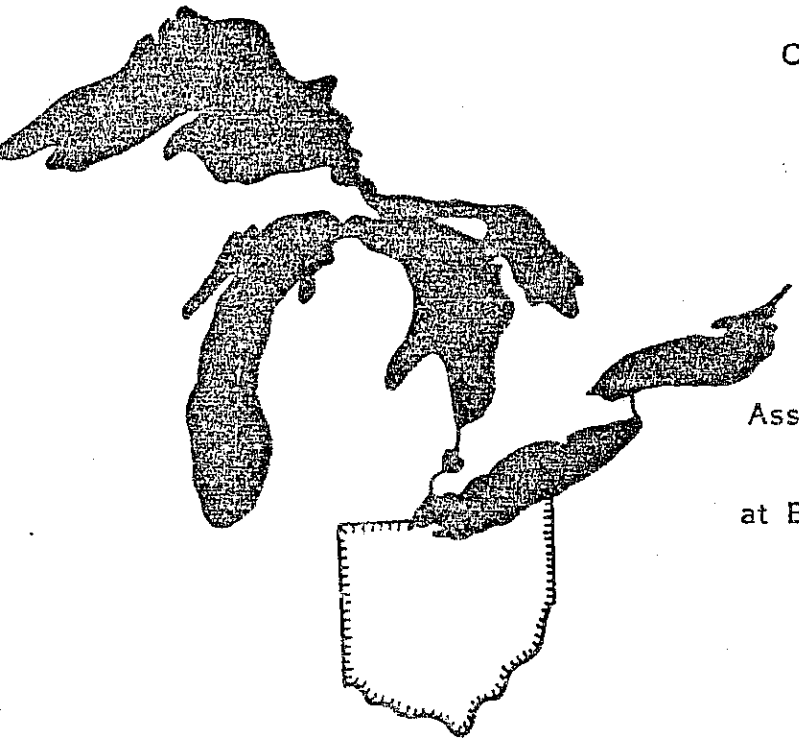

CLEAR TECHNICAL REPORT NO. 313

Assessment of the Anticipated Impacts to the Lake Erie Shoreline From the Construction of a Marina at Beachwood Villas in Erie County, Ohio

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for submission to

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March 1987

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EXECUTIVE SUMMARY

The Beachwood Shores Corporation of Huron, Ohio has made application to the Department of the Army to construct a private-boat marina on the south shore of Lake Erie approximately 6000 ft east of the Huron River in Erie County, Ohio. The Ohio Department of Natural Resources (ODNR), the U.S. Fish and Wildlife Service (US F&WS) and U.S. Environmental Protection Agency (US EPA) have expressed concerns to the U.S. Army, Corps of Engineers relative to potential adverse impacts to the adjacent shoreline if the construction is permitted. The purpose of this report is to describe an independent assessment, which considers all agency concerns and provides a set of recommendations designed to improve the proposed project. A key feature of the report is a new and more reliable analysis of sediment transport rates east of Huron, which show rates to be very low (less than 7000 cu yds/yr), especially in the inshore region from the shore out to 250 ft (less than 1000 cu yds/yr).

The proposed marina will consist of a breakwater system constructed of stone-filled timber cribs and placed armor stone. The structure will project 230 ft into the lake and provide wave-protection for about 66 recreational type boats at floating docks. The boat basin will be dredged to a depth of 4.6 ft below Low Water Datum (564.0 IGLD). Dredged material (sand and gravel) will be placed within the littoral system (below Ordinary High Water of 572.8 IGLD) to form fillets on the east and west sides of the marina. A sand by-pass system will be installed to move excess accumulated material (whenever fillets exceed 700 cu yds beyond original volume) to the downdrift side of the structures.

A relatively wide sand beach extends nearly 5000 ft east from the Huron east breakwater, tapering to a narrow beach west of the proposed marina. The bluffs in the vicinity of the project are largely protected against erosion. The predominant direction of littoral transport east of Huron is toward the west. The longer fetch distances to the northeast allow larger waves and greater wave energy to be directed to the west, accounting for net westerly movement of sand in the nearshore zone.

A new analysis of sediment transport in the study area, performed for this report, using Ohio Department of Natural Resources data gathered over a 9 yr interval, shows that the proposed marina lies in an area of accretion (or fillet) created by the Huron Harbor east breakater. The total sediment being transported within 1000 ft of the shore is small, less than 7000 cu yds/yr. Most of this transport takes place well offshore from the proposed structure, with less than 1000 cu yds/yr in the region of the marina.

ODNR, US F&WS and US EPA have issued comments on the proposed marina. These agencies expressed concerns about the lakeward projection of the breakwater structures, particularly the anticipated interruption of the littoral drift system. Questions were raised concerning the amount of sand that will be trapped by the structure and the potential for downdrift erosion. These agencies stressed the importance of an effective sand by-passing system and an adequate monitoring plan.

The U.S. Army, Corps of Engineers has also received comments from adjacent property owners and local agencies. These letters were supportive of the proposed project, including those from downdrift owners.

The assessment of the proposed project was undertaken to investigate the concerns expressed in the agency comments. The proposed marina breakwater will interrupt the natural flow of sediment in the littoral system, but the transport rates are low and the net accumulation is expected to be only 500 cu yds/yr. Because the project is located on the eastern flank of a massive fillet area created by the "shadow effect" of the Huron Harbor east breakwater, no downdrift erosion is anticipated, particularly with the recommended sand by-pass system to provide downdrift nourishment. Comparison with another marina project 4 miles east of the site tends to confirm that the calculated low rate of littoral transport in this area.

Based on the assessment of the proposed project, a set of recommendations were formulated to improve the marina design and operation. The basic design of the marina is reasonable. Minor alterations are recommended including: (1) smaller diameter, multiple unit culvert system with flap-type check gate to control sediment passage, (2) slight increase in the easterly projection of the north breakwater to provide storm protection and (3) incorporation of existing middle groin into east breakwater design. Specific recommendations are provided for an eductor type sand by-pass system which included the placement of two semi-permanent suction-heads. The by-passed material should be returned to the littoral system for the benefit of the downdrift shoreline. Placing sand lakeward at the north breakwater is not recommended. A monitoring plan, a long-term maintenance plan and a long-term ownership plan are recommended to ensure that the sand by-pass system will perform as anticipated and that there will be continuing responsibility for the facility.

In conclusion, the project as proposed (with implementation of the recommendations) will have very little impact on the adjacent shoreline of Lake Erie, given the low rate of littoral transport. This is particularly the case because the project lies within the fillet area of Huron east breakater which is still experiencing slow accretion. Any short-term adverse impact to the downdrift shore will be mitigated by a rapid-response, sand by-passing system. Effective monitoring, maintenance and ownership plans have been proposed which will ensure the long-term and appropriate operation of this facility. Given these considerations, the agency concerns have been satisfactorily addressed and a permit to undertake this project can be issued with negligible risk to the Lake Erie shoreline.

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INTRODUCTION

Background

The Beachwood Shores Corporation of Huron, Ohio has proposed the construction of a 66-slip marina in conjunction with the Beachwood Villas Condominium community, Huron Township, Erie, County, Ohio. The developer has submitted an application for a permit to undertake this work in Lake Erie to the U.S. Army Corps of Engineers, Buffalo District. On January 15, 1987, the Buffalo District published Public Notice 86-475-11 which described the proposed construction project (Appendix A) and solicited comments from governmental agencies and private citizens in regard to the issuance of the requested permit.

Three agencies, the Ohio Department of Natural Resources (ODNR), the U.S. Fish and Wildlife Service (USF&WS) and the U.S. Environmental Protection Agency (USEPA) have submitted letters to the Buffalo District which express concerns about the proposed marina. The primary concern deals with anticipated adverse effects of adjacent shoreline areas which may be caused by the disruption of existing coastal processes. The Ohio Environmental Protection Agency (Ohio EPA) has also expressed concern about adequate water circulation within the marina.

Purpose of Report

The purpose of this report is to present the results of an in-depth analysis and assessment of the anticipated impacts of the proposed marina construction on the shoreline of Lake Erie. In particular, the report is intended to provide a detailed examination of the concerns expressed by ODNR, USF&WS, USEPA, and Ohio EPA. The report also contains several recommendations to improve the marina design and operation in response to several issues raised by the state and federal agencies in their reviews of the proposed project.

PROPOSED MARINA

Description of Project Construction

The proposed marina facility at Beachwood Villas will consist of several elements which require Department of the Army (DA) authorization: (1) installation of stone-filled timber cribs and placement of stone to form a breakwater protected marina, (2) installation of culvert for exchange of water and fish, (3) excavation and dredging of lake bottom material to accomplish the placement of the breakwater and to form the marina basin, (4) disposal of dredged sand and gravel within the littoral system adjacent to the structure, (5) installation of floating walkway and docks and steel sheet pile bulkhead to facilitate docking and (6) installation of a sand by-pass system. (Appendix B)

Breakwaters. To provide safe protection for the boat basin a breakwater system will be installed which consists of stone filled timber cribs and the placed stone. The westerly breakwater will extend about 230 ft lakeward of the shoreline in an angled alignment, then easterly about 380 ft. The easterly breakwater (180 ft long) will extend about 110 ft lakeward from the shoreline, leaving an inlet entrance channel to the marina of about 70 ft in width. The breakwaters will be constructed largely from the land, with some armor being placed from a floating plant. An estimated 9,400 cu yds of crib core and armor stone will be placed, about 6,000 cu yds of this total will be place below Ordinary High water (OHW = 572.8 IGLD) and occupy about 34,300 sq ft of lake bottom. These quantities do not include upland construction areas.

Water exchange culvert. A 48 inch diameter corrugated metal culvert will be installed at the northwest corner of the westerly breakwater to provide for the exchange of water and for fish passage.

Excavation and dredging. An estimated 15,000 cu yds of sand, gravel and clay will be excavated or dredged to an elevtion of about 564.0 ft IGLD. This will be required to accomplish the installation of the breakwaters and to provide navigational clearance within the boat basin and entrance channel. This work will be accomplished by a suction dredge on a submerged boom and/or a floating plant.

Disposal of dredged materials. An estimated 1,500 cu yds of sand and gravel will be placed along the west side of the westerly breakwater and shoreline (below OHW)to form a fillet which will occupy about 9,700 sq ft of lake bottom. An additional estimated 500 cu yds will be placed along the east side of the easterly breakwater and shoreline (below OHW) to form a fillet which will occupy about 3,500 sq ft of lake bottom. The remaining sand and gravel will be disposed of within the littoral system, downdrift (westerly) from the project. The purpose of the fillets is to provide natural shore protection and a reservoir of material to the littoral system. If there is insufficient suitable material from the project dredging, additional sand will be obtained from an upland source to complete the fillets.

Floating walkway and docks. A main floating walkway about 240 ft long and having four 4 ft wide by 30 ft long and 15 4 ft wide by 24 ft long finger docks will be installed in the boat basin. A 4 ft wide by 160 ft long floating dock and an 18 ft long "L" section will be installed along and parallel to a steel pile bulkhead at the southerly side, two 4 ft wide by 26 ft long floating finger docks will be extended from the concrete capped crib bulkheads.

Bulkheads. The southerly side of the marina will consist of 140 ft of steel sheet piling with tie backs and 125 ft of stone filled timber cribbing with a concrete cap. The steel sheet pile will connect to the westerly breakwater and the crib; the cribs will connect to the easterly breakwater. The construction work for the southerly side of the marina will require excavation into bluff above OHW. The entire southerly side will be completed in the dry, above Department of Army (DA) jurisdiction and will not require DA authorization.

Sand by-pass system. An 8 inch diameter sand by-pass pipeline and suction pumping equipment will be installed to permit by-passing 80 cu yds of littoral material per hour in either direction.

Marina Operation

Maintenance dredging. As required for navigational clearance, maintenance dredging in the boat basin and entrance channel will be conducted. The dredged material will be discharged into the littoral system, downdrift (westerly) from the project.

Sand by-passing. When accretion of littoral material at the fillets reaches 700 cu yds beyond the proposed dimensions of the fillets, the excess accumulated material will be by-passed into the littoral system, down drift of the accumulation. The pumping system will be capable of by-passing this amount of material in approximately 9 hours.

PHYSICAL CHARACTERISTICS

The nearshore sediments and coastal processes in the study area (Huron River to the mouth of Old Woman Creek) have been investigated by the U.S. Army, Corps of Engineers (1946, 1953, 1984), Goodman (1956), Pincus (1960), Herdendorf (1963), Carter and Guy (1980) and Worthy (1980). The following description is based on these reports and field observations of the authors.

Coastal Features

Beach dimensions and materials. A wide sand beach extends from the east breakwater of Huron Harbor in an easterly direction for a distance of approximately one mile. The beach is about 200 ft wide at the breakwater and becomes progressively narrower east of this structure, pinching out just west of the proposed marina (Figure 1). The project site lies approximately 3000 ft west of Old Woman Creek.

Bluff height and material. The ground level behind the beach ranges from 3-20 ft above mean lake level (571.4 IGLD). This land is highly developed for residential purposes. About 50% of this shoreline has protective structures, largely along the easterly half of the reach.

Nearshore bottom topography and sediments. The nearshore zone between Old Woman Creek and the Huron River is characterized by 1 - 10 ft of sand covering glacial till or shale. This sand is thickest adjacent to the east breakwater and thins to the east. A persistant sand bar lies 200 - 300 ft offshore (U.S. Army, Corps of Engineers 1953, Carter and Guy 1980, Worthy 1980).

Hartley (1964) observed that in the Huron area most of the nearshore sand deposits are very fine-grained in nature. He concluded that most of the offshore material being transported within the littoral system is too fine to remain on the beach, even if transported shoreward by wave action.

A possible problem in using the fillet method is the unknown amount of sand that travels around the lakeward end of the east breakwater and is lost to the littoral system in the Huron River channel. Worthy (1980) explored this problem and found that the water depth at the breakwater tip is about 20 ft deep and that the lakeward limit of wave influence as revealed by sediment characteristics is about 15 ft. Therefore, it appears that the water depth is too great for significant sediment transport around the end of the breakwater. Worthy (1980) also obtained additional evidence that sand is not getting around the jetty from the construction firm under contract to the Corps of Engineers to dredge the Huron River channel in the vicinity of the breakwater consisted of silt and clay with no sand. Thus, the fillet-method appears to be reliable method for estimating the annual rate of nearshore sediment transport in the study area.

Based then, on the assumption that the Huron east breakwater interrupts all of the sediment transport, change in the fillet volume over a span of several years is needed to determine a reliable rate. The authors obtained from the Ohio Department of Natural Resources fathograms from three nearshore profile lines run in the fillet area in 1961 and again in 1970. The locations of the profile lines are shown in Figure 1. These were adjusted for water level. Both years for each line were then plotted on a single graph to depict any change in bottom depths over the nine-year period (Figures 2 -4). The results of the comparison, as determined by planimetry, are listed in Table 2 . Multiplying the mean cross-sectional area change found for two profile lines by the horizontal distance between them a yield a measure of the volume of the accumulation. These values for several distances offshore are presented in Table 3 .

The foregoing analysis of sediment transport and accumulation indicates that the nearshore region from shore out to about 1,000 ft, for 4,000 ft from the east breakwater, is an area of net sand buildup. For the next 2,000 ft. to the east the net accumulation area drops down to only 500 ft offshore. The offshore region from 250 to 500 ft from the shore is building more rapidly, growing at a rate of about four times the increased in volume for inshore zone from the waters edge out to 250 ft. From 500-700 ft offshore is the second highest growth area, about twice that of the inshore region.

The total annual longshore sediment transport in the study area is approximately 7,000 cu yd/yr. Based on accumulation rates the annual transport for the inshore region (0-250 ft offshore) is only 900 cu yd/yr. This low rate of alongshore transport is consistant with the small accumulations observed at new structures such as the east breakwater of the Westlake Land Co. marina located four miles east of Beachwood Villas.

Wave climate and storms. The range of wind generated waves extends from the west-northwest through north to east-southeast. Winds from the west through south to southeast approach the study area overland and are not significant in generating local waves. The longer fetch distances to the north and northeast across Lake Erie allow larger waves to develop than those that develop over shorter fetches from the west through northwest directions, although the latter are the directions of the prevailing winds (Table 4). The most destructive storms along the shore are "northeast," which are generated by low-pressure centers moving from west to east south of Lake Erie (Carter and Guy 1980).

Dr. Ernest F. Brater, professor of coastal engineering at the University of Michigan, studied the wave climate for the Lake Erie coast east of Huron in 1965 (Appendix F). He observed that the site is exposed to fetches of more than 125 miles in the northeasterly directions and northwesterly directions. Worthy (1980), using the method given in the Shore Protection Manual (U.S. Army, Coastal Engineering Research Center 1977), found the effective fetch length to be only 79 miles for northeast winds and 15 miles for northwest winds at Old Women Creek (Table 4).

Dr. Brater found that information published by the U.S. Beach Erosion Board indicates that winds will occur with about the same frequency from all portions of the sector for which the site is vulnerable, except for very large winds, which occur more often from the northwesterly direction. In determining the maximum size of waves to be expected at the breakwaters, the fact that waves break at a depth somewhat larger than the wave height becomes a controlling factor for the longer fetches. Troublesome waves will occur more often from the northeast than from northwesterly directions. For example, waves of seven feet or greater will occasionally approach from the sector between north and N 30° W. However, it requires a 40 mile per hour wind for at

least three hours to accomplish this, whereas for the larger northeasterly fetches a 30 miles per hour wind can produce waves. Tests based on model studies by the Corps of Engineers at the U.S. Waterways Experiment Station indicate that, with side slopes of 1.5 to 1.0, horizontal to vertical, stones having an average dimension of 3.6 ft will be required to withstand 7 ft waves. Based on these consideration, Dr. Brater concluded it is therefore desirable to provide the greater protection against the easterly waves.

Resio and Vincent (1976) have calculated design wave estimates for the Lake Erie shoreline in the vicinity of Huron, Ohio (grid point 6). Table 5 presents maximum wave heights predicted seasonally for 5-, 10- and 100- year return periods. Fall and winter conditions are the most severe; waves approaching at angles greater than 30° normal to the shore (northeast storms) attain heights of 9-10 ft once every 10 years and 8-9 ft every 5 years, on average. Because water depths adjacent to the marina breakwaters are relatively shallow (approximately 2-3 ft below Low Water Datum) waves of these magnitude would break well offshore. This conclusion is based on the generally accepted relationship: $H=0.78(\mathcal{Z})$, where H is the maximum wave height which can be developed in shallow water and $\mathcal{Z}$ is the still water depth (Komar 1976). Given this limitation, even with the present high water of 572.8 IGLD (February 1987), maximum wave heights of only 5-7 ft are expected in the vicinity of the structures.

Water levels. The following information has been assembled from reports and personal communications from Donald Guy, Ohio Div. Geological Survey; Dr. Frank Quinn, Great Lake Environmental Research Laboratory, John Byrne, U.S. Army, Corps of Engineers, and Dr. Charles Carter, University of Akron.

At present, lake level continues on an upward trend that began in 1965. Annual mean lake level reached a record high of 574.7 ft in 1973, and then dropped slightly during the late 1970's. In 1985, the lake rose again; the annual mean for 1985 was 572.6 ft. Between 1973 and 1986, the lake level has remained more than 1.5 ft above its long-term mean. This prolonged period of abnormally high levels results from excessive precipitation over the Great Lakes basin in 15 of the last 18 years. February 1987 was the second dry month in a row, with all the Great Lakes basin receiving below average precipitation. Thus, for the first time since August 1985, no new record high levels were

set on any of the Great Lakes. However, a prolonged dry period will be required to return Lake Erie to its mean level.

Annual lake level changes occur in response to seasonal variations in precipitation, run off,and evaporation. Although the magnitude of change varies from year to year, the average change from mid-winter low to mid-summer high is about 1.2 ft. Changes in monthly mean lake level through the course of the year record this annual cycle. In some years the maximum monthly mean may be quite high. In June 1973, the monthly mean level was 573.5 ft. In June 1986, the monthly mean level was 573.7 ft. If long-term mean lake level remains abnormally high, there is a good probability that the maximum monthly mean in any given year will exceed or be with in inches of 573.5 ft.

Short term changes in lake level last a few minutes to a few days. The most significant of these short term changes are those due to storm winds. Of particular concern in the western portion of central Lake Erie are set ups produced by northeast winds.

There is no periodicity to storm set ups in Lake Erie, although there is a higher incidence of set ups between September and May. An analysis of storm set ups at Toledo was performed by Carter (1986). Between 1939 and 1980, set ups exceeding 1 foot occurred 1-7 times per year, and 95% of these set ups were 2-3 ft in height, and 15% were 3-4 ft in height. The height of set up showed no temporal pattern and no correlation with lake level.

In contrast to the lack of periodicity in set ups, seiches (the inertial oscillations of water which occur when storm winds subside) do have fairly regular periods. Along the long axis of the lake, seiches have a period of 14 hours. Seiches along the long axis occur after northeast winds have set up the lake at the western end.

Ohio Department of Natural Resource (ODNR)

Interruption of littoral drift system. ODNR contends, in their letter of 4 March (Appendix C), that the breakwater would lie at or lakeward of the crest of the submerged nearshore sandbar, thereby disrupting or deflecting sand transport. Because the marine entrance faces updrift, storms would sweep sand into the boat basin. The boat basin will be deeper than the surrounding lake bed, therefor sand will tend to move into the basin. The culvert at the northwest corner of the breakwater will also allow sand to enter the basin during northwest storms. A wide range of estimates exist for the amount of sand transport in the littoral system and the effects of reversals. A more detailed, long-term analysis of nearshore processes in this area would help resolve the controversy.

Erosion of downdrift shoreline. Construction of fillets east and west of the marina breakwater is acceptable to ODNR. Sand dredged from the boat basin would be finer than beach material and more prone to erosion. Fillets would change configuration in time, growing at the expense of beaches elsewhere.

Adequate sand by-pass mechanism. Provisions for sand by-passing would be greatest during storms. The pumping system should be capable of operating during storms. By-passed sand should be placed into the littoral system in such a fashion that areas deprived of sand, by virtue of the breakwater's position, would be nourished. Lower water levels may require additional maintenance dredging and therefore more sand to be by-passed.

Adequate monitoring plan. Monitoring programs should include both subaerial and subaqueous measurements. The effect of water level change on fillet area should also be taken into consideration. Frequency and adequacy of by-passing should be carefully evaluated to determine effectiveness and need for additional special conditions.

U.S Fish and Wildlife Service (USF&WS)

Lakeward projection of structure. The USF&WS, in their letters of 12 February and 3 March (Appendix C), contends that the marina as designed will potentially disrupt sand transport in the project area. They speculate that their and ODNR concerns might be significantly reduced if the distal arm of the west breakwater extended no more than 150 ft offshore. They also asked that a monitoring program be developed to insure excess accumulated sand is properly by-passed around the marina.

Placement of stone at base of piling. USF&WS asked for "rip-rap" to be placed along the toe of steel sheet pile to maximum possible height without interference with docks and boats. This would provide additional fish/invertebrate habitat and wave energy absorption.

U.S. Environmental Protection Agency (US EPA)

Adequate sand by-pass system. US EPA in their letter of 11 February (Appendix C), stated no objection to the issuance of a permit subject to a condition concerning the sand by-pass system. US EPA would like to require that the sand by-pass system be operated whenever necessary as long as the marina is in existance, even if sold or transferred to another owner. They also suggest that periodic inspections be made to ensure that the system is operating as required.

ATTITUDE OF ADJACENT PROPERTY OWNERS

As part of the permit approval process, the U.S. Army, Corps of Engineers solicites comments from property owners adjacent to the applicant. Letters received from these individuals are included in Appendix D. Of particular concern in this assessment is the attitude of those property owners "downdrift" of the proposed marina and most likely to be adversely effected by any starvation of beach building materials resulting from the structure. Mr. and Mrs. Gray, the property owners immediately to the west of the project site, state their support of the project, as do the Lakefront-Lakeview Association. There were no opposing comments from either updrift or downdrift owners.

Littoral System

The proposed marina breakwater will interrupt the natural flow of sediment in the littoral system. The breakwater will be constructed to a distance of approximately 230 ft offshore, terminating near the offshore sand bar. Accumulation data (Table 3) show that this inshore region has much smaller values than the more offshore region, indicating a low rate of alongshore sediment transport (900 cu yd/yr). Because the breakwater does not project into an area of significant littoral drift it is not expected to trap large amounts of sand.

The offshore bottom topography will most probably alter its configuration to a convex (shoreward), arcuate form around the marine's lakeward outline. This adjustment will likely take place within a single season, thus permitting the resumption of nearshore sediment transport along the bar system.

Erosion and/or Accretion

Because the proposed marina lies within the fillet area created by the Huron east breakwater, and the fact that most of the littoral drift to the fillet is offshore of the marina, no shore erosion is anticipated. Some accretion is expected on both the east and west sides of the marina structure. The rate of accumulation is likely to be low, probably only 500 cu yd/yr on the east side, even if 50% of all the sediment being transported in the inshore region is trapped by the structure. Accretion on the west side will be activated by temporary reversals in drift direction caused by westerly storms. Based on other structures in the area, the amount trapped is expected to be somewhat less than the accumulated expected for the east side.

Sand By-Pass System

Because of the sand accumulations on the predicted for the updrift side of the marina, as well as possible bar formation in marina inlet channel, a sand by-pass system will be required to transport the material to a position where normal downdrift movement can be resummed. Because of the relative small amount of sand which will require by-passing, commercially available systems such as a jet pump eductor system (see Recommendations Section), should be adequate.

Water Circulation

Adequate water circulation and mixing is an important consideration in marina design. The 48 inch culvert recommended by Ohio EPA would provide the necessary exchange of water to prevent stagnent conditions, but its diameter and location on the west side may result in unwanted transport of sand into the boat basin. Alternative designs and placement of a water/fish exchange system are provided in the Recommendation Section.

Comparison Structures

Examination of the performance of other nearby and comparable structures can provide some insight as to the impact a proposed structure will have on shore processes. One of the few nearby comparable structures is the two-year-old breakwater structure at the Westlake Land Co. marina, (Appendix E), about four miles east of Beachwood Villas. The sediment transport values are assumed to be similar at both structures because of their close proximity and nature of the nearshore sand deposits (Carter and Guy 1980, Figure 3).

The east breakwater at the Westlake marina projects approximately 270 ft in to the lake, but no significant amounts of sand have been trapped by this structure, although some possible beach accumulate has been masked by the recent placement of a stone revetment along the shore (D.E. Guy, ODNR, Div. Geological Survey, personal communications). However, recent observations of this site do not indicate shoaling adjacent to this structure. No sand by-pass system has been installed or was specified by the Corps of Engineers for the Westlake marine. Figures 5 and 6 are oblique aerial photographs of the Beachwood Villas and the Westlake Land Co. marina sites, respectively, taken on 6 December 1986.

Dr. Brater's Evaluation

Dr. Ernest F. Brater, coastal engineer from Ann Arbor, Michigan first investigated the Beachwood area on the east side of Huron as a possible marina site in 1965. He is also the primary designer of the proposed marina structures. Details of Dr. Brater's involvement with the project are included in Appendix F. A summary of his independent evaluation of the impact of the proposed marina on the adjacent coast of Lake Erie is presented below.

Dr. Brater concluded that his initial evaluation of shore processes at the site have not changed over the past two decades. The amount of sand being transported along the beach is small. The direction of littoral drift is predominately from the east even though there are many more westerly than easterly storms. This is because the fetch is much greater from the east and the long piers at Huron block any possible sand movement from the west.

The major portion of littoral sand movement is produced by the waves and currents during major storms. This violent wave and current activity will carry much of the littoral drift past the proposed structure. Any sand that is captured can be by-passed by the proposed dredging program. The by-passing of sand artificially is an accepted technique for continuing the movement of littoral drift even at major inlets. The fact that rubble construction, which absorbs wave energy, is proposed for the marina walls will cause less disruption of the underwater environment than the reflections and turbulence caused by the sea walls which are so widely use along the adjacent shoreline.

Dr. Brater noted that the report by the Corps of Engineers on Huron Harbor, revised in 1984, also concludes that the littoral drift is small in that area and that even the long breakwaters at Huron cause a "minute incremental increase in shore erosion". The quote is from the top of p. 10. The second paragraph on p. 10 states "The fact that the amount of erosion is comparable for unprotected areas throughout the reach between Vermilion and Sandusky on both sides of Huron indicates that there is minor adverse impact of erosion due to the harbor structures". Dr. Brater's final conclusion is that the marina will have a much smaller impact than the harbor breakwaters at Huron especially in view of the fact that sand will by-pass the marina whereas little or no sand can pass by the breakwaters.

Structure Design

Except for three items, the current design of the marina structure appears adequate to provide necessary dockage and protection for 66 watercraft. Because of the low rate of alongshore sediment transport, the 230 ft lakeward projection of the protecting breakwater is reasonable and need not be reduced. The marina inlet, facing updrift, will invite some sedimentation problems, but this is much less of a problem than would be the case if the inlet faced west, toward the prevailing wind, and the attendant choppy conditions which would often occur in the boat basin.

One design feature that requires alteration is the water/fish exchange system. The diameter of the culvert can be reduced by using multiple units. A rubber flap type check gate or low head sewage type check valve would permit the exit of water and fish toward the west without allowing sand to enter the boat basin from that direction.

Another item that should be changed is the length of the northerly breakwater. To protect the marina from the most severe storms, that come from N 67.5° E (Appendix F), the breakwater should be extended easterly at least 20 ft. This will make the north breakwater a minimum of 400 ft long.

The final change to the structural design would be to angle the east breakwater armor rock toward the existing groin. This change will offer better protection for both the breakwater and the existing groin while using less material.

These changes are shown on Figure (7).

Sand By-Pass System

It is our understanding the Corps of Engineers will specify the extent of fillet(s) size built during marina construction. We also understand they will specify the amount of littoral material which is allowed to accumulate once the by-passing system is started.

An eductor system is recommended for by-passing the sand which is trapped by the breakwater structure and which accumulates in the inlet channel. To operate a system of this type, a high pressure stream of water is injected through a nozzle into the venturi section of a jet pump. This reduces the pressure inducing a flow of sand and water into the primary suction of the jet and provides energy for transporting the sand/water slurry to discharge area. Successful installations of such systems, constructed by the Corps of Engineers, on the west coast shows that the pump remains effective even when the suction head is buried by over 10 ft of sand (Appendix G).

Since the study indicates a small amount of littoral material being transported, a by-passing system of less capacity than originally considered, but with multiple inlets, is advised. The system should have a total capacity of 40 to 50 cu. yds. per hour. this capacity will permit the pump to operate for extended periods of time without suction-starvation. One inlet should be placed just inside the entrance to the marina and another just outside (Figure 7). These inlets would be more or less permanent but capable of being moved to a different location when by-passing to the east becomes necessary or when the western fillet grows to the point where it must be reduced. To facilitate operations during periods of storms (when most transport occurs) a remote on-off switch should be located in a protected area.

The by-pass material should be returned to the littoral system downdrift of the accumulation area in such a fashion that the shoreline immediately downdrift of the structure will benefit from this nourishment. Placing sand lakeward of the north breakwater is not recommended.

Monitoring Plan

In order to ensure an adequate plan for determining the frequency and adequacy of sand by-passing, we recommend that persons familar with the conditions prevelent at the project site assist the developer in preparing and submitting to the Corps of Engineers a monitoring plan for their approval. This plan would involve an initial (upon completion of construction) survey by sonar of the marina basin and an area extending out 250 ft to the west, north and east of the outer crest of the two major breakwaters. This information would be plotted on the same grid as the marina plan. This process would be repeated yearly during the month deemed most critical by all concerned, and the volumetric changes by station so noted and reported to the Corps of Engineers. During the first year of operation a system of pipe markers driven to firm position, would be placed to indicate changes in sub-aerial accretion of sand and monthly sonar profiles until November 1987, of the boat basin and surrounding areas to indicate subaqueous changes. Plotting of data on a standard grid and volumetric calculations would be used to develop a monitoring plan that will control the operation of the sand by-pass system. This plan would be drafted by November 1987, and submitted to the Corps of Engineers for comment. The final monitoring plan would be submitted to the Corps of Engineers approximately one year after marina operations start for their approval, and use in evaluating the results of annual operating reports submitted by the marina association.

Long-Term Maintenance Plan

Once the marina is constructed including the west breakwater fillet containing some 1,500 cu. yd. of dredged sand (roughly 200 ft by 106 ft = 9700 sq. ft.) and the east breakwater fillet containing some 500 cu. yd. (roughly 100 ft by 70 ft = 3,500 sq. ft.), the maintenance program would include by-passing accreted sand to the specified direction when sand accumulates to 700 cu. yd. each location, as well as timely by-passing of sand which may accumulate in a depositional bar inside the marina entrance. The by-pass system should be placed to pump sand from any or the 3 designated locations and should be activated on a predetermined time schedule according to the recommendations of the monitoring plan or a major storm related event. The recommended location of the Jet Pump System is at the east breakwater fillet and harbor entrance (Figure 7). It is further recommended that a remote on-off starting switch be located at the top of the bank so that the maintenance operator can activate the jet pump at a predetermined point in time during the development of a major storm. Time of duration for pumping will be predetermined for normal maintenance (time schedule related). Major storm direction, intensity and duration will be the determining factors for the length of pumping (see monitoring plan details) during storm related events.

Accumulation of sand at the west breakwater fillet will necesitate reversal of the jet pumping system from it's normal location. It is anticipated that this accretion will occur when prevailing winds are from the westerly quadrant and will generally be during the warmer weather thus facilitating the moving of the jet pump equipment.

In the event that a floating dredge is needed to supplement the jet pumping system, Sawmill Creek Marina has equipment available to rent to the Beachwood Villa Marina (William Bainbridge, personal communication). Other floating dredges are available from the Port Clinton-Marblehead area.

Long-Term Ownership Plan and Compliance with Permit Stipulations

Beachwood Shores Corporation is the developer of Beachwood Villas Condominiums located at 1500 Cleveland Road East, Huron Township, Erie County, Ohio. This project is an expandable condominium as provided in the Ohio Revised Code, which allows the developer to add additional property to the condominium from time to time until fully developed. Upon completion of the marina the developer intends to convey the property to the Beachwood Villas Condominium property owners' association. The marina property would be designated as condominium limited common area. Only those condominium unit owners who lease docks from the property owners' association would be entitled to use the facility.

We recommend that the property owners' association have the authority to assess the cost of maintenance and repairs of the authority to assess the cost of maintenance and repairs of the marina property against the unit owners leasing the docks from the association. The funds derived from this source would provide the means by which the property owners' association can assure compliance with all stipulations which might be set forth in the Corps. permit.

By implimenting this recommandation, the developer can assure the Corps of Engineers of:

(1) continuity of ownership through the non-profit property owner's association
(2) the ability to raise funds necessary to guarantee compliance with all maintenance requirements
(3) monitoring requirements through the assessments of costs against unit holders leasing docks from the association
(4) the vehicle (property owners' association) to assure the presence of a responsible party for the life of the facility.

The Beachwood Villas marina project as proposed and including the modifications recommended in this report, will have very little adverse impact on the adjacent shoreline of Lake Erie. This is the case because the rate of sediment transport is low and because the area lies at the eastern edge of a massive fillet area created by the Huron Harbor east breakwater, which is still experiencing slow accretion. Any short term downdrift erosion will be mitigated by a rapid-response, sand by-passing system. Downdrift property owners have had an opportunity to examine design plans for the marina and they have voiced their support of the project.

