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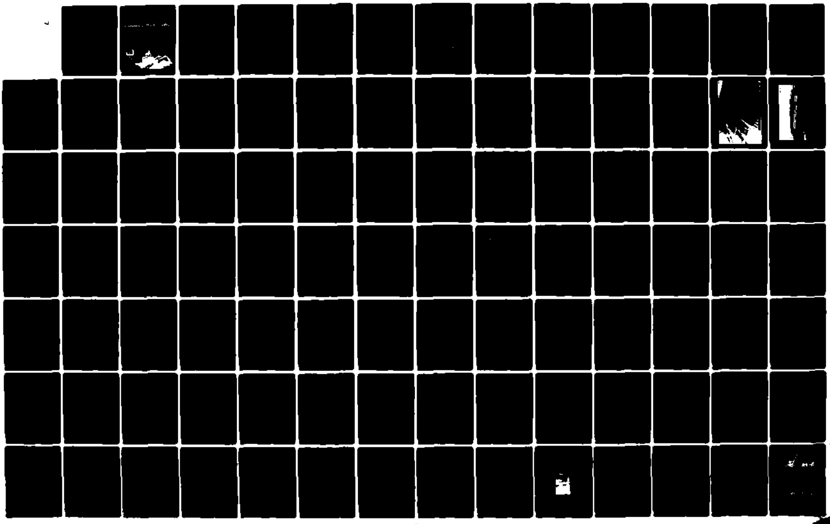

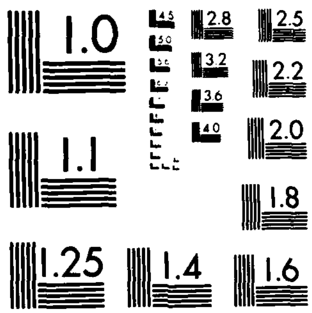

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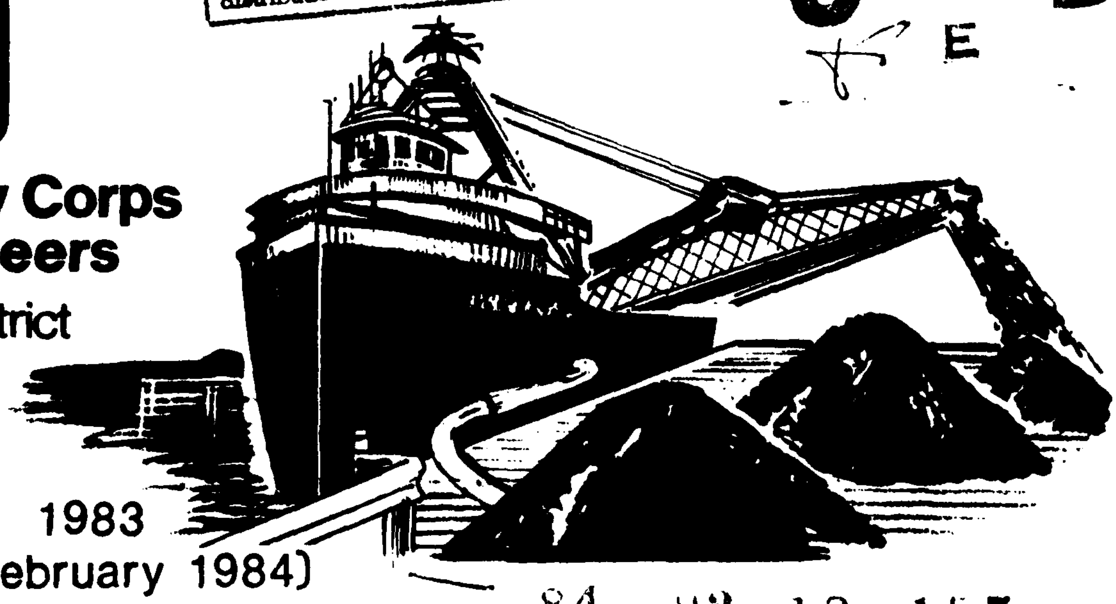
Draft Reformulation Phase I
General Design Memorandum and Draft Supplement to the Final Environmental Impact Statement

Cleveland Harbor, Ohio



US Army Corps of Engineers
Buffalo District

November 1983
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The report documents the study conducted to determine the feasibility of improving Cleveland Harbor on the interest of commercial navigation. Types of improvements considered included: 1) plans to provide a storm entrance in the Lakefront Harbor; 2) deepening and widening the Old River; 3) deepening the Cuyahoga River; and 4) widening the Cuyahoga River at historically restricted locations. The tentatively selected plan includes deepening and widening the east entrance and deepening the east basin channel in the Lakefront Harbor.

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CLEVELAND HARBOR, OH
DRAFT REFORMULATION PHASE I GDM

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This Phase 1 Report was prepared through the efforts of many individuals on the Interdisciplinary Team within the Buffalo District and Waterways Experiment Station of the Corps of Engineers and from other agencies and industry representatives involved with the Cleveland Harbor project. The following are the Corps personnel who were most instrumental in conducting the investigation and preparing the text presented herein:

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Other agencies have contributed to this report through the preparation of supplemental reports and participation in agency workshops. The individuals involved are numerous and not easily identified. Therefore, recognition is provided by the names of their employing agencies as follows:

North Central Division, Corps of Engineers
Cleveland-Cuyahoga County Port Authority
U.S. Fish and Wildlife Service, Columbus Field Office
Ohio Department of Natural Resources
United States Coast Guard, Ninth Coast Guard District
Industrial Users of Cleveland Harbor

The report itself was produced through the efforts of many other Corps personnel, including the following who contributed significantly to its preparation:

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The Buffalo District Commander during preparation of this Phase I Report was Colonel Robert R. Hardiman, the Chief of the Engineering Division was Donald M. Liddell, and the Chief of the Planning Division was Kenneth R. H''ock.

Special thanks go to Captain William J. McSweeney, consultant to t Buffalo District, Captain Alton H. Haines of American Steamship Company, C ain G. V. Chamberlain of Hanna Mining Company, and Captain Victor Ande n of Great Lakes Pilots Association who conducted ship navigation tests Waterways Experiment Station in conjunction with the development o bor entrance plans for 1,000-foot vessel operation.

Finally, the efforts of other individuals who participated in the study and report preparation but whose names have not been mentioned above, are gratefully acknowledged.

SECTION 1
INTRODUCTION

The purpose of this section is to introduce the reader to the Cleveland Harbor study and to explain the content and organization of this report. The section presents information on the geographical setting of the study area, the study authority, the purpose of the study, the scope of the study, study participants and coordination, the organization of the report and prior studies and reports pertinent to this Cleveland Harbor study.

1. GEOGRAPHICAL SETTING

Cleveland Harbor, Ohio (see Figure 1) is located on the south shore of Lake Erie, at the mouth of the Cuyahoga River, approximately 176 miles southwest of Buffalo, New York and 96 miles east of Toledo, Ohio. The harbor includes a breakwater protected Lakefront Harbor and an Inner Harbor consisting of improved navigation channels on the Cuyahoga River and Old River. The harbor area is shown on Plates 1 and 2 in Appendix I, "Plates."

The Cleveland Lakefront Harbor extends for a distance of about 5 miles along the shoreline and varies in width from about 1,600 to 2,400 feet. Entrance into the Lakefront Harbor is provided through either the dredged channel between the arrowhead breakwaters (main or west entrance) or between the easterly end of the east breakwater and the shore (east entrance). The Cleveland Inner Harbor includes improved navigation channels on the lower 5.8 miles of the Cuyahoga River and about 1 mile of the Old River, the former outlet of the Cuyahoga River. Widths in the navigation channels vary from 100 to 325 feet, except at the bends and in the existing turning basin in the Cuyahoga River where a width of 800 feet is available.

Cleveland Harbor accommodates the waterborne movement of bulk and general cargo to and from the city of Cleveland and inland portions of the State of Ohio and adjacent States. During the 10-year period 1972 to 1981, an average of about 18,300,000 net tons of cargo entered the harbor and about 700,000 net tons of cargo were shipped from the harbor, ranking it as one of the major harbors on the Great Lakes. Vessel movement of bulk iron ore, limestone, sand and gravel, and salt accounted for about 93 percent of the total cargo. The configuration of the breakwaters and navigation channels, however, limit the effective utilization of the vessels which can move these commodities. Significant transportation savings could be realized if the harbor were modified to permit more efficient utilization of these vessels.

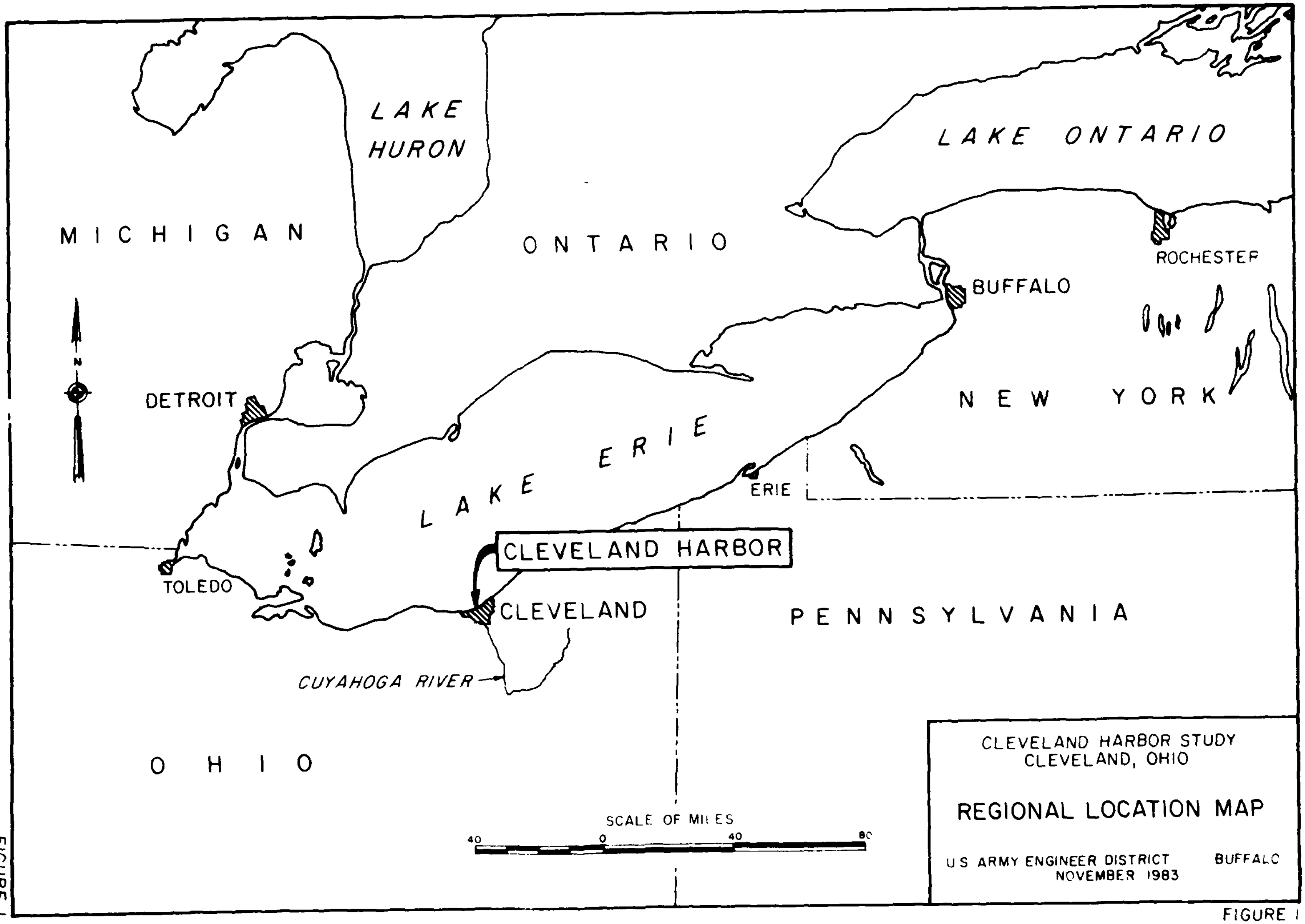


FIGURE I

FIGURE I

2. STUDY AUTHORITY

a. Congressional Authority.

A resolution passed by the Committee on Public Works of the House of Representatives on 2 December 1970, authorized the Corps of Engineers to conduct a feasibility study to determine if modifications to the general navigation features of Cleveland Harbor were needed in the interest of commercial navigation and to determine if such improvements were economically justified and environmentally acceptable. In compliance with this authority, the Buffalo District conducted a feasibility study from 1972 to 1976 and the results of this study were documented in the Cleveland Harbor, Ohio Feasibility Report for Harbor Modifications, June 1976. Contained within this report, was the Buffalo District Engineer's recommendation to modify both the west (main) entrance and east entrance of Cleveland Harbor for safe and efficient operation of 1,000-foot bulk cargo vessels in the Lakefront Harbor. The proposed modifications to the west (main) entrance would permit 1,000-foot vessels to use this entrance during relatively calm weather conditions and proposed modifications to the east entrance would permit 1,000-foot vessel operation during storm conditions. The District Engineer also recommended that the existing west breakwater be modified to provide for fishermen access and thus increase the recreational fishing opportunities available for area fishermen. (Note: A detailed summary of the results of the 1972 to 1976 Feasibility Study is provided in Section III of the Main Report, "Formulation of Preliminary Alternative Plans").

Based on the District's 1976 Feasibility Report, this Phase I General Design Memorandum stage of Advanced Engineering and Design was subsequently authorized by Section 175 of the 1976 Water Resources Development Act (Public Law 587, 94th Congress), approved 22 October 1976. The text of this authorization is as follows:

> "Sec. 175. The Secretary of the Army, acting through the Chief of Engineers, is authorized to undertake the phase I design memorandum stage of advanced engineering and design of the project for harbor modification at Cleveland Harbor, Ohio, in accordance with the report of the District Engineer, dated June 1976, at an estimated cost of $500,000. This shall take effect upon submittal to the Secretary of the Army by the Chief of Engineers and notification to Congress of the approval of the Chief of Engineers."

This Phase I study authorization became effective on 26 October 1978, upon notification to Congress of the approval of the District's 1976 Feasibility Report by the Chief of Engineers, as required by the authorizing legislation.

b. Description of Feasibility Study Plan.

The plan, as recommended in the 1976 Feasibility Report, would modify the general navigation features of Cleveland Harbor in the interest of commercial navigation and would provide for increased recreational fishing opportunities at Cleveland Harbor. These proposed modifications, shown on Plate 3 in Appendix I, include:

(1) Extending and deepening lake approach channels at both entrances to the Lakefront Harbor;

(2) Deepening the east basin channel and west (main) entrance;

(3) Removing portions of the west (main) entrance spur breakwaters;

(4) Constructing a breakwater extension on the east end of the existing east breakwater;

(5) Constructing a diked disposal area; and

(6) Installation of recreational fishing facilities on the west breakwater.

c. Items of Local Cooperation in Authorizing Document.

The June 1976 Feasibility Report recommended the above modifications with the provision that non-Federal interests would:

(1) Navigation.

(a) Provide without cost to the United States all lands, easements and rights-of-way required for construction and maintenance of the harbor entrance improvements and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for the disposal of dredged materials resulting from the proposed modifications to the harbor entrance and lakefront channels.

(b) Contribute in cash 25 percent of the first cost of construction of required contained spoil disposal facility. This contribution may be waived by the Secretary of the Army based upon a recommendation by the Administrator of the U. S. Environmental Protection Agency.

(c) Adequately maintain the contained spoil disposal area.

(d) Comply with the applicable provisions of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970," Public Law 91-646, approved 2 January 1971, in acquiring lands, easements and rights-of-way.

(e) Accomplish without cost to the United States all utility and other relocations or alterations made necessary by the project, except for aids to navigation.

(f) Hold and save the United States free from damages due to the construction works, not including damages due to the fault or negligence of the United States or its Contractors.

(g) Provide and maintain without cost to the United States depths in berthing areas and local access channels commensurate with depths provided in related project areas.

(h) Provide without cost to the United States, terminal, transfer and transshipment facilities in the West Basin. Plans and schedules for construction of these facilities must be approved by the Chief of Engineers.

(i) Comply with the provisions of Section 221 of Public Law 91-611, approved 31 December 1970.

(2) Recreational Fishing.

(a) Pay, contribute in kind, or repay (which may be through user fees) with interest, one-half of the cost of modifications necessary to provide for recreational fishing on the breakwater and one-half of the cost of associated access facilities, parking areas and sanitary facilities, the amount involved being currently estimated at about $1.3 million (1) subject to final adjustment after actual costs have beeen determined; and

(b) Bear all costs of maintenance, operation and replacement of the modifications and associated facilities, the amount involved being currently estimated at $4,000 (2) on an average annual basis.

The local cooperator for the navigation project is the Cleveland-Cuyahoga County Port Authority (Cleveland Port Authority) and the local cooperator for the recreational fishing project is the Ohio Department of Natural Resources (ODNR). Correspondence with the Cleveland Port Authority and ODNR, indicating their willingness to provide the local cooperation, is included as Exhibits F-1, F-2 and F-3 in Appendix F, "Pertinent Correspondence." In addition, these two agencies have repeatedly stated their continued interest in providing the required local cooperation at various workshop meetings and during verbal conversations with District personnel.

3. PURPOSE OF REFORMULATION PHASE I GDM STUDY AND THE DRAFT REFORMULATION PHASE I GDM REPORT

a. Reformulation Phase I GDM Study.

Subsequent to completion of the 1976 Feasibility Report, the Buffalo District conducted additional investigations in late 1976. The purpose of these additional investigations was to compare the harbor entrance improvements recommended in the June 1976 Feasibility Report with options for improving only one of the harbor entrances (i.e.; improving either the west

(1) $2,320,320 on October 1983 price levels.

(2) $7,000 on October 1983 price levels.

(main) entrance or the east entrance). Based on the results of these additional investigations, the following conclusions were reached:

(1) Proposed modifications to the east entrance, as an added increment to the basic plan of improving the west (main) entrance, could be economically justified, depending on the choice of wind speed criteria limiting the use of the proposed west (main) entrance. (Note: As previously discussed, the proposed modifications for commercial navigation would permit safe and efficient operation of 1,000-foot bulk cargo vessels in the Lakefront Harbor. These vessels would use the modified west (main) entrance during relatively calm weather conditions and would use the modified east entrance during storm conditions. Depending on the choice of wind speed criteria limiting the use of the west (main) entrance, the east entrance improvements may or may not be incrementally justified.);

(2) If modifications to only one entrance were economically justified, development of the west (main) entrance was the preferred improvement based on the desires of the Lake Carriers Association which represents the majority of the prospective harbor users. However, there was also significant support for modifying the east entrance rather than the west (main) entrance from shipping companies not represented by the Lake Carriers Association and by the U. S. Coast Guard; and

(3) Regardless of which entrance was modified for safe and efficient operation of 1,000-foot vessels, principal navigation interests stated that the channel and breakwater modifications proposed at the west (main) entrance were not totally satisfactory and that the proposed east entrance modifications may not provide the degree of storm protection thought possible during the feasibility study. Therefore, formulation of additional plans would be required before selection of a final harbor modification plan could be made for safe and efficient operation of 1,000-foot vessels. In addition, because of the limited experience with operation of the new generation of 1,000-foot bulk cargo vessels on the Great Lakes, physical modeling of any proposed modification plan would be required.

Based on the results of these additional investigations, the Buffalo District Engineer issued a supplemental recommendation to his basic recommendation contained in the 1976 Feasibility Report. This supplemental recommendation recommended that a Reformulation Phase I GDM study be undertaken with the purpose of developing a final plan for Congressional authorization for construction.

In addition to the need to reformulate Outer Harbor entrance plans for safe and efficient operation of 1,000-foot vessels, several other events have occurred since 1976 which may impact on the economic feasibility of any proposed modification plan. These events include; (1) the closing of the U. S. Steel Corporation blast furnaces on the Cuyahoga River; (2) the construction of a new iron ore transshipment facility at Lorain Harbor, Ohio, by Republic Steel Corporation; (3) the changed position of Jones & Laughlin Steel Corporation in regards to participation in the construction of a new transshipment facility for iron ore in the Lakefront Harbor; and (4) the use of 1,000-foot vessels to transport iron ore to the existing iron ore transshipment facility in the Lakefront Harbor.

The harbor modifications proposed in the 1976 Feasibility Report were developed assuming, among other things, that the three local steel mills in Cleveland would construct a new iron ore transshipment facility in the Lakefront Harbor, capable of receiving iron ore in 1,000-foot vessels, in-lieu-of receiving iron ore directly at their docks adjacent to the Cuyahoga River in less efficient 630-foot vessels. The iron ore delivered to this new transshipment facility would then be transshipped to the three local steel mills by either a conveyor system or by barges. However, US Steel closed their blast furnaces in Cleveland in 1978 and their property is presently up for sale. (Note: US Steel is also considering closing their finishing mill in Cleveland, if operating costs cannot be reduced. This mill receives raw steel from US Steel's plant in Lorain by rail.) Further, Republic Steel constructed a new iron ore transshipment facility at Lorain Harbor to service, among other things, the iron ore requirements of their steel mill in Cleveland. Thus, neither company is interested in developing a new transshipment facility in the Cleveland Lakefront Harbor. Also, J & L Steel has indicated that they are no longer interested in participating in the construction of a new iron ore transshipment facility in Cleveland (see Exhibit F-4 in Appendix F). Thus, no new iron ore transshipment facility will be constructed in the Lakefront Harbor for receipt of iron ore destined for local steel mills in Cleveland. Since benefits resulting from operation of 1,000-foot vessels delivering iron ore to this proposed transshipment facility were used, in part, to economically justify the harbor modifications proposed in the 1976 Feasibility Report, a reanalysis of the economic feasibility of any proposed modification plan, reflecting current conditions, would be required before any such modification plan could be authorized for construction.

