facility.

All of the improved residential properties and vacant residential lots are within the corporate limits of South Milwaukee. This also holds true for the privately held marina.

The Metropolitan Sewerage Commission sewerage treatment plant occupies a large area at the northeast corner of the city of Oak Creek near the center of the proposed project. In addition to upland, the facility includes land which has been reclaimed from Lake Michigan.

All of the improved industrial properties in the shoreline project area within Oak Creek are situated immediately south of the sewerage treatment plant. These include an industrial adhesives and glues plant of Peter Cooper Corporation, a fertilizer plant of Hynite Corporation, the Vulcan Materials Company metals division plant, the city of Oak Creek water intake facility, and an industrial complex of Allis-Chalmers Corporation including laboratories, testing facilities, and a warehouse. The only tract of vacant industrial land is situated immediately south of the Allis-Chalmers complex.

The remainder of the proposed project comprises Bender Park, occupying the shoreline between Ryan Road and Oakwood Road. At the present time, Bender Park has only nominal development consisting primarily of gravel roads.

Beyond the proposed project limits, from Oakwood Road south to the Racine County Line, the shoreline is owned by the Wisconsin Electric Power Company. This encompasses approximately 6,000 feet of shoreline, or about 1.14 miles. The large power plant is situated south of Elm Road partly on land reclaimed from Lake Michigan. The power company owns a substantial amount of surrounding land.

Topography of the upland throughout the proposed project varies from level to rolling, and most of the undeveloped land is covered with brush and some woods. The bluff to Lake Michigan varies from approximately 60 to 100 feet. Reportedly, erosion during the past 100 years has claimed as much as 300 feet of the shoreline as a result of wave action below and ground water runoff from above.

At the present time, there are several proposed plans for development of public access and stabilization of the beach and bluff. Common to each plan are an enlarged marina at the present South Milwaukee Yacht Club, a new marina at Bender Park, and a bicycle-foot path over a breakwater which would protect the remaining beach over the length of the project. The various plans differ in the amount of fill required, the extent of bluff stabilization, and the resultant lands and lagoons.

Valuation

The valuation of riparian rights may consider either or both of two approaches: market analysis or value to an enterprise.

Market Analysis

This is the most direct method of valuation. In this approach, the appraiser gathers recent transactions involving riparian rights as well as sales or offerings of property without riparian rights. These paired sales are compared with regard to date of transaction, location, size, topography, improvements, utilities, zoning, and prospective use. After proper adjustments for these factors, the differences between the indicated unit prices of the sales with riparian rights and those without would indicate the value of the riparian rights.

This preliminary investigation did not reveal any recent sales of any class of land within the project area where the value of riparian rights could be isolated. Approximately ten years ago, Peter Cooper Industries traded their riparian rights to the park commission for fill rights and lakeshore protection. As a part of the agreement, the park commission was to gain title to any land accretion around the breakwater.

There are several vacant residential lots along the east line of 3rd Avenue in South Milwaukee which are currently for sale at about $18,000 per lot. These lots have about 90 feet of street frontage, but the usable depth is seriously being affected by the present erosion of

the bluff. Whether a building permit could be obtained is questionable. Other residential lots in South Milwaukee, without lake exposure, are currently selling for $15,000 to $22,000 for lots of sizes 60 feet by 120 feet to 66 feet by 130 feet. Residential lots in the city of Oak Creek are currently selling for $20,000 to $25,000 for lots of sizes 65 feet by 140 feet to 100 feet by 160 feet. Based on this limited information, riparian rights do not appear to offer a premium considering the topography.

Industrial land in the established Northbranch Industrial Park of Oak Creek is currently selling within the range of $13,000 to $29,000 per acre, with most sales in a fairly tight range of $22,000 to $24,000 per acre. In the Southbranch Industrial Park of Oak Creek, land has been selling within the range of $11,000 to $24,000 per acre. There has not been any industrial land activity in South Milwaukee since 1978. The most recent sales until that time were within the range of $10,000 to $18,000 per acre. The industrial land along the lakeshore within the project area is considered inferior to the industrial parks with regard to freeway access, soil erosion problems, and the proximity to possibly offensive property uses such as sewerage treatment plants.

Waterfront industrial land in the Milwaukee harbor, including the Menomonee Valley, has recently sold within the range of $30,000 to $60,000 per acre. Variances in selling prices are generally related to size, location, condition of the bulkhead, and proposed use.

A tract of 52.76 acres on the south side of Fitzsimmons Road adjacent to Bender Park is currently for sale at $110,000, or $2,085 per acre. This land does not have exposure to Lake Michigan. Sale of this tract has been curtailed by the lack of the availability of sewer and water.

Raw residential subdivision land in Oak Creek, with sewer and water available, has been selling within the range of $6,000 to $11,000 per acre. Where these utilities were not available, the selling price range was $1,500 to $7,000 per acre, with most sales within the range of $3,800 to $6,000 per acre. In South Milwaukee, raw residential

subdivision land with sewer and water available has been selling within the range of $8,000 to $10,000 per acre.

A recent project in the North Shore area of Milwaukee County provides indirect indication to the value of riparian rights when paired sales are considered. The area is along the Lake Michigan shoreline in the village of Whitefish Bay, between East Henry Clay Street on the south and East Silver Spring Drive on the north. For some time, the lake bluff had been eroding, endangering the exclusive mansions in this neighborhood. In about 1975, Foundation Engineering, Inc., was called upon to attempt to arrest this situation. Work varied from property to property but included buttressing the bluff with concrete block ballast, constructing a limestone breakwater, draining an unstable sand layer which is sandwiched between layers of clay, and terracing the bluff. According to Dr. William Painter, President of Foundation Engineering, Inc., the average cost per linear foot of shoreline was approximately $150. This unit price reflects, in part, the availability of ballast material in the immediate area from construction projects and the freedom from dumping fees. Current costs in the Grant Park/Bender Park project area could be considerably higher due to inflation and distances involved.

Pairing sales of properties within the Whitefish Bay project before and after the beach and bluff stabilization provides some indication of the value of the shoreline and thus the riparian rights. Although rights to the beach were inherent in the properties prior to the stabilization, their use and value were essentially limited due to the topography and erosion. In analyzing these sales, consideration is given to selling prices before and after the stabilization, an allocation between land and improvements based on assessment data, general increase in property values between the sales dates, and the estimated cost of the beach and bluff stabilization.