Separate plans have been proposed in this report for long-term monitoring, maintenance, and ownership of the marine. These plans have been designed to provide effective and appropriate management and operation for the life of the facility. These plans go far beyond schemes for existing or recently permitted marinas. For example the Westlake Land Company received a permit 2½ years ago to construct a breakwater which extends 270 ft into the lake which contained no stipulation for sand by-passing or monitoring.

The Various agency concerns have been satisfactorily addressed by this report and it's recommendation. Given these considerations, we believe that a permit to undertake this project can be issued with only negligible risk to the resources of the Lake Erie shoreline.

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TABLES

1 - 5

TABLE 1 . NEARSHORE WATER DEPTHS FOR
PROFILE LINES EAST OF HURON RIVER

Range No.	SP No.	General Location	Distance Offshore (ft)								
			50	100	200	300	400	500	1000	1500	2000
20	4	Marina Site	2.0	3.5	4.0	4.5	6.5	8.0	13.0	16.0	18.0
21	3	Beachwood Cove	0.5	0.0	2.5	2.5	5.5	7.0	12.5	15.5	17.0
22	1	E. Breakwater	+1.5	+0.5	1.5	3.5	4.5	5.5	9.5	12.5	15.0

Note: water depth to nearest 0.5 ft below low water datum (568.6 ft, IGLD)

Data Source: Carter and Guy (1980)

TABLE 2. CHANGES IN NEARSHORE DEPTHS BETWEEN 1961 AND 1970 EAST OF HURON HARBOR, OHIO

SHORE POINT	DISTANCE OFFSHORE (FT)	PROFILE AREA (FT 2/9yr.)	PROFILE AREA (FT 2/yr.)	DOMINENT PROCESS
SP-1	0-250	+ 39.4	+ 4.4	Accretion
	0-500	+145.6	+16.2	"
	0-750	+287.5	+31.9	"
	0-1000	+345.6	+38.4	"
	0-2000	+162.5	+18.1	"
SP-3	0-250	+ 41.9	+ 4.7	"
	0-500	+231.2	+25.7	"
	0-750	+264.4	+29.4	"
	0-1000	+316.9	+35.2	"
	0-2000	+200.0	+22.2	"
SP-4	0-250	+ 10.6	+ 1.2	"
	0-500	+ 4.4	+ 0.5	"
	0-750	- 45.6	- 5.1	Erosion
	0-1000	-241.9	-26.9	"
	0-2000	-1,358.1	-150.9	"

TABLE 3. VOLUME OF NEARSHORE SAND ACCUMULATION PER YEAR (1961-1970) EAST OF HURON HARBOR, OHIO

DISTANCE OFFSHORE (FT)	VOLUME SP-1 TO SP-3 (YD 3/yr)	VOLUME SP-3 TO SP-4 (YD 3/yr)	VOLUME SP-1 TO SP-4 (YD 3/yr)
0-250	674	219	893
250-500	2,430	970	3,400
500-750	1,437	---	1,437
750-1000	911	---	911
0-1000	5,452	1,189	6,641*

* Triangular end areas may add 5-10% to the total volume.

TABLE 4. WIND CHARACTERISTICS FOR STUDY AREA

Wind Direction	Effective Length (miles)	Percent Time	Average Lake Depth (ft)
E	36	10	15
NE	79	10	60
N	47	5	30
NW	15	11	20
W	1	15	15

Data Sources: U.S. Army, Corp of Engineers (1953) and Worthy (1980)

TABLE 5. ESTIMATES OF EXTREME WAVE HEIGHTS FOR LAKE ERIE AT HURON, OHIO

Return Period (yrs)	Mean Wave Approach		
	30° to right of normal to shore	within 30° to right or left of normal to shore	30° to left of normal to shore
		- WINTER -	
5	7.5 + 0.5 ft	8.9 + 0.5 ft	6.6 + 0.6 ft
10	8.9 + 0.7	10.2 + 0.7	7.2 + 0.7
100	12.8 + 1.2	14.4 + 1.3	12.2 + 1.3
		- SPRING -	
5	3.3 + 0.7 ft	2.3 + 0.5 ft	3.9 + 0.4 ft
10	4.9 + 0.9	3.3 + 0.6	4.9 + 0.5
100	10.5 + 1.6	6.9 + 1.1	8.2 + 0.9
		- SUMMER -	
5	3.9 + 1.4 ft	3.6 + 0.7 ft	3.9 + 0.6 ft
10	4.9 + 1.8	4.3 + 0.9	4.9 + 0.8
100	8.9 + 3.3	6.2 + 1.7	6.9 + 1.4
		- FALL -	
5	7.5 + 0.8 ft	8.5 + 0.2 ft	6.6 + 0.4 ft
10	9.5 + 1.0	8.9 + 0.3	7.9 + 0.5
100	15.7 + 1.8	11.2 + 0.6	10.8 + 0.9

Data Source: Resio and Vincent (1976)

FIGURES

1 - 7

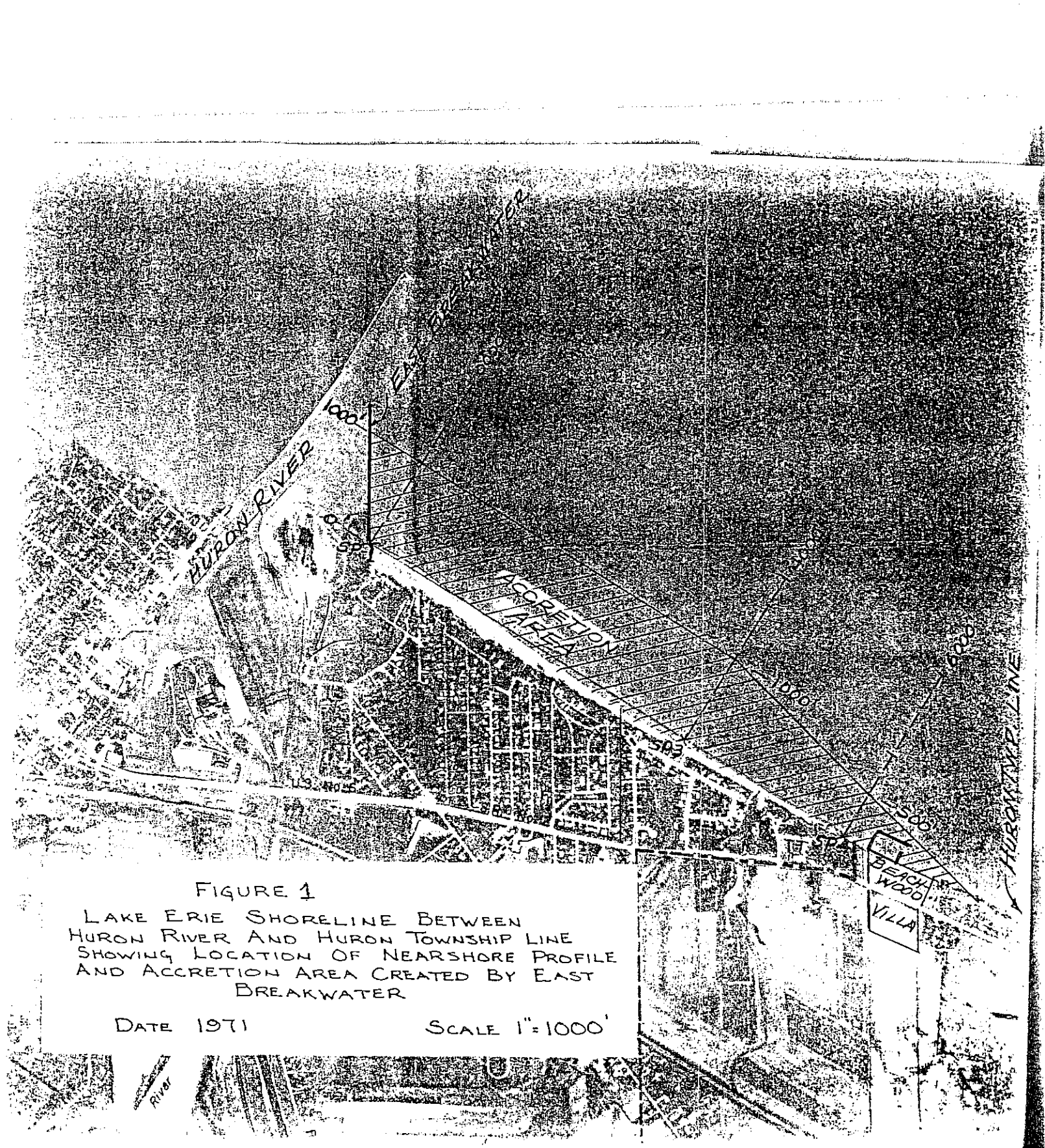


FIGURE 1

LAKE ERIE SHORELINE BETWEEN HURON RIVER AND HURON TOWNSHIP LINE SHOWING LOCATION OF NEARSHORE PROFILE AND ACCRETION AREA CREATED BY EAST BREAKWATER

DATE 1971 SCALE 1"=1000'

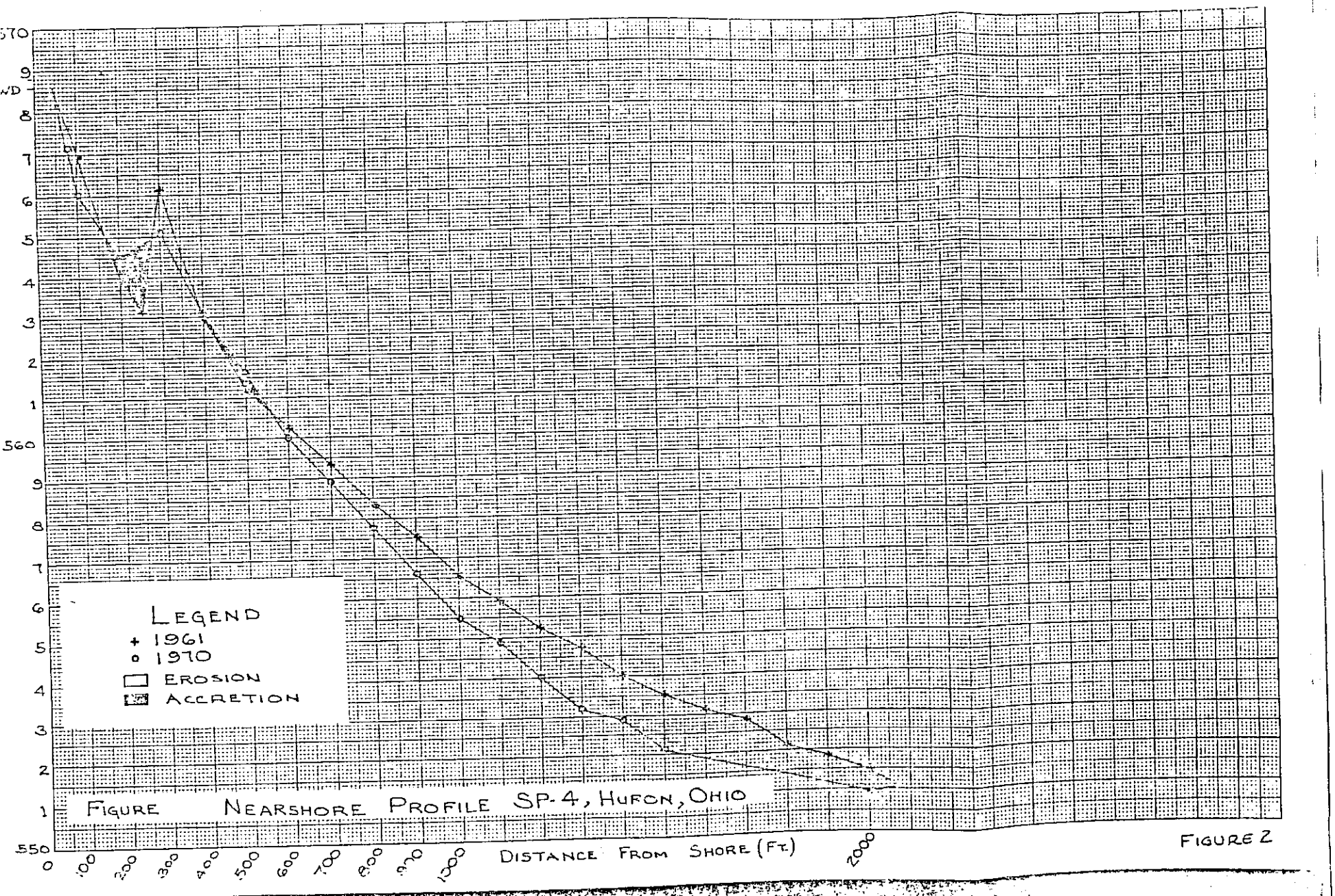


FIGURE NEARSHORE PROFILE SP-4, HURON, OHIO

FIGURE 2

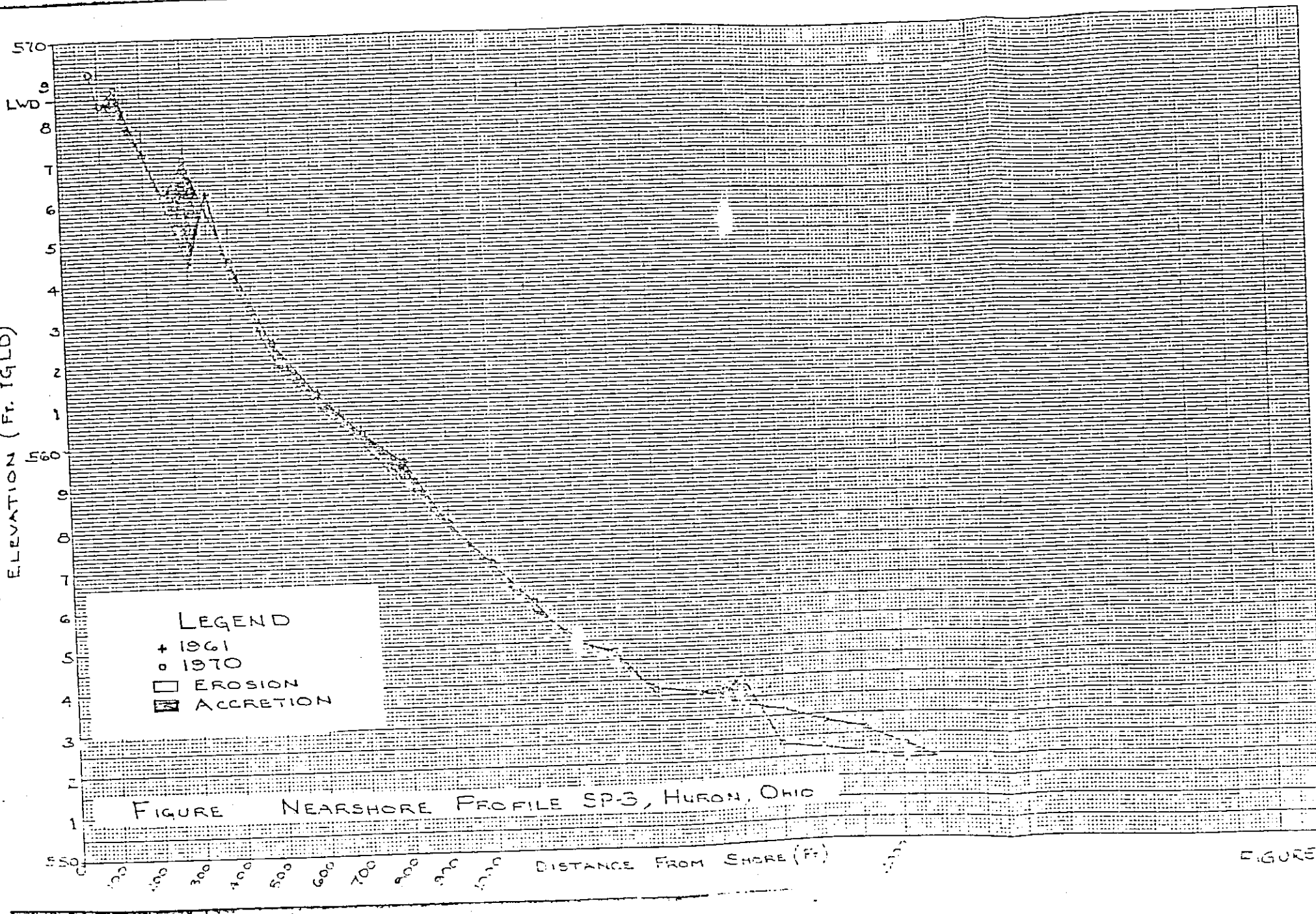


FIGURE Nearshore Profile SP-3, Huron, Ohio

FIGURE 1

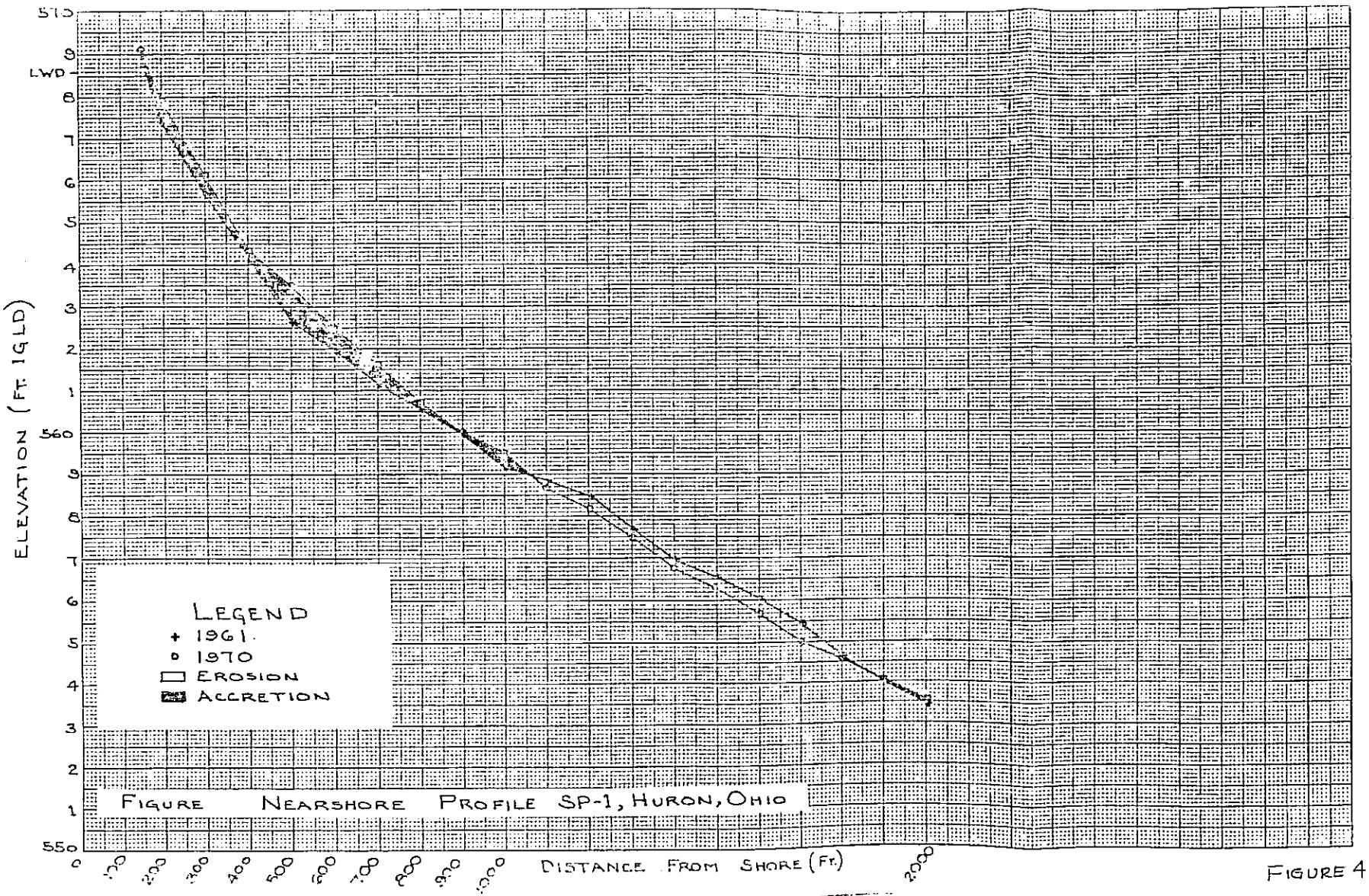
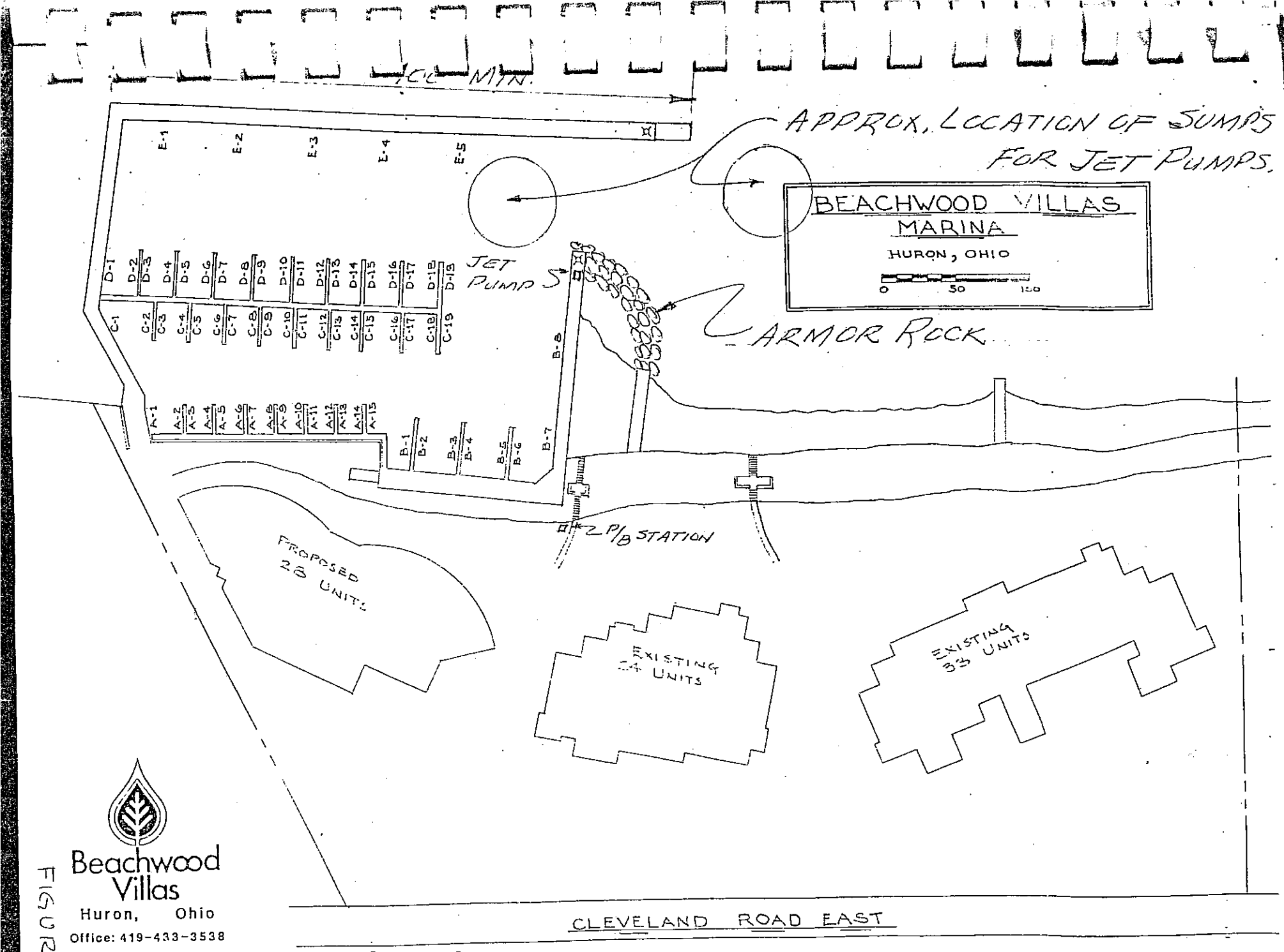


FIGURE NEARSHORE PROFILE SP-1, HURON, OHIO

FIGURE 4



Beachwood Villas
Huron, Ohio
Office: 419-433-3538

FIGURE 7

PRELIMINARY AND SUBJECT TO CHANGE

APPENDIXED

A - H

APPENDIX A

U.S. ARMY, CORPS OF ENGINEERS

PUBLIC NOTICE: 86-475-11 (15 January 1987)

BEACHWOOD SHORES CORPORATION

S Army Corps
f Engineers
uffalo District

Public Notice

Applicant: BEACHWOOD SHORES CORP.

Date:
Published: 15 January 1987
Expires: 14 February 1987

In Reply Refer To:

NCBCO-S Re: 86-475-11 Section Ohio 10 and 404

Application for a Permit under Authority of
Section 10 of the River and Harbor Act of 1899
and Section 404 of the Clean Water Act

Beachwood Shores Corp, 1500 Cleveland Road East, Huron, Ohio 44839 has applied for a Department of the Army (DA) permit to construct a marina in conjunction with, Beachwood Villa Condominium community at 1500 Cleveland Road East, Huron Township, Erie County, Ohio.

The work requiring DA authorization will consist of:

a. Excavating and dredging (see item c below) to accomplish the installation of stone filled timber cribs and the placement of stone to form a breakwater protected marina basin. The westerly breakwater will extend about 230 feet waterward from the shoreline in an irregular alignment, then easterly about 375 feet. The easterly breakwater, about 180 feet long, will extend about 115 feet waterward from the shoreline. The breakwater(s) will serve as a haul road for land based mechanical equipment as work progresses. Floating plant mechanical equipment may be used to place the armor stone. An estimated 9,400 cubic yards of crib core and armor stone will be placed. About 6,000 cubic yards of the total will be placed below Ordinary High Water (OHW) elevation 572.8 feet, International Great Lakes Datum (IGLD) and occupy about 34,300 square feet (0.78 acre) of lake bottom. These quantities represent the amount that will be placed in the present bounds of the lake and do not include the amounts that will be placed in areas excavated from present upland such as: the stone filled concrete capped timber cribs that will connect to the easterly breakwater.

b. Installing a 48 inch diameter corrugated metal culvert at the northwest corner of the westerly breakwater. The culvert will provide for the exchange of water and fish passage.

c. Dredging of an estimated 15,000 cubic yards of sand gravel and clay to an elevation of about 564.0 feet IGLD. Except for the material removed during construction of the breakwater(s) and dock system installation see paragraph (d), dredging will follow completion of all other project features and will provide navigational clearance within the basin for pleasure boats. The work will be accomplished with the use of a suction dredge on a submerging boom and/or floating plant mechanical equipment. An estimated 1,500 cubic yards of sand and gravel will be placed along the westerly side of the westerly breakwater and shoreline below (OHW) to form a fillet which will occupy about 9,700 square feet of lake bottom. An additional estimated 500 cubic yards will be placed along the easterly side of the easterly breakwater and shoreline below (OHW) to form a fillet which will occupy about 3,500 square feet of lake bottom. The remaining sand and gravel will be disposed of lakeward and downdrift (Westerly) from the project for beach nourishment. The purpose of the fillets is to provide

recreational beaches and return material to the littoral system. If the fillets are permitted and in the event there is insufficient suitable material dredged during construction, additional sand and gravel from an upland source, will be provided. When accretion of littoral material at the fillets reaches 700 cubic yards beyond the proposed dimensions of the fillets shown on the plan drawing (Sheet 1 of 2) the accumulated material will be bypassed northerly of the north breakwater into the littoral system. The bypassing system will be a suction dredge on a submerging boom arrangement or a jet pump installation. The system will be capable of bypassing up to 80 cubic yards of the material per hour and should complete the bypass in about 9 hours.

d. Installing a main floating walkway about 240 feet long and having four 4 foot wide by 30 foot long and fifteen 4 foot wide by 24 foot long finger docks. Installing a 4 foot wide by 160 foot long floating dock and 18 foot long L section along and parallel to the steel sheet pile bulkhead at the southerly side of the marina and two 4 foot wide by 25 foot long floating finger docks extending from the concrete capped crib bulkhead at the southerly side of the marina. The docking system will accommodate about 50 boats. See plan drawing sheet 1.

The applicant also proposes maintenance dredging within the basin area. At this time, there is no historical data to determine the quantity of material to be dredged nor the frequency of dredging. However, the proposal is to discharge the material to the prevailing downdrift (westerly) side of the project. If a permit is issued, we intend to authorize the dredging for a period of 5 years.

Further, the applicant proposes to excavate into the bluff and install about 140 feet of steel sheet pile and about 125 feet of stone filled concrete capped timber cribs. The steel sheet pile will connect to the westerly breakwater and cribs. The cribs will connect to the easterly breakwater. The structures will form the southerly side of the marina basin. The work will be completed in the dry above DA jurisdiction and will not require DA authorization.

Location and details of the above described work are shown on the attached maps and drawings.

There are no registered historic properties or properties listed as being eligible for inclusion in the National Register of Historic Places that will be affected by this project. By this notice, the National Park Service (NPS) is advised that presently unknown archaeological, scientific, prehistorical or historical data may be lost or destroyed by work to be accomplished under the requested permit.

Based on the review of available environmental data, we have determined that the proposed work will not affect a species proposed or designated by the U.S. Department of the Interior as threatened or endangered nor will it affect the critical habitat of any such species. Therefore, unless additional information indicates otherwise, no formal consultation pursuant to Section 7 of the Endangered Species Act Amendments of 1978 will be undertaken with the U.S. Fish and Wildlife Service.

The following authorizations may be required for this project:

Water Quality Certification (or waiver thereof) from the Ohio Environmental Protection Agency.

This notice is promulgated in accordance with Title 33, Code of Federal Regulations, parts 320-330. Any interested parties and\or agencies desiring to express their views concerning the proposed work may do so by filing their comments, in writing, no later than 4:30 p.m. 30 days from the date of issuance of this notice. A lack of a response will be interpreted as meaning that there is no objection to the proposed work.

The decision whether to issue a permit will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including the cumulative effects thereof; among these are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties fish and wildlife values, flood hazards, flood plain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and in general, the needs and welfare of the people.

This activity involves the discharge of dredged or fill material into waters of the United States. Therefore the evaluation of the impact of the activity on the public interest will include application of the guidelines promulgated by the Administrator Environmental Protection Agency, under the authority of Section 404 (b) of the Clean Water Act (40 CFR part 230).

The District Commander will authorize the proposed project provided it is determined the project is not contrary to the public interest, and, provided further that the project is consistent with the above USEPA guidelines at 40 CFR part 230.

Any person may request in writing, within the comment period specified in this notice, that a public hearing be held to consider the application. Requests for a public hearing shall state particular reasons for a public hearing. The District Commander will grant hearing requests if the issues are relevant and substantial, and cannot the same weight in our review as verbal comments whether or not a public hearing is held.

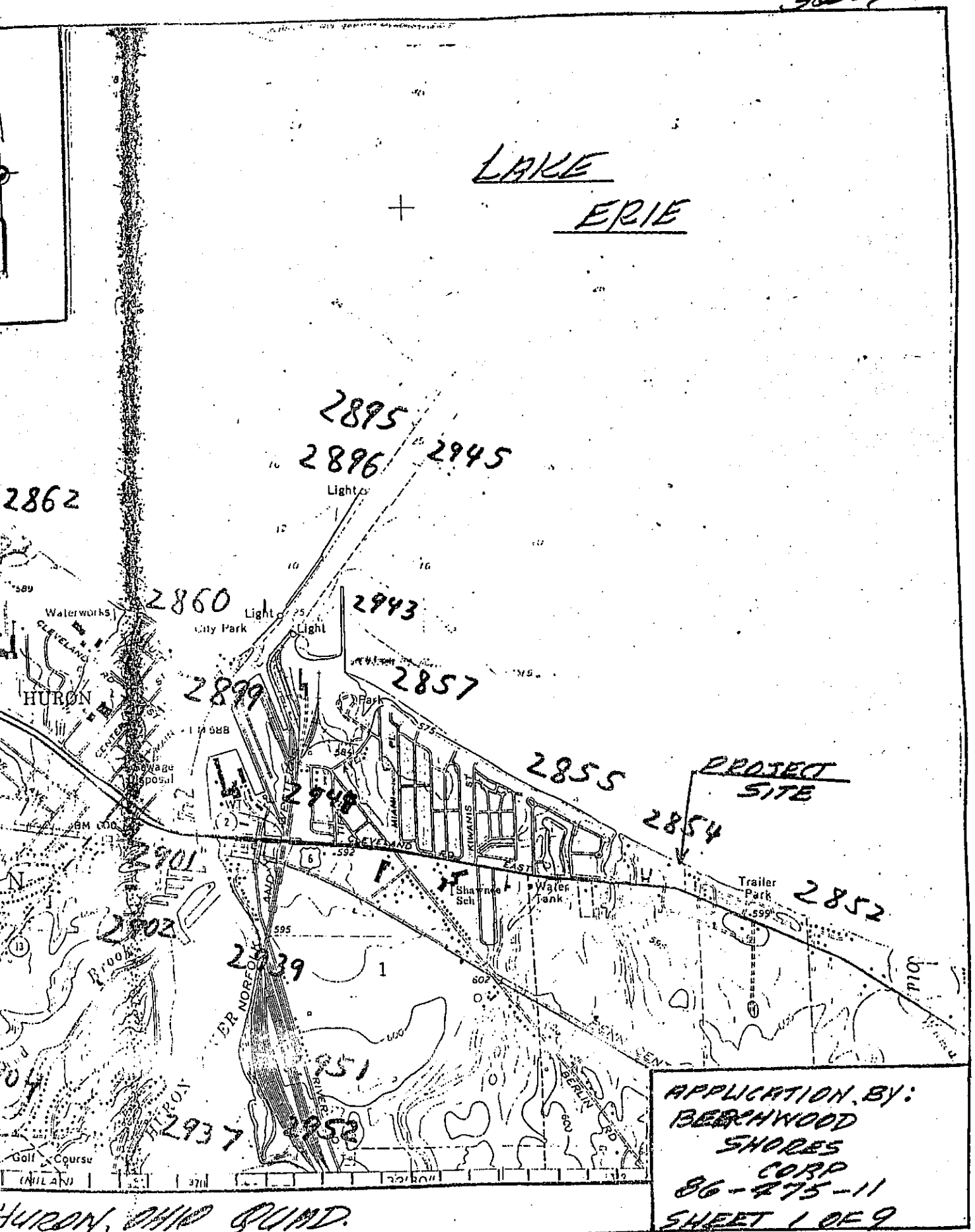
My point of contact pertaining to this matter is Mr. Steve Roy of my Regulatory Branch, who can be contacted by calling commercial number 716-876-5454, extension 2322, or by writing to:

District Commander
U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, NY 14207
ATTN: Mr. Steve Roy

Buffalo District - Leadership in Engineering.

for DANIEL R. CLARK
Colonel, Corps of Engineers
District Commander

NOTICE TO POSTMASTER: It is requested that this notice be posted continuously and conspicuously for 30 days from the date of issuance.