In addition to benefits resulting from operation of 1,000-foot vessels delivering iron ore to the assumed new transshipment facility in the Lakefront Harbor, benefits resulting from use of 1,000-foot vessels to deliver iron ore to the existing Conrail iron ore transshipment dock in the Lakefront Harbor were also credited to the harbor modifications proposed in the 1976 Feasibility Report. This existing facility transships iron ore from bulk cargo vessels to inland steel mills in southern Ohio, West Virginia, and Pennsylvania via rail. At the time the feasibility study was conducted, it was the opinion of those involved (ie., Corps of Engineers, harbor users, etc.) that 1,000-foot vessels could not safely operate in the Lakefront Harbor without improvements to one or both harbor entrances. However, based on several sea trails in 1978 and 1979 in which 1,000-foot vessels successfully entered the harbor and unloaded their cargo, 1,000-foot vessels were subsequently placed in regular operation delivering iron ore to the Conrail dock. Thus, although 1,000-foot vessels experience a certain amount of delay time because they cannot enter the harbor during stormy conditions due to the constricted nature of the harbor entrances, as discussed in detail in Section II of the Main Report, benefits resulting from use of 1,000-foot vessels to deliver iron ore to the Conrail dock can no longer be credited to the project, further negatively impacting on the economic feasibility of the plan proposed in the 1976 Feasibility Report.

Therefore, based on the foregoing discussion, the District proposed that a Reformulation Phase I GDM study be undertaken. Approval to conduct a reformulation study was subsequently provided by the Division Engineer, North Central Division, in November 1979.

b. Draft Reformulation Phase I GDM Report (Draft Stage 3 Report).

The purpose of this Stage 3 Report is to present the results of the Stage 3 planning effort to refine and assess the impacts of the alternative plans recommended for additional detailed study at the conclusion of Stage 2 planning (development and analysis of a wide range of preliminary alternative plans). As will be discussed in greater detail in Section III of the Main Report ("Formulation of Preliminary Alternative Plans"), the alternative plans recommended for additional detailed study were Alternative Plan 1 ("Severe-Weather" East Entrance), Alternative Plan 7G (Remove Jefferson Avenue Bridge Abutments), Alternative Plan 11 (Deepen Turning Basin), Alternative Plan 8A (Recreational Breakwater Fishing-Edgewater Marina Breakwater), and Alternative Plan 8B (Recreational Breakwater Fishing-West Breakwater). In addition, as with any potential water resources project, Alternative Plan 10 "No-Action" was also carried forward in the event that more detailed studies showed that no structural and/or nonstructural plan could be implemented because of the absence of engineering, economic, environmental, financial, social, or political viability. Plan 10 was also used as the basis-of-comparison in evaluating the structural plans under consideration. Additional evaluation and assessment of these structural plans, subsequent to completion of Stage 2 studies, indicated that Plans 8A and 8B should also be eliminated from further consideration. Thus, no additonal studies were completed for either Plans 8A or 8B during Stage 3 planning. The rationale for eliminating Plans 8A and 8B from further consideration is discussed in detail in Section IV of the Main Report ("Assessment and Evaluation of Detailed Plans").

At the conclusion of this Draft Stage 3 Report, a tentative recommendation will be made as to whether or not a harbor modification plan should be implemented at Cleveland Harbor. This tentative recommendation will then be coordinated with the general public and affected governmental agencies to ascertain their views. Following completion of this coordination, the final recommendation of this Reformulation Phase I GDM study will be developed.

4. SCOPE OF STUDY

a. General.

As previously discussed, the main thrust of this Reformulation Phase I GDM study is to develop a final plan to modify Cleveland Harbor for safe and efficient operation of 1,000-foot vessels in the Lakefront Harbor. The recreational fishing plan recommended in the 1976 Feasibility Report will also be reevaluated. However, as will be discussed in Section II of the Main Report, "Problem Identification," during coordination of the Plan of Study for this study and subsequent correspondence, local interests expressed the need for futher modifications to the general navigation features of Cleveland Harbor in the interest of commercial navigation. These additional modifications included: (1) deepening the Cuyahoga River such that the depth of the navigation channel would be compatible with the Great Lakes System's draft of 25.5 feet at Low Water Datum (LWD) (NOTE: The Cuyahoga River is presently authorized for a 23-foot project depth and can accommodate a vessel loaded to about 21 feet at LWD. Thus, vessels are forced to lighter (reduce their draft) or come into Cleveland Harbor light-loaded initially before proceeding upriver.); (2) modify the Cuyahoga River navigation channel at various locations where undue vessel delays are encountered due to physical restrictions in the channel; (3) deepening the turning basin on the Cuyahoga River from its existing 18-foot depth to 23 feet LWD in order to permit turning of a fully loaded vessel; and (4) completion of the authorized but uncompleted improvements on the Old River (discussed in greater detail in Section II of the Main Report, "Problem Identification"). Therefore, the orginal scope of this study was expanded to include formulation, assessment and evaluation (both economic and environmental) oi these proposed additional modification plans.

b. Field Investigations.

Several field investigations, as discussed below, were conducted for this Phase I study. These investigations included: (1) a bathymetric survey to establish offshore conditions; (2) a topographic survey to establish onshore conditions; (3) a preliminary real estate appraisal to estimate the value of buildings and lands required for various alternative plans under consideration; and (4) a sediment testing program to determine whether or not dredged material is polluted and thus requires diked disposal.

(1) Bathymetric Survey - A bathymetric survey was undertaken by Buffalo District personnel in the spring of 1978 and supplemented by additional survey work completed in the spring of 1980 and 1982. This information was required in order to estimate the quantity of construction dredging that would be required for various alternatives.

(2) Topographic Survey - A topographic survey of Cuyahoga County was conducted for the Cuyahoga County's Sanitary Engineer in 1978. Although this survey was not conducted for this Phase I study, topographic information from this survey was used to establish ground contours in the study area. This information was required in order to prepare excavation quantity estimates used to determine the construction cost of various alternatives.

(3) Preliminary Real Estate Appraisals - Preliminary real estate appraisals were prepared in the winter of 1981-1982 for plans considered in Stage 2 and in the winter of 1982-1983 for plans considered in Stage 3 by personnel of North Central Division. The purposes of these preliminary real estate appraisals were to estimate: the value of land that would be acquired in fee title for various alternatives; the cost of obtaining temporary construction easements; and the cost of purchasing several buildings that would have to be demolished or relocated for various alternatives. This information was then included in the cost estimates prepared for each alternative. Results of the preliminary real estate appraisal pertinent to the Stage 3 study are presented in Appendix E, "Cost Estimates."

(4) Sediment Testing Program - Sediment sampling and testing in Cleveland Harbor was conducted from 1982 to 1983 as part of the Operations and Maintenance Program for Cleveland Harbor. The purpose of this program was to determine whether or not sediments dredged from the harbor were polluted, and thus require dike disposal, or were unpolluted, and thus suitable for open lake disposal. The limits of this sampling program were extended to include

all sites under consideration in this Phase I study for possible harbor modifications.

Final results of the sediment sampling and testing program are not known at the present time. However, preliminary results indicate that sediments which would be dredged under all alternatives considered in Stage 3 (Plans 1, 7G and 11) are heavily polluted and unsuitable for open-lake disposal. Thus, sediment dredged under these three plans will be disposed of in a dike disposal area. It is anticipated that the sediment sampling and testing program will be finalized in the near future and the final results will be incorporated into the Final Phase I GDM Report at that time.

c. Office Investigations.

Several office investigations, as discussed below, were also conducted for this Phase I study. These studies included: (1) a geotechnical study to evaluate subsurface conditions and their impact on various alternatives; (2) a fishing demand analysis to establish recreational fishing needs in the area; (3) development of a traffic flow computer model to simulate traffic movement on the Cuyahoga River; (4) fleet and tonnage forecasts to project future commodity movements at Cleveland Harbor and the fleet that would carry this future cargo; (5) a wave refraction analysis to establish deep-water wave conditions used for design of the breakwaters for several alternatives; (6) a hydraulic model study of the west (main) entrance to Cleveland Harbor used in formulating various entrance alternatives and assessing their impact on existing wave conditions in the Lakefront Harbor; (7) a literature search of existing fish and wildlife resources data in the study area used to evaluate the environmental impacts of the alternatives; (8) a review of the U. S. Coast Guard accident reports for Cleveland Harbor from 1972 to 1981; (9) an analysis of channel depth requirements for bulk cargo vessels; and (10) a review of available Department of The Army permits and as-built drawings for existing bulkheads along the Cuyahoga and Old Rivers.

(1) Geotechnical Study - A survey was conducted to collect available information on soil and rock data in the Cleveland Harbor area in order to evaluate subsurface conditions and assess their impact on the considered alternatives. Subsurface explorations were available from past studies performed by the Buffalo District. In addition, information was also obtained from public and private offices in the study area. A sediment analysis was also conducted to estimate the increase in maintenance dredging associated with various deepening alternatives. In addition, a preliminary materials survey was conducted to determine the availability of various stone materials required for several alternatives investigated during Stage 2 planning. Additional details on this study are provided in Appendix A, "Geotechnical Design."

(2) Fishing Demand Analysis - Various current and projected economic variables such as income level, household size, and population were assembled and analyzed to forecast existing and future demand for fishing activity days in the Cleveland Harbor area. This demand forecast was then used to size various components (such as needed parking space, restroom facilities, etc.) of the breakwater fishing plans under consideration during Stage 2 planning.

A monetary value for each activity day was also developed. This information was then used to estimate benefits that would result from providing fishermen access to the west breakwater. The results of the fishing demand analysis are discussed in Section II of the Main Report, "Problem Identification".

(3) Traffic Flow Computer Model - A traffic flow computer model was developed by personnel of North Central Division in the spring of 1981. The purpose of this computer model was to simulate traffic flow on the Cuyahoga River for the four main commodities shipped at Cleveland Harbor - iron ore, limestone, sand and gravel, and salt. Included in the computer model were delay times associated with navigating various restricted portions of the navigation channel. By having the computer model assume that these restricted portions of the navigation channel were modified to permit unhindered navigation, the annual savings in vessels transit times could be calculated. These projected annual time savings were then multiplied by the hourly operating cost of the vessels in order to estimate annual benefits that would accrue if these restricted portions of the navigation channel were modified. Additional details on this traffic flow computer model are provided in Appendix B, "Economic Evaluation."

(4) Fleet and Tonnage Forecast - Past commodity movements of iron ore, limestone, sand and gravel, salt, and general cargo at Cleveland Harbor were analyzed in order to establish a historical volume of cargo shipped at Cleveland Harbor. This historical cargo movement was then multiplied by projected growth rates for these commodities in order to estimate future commodity movements at Cleveland Harbor to the year 2040. In addition, the historical fleet composition in use at Cleveland Harbor was also analyzed. Future fleet compositions for various alternatives (including No-Action) were then developed to the year 2040 by changing this historical fleet composition based on such factors as the average age of the present fleet, the trends for new vessel construction on the Great Lakes, and future vessel replacement plans of various shipping companies that call at Cleveland Harbor. These tonnage and fleet forecasts were then used to estimate navigation benefits that would accrue if Cleveland Harbor was modified. The results of these forecasts are presented in Appendix B, "Economic Evaluation."

(5) Wave Refraction Analysis - A wave refraction analysis, which defined the shoreward propagation of the design deep-water waves at Cleveland Harbor, was conducted by personnel of the Corps Waterways Experiment Station. This information was required in order to design breakwaters for various alternatives investigated and to define the deep-water wave at the boundary of the hydraulic model. The results of this refraction analysis are presented in WES Technical Report HL-83-6 Cleveland Harbor, OH, Design for the Safe and Efficient Passage of 1,000-foot-Long Vessels at the West (Main) Entrance Hydraulic Model Investigation, March 1983 (hence referred to as the hydraulic model study report).

(6) Hydraulic Model Study - As previously discussed, during supplemental studies conducted by the Buffalo District subsequent to completion of the 1972-1976 Feasibility Study, local shipping interests stated that physical modeling of any proposed modifications to the west (main) entrance for 1,000-foot vessel operation would be required. The purposes of this physcial

modeling were to determine optimum design for proposed modifications to the west (main) entrance for 1,000-foot vessel operation and to determine resultant wave heights in the Lakefront Harbor as a result of these modifications. Accordingly, the District contracted with the Corps Waterways Experiment Station for the construction of a 1:100 scale hydraulic model of the west (main) entrance to Cleveland Harbor and subsequent model testing. The physical limits of the model and the model layout are shown on Figure 2. Figure 3 is an overhead photograph of the model.

Model construction was completed in January 1979 and model testing was conducted from February 1979 to February 1981. Included in these model tests were ship navigation tests using a remote controlled scale model of a 1,000-foot vessel operated by experienced masters of 1,000-foot vessels. A photograph of this scale model ship is provided in Figure 4. The purpose of these ship navigation tests was to ensure that proposed modifications to the west (main) entrance would provide for safe and efficient operation of 1,000-foot vessels. In addition, during some of the ship navigation tests, an erractic wind field was simulated to qualitatively access the effects winds would have on 1,000-foot vessel operation while entering or leaving a modified west (main) entrance.

Results of the model tests and ship navigation tests are presented in the hydraulic model study report. However, as discussed in Section III of the Main Report, all plans involving modifications to the west (main) entrance were eliminated from further consideration at the conclusion of Stage 2 planning. Since the purpose of this Draft Phase I GDM Report is to present the results of the Stage 3 planning effort, further discussion of the hydraulic model study is not contained herein. For further information on how the model study was used to formulate alternative west (main) entrance modification plans, the reader is referred to the Cleveland Harbor, OH, Stage 2 Report for Reformulation Phase I General Design Memorandum, July 1982 (revised February 1983).

(7) Literature Search - The U. S. Fish and Wildlife Service, under an Interagency Support Agreement with the District, conducted a literature search of available data on fish and wildlife resources in the study area. The information obtained from this literature search was then used to assess the impacts of alternative plans on the existing environment at Cleveland Harbor. Results of this literature search are provided as Exhibit H-3 in Appendix H, "Reports of Others."

(8) Review of U. S. Coast Guard Accident Reports - As will be discussed in Section II of the Main Report, "Problem Identification," shipping interests identified seven locations on the Cuyahoga River where undue vessel delays are encountered due to physical restrictions in the navigation channel. However, these shipping interests did not indicate whether or not any vessel accidents had occurred at these seven locations. Accordingly, District personnel reviewed the accident reports for Cleveland Harbor compiled by the U. S. Coast Guard-9th Coast Guard District for the 10-year period 1972 to 1981. This information was then used to estimate general navigation benefits that would accrue from reduced vessel accidents if these physical channel restrictions were eliminated.

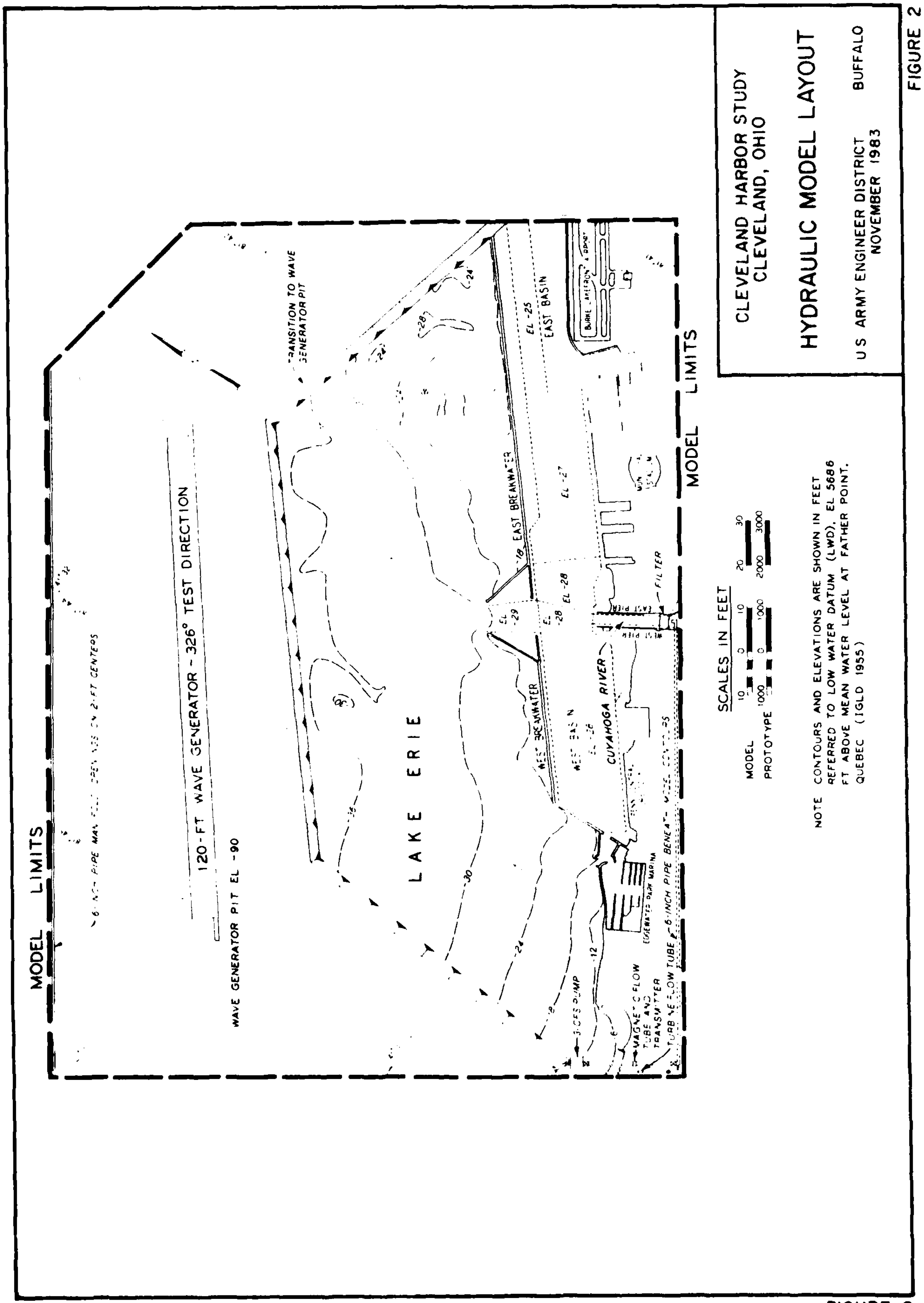

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
HYDRAULIC MODEL LAYOUT
U S ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983
FIGURE 2
MODEL LIMITS
MODEL LIMITS
120-FT WAVE GENERATOR - 326° TEST DIRECTION
WAVE GENERATOR PIT EL -90
TRANSITION TO WAVE GENERATOR PIT
LAKE ERIE
EAST BREAKWATER
WEST BREAKWATER
EAST BASIN
EL -25
EL -27
EL -28
EL -29
CUYAHOGA RIVER
EAST PIER
WEST PIER
FILTER
3-CFS PUMP
SCALES IN FEET
MODEL 10 0 10 20 30
PROTOTYPE 1000 0 1000 2000 3000
NOTE CONTOURS AND ELEVATIONS ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD), EL 568.6 FT ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955)

FIGURE 2

FIGURE 3 OVERHEAD PHOTOGRAPH OF HYDRAULIC MODEL

FIGURE 4 - SCALE MODEL 1000-FOOT VESSEL

(9) Analysis of Channel Depth Requirements - As will be discussed in Section II of the Main Report, "Problem Identification," the Cuyahoga and Old River navigation channels at Cleveland Harbor do not provide adequate channel depths for most bulk cargo vessels. Thus, vessels are forced to navigate light-loaded (i.e., at less than the maximum system's draft of 25.5 feet at LWD), resulting in increased transportation costs. In addition, several alternatives were developed that would permit vessels up to 1,000 feet in length to enter the Lakefront Harbor under storm conditions. These plans required, among other things, that harbor entrance and interior channels be deepened.

As part of this Phase I study, an analysis of channel depth requirements for bulk cargo vessels was undertaken. Five factors were evaluated: static draft; squat; roll; pitch and heave; and underkeel clearance. As part of the evaluation, vessel motion tests were also conducted at the Corps Waterways Experiment Station with the scale model 1,000-foot vessel (see Figure 4) in April 1983. The purpose of these vessel motion tests was to determine the degree 1,000-foot vessels roll or pitch and heave under various weather conditions in a shallow water environment (ie., a harbor entrance channel). The tests also qualitatively assessed the effect of various underkeel clearances on vessel maneuverability. The resulting required channel depths were then incorporated into several harbor modification plans which involved channel deepening. Results of this analysis are discussed in Sections II and IV of the Main Report and in Appendix C, "Coastal Engineering Design." Results of the vessel motion tests are provided as Exhibits H-1 and H-2 in Appendix H, "Reports of Others".

(10) Review of Department of The Army Permits - As will be discussed in Section II of the Main Report, "Problem Identification," shipping interests indicated a need to study the feasibility of deepening the navigation channels at Cleveland Harbor. This proposed deepening would make the depth of the navigation channels compatible with the maximum Great Lakes System's Draft of 25.5 feet at LWD.

As part of the study of deepening the navigation channels, the effect this deepening would have on the stability of the existing bulkheads was analyzed (i. e. whether deepening the navigation channels would cause failure of the existing bulkheads). Basic data on the construction of the existing bulkheads was obtained primarily from Department of the Army Permits for these bulkheads, when available. This information was supplemented with a limited number of as-built drawings supplied by the owners. (NOTE: Permit information was available for about 40 percent of the existing bulkheads on the Cuyahoga River and for about 25 percent of the existing bulkheads on the Old River. The stability analysis was therefore conducted on the bulkheads for which permit information was available and based on the indicated percentages, the results were expanded to cover the remaining bulkheads for which permit information was not available). When the analysis indicated that deepening would cause failure of the existing bulkheads, replacement of these bulkheads was included as a plan component of the alternative and its cost was included in the cost estimate of the alternative. Additional details on this analysis are provided in Appendix D, "Design."

5. STUDY PARTICIPANTS AND COORDINATION

a. Public Involvement.

On 19 April 1983, a public meeting was held in Cleveland, OH, to present the results of the Stage 2 planning effort and to solicit comments and information from the general public. Comments made at this meeting, with the exception of those that requested additional clarification of study results, indicated strong support for continuation of the study into Stage 3. A copy of the public meeting announcement, along with the information packet on the Cleveland Harbor Stage 2 study and the public responses received, are provided in the Record of Public Meeting on Cleveland Harbor, OH, Reformulation Phase I General Design Memorandum Study on file at the Cleveland Public Library.