The property at 5240 North Lake Drive was acquired by Stephen King on July 29, 1977, for $220,000. The property consists of an older mansion situated on a land parcel with approximately 250 feet of road

frontage and an average depth of about 650 feet. Based on the assessed valuation, the allocated value of this sale is $80,000 for land and $140,000 for improvements. The property is currently under contract for purchase at $360,000. Analysis of this sale is as follows:

July 1980 Sale Price	$360,000	
July 29, 1977, Sale Price	220,000	
Difference		$140,000
Cost of Beach and Bluff Stabilization 250 feet @ $150 = $37,500	Say	40,000
		$100,000
Increase in Property Value after three years $220,000 @ 25% (Removes effect of inflation)	Say	(55,000)
Enhancement of Property Value as a Direct Result of Stabilization	$ 45,000 or $180 per linear foot of shoreline	

The property at 5530 North Lake Drive was sold by Dorothy Kohner to Curtis J. Schwarten and Jerry C. Schwarten (d/b/a Spartan Real Estate Company) on May 20, 1975, for $75,000. The property consists of a single-family dwelling on a land parcel with 95 feet of road frontage and an average depth of about 320 feet. As a result of erosion, the bluff was approximately ten feet from the rear of the dwelling. Based on the assessed valuation, the allocated value of this sale is $25,000 to land and $50,000 for improvements. The property was resold on July 18, 1975, to Lowell C. and Suzanne Norman for $77,500 and again resold on March 5, 1977, to Jay Barrett, Jr., and William D. Painter for $82,000. Approximately $15,000 of improvements were made to the dwelling in addition to the beach and bluff stabilization. On December 14, 1977, following completion of the stabilization, the property was resold to William D. and Mary Jane Jefferson for $125,000. Analysis of this sale is as follows:

December 14, 1977, Sale Price		$125,000	
May 20, 1975, Sale Price		75,000	
Difference			$ 50,000
Cost of Beach and Bluff Stabilization 95 feet @ $150 = $14,250		Say	15,000
			$ 35,000
Increase in Property Value - Time	$10,000		
Improvements	15,000		(25,000)
(Removes effects of inflation and betterment)			
Enhancement of Property Value as a Direct Result of Stabilization			$ 10,000 or $105 per linear foot of shoreline

The enhancement of property value as a direct result of beach and bluff stabilization may logically be called the value of riparian rights in these two examples since the estimated cost of stabilization has been deducted. Prior to the project, these properties had only limited use of their riparian rights. As a result of the project, the availability for use of these rights is greatly increased in addition to arresting erosion and providing protection for existing improvements on the top of the bluff.

Considering locational amenities, these residential properties in Whitefish Bay are superior to those in South Milwaukee. The investigation did not reveal the differential between residential and industrial land; however, it appears a lesser unit would be appropriate considering the less intensive use.

Value to an Enterprise

The value of riparian rights to an enterprise can be measured by comparative analysis with similar enterprises not situated on the shoreline, when it can be shown that such location is essential to efficient operation. This in-depth analysis must be done on an individual property basis and is beyond the scope of this report.

Alternatives of Acquisition

Riparian rights may be acquired through purchase, lease, or easement. Although we have not investigated the legal implications of these procedures, it would seem that individual property appraisals would be required which would set out the value of the property before the acquisition and the value of the property after the acquisition, assuming completion of the improvements in accordance with plans and specifications. These appraisals would logically include consideration of general and special benefits as they relate to the properties in question. Under current eminent domain in the state of Wisconsin, special benefits accruing directly and solely to the advantage of the property remaining after a partial taking may be set off against the severance damages. There is no setoff of general benefits which accrue to the community, to the area adjacent to the improvement, or to other property similarly situated as that taken.

Conclusion

The proposed plans for stabilization of the beach and bluff in the project area vary, but all include enlargement of the marina at the present South Milwaukee Yacht Club, a new marina at Bender Park, and a bicycle-foot path over a breakwater which would protect the remaining beach. In areas where private property is involved, there are openings in the breakwater to allow ingress and egress to Lake Michigan. It would seem, therefore, that the use and value of the riparian rights to the owners would remain substantially intact, but this is subject to legal interpretation. The breakwater would greatly protect the beach and bluffs from further erosion as a result of wave action, thereby benefiting the property owners.

The investigation revealed little data which isolates the value of riparian rights from the total bundle of rights. Analysis of several paired sales in Whitefish Bay before and after beach and bluff

stabilization indicate $105 and $180 per linear foot of shoreline. This location is considered superior to the Grant Park/Bender Park project area. On this basis, it is concluded that the value of riparian rights vary from a nominal amount to, say, $100 per linear foot. Considering the intensity of use and locational factors peculiar to different types of property, riparian rights are of value (in descending order of magnitude) for water-related commercial facilities such as marinas, residential properties, industrial properties, and parks.

The value of created land would relate directly to adjoining and nearby lands. Based on this limited investigation, it is concluded that this value would fall within the range of $2,000 to $10,000 per acre.

Respectfully submitted,
THE AMERICAN APPRAISAL COMPANY
By

Vice President

O. W. Liessmann
August 4, 1980

Investigation and Report
By R. J. Gemeinhardt

EXHIBIT A

MILWAUKEE COUNTY PARK COMMISSION

SUMMARY OF OWNERSHIP

Tax Key Number	Location	Owner	Land Area: Approximate Frontage on Lake Sq. Ft.	Land Area: Acres	Zoning	Present Use	Assessed Valuation - 1980: Land $	Assessed Valuation - 1980: Improvements $	Assessed Valuation - 1980: Total $
	South Milwaukee								
6116	North of Oak Creek	Milwaukee County Park Commission	N.A.	N.A.	Park and Parkway	Grant Park			Exempt
6144	East of Lake Shore Boulevard, north of Marshall Avenue	City of South Milwaukee	600	9.0±	Park and Parkway	City Water Filtration Plant and Yacht Club			Exempt
6145	East of Lake Shore Boulevard, south of Marshall Avenue	Edwin Benkowski	750	3.12	Park and Parkway	Vacant Land, Bluff	32,900	-	32,900
6146	East of 5th Avenue, south of Marion Avenue	Everbrite Investment Company	1,100	34.00	M-2, Heavy Industrial	Everbrite Sign Company Industrial Plant	227,900	1,392,500	1,620,400
6147	East of 5th Avenue, north of Drexel Avenue	City of South Milwaukee	350	12.00	M-2, Heavy Industrial	City Sewerage Treatment Plant			Exempt
6173-1	East of 5th Avenue, north of Marina Drive	Unicare Development Corporation	825	21.00±	M-2, Heavy Industrial	Mostly vacant land, older house at 3111 5th Avenue	174,000	17,700	191,700
6174	Foot of Marina Drive, east of 5th Avenue	Gary L. Luedtke	150	1.00±	RA, Residential	Lake Ridge Apartments and Lake Ridge Boat Club Marina	102,000	527,900	629,900
6177	230 Lakeview Road	Hilda I. Balbanz and Helen M. Rollman	130	1.50±	RA, Residential	Single-family residence	18,000	18,200	36,200
6180	235 Lakeview Road	Edward E. Gouin, Jr.	120	1.25±	RA, Residential	Single-family residence	17,000	28,600	45,600
6181	East side of 3rd Avenue (as platted) north of Williams Avenue	TRB Joint Venture	300	2.80±	RA, Residential	Vacant land, inaccessible at present	42,000	-	42,000
6183	East side of 3rd Avenue (as platted) north of Williams Avenue	TRB Joint Venture	200	1.75±	RA, Residential	Vacant land, inaccessible at present	22,000	-	22,000
6183-5	East side of 3rd Avenue at Williams Avenue	Esahage Haidarian	90	0.80±	RA, Residential	Vacant lot	13,000	-	13,000
6183-3	East side of 3rd Avenue at Williams Avenue	Paul R. Trautmann	93	0.85±	RA, Residential	Vacant lot	17,000	-	17,000
6183-1	East side of 3rd Avenue south of Williams Avenue	Theresa Accetta	60	0.55±	RA, Residential	Vacant lot	14,000	-	14,000
6183-2	3709 3rd Avenue	Larry R. Johnson	60	0.55±	RA, Residential	Single-family residence	17,300	39,900	57,200
6184	3713 3rd Avenue	Michael Varichak	129	1.20±	RA, Residential	Single-family residence	22,000	24,300	46,300
6188-1	3805 3rd Avenue	Frank Pinchar	60	0.55	RA, Residential	Single-family residence	17,400	30,600	48,000