LAKE ERIE
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PROJECT SITE
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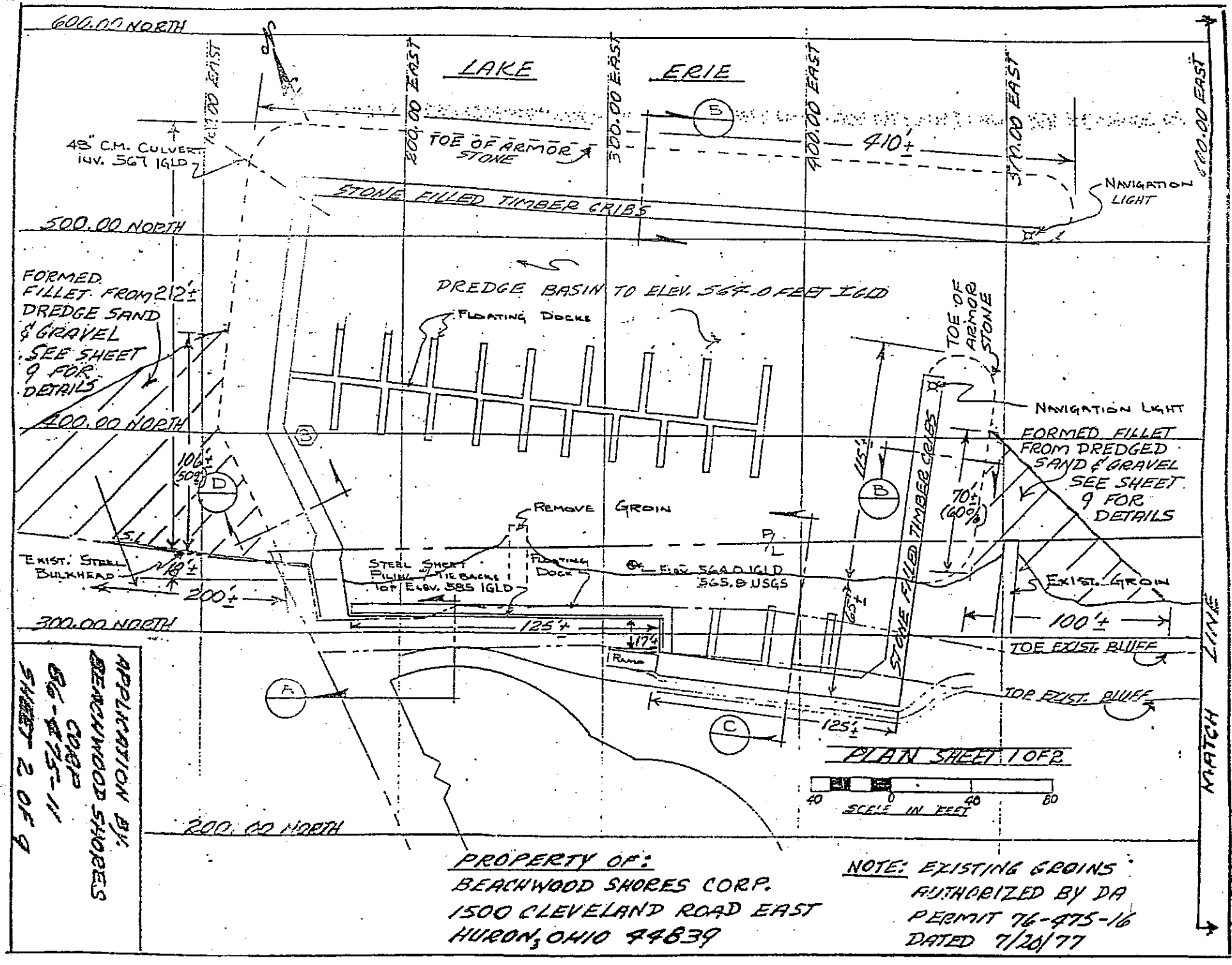
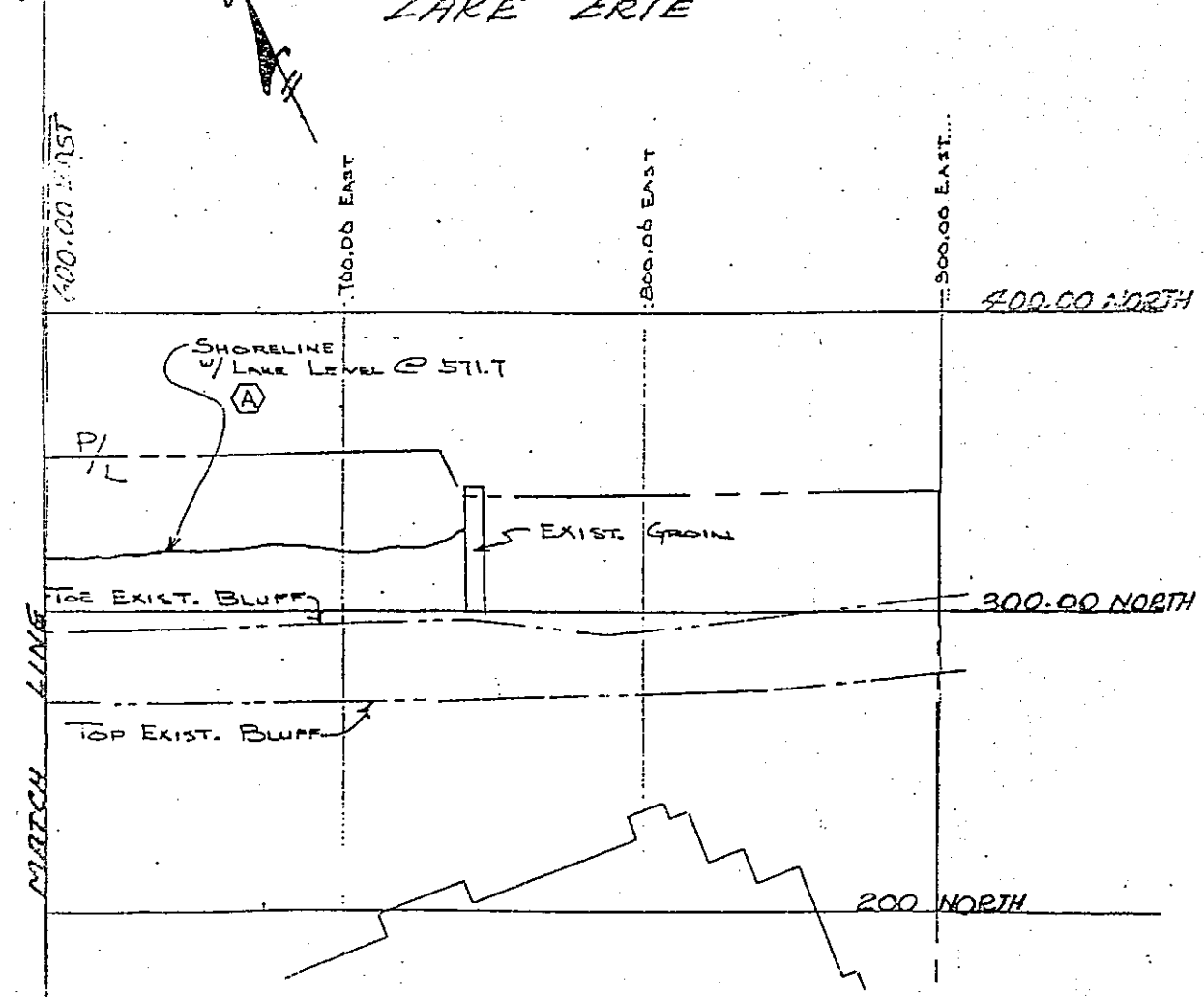
HURON, OHIO QUAD.
APPLICATION BY:
BERRYWOOD SHORES CORP
86-275-11
SHEET 1 OF 9



PROPERTY OF:
BEACHWOOD SHORES CORP.
1500 CLEVELAND ROAD EAST
HURON, OHIO 44839

NOTE: EXISTING GROINS AUTHORIZED BY DA PERMIT 76-775-16 DATED 7/20/77



PLAN SHEET 2 OF 2

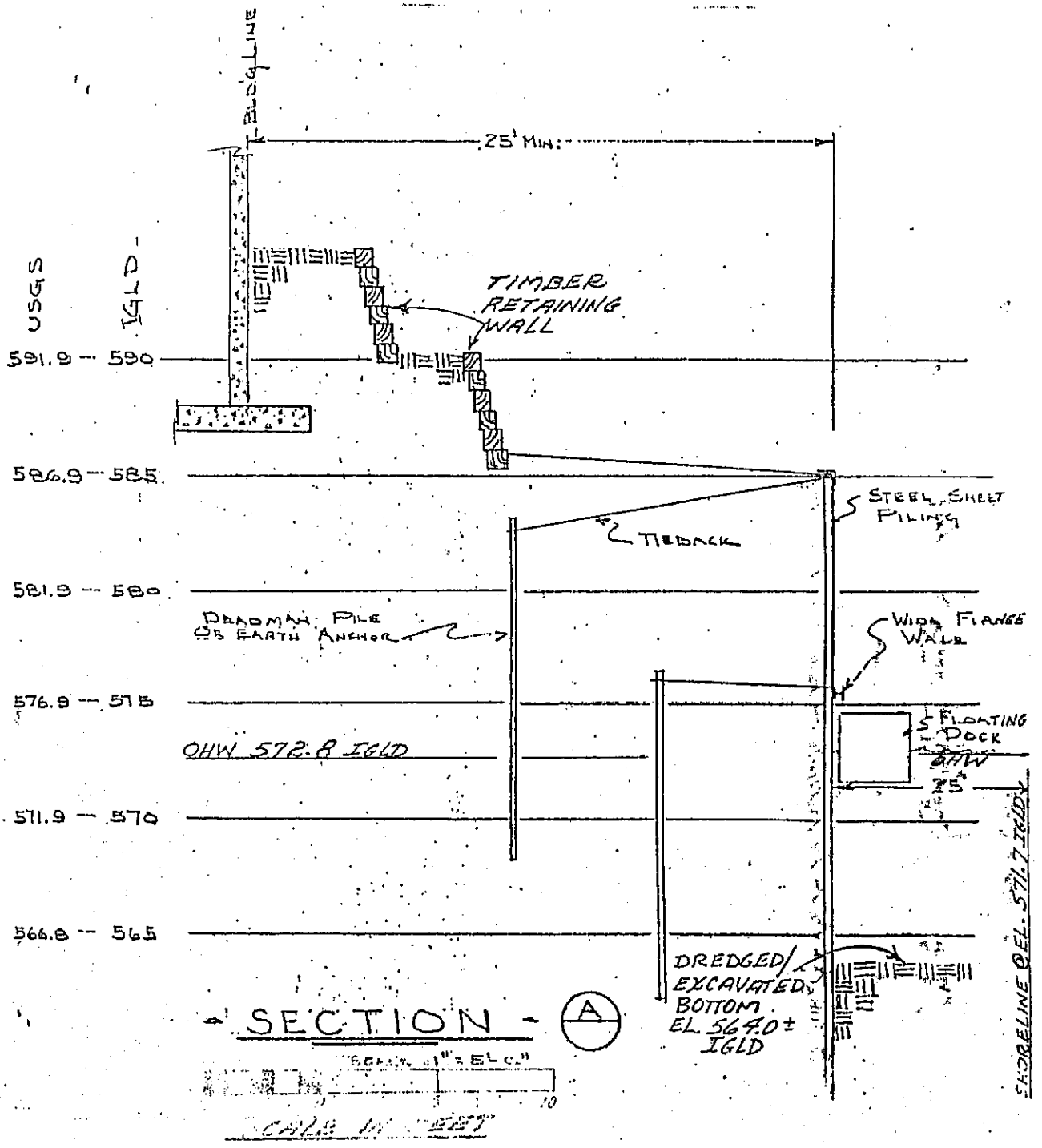
ADJACENT OWNER
WESTERLY

PETER C. & MOLLY GRAY
1409 CLEVELAND ROAD EAST
HURON, OHIO 44839

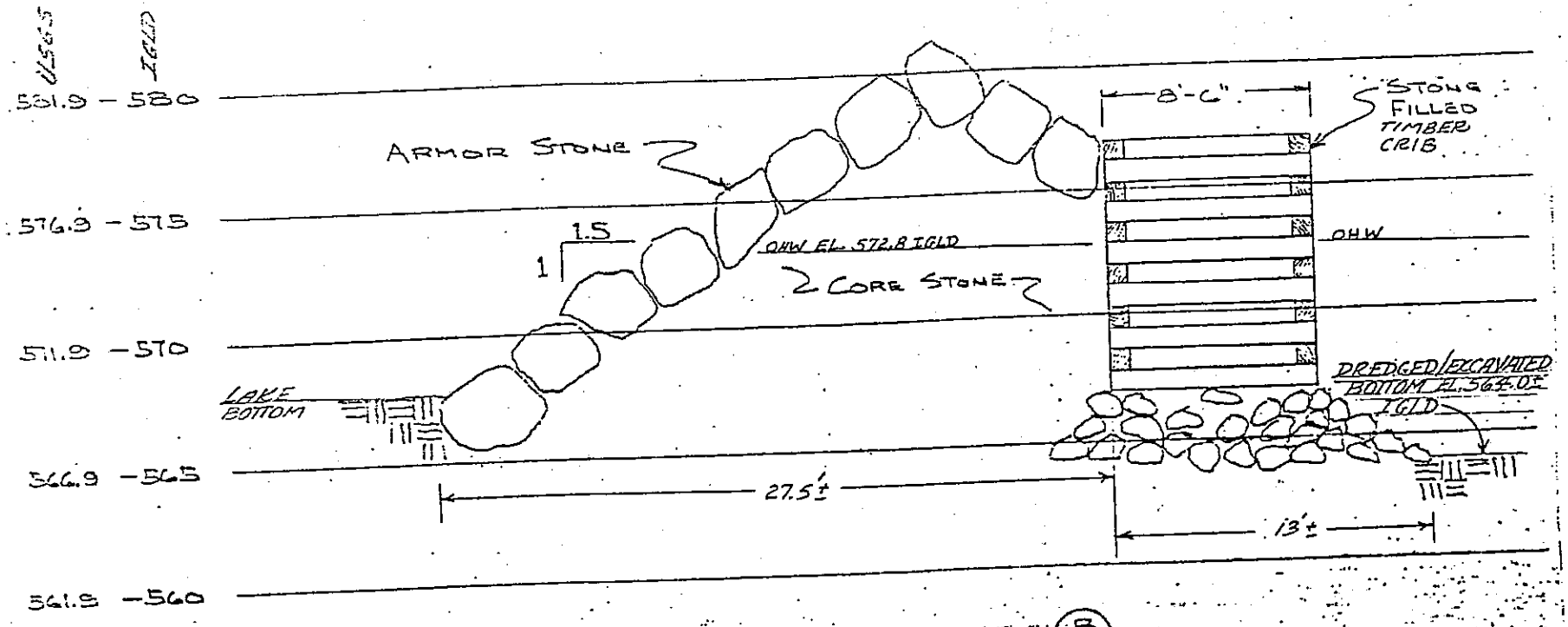
ADJACENT OWNER
EASTERLY

BEACHWOOD VILLA CONDOMINIUM OWNERS
ASSOCIATION
1507 CLEVELAND ROAD EAST
HURON, OHIO 44839

APPLICATION BY:
BEACHWOOD SHORES CORP
96-225-11
SHEET 3 OF 9



APPLICATION BY:
BEACHWOOD SHORES CORP.
86-475-11
SHEET 4 OF 9



SECTION B

SCALE: 1" = 5'-0"

5 0 5 10

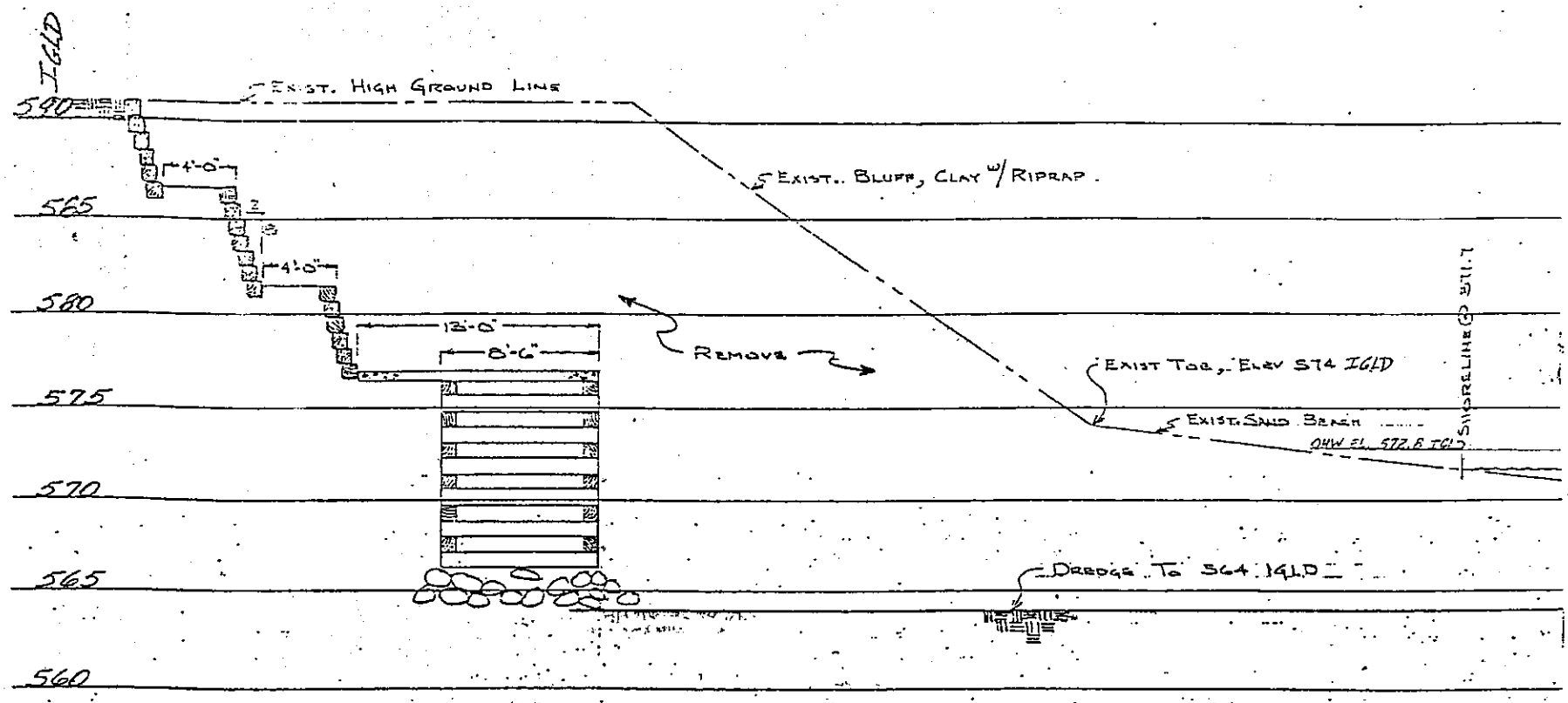
SCALE IN FEET

APPLICATION BY: SEAFARM WOOD SHORES CORP.

11-525-98

SHEET 5 OF 9

FIGURE



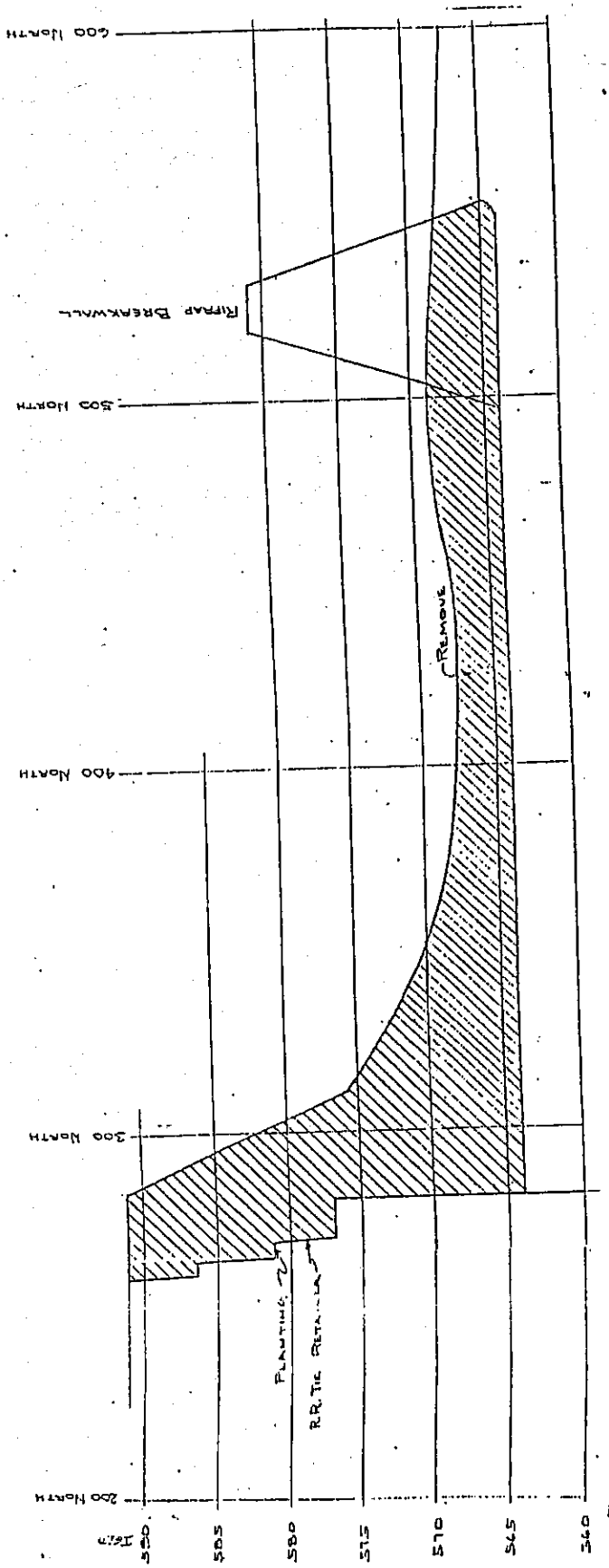
SECTION Ⓒ

SCALE 1"=5'-0"

5 0 5 10

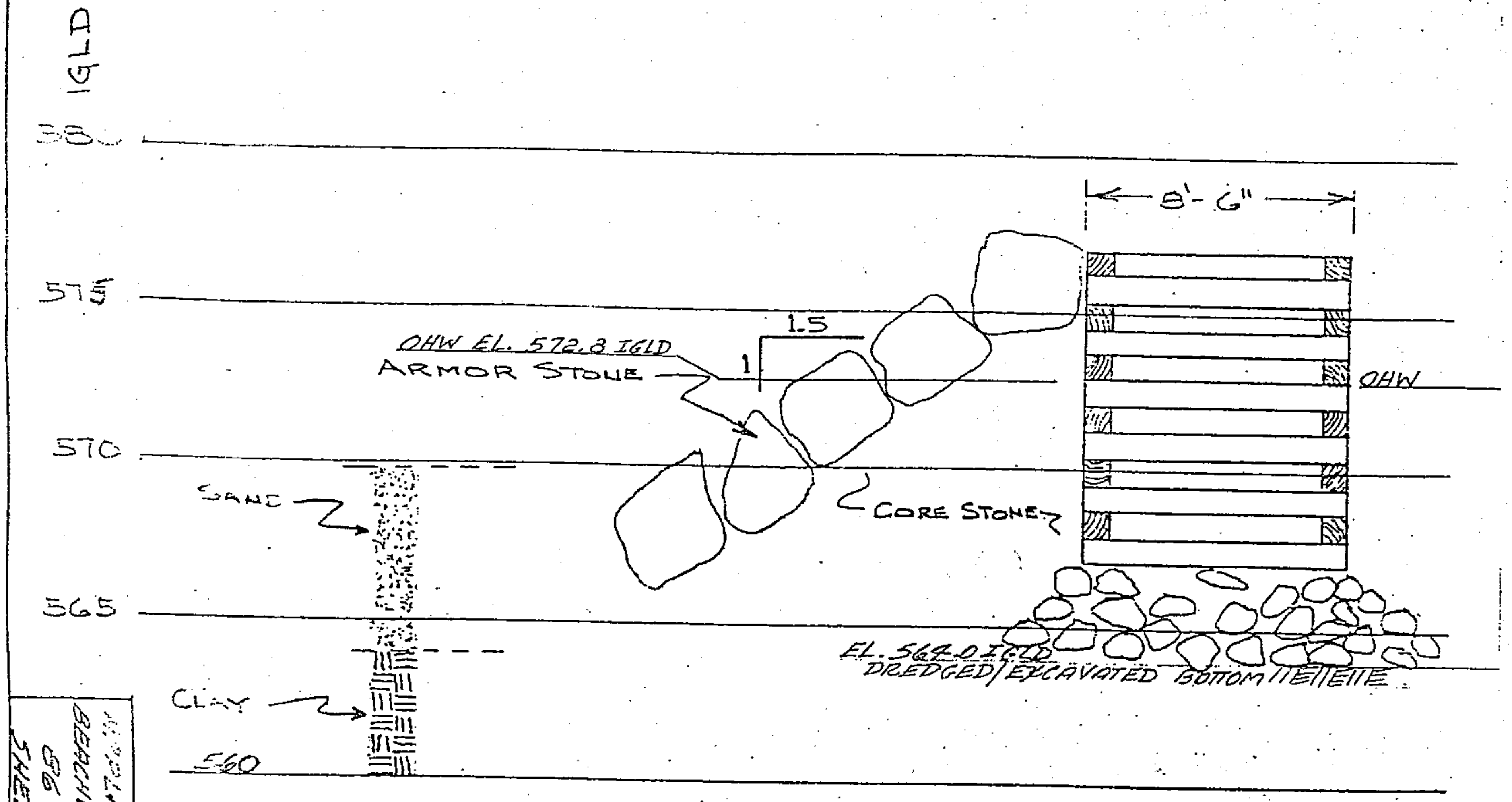
SCALE IN FEET

APPLICATION BY:
BEECHWOOD SHORES CORP
DG - 22511-11
SHEET 6 OF 6



- PROFILE 400 EAST -

APPLICATION BY:
BEACHWOOD SHORES CORP
86-475-11
SHEET 8 OF 9

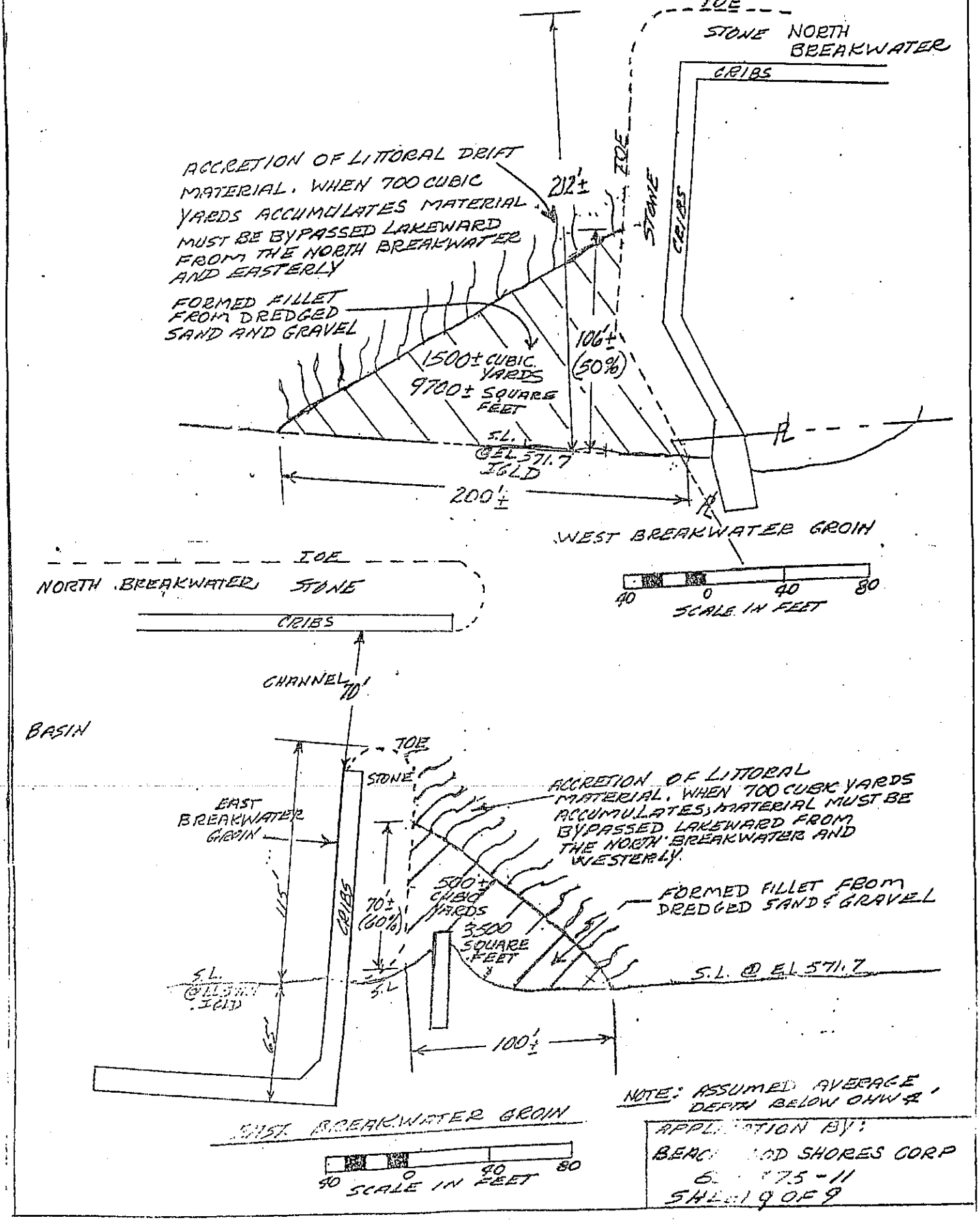


SECTION (D)

SCALE 1" = 5'-0"

APPLICATION BY:
BEACHWOOD SHORES CORP.
86-575-11
SHEET 7 OF 9

FRM



APPLICATION BY:
BEACHWOOD SHORES CORP
[illegible]75-11
SHEET 9 OF 9

APPENDIX B

PERMIT APPLICATION (1 August 1986)

BEACHWOOD SHORES CORPORATION

APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT

(33 CFR 325)

OMB APPROVAL NO. 0702-0036
Expires 30 June 1986

e Department of the Army permit program is authorized by Section 10 of the River and Harbor Act of 1899, Section 404 of the an Water Act and Section 103 of the Marine, Protection, Research and Sanctuaries Act. These laws require permits authorizing ivities in or affecting navigable waters of the United States, the discharge of dredged or fill material into waters of the United States, l the transportation of dredged material for the purpose of dumping it into ocean waters. Information provided on this form will be d in evaluating the application for a permit. Information in this application is made a matter of public record through issuance of a blic notice. Disclosure of the information requested is voluntary; however, the data requested are necessary in order to communicate h the applicant and to evaluate the permit application. If necessary information is not provided, the permit application cannot be ocessed nor can a permit be issued.

e set of original drawings or good reproducible copies which show the location and character of the proposed activity must be ached to this application *(see sample drawings and instructions)* and be submitted to the District Engineer having jurisdiction over location of the proposed activity. An application that is not completed in full will be returned.

LICATION NUMBER *(To be assigned by Corps)*

3. NAME, ADDRESS, AND TITLE OF AUTHORIZED AGENT

Telephone no. during business hours

A/C ( ) _____ *(Residence)*

A/C ( ) _____ *(Office)*

ME AND ADDRESS OF APPLICANT

Beachwood Shores Corporation
Marshall G. Browne, President
1500 Cleveland Rd. E.
Huron, Ohio 44839

Statement of Authorization: I hereby designate and authorize _____ to act in my behalf as my agent in the processing of this permit application and to furnish, upon request, supplemental information in support of the application.

phone no. during business hours

A/C (419) 433-5484 *(Residence)*

A/C (419) 433-3539 *(Office)*

SIGNATURE OF APPLICANT

DATE

TAILED DESCRIPTION OF PROPOSED ACTIVITY

CTIVITY

Construction of a marina facility in Lake Erie. The facility will consist of a riprap breakwall parallel to the shoreline placed less than 200 feet offshore. Stone-filled timber cribs, protected with riprap, extend from shore to enclose the marina. Approximately 17,000 square feet of dry land will be excavated for inclusion in the marina. Twenty-six floating finger docks will be installed for pleasure craft mooring. The marina will be dredged to elevation 564.0. An 8" diameter sand bypassing pipeline and pumping equipment will be installed to permit bypassing 80 cu. yds. of littoral material per hour in either direction.

URPOSE

The purpose of the marina will be for the private use of the owners' pleasure craft.

SCHARGE OF DREDGED OR FILL MATERIAL

All littoral material dredged during construction (approximately 15,000 cu. yds.) will be placed in the littoral system. Littoral material to form a fillet, considered normal by the Corps and ODNR will be placed to the east. All other littoral material will be placed to the west. All clay excavated from the bluff area will be hauled to an upland site for disposal. Bypassing will be initiated when sand accumulates beyond a predetermined limit of either the east or west fillet.

5. NAMES AND ADDRESSES OF ADJOINING PROPERTY OWNERS, LESSEES, ETC., WHOSE PROPERTY ALSO ADJOIN[illegible] WATERWA

1. Beachwood Villas Condominium Owners Association
   1507 Cleveland Road East
   Huron, OH 44839

2. Peter C. & Molly Gray
   1409 Cleveland Road East
   Huron, OH 44839

6. WATERBODY AND LOCATION ON WATERBODY WHERE ACTIVITY EXISTS OR IS PROPOSED

Lake Erie

7. LOCATION ON LAND WHERE ACTIVITY EXISTS OR IS PROPOSED

ADDRESS: 1500 Cleveland Road East

STREET, ROAD, ROUTE OR OTHER DESCRIPTIVE LOCATION

Erie | Ohio | 44839

COUNTY | STATE | ZIP CODE

Huron Township

LOCAL GOVERNING BODY WITH JURISDICTION OVER SITE

8. Is any portion of the activity for which authorization is sought now complete? ☐ YES ☒ NO
If answer is "Yes" give reasons, month and year the activity was completed. Indicate the existing work on the drawings.

9. List all approvals or certifications and denials received from other federal, interstate, state or local agencies for any structures, construction, discharges or other activities described in this application.

ISSUING AGENCY	TYPE APPROVAL	IDENTIFICATION NO.	DATE OF APPLICATION	DATE OF APPROVAL	DATE OF DENIAL

10. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities or I am acting as the duly authorized agent of the applicant.