Both the completed Plan of Study and Stage 2 Report for this Phase I study were distributed to the political leaders in the area and to various local, State, and Federal agencies for their review and comment. Loan copies of the reports were also supplied to local libraries for review by the general public and various civic groups. In addition, until the supply was exhausted, personal copies of the report were made available to study participants free of charge. With the exception of requests for additional copies, no comments were received on either report.

Following approval of this Draft Stage 3 Report, a public meeting will be held in Cleveland, OH. The purposes of this meeting will be to present the results of the Stage 3 investigation and to solicit public comment. All comments made at this meeting will be given equal consideration in developing the final recommendation of this Phase I study.

b. Pre-Phase I GDM Coordination.

Prior to initiation of this Phase I study, the Buffalo District met with local interests, including the Cleveland Port Authority, the Lake Carriers Association, various shipping companys, Consolidated Rail Corporation (Conrail), various dock operators, the U. S. Coast Guard and technical advisors (University of Michigan and the Corps Coastal Engineering Research Center and Waterways Experiment Station), on 19 and 20 July 1977. The purposes of these workshops meetings were to discuss and define criteria for the design of harbor entrance improvment plans for 1,000-foot vessel operation, to establish a range of harbor entrance alternatives which should be investigated during the Phase I study and to discuss physical modeling of the proposed harbor modifications. Local interests expressed a preference for an east entrance-west exit concept for operation of 1,000-foot vesels in the Lakefront Harbor similar to the plan developed during the 1972-1976 Feasibility Study with emphasis on early construction of the east entrance component of the project plan. This position was consistent with Congressional attempts at that time to authorize the east entrance component of the project plan for construction. Early construction of the east entrance component would have accomodated Republic Steel's proposed plan to construct a new iron ore transshipment facility in the Lakefront Harbor which would accommodate receipt of iron ore in 1,000-foot vessels. (Note: As previously discussed, this proposed transshipment facility was subsequently constructed at Lorain Harbor, OH). In addition, it was decided to eliminate the proposed breakwater extension at the east end of the east breakwater from the project plan since shipping companies stated that, although it would be nice to have, it was not absolutely necessary for safe and efficient operation of 1,000-foot vessels. Minutes of these two workshop meetings are provided in the Classification Report and Plan of Study for Cleveland Harbor, OH, February 1979 (revised October 1979).

c. Coordination during Preparation of the Plan of Study.

During preparation of the Plan of Study for this Phase I study several meetings were held with local interests to obtain their views on how the study should be conducted and the alternatives that should be investigated. Minutes of these workshop meetings are included in the Plan of Study. A summary of the results of these workshop meetings follows.

The initial workshop meeting was held on 12 January 1979, with the Lake Carriers Association, various shipping companies, Conrail, the Greater Cleveland Growth Association and the Cleveland Port Authority. At this meeting, participants stated that there was now no need for early construction of the east entrance component of the project plan due to construction of Republic Steel's new iron ore transshipment facility in Lorain Harbor instead of at Cleveland Harbor. The participants also stated their preference for a total study of all alternatives in order to develop the best long range plan. However, there was a difference of opinion on which entrance (i.e. west (main) or east entrance) should be developed for 1,000-foot vessel operation, if only one entrance could be economically justified.

The second workshop meeting was also held on 12 January 1979, with officials of the city of Cleveland. At this meeting, city officials stated that the city had no official Lakefront development plan. However, expansion of Burke Lakefront Airport was under consideration. This proposed expansion would include construction of new land fill areas in the Lakefront Harbor immediately east and north of the existing airport and the city would be interested in using any dredged material from the harbor modification plan for this land-fill area. They also stated their support for expansion and upgrading of Conrail's existing iron ore transshipment facility adjacent to the west basin of the Lakefront Harbor. (NOTE: Conrail presently owns and operates an iron ore transshipment facility adjacent to the west basin of the Lakefront Harbor (see Plate 1 in Appendix I). Iron ore is received at this dock in bulk cargo vessels and is transferred to railroad cars for delivery to inland steel mills located in southern Ohio, West Virginia, and Pennsylvania. During the 1972-1976 Feasibility Study, it was assumed that this transshipment facility would be upgraded and expanded since the existing facility is in a state of disrepair and could not economically handle the forecasted increase in iron ore tonnage that would be required by the steel mills presently served by this facility. The assummed expansion/upgrading of this facility was in addition to the assumption that the three local steel mills would construct an additional transshipment facility, as previously discussed, in the Lakefront Harbor for receipt of iron ore destined for upriver steel mills in Cleveland. Thus, it was assumed during the Feasibility Study that there would be two iron ore transshipment facilities in the Lakefront Harbor).

A third workshop meeting was held on 25 January 1979, with the Cleveland Port Authority. At this meeting the Cleveland Port Authority stated that they continued to support the development of a new iron ore transshipment facility at their Dock 20-24 area and were coordinating with prospective users. They also stated their preference for an east entrance plan in-lieu-of modifying the west (main) entrance for 1,000-foot vessel operation and restated their previous commitment to act as the project's local sponsor.

The fourth workshop meeting was held on 1 February 1979 with Conrail. At this meeting Conrail stated that they were very interested in upgrading/expanding their existing iron ore transshipment facility in the Lakefront Harbor and were in the process of hiring a consultant to conduct a feasibility study. In addition, Conrail stated that their iron ore dock on the Old River (Erie Ore Dock) was permanently closed down. Further, Conrail stated that railroad companies have previously studied the economic feasibility of unit train movements of iron ore directly from the Mesabi iron ore range to consuming steel mills but they have concluded that it was not economically competitive with water movement.

The final workshop meeting conducted during preparation of the Plan of Study was on 28 March 1979 with State and local agencies, the U. S. Coast Guard and industry representatives. At this meeting, study participants expressed their support for an east entrance plan for 1,000-foot vessel operation. The Ohio Department of Natural Resources also stated that, although their Lakefront recreational plan proposes an island development in the east basin which could conflict with an east entrance modification plan for commercial navigation, they expect to modify the plan in the near future to eliminate this potential conflict.

d. Coordination With Harbor Users.

During the course of this Phase I study, several workshop meetings were held with industry representatives. The first workshop meeting was held on 14 March 1979 with experienced vessel masters of 1,000-foot vessels representing various shipping companies using Cleveland Harbor. At this meeting, vessel masters expressed their unaminous preference for an east entrance plan for 1,000-foot vessel operation with minor changes to the west entrance to facilitate vessel egress. The vessel masters also agreed that the proposed breakwater extension at the east end of the east breakwater in the project plan recommended in the 1976 Feasibility Report was not required. In addition, the vessel masters discussed various operating characteristics of 1,000-foot vessels and proposed tentative channel dimensions for the east entrance plan. Summary minutes of this workshop meeting are provided as Exhibit G-1 in Apendix G, " Public Involvement."

A second workshop meeting was held with vessel masters on 8 April 1981. At this meeting vessel masters developed several preliminary concepts to modify the west (main) entrance for 1,000-foot vessel operation during storm conditions. These preliminary concepts were then tested in the hydraulic model at WES to ensure that the design criteria, also established by the vessel masters at this workshop meeting, were met. The vessel masters also defined "fair-weather" and "all-weather" weather conditions for 1,000-foot vessel operation, established channel depth requirements for 1,000-foot vessels during both fair and stormy weather conditions, and reviewed the "all-weather" east entrance plan and a "fair-weather" west entrance plan which were developed by the Buffalo District. The vessel masters again expressed their preference for the proposed east entrance plan. Minutes of this workshop meeting are provided as Exhibit G-2 in Appendix G.

A third workshop meeting was held with vessel masters on 29 and 30 October 1981 at the Corps Waterways Experiment Station. At this workshop meeting vessel masters conducted ship navigation tests on the "all-weather" west entrance plan developed at the 8 April 1981 workshop meeting, modified by WES personnel in order to meet design criteria also established at this workshop meeting. As a result of these ship navigation tests, an additional "all-weather" west entrance plan was formulated and model tested to eliminate the problem the vessel masters had with the previous plan when entering the harbor when winds were from the north-northeast. Summary minutes of this workshop meeting are provided as Exhibit G-3 in Appendix G.

A fourth workshop meeting was held on 16 February 1982 with Ontario Stone Corporation, the new owner of the former Erie Ore Dock on the Old River. At this workshop meeting Ontario Stone indicated their short range plans for operation of their new dock. They also indicated that they were in the preliminary stages of discussions with a company interested in exporting approximately 2,000,000 tons of coal per year from their new dock. However, since they were still in preliminary discussions, no firm commitment for this activity could be made at that time. In addition, Ontario Stone indicated that if authorized but uncompleted improvements on the Old River were implemented, they would transfer stone receipts (approximately 1,000,000 tons per year) from their Cuyahoga River dock that they presently use to their new Old River dock in order to take advantage of the potential transportation savings that these improvements would permit. Summary minutes of this workshop meeting are provided as Exhibit G-4 in Appendix G.

The fifth workshop meeting was held on 4 May 1982. In attendance were representatives of the Lake Carriers Association, various shipping companies, various dock owners, the Chessie System, the U. S. Coast Guard, the U. S. Fish and Wildlife Service, the city of Cleveland, the Cleveland Port Authority, and the Ohio Department of Natural Resources. At this meeting, the Buffalo District presented the results of the Stage 2 planning effort for commercial navigation and solicited comments from meeting participants. In addition, a consensus of opinions was reached on which commercial navigation alternatives to carry forward into Stage 3 planning and which alternatives to eliminate from further consideration. Summary minutes of this workshop meeting are provided as Exhibit G-5 in Appendix G.

The final workshop meeting was held on 24 February 1983. In attendance were representatives of the Lake Carriers Association, various shipping companies, the Lakes Pilots Association, the Cleveland Port Authority, the Ohio Department of Natural Resources, representative of Congresswoman Mary Rose Oakar's office, the Maritime Administration, and the U.S. Coast Guard. At this workshop meeting, storm delays and vessel transit delays that vessel operators currently experience when attempting to enter Cleveland Harbor, but which would be eliminated if the east entrance was modified, were discussed. Summary Minutes of this workshop meeting are provided as Exhibit G-6 in Appendix G.

In addition to the workshop meetings held with harbor users as previously discussed, two sets of questionnaires were also sent to harbor users to obtain their input in formulating alternative plans and to ensure that navigation benefits that would accrue due to the alternative plans were accurately estimated. The first questionnaire was sent to shipping companies who regularly use Cleveland Harbor. The questionnaire requested their response to questions dealing with: (1) modifications to the harbor entrances and Lakefront Harbor for safe and efficient operation of 1,000-foot vessels; (2) modifications to the Cuyahoga and Old River navigation channels in order to reduce vessel delay; (3) deepening of the Cuyahoga River navigation channel; and (4) authorized but uncompleted improvements on the Old River. Results of this questionnaire are discussed in Section II of the Main Report, "Problem Identification."

The second questionnaire was sent to dock operators at Cleveland Harbor and requested that they confirm records of historical commodity movements at their docks for the 10-year period 1969 to 1978. They were also requested to project future anticipated commodity movements at their docks. This information was then used in developing historical and future commodity movements at Cleveland Harbor, as discussed in subsequent sections of the Main Report.

e. Coordination With the Cleveland-Cuyahoga County Port Authority.

The local sponsor for the navigation project is the Cleveland Port Authority. As such, the Cleveland Port Authority attended and participated in the pre-Phase I coordination meetings, a majority of the workshop meetings held during preparation of the Plan of Study and the 8 April 1981, the 29 and 30 October 1981, the 4 May 1982, and the 24 February 1983 workshop meetings previously discussed. They also met with the Buffalo District on 26 February 1980. At this meeting, the Cleveland Port Authority again expressed their support for an east entrance plan for 1,000-foot vessel operation. They also indicated that they would attempt to develop a unified position from the harbor users as to which entrance to modify for 1,000-foot vessel operation. However, as will be discussed in Section II of the Main Report, "Problem Identification," they were unsuccessful in this attempt. Summary minutes of this workshop meeting are provided as Exhibit G-7 in Appendix G.

In addition to the coordination required for this Phase I study, the Buffalo District also provided input into the Cleveland Port Authority's harbor development study conducted in 1981 by the engineering firm of Tippetts-

Abbett-McCarthy-Stratton. This harbor development plan will be discussed in greater detail in Section III of the Main Report, "Formulation of Preliminary Alternative Plans."

f. Coordination With the City of Cleveland.

In addition to participating in the 12 January 1979 workshop meeting conducted during preparation of the Plan of Study, officials of the city of Cleveland attended and participated in the 14 March 1979, 8 April 1981, and the 4 May 1982 workshop meetings. At these workshop meetings, city officials discussed their proposed plans to expand Burke Lakefront Airport and stated their interest in using dredged material from any proposed improvement plan to construct additional land fill areas required by this proposed expansion. Additional coordination with the city of Cleveland on this aspect was conducted during Stage 3 planning. Although the city of Cleveland is interested in using dredged material for the proposed improvements, there are no current plans to expand Burke Lakefront Airport prior to 1985. Expansion plans subsequent to this date are also uncertain. It was, therefore, agreed to assume dredged material from proposed improvements would be placed in Dike Site 14 for this Phase I study. However, prior to actual construction, additional coordination with the city of Cleveland on this aspect will be conducted to ascertain the current status of plans to expand Burke Lakefront Airport.

g. Coordination With the U. S. Coast Guard.

In addition to attending and participating in the 19 and 20 July 1977, the 28 March 1979, the 4 May 1982 and the 24 February 1983 workshop meetings, the U. S. Coast Guard, 9th Coast Guard District, met with the Buffalo District on 16 September 1981. At this workshop meeting, the Coast Guard defined the aids to navigation that would be required for various Lakefront Harbor modification plans under consideration and estimated their initial construction costs and additional annual maintenance costs. The Coast Guard also provided the same information for an additional Lakefront Harbor modification plan developed subsequent to the 16 September 1981 workshop meeting via telephone conversation on 23 December 1981. Summary minutes of the 16 September 1981 workshop meeting are provided as Exhibit G-8 in Appendix G.

h. Coordination With the Ohio Department of Natural Resources.

As previously discussed, the local sponsor for the proposed recreational fishing project is the Ohio Department of Natural Resources (ODNR). As such, ODNR attended the 15 March 1982 workshop meeting on recreational fishing. At this meeting, it was decided to develop two recreational fishing plans to provide fishermen access to the west breakwater. These two plans would differ from each other depending on the type of improvements made at Edgewater Marina, the small-boat marina immediately west of Cleveland Harbor (see Plate 1 in Appendix I). The first plan assumed the existing entrance to Edgewater Marina is completely blocked off with a new breakwater and that a new entrance would be provided into the west basin of the Cleveland Lakefront Harbor. Small boats would use this new entrance to enter the west basin and would then continue into Edgewater Marina through the existing gap in the west breakwater. The second recreational fishing plan that was developed assumed that the existing entrance to Edgewater Marina is only slightly modified to reduce wave energy entering the marina and continues to serve as the main entrance to Edgewater Marina. However, selection of the plan to recommend for construction, if economically justified, would await the results of the Section 107 Study for Edgewater Marina. Summary minutes of the 15 March 1982 workshop meeting are provided as Exhibit G-9 in Appendix G.

Personnel of ODNR also attended the 28 March 1979, the 4 May 1982 and the 24 February 1983 workshop meetings. At these meetings, ODNR assessed the impact of various commercial navigation alternative plans on their proposed Cleveland Lakefront State Park master plan. This master plan will be discussed in Section III of the Main Report.

i. Coordination With the U. S. Fish and Wildlife Service.

The U. S. Fish and Wildlife Service, Columbus Field Office, provided the Buffalo District with a "Planning Aid Letter" and an Intermediate Report during Stage 2 planning (Exhibits H-3 and H-4 in Appendix H, respectively). In their "Planning Aid Letter," the Fish and Wildlife Service documented the results of their literature search conducted to summarize existing data on the fish and wildlife resources in the study area. In their Intermediate Report (Exhibit H-4), the Fish and Wildlife Service expressed their support for carrying forward various alternative plans into Stage 3 planning and discussed the need to investigate measures to mitigate for adverse environmental impacts of the alternatives.

During Stage 3 planning, the Fish and Wildlife Service provided the Buffalo District with a supplement to their original Planning Aid Letter documenting the results of a cursory fish survey they conducted in 1982 in the vicinity of the Jefferson Avenue bridge abutments at river mile 4.3 (see Exhibit H-5). They also provided the district with a Draft Fish and Wildlife Coordination Act Report outlining the major impacts of the alternatives studied in Stage 3 on fish and wildlife resources in the study area and setting forth their recommendations in regards to these plans (see Exhibit H-6).

The Fish and Wildlife Service also attended and participated in the 15 March 1982 and 4 May 1982 workshop meetings. At the 15 March 1982 workshop meeting they assisted in formulating recreational fishing plans and reviewed the need for developing additional fish habitat areas on the lakeward side of the breakwaters at Cleveland Harbor. At the 4 May 1982 workshop meeting, they assisted in the selection of the commercial navigation alternatives to be carried forward into Stage 3 planning. Minutes of these two workshop meetings are provided as Exhibits G-9 and G-5 in Appendix G, respectively.

j. Cultural Resources Coordination.

By letter dated 13 October 1981 to the Western Reserve Historical Society, the Buffalo District requested information on the eligibility of the lighthouse at the lakeward end of the west arrowhead breakwater at Cleveland Harbor for nomination to the National Register of Historic Places. Mr. Eric Johannesen, Preservation Officer, replied by letter dated 15 October 1981

(Exhibit F-5a in Appendix F) that the lighthouse was included in a thematic resource nomination to the National Register submitted in August 1980. However, he did not know if the lighthouse was subsequently listed.

By letter dated 25 February 1982, the Buffalo District also requested information on the impacts of alternatives developed during Stage 2 planning on cultural resources in the study area. This letter was sent to the National Park Service and the Ohio Historic Preservation Office. By letter dated 2 March 1982 (Exhibit F-5b in Appendix F), the National Park Service replied that with the exception of the lighthouse on the west arrowhead breakwater, they were not aware of any significant cultural resources that would be affected by the alternatives. The Ohio Historic Preservation Office replied by letter dated 17 March 1982 (Exhibit F-5c) that the lighthouse on the west arrowhead breakwater should be considered eligible for the National Register of Historic Places and that a Preliminary Case Report would have to be prepared if a plan that affected this lighthouse was recommended for construction. They also listed properties eligible for or presently on the National Register that may be affected by various Cuyahoga and Old River navigation alternatives under consideration.

Additional coordination with the National Park Service and the Ohio Historic Preservation Office was conducted during Stage 3 regarding the potential impacts of the alternatives being considered further (Plans 1, 7G, and 11) on significant cultural resources in the study area. By letter dated 27 June 1983 (Exhibit F-5d), the National Park Service stated that the alternatives under consideration would have no effect on known significant cultural resources in the study area. The Ohio Historic Preservation Office provided a similar response by letter dated 8 July 1983 (Exhibit F-5e).

k. Model Study Coordination.

As previously discussed, a hydraulic model study of the west (main) entrance to Cleveland Harbor was conducted by the Corps Waterways Experiment Station. The purposes of this model study were to determine optimum designs for proposed modifications to the west (main) entrance for 1,000-foot vessel operation and to determine resultant wave heights in the Lakefront Harbor as a result of these modifications. Approval to conduct this hydraulic model study was provided by the Office of the Chief of Engineers by letter dated 24 January 1978.

Throughout the course of the model study, study participants were kept informed on the results of the model tests through verbal conversations, site visits to WES, and discussions and movies presented at the 8 April 1981 and 4 May 1982 workshop meetings. Study participants were also provided with either a copy of the model study report or the location of the library where the report was available for public review.

l. Preliminary Coordination of the Draft Supplement to the Final Environmental Impact Statement

A Notice of Intent to prepare a Draft Supplement to the Final Environmental Impact Statement (EIS) was published in the Federal Register on 29 March 1983. The purpose of the supplement is to update the Fianl EIS prepared in conjunction with the 1976 Feasibility Report by describing the resultant environmental impacts of the currently proposed plan which differs from the plans analyzed in the original EIS. By separate correspondence to concerned agencies, the Buffalo District also requested comments regarding the significant issues that should be addressed in the Draft Supplement.

Several responses were received as a result of this request. By letter dated 3 June 1983 (Exhibit F-6 in Appendix F), the Ohio Department of Natural Resources expressed concern over possible increases in wave induced storm damages as a result of modifying the east entrance. The U.S. Environmental Protection Agency (EPA), in their letter of 1 June 1983 (Exhibit F-7), identified three issues which they suggested be addressed: the effects of dredging and disposal of harbor sediments; the project effects on water quality due to ship movements; and the potential for enhancement of fish habitat. The issues raised by both agencies are addressed in the Draft Supplement. An additional response was received from the Cleveland City Planning Commission (Exhibit F-8) expressing their concern over elimination of the recreational fishing plans (Plans 8A and 8B) from further consideration during the initial stage of Stage 3 planning. By letter dated 7 June 1983 (Exhibit F-9) the District responded to their concerns. The rationale for eliminating these plans from further consideration is also discussed in detail in Section IV of the Main Report - "Assessment and Evaluation of Detailed Plans".

6. THE REPORT

The overall organization of this report consists of a Main Report, a series of Technical Appendices (Appendices A through E), a Pertinent Correspondence Appendix (Appendix F), a Public Involvement Appendix (Appendix G), Reports of Others Appendix (Appendix H), and a Plate Appendix (Appendix I). The Main Report is written to give both the general and technical reader a clear understanding of the study, the study results, and the key decisions and conclusions. The Main Report also includes the Draft Supplement to the Final Environmental Impact Statement prepared for this project. The Technical Appendices provide additional detailed information on the design, costs and benefits of the alternatives studied. The Pertinent Correspondence Appendix includes copies of pertinent correspondence with organizations and individuals, significant in the development of this Phase I study. The Public Involvement Appendix includes minutes of the workshop meetings conducted during the course of this study. Reports of Others (Appendix H) includes the reports documenting the results of the vessel motion tests conducted at the Corps Waterways Experiment Station and the reports of the U.S. Fish and Wildlife Service. The Plate Appendix includes all the plates developed for the Main Report for easy reference.

7. PRIOR STUDIES AND REPORTS

a. Cleveland Harbor Area.