Tax Key Number	Location	Owner	Land Area: Approximate Frontage on Lake	Land Area: Acres	Zoning	Present Use	Assessed Valuation - 1980: Land $	Assessed Valuation - 1980: Improvements $	Assessed Valuation - 1980: Total $
	South Milwaukee Contd.								
6188	3809 3rd Avenue	First Bank (N.A.)	60	0.55±	RA, Residential	Vacant lot	17,400	-	17,400
6190	East side of 3rd Avenue at Edgewood Avenue	Eugene J. Lenda	270	2.40±	RA, Residential	Vacant lot	18,000	-	18,000
	Oak Creek								
821-9999	8300 South 5th Avenue	City of Oak Creek	100	2.76	M-3, Heavy Manufacturing	Storm water drainage ditch			Exempt
821-9998	8400 South 5th Avenue	Metropolitan Sewerage Commission	1,270	31.78	M-3, Heavy Manufacturing	Sewerage disposal plant			Exempt
821-9997	8600 South 5th Avenue	Metropolitan Sewerage Commission	1,380	76.35	M-3, Heavy Manufacturing	Sewerage disposal plant			Exempt
866-9999	8740 South 5th Avenue	Metropolitan Sewerage Commission	640	32.28	M-3, Heavy Manufacturing	Sewerage disposal plant			Exempt
866-9992-001	9006 South 5th Avenue	Rousselot Gelatin Corporation	1,650	80.82	M-3, Heavy Manufacturing	Peter Cooper Corp. industrial adhesives and glues	163,300	638,800	802,100
866-9989	4301 East Depot Road	Hynite Corporation	430	7.33	M-3, Heavy Manufacturing	Fertilizer plant	14,800	30,000	44,800
868-9999-001	9100 South 5th Avenue	Vulcan Materials Company	120	22.43	M-3, Heavy Manufacturing	Vulcan Materials Co. Metals Division Plant	45,300	666,600	711,900
868-9998-002	9170 South 5th Avenue	City of Oak Creek	360	10.94	M-3, Heavy Manufacturing	City Water Intake			Exempt
868-9996-001	9180 South 5th Avenue	Allis-Chalmers Corporation	1,050	55.10	M-3, Heavy Manufacturing	Industrial complex-laboratories, testing, and warehouse	96,000	348,900	444,900
868-9993	4240 East Ryan Road	E. M. Boerke	860	66.32	M-3, Heavy Manufacturing	Primarily vacant land	12,650	4,150	16,800
914-9999	4503 East Ryan Road	Milwaukee County Park Commission	3,200	67.40	M-3, Heavy Manufacturing	Part of Bender Park, nominal improvements			Exempt
916-9999-001	4501 East Fitzsimmons Road	Milwaukee County Park Commission	2,900	92.25	M-3, Heavy Manufacturing	Part of Bender Park, nominal improvements (Total park 283,748 acres)			Exempt

Note: Reported assessed value to assessor's opinion of market value:
South Milwaukee 70%
Oak Creek 18.33%