Beachwood Shores Corp
Marshall G Blouse, Pres 8-1-86
SIGNATURE OF APPLICANT DATE

SIGNATURE OF AGENT DATE

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in Block 3 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

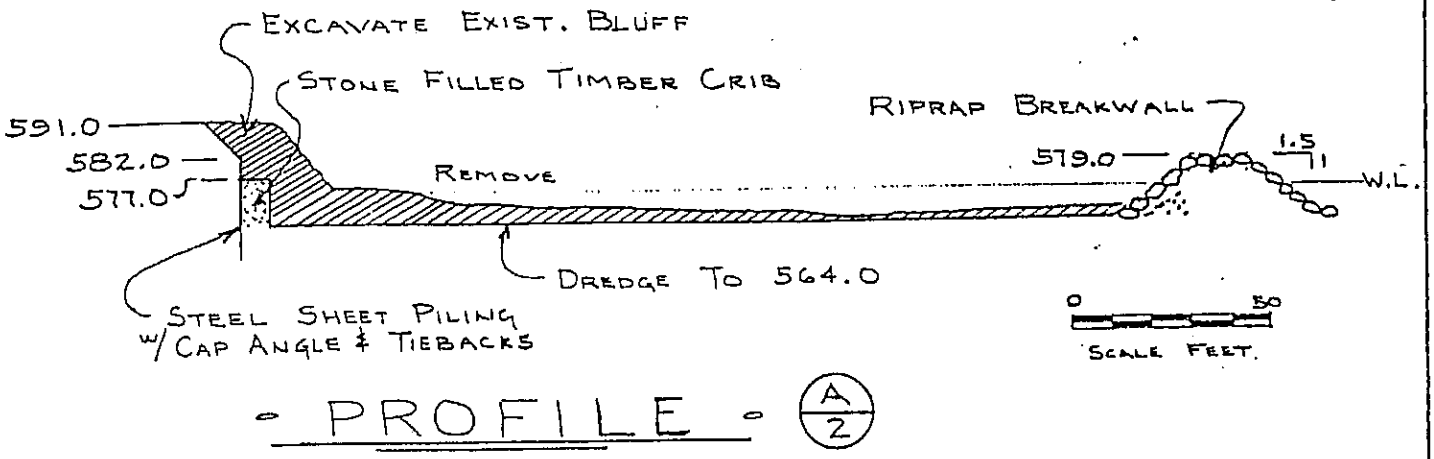
Do not send a permit processing fee with this application. The appropriate fee will be assessed when a permit is issued.

LOCATION MAP.

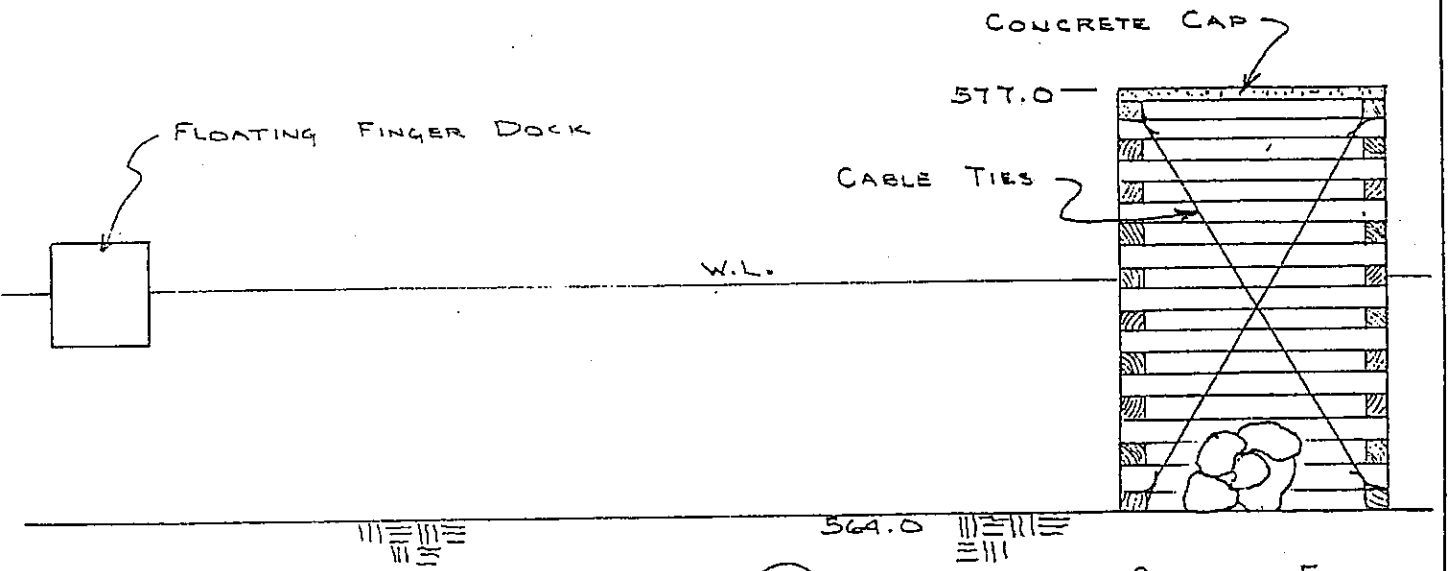
Proposed Marina Construction
In Lake Erie At Huron
County Of Erie
State Of Ohio
Application By Marshall G. Browne

SH. 1 OF 4

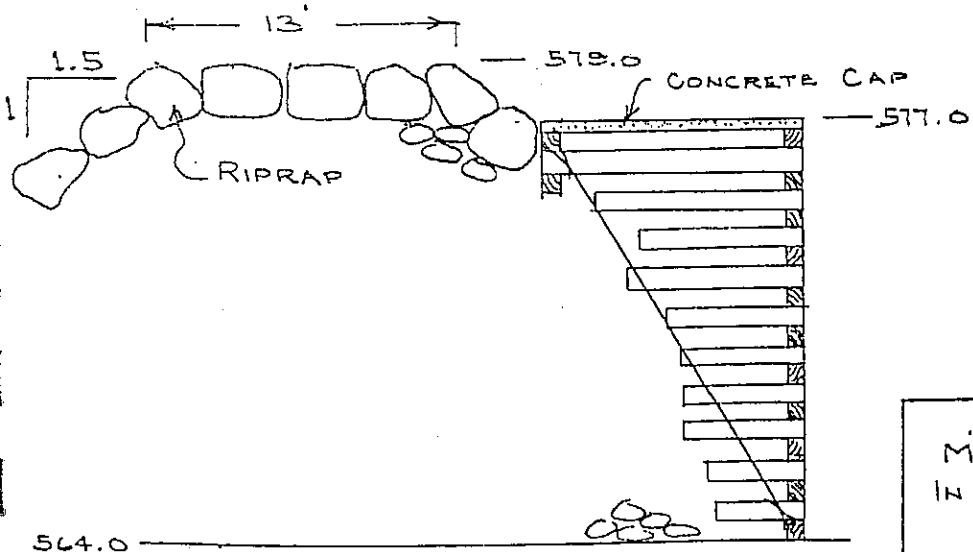
19 Nov 1984



PROFILE (A/2)



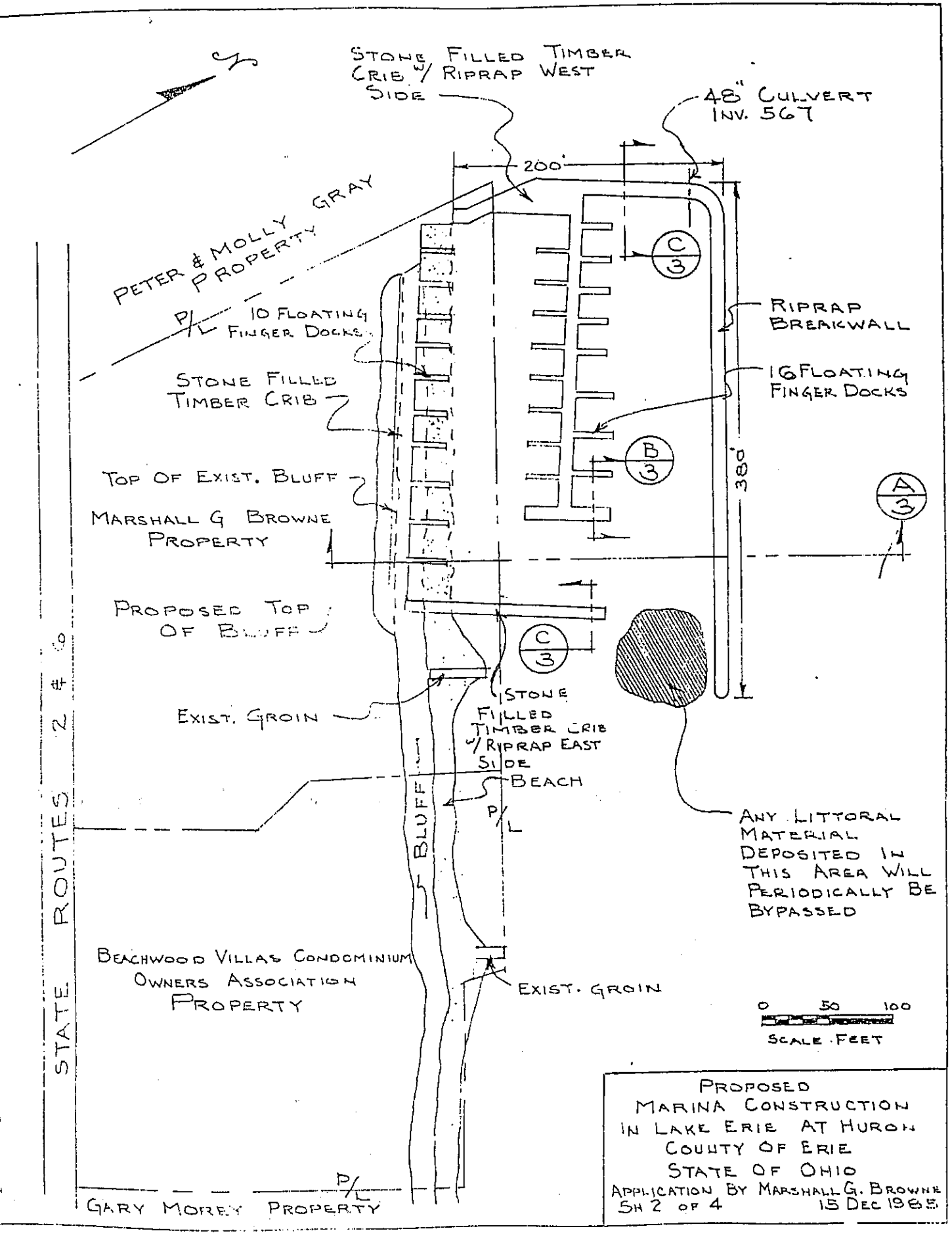
SECTION (B/2)



SECTION (C/2)

PROPOSED
MARINA CONSTRUCTION
IN LAKE ERIE AT HURON
COUNTY OF ERIE
STATE OF OHIO

APPLICATION BY MARSHALL G. BROWNE
SH. 3 OF 4 15 DEC 1985



PROPOSED
MARINA CONSTRUCTION
IN LAKE ERIE AT HURON
COUNTY OF ERIE
STATE OF OHIO

APPLICATION BY MARSHALL G. BROWNE

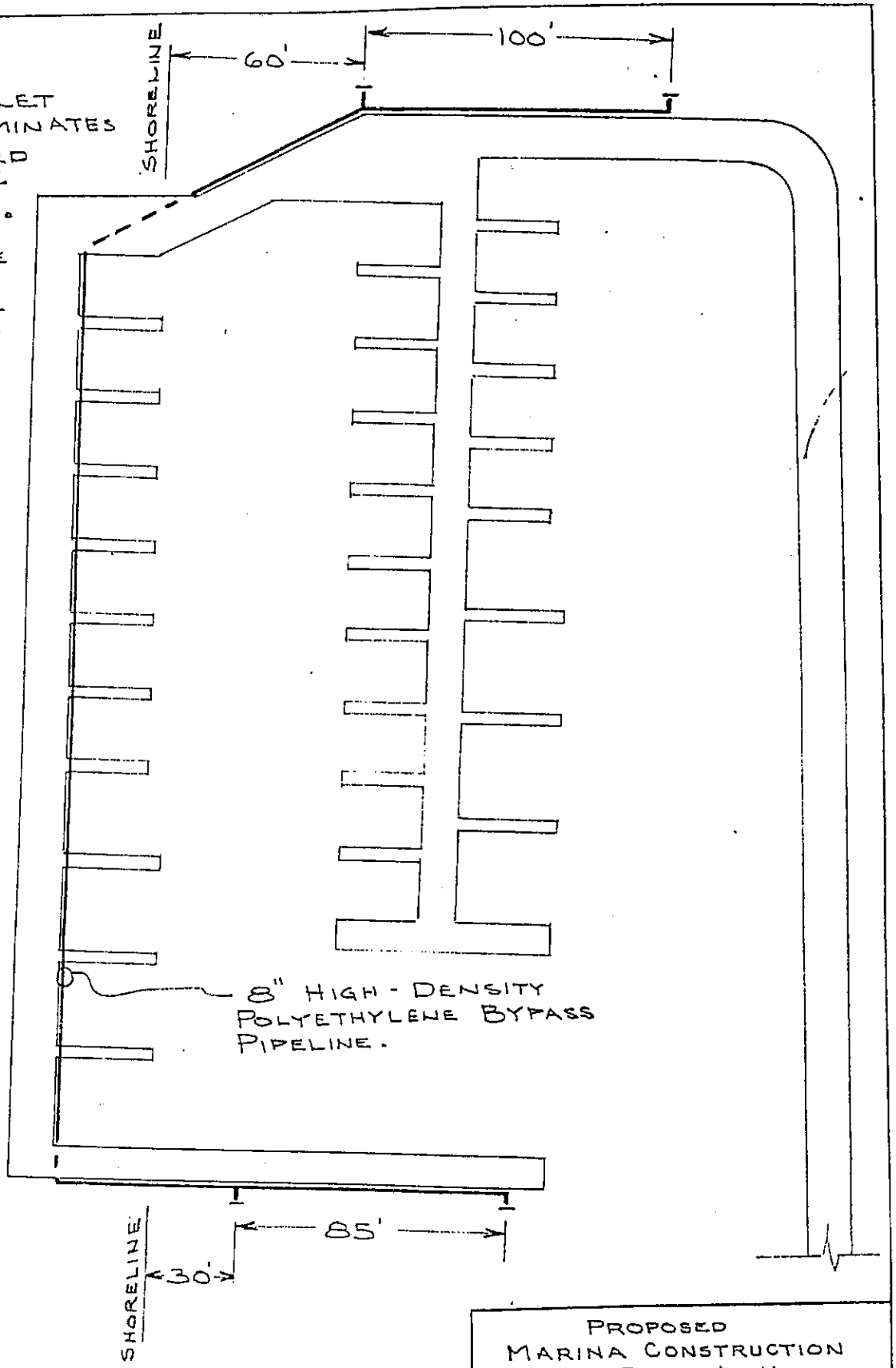
SH 2 OF 4

15 DEC 1965

NOTE:

1. AT INLET/OUTLET PIPELINE TERMINATES WITH STANDARD PIPE FLANGE & BLIND FLANGE.

2. WHERE PIPELINE PASSES UNDER DOCKS IT SHALL BE IN 10" STEEL CONDUIT.



SAND BYPASS PIPELINE

SCALE 1" = 50'

PROPOSED
MARINA CONSTRUCTION
IN LAKE ERIE AT HURON
COUNTY OF ERIE
STATE OF OHIO
APPLICATION BY MARSHALL G. BROWNE
SH 4 OF 4 20 JUL 1986

APPENDIX C

AGENCY CONCERNS:

ODNR, US F&WS, US EPA

ODNR
OHIO DEPARTMENT OF
NATURAL RESOURCES

Fountain Square
Columbus, Ohio 43224

March 26, 1987

Colonel Daniel R. Clark
District Engineer
Buffalo District, Corps of Engineers
U.S. Department of the Army
1776 Niagara Street
Buffalo, New York 14207

RE: NCBCO-S, 86-475-11, Beachwood Shores Corporation

Dear Colonel Clark:

The ODNR has received considerable inquiry regarding the status of the application for a Section 10/404 permit for the above-referenced project. As you know, this project is a revision of an earlier proposal by Marshall and Delores Browne (public notice 84-475-12, published 29 January 1985). In order to help expedite your decision on authorization of the proposed activities, I wish to further clarify ODNR's comments and concerns so they may be quickly addressed by the applicant or in conditions of Corps Authorization as you deem necessary. Please reference the March 4, 1987 comments submitted by Dr. Craden of my staff.

Detailed comments 8 through 12 discuss the need to ensure that sand bypassing will be performed on a regular basis for the life of the project. Further, the placement of sand lakeward of the north breakwater would not constitute sand bypassing (see comment 12). To be effective in abating potential increased erosion on nearby shoreline properties, sand must instead be placed along the shoreline adjacent to the marina in the appropriate direction as dictated by storm conditions. A method to assure sand bypassing for the life of the project is considered essential in order that potentially agrieved down drift landowners will have a course of action in the event problems are caused by this structure.

The mechanism for insuring that the sand-bypassing will be effected for the life of the marina is ODNR's principle concern. This concern was also highlighted by your Coastal Engineering Division in its review of the permit application. All other ODNR comments are technical and advisory in nature and I hope the applicant will give full consideration of those comments and ODNR's constructive intent in providing them.

ODNR staff is prepared to assist further as may be appropriate. My point of contact is Michael Colvin, Environmental Review Administrator (phone 614/265-6413).

Thank you for your consideration in this matter.

Sincerely,

JOSEPH J. SOMMER
Director

JJS/cag

cc: William Charles Stenk
Marshall G. Browne
Jared LeFavour, ODAS
Michael D. Craden, Ph.D., Chief
Office of Outdoor Recreation Services
Horace Collins, Chief
Division of Geological Survey

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

Columbus Field Office
Post Office Box 3990
Columbus, Ohio 43216-5000

February 12, 1987

Colonel Daniel R. Clark
District Engineer
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Attention: Steve Roy

Dear Colonel Clark:

The U. S. Fish and Wildlife Service has completed review of Public Notice NCBCO-S Re: 86-475-11, dated January 15, 1987. The applicant, Beachwood Shores Corporation, proposes to construct a 310-foot long by 200-foot wide marina basin in Lake Erie just east of the City of Huron, Erie County, Ohio.

These comments have been prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and are consistent with the intent of the National Environmental Policy Act of 1969 and the U. S. Fish and Wildlife Service's Mitigation Policy.

The presently proposed marina basin appears to project lakeward about 70 feet less than the one originally proposed in Public Notice 84-475-12, dated January 29, 1985.

In our letter of March 7, 1985, we supported the Ohio Department of Natural Resources' (DNR) opposition to the originally proposed marina due to potential disruption of sand transport in the project area. We understand that the Ohio DNR may have similar concerns regarding the new proposal. We have not been able to complete our coordination with them and request an extension of time to February 27, 1987 to complete that coordination and provide final comments.

Sincerely yours,

Kenneth A. Mullen

Kenneth A. Mullen
Acting Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Service, Attn: M. Colvin, Columbus, OH
Ohio EPA, Water Quality Monitoring & Assessment, Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

FEB 1 1 1987

REPLY TO THE ATTENTION OF:
5WQA-TUB8

Colonel Daniel R. Clark, USA
District Engineer
Buffalo District, Corps of Engineers
Department of the Army
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Clark:

This letter is in response to your request for comments regarding activities proposed by Beachwood Shores Corporation under Public Notice 86-475-11, dated January 15, 1987. The applicant requested a Section 10 and 404 permit to construct a marina adjacent to Lake Erie in Erie County, Ohio.

We have reviewed the proposed work and evaluated its potential impacts on environmental resources in the area. Based on this review, we will not object to the issuance of a permit subject to the following conditions:

The sand bypass system described in Paragraph C should be required as a permit condition and should be operated whenever necessary as long as the marina is in existence, even if sold or transferred to another owner. We suggest that your staff make periodic inspections to ensure that this system is operating as required.

We appreciate the opportunity to comment on this permit application. If you have any comments, please contact Mr. Thomas Glatzel at (312)886-6678.

Sincerely yours,

Edward Watters

for Doug Ehorn, Chief
Planning & Standards Section

cc: U.S. Fish and Wildlife Service, Columbus, Ohio
Ohio Environmental Protection Agency, Columbus, Ohio
Ohio Department of Natural Resources, Columbus, Ohio

DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207-3199

REPLY TO
ATTENTION OF

NCBCO-S

Date: 16 March 1987

SUBJECT: Application for Department of the Army Permit Number 86475II

Rec'd 3-19-87

Beachwood Stone
1500 Cleveland Rd East
Huron OH 44839

Dear Sir

Enclosed is a copy of a letter dated 4 March 1987 from the ODNR in response to the public notice for the referenced application.

If you do not respond to the issues raised within 15 days, we will assume that you are in agreement with them and we will make a decision on your application based on the information contained in the administrative record.

My point of contact pertaining to this matter is Steve Roy of my Regulatory Branch, who can be contacted by calling commercial number 716-876-5454, extension 2322, or by writing to:

District Commander
U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, NY 14207-3199
ATTN: Steve Roy

Buffalo District - Leadership in Engineering.

Sincerely,

DANIEL R. CLARK
Colonel, Corps of Engineers
District Commander

/ Enclosure(s)
as stated

ODNR
OHIO DEPARTMENT OF
NATURAL RESOURCES

Fountain Square
Columbus, Ohio 43224

March 4, 1987

SR

Colonel Daniel R. Clark
District Engineer
Buffalo District, Corps of Engineers
U.S. Department of the Army
1776 Niagara Street
Buffalo, New York 14207

Re: NCBCO-S, 86-475-11, Beachwood Shores Corporation

Dear Colonel Clark:

The Ohio Department of Natural Resources has completed a review of the above referenced public notice. The applicant has requested authorization to construct a marina in Lake Erie near Huron, Erie County, Ohio. Details of the project are given in the public notice.

The current marina proposal is similar to an earlier proposal that was advertised in public notice number 84-475-12 (January 29, 1985; Marshall and Delores Browne, applicants). In ODNR's review of that notice (letter of February 28, 1985), we indicated that the marina structures as proposed would have an adverse effect on littoral zone transport processes which would exacerbate erosion on downdrift lakeshore properties. We recommended that the Corps of Engineers not authorize the project as designed.

To attempt to resolve outstanding concerns, the applicant met with representatives of ODNR and other agencies. Possible project design modifications discussed included reducing the size of the marina so that it would only extend 150 feet offshore, excavating and sidecasting sand that would be buried by the construction of the breakwater, and incorporating a sand bypassing system in the marina. These modifications would reduce adverse impacts to the littoral system by conserving sand in the littoral zone and helping to maintain regional sand transport. The present plans include a breakwater complex extending 220-230 feet offshore, provision for sidecasting sand excavated during construction of the breakwater complex, and 'bypassing' sand whenever 700 cubic yards of sand accumulate next to the breakwater.

Since 1973, beach widths along this stretch of shore have decreased. This decrease may be due in part to a decrease in volume of sand coming from the east or to erosion/inundation of the beach because of high lake levels. Much of the shore west of the worksite has vertically faced concrete or steel sheet pile seawalls. At present lake levels, reflection of waves off these structures creates such turbulence that sand is not stable on the beach and is carried offshore. With the loss of beaches, many property owners have been forced to reinforce their seawalls. At a lower lake level, sand would probably move shoreward to form wider beaches; this has occurred during some of the lower water

years since 1973. However, while lake level is high, disruption of sand transport could aggravate existing beach erosion problems and endanger existing structures. When (and if) lake levels return to normal, beaches along this shore will probably be wider and the volume of sand which must be bypassed around the breakwater would probably increase.

ODNR's comments on the applicants' original proposal recognized potentially serious constraints upon development due to the characteristics of the nearshore zone of Lake Erie in the immediate project area. Enclosed are specific comments to assist the Corps in it's analysis of the currently proposed project's potential effects on littoral zone processes. These comments amplify concerns raised in my February 28, 1985 letter. The revised proposal does not appear to have addressed ODNR's original concerns.

We appreciate the opportunity to provide these comments. If you have any questions, please contact John Rupert (614/265-6415) of the Environmental Review Section of this office.

Sincerely,

Michael D. Craden

Michael D. Craden, Ph.D., Chief
Office of Outdoor Recreation Services

MDC/JCR/cag

cc: Bob Strohm, Division of Wildlife
Kent Kroonemeyer, USFWS
Elmer Shannon, USEPA
Colleen Crook, OEPA
Donald Guy, Division of Geological Survey
Bob Lucas, Office of Chief Engineer
Richard Bartz, Division of Water
Jared LeFavour, ODAS

COMMENTS

P.N. 86-475-11

BEACHWOOD SHORES CORPORATION

The revised proposal for the marina project referenced above is a modification proposed plans originally announced in public notice no. 84-475-12 dated January , 1985. The following comments pertain to the latest proposal for construction breakwaters, excavation and placement of sand and gravel and future periodic nd by passing:

1. The breakwater would lie at or lakeward of the crest of the submerged nearshore sandbar. During the summer months this bar moves landward about 50 feet and the elevation of the crest of the bar may increase up to 2.5 feet. Disruption of sand transport and deflection of littoral currents by the breakwater would likely cause abnormal changes in the position of the bar near the breakwater, altering the amount of wave energy impinging on the adjacent shoreline.

2. The breakwater entrance would face east (updrift). During storms with waves from the northeast, significant volumes of sand may be swept into the basin.

3. The marina basin would be dredged 3.5-4.0 feet deeper than the lake bed lakeward of the breakwater. As a result, there would be a tendency for sand to move shoreward into the deeper water of the basin even during mild wave conditions.

4. A four foot diameter culvert, to be placed at the northwest corner of the breakwater, would allow littoral sediment to wash into the basin during reversals in regional east to west sand transport.

5. About one third of the estimated 20,000 cubic yards of sand and gravel to be excavated during construction of the breakwater and basin would be placed updrift (east) of the breakwater to build a fillet of sand (beach). The remaining sand would be placed downdrift (west) of the breakwater to build a beach. Established ODNR policy requires sand to be returned to the littoral system downdrift of the point of dredging. However, given the frequent reversals of sand transport along this stretch of shore, limited disposal to the east of sand dredged during construction would probably be acceptable.

6. Sand dredged from the nearshore probably would be finer grained than the sand and gravel found on the beaches, so beaches constructed with the dredged sand may be prone to erosion.

7. The configuration of the sand fillets to be formed from dredged sand and gravel (sheets 2 and 9 of 9) would probably change significantly from that shown. Measurements of beaches trapped by shore-normal structures at the worksite from 1980 and 1986 aerial photography shows that the width of the beach on the updrift side of the structures typically is

about 42% of the structure length. Length of the beach trapped by the structures is about 4 times the width of the beach where it meets the structure. From these relationships, beaches formed of sand placed or trapped on both sides of the breakwater could grow to 90 feet in width and 360 feet in length. This is a combined beach area of 32,400 square feet and represents an entrapment of at least 16,000 to 32,000 cubic yards of sand. Entrapment of this much sand next to the breakwater would be at the expense of beaches elsewhere.

8. Maintenance dredging would be done whenever "accretion of littoral material at the fillets reaches 700 cubic yards beyond the proposed dimensions of the fillets shown on the plan drawing". Accretion of sand next to a shore-normal structure may be subaerial or subaqueous. Therefore, monitoring only subaerial changes in the beach area may not accurately measure how much sand is accumulating offshore. In addition, measuring changes in beach area that are due to sediment accretion as opposed to those that are due to changes in lake level would be extremely difficult unless sophisticated surveys are made. Basing the frequency and direction of sand bypassing solely on changes of area of the beach is inadequate to maintain uninterrupted transport of littoral sediments along this stretch of shore.

9. Frequency and adequacy of bypassing would need to be monitored and enforced. The Corps of Engineers would need to ensure such a program is developed and implemented. Continuing review and establishment of additional special conditions may be necessary to reduce unforeseen adverse impacts that may occur.

10. The provisions of sand bypassing would need to be guaranteed regardless of cost or change of ownership. Sand must continue to be bypassed by the responsible party for the life of the facility.

11. The need to bypass sand would be greatest during the storm season (fall through spring). The pumping system should be capable of operating in all wave conditions. Ideally, sand bypassing should take place during storms so that the downdrift shore is not deprived of sand during the storm.

12. Bypassing sand "northerly of the north breakwater into the littoral system" does not constitute sand bypassing. Sand placed lakeward of the breakwater would be lakeward of the nearshore bar and wave conditions appropriate for transporting sand shoreward might not occur for some time after disposal of the sand. When the sand eventually moves shoreward, it might not be adjacent to the breakwater. As a result, portions of the shore would be deprived of sand that would have moved along the shoreline if the breakwater were not constructed.

13. Elevation of the lakebottom just lakeward of the breakwater is about 568 feet (IGLD). At present lake level, water depth is about 5 feet. However, relative to mean lake level between 1973 and 1986 (about 572 feet) there would be about 4 feet of water depth and relative to long term mean (about 570.5 feet) there would be only 2.5 feet of water depth. Maintaining access to the marina may require continual maintenance dredging through the nearshore bar and at the marina entrance.

As previously mentioned, direction of sand transport reverses frequently because of the shoreline orientation. One estimate is that net transport could range from as much as 7,000 cubic yards per year to the west to as much as 7,000 cubic yards per year to the east depending upon wind and wave conditions. In addition, the most recent calculation of sand movement along this shoreline shows that gross transport rates could be as high as 50,000 cubic yards per year. Without the breakwater, sand is free to move uninterrupted in any direction as wave conditions change. Construction of this breakwater can only disrupt this process. Even if implemented, a bypass system would only partially mitigate not prevent adverse impacts.

APPENDIX D

COMMUNICATIONS IN SUPPORT OF PROPOSED PROJECT

rom the desk of -
Peter Gray
1409 Cleveland Road East
Huron, Ohio 44839

February 24, 1986

Department of the Army
Buffalo District
Corps of Engineers
1776 Niagara Street
Buffalo, N.Y. 14207

RE: Proposed Beachwood Villa Marina

Gentlemen:

We are the adjacent property owners to the west of the Beachwood Villas Condominium Project. We understand that an application was made to the Corps of Engineers in December showing a revised and smaller marina layout. Mr. Marshall Browne, President of Beachwood Shores Corporation, has explained his efforts to reduce the size of his marina by placing the south line 40 feet in an area excavated from his shoreline.

We approve his efforts to redesign the marina and support his application for such a permit. We believe such a structure will help protect our steel bulkhead during the northeast storms and we are pleased that sand will be placed adjacent to our bulkhead during construction and regular maintenance periods, thus providing us with shoreline protection and a better bathing beach.

Peter C. Gray
Peter Gray

Molly A. Gray
Molly Gray

LAKEFRONT-LAKEVIEW ASSOCIATION, INC.
1132 By the Shores
Huron, Ohio 44839

December 8, 1986

District Commander
U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, NY 14207-3199

Dear Sir:

This letter is in reference to the proposed marina project at Beachwood Villas, Huron, Ohio.

Our two subdivisions, comprising this Association, are located immediately west of the Gray's residence, which adjoins Beachwood Villas to the west.

Our Association is strongly in favor of this marina project. We feel the additional dockage is necessary and badly needed. In addition, we feel the marina will be a stabalizing influence on the shoreline erosion and continuing water damage.

We are particularly impressed with the proposed sand transfer system, which will allow the buildup of sand to be placed as needed in either direction.

This is an excellent project for our area and one which we hope will receive your immediate approval so that work can be started early in the 1987 season.

Sincerely yours,

LAKEFRONT-LAKEVIEW ASSOCIATION, INC.

Bill Maclean
President

wrm:sg

cc Marsh Brocone

THE HURON JOINT PORT AUTHORITY

CITY HALL

HURON, ERIE COUNTY, OHIO

February 28, 1986

Colonel Daniel R. Clark, District Engineer
Buffalo District Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Clark:

The Huron Joint Port Authority at its regular meeting last night, reviewed the proposed Marina plans submitted by Marshall G. Browne, President of the Beachwood Shores Corporation.

The Huron Joint Port Authority will go on record voicing no objections to this project.

Your further consideration will be appreciated.

Sincerely,

H. J. Micheals, Secretary

HJM/ems.

cc: Marshall G. Browne

APPENDIX E

U.S. Army, Corps of Engineers Permit No. 84-375-1

for the

Westlake Land Company Marina

Vermilion Township Erie County, Ohio

DEPARTMENT OF THE ARMY
PERMIT

BUFFALO DISTRICT
CORPS OF ENGINEERS
BUFFALO, NY 14207

NCBCO-S

PERMIT NO. 84-375-1

NAME OF APPLICANT WESTLAKE LAND COMPANY

28 September 1984
EFFECTIVE DATE

28 Sept. 87
EXPIRATION DATE

Referring to written request dated 23 APRIL 1984 for a permit to:

(X) Perform work in or affecting navigable waters of the United States, upon the recommendation of the Chief of Engineers, pursuant to Section 10 of the River and Harbor Act of March 3, 1899 (33 U.S.C. 403);

(X) Discharge dredged or fill material into waters of the United States upon the issuance of a permit from the Secretary of the Army acting through the Chief of Engineers pursuant to Section 404 of the Clean Water Act (Pub. L. 95-217, 33 U.S.C. 1344):

WESTLAKE LAND COMPANY, 1000 CROCKER ROAD, WESTLAKE, OHIO 44145 IS HEREBY AUTHORIZED BY THE SECRETARY OF THE ARMY: TO CONSTRUCT A SAND BEACH AND GROIN FIELD ALONG ABOUT 2200 FEET OF SHORELINE AND ESTABLISH A BOAT ANCHORAGE AREA IN LAKE ERIE, VERMILION TOWNSHIP, ERIE COUNTY, OHIO IN ACCORDANCE WITH THE GENERAL AND SPECIAL CONDITIONS, AND THE PLANS AND DRAWINGS AND ANY ADDITIONAL SPECIAL CONDITIONS ATTACHED HERETO WHICH ARE INCORPORATED IN AND MADE A PART OF THIS PERMIT.