Many studies of the water resources problems and needs in the Cleveland Harbor area have been made by the Corps of Engineers. The following is a summary of the various reports pertinent to this Cleveland Harbor Phase I study:

(1) Beginning in 1914, there have been 14 Corps of Engineers reports that address improvements to, and modification of, the Cleveland Harbor commercial navigation project. A summary of these reports, including the 1976 Feasibility Report, is provided in Table 1.

(2) In response to U.S. House of Representative's Committee resolutions of 28 December 1946 and 9 June 1960, the Buffalo District prepared a report entitled Review of Reports for Flood Control and Allied Purposes, Cuyahoga River, OH (1 September 1969) recommending:

(a) Improvements for flood control and streambank erosion in the 9-mile reach of the Cuyahoga River between the Harvard-Dension Bridge (approximate river-mile 7) and the mouth of Tinkers Creek (approximate river-mile 16).

(b) Construction of a sediment settling basin in the vicinity of river mile 8.0 (approximately 2 miles upstream from the head of commercial navigation) in the interest of commercial navigation, pollution abatement, and Lake Erie restoration.

The report was returned to the Buffalo District in June 1970 as the necessary local assurances were not furnished to cover the cost-sharing requirements for a cash contribution in return for windfall benefits. For this reason, and because subsequent legislation for the Cuyahoga River Restoration Study under Section 108 of the 1970 River and Harbor Act provided for expanded study scope, no further action was taken on the 1969 Review of Reports.

(3) Section 108 of the River and Harbor Act of 1970 authorized the Chief of Engineers to study and undertake measures in the interest of water quality, environmental quality, recreation, fish and wildlife and flood control for the Cuyahoga River basin, OH. To date, three Interim Reports have been completed under the resulting Cuyahoga River Restoration Study. The First Interim Report (September 1971) presented the scope of the longer-term Framework Plan plus an Early-Action Program for the Cuyahoga River Restoration Study. The Framework Plan presented a description of the basin's resource problems and needs and possible alternative means of dealing with these problems and needs. Sources of pollution and other degradable conditions were sought out and identified. Current pollution abatement programs were inventoried to determine their effects on pollution. The Early-Action Program consisted of four action programs that were considered compatible with the overall framework plan and which could be constructed or accomplished without additional study. Big Creek, an Early-Action flood control project, is in the final plans and specification stage.

Table 1 - Prior Corps of Engineers Reports for Cleveland Harbor

Year of Report	Work Considered	Congressional Document	Recommendation	Action by Congress (1)
1914	Elimination of bends in Cuyahoga River.	H. Doc. 707, 63rd Cong., 2nd sess.	Partly Unfavorable (2)	8 Aug 1917 Rivers and Habors Act
1932	Dredging in outer harbor to 25 feet, constructing spur breakwater, removing part of old breakwater, abandoning 932 feet, thereof, and eliminating from project 298 feet of the shoreward extension of west pier.	H. Doc. 477 72nd Cong., 2nd sess.	Favorable	30 Aug 1935 Rivers and Harbors Act
1935	Emergency dredging in Cuyahoga and Old Rivers for 1 year only.	Rivers & Harbors Committee Doc. 84, 74th Cong., 1st sess.	Favorable	30 Aug 1935 Rivers and Harbors Act
1936	Maintenance and improvement of Cuyahoga and Old Rivers to a depth of 21 feet, and 18 feet turning basin and bank cuts 1-9.	Rivers & Harbors Committee Doc. 84, 74th Cong., 1st sess.	Favorable	26 Aug 1937 Rivers and Harbors Act
1939	Turning basin and channel extension to Harvard-Dension Vaiduct.	H. Doc. 232, 76th Cong., 1st sess.	Partly Favorable (3)	2 Mar 1945 Rivers and Harbors Act
1942	1,300-foot channel extension.	H. Doc. 95, 79th Cong., 1st sess.	Favorable	2 Mar 1945 Rivers and Harbors Act
1942	Flood control.	Preliminary examination.	Unfavorable	20 Apr 1943 (4)
1946	Elimination of turning basin, deepening from 21 feet to 23 feet in Cuyahoga and Old Rivers, Federal participation in replacement or pier reconstruction of 7 railroad bridges and bank cut 10.	H. Doc. 629, 79th Cong., 2nd sess.	Favorable	24 Jul 1946 Rivers and Harbors Act
1957	Deepening east basin of outer harbor to a depth of 25 feet, replacement of 2 railroad bridges and 1 highway bridge, bank cuts 11-15 and elimination of pier reconstruction for one railroad bridge.	H. Doc. 107, 85th Cong., 1st. sess.	Favorable	3 Jul 1958 Rivers and Harbors Act

(1) Act authorizing a recommended improvement.
(2) Recommended Federal dredging, not exceeding $400,000 in any official plan adopted by the city.
(3) Unfavorable to channel extension.
(4) Date of submission to Congress.

Table 1 - Prior Corps of Engineers Reports for Cleveland Harbor (Cont'd)

Year of Report	Work Considered	Congressional Document	Recommendation	Action by Congress (1)
1958	Deepening lake approach entrance channel, to 29 feet, west basin and west end of east basin to 28 feet, lower Cuyahoga River to junction with Old River and Old River to upstream limit of 23-foot project to 27 feet.	H. Doc. 152, 86th Cong., 1st sess.	Favorable	14 Jul 1960 Rivers and Habor Act
1961	Deepening an area extended easterly about 3,800 feet from the existing 28-foot project area and southerly from the existing maintenance limit on the north to a limit 75 feet north of the harbor line on the south, 27 feet deep easterly of a line 800 feet east of the west end of the east breakwater and 28 feet deep westerly of that line. Dredging a dock approach channel to the Nicholson Cleveland Terminal Company pier, 25 feet deep, from the 25-foot depth contour to a limit 75 feet north of the pierhead line, 400 feet ft. wide at the shore ward end and flared toward the lake.	H. Doc. 527, 87th Cong., 2d sess.	Favorable	23 Oct 1962 Rivers and Habor Act
1966	Deepening Old River to 27 feet, from the present upstream limit of authorized deepening to 27 feet to the head navigation thereon.	Not Applicable	Favorable	(5)
1976	Deepening and widening east entrance to 32 feet, deepening east basin channel to 28 feet, removing portion of spur breakwaters at west (main) entrance and improvements for recreational fishing.	H. Doc. 24, 96th Cong., 1st Sess.	Favorable	1976 Water Resoruces Development Act (6)
1977	Removal of Jefferson Avenue Bridge abutments.	Not Applicable	Unfavorable	(5)

(5) Authority: Section 107 of the 1960 River and Harbor Act.
(6) Authorized Phase I GDM.

In Addition to the above, the River and Harbor Act of 13 June 1902 states: "The Secretary of War may, in his discretion, dredge to a depth of twenty-five feet (23 feet referred to low-water datum) in any portion of said (Cleveland) Harbor."

The Second Interim Report (March 1976) identified the significant flooding problems within the Cuyahoga River Basin and developed corrective plans for these problems. In the report, it was concluded that flood control correction plans could not be economically justified (excluding the Big Creek improvements). Further, it was recommended that, in general, the affected communities implement flood plain management programs to prevent increased flood damages.

The Third Interim Report (November 1979, revised April 1981) investigated the erosion and sedimentation problems in the Cuyahoga River Basin. In this report it was concluded that streambank erosion was a minor contributor (approximately 5 percent) to the Cuyahoga River sediment load and that streambank erosion control plans were not economically feasible. Further, it was also concluded that upland (sheet and rill) erosion contributes significantly to the Cuyahoga River sediment load (approximately 50 percent) and recommended that local interests implement land management programs to control this erosion.

(4) In August 1973, the Buffalo District completed the Wastewater Management Study for Cleveland-Akron Metropolitan and Three Rivers Watershed Area which evaluated alternative plans for water quality improvement in the Cuyahoga, Chargin and Rocky River watersheds and receiving Lake Erie by treatment of municipal and industrial waste-waters and urban storm runoff. The findings of this study, which identified four alternative land and water-oriented methods for wastewater treatment, along with the findings of similar studies conducted by the Corps of Engineers in five other areas, were submitted to both houses of Congress by the Secretary of the Army (SOA) by letter dated 28 April 1978. No recommendation for program implementation was provided by the SOA.

(5) In May 1982, a Detailed Project Report was initiated for Edgewater Marina under authority of Section 107 of the 1970 River and Harbor Act. The purposes of this study are to determine the economic and environmental feasibility of modifying Edgewater Marina for wave reduction in the existing small-boat docking area and for expansion of this small-boat docking area. Based on results of the preliminary study completed in the summer of 1983, a plan to modify the existing entrance and breakwater system was selected as the "Candidate Selected Plan" for final detailed studies. Additional information on this plan is provided in Section IV of the Main Report, "Assessment and Evaluation of Detailed Plans". The study is currently scheduled for completion in 1984 with construction to follow in 1985.

(6) In partial response to Section 6 of Public Law 79-14, approved 2 March 1945, the Buffalo District initiated the Lake Erie Coast-Cleveland Interim Feasibility Study in 1979. The purposes of this study are to define the recreational small-boat needs in the Cleveland Harbor area and to determine if plans addressing these needs are economically and environmentally justified. Stage 1 planning for this Interim was started in 1979 and concentrated on two areas for future modifications and/or expansion: (1) the existing East 55th Street Marina in the east basin of Cleveland Harbor (see Plate 1 in Appendix I); and (2) at the upstream end of the Old River. However, planning is currently suspended, pending receipt of additional funding to complete the Interim Study.

(7) By letter dated 9 April 1975, the Mayor of the village of Bratenahl, located immediately east of Cleveland Harbor, stated that lakefront properties in the village were experiencing considerable beach starvation and shoreline erosion. The Mayor also expressed his concern that the Cleveland Harbor breakwaters were a significant contributing factor to this degrading condition. Accordingly, the Buffalo District conducted a Section 111 Study from 1982 to 1983 for the Bratenahl area. The purposes of this study were to determine the effects of the harbor structures on shoreline erosion and to determine if mitigation of such damages attributable to the harbor structures was warranted. The study determined that the areas immediately adjacent to the harbor (Bratenahl to the east and Perkins Beach to the west) have been adversely impacted due to denial of sand-sized material from the littoral system as a result of maintenance dredging in the Cuyahoga River. To alleviate these damages, dredged material (primarily sand) from the upper reaches of the Cuyahoga River, which was determined to be suitable for open-lake disposal, will be disposed of offshore of these two areas. The dredged material would then enter the littoral system in sufficient quantity to totally mitigate the Federally induced damages to the shoreline. The plan will be implemented under the Cleveland Harbor Operation and Maintenance Program beginning in 1984, pending preparation and favorable review of an Environmental Assessment, FONSI Section 404 Evaluation and Public Notice for the recommended program.

b. Other Corps of Engineers Studies.

Other ongoing studies by the Corps of Engineers are pertinent to and may have an influence on future considerations at Cleveland Harbor. A summary of these various studies follows:

(1) The Navigation Season Extension Study - The purpose of this study, completed in December 1979, was to determine the economic feasibility of extending the navigation season for all the Great Lakes and the St. Lawrence Seaway. Navigation on the GL/SLS presently occurs from about the first week in April to mid-to-late December. A limited 8-1/2 to 9-month season results in diseconomies to commerce and industry which resort to stockpiling of raw materials or to more costly alternate transportation routes to sustain year round operations. In his letter of 3 March 1982 transmitting the final study report to the Secretary of the Army, the Chief of Engineers recommended a navigation season extension to 10-3/4 months on the upper lakes and 10 months on Lake Ontario and the St. Lawrence River.

For this Cleveland Harbor Phase I study, a 9-month navigation season has been assumed since extension of the navigation season on the GL/SLS system is uncertain at the present time. In addition, the feasibility of the harbor improvement plan recommended for implementation is not affected by the length of the navigation system.

(2) The Great Lakes Connecting Channels and Harbors Study - This current feasibility study covers the upper Great Lakes Navigation System (Lakes Superior, Michigan, Huron, Erie and their connecting channels). The purpose of this study is to determine the feasibility of modifications to the existing commercial navigation system, including the need to increase the

system's draft (presently at 25.5 feet at LWD) and /or size of vessel using the system (presently limited to a vessel no larger than 1,000 X 105 feet). The study will also determine the feasibility of enlarging and/or augmenting the locks at Sault Ste. Marie. The study is presently scheduled for completion in 1985.

Results of the studies to date indicate that a second Poe-sized lock at Sault Ste. Marie, capable of accommodating 1,000-foot vessels, is warranted. The studies also concluded that increasing the system's draft beyond 25.5 feet at LWD is not warranted. It has, therefore, been assumed for this Cleveland Harbor study that: (1) the locks at Sault Ste. Marie will not constrain the use of 1,000-foot vessels at Cleveland Harbor; and (2) the draft of the existing commercial navigation system (ie., 25.5 feet at LWD) will not change.

(3) St. Lawrence Seaway Additional Locks Study - The purpose of this current feasibility study is to determine the adequacy of the existing locks and channels in the U. S. section of the Seaway with respect to present and future commercial navigation needs, and the advisability of their rehabilitation, enlargement, or augmentation. The study is scheduled to be completed in 1986.

Results of the studies to date indicate that construction of additional locks, capable of handling either Seaway size vessels (730-foot long vessels) or 1,000-foot vessels, are the only plans that warrant further detailed study. This detailed study is presently being conducted with completion scheduled for 1986. The study results also concluded that increasing the system's draft beyond 25.5 feet at LWD is not warranted. Based on these preliminary results, it has been assumed for this Cleveland Harbor study that: (1) the maximum-sized vessel capable of transiting the seaway will continue to be a Seaway size vessel (730-foot-long vessel); and (2) the draft of the system (ie., 25.5 feet at LWD) will not change. It should be noted, however, that the feasibility of the harbor improvements recommended for implementation at Cleveland Harbor will not be affected if the final recommendation of the St. Lawrence Seaway Additional Locks study is to increase the size of the vessel capable of transiting the Seaway system.

(4) The Maximum Ship Size Study - This study was completed in 1977 by North Central Division, Corps of Engineers, to screen future vessel sizes and improvement alternatives for use in the Great Lakes Connecting Channels and Harbors and the St Lawrence Seaway Additional Locks studies. One conclusion reached in this study was that the maximum economically sized bulk cargo vessel that would use the Great Lakes Navigation System would be 1,200 feet long by 130 feet wide. However, this study was subsequently revised and updated in 1981 to reflect current industry views that the maximum sized vessel that would use the Great Lakes Navigation System would be 1,100 feet long by 105 feet wide.

During this Cleveland Harbor study, no plans were formulated to accommodate 1,100-foot long vessels since no shipping company indicated any long range plans to construct such a vessel. However, the adaptability of plans developed for 1,000-foot vessel operation to accommodate 1,100-foot vessel operation was assessed and analyzed. The results of this assessment were then used, along with other criteria, in selecting the harbor modification plan to recommend for implementation.

(5) National Waterways Study - This study examined the capabilities of the Nation's existing waterway system and the additional waterway improvements necessary to effectively serve present and future transportation requirements of the Nation. The study was conducted by the Institute for Water Resources, Corps of Engineers, and was completed in August 1981. As discussed in the next section of the Main Report, "Problem Identification," growth rates developed in this study for iron ore and limestone were used, in conjuction with other information, to estimate future movement of these commodities at Cleveland Harbor.

(6) Great Lakes/St. Lawrence Seaway Regional Transportation Study - This study was conducted by Booz-Allen and Hamilton, Inc. during 1981 to investigate the feasibility of future modifications to the Great Lakes - St. Lawrence Seaway Navigation System. Individual study components included tonnage forecasts, fleet forecasts and freight rate studies. In addition, the costs of alternative lock sizes were also compared with estimates of future navigation benefits. Preliminary conclusions reached during this study were further refined by Detroit and Buffalo Districts.

Tonnage and fleet forecasts developed for this study were used, in conjunction with other information, to develop forecasts of future commodity movements at Cleveland Harbor and the future fleet that would carry these commodities.

(7) Section 108d of Public Law 92-500 directed the Corps of Engineers to develop a program for the "restoration and environmental repair" of Lake Erie. The resulting Lake Erie Wastewater Management Study (LEWWM), completed in 1982 by the Buffalo District, identified nutrient enrichment - particularly phosphorus in all of its forms - as the primary cause of heavy eutrophication in the western basin of Lake Erie and marginal eutrophication in the central and eastern basins. The study has also determined that 44 percent of the phosphorus loading to Lake Erie is from nonpoint or diffuse sources such as that attached to sediment. The Final Report, outlining a 10-year conservation tillage program as the most cost effective method of reducing phosphorus pollution in Lake Erie, was sent forward to Congress "for its information."

SECTION 11
PROBLEM IDENTIFICATION

The purpose of this section is to inform the reader of this report of the water and related resource problems and needs in the study area and for which this study seeks a solution. The section presents information on the existing physical and human environment and the commercial navigation facilities in the study area; discusses the need to modify the existing commercial navigation features of Cleveland Harbor and other water-related resource problems for which this study seeks a solution; reviews the planning constraints under which this study was conducted; discusses the specific planning objectives of the study; and reviews the conditions that would exist if no Federal action was taken.

8. EXISTING CONDITIONS

The purpose of this subsection is to present the environmental setting without the project to permit impact assessment of the various alternatives. The information presented will provide a data base for impact assessment and evaluation purposes.

a. Physical Environment.

(1) Location. The city of Cleveland, OH, is located on the south shore of Lake Erie about 176 miles southwest of Buffalo, NY, and 96 miles east of Toledo, OH. Cleveland Harbor consists of a breakwater protected Lakefront Harbor in Lake Erie and improved navigation channels on the Cuyahoga River and Old River. The limits of the existing Federal navigation project are shown on Plates 1 and 2 in Appendix I.

(2) Physiography - Topography. The Ohio shoreline of Lake Erie lies within the Central Lowland Physiographic Province (Fenneman, 1938). East of Cleveland, this province is typically a 5 to 10-mile wide strip of relatively flat land bordering the lake. The natural land surface often rises abruptly, forming bluffs 20 to 40 feet high at or near the Lake Erie shoreline. West of Cleveland, the province continues to follow the Lake Erie shore, but broadens to include approximately the western half of Ohio. On the south, the province is bordered by the Appalachian Plateaus Province. Terrain in the Cleveland area is relatively flat, sloping toward Lake Erie with elevations ranging from about 580 feet at the lake to about 1,000 feet, 10 to 15 miles inland. Most of the city is located on plateaus about 80 to 100 feet higher than the lakefront and is divided from the lakefront by steep bluffs.

(3) The Cuyahoga River. The Cuyahoga River rises about 10 miles northeast of Burton in Geauga County, OH, and flows in a generally "U" shaped curve through northeastern Ohio, emptying into Cleveland Harbor and ultimately Lake Erie at Cleveland, OH. The river is approximately 100 miles long and, with its tributaries, drains an area of 810 square miles. The river varies in width

from 20 to 85 feet and in depth from a few inches to 4 or 5 feet, except in Cleveland where the river channel has been widened and deepened to the project depths shown on Plates 1 and 2.

(4) Climate. The Cuyahoga County region is dominated by a continental climate which is moderated by Lake Erie. The area experiences an average growing season of 195 days which is greater than that observed at most other locations in the U.S. at the same latitude.

The mean annual temperature at Cleveland based on a 40-year record (1941-1980) is 49.8°F (U.S. Department of Commerce, 1980). The mean annual snowfall of 52.0 inches comprises about 15 percent of the average annual precipitation of 34.22 inches. Precipitation is normally well distributed throughout the year.

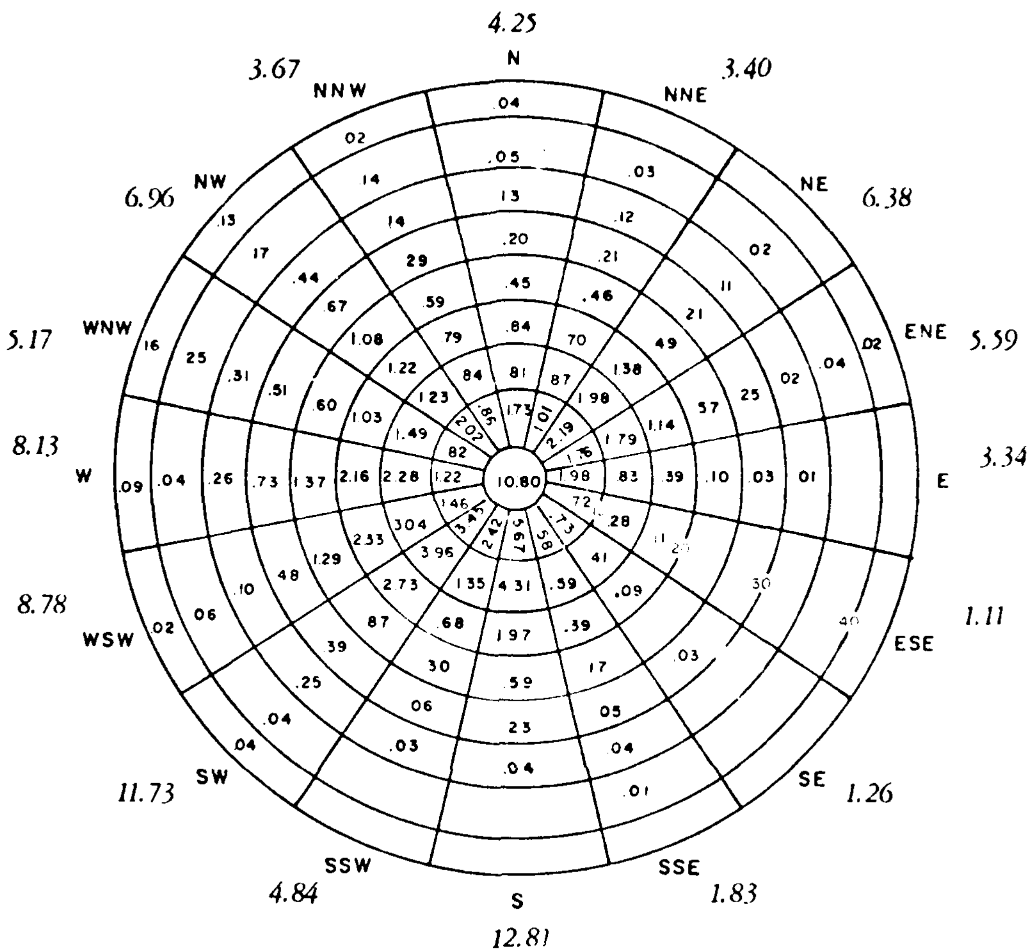
Winds in the Cleveland area are most commonly from the south and average about 11 miles per hour. A wind diagram for the Cleveland Coast Guard Station on the Cleveland Lakefront is presented on Figure 5.