EXHIBIT B-1

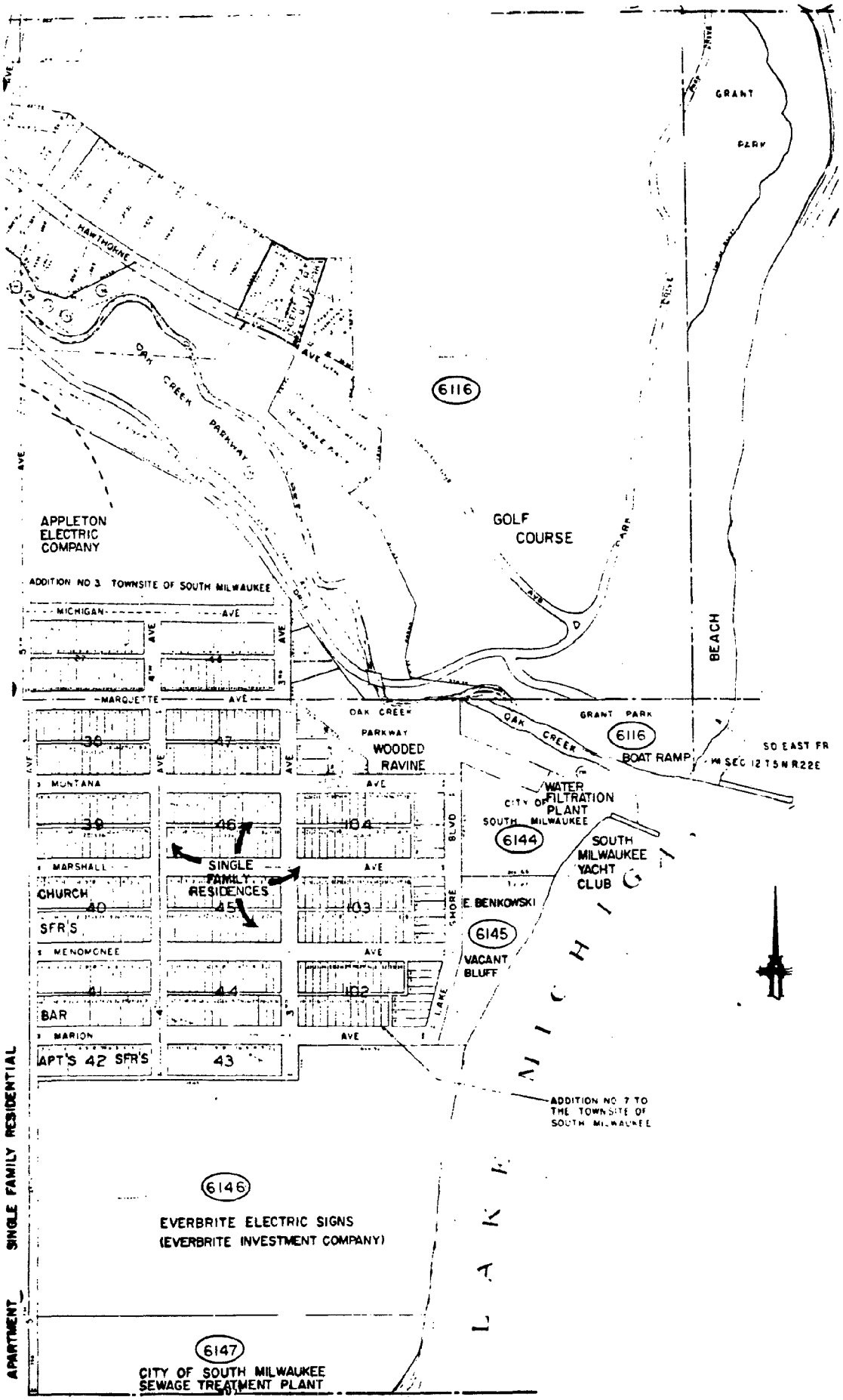

GRANT PARK
HAWTHORNE
OAK CREEK PARKWAY
6116
APPLETON ELECTRIC COMPANY
GOLF COURSE
ADDITION NO 3 TOWNSITE OF SOUTH MILWAUKEE
MICHIGAN AVE
MARQUETTE AVE
OAK CREEK PARKWAY
WOODED RAVINE
OAK CREEK
GRANT PARK
6116
BOAT RAMP
BEACH
SO EAST FR
SEC 12 T5N R22E
MONTANA AVE
WATER FILTRATION PLANT
CITY OF SOUTH MILWAUKEE
6144
SOUTH MILWAUKEE YACHT CLUB
MARSHALL AVE
SINGLE FAMILY RESIDENCES
CHURCH
SFR'S
E. BENKOWSKI
6145
VACANT BLUFF
MENOMONEE AVE
BAR
MARION AVE
APT'S 42 SFR'S
ADDITION NO 7 TO THE TOWNSITE OF SOUTH MILWAUKEE
6146
EVERBRITE ELECTRIC SIGNS
(EVERBRITE INVESTMENT COMPANY)
6147
CITY OF SOUTH MILWAUKEE
SEWAGE TREATMENT PLANT
SINGLE FAMILY RESIDENTIAL
APARTMENT
LAKE MICHIGAN

EXHIBIT B-2

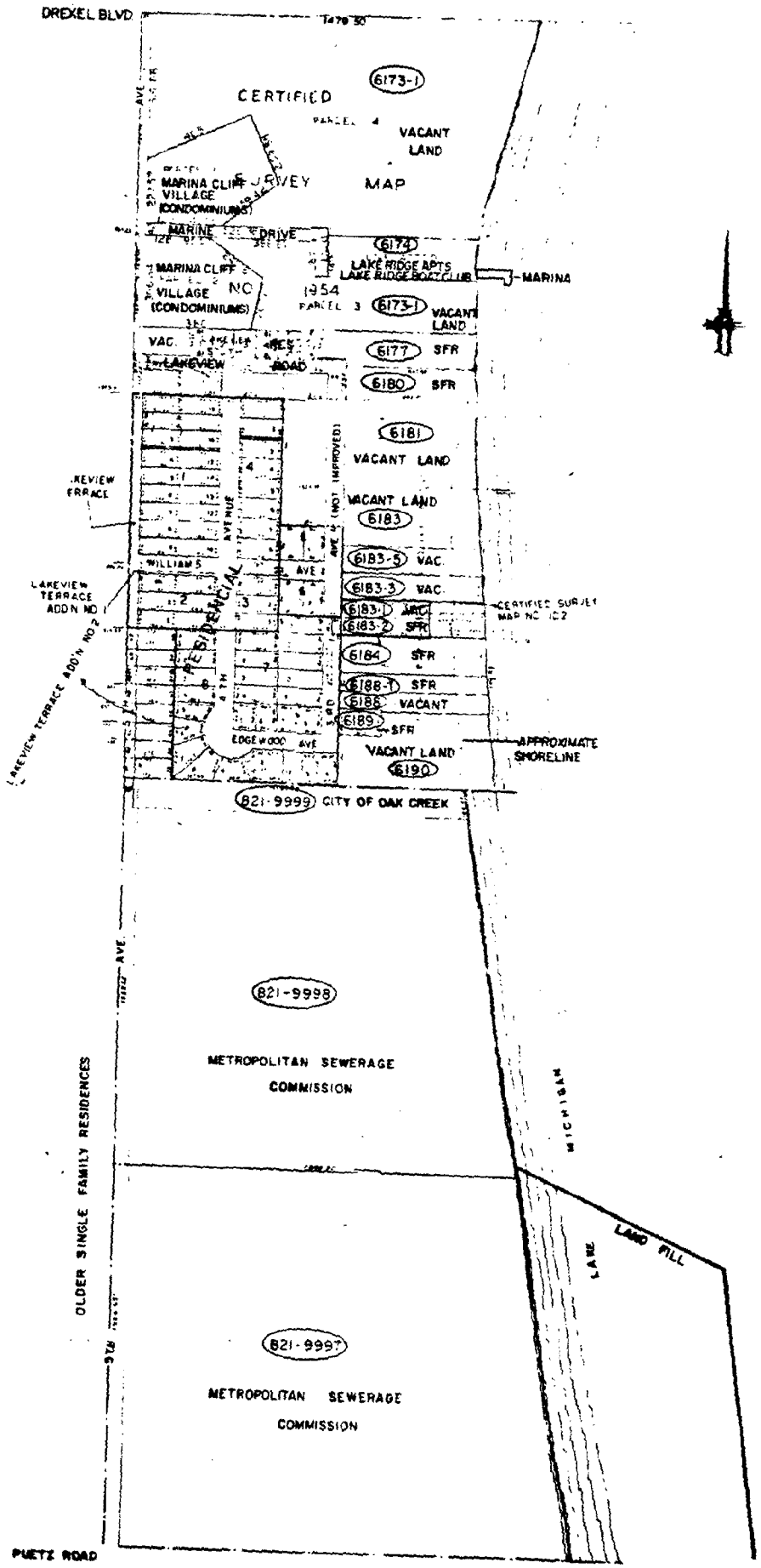
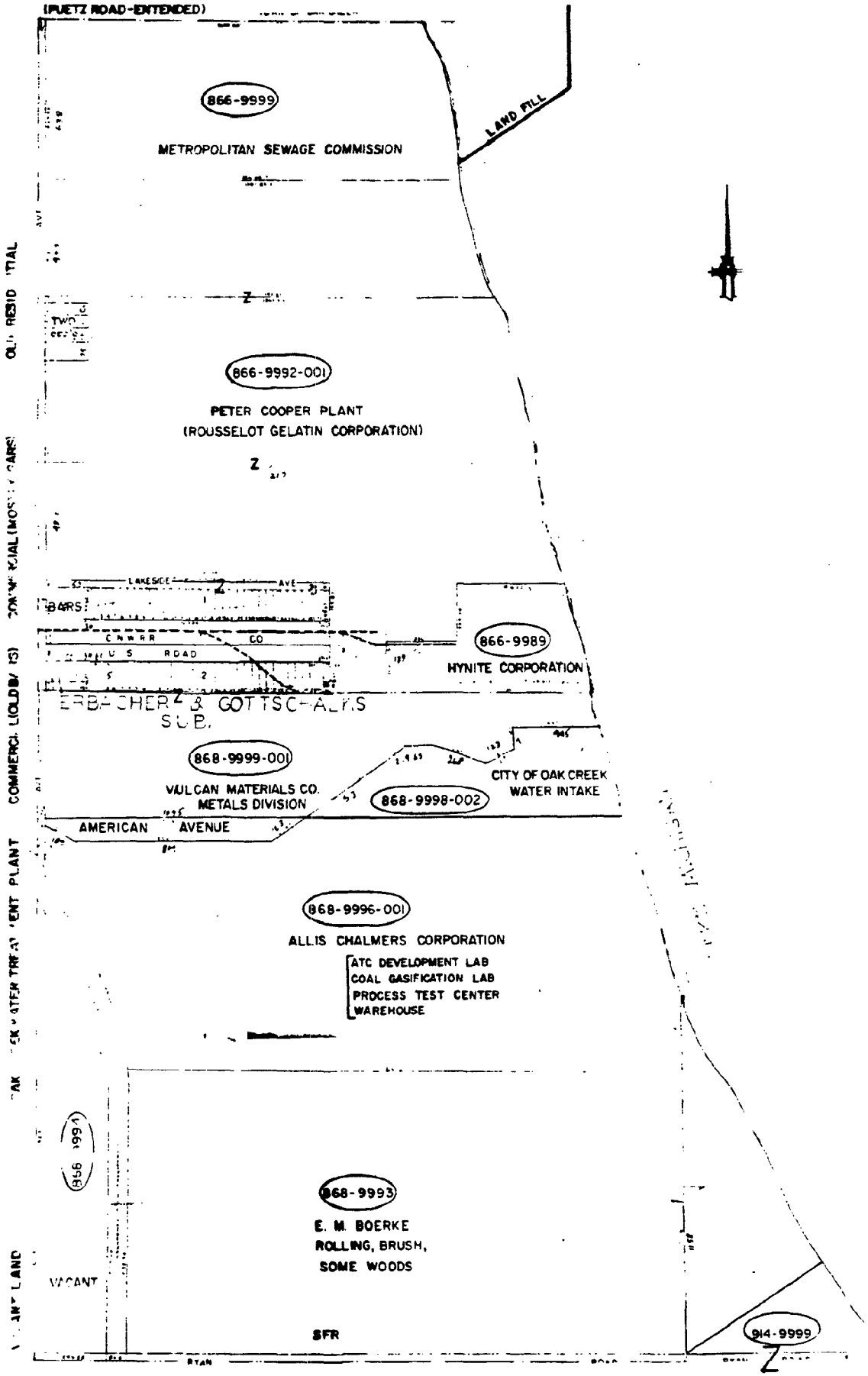