GENERAL CONDITIONS:

a. That all activities identified and authorized herein shall be consistent with the terms and conditions of this permit; and that any activities not specifically identified and authorized herein shall constitute a violation of the terms and conditions of this permit which may result in the modification, suspension or revocation of this permit, in whole or in part, as set forth more specifically in General Conditions k or l hereto, and in the institution of such legal proceedings as the United States Government may consider appropriate, whether or not this permit has been previously modified, suspended or revoked in whole or in part.

b. That all activities authorized herein shall, if they involve, during their construction or operation, any discharge of pollutants into waters of the United States, be at all times consistent with applicable water quality standards, effluent limitations and standards of performance, prohibitions, pretreatment standards and management practices established pursuant to the Clean Water Act (Pub. L. 95-217, 33 U.S.C. 1344), the Marine Protection, Research and Sanctuaries Act of 1972 (Pub. L. 92-532, 86 Stat. 1052), or pursuant to applicable State and local law.

c. That when the activity authorized herein involves a discharge during its construction or operation, of any pollutant (including dredged or fill material), into waters of the United States, the authorized activity shall, if applicable water quality standards are revised or modified during the terms of this permit, be modified, if necessary, to conform with such revised or modified water quality standards within 6 months of the effective date of any revision or modification of water quality standards, or as directed by an implementation plan contained in such revised or modified standards or within such longer period of time as the District Engineer, in consultation with the Regional Administrator of the Environmental Protection Agency, may determine to be reasonable under the circumstances.

d. That the discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act, or endanger the critical habitat of such species.

e. That the permittee agrees to make every reasonable effort to prosecute the construction or operation of the work authorized herein in a manner so as to minimize any adverse impact on fish, wildlife, and natural environmental values.

f. That the permittee agrees that it will prosecute the construction or work authorized herein in a manner so as to minimize any degradation of water quality.

g. That the permittee shall allow the District Engineer or his authorized representative(s) or designee(s) to make periodic inspections at any time deemed necessary in order to assure that the activity being performed under authority of this permit is in accordance with the terms and conditions prescribed herein.

h. That the permittee shall maintain the structure or work authorized herein in good condition and in accordance with the plans and drawings attached hereto.

i. That this permit does not convey any property rights, either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to property or invasion of rights or any infringement of Federal, State, or local laws or regulations.

j. That this permit does not obviate the requirement to obtain state or local assent required by law for the activity authorized herein.

k. That this permit may be either modified, suspended or revoked in whole or in part pursuant to the policies and procedures of 33 CFR 325.7.

l. That in issuing this permit, the Government has relied on the information and data which the permittee has provided in connection with his permit application. If, subsequent to the issuance of this permit, such information and data prove to be materially false, materially incomplete or inaccurate, this permit may be modified, suspended or revoked, in whole or in part, and/or the Government may, in addition, institute appropriate legal proceedings.

m. That any modification, suspension, or revocation of this permit shall not be the basis for any claim for damages against the United States.

n. That the permittee shall notify the District Engineer of the time the activity authorized herein will be commenced, as far in advance of the time of commencement as the District Engineer may specify, and of any suspension of work, if for a period of more than one week, resumption of work and its completion.

o. That if the activity authorized herein is not completed on or before _____ day of _____, 19 _____, (three years from the date of issuance of this permit unless otherwise specified) this permit, if not previously revoked or specifically extended, shall automatically expire.

p. That this permit does not authorize or approve the construction of particular structures, the authorization or approval of which may require authorization by the Congress or other agencies of the Federal Government.

q. That if and when the permittee, desires to abandon the activity authorized herein, unless such abandonment is part of a transfer procedure by which the permittee is transferring his interests herein to a third party pursuant to General Condition t. hereof, he must restore the area to a condition satisfactory to the District Engineer.

r. That if the recording of this permit is possible under applicable State or local law, the permittee shall take such action as may be necessary to record this permit with the Register of Deeds or other appropriate official charged with the responsibility for maintaining records of title to and interest in real property.

s. That there shall be no unreasonable interference with navigation by the existence or use of the activity authorized herein.

t. That this permit may not be transferred to a third party without prior written notice to the District Engineer, either by the transferee's written agreement to comply with all terms and conditions of this permit or by the transferee subscribing to this permit in the space provided below and thereby agreeing to comply with all terms and conditions of this permit. In addition, if the permittee transfers the interests authorized herein by conveyance of realty, the deed shall reference this permit and the terms and conditions specified herein and this permit shall be recorded along with the deed with the Register of Deeds or other appropriate official.

u. That if the permittee during prosecution of the work authorized herein, encounters a previously unidentified archeological or other cultural resource that might be eligible for listing in the National Register of Historic Places, he shall immediately notify the District Engineer.

SPECIAL CONDITIONS: (CONTINUED ON PAGE 6)

(1) That this permit does not authorize the interference with any existing or proposed Federal project and that the permittee shall not be entitled to compensation for damage or injury to the structures or work authorized herein which may be caused by or result from existing or future operations undertaken by the United States in the public interest.

(2) That no attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the activity authorized by this permit.

(3) That if the display of lights and signals on any structure or work authorized herein is not otherwise provided for by law, such lights and signals as may be prescribed by the United States Coast Guard shall be installed and maintained by and at the expense of the permittee.

(4) That the permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the authorized structure or work, shall, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the waterway to its former conditions. If the permittee fails to comply with the direction of the Secretary of the Army or his authorized representative, the Secretary or his designee may restore the waterway to its former condition, by contract or otherwise, and recover the cost thereof from the permittee.

(5) That the permittee hereby recognizes the possibility that the structure permitted herein may be subject to damage by wave wash from passing vessels. The issuance of this permit does not relieve the permittee from taking all proper steps to insure the integrity of the structure permitted herein and the safety of boats moored thereto from damage by wave wash and the permittee shall not hold the United States liable for any such damage.

( ) That when the work authorized herein includes periodic maintenance dredging, it may be performed under this permit for years from the date of issuance of this permit (ten years unless otherwise indicated).

( ) That the permittee will advise the District Engineer in writing at least two weeks before he intends to undertake any maintenance dredging.

( ) That the discharge will be carried out in conformity with the goals and objectives of the EPA Guidelines established pursuant to Section 404 (b) of the Clean Water Act and published in 40 CFR Part 230.

(6) That the discharge will consist of suitable material free from toxic pollutants in toxic amounts.

( ) That the fill created by the discharge will be properly maintained to prevent erosion and other non-point sources of pollution.

( ) That the discharge will not occur in a component of the National Wild and Scenic River System or in a component of a State Wild and Scenic River System.

THIS PERMIT SHALL BECOME EFFECTIVE ON THE DATE OF THE DISTRICT ENGINEER'S SIGNATURE.

PERMITTEE HEREBY ACCEPTS AND AGREES TO COMPLY WITH THE TERMS AND CONDITIONS OF THIS PERMIT.

WESTLAKE LAND COMPANY

X BY Robert E. Schilling X Project Manager
Permittee Title

Robert E. Schilling

X 9-25-84
Date

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

ROBERT R. HARDIMAN, COL, CE

District Commander

28 September 1984
Date

TRANSFEREE HEREBY AGREES TO COMPLY WITH THE TERMS AND CONDITIONS OF THIS PERMIT.

Transferee Date

SPECIAL CONDITIONS

(7) That no building or other structure may be erected on the fill approved on the attached plans, unless specifically indicated.

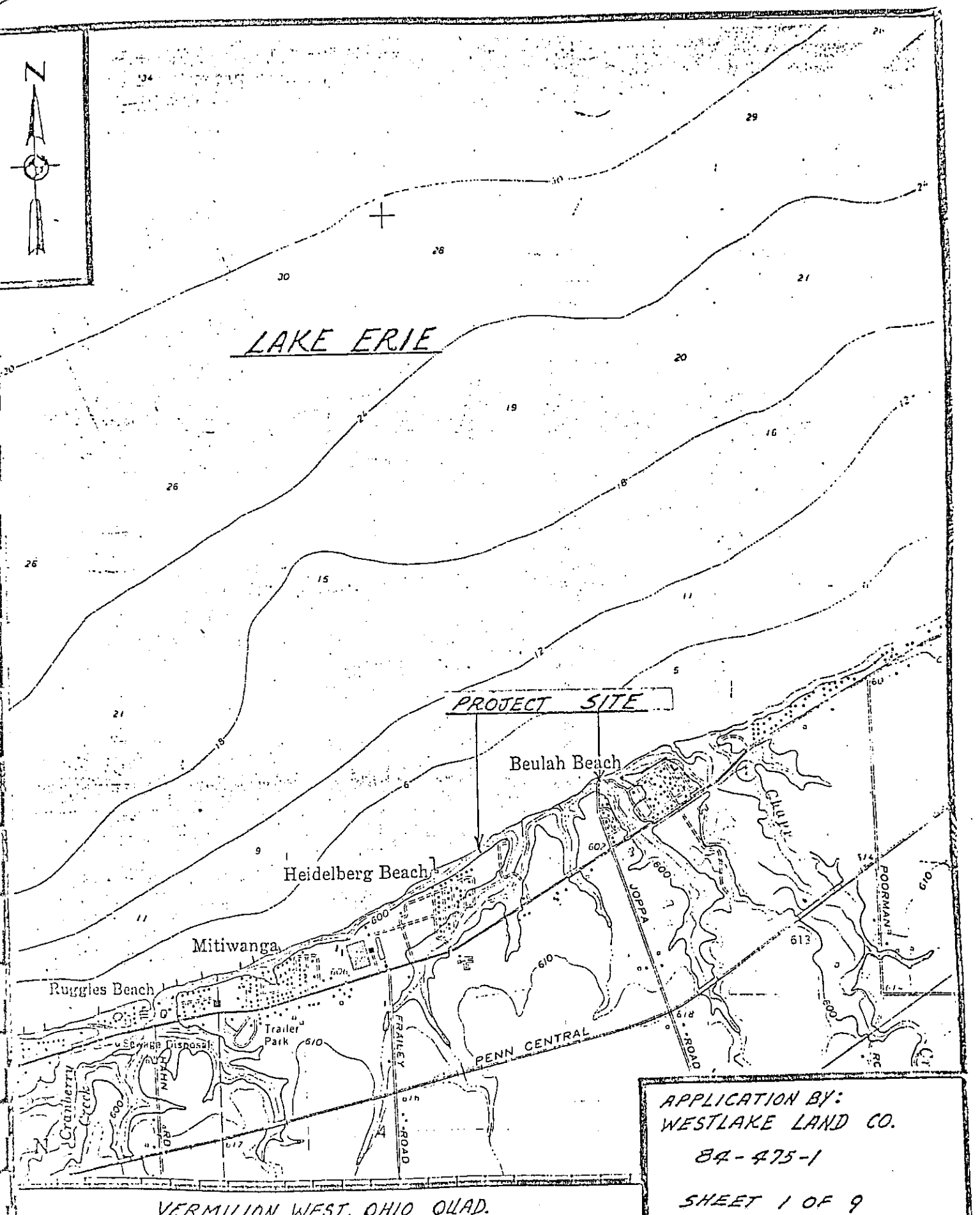
(8) That if the permittee proposes to use a disposal site not specifically authorized by this permit, the location of the proposed site must be submitted to the District Commander, prior to the discharge of any dredged or fill material, to determine if additional Department of the Army authorization is required.

(9) That the issuance of this permit does not constitute any endorsement of the engineering design and integrity of the structure authorized herein and that the permittee recognizes the possibility of damage to the structure from natural causes such as ice and storms and that the permittee shall not hold the United States liable for such damage to the structure or caused as a result of such damage to the structure.

(10) That the mechanical equipment used to execute this project be operated in such a way as to minimize turbidity that could degrade water quality and adversely affect aquatic plant and animal life.

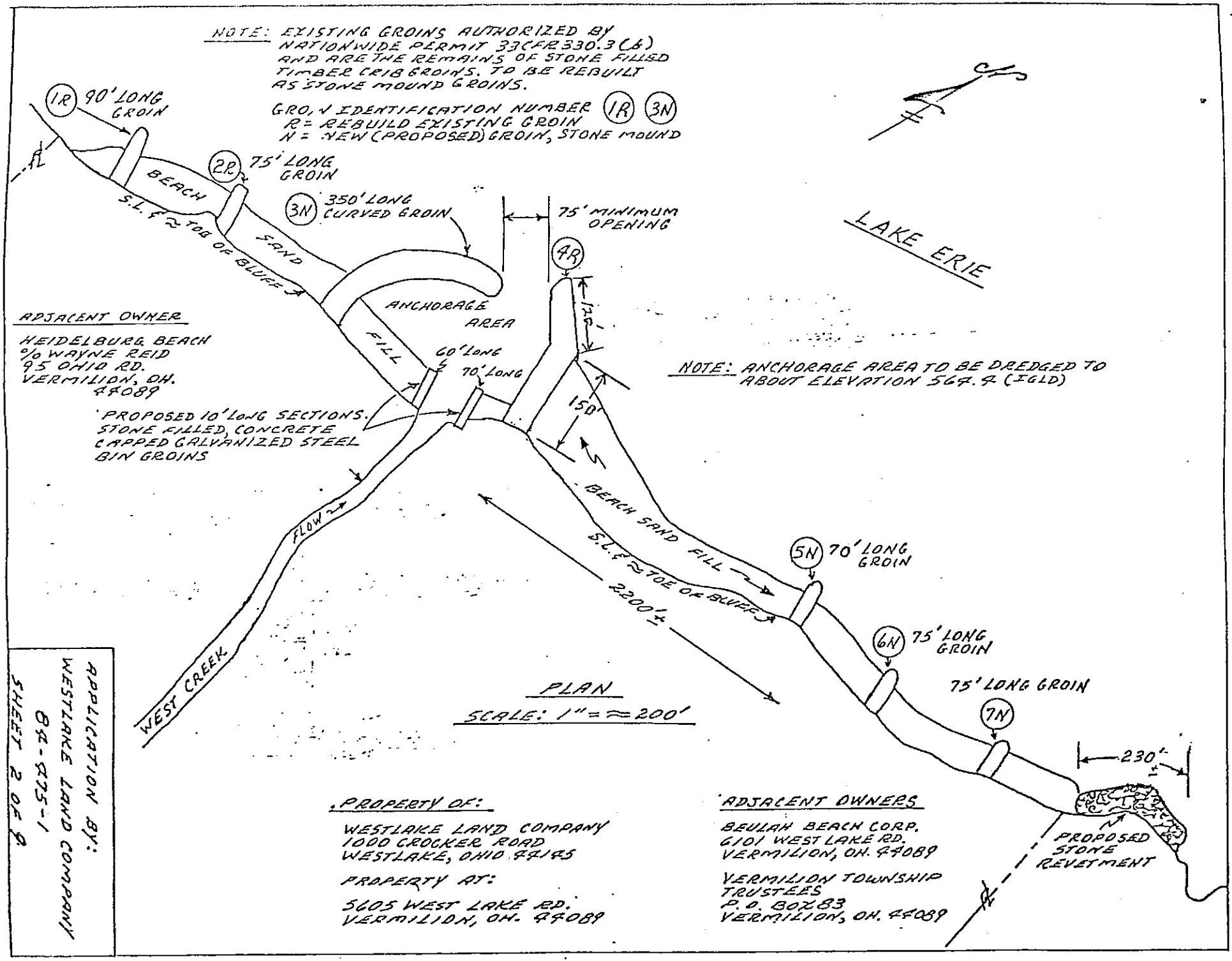
(11) That if the District Commander finds that significant amounts of littoral material have been trapped by the structure, the permittee will agree to place coarse sand and gravel from an upland source in the littoral drift system in quantities and at locations to be determined by the District Commander.

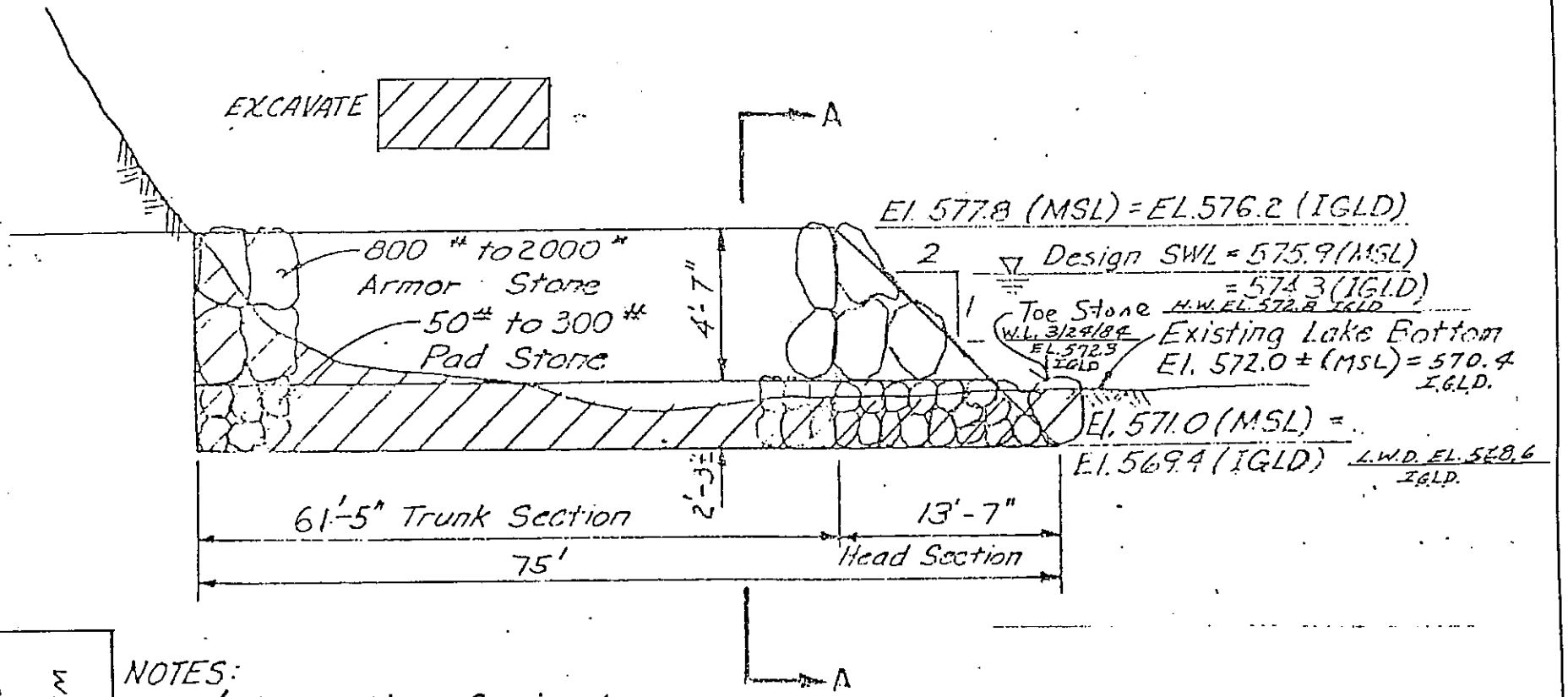
(12) That all disturbed upland areas shall be seeded and mulched following construction to prevent erosion.



VERMILION WEST, OHIO QUAD.

APPLICATION BY:
WESTLAKE LAND CO.
84-475-1
SHEET 1 OF 9


NOTE: EXISTING GROINS AUTHORIZED BY NATIONWIDE PERMIT 33CFR330.3(A) AND ARE THE REMAINS OF STONE FILLED TIMBER CRIB GROINS. TO BE REBUILT AS STONE MOUND GROINS.
GRO. # IDENTIFICATION NUMBER (1R) (3N)
R = REBUILD EXISTING GROIN
N = NEW (PROPOSED) GROIN, STONE MOUND
1R 90' LONG GROIN
2R 75' LONG GROIN
3N 350' LONG CURVED GROIN
75' MINIMUM OPENING
4R
12R'
BEACH
S.L.F ≈ TOE OF BLUFF
SAND
ANCHORAGE AREA
FILL
60' LONG
70' LONG
150'
LAKE ERIE
ADJACENT OWNER
HEIDELBURG BEACH
% WAYNE REID
95 OHIO RD.
VERMILION, OH.
44089
PROPOSED 10' LONG SECTIONS. STONE FILLED, CONCRETE CAPPED GALVANIZED STEEL BIN GROINS
NOTE: ANCHORAGE AREA TO BE DREDGED TO ABOUT ELEVATION 569.4 (IGLD)
FLOW
WEST CREEK
BEACH SAND FILL
S.L.F ≈ TOE OF BLUFF
2200'±
5N 70' LONG GROIN
6N 75' LONG GROIN
75' LONG GROIN
7N
230'±
PROPOSED STONE REVETMENT
PLAN
SCALE: 1" = ≈200'
PROPERTY OF:
WESTLAKE LAND COMPANY
1000 CROCKER ROAD
WESTLAKE, OHIO 44145
PROPERTY AT:
5605 WEST LAKE RD.
VERMILION, OH. 44089
ADJACENT OWNERS
BEULAH BEACH CORP.
6101 WEST LAKE RD.
VERMILION, OH. 44089
VERMILION TOWNSHIP TRUSTEES
P.O. BOX 83
VERMILION, OH. 44089
APPLICATION BY:
WESTLAKE LAND COMPANY
BX-875-1
SHEET 2 OF 8



NOTES:

75' Long New Groin shown, other groins similar.

For Section A-A, see Sht. 5

For Section Views of Groins 3N & 4R, see Sht 6

SWL = Design Stillwater Level

SCALE: NOT TO SCALE

APPLICATION BY:
WESTLAKE LAND COMPANY
82-425-1
SHEET 4 OF 9

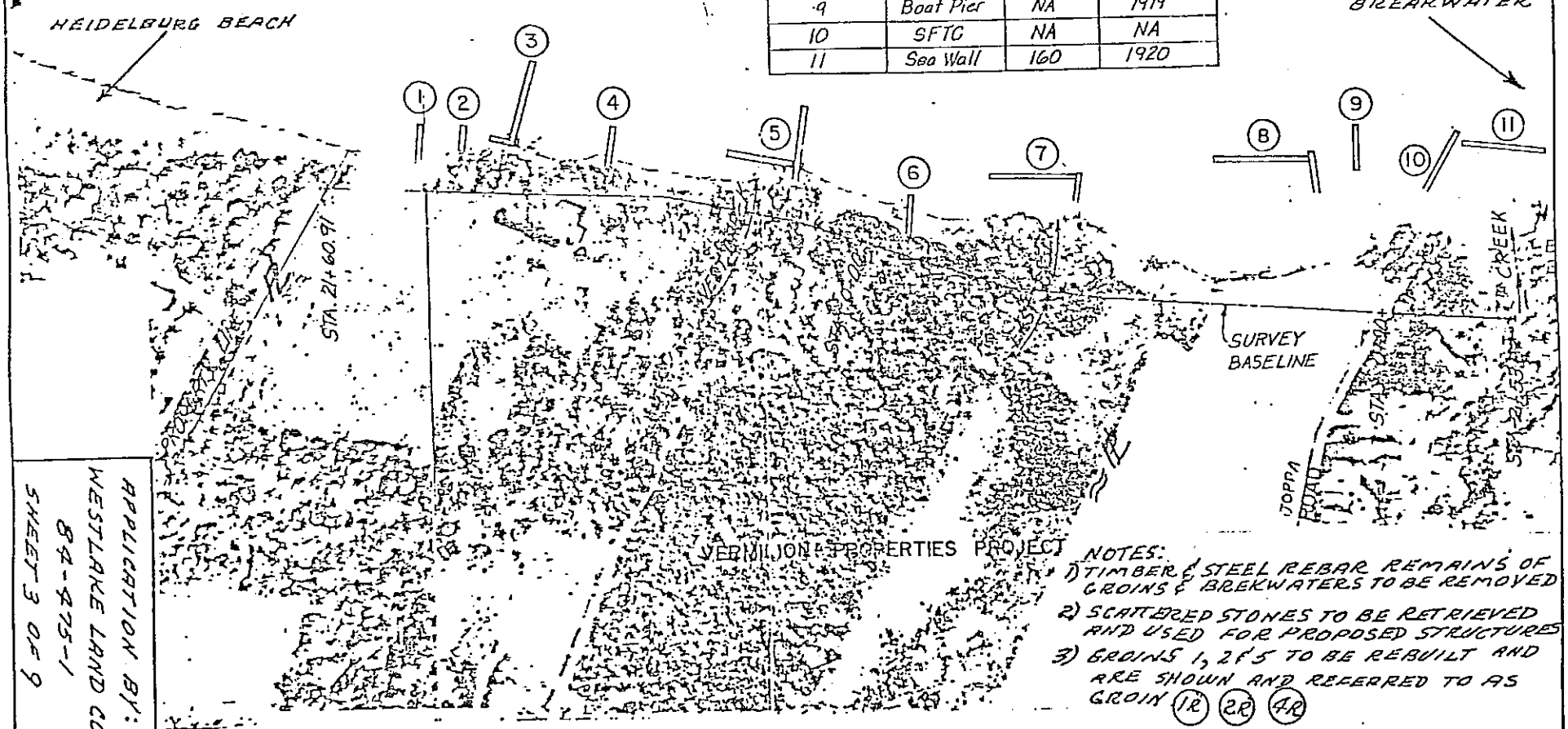
SFTC = Stone Filled Timber Crib Groin
Sea Walls are also constructed of Stone Filled Timber Cribs
Lengths are measured from toe of slope to end of groin
NA = Not available
Structure 11 is on Beulah Beach Property
Existing structures are generally in poor condition. Most consist of scattered stone.

EXISTING STRUCTURES

STRUCTURE NO.	STRUCTURE TYPE	APPROX. LENGTH (FT.)	YEAR BUILT
1	SFTC	74	1919
2	SFTC	53	1919
3	SFTC & SeaWall	160, 40	1919
4	SFTC	80	1919
5	SFTC & SeaWall	140, 140	1919
6	SFTC	80	NA
7	SFTC & SeaWall	NA, 170	1919
8	SFTC & SeaWall	NA, 190	NA
9	Boat Pier	NA	1919
10	SFTC	NA	NA
11	Sea Wall	160	1920

EXISTING STRUCTURES AUTHORIZED BY NATIONWIDE PERMIT 33CFR330.3(b).

180' Long Heidelburg Beach Groin Structure



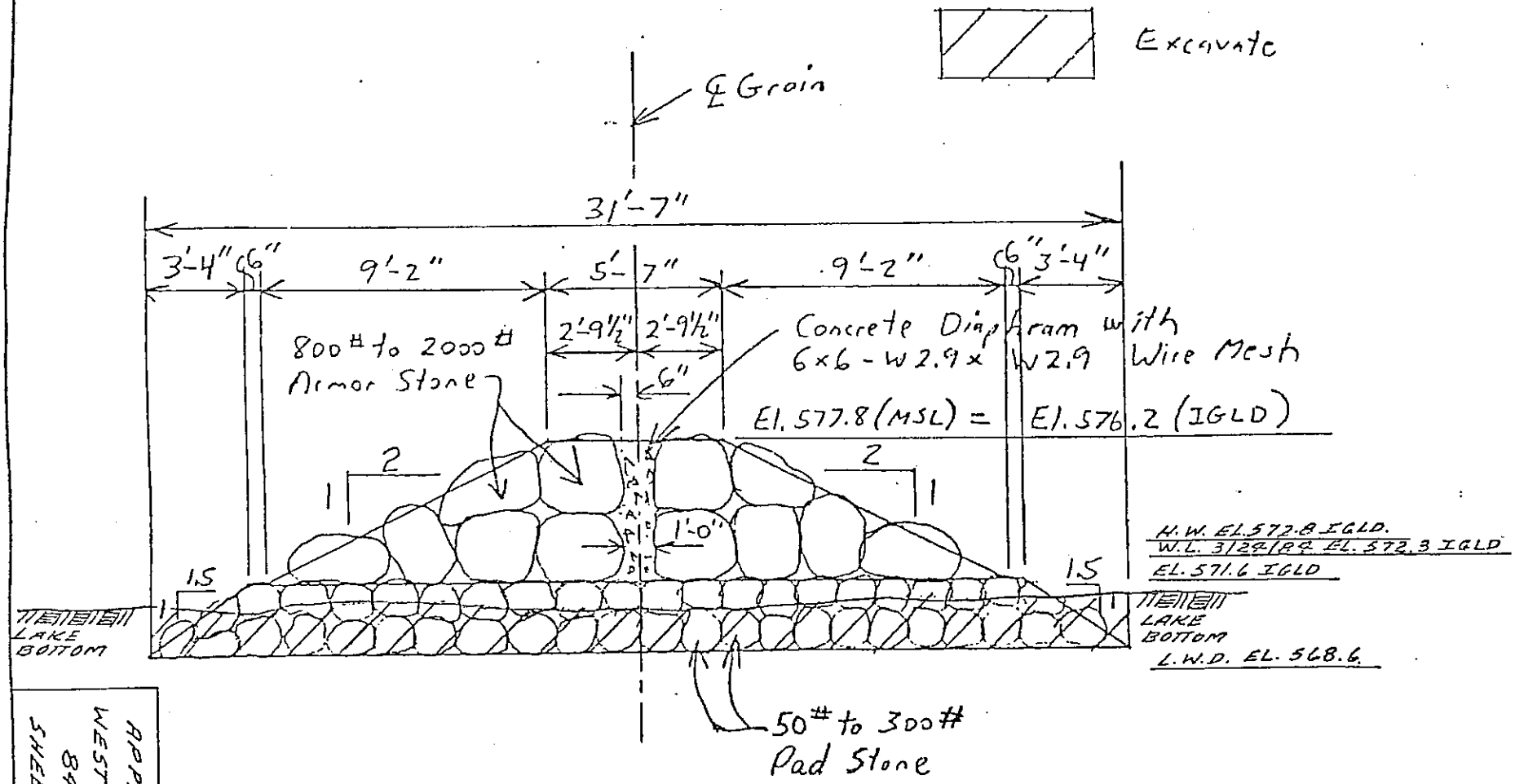
NOTES:
1) TIMBER & STEEL REBAR REMAINS OF GROINS & BREAKWATERS TO BE REMOVED
2) SCATTERED STONES TO BE RETRIEVED AND USED FOR PROPOSED STRUCTURES
3) GROINS 1, 2 & 5 TO BE REBUILT AND ARE SHOWN AND REFERRED TO AS GROIN (1R) (2R) (4R)

EXISTING STRUCTURES TO BE REMOVED OR REBUILT

PLAN

NOT TO SCALE

APPLICATION BY:
WESTLAKE LAND COMPANY
84-275-1
SHEET 3 OF 9

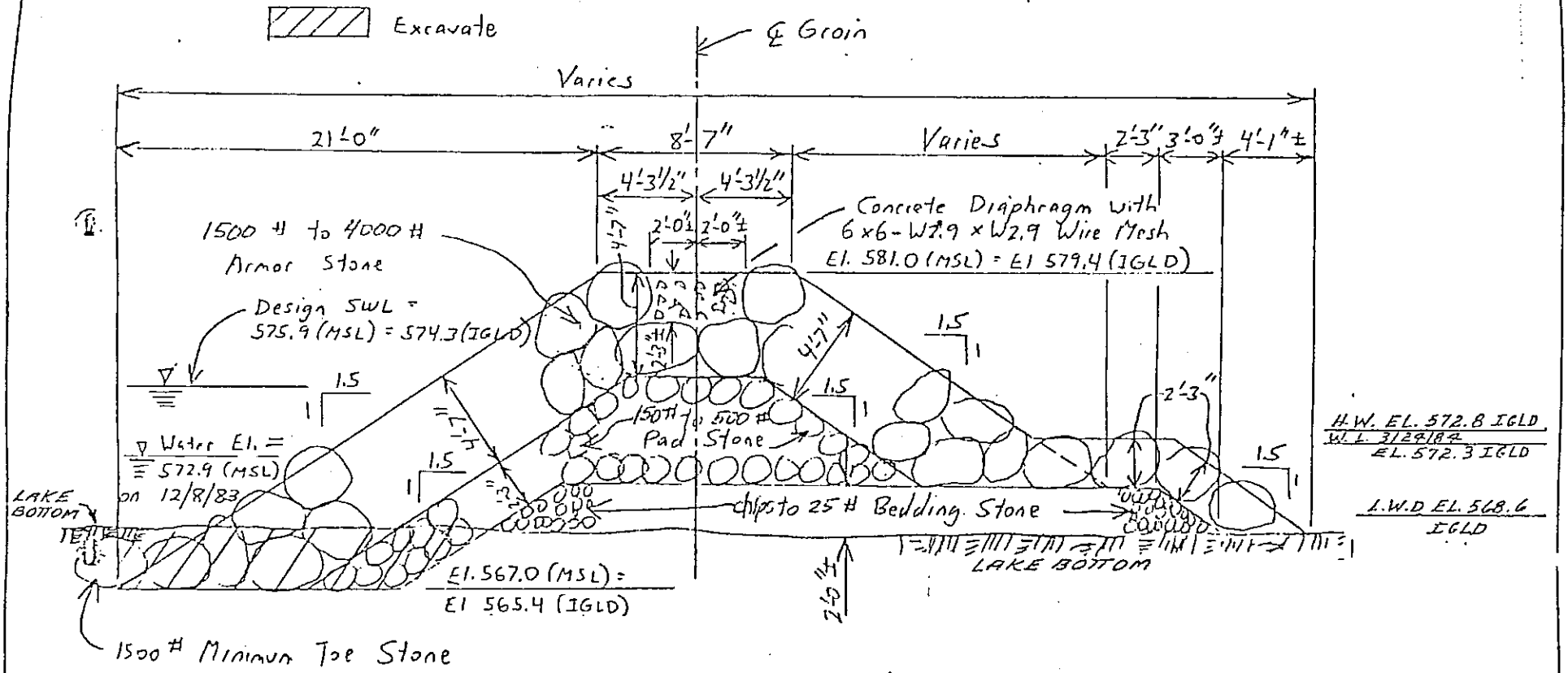


SECTION VIEW - TYPICAL GROIN

SECTION A-A

SCALE: 3/16" = 1'

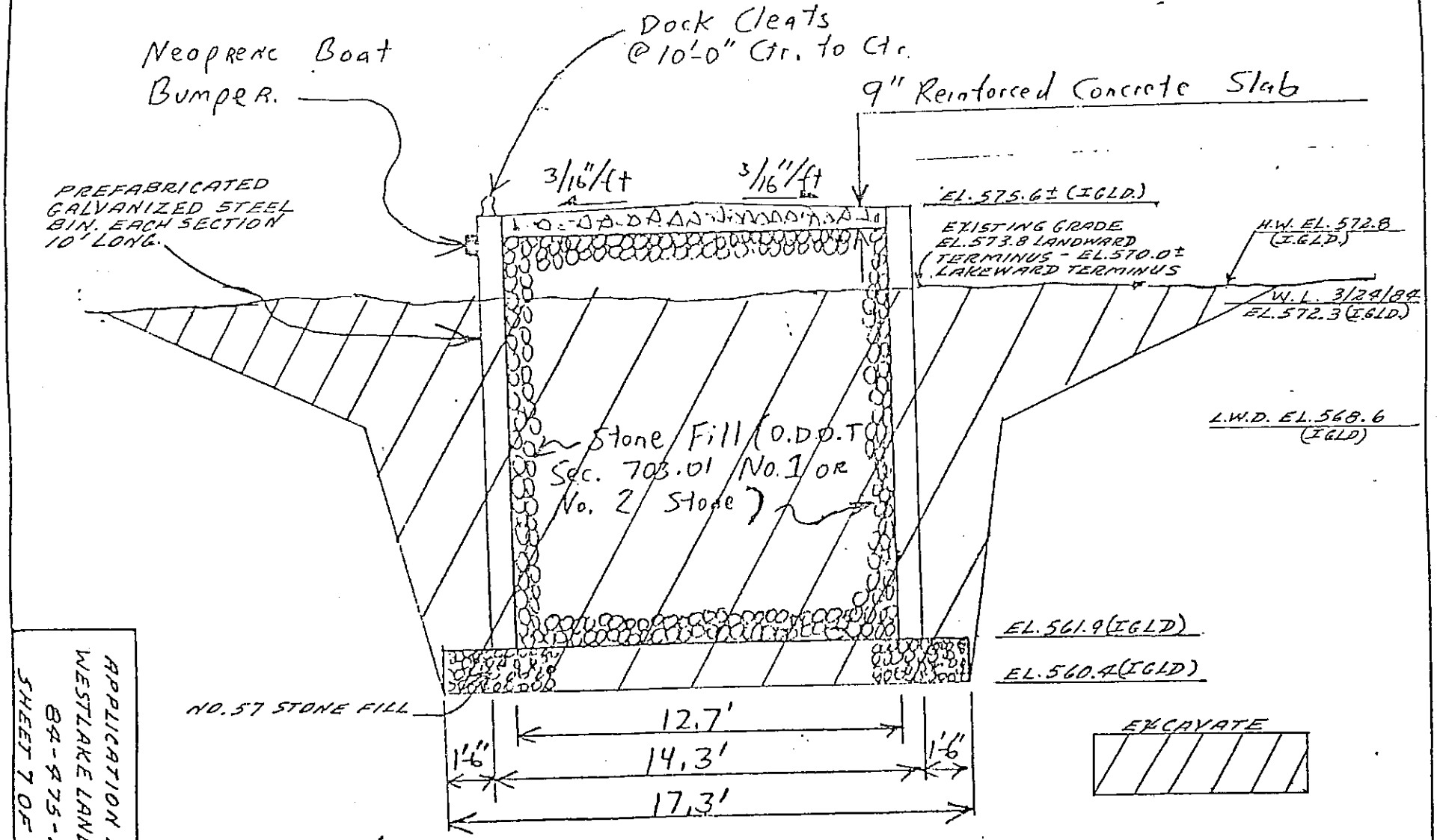
APPLICATION BY:
WESTLAKE LAND COMPANY
84-425-1
SHEET 5 OF 9