(5) Geology. In northern Ohio, a thick sequence of sedimentary, Paleozoic strata is extensively mantled by Pleistocene glaciolacustrine and glacial till deposits. The Paleozoic strata are underlain primarily by Precambrian gneiss and granites. Outcrops of Precambrian rocks are absent in Ohio (U.S. Army Engineer District, Buffalo, 1978; Ohio Geological Survey, 1920; and Stour, et al., 1943).

Natural, unconsolidated surface deposits in the Cleveland area are derived from material associated with Pleistocene glaciation, fossil beaches and ridges formed during the development of Lake Erie, and the weathering of exposed bedrock. The glacial drift material is extremely variable in character, consisting of dense, impermeable till in some areas and open, permeable sand and gravel in others.

In the vicinity of Cleveland, the unconsolidated surface deposits are underlain by members of the Ohio Shale Formation of Devonian age along a 5 to 7 mile wide belt that parallels the south shore of Lake Erie. Total thickness of this formation is as great as 500 to 600 feet in some areas. South of the Ohio Shale Formation belt, surface deposits are underlain by younger Mississippian and Pennsylvanian shales, sandstones, and limestones. These materials are eroded and transported to the Cleveland Harbor area by way of the Cuyahoga River (U. S. Army Engineer District, Buffalo, 1978; Ohio Geological Survey, 1920; and Stour, et al. 1943).

(6) Soils. Shorelines of Cleveland Harbor and the lower Cuyahoga River consist primarily of Urban land which is characterized by nearly level and gently sloping areas that are predominantly covered by concrete, asphalt, buildings, and other impervious surfaces (Musgrave and Holloran, 1980). Fill along the harbor shore consists primarily of material dredged from Lake Erie and the Cuyahoga River while some areas along the river contain waste from the local steel industry.



4.34 —% OF OBSERVATIONS FROM DIRECTION SHOWN

1.46 —% OF OBSERVATIONS FOR MAGNITUDE SHOWN

(5 KNOTS GRADUATIONS)

CLEVELAND HARBOR, OHIO

WIND DIAGRAM FOR

CLEVELAND, OHIO

U.S. ARMY ENGINEER DISTRICT, BUFFALO

Source: U.S. Coast Guard, Cleveland Station Data, April-Dec. 1962-64

Figure 5

In addition to Urban land, the Urban land-Mahoning soil association, the Allis-Urban land association, the Oshtemo-Urban land - Chili association, and the Urban land - Elnora - Jimtown association exist in close proximity to the lower Cuyahoga River and Cleveland Harbor. A general soils map for Cuyahoga County is shown on Figure 6. No prime or unique farmlands border the Federal project site.

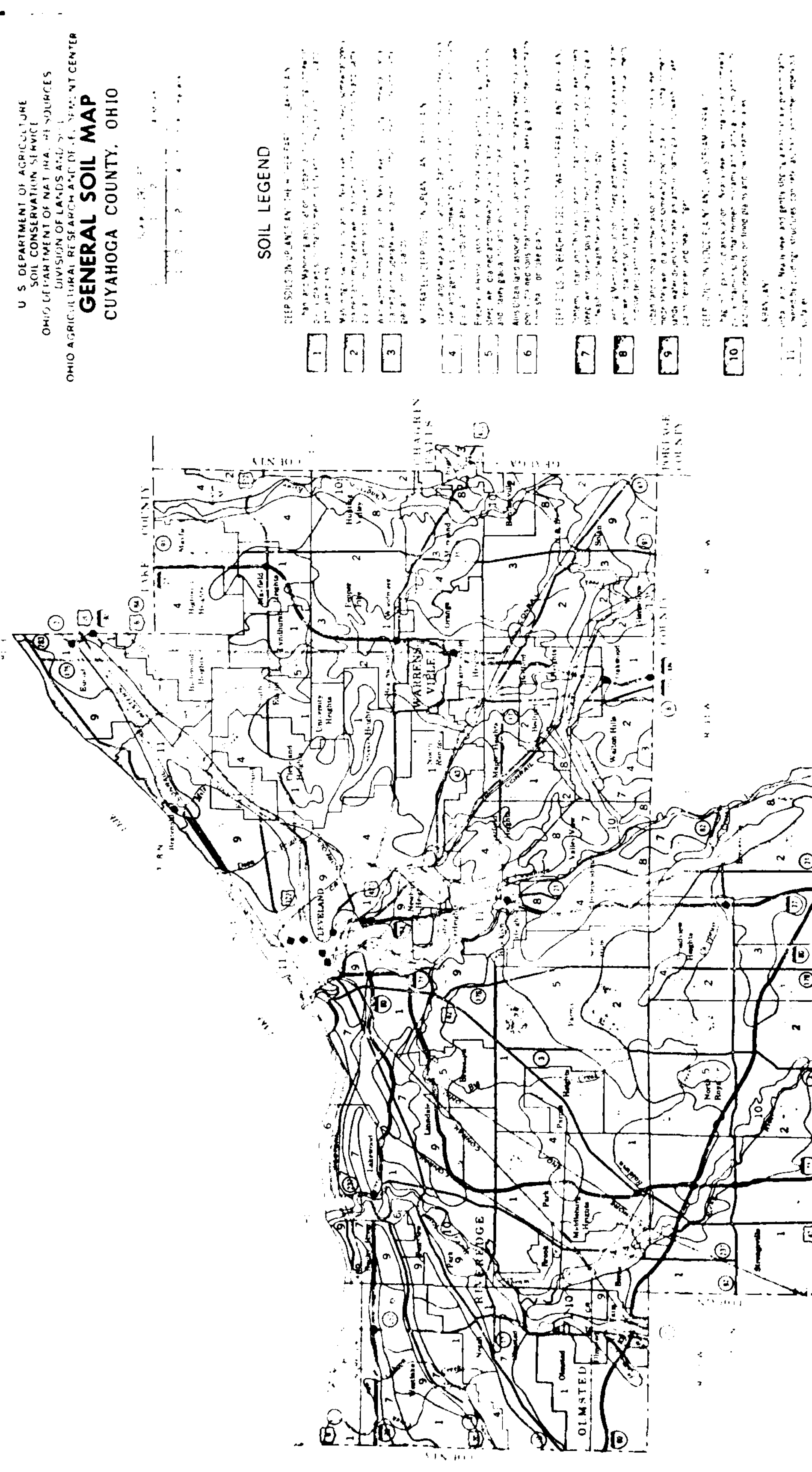
(7) Littoral Transport. The predominant Lake Erie longshore current in the Cleveland area is from west to east. Longshore movement of littoral material is impeded by the lakeward extremities of the harbor breakwaters which extend past the 30-foot depth contour. Coastal structures west of Cleveland Harbor at Edgewater Park have also trapped a considerable amount of sand which is unavailable for beach building to the east.

(8) Water Levels and Fluctuations. All depths mentioned, unless otherwise stated, are referred to International Great Lakes Datum - 1955 (IGLD-1955) low water datum for Lake Erie, which is 568.6 feet above mean water level at Father Point, Quebec. Water levels in Cleveland Harbor and the lower portion of the Cuyahoga River are influenced by water level fluctuations in Lake Erie. Long-term Lake Erie levels are dependent on precipitation, evaporation, and runoff, with the highest levels generally occurring in summer and the lowest in winter. Temporary changes in the level of Lake Erie are caused by the action of wind which may push water towards either end of the lake. Amplitudes greater than 13 feet have been recorded simultaneously between opposite ends of the lake. Water levels generally do not fluctuate greatly with the wind near the center of the lake, although wave activity during storms is often violent, creating hazardous boating conditions and accelerating shore erosion.

(9) Water Quality. The Lake Erie Nearshore Study of the area between Ashtabula, OH, and Vermilion, OH, (Richards, 1981) concluded that concentrations of most water quality parameters investigated were highest at river mouths. Water quality problem areas included the Black River, Rocky River, Chagrin River, Grand River, Ashtabula River, and Cleveland Harbor including the Cuyahoga River. For the Cleveland Harbor - Cuyahoga River area, the study detected violations of Ohio EPA water quality standards and/or International Joint Commission objectives for conductivity, dissolved oxygen, ammonia, manganese, iron, cyanide, phenols, lead, zinc, cadmium, and nickel.

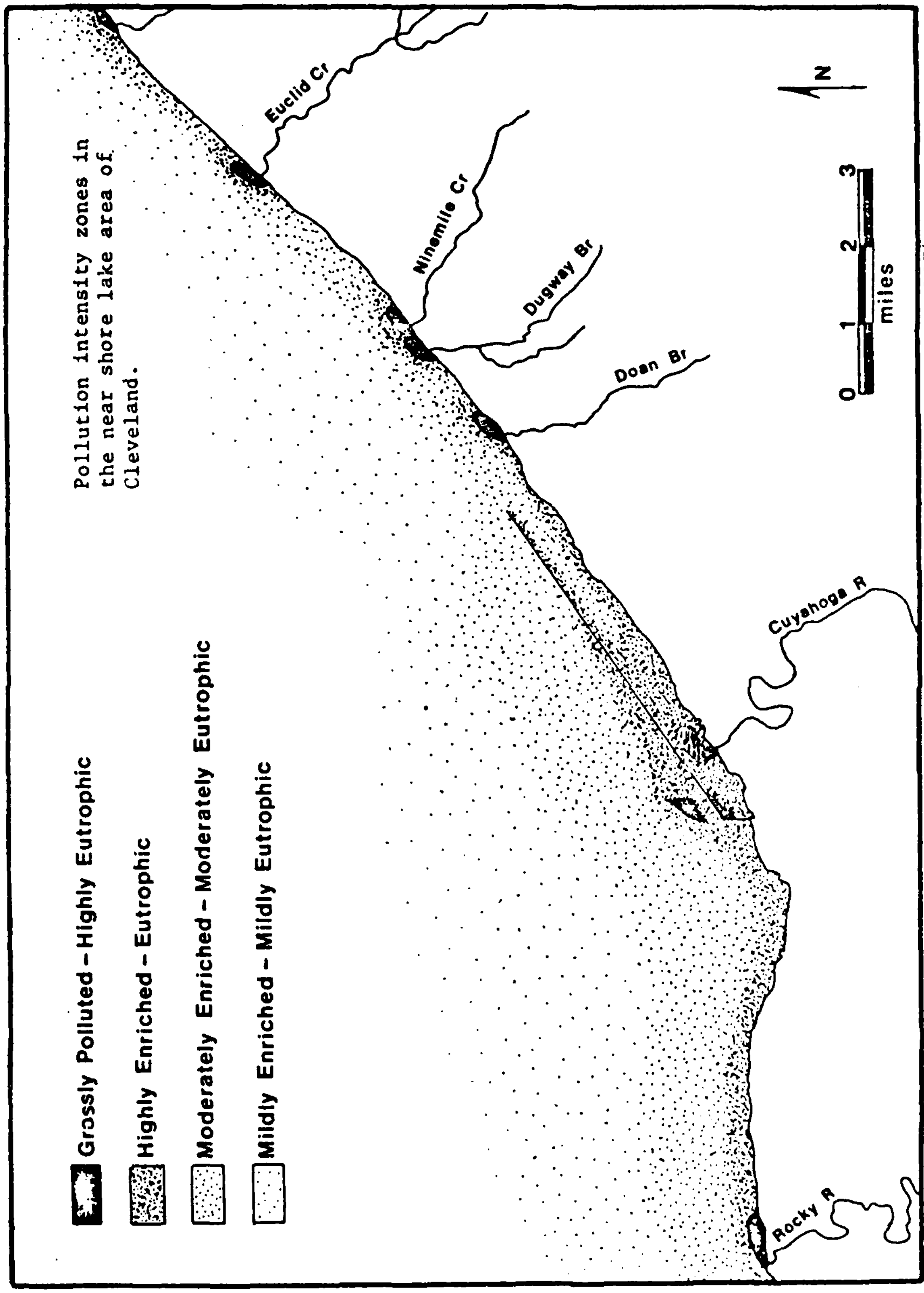
Richards (1981) determined that seasonal patterns in runoff and biological activity produced significant water quality changes in the nearshore zone. At most nearshore sampling stations, stratification of chemical parameters in the water column did not occur, although stratified conditions did occur intermittently at the outermost stations. Concentrations of most parameters investigated were higher and more variable in the nearshore zone than in the open lake.

Garlauskas (1974) identified zones of water quality in the Cleveland lake shore area as shown on Figure 7. In general, water quality deteriorates from west to east along the Cleveland shoreline and improves with distance from shore. Local areas of water quality degradation occur near the mouth of the



Source: Musgrave and Holloran, 1980

Figure 6



Source: Garlauskas, 1974

Figure 7

Cuyahoga River, near the westerly and easterly wastewater treatment plants, and along the lake side of the east breakwater opposite Burke Lakefront Airport where dredged material was deposited in past years. Concentration ranges of water quality parameters recorded in Cleveland Harbor in 1967 are presented in Table 2.

Maximum and minimum values for water quality parameters recorded by the Ohio Environmental Protection Agency for 1978-1980 at the Lower Harvard Avenue and the West 3rd Street Bridges are shown in Table 3. In general, the waters of the lower Cuyahoga River are grossly polluted and have high temperatures, low concentrations of dissolved oxygen, intermittent toxicity, and excessive amounts of solids, ammonia, BOD, COD, oil, fecal coliform bacteria, zinc, iron, lead, cyanide, phenols, floating debris, odor, and turbidity.

Table 2 - Concentration Ranges of Water Constituents
Cleveland Outer Harbor, 1967

Constituent	Range
Total P mg/l	0.08 - 0.55
Soluble P mg/l	0.03 - 0.16
Organic N mg/l	0.22 - 1.93
Ammonia N mg/l	0.36 - 2.42
Nitrate N mg/l	0.43 - 1.50
Chloride mg/l	32 - 90
Phenol ug/l	1 - 86
Total Solids mg/l	219 - 585
Dissolved Solids mg/l	173 - 428
Conductivity umhos/cm	260 - 620
Coliforms/100ml	1,400 - 58,000

SOURCE: Hartley, 1968

Table 3 - Cuyahoga River Water Quality 1978-1980

Parameter	Maximum and Minimum Concentrations: At Lower Harvard Avenue (Based on 21 Collections 18 Oct 78 - 18 Sep 80) Maximum	Minimum	At West 3rd Street (Based on 7 Collections 28 Aug 78 - 18 Sep 80) Maximum	Minimum
Water Temperature °C	25.0	1.0	30.0	7.5
pH Field S.U.	8.0	6.6	7.7	6.7
DO mg/l	12.2	4.0	6.5	0.2
Conductivity - Field Micromhos	1472	350	1224	650
Suspended Solids mg/l	562	<10	18	10
Dissolved Solids mg/l	764	330	593	506
TKN mg/l	6.69	1.13	7.55	3.31
Ammonia N mg/l	4.24	0.66	6.77	2.26
Nitrite N mg/l	0.9	<0.01	0.89	<0.02
Nitrate N mg/l	2.45	0.53	2.42	1.20
Total Phosphorus mg/l	1.00	0.18	0.69	0.15
Soluble Phosphorus mg/l	0.26	0.10	-	-
BOD, 5 Day mg/l	10	5.8	-	-
COD mg/l	94.4	10	28	8
TOC mg/l	22	7.1	-	-
Chloride mg/l	213	25	128	124
Fluoride mg/l	0.94	0.30	1.8	1.62
MBAS mg/l	0.28	0.09	0.25	0.25
Fecal Coliform 100 ml	41000	6000	15000	3900
Fecal Strep 100 ml	27000	200	2500	100
Phenols ug/l	50	5	21	7

Table 3 - Cuyahoga River Water Quality 1978-1980 (Cont'd)

Parameter	Maximum and Minimum Concentrations: At Lower Harvard Avenue (Based on 21 Collections 18 Oct 78 - 18 Sep 80)		At West 3rd Street (Based on 7 Collections 28 Aug 78 - 18 Sep 80)	
	Maximum	Minimum	Maximum	Minimum
Hardness Total Ca CO_3 mg/l	269	167	356	225
Copper Total ug/l	60	<30	<30	<30
Zinc Total ug/l	600	40	100	60
Arsenic Total ug/l	<10	<10	<10	<10
Cadmium Total ug/l	15	<5	<10	<5
Chromium Total ug/l	60	<30	<30	<30
Iron Total ug/l	25,000	910	1330	290
Lead ug/l	130	8	56	6
Manganese ug/l	510	130	310	250
Mercury Total ug/l	<0.5	<0.5	<0.5	<0.5
Nickel Total ug/l	100	<100	100	<100
Oil-Grease mg/l	1340	1340	<5.0	<5.0
Cyanide mg/l	0.15	<.01	0.14	0.04
PCB ug/l	<0.5	<0.5	-	-

NOTE: Not all water quality parameters listed were analyzed for each water sample taken.

SOURCE: Ohio Environmental Protection Agency, 1981.

Steel companies along the [illegible] about [illegible] million gallons of water per [illegible]. This use represents about 73 percent [illegible] water quality in the lower Cuyahoga River [illegible] depressed during periods of low river flow (Baria[illegible]

The U.S. Environmental Protection Agency has determined that [illegible] summer low flow conditions, at least the lower [illegible] mile of the Cuyahoga River acts as an estuary. On occasion, lake water invades the river, creating a mixing zone in the lower mile of the Cuyahoga River.

Normally, a mixing zone exists where the Cuyahoga River enters the harbor and Lake Erie. Currents moving from west to east within the breakwater protected harbor tend to deflect the plume of the Cuyahoga River to the east. Havens and Emerson Ltd. (1968) reported that under typical conditions, about 80 percent of the water from the Cuyahoga River flowed easterly through the harbor, while about 20 percent exited through the existing harbor entrance channel.

(10) Sediments. Sediments enter Cleveland Harbor and the lower Cuyahoga River through surface runoff, shore and bank erosion, and the discharge of industrial and domestic waste. Dissolved materials from industrial and upland agricultural activities also enter the water and become attached to the sediments. Sediments carried downstream by the Cuyahoga River are deposited in the Federal navigation channel, where widening and deepening have created low current velocities.

Sediments reaching Cleveland Harbor and the lower Cuyahoga River consist primarily of medium to fine grained materials and contain high concentrations of iron, nitrogen, phosphates, oil, grease, and other pollutants. High pollution levels depress aquatic populations and inhibit natural oxidation processes in the river sediments, although a somewhat lesser effect is observed in the Outer Harbor area.

Region 5 of the U.S. Environmental Protection Agency (USEPA) conducted sediment sampling in Cleveland Harbor and the lower Cuyahoga River in 1977. Based on the 1977 sediment test results, the USEPA classified the sediments within the entire Cuyahoga River section of the Cleveland Federal navigation project as heavily polluted. Harbor surface sediments within the breakwaters were also classified as heavily polluted (see Plate 4 in Appendix I). Sediment core samples were taken at 4 of the 1977 harbor sampling locations. The core sample taken at the east end of the existing Federal project and the core sample taken directly southeast of the west arrowhead breakwater were heavily polluted for the entire lengths of the cores.

The USEPA classified the sediments outside the breakwaters in the lake approach channel as unpolluted, while sediments outside the east entrance light were considered as borderline unpolluted/moderately polluted. Comparison of the 1977 test results with previous data collected in 1972 indicated that an improvement in sediment quality had occurred for some parameters tested.

Testing of sediments at the extreme upstream end of the Cuyahoga River Federal navigation channel was performed during the spring of 1982 in conjunction with the Buffalo District's Cleveland Section 111 study. Sediment grain size analyses were performed by the Ohio River Division (ORD) Laboratory of the U. S. Army Corps of Engineers, Cincinnati, OH. Bulk chemical and elutriate tests were performed by EG&G, Bionomics, Wareham, MA. In general, the 1982 testing indicated that the sediments at the extreme upstream end of the Federal navigation channel (river mile 5.6 to 7.5 - see Plate 2) consisted predominantly of clean, fine-grained sand suitable for open-lake disposal. Additional testing of sediments from the upstream end of the Cuyahoga River is scheduled to be performed during the fall of 1983.

Sediments in the more downstream regions of the Cuyahoga River, the Old River, and the Cleveland Lakefront Harbor were analyzed for sediment grain size by the ORD Laboratory in late 1982. Sediments from these areas are currently being analyzed for the Buffalo District by EG&G, Bionomics, with respect to toxicity, bulk chemistry, and elutriate characteristics.

A final sediment test report has not been submitted by EG&G and approved by the Buffalo District. However, the ORD test results and preliminary results from EG&G indicate that sediments which would be dredged under Plans 1, 7G, and 11 consist primarily of fine-grained material which is heavily polluted and unsuitable for open-lake disposal. The preliminary sediment test information should be confirmed upon completion of the final EG&G sediment test report and will be incorporated into the Final Phase I GDM Report.

(11) Air Quality. The Ohio Environmental Protection Agency (OEPA) considers air pollutants to be those airborne substances affecting public health and welfare (OEPA, 1981). Six substances are presently known which have harmful effects at concentrations above the National Ambient Air Quality Standards. These six substances are referred to as Criteria Pollutants (substances for which air quality standards have been adopted by the U.S. Environmental Protection Agency) and include total suspended particulates (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), photochemical oxidants (ozone), and lead.

Although a seventh class of substances known as non-methane hydrocarbons (NMHC) is not harmful in itself, guidelines have been established in an attempt to control their role in the formation of dangerous photochemical oxidants such as ozone. Table 4 shows the air quality standards in effect during 1981 for the seven pollutants listed above.

The Cleveland Air Quality Control Region consists of Lorain, Cuyahoga, Lake, Geauga, Portage, Summit, Medina, and Stark Counties, OH. Table 5 summarizes the number of days in which short-term air quality standards were exceeded in 1981 for the various air quality control regions in Ohio.