DREXEL BLVD
CERTIFIED
SURVEY
MAP
6173-1
VACANT LAND
MARINA CLIFF VILLAGE (CONDOMINIUMS)
MARINE DRIVE
6174
LAKE RIDGE APTS
LAKE RIDGE BOAT CLUB
MARINA
MARINA CLIFF VILLAGE (CONDOMINIUMS)
NO 1954
6173-1
VACANT LAND
VAC.
LAKEVIEW ROAD
6177 SFR
6180 SFR
6181
VACANT LAND
LAKEVIEW TERRACE
VACANT LAND
6183
WILLIAMS AVE
6183-5 VAC.
LAKEVIEW TERRACE ADD'N NO 1
6183-3 VAC.
6183-1 VAC.
6183-2 SFR
CERTIFIED SURVEY MAP NO 102
RESIDENCIAL
6184 SFR
6188-1 SFR
6188 VACANT
6189 SFR
LAKEVIEW TERRACE ADD'N NO 2
EDGEWOOD AVE
VACANT LAND
6190
APPROXIMATE SHORELINE
821-9999 CITY OF OAK CREEK
821-9998
METROPOLITAN SEWERAGE COMMISSION
OLDER SINGLE FAMILY RESIDENCES
MICHIGAN
LAKE
LAND FILL
821-9997
METROPOLITAN SEWERAGE COMMISSION
PUETZ ROAD