SECTION VIEW - GROINS 3N & 4R
(Groin 4R Shown, Groin 3N Opposite Hand)
NOT TO SCALE

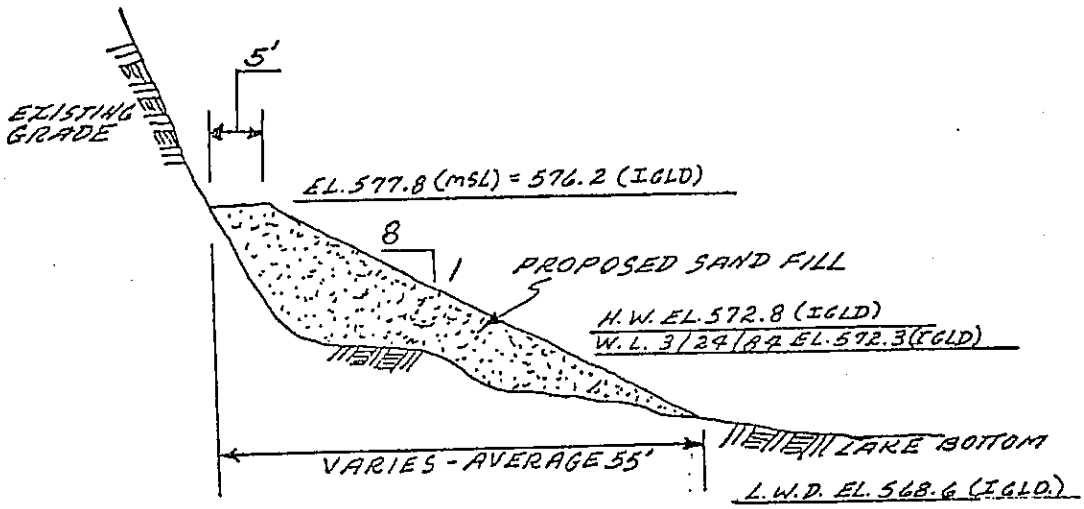
NOTES:
SWL = Design Stillwater Level
Water Depth at Lakeward End of Groin 4R was 5.4 feet on 12/8/83

APPLICATION BY:
WESTLAKE LAND COMPANY
84-475-1
SHEET 6 OF 9



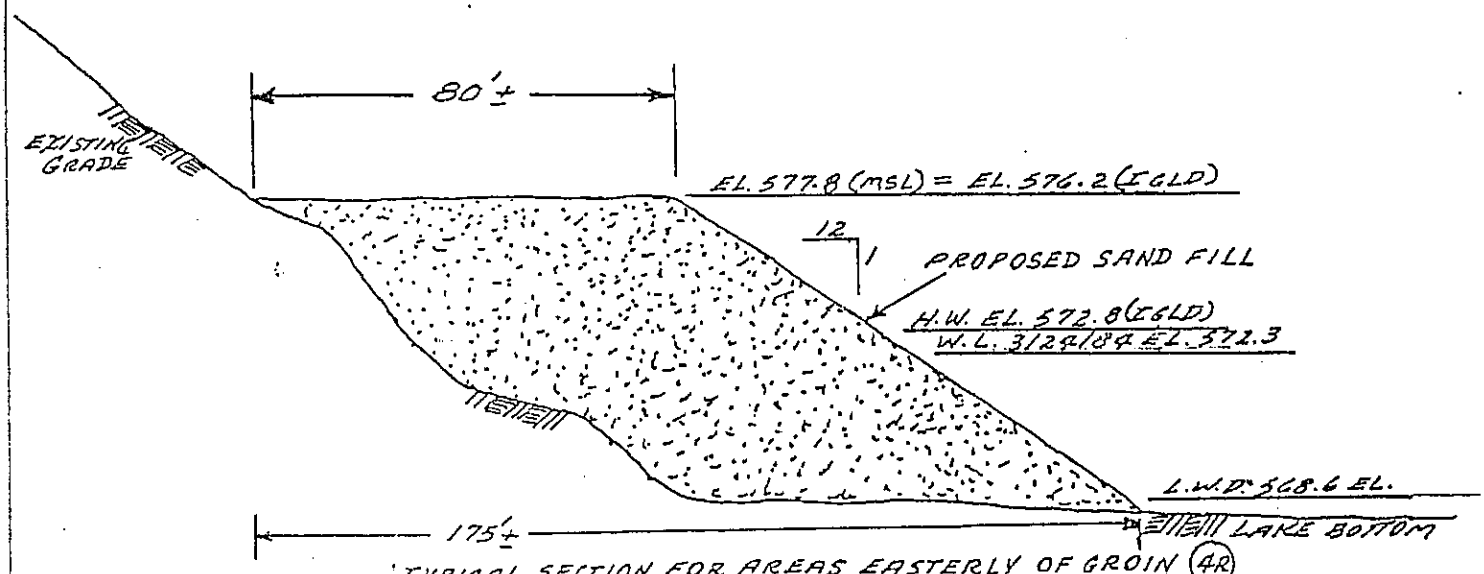
SECTION VIEW
Scale: 1" = 5'

APPLICATION BY:
WESTLAKE LAND COMPANY
84-875-1
SHEET 7 OF 9



TYPICAL SECTION FOR AREAS WESTERLY OF GROIN (4R)

SCALE: 1" = 5' VERTICAL
1" = 20' HORIZONTAL



TYPICAL SECTION FOR AREAS EASTERLY OF GROIN (4R)

SCALE: 1" = 5' VERTICAL
1" = 40' HORIZONTAL

APPLICATION BY:
WESTLAKE LAND COMPANY
BR-475-1
SHEET 9 OF 9

10. Date activity is proposed to commence. June 11, 1984

Date activity is expected to be completed September 28, 1984

11. Is any portion of the activity for which authorization is sought now complete? ☐ YES ☒ NO
If answer is "Yes" give reasons in the remark section. Month and year the activity was completed _____. Indicate the existing work on the drawings.

12. List all approvals or certifications required by other federal, interstate, state or local agencies for any structures, construction, discharges, deposits or other activities described in this application.

Issuing Agency	Type Approval	Identification No.	Date of Application	Date of Approval

13. Has any agency denied approval for the activity described herein or for any activity directly related to the activity described herein?

☐ Yes ☒ No (If "Yes" explain in remarks)

14. Remarks or additional information.

creek mouth. Bin-type retaining walls will be constructed within the basin to provide boat docking space. The revetment structure will armor the Joppa Rd. point and will be partially constructed on Beulah Beach property.

Beach sand fill will be placed throughout most of the 2200 ft shoreline length. The sand will be obtained both from an off-site source and from the dredged basin. It will consist of a medium grained, well graded material.

Excavated material from structure excavation will be dewatered on-site and used for on-site fill material. No dredged material will be deposited in Lake Erie or in tributary waterways.

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

Robert E Schilling
Signature of Applicant or Authorized Agent

Robert E. Schilling, Project Manager

The application must be signed by the applicant; however, it may be signed by a duly authorized agent (named in Item 5) if this form is accompanied by a statement by the applicant designating the agent and agreeing to furnish upon request, supplemental information in support of the application.

18 U. S. C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of The United States knowingly and willfully falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisioned not more than five years, or both. Do not send a permit processing fee with this application. The appropriate fee will be assessed when a permit is issued.

For use of this form, see EP 1145-2-1

The Department of the Army permit program is authorized by Section 10 of the River and Harbor Act of 1899, Section 404 of P. L. 92-500 and Section 103 of P. L. 92-532. These laws require permits authorizing structures and work in or affecting n waters of the United States, the discharge of dredged or fill material into waters of the United States, and the transportatio dredged material for the purpose of dumping it into ocean waters. Information provided in ENG Form 4345 will be used in ev the application for a permit. Information in the application is made a matter of public record through issuance of a public n Disclosure of the information requested is voluntary; however, the data requested are necessary in order to communicate wi applicant and to evaluate the permit application. If necessary information is not provided, the permit application cannot be cessed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity mu be attached to this application (see sample drawings and checklist) and be submitted to the District Engineer having jurisdi over the location of the proposed activity. An application that is not completed in full will be returned.

1. Application number (To be assigned by Corps)	2. Date	3. For Corps use only.
84-475-1	23 April 1984 (Day / Mo. / Yr.)	

4. Name and address of applicant.

Westlake Land Company
1000 Crocker Road
Westlake, OH 44145

Telephone no. during business hours
A/C (216) 871-1000 ROBERT E. SCHILLING
A/C ( ) _____

5. Name, address and title of authorized agent.

Telephone no. during business hours
A/C ( ) _____
A/C ( ) _____

6. Describe in detail the proposed activity, its purpose and intended use (private, public, commercial or other) including de tion of the type of structures, if any to be erected on fills, or pile or float-supported platforms, the type, composition an quantity of materials to be discharged or dumped and means of conveyance, and the source of discharge or fill material. additional space is needed, use Block 14.

The project consists of shoreline protection for the Vermilion Properties Project lo in Vermilion Township, Erie County, Ohio. The site is privately owned by the Westla Land Co. and is being developed for residential homes. Shoreline protection consist (7) stone groin structures and a stone revetment structure. The two longest groin s tures adjacent to the West Creek will be modified to form a boat basin entrance at t

7. Names, addresses and telephone numbers of adjoining property owners, lessees, etc., whose property also adjoins the wa

(West Side)
Heidelburg Beach
Vermilion, Ohio 44089
Attn: Mr. Wayne Reid
(216) 967-6009
9.5 ACRES ±

(East Side)
Beulah Beach Corporation
6101 Westlake Road
Vermilion, Ohio 44089
Attn: Reverend Fye
(216) 967-4861

(Joppa Road)
Vermilion Township Tr
P. O. Box 83
Vermilion, OH 44089
Attn: Joe Thayer
(216) 967-4895

8. Location where proposed activity exists or will occur.

Address:
5605 Westlake Road
Street, road or other descriptive location

Vermilion Township
In or near city or town

Erie (County) Ohio (State) 44089 (Zip Code)

Tax Assessors Description: (If known)
Map No. _____ Subdiv. No. _____ Lot No. _____
Sec. _____ Twp. _____ Rge. _____

9. Name of waterway at location of the activity. The East Creek and West Creek are unnamed waterway Both creeks convey storm water runoff from surrounding residential areas and are gene inactive, except during rain events.

APPENDIX F

DR. ERNEST F. BRATER'S EVALUATION

OF PROPOSED MARINA PROJECT

ERNEST F. BRATER
2321 Packard Dr.
HYDRAULIC ENGINEER - HYDROLOGIST
[illegible]
ANN ARBOR, MICHIGAN 48103
320 West Eng. Bldg.
(313) 668-6668

October 13, 1965

Mr. Marshall G. Browne, President
Sages Grove, Inc.
1630 Sycamore Line
Box 2036 Annex
Sandusky, Ohio 44871

Dear Mr. Browne:

In accordance with your request I have studied the proposed harbor arrangement for Beachwood Cove located near Huron, Ohio. The background information for my investigation consisted of the U.S. Lakes Survey charts, reports of the U.S. Beach Erosion Board, the drawings entitled "Marina and East Parcel" prepared by Richard E. Mutz, and the observations and discussions during my visit to the site on September 24, 1965.

The site is exposed to fetches of more than 125 miles in the northeasterly directions and approximately 40 miles in the northerly and northwesterly directions. In the sector from N to N 30° W the islands interfere with the maximum formation of waves. Information published by the U.S. Beach Erosion Board indicates that winds will occur with about the same frequency from all portions of the sector for which the site is vulnerable, except for very large winds, which occur more often from the northwesterly direction. In determining the maximum size of waves to be expected at the piers the fact that waves break at a depth somewhat larger than the wave height becomes a controlling factor for the longer fetches. Troublesome waves will occur more often from the northeast than from northwesterly directions. For example, waves of seven feet or greater will occasionally approach from the sector between north and N 30° W. However, it requires a 40 mile per hour wind for at least three hours to accomplish this, whereas for the larger northeasterly fetches a 30 mile per hour wind can produce seven foot waves. It is therefore desirable to provide the greater protection against the easterly waves. This leaves the harbor somewhat vulnerable to waves approaching from about due north. If experience shows that these northerly waves cause problems inside the harbor, it would be possible to eliminate the bad effect by extending the east pier.

Tests based on model studies by the Corps of Engineers at the U.S. Waterways Experiment Station indicate that, with side slopes of 1.5 to 1.0, horizontal to vertical, stones having an average dimension of 3.6 feet will be required to withstand

seven foot waves. For eight and nine foot waves the required sizes would be 4.2 and 4.7 feet, respectively. Stones of these sizes would be displaced only rarely whereas smaller ones would be displaced more often. These computations are based on rough stones dumped into place. Carefully placed stones have a greater stability. The west pier will never be subjected to waves larger than about seven feet. However, maximum wave heights at the east pier will be about two feet smaller than the depths. It is obvious therefore that the portion of the east pier which extends from the bend into water as deep as 12 feet will be quite vulnerable. Since this portion of the breakwater is also the most expensive it would be most beneficial if the parallel portions of both piers could be shortened somewhat, 50 feet for example. Shortening the piers might increase the amount of maintenance dredging that will be required but it would greatly reduce the vulnerability of the piers to storm damage.

The wave run-up for a 1.5 to 1.0 slope will be about 4/3 times the wave height. Thus, for a 7 foot wave the water would rise about 9 feet, vertically, above the stillwater level. This means that with the crest elevation of the piers at elevation 580.0 feet there will be occasional overtopping. I do not think that this will be serious.

There is a littoral drift at the harbor site which moves predominantly from the east to the west. The rate is not great as indicated by the lack of a substantial build-up at the smaller groin which you have already constructed. The proposed piers may cause a temporary delay in the sand movement although sand will be moved around piers at depths of ten to twelve feet during large storms. The delay in the sand movement can be largely overcome by dumping the sand dredged from the channel on the west side of the piers. This same procedure should be used insofar as possible for maintenance dredging. This plan of action will prevent beach recession on the west side of the piers. The danger of developing an erosion area west of the proposed piers is greatly reduced by the presence of the large piers which form the harbor at Huron.

There will be a maintenance expense involved in the operation of the harbor. This will be in part due to the displacement of rubble by storm waves and in part due to the dredging which will be required to maintain the channel. With the limited information available it is very difficult to estimate

the extent of the annual maintenance. I would say that you should plan to have available about 1/20 of the original cost for annual maintenance. There will probably be years when little or no work needs to be done while during other years several major storms may damage the piers and deposit large quantities of sand in the channel. It may be desirable to sweep the channel after major storms to be sure that some of the large stones have not been deposited in the channel.

Upon checking I find that it is common practice to build up rubble breakwaters by dumping stones on the original bottom. The important factor is to place a layer of smaller stones first in order to act as a protection against the jetting action of the waves. The smaller stones can be used for the entire core of the pier. The computations I have made regarding stone sizes are based on having at least two layers of the larger stones.

There is one general principal that should be followed inside the harbor. This is to avoid smooth straight walls wherever possible. Many harbors of this type are uncomfortable and even dangerous during storms because of wave reflections. I doubt whether you will be able to use Slip 71 for a mooring. I would plan to use the dock between Slips 71 and 70 for a protective pier. You have a good chance of having a fairly quiet harbor because you are using rubble mound piers. If you had planned on steel piers I would recommend a model study before beginning construction.

If you have any additional questions, or if you would like to have more details, please let me know.

Very truly yours,

Ernest F. Brater

Ernest F. Brater

EFB/b

BEACHWOOD VILLAS SHORE PROTECTION AND MARINA

Submitted to Marshall G. Browne

by

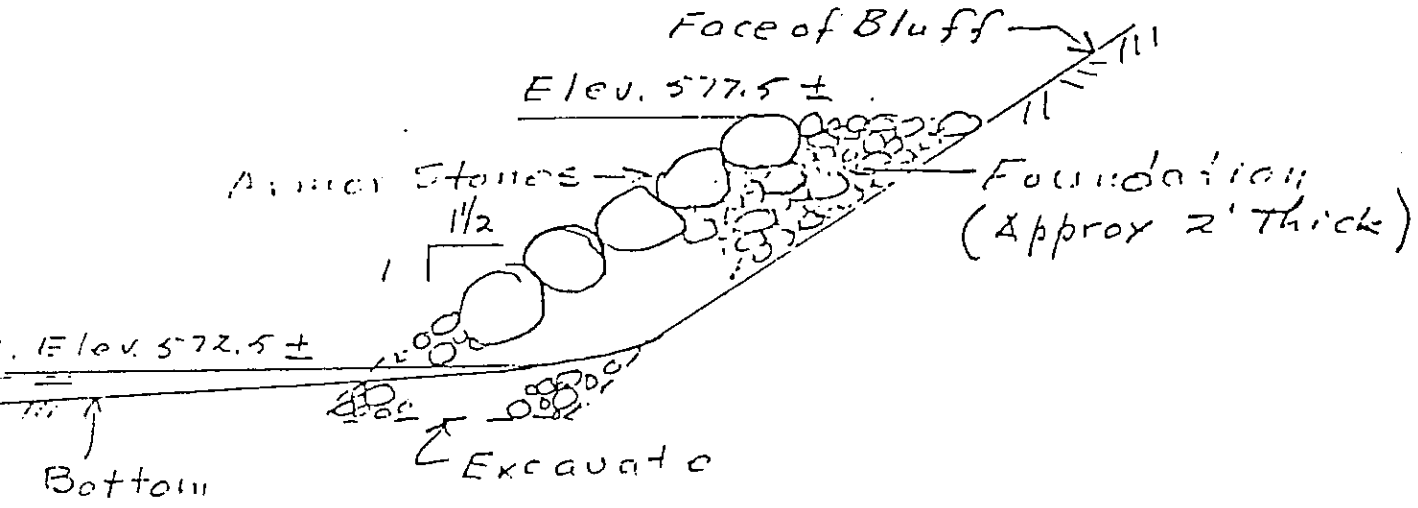
E. F. Brater, Consulting Engineer

June 8, 1984

Shore Protection: The system of three groin which you installed in 1977 has collected some sand which has provided considerable protection for the bluff. The rocks placed on the bluff have undoubtedly helped also but they will not be effective during a major storm.

The groin system could be made more effective by adding two or three groins. A rule of thumb for an exposed area like yours is to have the distance between groins no more than twice as much as the length of the groins. I don't think there is sufficient littoral drift to gain much more sand naturally. Therefore, you should plan on filling between the groins by hauling in sand.

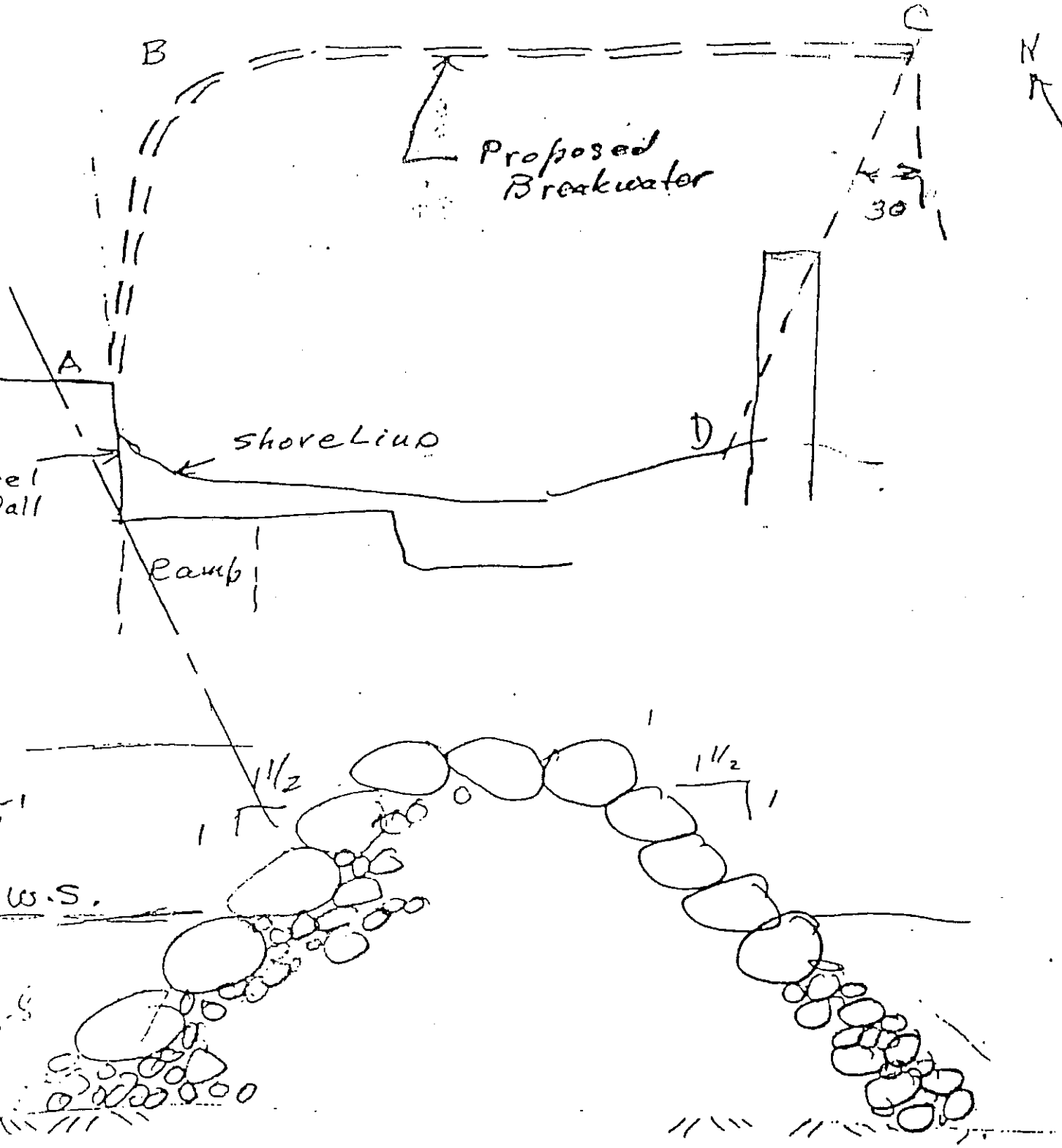
Another method of providing very effective bluff protection is to build a rock revetment at the toe of your bluff. This should have a slope no steeper than 1-1/2 to 1 with an armor layer of large stones and a foundation layer of smaller stones of mixed sizes as shown in the sketch. The armor stones should have a weight of about 650 pounds which correspond to a cube of about 1.6 feet on a side. The rocks should be placed so that they touch each and form a reasonably uniform plan surface. The rocks should be roughly cubical or spherical and not flat slabs. The underlayer should be about two feet thick and made up of a mixture of sizes varying from about two inches to 10 inches. The purpose of this foundation layer is to break up the jets of water which penetrate the armor layer. Notice that the foundation should be supported by a trench at its toe.



Typical Revetment
for
Beachwood Villas

6/19/87 E.I. Erdter

Marina: The most practical and least expensive marina arrangement for Beachwood Villas would be a single breakwater extending out from your western boundary and then turning eastward, parallel to the shore at whatever depth you select. This is illustrated by the dashed line ABC in the sketch. No east breakwater would be needed. An east wind would cause very little problem because of the very short fetch and the energy dissipation by refraction. The only direction which might cause a problem is in the sector near 22.5° north of east. Taking into account both that refraction turns the wave direction toward shore and diffraction turns the waves into the harbor the only area behind the breakwater which will still be subjected to waves of about half the size of the approaching waves will be in the area easterly of the line CD. If you retain your beach between D and A the remainder of the harbor should be quite calm even during a large storm from E 22.5°N. It would also help of course if you used rubble-mound construction for the breakwater. The location of BC (distance from shore) would depend on whether you want to only provide access to a ramp or whether you want to provide slips for larger boats. For only a ramp, BC could be at a depth of about 6 feet. The location of C (from E to W) depends on how much shoreline or mooring area you want in the protected zone to the west of CD. For a breakwater located at a depth of six feet the armor stones should weigh about 6000 pounds which would correspond to a cube having a dimension of 3.3 feet. Such a breakwater should suffer some damage only during rare large storms. If you only protect a ramp it would be acceptable to build the breakwater low enough to allow some overtopping during major storms when no one would be using the ramp. You could probably get by with a structure extending only about five feet above the water surface.



Typic Rubble Breakwater

ERNEST F. BRATER
HYDRAULIC ENGINEER - HYDROLOGIST
DEPARTMENT OF CIVIL ENGINEERING
2116 Engineering 1A Bldg.
ANN ARBOR, MICHIGAN 48109-2125
(313) 764-9406

November 9, 1984

Mr. Marshall G. Browne
1630 Sycamore Line
C/N 5005
Sandusky, OH 44870

Dear Mr. Browne:

In response to your request, I have reviewed your revised plans for the Beachwood Villa Marina. The plans have incorporated my recommendations. If you use the rock sizes that I specified you should have maintenance to take care only after major storms. There will also be some overtopping during major storms at the present lake levels, but the breakwaters should remove most of the wave energy. At more normal lake levels there will be little or no overtopping.

My observations on littoral drift at the site were made during my study in 1965 and again this year. In both cases I studied the shore line at the site and for several miles to the east and west. In 1965 I made a detailed investigation of winds and fetches at the site. The evidence from existing groins and piers shows that there is a small amount of littoral drift at the site. The accumulation is so small that where groins are being considered I have recommended that they be filled artificially with sand from a land source. The prevailing direction of drift is from the east to the west because of the longer fetches from the east and the long pier to the west at Huron.

Most sand movement takes place during major storms. Since your breakwaters only extend to depths of 6 or 7 feet even during high water much sand will pass by the breakwater. However, to be sure that no sand is permanently held I recommend the spoil from dredging be placed on the down-drift side so that it continues to move along the beach in a natural manner. During normal and low lake levels your dredging will provide excess sand which will nourish beaches.

Very truly yours,

Ernest F. Brater

Ernest F. Brater

EFB:spz

ERNEST F. BRATER
HYDRAULIC ENGINEER - HYDROLOGIST
2729 PARKRIDGE DRIVE
ANN ARBOR, MICHIGAN 48103

(313) 668-6668

December 6, 1985

Mr. Marshall G. Browne
1630 Sycamore Line
C/N 5005
Sandusky, OH 44870

Dear Mr. Browne:

This is a summary of my conclusions regarding the coastal engineering aspects of your proposed marina construction at the Beachwood Villas site. My consultation was for the purpose of helping to develop a design which would be safe, economically feasible and have a minimum effect on the local shore process. I studied the site in 1965, 1984 and again in December 1985. During the 1984 visit I also was involved in helping to provide shore protection for the Beachwood Cove area located to the west of Beachwood Villas. I believe that the final design prepared for you by Mr. John Minderman comes as close as possible to meeting all of these objectives.

In regard to the harbor itself, the layout is arranged so that it provides full protection from the more frequent northwesterly storms. The entrance is so arranged that very little energy can enter the harbor from easterly storms. Rubble mound construction is utilized, which cuts down on damaging reflections and makes a better environment for marine life. The advantage of this type of construction over vertical walls is demonstrated by the success of your revetment on the Beachwood Villa shore as compared with the vertical walls built by adjacent property owners. The rubble construction of the harbor walls is planned to require some maintenance only after rare large storms. As mentioned in my previous reports, while the littoral drift in the area is small you must expect that there will be enough sand carried into the harbor entrance to require periodic dredging.

In regard to the effect on the shore processes the chief concern would be that the natural recreational and protective value of beachs along adjacent shores would be reduced because some sand will be delayed in its movement along the shore. Because of this and the dredging problem I have made an effort to determine the nature of the littoral drift in the area. I have done this by looking for accumulations of sand on the groins and piers in the area, and by studying the lengths of the fetches and the directions and frequencies of the prevailing winds. The field observations plus the availability of some aerial photographs indicated that there is some littoral drift from both directions but that the rate of drift is relatively small. From the west, any large scale littoral drift would be blocked by the piers at Huron. However, the lack of any accumulation of the west side of these piers shows that even without them there would be little sand coming into the area from the west. Another aspect of the local shore environment is the presence of so many vertical walls both to east and west of the site. Such structures

promote erosion near shore and create an environment in which the presence of littoral drift loses much of its usual benefit for recreation or protection. Nevertheless, it is essential that you provide for by-passing any drift material which is captured by your harbor. This you are planning to do by periodic dredging and dumping on the down drift side. Even though the local drift occasionally comes from the west the evidence indicates that it is predominantly from the east and therefore the spoil should normally be placed to the west of the harbor. It should be noted, however, that this dumped sand would still be moved back to east by a large westerly storm because the depths outside the harbor are well within the range of rapid sand transport.

Please call me if there are any points which I have not covered.

Very truly yours,

Ernest F. Brater

Ernest F. Brater

EFB:spz

ERNEST F. BRATER
Coastal Engineer
2729 Parkridge Dr., Ann Arbor, MI 48103

Mr. Marshall Browne
1500 Cleveland Rd. East
Huron, Ohio, 44839

March 18, 1986

Dear Mr. Browne:

This is in response to your request for my comments regarding the material you sent which deals with the proposed marina. I have reviewed the material you sent as well as my notes and reports on the site which cover the period from 1965 to date.

My evaluation of the shore processes at the site has not changed over the years. The amount of sand being transported along the beach is small. The direction of littoral drift is predominately from the east even though there are many more westerly than easterly storms. This is because the fetch is much greater from the east and the long piers at Huron block any possible sand movement from the west.

The major portion of littoral sand movement is produced by the waves and currents during major storms. This violent wave and current activity will carry much of the littoral drift past your proposed structure. Any sand that is captured can be by-passed by your proposed dredging program. The by-passing of sand artificially is an accepted technique for continuing the movement of littoral drift even at major inlets. The fact that you propose to use rubble construction, which absorbs wave energy, for your marina walls will cause less disruption of the underwater environment than the reflections and turbulence caused by the sea walls which are so widely use along the adjacent shoreline.

I note that the report by the Corps of Engineers on Huron Harbor, revised in 1984, also concludes that the littoral drift is small in that area and that even the long piers at Huron cause a "minute incremental increase in shore erosion". The quote is from the top of p.10. The second paragraph on p.10 states "The fact that the ammount of erosion is comparable for unprotected areaas throughout the reach brtween Vermilion and Sandusky on both sides of Huron indicates that there is minor adverse immpact of erosion due to the harbor structures". I think that your proposed marina will have a much smaller impact than the piers at Huron especially in view of the fact that sand will by-pass the marina whereas little or no sand can pass by the piers.

If you have other questions, please let me know.

Very truly yours,

Ernest F. Brater

Ernest F. Brater

APPENDIX G

JET PUMP POWERED

EDUCTOR SYSTEM FOR

SAND BY-PASS SYSTEM

A. Jet Pump - A possible answer to Santa Cruz Port Shoaling

B. The Jet Pump sand bypassing system as proposed by Pekor

(A)

Jet Pump — A Possible Answer To Santa Cruz Port Shoaling

Henry DeGraca

by Henry M. De Graca

Henry M. De Graca is a project manager in charge of small navigation and beach erosion control projects for the San Francisco District of the Corps of Engineers. He received his civil engineering degree from California State University at San Jose and is pursuing a master of science degree from the University of California at Berkeley.

As existing methods used for beach and navigation channel maintenance continue to climb in cost, the San Francisco District of the Corps of Engineers is searching for new techniques to provide a permanent solution to the shoaling problem at Santa Cruz Harbor. One of these methods is sand bypassing.

Santa Cruz Harbor is a popular small craft harbor for almost 1,000 sail and power boats. It is located at the northern end of Monterey Bay about 65 nautical miles south of San Francisco. The 1958 River and Harbor Act provided for the construction of a harbor for light-draft vessels, including an entrance channel, inner channel, turning basin, two jetties, and a sand bypassing plant by the U.S. Army Corps of Engineers.

With the exception of the sand bypassing plant, construction of the project was completed in 1963 by the San Francisco District of the corps.

The maintenance of the Santa Cruz Harbor channels is the responsibility of the federal government until such time as a sand-bypassing plant is constructed to provide a permanent solution to the shoaling of the entrance channel. In 1972, a 12-inch hydraulic dredge, work boat and pipeline were acquired by the Corps of Engineer to accomplish the sand bypassing.

However, the dredge was unable to operate in the wave environment at the harbor entrance channel. This led to a reassessment of the plant's capabilities. The plant was determined to be unsuitable to accomplish the required bypassing and was subsequently transferred to another project. Contract maintenance dredging resumed. Table I shows a tabulation of dredging quantities and costs at Santa Cruz Harbor from 1965, when the traditional maintenance dredging contract first began, until the present time:

TABLE I
Maintenance Dredging 1965 - 1975

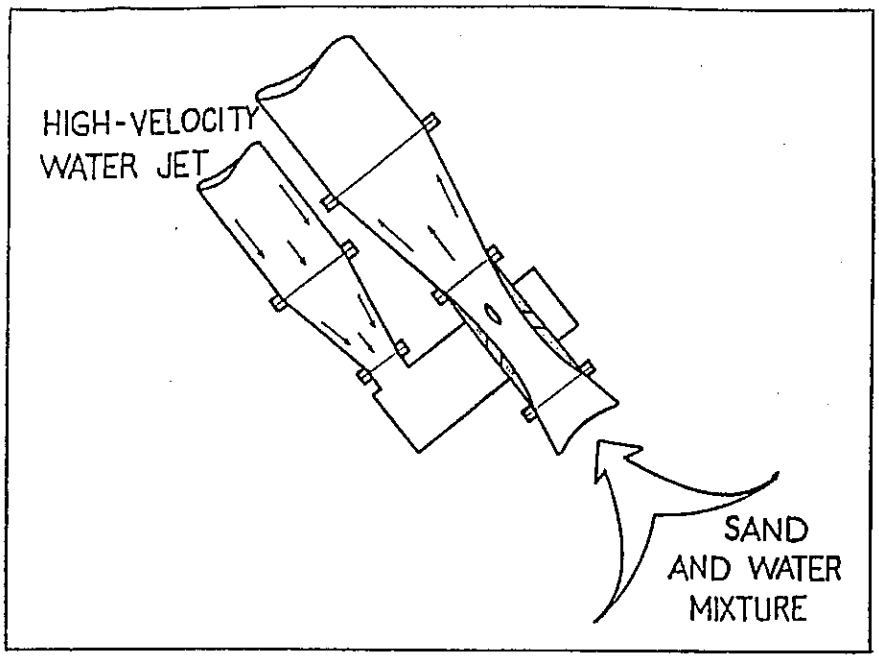
	Quantities (cubic yards)	Cost ($)
May-Aug 65	70,000	124,000
Jun-Jul 66	34,000	90,000
May-Jun 67	57,000	93,000
Apr-May 68	61,000	104,000
Mar-Apr 69	79,000	118,000
Apr-May 70	95,000	151,000
May-Jun 70	12,000	42,000
May-Jun 71	103,000	179,000
May-Jun 72	90,000	185,000
Feb-Mar 73	109,000	219,000
Mar-Apr 74	60,000	179,000
Apr-May 75	91,000	197,000

The San Francisco District is in the process of evaluating all known alternatives in search of an effective, permanent and economical solution to shoaling at the Santa Cruz Harbor, as annual maintenance dredging does not provide a year-round open harbor. The project, as constructed, is safely navigable under storm conditions on the average of only about 8 to 9 months out of the year.