Although violations of short term air quality standards did occur, Ohio's air quality has improved significantly in recent years. Although air pollution alerts were common in the early 1970's, none have occurred in the past [illegible] years and the number of health advisories has been greatly reduced.

Table 4 - USEPA and Ohio EPA Ambient Air Quality Standards*

Pollutant	Duration	Restriction	Maximum Allowable Concentrations: Primary	Maximum Allowable Concentrations: Secondary
Total Suspended Particulates	Annual Geometric Mean	Not to be exceeded.	75 ug/m^3	60 ug/m^3**
Total Suspended Particulates	24-Hour Concentration	Not to be exceeded more than once per year.	260 ug/m^3	150 ug/m^3
Sulfur Dioxide	Annual Arithmetic Mean	Not to be exceeded.	0.03 ppm (80 ug/m^3)	
Sulfur Dioxide	24-Hour Arithmetic Mean Concentration	Not to be exceeded more than once per year.	0.14 ppm (365 ug/m^3)	
Sulfur Dioxide	3-Hour Arithmetic Mean Concentration	Not to be exceeded more than once per year.		0.5 ppm (1,300 ug/m^3)
Carbon Monoxide	8-Hour Arithmetic Mean Concentration	Not to be exceeded more than once per year.	9.0 ppm (10 mg/m^3)	
Carbon Monoxide	1-Hour Mean Concentration	Not to be exceeded more than once per year.	35.0 ppm (40 mg/m^3)	
Ozone	1-Hour Mean Concentration	Not to be exceeded on more than 1 day per year.	0.12 ppm (240 ug/m^3)	
Non-methane Hydrocarbons	3-Hour Arithmetic Mean Concentration	Not be be exceeded between 6:00 am and 9:00 am.	0.24 ppm** (160 ug/m^3)	
Nitrogen Dioxide	Annual Arithmetic Mean	Not to be exceeded.	0.05 ppm (100 ug/m^3)	
Lead	3-Month Arithmetic Mean Concentration	Not to be exceeded.	(1.5 ug/m^3)	

NOTES: Primary standards established for the protection of public health.
Secondary standards are established for the protection of public welfare.

* USEPA and Ohio EPA Air Quality Standards are identical.
** Air Quality Guidelines

SOURCE: Ohio Environmental Protection Agency, 1981.

Table 5 - Number of Days in Which Short-Term Air Quality Standards Were Exceeded, 1981

AQCR	TSP 24-Hour obs. >260 ug/m^3	SO_2 3-Hour Avg. >1,300 ug/m^3	SO_2 24-Hour Avg. >365 ug/m^3	CO 8-Hour Avg. 10 mg/m^3	CO 1-Hour Avg. >40 mg/m^3	OZONE 1-Hour Avg. >235 ug/m^3
No. 079 Cincinnati	0	0	0	2	0	4
No. 103 Portsmouth	0	0	0	-	-	-
No. 124 Toledo	0	0	0	1	0	8
No. 173 Dayton	1	0	0	1	0	7
No. 174 Cleveland	11	0	0	10	0	12
No. 175 Mansfield	6	0	0	-	-	-
No. 176 Columbus	0	0	0	2	0	1
No. 177 NW Ohio	0	0	0	-	-	0
No. 178 Youngstown	2	0	0	0	0	4
No. 179 Marietta	0	0	0	-	-	-
No. 180 Sandusky	38	0	0	-	-	-
No. 181 Steubenville	4	1	1	0	0	0
No. 182 Chillicothe	0	0	0	-	-	3
No. 183 Zanesville	1	0	0	-	-	-

NOTE: No short-term standards were in effect for NO_2 or lead.

SOURCE: Ohio Environmental Protection Agency, 1981.

b. Biological Environment.

(1) Upland Vegetation - Only a very limited quantity of upland vegetation currently exists along the Cuyahoga River and the Lakefront Harbor areas. Some trees, vines, and shrubs occur along the west side of Irishtown Bend between bridges 5 and 8 on the lower Cuyahoga River. The eastern end of Whiskey Island and the filled diked disposal areas are partially vegetated with grasses, shrubs, and small trees.

(2) Mammals, Reptiles, and Amphibians - Recent surveys of mammals, reptiles, and amphibians in the Cleveland Harbor area are lacking. Loss of upland habitat due to urbanization has probably eliminated most mammals from the Cleveland Harbor area. Populations of reptiles and amphibians are believed to be limited due to habitat modification and degraded water quality.

(3) Birds - A total of about 260 species of birds have been reported in the Cleveland area. The harbor is situated on the edges of both the Atlantic and Mississippi flyways. Waterfowl migrate through the Cleveland area on both north-south and east-west routes between breeding and wintering grounds.

Birds which are especially common in the harbor area include Bonaparte's gull (*Larus philadelphia*) , the ring billed gull (*L. delawarensis*), and the herring gull (*L. argentatus*). These gulls rest on harbor structures and feed in the surrounding waters. Other common bird species include the horned grebe (*Podiceps auritis*), common loon (*Gavia immer*), great blue heron (*Ardea herodias*), mallard (*Anas platyrhynchos*), black duck (*Anas rubripes*), canvasback (*Aythya valisineria*), goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), oldsquaw (*Clangula hyemalis*), and common merganser (*Megus merganser*). When ice is on the lake, waterfowl are often attracted to the open water areas associated with power plant effluents in Cleveland Harbor.

(4) Fish - Fish populations in the Cleveland area have suffered greatly due to degradation of aquatic habitat. The fish fauna of the lower 7 miles of the Cuyahoga River generally consists of relatively few individuals and species, although fish routinely enter the river from the Lakefront Harbor (White *et al.*, 1975). The relative abundance of species collected by White, *et al.* (1975) in Cleveland Harbor and adjacent marinas during 1971-1974 is presented on Table 6. The most abundant species in the harbor are common emerald shiner, eastern gizzard shad, and yellow perch. The yellow perch is the species making the most important contribution to the commercial and sport fisheries harvest. Both coho and chinook salmon occur in the harbor and are stocked in the Chagrin River, which empties into Lake Erie about 15 miles east of Cleveland Harbor (White *et al.*, 1975).

White *et al.* (1975) described the area of Cleveland Harbor and adjacent marinas as one of the fish nursery zones in the Cleveland area. Species collected as fry or young-of-the-year in Cleveland Harbor are identified on Table 7. Most of the harbor nursery areas are dominated by a few abundant species.

Table 6 - Relative Abundance of Fishes Collected in Cleveland Harbor and Adjacent Marinas during 1971-1974

Species	Number Collected	Percent of Total
Longnose Gar	1	0.01
Alewife	92	0.85
Eastern Gizzard Shad	2525	23.43
Chinook Salmon	9	0.08
Coho Salmon	42	0.39
Rainbow Trout	2	0.02
Rainbow Smelt	323	3.00
Northern Pike	15	0.14
Carp	64	0.59
Goldfish	97	0.90
Golden Shiner	393	3.65
Longnose Dace	1	0.01
Creek Chub	1	0.01
Western Blacknose Dace	1	0.01
Common Emerald Shiner	4092	37.97
Striped Shiner	1	0.01
Spottail Shiner	903	8.38
Spotfin Shiner	6	0.06
Northeastern Sand Shiner	33	0.31
Northern Mimic Shiner	6	0.06
Northern Fathead Minnow	1	0.01
Bluntnose Minnow	74	0.69

Table 6 - Relative Abundance of Fishes Collected in Cleveland Harbor and Adjacent Marinas during 1971-1974 (Cont'd)

Species	Number Collected	Percent of Total
Stoneroller Minnow	2	0.02
Eastern Quillback	1	0.01
Black Redhorse	1	0.01
Golden Redhorse	2	0.02
Northern Shorthead Redhorse	1	0.01
Common White Sucker	89	0.83
Channel Catfish	2	0.02
Brown Bullhead	23	0.21
Black Bullhead	14	0.13
Stonecat Madtom	13	0.12
Trout-perch	153	1.42
Brook Silverside	3	0.03
White Bass	223	2.07
White Crappie	80	0.74
Black Crappie	11	0.10
Northern Rock Bass	5	0.05
Northern Largemouth Black Bass	3	0.03
Warmouth Sunfish	1	0.01
Green Sunfish	3	0.03
Bluegill Sunfish	4	0.04
Pumpkinseed Sunfish	34	0.32
Yellow Walleye	2	0.02

Table 6 - Relative Abundance of Fishes Collected in Cleveland Harbor and Adjacent Marinas during 1971-1974 (Cont'd)

Species	Number Collected	Percent of Total
Yellow Perch	1254	11.64
Northern Logperch Darter	1	0.01
Freshwater Drum (Sheepshead)	170	1.58
TOTALS 47 Species	10,777	100.05

SOURCE: White, et al., 1975

Table 7 - Fish Species Collected as Fry or Young-of-the-Year in Cleveland Harbor, 1972-74

Species	Relative Abundance
Alewife	Abundant
Eastern Gizzard Shad	Abundant
Rainbow Smelt	Abundant
Eastern Quillback	Rare
Common White Sucker	Uncommon
Carp	Common
Goldfish	Common
Golden Shiner	Abundant
Longnose Dace	Rare
Common Emerald Shiner	Abundant
Spottail Shiner	Uncommon
Fathead Minnow	Rare
Bluntnose Minnow	Common
Trout-Perch	Rare
Brook Silverside	Rare
White Bass	Uncommon
Rockbass	Uncommon
Largemouth Blackbass	Rare
Green Sunfish	Uncommon
Bluegill Sunfish	Common
Pumpkinseed Sunfish	Abundant
Yellow Perch	Common
Northern Logperch Darter	Rare
White Crappie	Uncommon

SOURCE: White, et al., 1975

The lower 5 miles of the Cuyahoga River were reported to support young-of-the-year populations of goldfish, emerald shiner, and green sunfish (White et al., 1975). Cursory examinations indicate that goldfish may deposit eggs on the undersides of boats and on harbor pilings.

A list of species spawning in Cleveland Harbor would probably be similar to Table 7 (White et al., 1975). Goldfish, pumpkinseed sunfish, largemouth bass, and yellow perch were observed spawning within Cleveland Harbor during the period 1972-74 (White et al., 1975). The actual success of spawning in Cleveland Harbor has not been documented, but is probably limited due to relatively poor water quality.

(5) Benthos and Plankton - Table 8 presents a list of benthic macroinvertebrates collected in the Lake Erie nearshore zone near Cleveland. Pliodzinkas (1979) found that the majority of these organisms consisted of aquatic oligochaetes. Fisheries investigations performed for the U.S. Army Corps of Engineers (1978) indicate that abundant populations of relatively mobile benthic macroinvertebrates such as crayfish, amphipods, and isopods may be found on the harbor breakwalls, where abundant growths of the algae *Cladophora* sp. occur.

Significant increases in phytoplankton populations occur during the spring and fall in Cleveland Harbor. Although the dominant species are diatoms such as *Asterionella* spp., *Melosira* spp., and *Fragilaria* spp., the green and blue-green algae also contribute to phytoplankton blooms (Hartley and Van Vooren, 1977; U.S. Army Corps of Engineers, 1978).

The most abundant zooplankton in Cleveland Harbor include Rhizopoda, Rotifera, Cladocera, and Copepoda. Populations of zooplankton generally appear to peak in the fall.

(6) Threatened and Endangered Species - Section 7 of the Endangered Species Act of 1973, as amended, requires Federal agencies to coordinate with the U.S. Fish and Wildlife Service regarding any threatened or endangered species, either listed or proposed to be listed, which may be present in the concerned area. Chapter 119 of the Ohio Revised Code gives protection to species designated as endangered by the state of Ohio.

The U. S. Fish and Wildlife Service's June 1983 Draft Fish and Wildlife Coordination Act Report (Exhibit H-6 in Appendix H) listed the Indiana bat as a threatened/endangered species which may be present in the project area. However, this report concluded that since proposed project measures are primarily water oriented in an industrialized urban area, the likelihood of project induced impacts on the Indiana bat are remote.

No species listed as threatened or endangered by either the Federal Government or the State of Ohio are known to inhabit the project area. The eutrophic nature of Cleveland Harbor and the lower Cuyahoga River effectively eliminates any inhabitation of endangered fish species in the project area. Although endangered fish species may occasionally pass through the harbor area, it is unlikely that any such occurrence is anything but of an infrequent and transitory nature.

Table 8 - Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, OH

Phylum Coelenterata	Class Hydrozoa
	Hydra sp.
Phylum Aschelminthes	Class Nematoda
	Alaimus sp.
	Dorylaimus sp.
	Mesodorylaimus sp.
Phylum Annelida	Class Polychaeta
	Manayunkia speciosa
	Class Oligochaeta
	Aulodrilus piqueti
	A. pluriseta
	Branchiura sowerbyi
	Ilyodrilus templetoni
	Limnodrilus angustipenis
	L. cervis
	L. claperedeianus
	L. hoffmeisteri
	L. profundicola
	L. udekemianus
	Peloscolex ferox
	P. mulisetosus
	Potamothrix moldaviensis
	P. vejdovskyi
	Tubifex tubifex
	Dero digitata
	Nais communis
	N. pseudobtusa
	N. variabilis
	Ophidonais serpentina
	Stylria fossularis
	Class Hirudinea
	Illinobdella sp.
	Helobdella stagnalis
Phylum Mollusca	Pelecypoda
	Pisidium sp.
	P. casertanum
	P. henslowanum
	P. lilljeborgi
	Sphaerium sp.

Table 8 - Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, OH (Cont'd)

	Class Gastropoda
	Amnicola sp.
	Physa sp.
	Valvata sincera
Phylum Arthropoda	Class Crustacea
	Lirceus sp.
	Cypricercus sp.
	Asellus intermedius
	Gammarus fasciatus
	Ponotoporeia affinis
	Class Insecta
	Order Diptera
	Chironomus sp.
	C. plumosus
	C. riparius
	Tanytarsini (Tribe)
	Procladius sp.
	P. adumbratus
	P. attenuatus
	P. euliciformes
	P. riparius

SOURCE: Rolan, 1973
Nacht, 1977

From Pliodzinkas 1979

c. Human Environment

(1) Land and Water Use. Most of the land adjacent to the Cleveland Harbor Federal project has been developed for industrial and commercial use. Almost the entire lengths of the Cuyahoga and Old River navigation channels are lined with industrial plants, warehouses, commercial offices, and dock and terminal storage facilities. The locations of major industrial and commercial tracts adjacent to the Federal project are shown on Plates 1 and 2.

Major storage areas for general cargo are located along the east basin and the west bank of the Cuyahoga River just upstream of the Old River mouth.

Dry bulk storage areas are located along the west basin, along the middle section of the Old River, and along the middle and upper sections of the Cuyahoga. Liquid bulk storage tanks are also situated along the middle section of the Cuyahoga.

Lands used for transportation purposes include the Burke Lakefront Airport along the east basin and numerous railroad trunk lines that cross the industrialized sections along the Cuyahoga and Old Rivers. Several small-boat marinas are located along the Lakefront Harbor and one is located along the Old River. Open space areas adjacent to the project channels include the eastern part of Whiskey Island, the Corps diked disposal facilities along the east basin, and some vacant lots along the river shoreline. Public lands include the Coast Guard and Corps docks west of the airport and the Federal piers and breakwaters in the Lakefront Harbor. The Cleveland central business district is located immediately east of the industrial area along the east bank of the Cuyahoga. Land west of the Cuyahoga is predominantly occupied by a mixture of residential, light industrial, warehousing, and commercial structures and facilities (Doxiadis Associates International, 1971).

Water from the Cuyahoga and Old Rivers is used primarily for commercial and industrial purposes. Water use in the Lakefront Harbor is somewhat more diversified and includes recreational, commercial, public utility, and government activities. The adjacent open lake area is used primarily for recreation, commercial navigation, public water supplies, and limited commercial fishing operations.

(2) Bridges, Pipelines, and Utility Crossings. Table 9 lists the bridges spanning the Cuyahoga and Old Rivers within the existing Federal project limits. Submerged pipelines, submerged cables, tunnels, and aerial cables crossing the Cuyahoga and Old Rivers are listed on Table 10. Submerged cables to the east and west breakwaters, three water supply intake tunnels, and one sewer outfall pipeline exist in the general Lakefront Harbor area.

(3) Population and Housing. The city of Cleveland is the largest city in Ohio, with a population of 573,822 (U.S. Department of Commerce, 1981, a). Cuyahoga County is the largest county in Ohio, with about 38 percent of its population residing in the city of Cleveland. The four-county Cleveland Standard Metropolitan Statistical Area (SMSA) was inhabited by 1,898,800 persons in 1980 and was at that time the 19th most populated metropolitan area

Table 9 - Bridges Spanning the Cuyahoga River and the Old River

Miles Above: West Pier-head Light	Location and Name	Type	Center-Draw Openings-Clear: Width Normal to: Channel (Feet)	Minimum Clear Height Above LWD: Open (feet)	Minimum Clear Height Above LWD: Closed (feet)	Purpose for Which Used
	Cuyahoga River					
0.76	Consolidated Rail Corporation	Vertical Lift	250	98.6 (1)	8.6	Railroad
1.01	Main Avenue Viaduct	Fixed (2)	210	-	9..7 (3)	Highway
1.28	Baltimore & Ohio Railroad	Bascule (4)	220	-	8.7	Railroad
1.39	Center Street	Swing	113	-	17.7	Highway
1.42	Detroit-Superior Viaduct	Fixed (2)	113	-	98.0	Highway
1.89	Union Terminal Viaduct	Fixed (2)	200	-	98.2	Railway
1.93	Columbus Road	Vertical Lift	220	98.6 (1)	17.6	Highway
2.24	Consolidated Rail Corporation (British Street)	Vertical Lift	200	97.7 (1)	8.6	Railroad
2.42	Consolidated Rail Corporation (Carter Road)	Vertical Lift	200	98.8 (1)	23.5	Railroad
2.43	Carter Road	Vertical Lift	201	97.3 (1)	22.6	Highway
2.80	Eagle Avenue	Vertical Lift	187	97.5 (1)	15.6	Highway
3.14	Lorain-Carnegie Viaduct	Fixed (2)	178	-	96.4	Highway
3.19	Consolidated Rail Corporation (Lorain-Carnegie)	Bascule (4)	134	-	20.8	Railroad
3.34	Norfolk & Western Railway	Vertical Lift	200	97.7 (1)	64.2	Railroad
3.42	Inner Belt Freeway	Fixed (2)	230	-	97.0 (5)	Highway
3.69	West 3rd Street	Vertical Lift	200	97.3 (1)	10.5	Highway
4.33	Consolidated Rail Corporation (Erie Lackawanna)	Bascule (4)	117	-	29.3	Railroad
4.51	Jefferson Avenue	-	100	-	-	Super-Structure Removed
4.71	Newburgh & South Shore Railway	Bascule (4)	110	-	11.1	Railroad
4.75	Baltimore & Ohio Railroad	Bascule (4)	110	-	10.3	Railroad
5.35	Republic Steel Corporation	Fixed	210	-	99.0	Conveyor and Pipe-line Bridge
5.42	River Terminal Railroad	Bascule (4)	120	-	15.5	Railroad
5.43	Clark Avenue Viaduct	Fixed (2)	184	-	98.4	Highway (6)
5.47	Norfolk & Western Railway	Vertical Lift	200	97.7 (1)	28.9	Railroad
	Old River					
1.75	Baltimore & Ohio Railroad	Bascule (4)	170	-	6.9	Railroad
1.89	Willow Avenue	Vertical Lift	150	98.0 (1)	12.6	Highway

(1) Raised position.
(2) High level.
(3) Min. clear height in center 165 feet.
(4) Single leaf.
(5) Minimum clear height in center 199 feet.
(6) Bridge closed to vehicular traffic - to be replaced.

SOURCE: U.S. Army Corps of Engineers, 1978 and U.S. Army Corps of Engineers, 1981.

Table 10 - Submerged Pipelines, Submerged Cables, Tunnels and Aerial Cables Crossing the Cuyahoga and Old Rivers within the Existing Federal Project Limits

Miles Above West Pierhead Light	Description of Crossing	Depth Below LWD or Minimum Clear Height Above LWD (feet)
	Cuyahoga River	
0.98	City of Cleveland water main in tunnel.	60.4 below
1.14	City of Cleveland water main in tunnel	57.0 below
1.16	Cleveland Electric Illuminating Company; 12 submerged cables (out of service)	34.5 below
1.20	City of Cleveland water main in tunnel	56.7 below
2.80	Cleveland Electric Illuminating Company; 6 cables	34.0 below
3.09	City of Cleveland water main tunnel (out of service)	56.4 below
3.33	Western Union Telephone; 4-4-inch pipes	27.7 below
3.70	City of Cleveland Branch cable (out of service)	31.7 below
3.71	Aerial power cable	124.0 above
4.32	Mobil Oil Company; 2-6 inch pipes	32.0 below
4.49	City of Cleveland; 3 Branch cables (out of service)	30.7 below
4.50	City of Cleveland Branch cable (out of service)	31.7 below
4.52	City of Cleveland Branch cable	30.0 below
4.65	Standard Oil Company; 3-6 inch pipes	32.0 below
4.73	Aerial cable	118.0 above
4.76	Aerial cable	118.0 above
4.77	Baltimore & Ohio Railroad; 2 cables	30.0 below
5.34	Aerial electrical cable	122.0 above

Table 10 - Submerged Pipelines, Submerged Cables, Tunnels and Aerial Cables Crossing the Cuyahoga and Old Rivers within the Existing Federal Project Limits (Cont'd)

Miles Above West Pierhead Light	Description of Crossing	Depth Below LWD or Minimum Clear Height Above LWD (feet)
5.40	Republic Steel Corporation service tunnel	45.0 below
5.43	City of Cleveland water main in tunnel	41.2 below
5.48	Standard Oil Company; 5 pipes	32.0 below
5.49	Aerial cable	unknown
5.78	Sun Oil Company pipe	32.0 below
	Old River	
1.00	City of Cleveland Branch cable (out of service)	29.7 below
1.04	City of Cleveland Branch cable (out of service)	31.7 below

SOURCE: U.S. Army Corps of Engineers, 1980 and U.S. Department of Commerce, 1981c.

in the United States (National Decision Systems, Inc.; 1982). During the period between 1970 and 1980, the city of Cleveland experienced a 23.6 percent decrease in population, while the county experienced a somewhat lesser reduction in population of 12.9 percent. By the year 2030, the population of the Cleveland SMSA is expected to reach 2,265,333 (U.S. Department of Commerce, 1981, b) and the population of the city of Cleveland is expected to reach 634,848 (U.S. Department of Commerce, 1981, c).