EXHIBIT B-3


(PUETZ ROAD-EXTENDED)
866-9999
METROPOLITAN SEWAGE COMMISSION
LAND FILL
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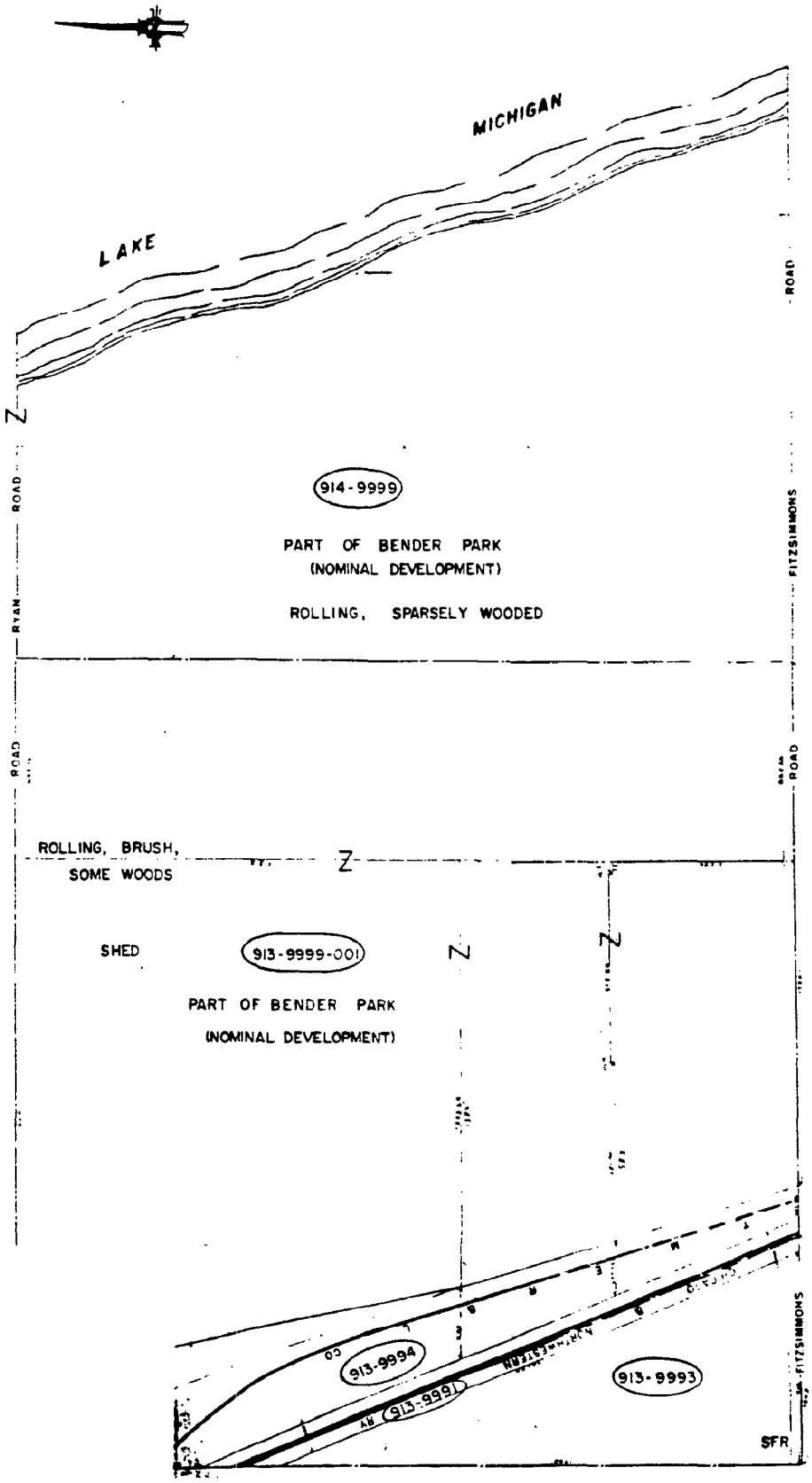
PETER COOPER PLANT
(ROUSSELOT GELATIN CORPORATION)
BARS
866-9989
HYNITE CORPORATION
868-9999-001
VULCAN MATERIALS CO.
METALS DIVISION
868-9998-002
CITY OF OAK CREEK
WATER INTAKE
AMERICAN AVENUE
868-9996-001
ALLIS CHALMERS CORPORATION
ATC DEVELOPMENT LAB
COAL GASIFICATION LAB
PROCESS TEST CENTER
WAREHOUSE
868-9993
E. M. BOERKE
ROLLING, BRUSH,
SOME WOODS
VACANT
SFR
914-9999

EXHIBIT B-4


LAKE MICHIGAN
914-9999
PART OF BENDER PARK
(NOMINAL DEVELOPMENT)
ROLLING, SPARSELY WOODED
RYAN ROAD
FITZSIMMONS ROAD
ROLLING, BRUSH,
SOME WOODS
SHED
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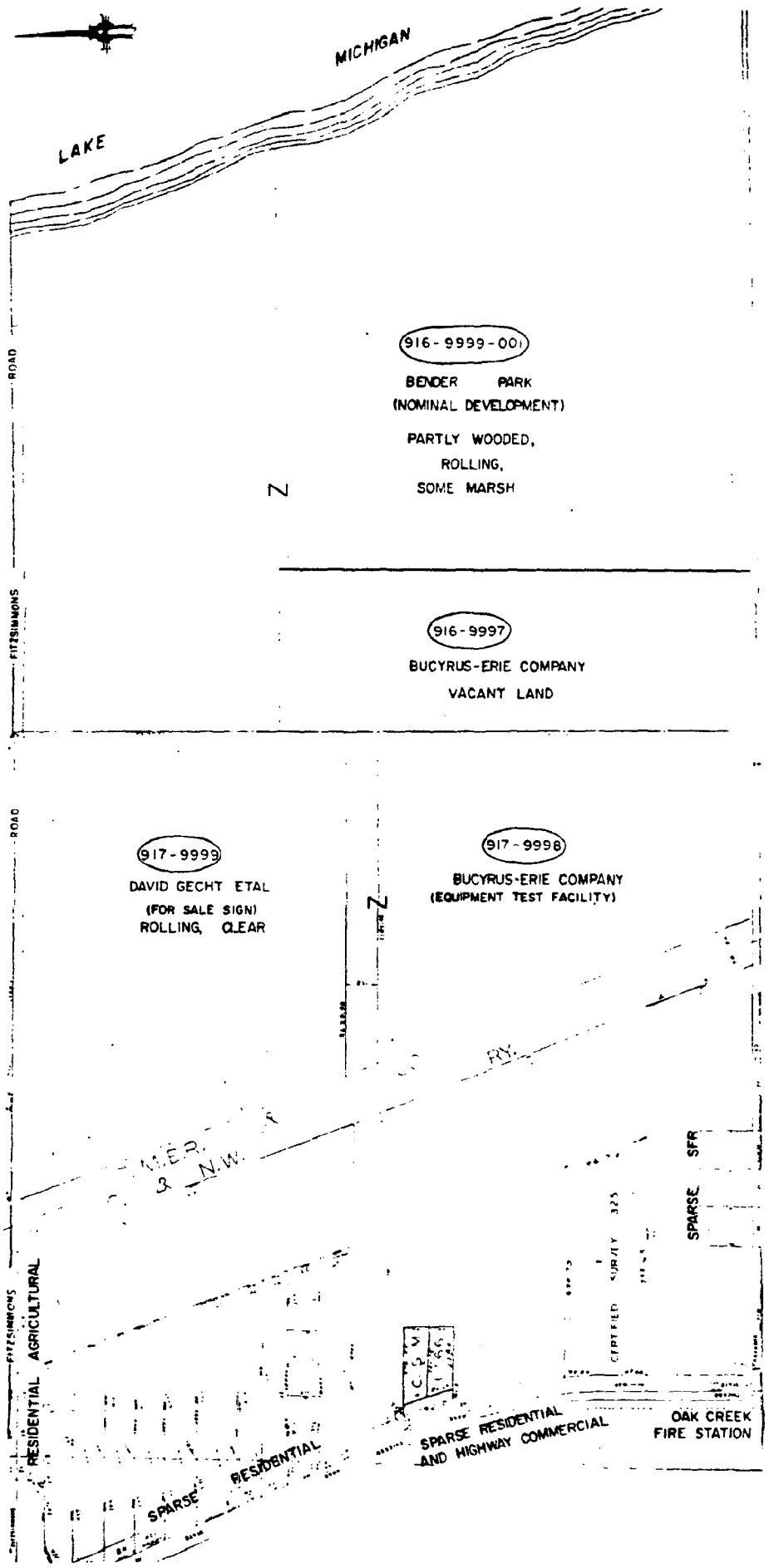
PART OF BENDER PARK
(NOMINAL DEVELOPMENT)
913-9994
913-9991
913-9993
SFR