COAST LINE PROBLEM

The situation which exists in Santa Cruz is not unique. Throughout the coastline of the United States, major problems exist in maintaining beaches and navigation channels to harbors and bays. What is needed is a system that could operate in reasonably high waves, that could reach all portions of a sand collection area, that would not be a hindrance to normal operations, that could be operated by a small crew, and that would not be prohibitively expensive. Research studies at the Corps of Engineers' Waterways Experiment Station (WES) in Vicksburg, Mississippi, are being directed to meet these needs. The system being developed is known as the eductor system and is designed around a jet pump as the basic tool to pick up and discharge sand. This system is environmentally acceptable since it would be compatible with the natural process of sand movement for the replenishment of down coast beaches.

On the basis of the district's studies to date, it has been concluded that the eductor system being developed at WES, if found to be workable, appears to be the most economically feasible solution and that an experimental eductor system warrants installation at Santa Cruz Harbor. This system has historically been used for the mining of gold, but has never been used commercially for the maintenance of beaches and/or navigation channels to harbors and bays.



An eductor system is being studied by the U.S. Army Corps of Engineers. The system is designed around a jet pump as the basic tool to pick up and discharge sand.

The eductor system differs from conventional in-line hydraulic pumping systems in that the pumps are external to sediment transport. The pumps generate a high velocity jet of water for sediment transport. The construction is relatively simple because it contains no moving parts in the sediment transport phase. The basic principle behind the operation of the jet pump is the exchange of momentum. High pressure water, normally supplied by a centrifugal pump, is forced through a venturi nozzle and converted into a high velocity, low pressure jet stream within the pump. The low pressure at the nozzle induces flow of the surrounding water containing sand particles into the mixing chamber of the pump. The jet stream imparts momentum to the new fluid and accelerates it through the mixing chamber for transfer through a discharge line to a down-beach area, when being used to bypass sand.

JET PUMP

The actual eductor system might well consist of the placement of a number of small units at strategic points, or a single mobile unit that might be operated to periodically sweep the shoal locations within the harbor. Once in place, the entire system, except for the drive water pump, might be stationary. Initially, the jet pump assembly would be filled with air and floated above the desired sediment removal area. The assembly is then flooded with water. Once at the bottom, the jet pump is ready for excavation. The excavated depression acts as a trap for littoral material and a storage area for the material to be moved. If at any time the jet pump is buried with sediments, it would still be operable. The jet pump assembly may be retrieved on the surface at any time by merely flooding the compartments with air instead of water.

WES's research program, involving laboratory tests for the refinement of the eductor system for field installation have essentially been completed. However, laboratory tests to verify field data including those that will be obtained at Santa Cruz will be continued throughout the research program.

FIELD TESTS

Field tests have been conducted at Mexico Beach, Florida, and at East Pass Inlet in Destin, Florida. The Mexico Beach site was chosen, not because of existing sediment problems, but rather to evaluate the configuration and operation of the eductor system. At the East Pass Inlet site, the littoral sediment transport has periodically closed the inlet channel. The eductor system was utilized at this site primarily for the recycling of material being deposited in the channel for beach nourishment downdrift. Approximately 20,000 to 30,000 cubic yards of material have been recycled within a 5- to 6-month period. The system was operational only during intermittent periods during favorable conditions and not during critical shoaling conditions.

The current field site which began operation in May, 1975, is Rudee Inlet near Virginia Beach, Virginia. This is the first site to have a system specifically designed to solve a sediment problem. As this site is similar to Santa Cruz Harbor (jettied entrance), it will be a testing ground for Santa Cruz. Although a system with multiple eductors will be used for the first time, most of the equipment will be taken from previous tests. In conjunction with this field test, simultaneous laboratory tests will be conducted to determine optimum design for Santa Cruz.

In anticipation of the planned installation at Santa Cruz sometime in the spring of 1976, the San Francisco District, with the aid of WES and the Santa Cruz Port District, is in the process of acquiring necessary baseline data relating to the understanding of the causative factors of the bypassing problem. The data acquisition program will provide information pertinent to the system design and system performance, with emphasis on beach and hydrographic surveys and wave data. The surveys will define the offshore bathymetry, the fluctuation of shoreline and beach profile, and an indication of the shoaling volume and location at the harbor entrance. The wave data will provide an indication of the predominant direction of littoral transport, seasonal transport variations, the quantity of potential littoral transport, and the level of wave intensity to be expected during the operation of the system. In addition to the wave and survey data, the program will gather and analyze sand samples, boring samples, and tide and current measurements. The program is expected to continue between now and the scheduled installation of the eductor system during the spring of 1976.

With the increasing interest for recreational boating, the need for boating accommodations will also increase. Consequently, the amount of material to be dredged will increase during the foreseeable future. Unit dredging cost will also increase due to rising costs for labor and equipment. The system might lower costs for beach material borrow by making economically inaccessible beach material sources more readily available for commercial use. Consequently, if the eductor system proves successful at the completion of the research project at Santa Cruz Harbor, those entities responsible for the dredging of sandy inlets could experience savings because of a more effecitve means for sand transfer with a low capital investment.

THE PEKOR SYSTEM

The problem of maintaining a navigable channel for small ocean craft while at the same time preventing downdrift beach erosion is a common dilemma for thousands of marinas, inlets, and harbors. Pekor has designed a simple, low-cost effective solution to this problem. The Jet Pump Sand Bypass System was developed and tested over a five-year period in various wave and climate conditions to prove its reliability and adaptability to virtually all operating conditions.

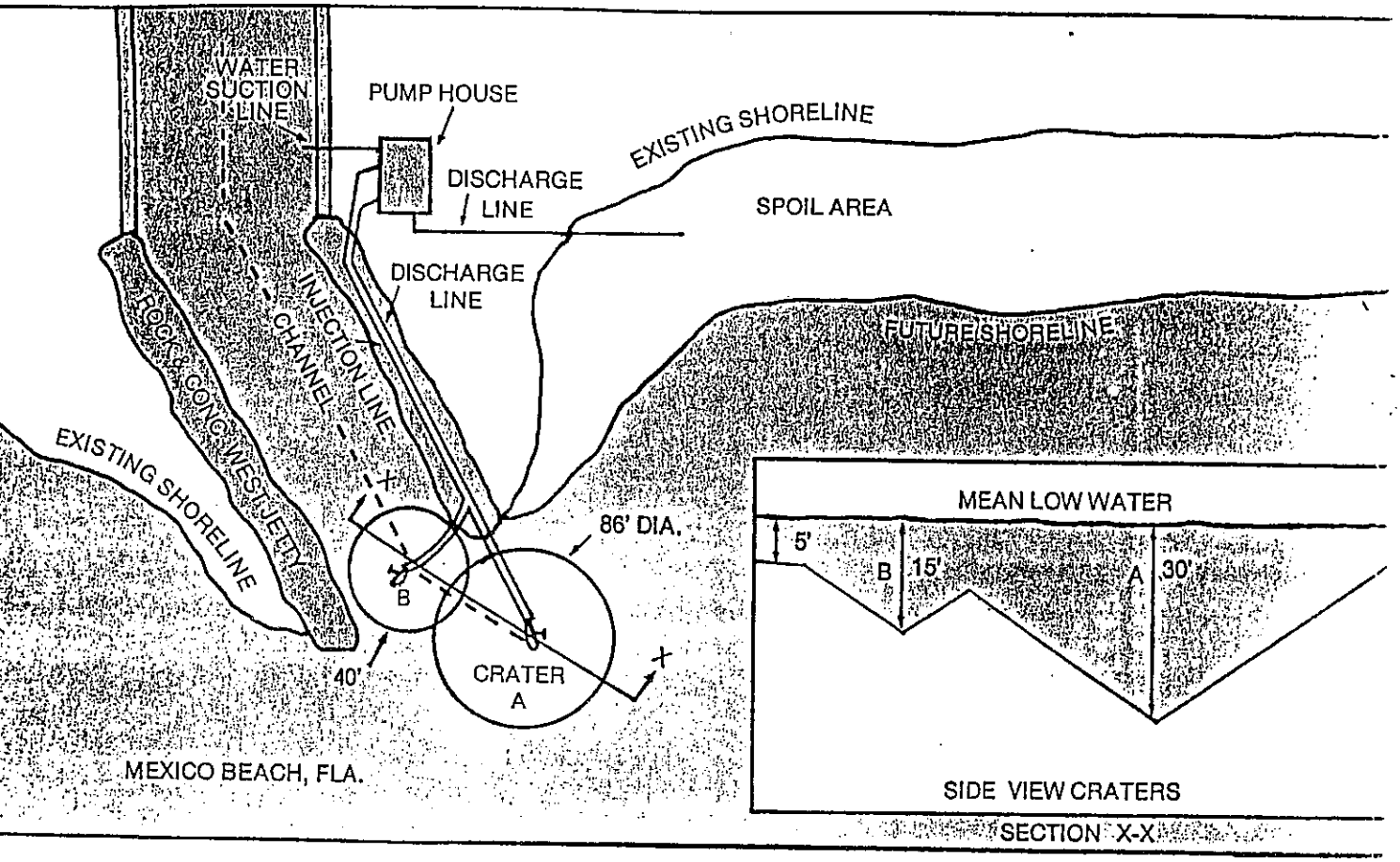
- **BASIC SYSTEM DESIGN:** The basic design features of the Pekor System include installing a single jet if the area to be maintained is small, or several jet pumps in a configuration to create a series of overlapping craters. These craters become sand traps which trap the sand which would otherwise shoal and block the channel. As the craters fill with sand, the jet pump system is periodically activated (daily, weekly, monthly, as required) and the sand is then either reintroduced into the littoral drift, or deposited on the downdrift beach for beach nourishment.

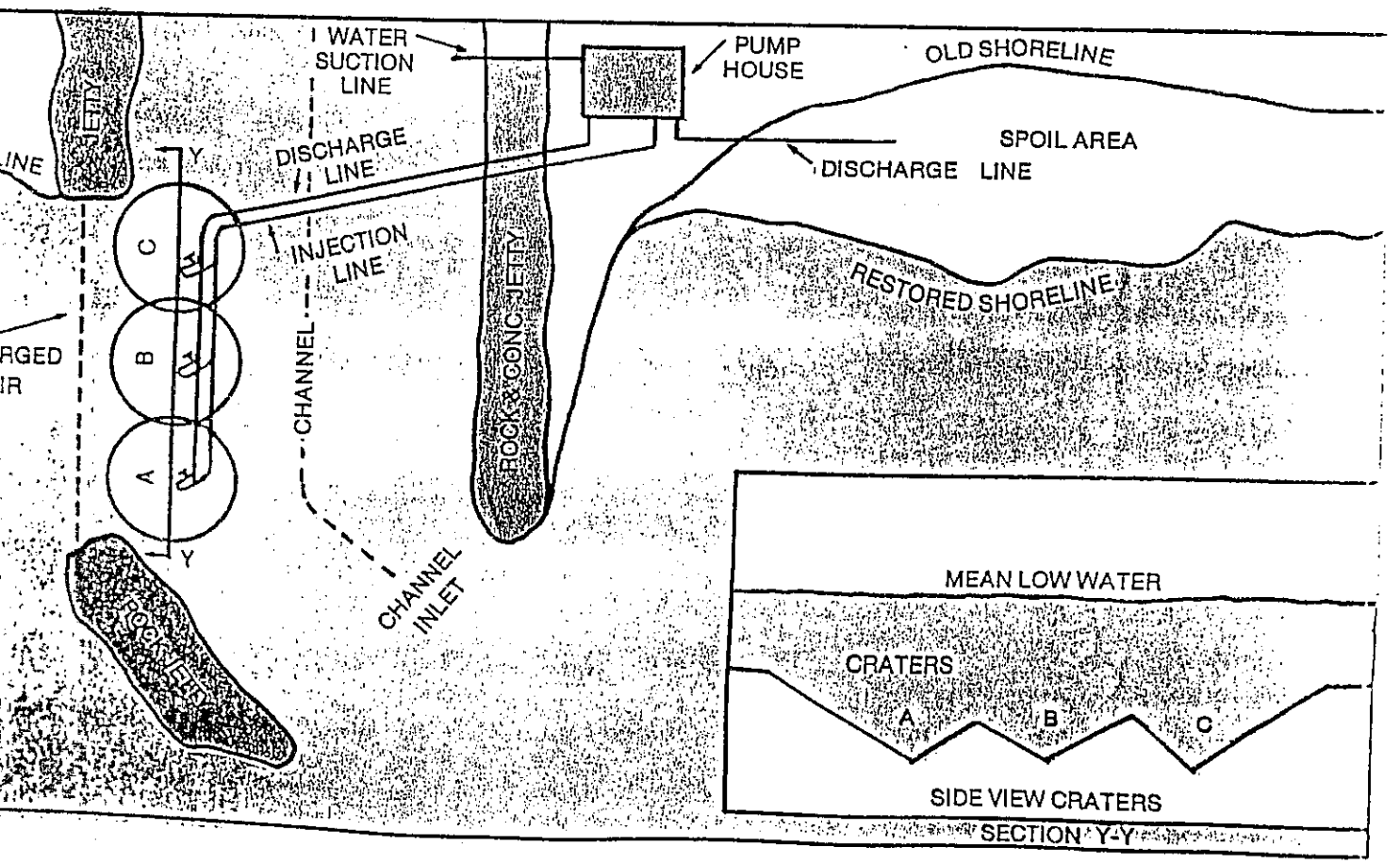
- **SELF-INSTALLATION AND RECOVERY:** Using an exclusive Pekor design, the system actually pumps its way down to the desired depth, utilizing the system's own operating equipment for easy and inexpensive installation and recovery. If hardpan, rock or shell layers are present, they must be removed prior to installation. In the installation/recovery process, the high pressure injection water is diverted to an additional pipe running directly under the injection and slurry discharge pipes. This installation/recovery pipe is perforated on the underside with holes of varying size and spacing, and is designed to fluidize all of the sand above the recovery pipe. This creates a quick condition which allows the entire pipe and pump assembly to be lifted out of the sand. Without this feature, the pump and piping would be anchored under the sand with a resistance equal to hundreds of Danforth anchors.

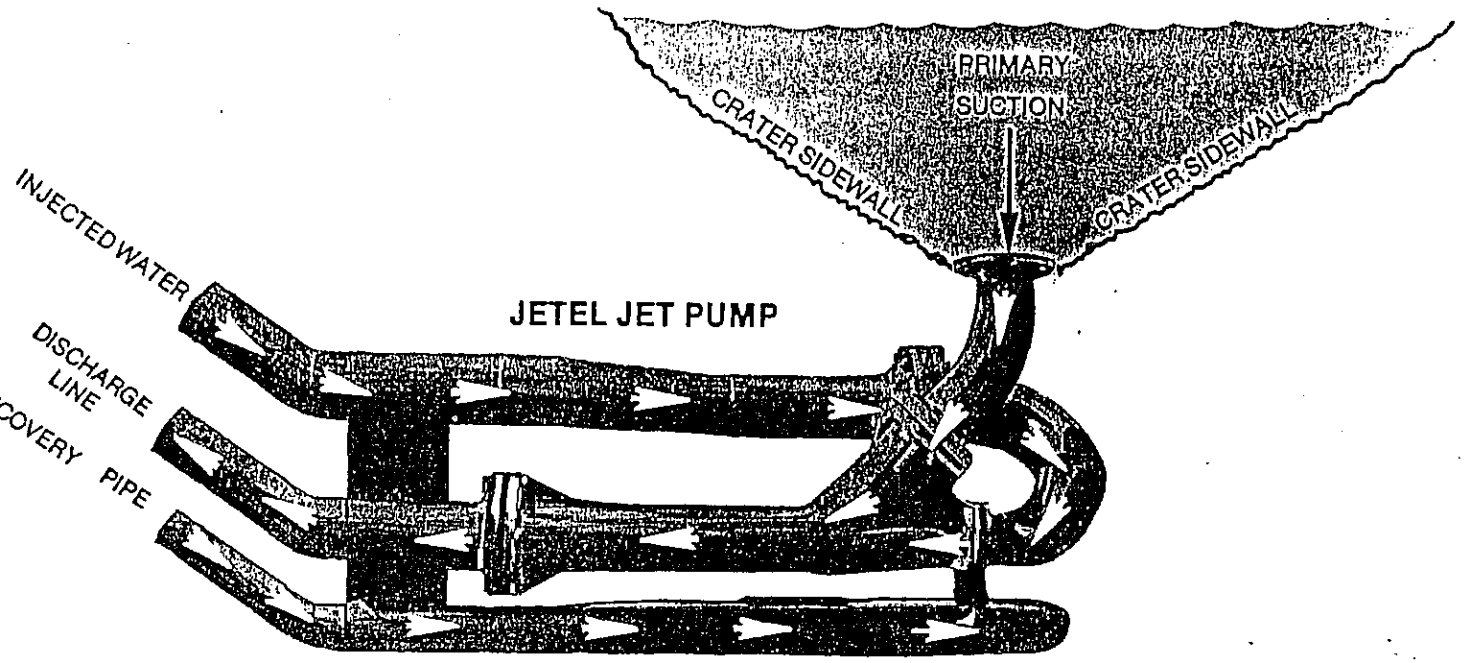
- **CHANNEL MAINTENANCE:** Keep channel open year round using this simple system. No waiting on large dredges to come. The Pekor jet pump system is often placed directly in the channel itself, with no interference with channel passage.

- **BEACH NOURISHMENT EROSION CONTROL:** Since sand is captured and put back into the littoral drift, erosion is halted and downdrift beaches are renourished. By using a Pekor slurry pump, the sand slurry can be pumped to any point required for beach nourishment.

TYPICAL INSTALLATIONS







HOW A JET PUMP OPERATES: A high pressure stream of water is injected through a nozzle into the venturi section of the jet pump. This reduces the pressure inducing a flow of sand and water into the primary suction of the jet and provides the energy for transporting the solids water slurry out of the discharge. The unique Pekor design allows the jet pump to operate effectively even when buried under 15-20 feet of sand.

Advantages of the Pekor System

- LOW INITIAL COST
- LOW OPERATING COST
- NO MOVING PARTS UNDER WATER
- NI-HARD ONE-PIECE CONSTRUCTION
- OPERATES UNDER ALL WEATHER & WAVE CONDITIONS
- SEMI-PERMANENT INSTALLATION
- OPTIONAL PORTABLE INSTALLATION

Write or call today for complete information.

PEKOR IRON WORKS, INC.
Box 909 / Columbus, Georgia 31902 / Telephone (404) 324-1354

APPENDIX H

QUALIFICATIONS OF ASSESSMENT AUTHORS

BIOGRAPHICAL DATA AND QUALIFICATIONS

Charles Edward Herdendorf

January 1987

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The Ohio State University
484 West 12th Avenue
Columbus, OH 43210-1292 Telephone: (614) 292-8949

Born: 2 October 1939, Sheffield Lake, OH Soc. Sec. No.: 292-34-1495

Education:

	School	Year	Field
B.S.	Ohio University	1961	Geology
M.S.	Ohio University	1963	Geology (Hydrogeology)
Ph.D.	Ohio State University	1970	Zoology (Limnology)

Major Research Interests: Aquatic and wetlands ecology; fisheries biology; geological and physical limnology; sedimentology and marine mineral resources; coastal processes, geomorphology, and engineering.

Professional Experience:

1. Conservationist, Division of Shore Erosion, Ohio Department of Natural Resources (1960-61).

2. Geologist, Lake Erie Section, Ohio Division of Geological Survey, Ohio Department of Natural Resources (1961-64).

3. Section Head, Lake Erie Section, Ohio Division of Geological Survey, Ohio Department of Natural Resources (1964-71).

4. Director, Center for Lake Erie Area Research and Associate Professor of Zoology, College of Biological Sciences, Ohio State University (1971-present).

5. Faculty of Environmental Biology, College of Biological Sciences, Ohio State University (1971-present)

6. Director, Franz Theodore Stone Laboratory, College of Biological Sciences, Ohio State University (1973-present)

7. Associate Professor of Natural Resources, College of Agriculture; and Associate Professor of Geology and Mineralogy, College of Mathematics and Physical Sciences, Ohio State University (1974-1977).

8. Faculty of Atmospheric Sciences, and Associate Faculty of Civil Engineering, College of Engineering, Ohio State University (1977-present).

9. Professor of Zoology, Geology and Natural Resources, Ohio State University (1977-present).

10. Director, Ohio Sea Grant Program, Ohio State University (1978-present)

CHARLES E. HERDENDORF

Pertinent Publications

Herdendorf, C.E. 1966. Geology of the Berlin Heights and Vermilion West Quadrangles. Ohio Dept. Nat. Res., Div. Geol. Surv. Rep. Invest. 60 1 map.

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Mizera, J.J., C.L. Cooper and C.E. Herdendorf. 1981 Limnetic larval fish in the nearshore zone of the western basin of Lake Erie. J. Great Lakes Res. 7(1):62-64.

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Herdendorf, C.E. 1982. Large lakes of the world. J. Great Lakes Res. 8(3): 379-412.

Herdendorf, C.E. 1985. Physical and limnological characteristics of natural spawning reefs in western Lake Erie. pp. 149-183 In Artificial reefs: marine and freshwater applications. Lewis Publ. Chelsea Michigan.

E. John Minderman, P.E.
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EDUCATION

1943 Grades 1-12, Port Clinton Public School
1944 Basic Engineering Service School, U.S. Navy
1951 B.M.E. & M.Sc., Ohio State University

Continuing education, Toledo University, Case Western Reserve, & NASA. Waste water treatment, advanced physics, digital control, computer science.

CERTIFICATION

Professional Engineer, State of Ohio Certified Fallout Shelter Analysis

EXPERIENCE

1951-52 Engineer, U.S. Gypsum Co., Oakfield, N.Y.
1952-55 Plant Engineering Superintendent, Alabaster, MI.
1955-61 Plant Engineering Superintendent & Construction Engineer, Shoals, IN.
1961-75 Maintenance Engineer, NASA Nuclear Reactor, Sandusky, Ohio
1975-82 Facilities Design Engineer, NASA Lewis Research Center, Cleveland, Ohio
1982- Consulting Engineer, Port Clinton, Ohio

ACCOMPLISHMENTS

Alabaster, MI. - Designed, coordinated, & supervised shore protection of plant & ship loading facilities located 1¼ miles off shore. Responsible for maintenance of Aerial Tramway serving ship loading facility. Tramway was supported on seven rock-filled timber cribs.

Shoals, IN. - Construction engineer for new Gypsum Mine, Processing Plant, and Associated Wallboard Manufacturing Plant. Included was the construction of a lake for water supply.

Sandusky, Oh. - Supervised all mechanical maintenance for Nuclear Reactor.

Cleveland, Oh. - Designed test facilities for the Aero-Space Research Center.

Port Clinton, Oh. - Self employed, performed engineering for the construction or expansion of six marinas in the Port Clinton area. Designed shore protection for several properties located along the shores of Lake Erie. Designed manufacturing facilities for several local industrial firms.

BIOGRAPHICAL OUTLINE

Ernest F. Brater, Professor of Hydraulic Engineering

Education:

B.S. (C.E.) University of Michigan, 1934
M.S.E. (Hydraulics) University of Michigan, 1936
Ph.D. (Hydraulics and Hydrology) University of Michigan, 1938

Professional Record:

Teaching

Member of the staff of the Department of Civil Engineering, University of Michigan, 1937 to present time. Professor of Hydraulic Engineering 1951 to date.

Research

Hydrology: Investigation of rainfall-runoff relations with particular emphasis on the effect of land use practices and urbanization on flood flows.

Hydraulics: In charge of University of Michigan Lake Hydraulics Laboratory. Investigations of wave action in harbors, wave forces on submerged structures and shore protection procedures.

States in which Registered:

Michigan

Recent Consulting Work:

Metcalf & Eddy, Boston, Mass., Offshore Pipeline.
Ayers, Lewis, Norris & May, Consulting Engineers in Ann Arbor, Michigan, Flood Prediction.
Detroit Edison Co., Detroit, Michigan, Shore Protection.
Bechtel Corp., San Francisco, California, Offshore Pipeline.
MacNamee, Porter, and Seeley, Ann Arbor, Michigan, Flood Prediction.
City of Grosse Ile, Michigan, Harbor Design.
City of Grosse Pointe Shores, Michigan, Harbor Design.
Costa Rica Land Development Corporation, Drainage Design.
EBASCO, New York, New York, Harbor Design.
Puerto Azul, Venezuela, Breakwater Design.
Camuri Grande, Venezuela, Harbor Design.
Johnson, Johnson & Roy, Ann Arbor, Michigan, Water Front Planning.

Recent Consulting Work con't:

Huron Clinton Metropolitan Authority, Water Storage Feasibility Study.
Gilbert Associates, Reading, Pennsylvania, Shore Erosion Investigation.
Michigan Dept. of Natural Resources, Shore Protection.
Government of Venezuela, Design of Ocean Outfalls.
Allegan County Michigan, Design of Shore Protection.
Oakland County Michigan, Clinton River Watershed Council and Associated Townships, Investigation of Flooding and Recommendations for Flood Reduction.
Flint, Michigan, Flood Prediction.

Chauncey & Marion Deering McCormick Foundation, Design of Shore Protection
Shore Erosion Advisory Panel, Coastal Engineering Res. Center, Planning shore protection projects.

Scientific and professional societies of which a member:

American Society of Civil Engineers, member of Task Force on Pipelines.
American Geophysical Union.
American Shore and Beach Preservation Association.
International Association for Hydraulic Research.
Council on Wave Research of ASCE.

Honors and awards:

Tau Beta Pi
Sigma Xi
Phi Kappa Phi
Stephen T. Attwood Distinguished Faculty Achievement Award

Committee assignments in department, college, and university:

Discipline Committee, College of Engineering, Chairman.
University Committee on Water Resources.
Graduate Guidance Committee of the Departmentof Civil Engineering.
University Sea Grant Advisory Committee.
University Sea Grant Policy Committee.

Writing:

Examples of articles and reports:

"Methods of Correcting Wave Problems in Harbors," Proc. ASCE, Jour. Waterways & Harbors Div., Dec., 1959.

"Model Study of Gordon Park Harbor, Cleveland, Ohio," University of Michigan Lake Hydraulics Laboratory Tech. Rep. No. 9, 1960.

"Wave Forces on Submerged Structures (with J. S. McNown and L. D. Stair), Trans., ASCE, Vol. 126, 1961.

"Laminar Flow in Rough Rectangular Channels," (with D. C. Woo), Jour. Geoph. Res., Vol. 66, Dec., 1961.

"Spatially Varied Flow from Controlled Rainfall," (with D. C. Woo), Proc. ASCE, Hydraulics Div., 1962.

"A Study of Refractions of Waves in Prismatic Channels," (with K. I. Beitinjani) Proc. ASCE, Waterways and Harbors Div., August 1965, p. 37, Vol. 97, No. ww3.

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"Storm Runoff," Proceedings of the 3rd Annual County Engineers Workshop, April, 1968, Ann Arbor, Michigan, pp. 63-79.

"Effects of Urbanization of Peak Flows," (with S. Sangal), Effects of Watershed Changes on Streamflow, Water Res. Symp., No. 2, Center for Water Res., University of Texas, 1969, pp. 201-214.

"A Comment of Optimization Methods for Branching Multi-stage Water Resource Systems," Water Resources Research, Vol. 5, No. 11, February, 1969.

"Developing Relations between Magnitudes and Frequencies of Floods for Drainage Basins of Various Sizes and for Various Degrees of Urbanization," Reconnaissance Flood Control Report, Lower Clinton River - Red Run Channel, Appendix A. Ayres, Lewis, Norris and May, July, 1969.

"Procedure for Predicting 10 Year and 50 Year Floods on the Frank and Poet Drain for the Highly Urbanized Conditions Expected in the Year 2000," Report to McNamee, Porter and Seeley, February, 1970.

"Prediction of the Magnitudes and Frequencies of Floods in Michigan," (with J. D. Sherrill), Report to Michigan Department of State Highways and the Federal Highway Administration, August, 1971.

"An Engineering Study of Shore Erosion in the Lower Peninsula of Michigan," (with E. Seibel, Report to Michigan Water Resources Commission, December, 1971.

"Physical Shore Processes," Presented at Conference of Coastal Zone and Shore Line Management, May, 1971.

Writing continued:

"Ludington Pumped Storage Project, Lake Front Model," (with R. B. Wallace) Rept. to Ebasco Services, Inc., 1970.

"A Hydrologic Study of the Proposed Mill Creek Dam and Lake" (with E. B. Wylie) Rept. to Huron Clinton Metropolitan Authority, July, 1971.

"A Hydrological Model for Estimating the Inflows to and Outflows from Grand Traverse Bay," University of Michigan Sea Grant Publication, August, 1972.

"Wave Forces on Submerged Pipe Lines," (with Roger Wallace), Proc. 13th Coastal Engineering Conference, ASCE, V. III, 1972, pp. 1703-1722.

"Seasonal Effects of Flood Synthesis," (with S. Sangal and J. D. Sherrill), Water Resources Research, American Geophysical Union, V. 10, No. 3, June, 1974, pp. 441-445.

"Shore Erosion Demonstration Project," (with J. M. Armstrong and M. R. McGill), Rept. to Michigan Department of Natural Resources, Lansing, Michigan, August, 1974.

"Laboratory Investigation of Shore Protection," (with D. Ponce-Campos) Rept. to Michigan Department of Natural Resources, August, 1974 and presented at the Great Lakes Shorelands Conference, September, 1974.

"Implications of Recession Rates," Proceedings of the Recession Rate Workshop, Great Lakes Basin Commission, Ann Arbor, Michigan, December, 1974.

"Rainfall-Runoff Relations on Urban and Rural Areas," (with J. D. Sherrill), Env. Protection Series, EPA-670/2-75-046, Cincinnati, Ohio, May, 1975.

"Michigan's Demonstration Erosion Control Program, Update Evaluation Report," (with J. M. Armstrong and M. R. McGill), Published by the Michigan Dept. of Natural Resources, Lansing, Michigan, August, 1975.

"Beach Erosion in Michigan, An Historical Outline," Published by the Michigan Dept. of Water Resources, Bureau of Water Management, Lansing, Michigan, October, 1975.

"A Study of Flood Conditions along the Clinton River in the Region which Includes the Western Part of Pontiac, Waterford Township and West Bloomfield Township," Report to the Oakland County Board of Commissioners, The Clinton River Watershed Council, The City of Pontiac and Others, March 4, 1976.

Writing continued:

"Laboratory Investigation of Shore Erosion Processes," (with David Ponce-Campos) Proceedings, 15th Intl. Conf. on Coastal Eng., Amer. Soc. of Civil Engrs. v. IV, 1976, pp. 1493-1511.

"Coastal Engineering and Erosion Protection, (With C.D. Ponce-Campos) Tech. Rept. No. 59, Mich. Sea Grant Progr., Jan. 1978.

"Evaluation of Low Cost Shore Protection," (with D.C. Ponce-Campos), Report to The Michigan Sea Grant Program, Oct., 1979.

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"Hindcasting Monthly Runoff," (with Roger Wallace). Jour. Hydraulic Eng. ASCE, V. 110, No 2, Feb., 1984, pp. 126-143.

Books:

Hydrology, (with C.O. Wisler) John Wiley & Sons, Inc., New York, 2nd edition, 1959.

Handbook of Civil Engineering, Hydraulics Section, McGraw-Hill Book Co., Inc., New York, 4th edition, 1959.

Handbook of Hydraulics, (with H. W. King), McGraw-Hill Book Co., 6th edition, 1976.

CLEAR TECHNICAL REPORT NO. 313-A

Assessment of the Structural Integrity of the Breakwall System for the Marina at Beachwood Villas in Erie County, Ohio

Prepared by

Dr. Ernest F. Brater, Hydraulic Engineer, Univ. of Michigan

Dr. Charles E. Herdendorf, Director, Ohio State Stone Laboratory

Mr. Richard Hoppenjans, P.E., Bowser-Morner

Mr. E. John Minderman, P.E., Minderman Engineering

for submission to

U.S. Army Corps of Engineers, Buffalo District

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO 43210

September 1987

TABLE OF CONTENTS

E. JOHN MINDERMAN, P.E.

MINDERMAN ENGINEERING
STRUCTURAL & MACHINE DESIGN
2833 SAND ROAD
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EXECUTIVE SUMMARY

CLEAR Technical Report No. 313 evaluated the impact of the proposed marina on the shoreline of Lake Erie. Report 313-A assesses the structural integrity of the breakwall system.

The proposed marina will be located in a basin formed by a breakwall system constructed of stone-filled timber cribs and placed armor stone. The structure will project 230 ft. into the lake and provide wave protection for 66 pleasure craft at floating docks. The basin will be dredged to a depth of 4.6 ft. below Low Water Datum (564.0 IGLD). Dredged sand will be discharged to the east and west of the structure to form fillet-shaped sand beaches. Figure 1 shows the plan of the marina.

The following persons provided detailed design information regarding the breakwall system:

Dr. Ernest F. Brater, Hydraulic Engineer, Univ. of Michigan
Dr. Charles E. Herdendorf, Director, Ohio State Stone Laboratory
Mr. Richard Hoppenjans, P.E., Bowser-Morner
Mr. E. John Minderman, P.E., Minderman Engineering

In addition to the above, considerable input was obtained from the two-volume Corps of Engineer Design Manual and from Corps personnel at the Buffalo Office.

The breakwall system was designed to withstand the forces in the most severe storm that will occur in a 100-year period. Consideration was given for the stability of the crib structure from sliding on the foundation and from overturning. The effect of wave action on the armor stone was also evaluated.

To prevent sliding of the cribs due to the weight of the stone and the hydrostatic forces from wave run-up, the cribs will be placed on a bed of large quarry-run stone. Prior to placing the stone, the sand will be excavated to a depth necessary to obtain a solid base of clay. Core borings taken in 1985 verify that solid clay exists under only a few feet of sand.

To prevent overturning of the cribs from the stone weight and wave forces, a continuous deadman and tieback system will be employed. This design feature is shown in Figure 2.

The breakwall will be protected from wave action on the lakeward side by the installation of large armor stone. Size selection was based on the wave height to be expected in this area. Calculations to determine the wave height using water depth and the distance of open water in the direction of the wind, indicate a maximum height of seven feet. This agrees with information published by the Corps of Engineers for the Huron, Ohio area.