The racial composition of Cleveland's 1980 population was 307,264 whites, 251,347 blacks, 1,094 American Indians, Eskimos, or Aleuts, 3,384 Asians or Pacific Islanders, and 10,733 individuals having other racial backgrounds (U.S. Department of Commerce, 1981,a). The percentage of nonwhites in Cleveland (46.4 percent) was nearly twice the percentage for the county (24.6 percent).

In 1980, the number of housing units in the city of Cleveland totaled 239,557, which constituted a 9.3 percent decrease from the 1970 total of 264,090 units. For Cuyahoga County, the number of housing units increased by 3.3 percent during this time period. Housing in the county consisted of 577,483 units in 1970 and 596,559 units in 1980 (U.S. Department of Commerce, 1981, a).

(4) Business and Industry. The Cleveland SMSA is one of the major manufacturing centers in the nation, accounting for 1.35 percent of total United States manufacturing employment in 1977 (U.S. Department of Commerce, 1980, a) although it had only 1 percent of total U.S. employment. Manufacturing accounts for 28 percent of the Cleveland SMSA's total employment (U.S. Department of Commerce, 1981, b). The fabricated metal products, machinery, primary metal, and transportation equipment industries are the dominant sectors, generating 54 percent of the total manufacturing jobs in the four-county region (U.S. Department of Commerce, 1980, a). Service industries follow a close second, accounting for 20 percent of the SMSA's total employment, followed by retail trade industries at 16 percent (U.S. Department of Commerce, 1981, b).

The city of Cleveland had .42 percent of total U.S. manufacturing employment in 977 (U.S. Department of Commerce, 1980, a), although it had only .24 percent of total U.S. employment (U.S. Department of Commerce, 1981, b). The city contained 47 percent of the SMSA's manufacturing establishments and 46 percent of the SMSA's manufacturing employment (U.S. Department of Commerce, 1980, a). However, this predominance is being eroded as economic opportunities follow the residential movement to the suburbs (U.S. Army Corps of Engineers, 1976). Manufacturing acounts for 34 percent of the city of Cleveland's total employment (U.S. Department of Commerce, 1981, c). The primary metal, fabricated metal, and machinery industries are the dominant sectors generating 47 percent of the total manufacturing jobs in the city (U.S. Department of Commerce, 1980, a). Service industries generated 16 percent of total employment followed by retail trade industries at 15 percent and government at 13 percent (U.S. Department of Commerce, 1981, c).

One of the important aspects of business and industry in the Cleveland area is the harbor facility. "It is generally accepted that the port affects 100,000 local jobs in some way" as well as being a major international port on the Great Lakes (Port of Cleveland, 1980). Ocean going vessels from over 50 overseas countries and 120 world ports deliver and receive goods at the Port of Cleveland. Nearby interstate highways and rail lines connect the port to important retail and industrial markets in America. The port is the second largest on Lake Erie and the fifth largest U.S. port on the Great Lakes. Cleveland's commercial water traffic generates more than $3 billion per year in wages and salaries, corporate revenues, and local purchases dependent upon waterborne commerce (The Port of Cleveland, 1981).

(5) Employment and Income. Table 11 summarizes historical and projected employment by industry in the Cleveland SMSA. In 1978, the two largest general categories of employers were the manufacturing industries, which employed 28.3 percent of the total work force and the service industries, which employed 20.5 percent of the labor force (U.S. Department of Commerce, 1981, b). Major employers within the manufacturing sector are the nonelectrical machinery industries, the fabricated metal products industries and the primary metal industries (U.S. Army Corps of Engineers, 1978).

In 1978, the per capita personal income of the Cleveland SMSA was $6,140, or about 117 percent of both the national average of $5,227 (U.S. Department of Commerce, 1981, b) and the State average of $5,238 (U.S. Department of Commerce, 1981, d). In 1970, only 6.9 percent of all families residing in the SMSA were below the poverty level compared to a national average of 10.7 percent and a State average of 6.9 percent. (U.S. Army Corps of Engineers, 1976). Per capita income for the city of Cleveland in 1978 was $4,830 or about 92 percent of both the national average (U.S. Department of Commerce, 1981, c) and the State average (U.S. Department of Commerce, 1980, d).

(6) Transportation. Cleveland is served by two major east-west interstate highways, I-90 and I-80. Access to the south is provided by I-71 and I-77 together with US-21 and US-42. Several State routes also provide interconnecting links for highway freight service in the region. The Cleveland area is served by more than 300 over-the-road motor common carriers (Greater Cleveland Growth Association, 1983).

The Baltimore and Ohio Railroad, the Norfolk and Western Railway, and Conrail are the three major trunk line railroads that serve the Cleveland area. The Newburgh and South Shore Railroad, the Cuyahoga Valley Railway, and the River Terminal Railway operate switching lines.

The primary air transportation terminals at Cleveland are the Cleveland-Hopkins International Airport and the Burke Lakefront Airport. The Burke Lakefront Airport is used primarily for short, regional flights, while the larger Cleveland-Hopkins terminal is used by the major airlines for long-distance air travel.

The existing commercial harbor at Cleveland consists of a breakwater protected Lakefront Harbor on Lake Erie and navigation channels on the Cuyahoga and Old Rivers. The Lakefront Harbor consists of about 1,300 acres, protected by a breakwater over 30,000 feet long. The channel in the Cuyahoga River is 5.8 miles long and the Old River channel is about one mile long. The commercial harbor is shown on Plates 1 and 2 in Appendix I.

Table 11 - Historical and Projected Employment by Industry in the Cleveland SMSA

	Historical		No-Change-in-Share				Low-Change-in-Share				Moderate-Change-in-Share			
	1969	1978	1985	1990	2000	2030	1985	1990	2000	2030	1985	1990	2000	2030
Total Employment	965,421	988,753	1,105,946	1,153,295	1,191,621	1,206,607	1,075,447	1,112,477	1,142,395	1,154,249	1,065,576	1,093,341	1,109,011	1,107,353
Agricultural Production	5,533	7,168	6,739	6,534	6,345	5,664	7,343	7,291	7,208	6,472	7,551	7,674	7,850	7,276
Nonfarm	959,888	981,585	1,099,207	1,146,761	1,185,276	1,200,943	1,068,103	1,105,187	1,135,188	1,147,778	1,058,024	1,085,668	1,101,161	1,100,078
Private	843,413	851,760	962,143	1,007,492	1,045,328	1,063,748	932,053	967,265	996,846	1,012,244	922,332	948,436	964,015	966,185
Agricultural services, forestry, fisheries, and other	2,027	3,436	3,799	3,987	4,042	3,968	4,167	4,476	4,616	4,556	4,293	4,714	5,006	5,071
Mining	1,751	1,601	2,254	2,414	2,387	2,276	1,858	1,883	1,785	1,678	1,737	1,660	1,441	1,247
Construction	48,488	41,521	47,333	48,798	50,128	50,753	44,673	45,302	45,958	46,338	43,848	43,741	43,289	42,631
Manufacturing	319,923	279,800	299,956	305,251	304,531	293,845	291,212	293,809	291,193	280,362	288,414	288,436	282,021	268,013
Nondurable Goods	81,269	73,210	77,406	78,513	78,585	75,961	75,223	75,665	75,254	72,588	74,486	74,264	72,869	69,384
Durable Goods	238,654	206,590	222,550	226,738	225,947	217,884	215,989	218,144	215,939	207,775	213,928	214,171	209,152	198,629
Transportation and Public Utilities	56,115	49,324	53,385	55,270	57,270	58,177	50,386	51,314	52,514	53,127	49,410	49,474	49,356	48,740
Wholesale Trade	59,576	66,324	74,884	77,580	79,640	80,007	71,407	72,954	74,095	74,174	70,304	70,804	70,331	68,909
Retail Trade	143,014	157,444	179,978	189,583	196,573	197,421	175,704	183,827	189,629	190,124	174,292	181,088	184,873	183,548
Finance, Insurance, and Real Estate	44,553	49,616	60,897	65,261	69,954	75,299	58,418	61,871	65,733	70,548	57,605	60,279	62,896	66,361
Services	167,966	202,694	239,658	259,350	280,801	302,001	234,227	251,831	271,324	291,337	232,428	248,240	264,802	281,666
Government	116,475	129,825	137,064	139,269	139,948	137,195	136,051	137,921	138,341	135,534	135,693	137,232	137,146	133,892
Federal Civilian	21,410	19,701	19,805	19,648	19,265	19,575	20,101	20,019	19,686	18,999	20,185	20,175	19,940	19,335
Federal Military	10,362	7,346	7,318	7,318	7,318	7,318	7,318	7,318	7,318	7,318	7,318	7,318	7,318	7,318
State and Local	84,703	102,778	109,941	112,303	113,365	111,302	108,632	110,584	111,338	109,217	108,190	109,739	109,888	107,240

SOURCE: U. S. Department of Commerce, 1981b

(7) Municipal Services. All of the various utility agencies and companies that serve the city of Cleveland have facilities in or provide service to the harbor area. The Cleveland Water Authority has public water supply intakes in Lake Erie to the east and west of the harbor. According to the Ohio Department of Natural Resources, the Cleveland public water intake system is divided into east and west subsystems by the Cuyahoga River. The area east of the river is served by the Nottingham and Baldwin Filtration Plants. The area west of the river is served by the Division and Crown Filtration Plants (Ohio Department of Natural Resources, 1972).

Three sewage treatment plants serve the harbor area. The Westerly Wastewater Treatment Plant is located near the western extremity of the harbor at the terminus of the Old River. This plant, the oldest of the three facilities, has a capacity of 30-31 mgd and provides only primary treatment. It is presently being rebuilt and upgraded, and discharges into Lake Erie. The Southerly Wastewater Treatment Plant is located along the Cuyahoga River about 6.5 miles upstream from Lake Erie. It provides both primary and secondary treatment, has a capacity of 100 mgd and discharges into the Cuyahoga River. The Easterly Wastewater Treatment Plant is located 8 miles northeast of the mouth of the Cuyahoga River. It has the present capability of providing primary and secondary treatment for about 125 mgd of sewage, and discharges into Lake Erie (Northeast Regional Sewer District, 1982).

Natural gas is provided to the project area by the East Ohio Gas Company. The Ohio Bell Telephone Company provides telephone services. Electrical services for the area are provided by the Cleveland Electric Illuminating Company (U.S. Army Corps of Engineers, 1978).

(8) Recreational Resources. Recreational boating is the most visible form of recreation in the Cleveland Harbor area. Marinas and yacht clubs are located along the east basin shoreline, immediately west of the west breakwater, and at the upper end of the Old River. Although some recreational boating takes place within the harbor navigation channels, these areas serve primarily as travel routes to areas outside the harbor. Harbor cruises are available to the general public on the tour ship Goodtime II.

Water skiing occurs in the Outer Harbor. Many anglers fish in the Outer Harbor around piers, breakwaters, and other structures, although access to these areas is presently limited. Swimming is generally limited to areas outside Cleveland Harbor. The closest public swimming facility is at Edgewater Park, located about 0.3 mile west of the base of the west breakwater. Numerous other beaches are located along Lake Erie in Cuyahoga County, although most are privately owned and open only to members of lakeshore property associations.

Court games, field games, and picnicking are available at several municipal parks and playgrounds and private beach clubs in the Cleveland lakeshore area. The Cleveland Metroparks System, comprising more than 18,000 acres of park land, contains eleven metroparks which surround the general Cleveland area. The system contains interpretive centers, hiking trails, bridle paths, bicycle trails, swimming and fishing areas, picnic areas, shelter houses, play fields, and golf courses. In addition, the Ohio Department of Natural Resources has developed plans for the Cleveland Lakefront State Park which will provide both water and nonwater related recreational facilities and will be developed over the next several decades. Cleveland Municipal Stadium, home of the Cleveland Indians baseball team and the Cleveland Browns football team, is located near the east basin shoreline within 1 mile of the river mouth.

(9) Cultural Resources. More than 40 properties in the city of Cleveland are listed on the National Register of Historic Places. Many of the city's National Register sites are located in or immediately east of the central business district. Past coordination with the Ohio State Historic Preservation Officer (SHPO) (see Exhibit F5c in Appendix F) indicates that the National Register or eligible properties along the Cuyahoga River include the Center Street Swing Bridge (Bridge No. 4 - see Plate 2), the Old Superior Avenue Viaduct (Detroit-Superior High Level Bridge - Bridge No. 5), the Columbus Road Vertical Lift Bridge (Bridge No. 7), the Union Terminal Groups (Union Terminal High Level Railroad Bridge - Bridge No. 6), and the Lorain-Carnegie Bridge (Bridge No. 10). The Ohio SHPO also stated that the Cleveland West Pierhead Light should be considered eligible for inclusion in the National Register of Historic Places. The Cleveland West Pierhead Light and a small metal beacon on the east arrowhead breakwater mark the main entrance to Cleveland Harbor. Erected in 1909-1910, the West Pierhead Lighthouse and its foundation occupy approximately .25-acre. The lighthouse played an important role in the development of Cleveland Harbor.

A cultural resources survey of the Cleveland Harbor project area was performed in April 1976 and was included in the Final Environmental Impact Statement prepared in 1978 in conjunction with the Cleveland Harbor Feasibility Study of 1972-1976.

d. Navigation Facilities.

(1) The Great Lakes - St. Lawrence Navigation System - The Great Lakes and interconnecting channels, the St. Lawrence River, and the Gulf of the St. Lawrence provide a 2,400-mile commercial waterway from the Atlantic Ocean to the westerly end of Lake Superior. The geographic extent of the system and a schematic profile through the system are shown on Figure 8.

The section of the system between Cleveland Harbor and the Upper Great Lakes (Superior, Huron, and Michigan) is designed for a vessel up to 1,000 feet in length, with a beam of 105 feet and a draft of 25.5 feet at low water datum. The limiting features in this section of the system are the locks in the St. Marys Falls Canal, which connect Lake Superior with Lake Huron.

The section of the system between Cleveland Harbor and the Atlantic Ocean is designed for a vessel up to 730 feet in length, with a beam of 75 feet and a draft of 25.5 feet at low water datum. The limiting features of this section of the system are the locks in the Welland Canal and the St. Lawrence Seaway.

(2) Vessel Traffic - In the past 300 years, vessel traffic on the Great Lakes has evolved from canoes to 1,000-foot bulk cargo carriers.

The first sailing vessels were introduced about 1680; the first steamer about 1820. The first bulk carrier (211 feet long) was built about 1890. Subsequent bulk carriers increased in size to about 500 feet in 1900, 600

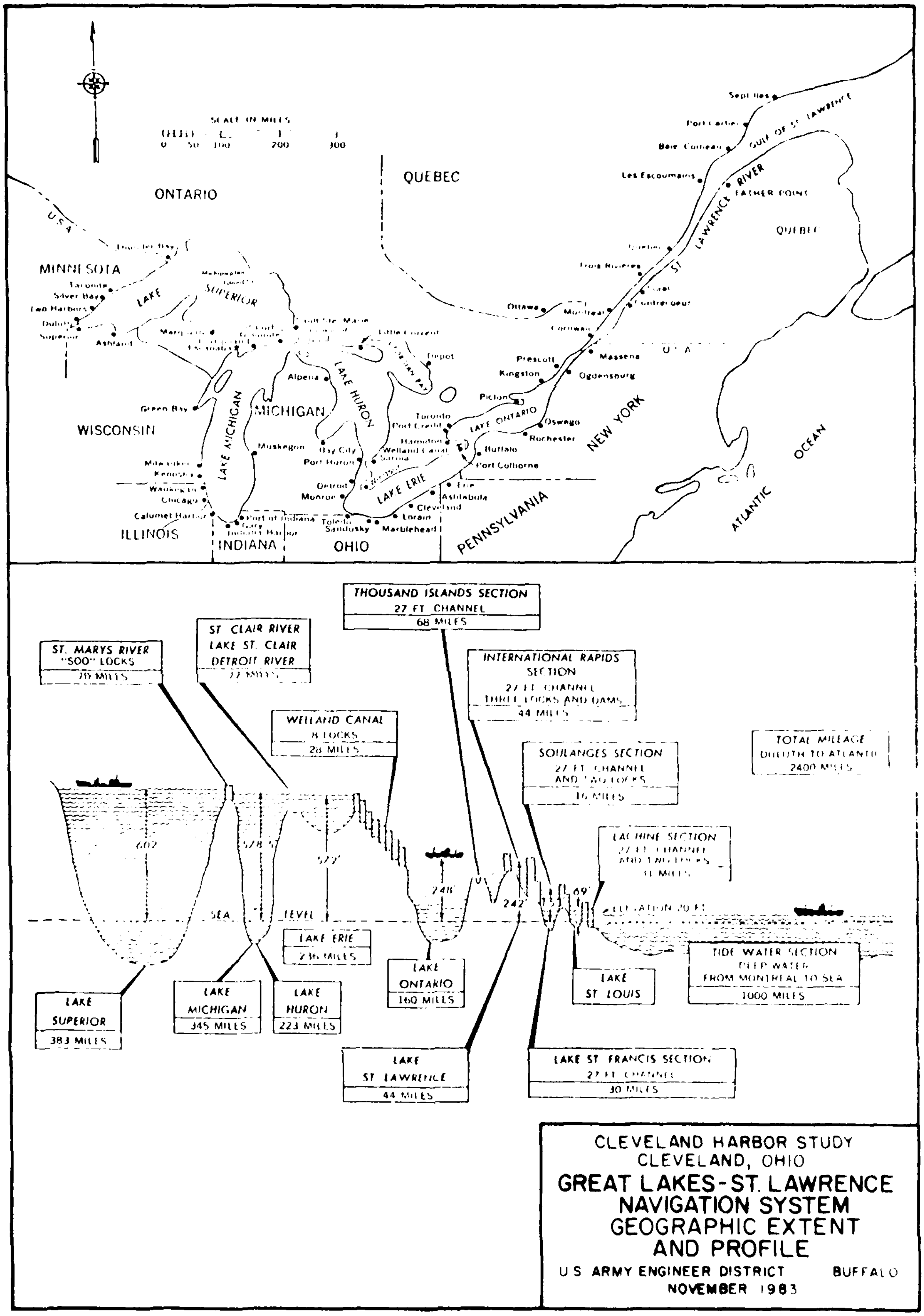

SCALE IN MILES
0 50 100 200 300
ONTARIO
QUEBEC
MINNESOTA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
ATLANTIC OCEAN
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
GULF OF ST LAWRENCE
ST LAWRENCE RIVER
U S A
Sept Iles
Port Cartier
Baie Comeau
Les Escoumains
FATHER POINT
Trois Rivieres
Montreal
Contrecoeur
Ottawa
Cornwall
Massena
Prescott
Ogdensburg
Kingston
Picton
Oswego
Rochester
Toronto
Port Credit
Hamilton
Welland Canal
Buffalo
Port Colborne
Erie
Ashtabula
Cleveland
Lorain
Marblehead
Sandusky
Toledo
Monroe
Detroit
Port Huron
Bay City
Alpena
Little Current
Depot
Green Bay
Muskegon
Milwaukee
Kenosha
Waukegan
Chicago
Calumet Harbor
Gary
Indiana Harbor
Port of Indiana
Marquette
Escanaba
Ashland
Superior
Duluth
Two Harbors
Silver Bay
Taconite
Thunder Bay
THOUSAND ISLANDS SECTION
27 FT CHANNEL
68 MILES
ST. MARYS RIVER
"SOO" LOCKS
70 MILES
ST CLAIR RIVER
LAKE ST. CLAIR
DETROIT RIVER
INTERNATIONAL RAPIDS SECTION
27 FT CHANNEL
THREE LOCKS AND DAMS
44 MILES
WELLAND CANAL
8 LOCKS
28 MILES
SOULANGES SECTION
27 FT CHANNEL
AND TWO LOCKS
16 MILES
TOTAL MILEAGE
DULUTH TO ATLANTIC
2400 MILES
LACHINE SECTION
27 FT CHANNEL
AND TWO LOCKS
31 MILES
602'
578.5'
572'
248'
242'
69'
SEA LEVEL
ELEVATION 20 FT
LAKE ERIE
236 MILES
LAKE ONTARIO
160 MILES
LAKE ST LOUIS
TIDE WATER SECTION
DEEP WATER
FROM MONTREAL TO SEA
1000 MILES
LAKE SUPERIOR
383 MILES
LAKE MICHIGAN
345 MILES
LAKE HURON
223 MILES
LAKE ST LAWRENCE
44 MILES
LAKE ST FRANCIS SECTION
27 FT CHANNEL
30 MILES
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
GREAT LAKES-ST. LAWRENCE
NAVIGATION SYSTEM
GEOGRAPHIC EXTENT
AND PROFILE
U S ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE 8

feet in 1906, 639 feet in 1941, 678 feet in 1949, 730 feet in 1956, and finally to 856 feet and to 1,000 feet in 1972. The 1,000-foot vessel put into service in 1972 doubled the record tonnage carried by any vessel built prior to that time.

The present (1981) Great Lakes vessel fleet consists of about 349 vessels, 155 Canadian and 194 United States. About 73 percent of the fleet are bulk carriers, which account for about 92 percent of the total cargo carrying capacity of the fleet. Characteristics of the combined United States and Canadian Great Lakes fleet are shown in Table 12.

The fleet is arbitrarily divided into 10 classes according to vessel length. The United States bulk carriers are predominantly Class V (600-649 feet) through Class VII (700-730 feet) vessels; the Canadian bulk carriers are predominately Class VII (700-730 feet) vessels. Many of the larger bulk carriers cannot efficiently operate in Cleveland Harbor due to the configuration and depths of the Lakefront Harbor entrance and the river channels. The balance of the Great Lakes fleet (tankers) are Class I (400 feet) through Class IV (550-599 feet) vessels. The physical dimensions of Cleveland Harbor do not restrict the operation of these size vessels.

The trend in new Great Lakes vessel construction for the last 10 years (1972-1981) is to build larger capacity vessels, especially Class X vessels (1,000 feet in length), the maximum size vessel that can transit the Upper Lakes. Of the 27 new vessels built during this period for the Great Lakes fleet, 13 vessels, or 48 percent, were Class X vessels. It is expected that this trend will continue for the foreseeable future.