EXHIBIT B-5


LAKE MICHIGAN
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BENDER PARK
(NOMINAL DEVELOPMENT)
PARTLY WOODED,
ROLLING,
SOME MARSH
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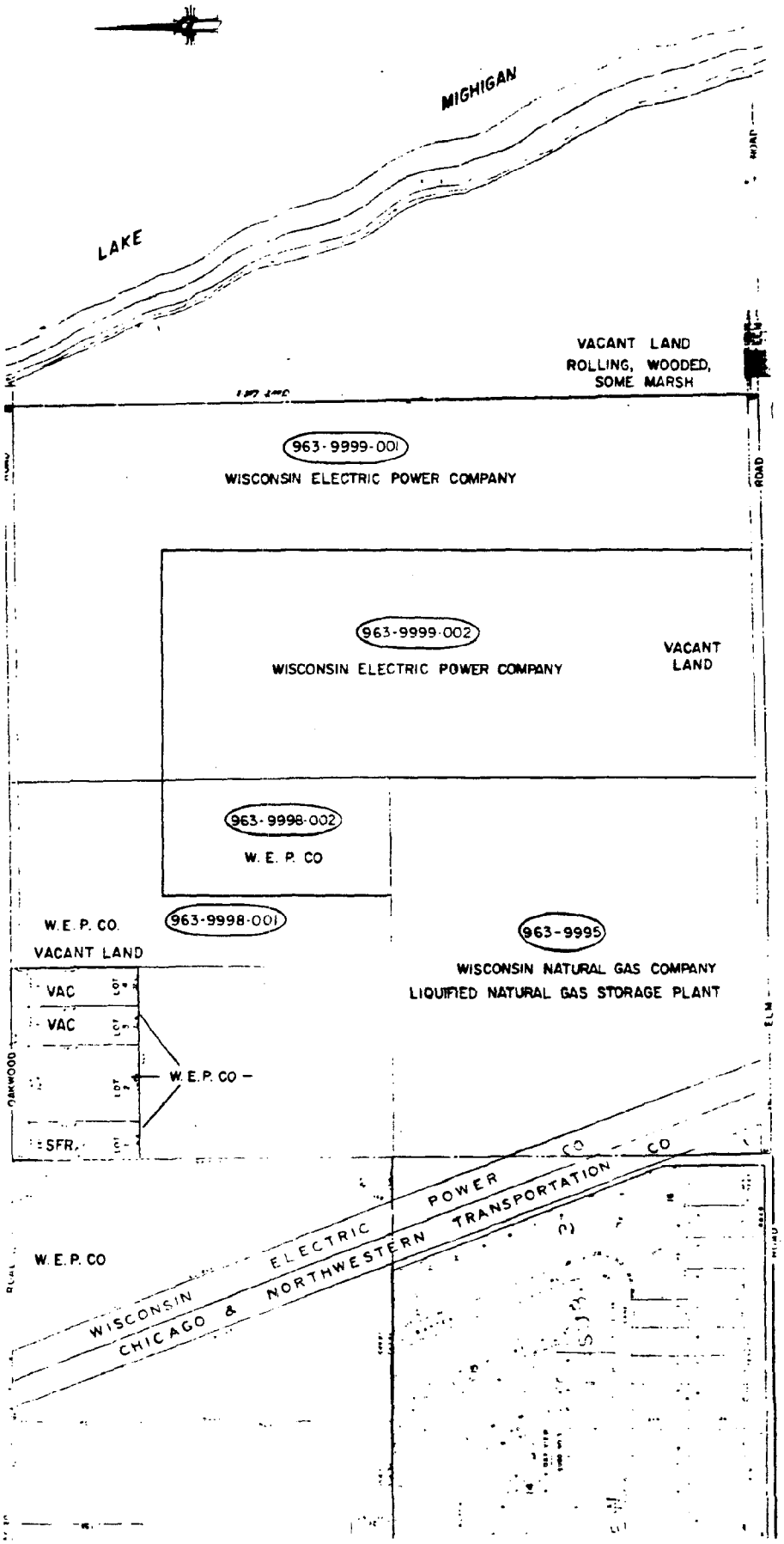
BUCYRUS-ERIE COMPANY
VACANT LAND
917-9999
DAVID GECHT ETAL
(FOR SALE SIGN)
ROLLING, CLEAR
917-9998
BUCYRUS-ERIE COMPANY
(EQUIPMENT TEST FACILITY)
RESIDENTIAL AGRICULTURAL
SPARSE RESIDENTIAL
SPARSE RESIDENTIAL
AND HIGHWAY COMMERCIAL
OAK CREEK
FIRE STATION
SPARSE SFR
FITZSIMMONS ROAD