While the breakwall design is based on sound engineering practices, a comparison was made to existing breakwall systems and it was found that the design of the Beachwood Villas marina is on the conservative side. The entrance to East Harbor in Ottawa County is protected with a breakwall system using much smaller stone than is proposed to be used at Beachwood. This breakwall has stood for many years with practically no maintenance while being subjected to some of the most severe weather in recent years.

CLEAR Technical Report 313-A explains the design features of the breakwall system in greater detail.

E. John Minderman, P.E.

E. John Minderman, P.E.

INTRODUCTION

Background:

To provide protection for pleasure craft moored in the proposed Beachwood Shores Corporation Marina, Huron, Ohio, a breakwall must be constructed. This breakwall will parallel the shore and will be located approximately 230 feet offshore. The parallel breakwall will be connected to shore on the westerly end with a breakwall positioned perpendicular to the shore. The easterly breakwall will be constructed perpendicular to the shore to within 70 feet of the parallel breakwall. This opening will provide access to the marina basin.

The breakwall will consist of a rock-filled timber crib on the basin side backed up by quarry-run rock. The breakwall will be protected from storm damage on the lakeward side with large armor stone.

Purpose of Report:

The purpose of this report is to present the results of an in-depth analysis of the structural integrity of the proposed breakwall system.

PROPOSED MARINA

The proposed marina will be a basin formed by a breakwall system in which floating docks will be provided for pleasure craft mooring. Figure 1 shows the plan of the marina.

The proposed breakwall system will consist of rock-filled timber cribs on the basin side backed up with rock fill. This back-up will be constructed with a 1-1/2:1 slope. To protect the rock, large armor stone will be placed on the lakeward side. Figure 2 shows the construction details.

To assure stability, a tie-back and dead man system will be installed.

Steel sheet piling will be installed at the shoreline on the westerly portion of the marina. This piling will be an extension of the existing piling. Timber crib construction will be used at the easterly shoreline.

Floating finger docks will be attached to a floating feeder dock placed adjacent to the shoreline cribs or piling. Floating finger docks will also be attached to a central floating feeder dock. Space for five larger boats will be provided along the northerly breakwall.

All docks will be provided with water and electricity. A coin-operated pump-out station will be installed. This station will discharge to the city sewer.

FORCES INVOLVED

The forces that will be imposed on the breakwall are a function of the wave run-up on the structure.

Wave run-up was calculated independently by Dr. Charles Herdendorf, Center for Lake Erie Area Research and Mr. Richard Hoppenjans, P.E., Bowser-Morner. Dr. Herdendorf calculated that run-up will overtop only during a 50-year storm while Mr. Hoppenjans calculated overtopping will occur only during a 100-year storm. During these very infrequent storms, while overtopping may occur, only minimal damage to the structure will be done. Both Dr. Herdendorf's and Mr. Hoppenjans' reports are a part of the appendix.

Failure of the breakwall system, by sliding or overturning, will be prevented by the installation of a continuous deadman and tie-back system as shown in Figure 2. Calculations for the tie-back system are included in Mr. Hoppenjans' report. Particular attention will be given to the quality of the clay base and the bedding rock.

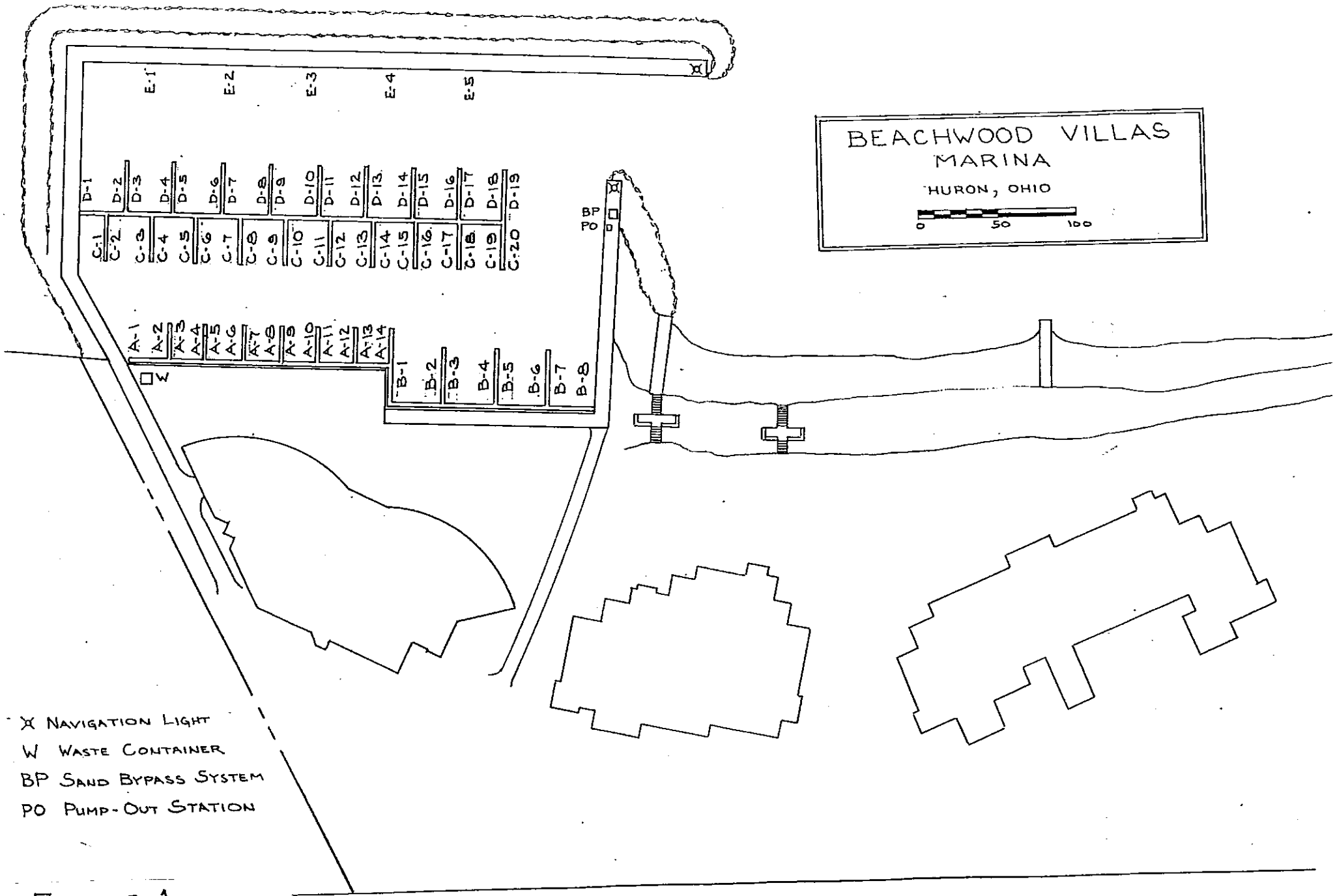
ARMOR STONE

Armor stone will be placed on all lakeward sides of the proposed breakwalls. As part of this report, calculations were made to determine the size armor stone required to withstand storms of 100-year frequency with only minimal maintenance required.

These calculations indicate an armor size of 3 feet cube will be required. This value was beyond the table in the literature; however, it was obtained by extrapolation of the data.

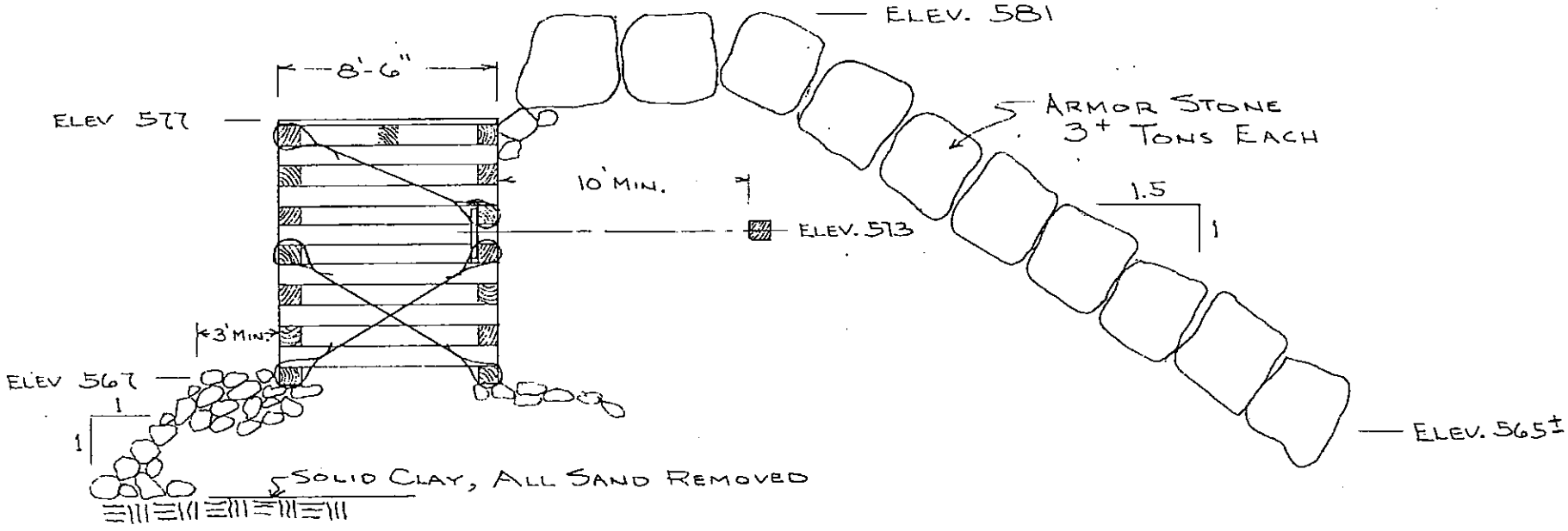
Dr. Ernest Brater, Coastal Engineer, University of Michigan, reports that the Corps of Engineers at the U.S. Waterway Experimental Station indicates that stones having an average dimension of 3.3 feet will be required to withstand the seven-foot waves that can be expected during a 100-year storm.

To assure protection of the breakwall, stones of an average size of 3.3 feet will be placed as armor.



X NAVIGATION LIGHT
W WASTE CONTAINER
BP SAND BYPASS SYSTEM
PO PUMP-OUT STATION

FIGURE 1



SECTION

SCALE 1"=5'-0"

FIGURE 2

APPENDIXE

A - C

OSU

The Ohio State University

Center for Lake Erie Area Research
Franz Theodore Stone Laboratory
Ohio Sea Grant Program

College of Biological Sciences
484 West 12th Avenue
Columbus, Ohio 43210-1292

Phone 614-422-8949

25 August 1987

Mr. E. John Minderman, P.E.
Minderman Engineering
2833 Sand Road
Port Clinton, Ohio 43452

RE: Beachwood Villas Marina Breakwaters

Dear John:

The purpose of this letter is to provide you with an estimate of the anticipated wave runup on the north breakwater of the Beachwood Villas Marina for various stillwater lake elevations. Waves breaking against an inclined structure will run up to an elevation higher than the stillwater level depending on the roughness of the structure. For rough slopes, such as proposed for the marina, Seeling (1980) gives the runup as

$$R = \frac{0.69r}{1 + 0.5r} H \qquad \text{where,}$$

R = runup in ft.

$$r = \frac{\tan \theta}{\sqrt{H/L_o}}$$

$L_o = 5.12\ T^2$ (deepwater wave length)

θ = structure slop (e.g. $\tan \theta = 0.667$ for a slope of 1:1.5)

T = wave period in sec. (Resio and Vincent 1976, p. E)

H = maximum height of breaking wave (H = 0.78 water depth, Komar 1976, p. 56)

The U. S. Army Corps of Engineers (1977) has prepared predications of the elevations for the highest storm water levels which can occur along the open coast of Lake Erie. For the shore

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reach between Huron and Vermilion, Ohio the following predictions have been made:

Chance of being equalled or exceeded in any given year	Return period for storm Elevation	Storm Elevation (ft above IGLD)
10%	10 years	574.3
2%	50 years	575.2
1%	100 years	575.4
0.2%	500 years	576.0

Based on these data, the following range of elevations were selected for calculations: elevations 570 (mean level of Lake Erie) to elevation 576 (maximum level for a 500-year storm). The following table presents the results of the runup calculations for these lake levels:

Water Level (Elev. IGLD)	Depth at Toe (ft)	Max Breaking Height (ft)	Period (sec)	Wave Length (ft)	Runup (ft)	Runup Elev. (ft above IGLD)
570	3	2.34	3.5	62.7	2.05	572.05
571	4	3.12	4.0	81.9	2.72	573.72
572	5	3.90	4.7	113.1	3.46	575.46
573	6	4.68	5.5	154.9	4.25	577.25
574	7	5.46	6.0	184.3	4.98	578.98
575	8	6.24	6.2	196.8	5.62	580.62
576	9	7.02	6.4	209.7	6.26	582.62

The top of the north breakwater is designed at an elevation of 581 IGLD. Therefore, runup shcould not be a problem for storms up to elevation 575 (about a 50-year storm). The construction of 2-ft high wave deflector on the top of the breakwater should protect the marina from even the most severe

storms (500-year).

References

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Seeling, W. 1980. Estimation of wave transmission coefficients for overtopping of impermeable breakwaters. CETA 8-7, U. S. Army Corps of Engineers, Coastal Engineering Research Center, Ft. Belvoir, Virginia.

U. S. Army Corps of Engineers. 1977. Report on Great Lakes open-coast flood levels. Prepared for U. S. Dept. Housing and Urban Development, Federal Insurance Admin. USACOE, Detroit District. 1 map and table.

Please contact me if you have any questions concerning this information.

Sincerely,

Charles E. Herdendorf
Director and Professor

CEH/amw

cc: Marshall Browne

BOWSER-MORNER

122 South St. Clair Street, P.O. Box 838, Toledo, Ohio 43696
(419) 255-8200

LABORATORY REPORT

Report to: Mr. Marshall Browne
Beachwood Villas
1500 Cleveland Road East
Huron, Ohio 44839

Date: September 9, 1987
Laboratory Job No.: 38575
Report No.: 38575-987-187

Report on: BREAKWATER DESIGN
Beachwood Villas
Huron, Ohio

Gentlemen:

The following report summarizes the results of our analysis of the composite rock fill dike and railroad tie crib wall proposed for your marina. Authorization to proceed with the necessary work was given by Mr. Marshall Browne during September of 1987. All work was to proceed in accordance with the verbal agreement between Mr. Browne and Mr. Hoppenjans of BOWSER-MORNER ASSOCIATES, INC.

The purpose of this work was to review the design of a proposed marina breakwater and to provide a short report on design considerations for the proposed composite structure. Design criteria included a 100-year storm and information provided in three reports prepared by Ohio State University and Minderman Engineering. Our design work was not to include reanalysis of the wave hydraulics, nor was it to include analysis of the rip rap stability. The focus of our work was specifically the interaction between the rock fill dike and the crib wall. It should be noted that we have performed this review by making

assumptions concerning the types of materials to be utilized in the dike and rock bedding layers. We do not have any soil boring data or other verification of the natural soil condition in the area in which the dike is to be constructed. Our calculations have been based on a description of the site which indicates that the dike bottom is covered with beach sand to a depth of about 3 feet. Reportedly, below this sand is a hard clay material.

It is our understanding that the construction of the dike is to proceed in somewhat the following manner. Railroad tie crib walls will be prefabricated on dry ground and brought to the site in sections which are 8.5 feet wide by approximately 17 feet long. We understand that the crib will be properly designed for internal stresses and will be able to withstand the anchor rod pull and earth stresses applied to it. The sand in the area of the proposed crib will be excavated to the top of the firm clay material. A rock bedding layer will then be placed in this trench as a foundation upon which to set the crib wall. It is important that the rock bedding extend on each side of the crib wall at least 3 feet. It is also important to ensure that on the marina side of the crib wall, the rock bedding cannot be eroded by wave action or other forces. Once the crib has been installed and filled with compacted stone, a rock fill dike section will be constructed on the lake side of the crib wall. We understand that the rock will be dumped through the open water and onto the beach sand. Compaction of the stone will occur after the stone reaches lake level.

In order to provide resistance against overturning for the crib wall, an anchor and anchor rods will be utilized. It is assumed that the anchor rods and a continuous anchor will be constructed as the rock fill dike proceeds upward.

Based upon the calculations which we have been provided, it is our understanding that for the 100 year storm, only moderate overtopping of the structure would be expected. We have not included any forces due to wave impact coming over the top of the dike and onto the crib structure.

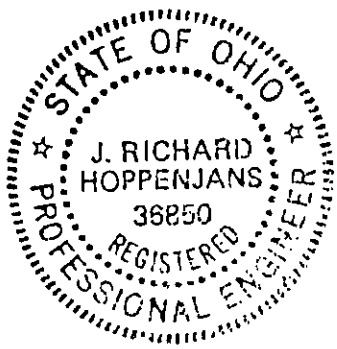
Information provided to us, as indicated above, suggests the use of dynamic wave forces in our analysis of the structure. Specifically, it was suggested that wave forces calculated by the Minikin method might be appropriate. It is our opinion that these wave forces are not appropriate in the design of this type of structure. Furthermore, we contacted the Corps of Engineers to discuss this design criteria with them and they seemed to agree that dynamic wave forces calculated by that method would not necessarily be appropriate. We have included in our analysis differential water forces which might be caused by wave runup. We believe that our analysis provides a conservative approach to the design.

Attached with this report are three pages of calculations which illustrate our understanding of the proposed construction, including its size and location relative to the existing lake bottom. Our calculations have been developed based upon the information provided relative to design wave heights and the 100 year water levels. Assumptions made by us are clearly stated, as are the forces

which we believe are acting on the structure. The attached calculations should be revised if the location of the anchor rod should be changed vertically, or should any other significant changes be made in the overall cross-section of the facility. Additionally, the crib structure should be checked for internal structural stability.

As can be seen from the attached calculations, it appears that the proposed structure, as proportioned, should perform satisfactorily. Relatively large anchor forces will be developed and it appears that anchor rods, approximately 1.75 inch diameter, will be needed every 8 to 9 feet. Smaller rods could be used on a closer interval. It should be noted that we have not checked the overall stability of the structure and/or bearing capacity due to a lack of information concerning the foundation soils. By inspection, however, it does not appear that there should be a problem with these items provided sand and firm clay are, in fact, found during construction. Should other or softer materials be encountered, a review should be made immediately of the foundation conditions and appropriate changes implemented.

If you have any questions or if we can be of further service on this project, please contact us.



Respectfully submitted,

BOWSER-MORNER ASSOCIATES, INC.

J. Richard Hoppenjans

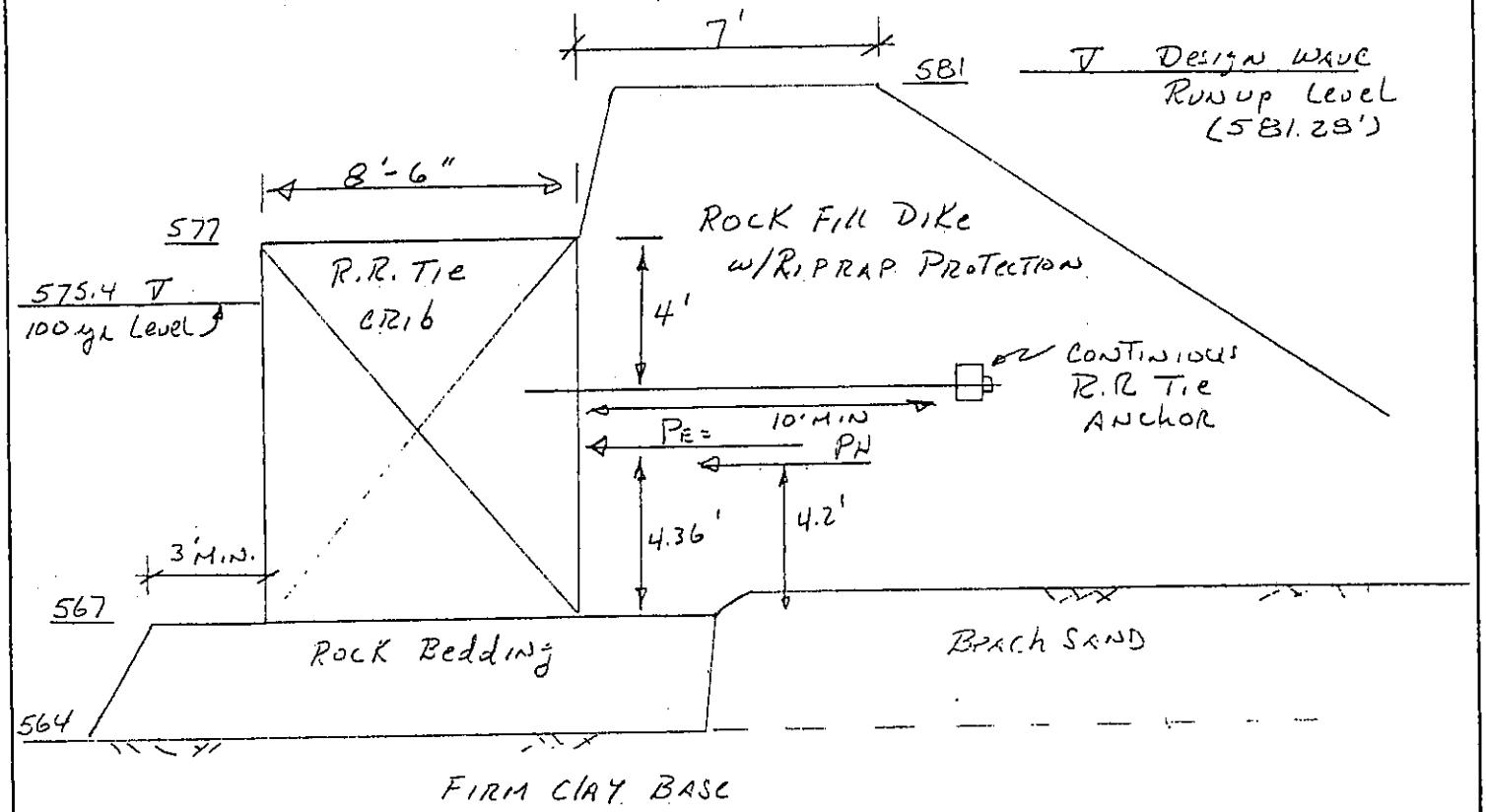
J. Richard Hoppenjans, P.E.
Chief District Engineer

JRH:jl(16)
Encls.
1-E. John Minderman, P.E.
Minderman Engineering

BOWSER MORNER

BOWSER-MORNER ASSOCIATES, INC
122 So. St. Clair St., P.O. Box 838
TOLEDO, OHIO 43696
(419) 255-8200

JOB 39575 - Beachwood Villas
SHEET NO. 1 OF 3
CALCULATED BY JRH DATE 9-8-87
CHECKED BY DATE
SCALE 1" = 5'



Assumptions

Rock Filled Crib: Rock Fill Sat. unit wt, γ_s = 115 PCF
Submerged " " γ_b = 50 PCF

Rock Fill Dike: Sat. unit wt, γ_s = 130 PCF
Sub. " " γ_b = 68 PCF

Calculated Values

Wt of Crib (Filled) ≈ 4428 PLF

P_E = Total Earth Pressure ≈ 3135 PLF

P_H = Total Hydrostatic Net Water Pressure = 2940 PLF

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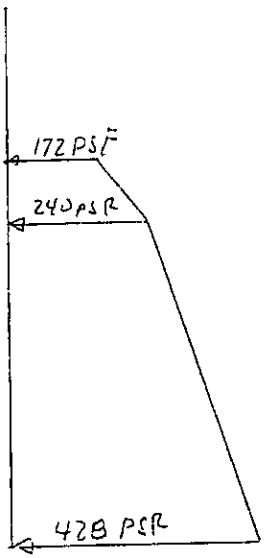
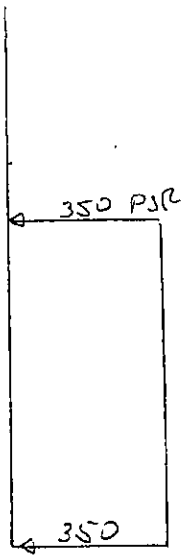
SHEET NO. 2 OF 3
CALCULATED BY JRA DATE 9-8-87
CHECKED BY DATE
SCALE



EARTH PRESSURE



HYDROSTATIC
NET WATER PRESSURE

ΣM Toe of CRIB
w/o DYNAMIC FORCE

$$4228 * 4.25 + A_p \times 6 - 2940 \times 4.2 - 3135 * 4.36$$

$$A_p = 1203 \text{ PLF}$$

w/ DYNAMIC FORCE EQUAL TO 1/2 of SLOPED FACE FORCE

$$AP = 1203 + \frac{1/2 \times 13187 \times 8.4}{6} = 1203 + 9230 = 10433$$

VERY HIGH

BECAUSE DYNAMIC FORCE IS VERY SHORT AND NOT EFFECTIVE OVER THE ENTIRE LENGTH AT ONCE, IGNORE THIS FORCE. FOR DESIGN OF CRIB.

DISCUSSED W/ [illegible] OF CORPS CONSTRUCTION SPECS AND

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JOB 38575
SHEET NO. 3 OF 3
CALCULATED BY JRA DATE 9-8-87
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Check Sliding

Shearing Force IN Bedding Stone = W Tan ϕ

Assume $\phi = 30°$

$\Sigma F_{HORIZONTAL} = 0$

$A_p + W\tan\phi = 1203 + 2555 = 3758$

Driving Forces. $= 3135 + 2940 = 6075$

$\therefore$ A_p must be Larger.

$A_p = 3520$ PLF

F.S. $= 1.5$ A_p Design $= 5280$ PLF

B.N wall should be checked For INTERNAL Shear.

Check Moment About Tie Rod

EARTH PRS	3135	(6-4.36)	5141	} 10433
N_2O "	2940	(6-4.2)	5292	
CRIB FRICTION	2555	(6)	15330	

$$F.S. = \frac{15330}{10433} = 1.47 \quad OK.$$

ANCHOR CAPACITY

Check CONTINUOUS R.R Tie For CAPACITY

Tie $= 6415$ PLF

$$F.S. = \frac{6415}{5290} = 1.2 \quad OK.$$

BEACHWOOD VILLAS SHORE PROTECTION AND MARINA

Submitted to Marshall G. Browne

by

E. F. Brater, Consulting Engineer

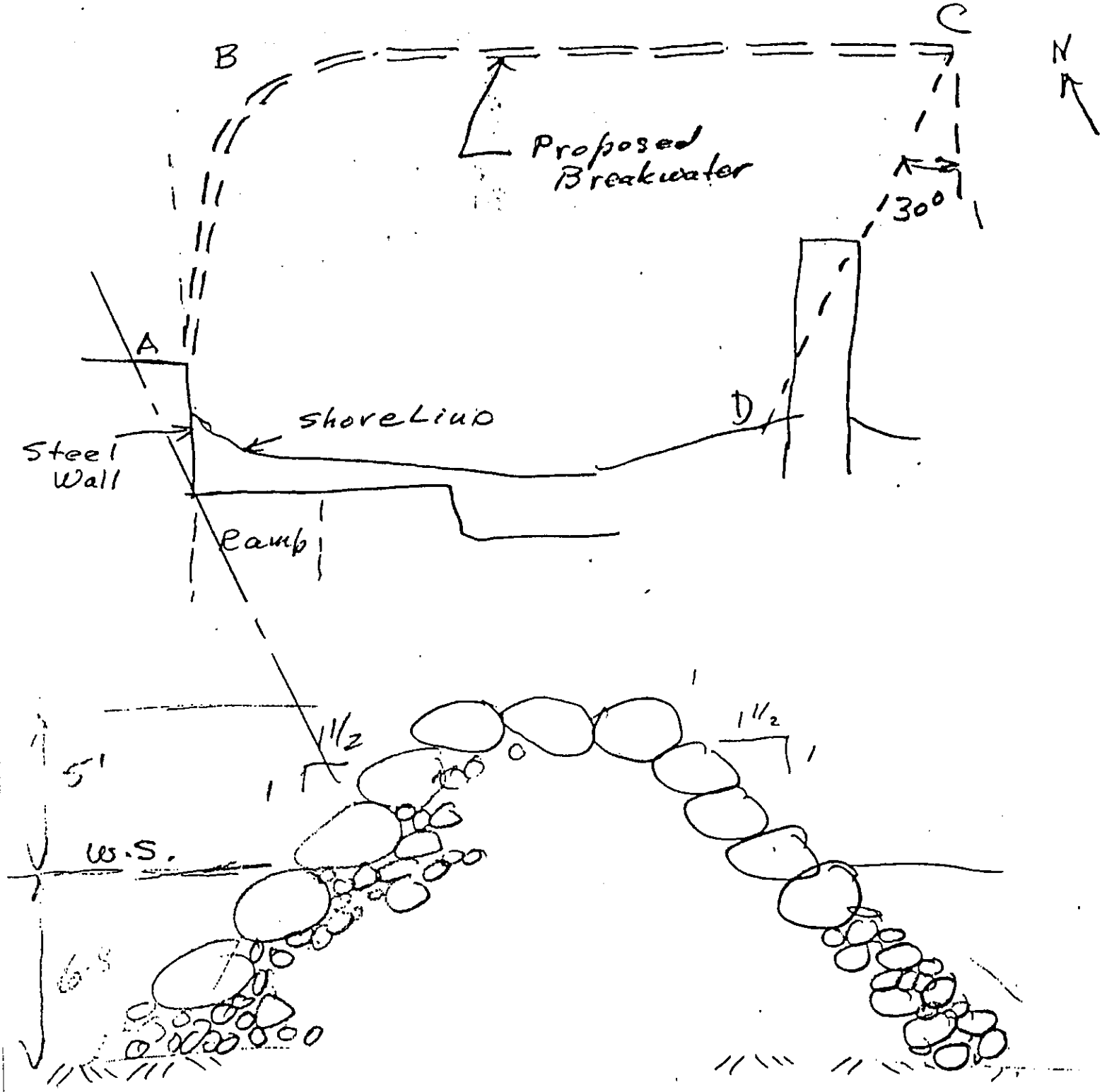
June 8, 1984

Shore Protection: The system of three groin which you installed in 1977 has collected some sand which has provided considerable protection for the bluff. The rocks placed on the bluff have undoubtedly helped also but they will not be effective during a major storm.

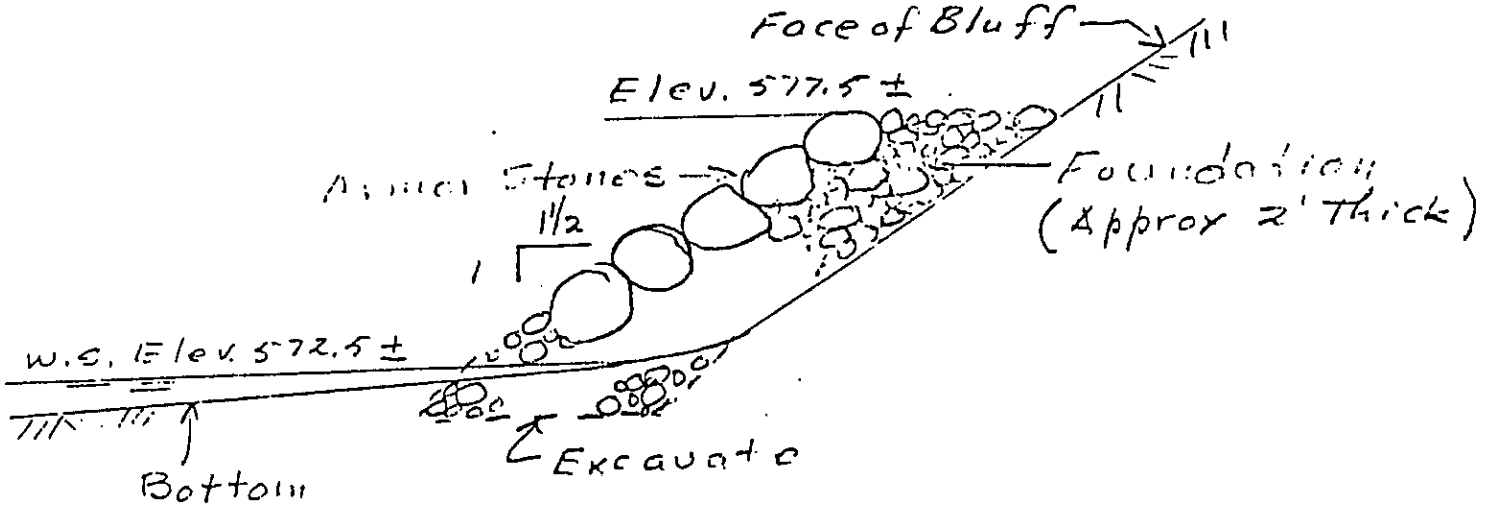
The groin system could be made more effective by adding two or three groins. A rule of thumb for an exposed area like yours is to have the distance between groins no more than twice as much as the length of the groins. I don't think there is sufficient littoral drift to gain much more sand naturally. Therefore, you should plan on filling between the groins by hauling in sand.

Another method of providing very effective bluff protection is to build a rock revetment at the toe of your bluff. This should have a slope no steeper than 1-1/2 to 1 with an armor layer of large stones and a foundation layer of smaller stones of mixed sizes as shown in the sketch. The armor stones should have a weight of about 650 pounds which correspond to a cube of about 1.6 feet on a side. The rocks should be placed so that they touch each and form a reasonably uniform plan surface. The rocks should be roughly cubical or spherical and not flat slabs. The underlayer should be about two feet thick and made up of a mixture of sizes varying from about two inches to 10 inches. The purpose of this foundation layer is to break up the jets of water which penetrate the armor layer. Notice that the foundation should be supported by a trench at its toe.

Marina: The most practical and least expensive marina arrangement for Beachwood Villas would be a single breakwater extending out from your western boundary and then turning eastward, parallel to the shore at whatever depth you select. This is illustrated by the dashed line ABC in the sketch. No east breakwater would be needed. An east wind would cause very little problem because of the very short fetch and the energy dissipation by refraction. The only direction which might cause a problem is in the sector near 22.5° north of east. Taking into account both that refraction turns the wave direction toward shore and diffraction turns the waves into the harbor the only area behind the breakwater which will still be subjected to waves of about half the size of the approaching waves will be in the area easterly of the line CD. If you retain your beach between D and A the remainder of the harbor should be quite calm even during a large storm from E 22.5°N. It would also help of course if you used rubble-mound construction for the breakwater. The location of BC (distance from shore) would depend on whether you want to only provide access to a ramp or whether you want to provide slips for larger boats. For only a ramp, BC could be at a depth of about 6 feet. The location of C (from E to W) depends on how much shoreline or mooring area you want in the protected zone to the west of CD. For a breakwater located at a depth of six feet the armor stones should weigh about 6000 pounds which would correspond to a cube having a dimension of 3.3 feet. Such a breakwater should suffer some damage only during rare large storms. If you only protect a ramp it would be acceptable to build the breakwater low enough to allow some overtopping during major storms when no one would be using the ramp. You could probably get by with a structure extending only about five feet above the water surface.



Typic Rubble Breakwater



Typical Revetment
for
Beachwood Villas

6/19/87 E.I. Erator