EXHIBIT B-6


LAKE MICHIGAN
VACANT LAND
ROLLING, WOODED,
SOME MARSH
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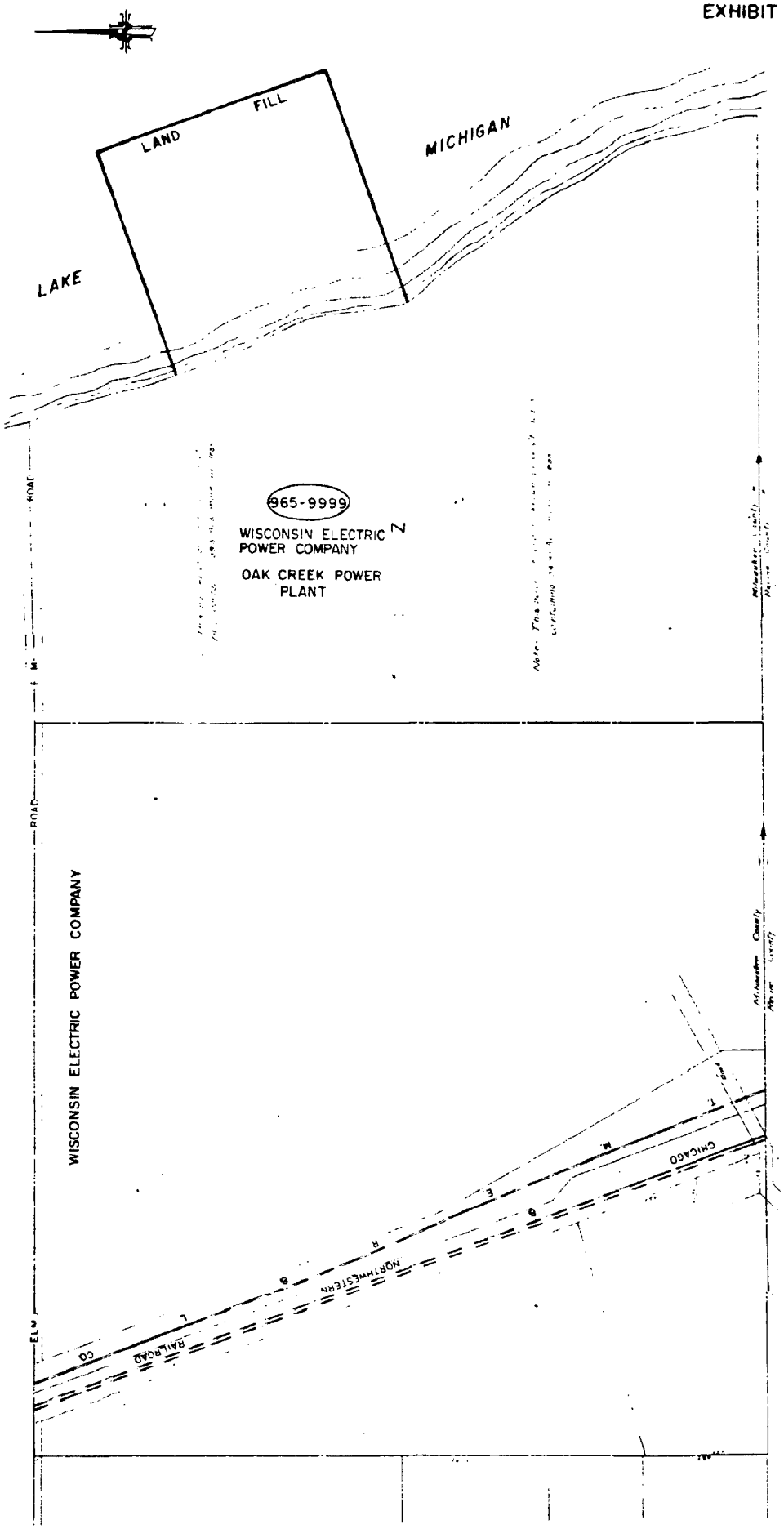
WISCONSIN ELECTRIC POWER COMPANY
963-9999-002
WISCONSIN ELECTRIC POWER COMPANY
VACANT
LAND
963-9998-002
W. E. P. CO
963-9998-001
W.E.P. CO.
VACANT LAND
963-9995
WISCONSIN NATURAL GAS COMPANY
LIQUIFIED NATURAL GAS STORAGE PLANT
VAC
VAC
SFR.
W. E. P. CO
W. E. P. CO
WISCONSIN ELECTRIC POWER CO
CHICAGO & NORTHWESTERN TRANSPORTATION CO

EXHIBIT B-7


LAND FILL
LAKE MICHIGAN
965-9999
WISCONSIN ELECTRIC POWER COMPANY
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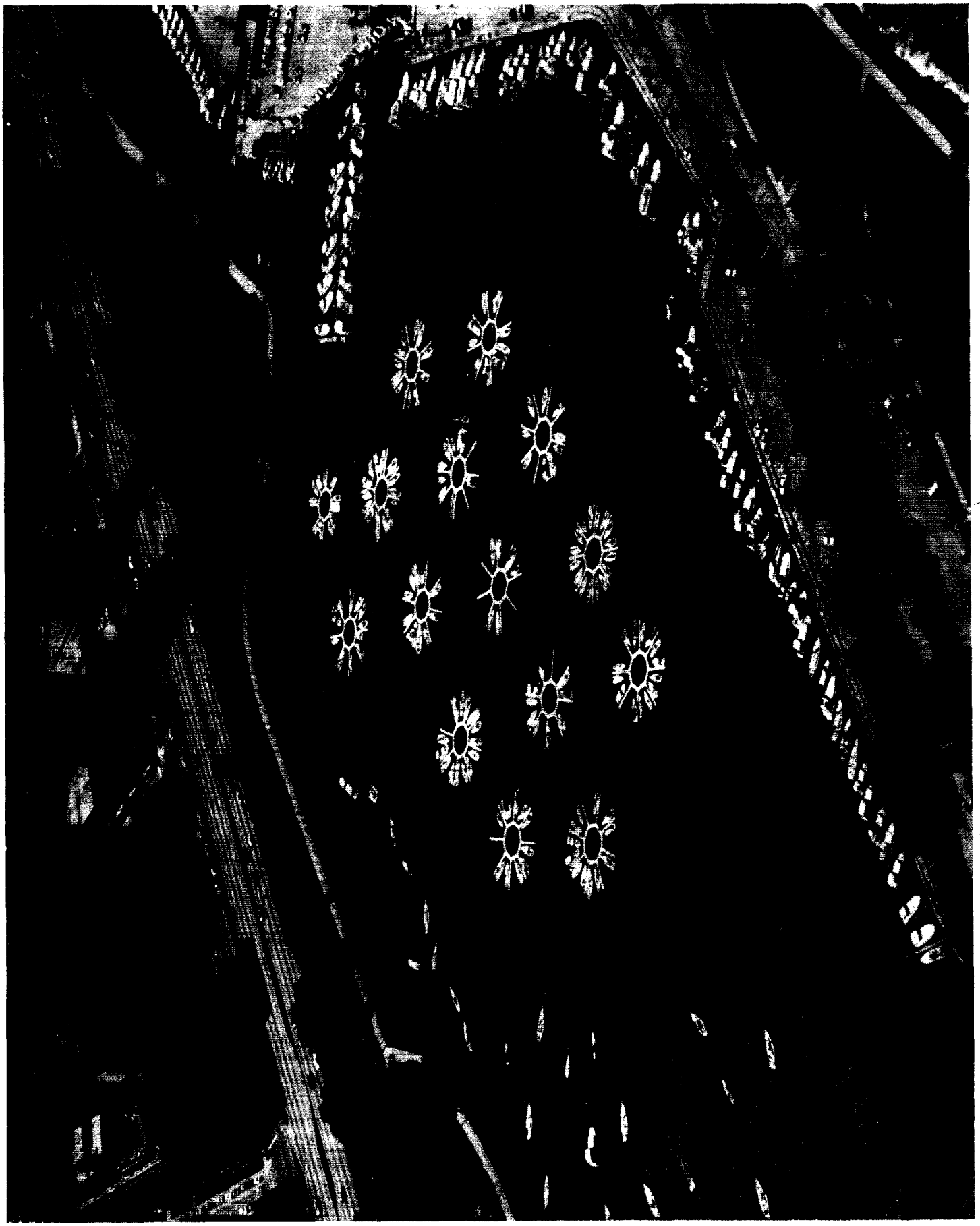
WISCONSIN ELECTRIC POWER COMPANY
CHICAGO NORTHWESTERN RAILROAD CO



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