Ocean vessels up to 730 feet in length and 75 feet in width trade in the Great Lakes. The size of ocean vessels, which have deeper drafts than lake vessels, is limited by the depths through the St. Lawrence Seaway and the Welland Canal. Ocean vessels deliver general cargo to facilities located along the Lakefront Harbor at Cleveland.

(3) The Present Harbor - Presently, Cleveland Harbor is used by commercial and recreational vessels. The commercial vessels trade primarily in bulk iron ore and ore concentrates, stone products, and salt. Iron ore and ore concentrates are delivered to rail transshipment facilities adjacent to the west basin and to steel plants on the Cuyahoga River. Stone products are delivered to docks on the two river channels. Salt is shipped from the Old River. General cargo movement, which is minor in terms of total harbor tonnage (about 3 to 4 percent), is concentrated in the Lakefront Harbor immediately east of the river entrance. Recreational boating activities are developed in the easterly one-third of the Lakefront Harbor, immediately west of the west breakwater, and at the upstream end of Old River.

The harbor consists of a breakwater-protected Lakefront Harbor in Lake Erie and improved navigation channels on the Cuyahoga River and Old River. The harbor is Federally improved and is shown on Plates 1 and 2 in Appendix I. The Lakefront Harbor encompasses an area of about 1,300 acres and extends for a distance of about 30,000 feet parallel to shore. There are two harbor entrances. The west (main) entrance channel is located opposite the mouth of

Table 12 - Characteristics of the Great Lakes Fleet, 1981

	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII	Class VIII	Class IX	Class X	TOTAL
Length Range (Feet)	400	400 - 499	500 - 549	550 - 599	600 - 649	650 - 699	700 - 730	731 - 849	850 - 949	950 - 1099	-
Representive Carrying Capacity (Short Tons)		10,136	13,160	15,792	22,568	25,984	30,072	35,840	49,840	66,080	-
Total Vessels	93	32	2	16	87	24	68	13	1	13	349
Percent of Total Fleet	26.6	9.2	.6	4.6	24.9	6.9	19.5	3.7	.3	3.7	100
US Fleet	63	10	2	7	65	12	10	11	1	13	194
Percent of Total Fleet	18.1	2.9	.6	2.0	18.6	3.4	2.9	3.2	.3	3.7	55.6
Canadian Fleet	30	22	0	9	22	12	58	2	0	0	155
Percent of Total Fleet	8.6	6.3	0	2.6	6.3	3.4	16.6	.6	0	0	44.4
Bulk Freighters (BF)	21	5	1	6	63	10	44	8	0	0	158
Percent of Total Fleet	6.0	1.4	.3	1.7	18.1	2.9	12.6	2.3	0	0	45.3
U S Bulk	8	4	1	2	45	2	7	6	0	0	75
Percent of Total Fleet	2.3	1.1	.3	.6	12.9	.6	2.0	1.7	0	0	21.5
Canadian Bulk	13	1	0	4	18	8	37	2	0	0	83
Canadian Tankers	15	20	0	2	0	0	0	0	0	0	37
Percent of Total Fleet	4.3	5.7	0	.6	0	0	0	0	0	0	10.6
Total Ship Capacity U.S. (Short Tons)	190,457	1,020,790	27,272	93,290	1,176,829	312,032	316,568	365,120	49,840	1,014,440	3,648,638
CAN.	151,502	229,686	0	122,261	439,628	258,396	1,886,326	63,112	0	0	3,150,911
Bulk Freighter Cap.	86,386	43,445	14,784	77,784	1,138,721	203,292	1,342,062	253,512	0	0	3,159,986
Percent of Total Cap.	1.3	.6	.2	1.1	16.7	3.0	19.7	3.7	0	0	46.5
US BF Capacity (Short Tons)	6,922	34,093	14,784	24,360	798,605	43,232	193,816	190,400	0	0	1,306,212
CAN BF Capacity(Short Tons)	79,464	9,352	0	53,424	340,116	160,060	1,148,246	63,112	0	0	1,853,774
Self - Unloader Cap. (Short Tons)	10,382	12,376	12,488	110,930	477,736	367,136	860,832	174,720	49,840	1,014,440	3,090,880
Percent of Total Cap.	.2	.2	.2	1.6	7.0	5.4	12.7	2.6	.7	14.9	45.5
US Self - Unloader Cap. (Short Tons)	6,507	0	12,488	68,930	378,224	268,800	1[illegible]752	174,720	49,840	1,014,440	2,096,701
CAN Self - Unloader Cap. (Short Tons)	3,875	12,376	0	42,000	99,512	98,336	738,080	0	0	0	994,179
Average Year Built U S	1953	1945	1921	1916	1938	1954	1957	1957	1972	1978	-
Canadian	1959	1968	-	193[illegible]	1949	1953	1965	1964	-	-	-

the Cuyahoga River. The secondary entrance is located at the end of the east breakwater. Small boats can also enter the Lakefront Harbor through a narrow opening in the west breakwater near the shore.

The east breakwater consists principally of dumped core stone that is covered with large, individually placed armor stone. The west breakwater is a stone-filled timber crib structure with a concrete cap. Most sections of the west breakwater are protected by a stone slope on the lakeward side.

Water depth through the main arrowhead entrance is 29 feet below low water datum. Depths are 28 feet in the west basin and in part of the east basin.

The remaining portion of the east basin, opposite the general cargo docks, is 27 feet deep. The channel through the east basin to the east entrance is 25 feet deep.

The entrance to the Cuyahoga River navigation channel is bounded by parallel, stone-filled timber crib piers with concrete superstructures located 325 feet apart. The navigation channel on the Cuyahoga River extends about 5.8 miles upstream from the lakeward end of the piers. The Old River navigation channel is about 1 mile long. The authorized depth of the Cuyahoga River navigation channel is 27 feet from the lakeward end of the piers to a point upstream of Old River. The balance of the Cuyahoga River navigation channel has an authorized depth of 23 feet. The Old River navigation channel has an authorized depth of 27 feet, but has been deepened and maintained to only about 23 feet.

Authorized Federal navigation improvements to the Lakefront Harbor are completed. Uncompleted portions of authorized Federal improvements to the Cuyahoga and Old River navigation channels are described in the following paragraphs and appear on Plates 1 and 2.

(a) Uncompleted Improvements to the Cuyahoga River Navigation Channel - Uncompleted work on the Cuyahoga River includes the replacement of Conrail Bridge No. 14 and related river bank Cut No. 11 and an unnumbered cut to include widening the channel to within 10 feet of the bank to the east in the vicinity of Bridge No. 14, authorized by the 1958 River and Harbor (R&H) Act; the remaining portion of bank Cut No. 4 adjacent to a mill owned by Cereal Food Processors, Inc., originally authorized by the 1937 R&H Act and reauthorized by the 1946 R&H Act; and deepening to 27 feet, the reach of the Cuyahoga River between Conrail Bridge No. 1 and the junction of Old River, authorized by the 1960 R&H Act.

The plans and specifications for the bridge replacement have been completed. Construction has been delayed indefinitely pending resolution of related real estate problems. Cut No. 11 and the unnumbered cut to the east are scheduled to follow the completion of the bridge replacement. The remaining portion of Cut No. 4 has been classified inactive and has not been completed because of problems related to real estate acquisition required for the bank cut. The deepening in the lower reach of the Cuyahoga River upstream of the Conrail Bridge is scheduled to be accomplished in conjunction with authorized channel deepening in the Old River.

(b) Uncompleted Improvements to the Old River Navigation Channel - Uncompleted work on the Old River includes the replacement of the Baltimore and Ohio Railway Bridge No. 23 at the mouth of the Old River and bank Cuts Nos. 12 through 15, authorized by the 1958 R&H Act and deepening of the channel to 27 feet from the mouth of the Old River to the upstream limit of navigation in the vicinity of the westerly end of the Forest City Publishing Company dock, authorized by the 1960 R&H Act and extended by authority of Section 107 of the 1960 R&H Act.

The plans and specifications for the bridge replacement have been completed. However, an alternative plan is being investigated which would provide a new rail connection between the Baltimore and Ohio and the Conrail trackage east of the river. This plan would eliminate the railway bridge crossing at the mouth of the Old River. Progress on this alternative plan requires a new agreement between the Corps of Engineers and the Baltimore and Ohio Railroad for design and construction of the alternative improvement. The design and construction of the bank cuts and channel deepening would follow the removal of the present bridge.

(4) Harbor Maintenance Operations - The Corps of Engineers is responsible for repairing the breakwaters and piers, and for dredging the river channels and Lakefront Harbor to authorized depths.

Corps of Engineers derrick boats are currently used to maintain the breakwaters. Repairs to the east breakwater, virtually a continuous process due to the deteriorated condition of the east breakwater, include rearrangement of the existing armor stone and the addition of new armor or core stone where required. Recently, the easternmost 4,400 feet of the east breakwater was rehabilitated with concrete dolos at a cost of about $9 million. The Buffalo District is currently investigating the feasibility of rehabilitating the remaining length of the east breakwater in a similar manner. Repairs to the west breakwater have been temporarily suspended. The practice of repouring the concrete cap has proven to be impractical because of the difficulty encountered in securing the concrete forms from the continual wave action of the lake. Several alternative methods of repair are under consideration. A recent inspection of the west breakwater disclosed that where the stone slope on the lakeside is built up above the lake level, the breakwater has remained in good condition. Future repairs will be focused on rebuilding the lakeside slope and repairing the concrete cap.

Dredging operations in Cleveland Harbor have historically been divided into contract dredging on the Cuyahoga and Old Rivers and the Government's hopper dredging in the Lakefront Harbor. The Cuyahoga River is normally dredged twice annually; once in the fall and once in the spring. The fall dredging provides a settling basin at the upstream limit of the navigation channel for the material brought downstream during the winter and early spring. Without this dredging, sediments transported by the spring runoff could significantly shoal the channel and restrict commercial shipping until the spring dredging was completed.

The Lakefront Harbor and the Cuyahoga River navigation channel are generally dredged to the authorized project depths. The Old River navigation channel is not maintained to the authorized depth of 27 feet because the prerequisite removal of the Baltimore and Ohio Railway Bridge at the mouth of the Old River, bank cuts, and channel deepening have not been completed. In general, the upper 1,000 feet of the Old River channel is maintained to 21 feet and the balance of the channel to 23 feet.

During the period of 1970-1974, virtually all of the dredged material was placed in two diked disposal areas constructed in the late 1960's as part of a pilot study of dredging and water quality problems in the Great Lakes. From 1972 to fall of 1974, harbor dredging was reduced to selective dredging in the Cuyahoga River because of the lack of adequate storage volume in the diked disposal areas. As a result of the reduced dredging, the Cuyahoga River channel was maintained at less than 23 feet.

The pilot dredging and water quality study of the late 1960's led to enactment of legislation in 1970 (Public Law 91-611) which authorized the construction of spoil disposal facilities of sufficient capacity for a period not to exceed 10 years. A new dike disposal area (Site 12) was constructed next to the earlier pilot dikes and was operational in the fall of 1974. This new dike disposal area, which has a capacity for about 3-1/2 years of dredging, was the first stage of the 10-year dike disposal program. A second diked area (Dike 14), opposite Gordon Park to contain the remaining 6-1/2 years of dredging, was constructed in 1980.

It is reported that over the 8-year period (fall 1974 to spring 1982) an average of about 625,000 cubic yards of sediments were removed each year to maintain the navigation channels and Lakefront Harbor at authorized depths. This average annual amount consisted of about 525,000 cubic yards from river channels and 100,000 cubic yards from the Lakefront Harbor, In addition, private interests dredged about 50,000 cubic yards of sediment annually along private docks.

A review of historical flooding along the Cuyahoga River navigation channel and preliminary hydraulics investigations were conducted as a part of the 1972 - 1976 Feasibility Study. These studies indicated that if the channel is maintained to the authorized depth, the 50-year and 100-year floods, and the estimated flood of record which occurred in 1913 would be retained within the limits of the navigation channel and would not overtop the bulkheads along the river banks. The hydraulic investigation also examined the potential for flooding that might result if dredging of the navigation channel was discontinued and the river sediments accumulated in the channel. Assuming that sediments would fill the navigation channel until the channel bottom attained the slope similar to the channel bottom upstream of the project, the sediments would reduce the depth of the channel at the river mouth from 27 feet to about 8 feet. This assumption is supported by field measurements taken in 1827 which indicated that at that time, the depth at the river mouth was about 7 or 8 feet. The results of the preliminary hydraulics investigation indicated that if dredging were discontinued and the river channel allowed to silt in, the 50-year and 100-year flood flows, and the 1913 flood would overtop the bulkheads. The extent of potential flood damage was not estimated.

(5) Cargo Movement: Great Lakes; Cleveland Harbor - Great Lakes commodity movement in 1981 totaled about 185,000,000 net tons. Of this total, 13,900,000 net tons, or 7.5 percent, were shipped to or from Cleveland Harbor, ranking Cleveland as the fifth largest harbor on the Great Lakes in terms of commodity movements. Great Lakes marine tonnages in 1981 (185,000,000 net tons) were only about 10 percent of the total United States commerce of about 1,900,000,000 tons, with Cleveland accounting for about 1 percent of the national total. However, 77 percent of the total United States iron ore tonnage of 120,000,000 net tons, was routed through the Great Lakes, with about 9 percent of the United States total iron ore shipments entering Cleveland Harbor.

Cleveland is an important but specialized harbor. Of the 13,900,000 net tons of cargo shipped in 1981 (see Table 13), 13,000,000 tons, or 93 percent, consisted of iron ore, limestone, sand and gravel, and salt. Iron ore, the largest commodity shipped in 1981 at 9,500,000 net tons, or 68 percent of the total, is either consumed locally at the local steel mills or transshipped to inland steel mills in southern Ohio, West Virginia, and Pennsylvania. Limestone, with 1,400,000 net tons received in 1981, or 10 percent of the total, and sand and gravel, with 1,100,000 net tons received in 1981 or 8 percent of the total, are both consumed locally. Salt, the fourth significant commodity at Cleveland Harbor and the major commodity exported, accounted for about 7 percent of the total commodity movement at Cleveland Harbor in 1981. In addition, salt constituted the major commodity shipped on the Old River segment of the harbor.

Projected future tonnages for these four commodities at Cleveland Harbor, in addition to general cargo which is received at the Cleveland Port Authority docks in the Lakefront Harbor, are presented in Table 14. These projections were developed by the Buffalo District by first establishing the historic long-term average tonnage for these five commodities based on the most recent 10-year period and projecting these tonnages into the future by anticipated commodity growth rates. Commodity growth rates for general cargo were obtained from the "Regional Transportation Study for U.S. Army Engineers, Booz, Allen and Hamilton, Inc., September 1981 and for all other commodities from the National Waterways Study. In all cases, these growth rates were modified to reflect information received from dock operators at Cleveland on the anticipated long-term commodity movements at their docks and the capacity of industrial plants at Cleveland consuming these commodities. Additional details on this process for iron ore, limestone, and general cargo are presented in Appendix B, "Economic Evaluation". Tonnage forecasts for sand and gravel and salt were obtained from the Stage 2 Report for this study and were not updated for this Stage 3 Report.

As indicated in Table 14, tonnages for these commodities are expected to grow from an estimated 1990 total of 17,700,000 net tons to 21,700,000 net tons in 2040, or an overall increase of 23 percent. Iron ore will experience the largest increase, growing from 12,700,000 net tons to 15,500,000 net tons. Movement of limestone and sand and gravel is expected to remain constant at 1,800,000 and 1,300,000 net tons, respectively, throughout the evaluation period.

Table 13 - Selected Commodity Movements at Cleveland Harbor, OH
(Thousands of Short Tons)

Year	Iron Ore		Limestone		Sand & Gravel		Salt		Selected Commodities: Sub-Total		Harbor Total
	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	
1972	17,450	73.1	2,477	10.4	1,378	5.8	871	3.6	22,176	92.6	23,866
1973	18,080	72.8	2,826	11.4	1,615	6.5	575	2.3	23,096	93.0	24,828
1974	15,635	71.3	2,590	11.8	1,404	6.4	964	4.4	20,593	93.9	21,934
1975	13,263	73.1	1,906	10.5	966	5.3	1,010	5.6	17,145	94.5	18,145
1976	13,396	73.7	1,935	10.7	823	4.5	804	4.4	16,958	93.3	18,168
1977	10,526	65.4	2,280	14.2	922	5.7	647	4.0	14,375	89.3	16,104
1978	13,770	70.0	2,653	13.5	1,225	6.2	534	2.7	18,182	92.5	19,659
1979	14,473	74.3	2,025	10.4	1,066	5.5	449	2.3	18,013	92.5	19,470
1980	10,040	71.5	1,436	10.2	1,023	7.3	508	3.6	13,007	92.6	14,045
1981	9,494	68.3	1,405	10.1	1,110	8.0	956	6.9	12,965	93.2	13,904
10 Year: Average	13,613	71.6	2,153	11.3	1,153	6.1	732	3.9	17,651	92.8	19,012

SOURCE: Waterborne Commerce Statistics, Part 3 - Great Lakes, Corps of Engineers, 1972-1981.

Table 14 - Projected Commodity Tonnages - Cleveland Harbor
(Tonnages are in Millions of Short Tons)

Commodity	Project Year 1 1990	5 1995	10 2000	20 2010	30 2020	40 2030	50 2040
Iron Ore							
Lakefront Domestic	4.3	4.8	5.5	6.8	6.8	6.8	6.8
Lakefront Canadian	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Lakefront Total	7.0	7.5	8.2	9.5	9.5	9.5	9.5
Cuyahoga River	5.7	5.9	6.0	6.0	6.0	6.0	6.0
Total Iron Ore	12.7	13.4	14.2	15.5	15.5	15.5	15.5
Limestone	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Sand and Gravel	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Salt	0.8	1.0	1.0	1.0	1.0	1.0	1.0
General Cargo	1.1	1.1	1.1	1.3	1.1	1.6	2.1
Total	17.7	18.6	19.4	20.9	20.7	21.2	21.7

(6) Docks and Terminal Facilities - There are 65 wharves and docks within the Federal project limits at Cleveland Harbor; 14 are located in the Lakefront Harbor, 40 are situated adjacent to the Cuyahoga River, and 11 are located adjacent to the Old River. Table 15 summarizes these commercial dock facilities. In addition, locations of these docks are shown on Plates 1 and 2 in Appendix I. As previously stated, the principal commodities shipped in terms of annual tonnage are iron ore, limestone, sand and gravel, and salt.

9. PROBLEMS, NEEDS, AND OPPORTUNITIES

a. Commercial Navigation Needs.

The fundamental commercial navigation need at Cleveland Harbor is to move bulk and general cargo more efficiently and economically through the harbor. There are also hazards to navigation which must be investigated.

The more specific commercial navigation problems related to the Lakefront Harbor, the Cuyahoga River navigation channel, and the Old River navigation channel are discussed below.

(1) Lakefront Harbor - There are two main commercial navigation problems in the Lakefront Harbor: (a) vessel delays during adverse weather; and (b) transit delays. These two problems will be discussed separately.

Presently, vessels loaded to a static draft greater than 25 feet are required to use the west (main) entrance to Cleveland Harbor since the east entrance, presently maintained at a depth of 25 feet below LWD, does not provide adequate channel depth. However, due to the configuration of the west (main) entrance as discussed below, this entrance cannot be used during adverse weather conditions. Thus, when adverse weather conditions occur, vessels are forced to wait outside the harbor until weather conditons subside. This additional delay time increases the cost of their operations.

There are three concerns at the west (main) entrance that hinder vessel operation during adverse weather conditions: inadequate stopping distance; physical obstacles; and inadequate channel width. According to experienced vessel masters at the 8 April 1981 workshop meeting (see Exhibit G-2), the required stopping distance for 1,000-foot vessels entering the harbor during adverse weather conditions, after the vessel is completely into the protected entrance channel, but prior to making the turn into either the east or west basin, is 1,800 to 2,000 feet. This stopping distance assumes that the vessel is traveling at 6 miles per hour (mph), the speed that is required to offset the effects of crosscurrents at the lakeward end of the arrowhead breakwaters and the effects of winds and waves that are present during adverse weather. Since the total length of the entrance channel at the west (main) entrance is only about 1,000 feet, it does not provide an adequate stopping distance for Class X vessels.

Table 15 - Commercial Dock Data - Cleveland Harbor

Dock Owner	Dock Operator	Principal Dock Use	Dock-Side Equipment	Dock Name
		Lakefront Harbor (1)		
Nicholson Cleveland Terminal Co.	do	Vessel mooring.	Two 10-ton cranes, six forklift trucks, one 4-ton freight elevator.	Nicholson Cleveland Terminal Co. Dock
U. S. Government	U. S. Coast Guard	Vessel mooring.	None.	Cleveland Harbor Station Dock
U. S. Government	COE	Vessel mooring.	None.	COE Dock
City of Cleveland	do	Not used.	None.	E. 9th Street Pier
City of Cleveland	Goodtime Transit, Inc.	Vessel mooring.	None.	City Pier
City of Cleveland	Cleveland Port Authority and Cleveland Stevedoring Co.	Receipt of general cargo.	Seven cranes, 42 forklift trucks, two front-end loaders	Berth 32E
City of Cleveland	Cleveland Port Authority and Cleveland Stevedoring Co.	Receipt of general cargo.	See Berth 32E.	Berths 28, 30, and 32N
City of Cleveland	Cleveland Port Authority and Cleveland Stevedoring Co.	Receipt of general cargo.	See Berth 32E plus one stiff-leg crane.	Berth 28W
City of Cleveland	Cleveland Port Authority and Cleveland Stevedoring Co.	Receipt of general cargo.	See Berth 32E.	Pier No. 26
City of Cleveland	Cleveland Port Authority and Cleveland Stevedoring Co.	Receipt of general cargo.	See Berth 32E.	Pier No. 24
Cleveland Port Authority	Lake Erie Asphalt Products, Inc.	Receipt of iron ore.	One front-end loader, portable conveyors.	Dock No. 20
City of Cleveland	do	Launch mooring.	None.	West Basin Docks
Conrail	Great Lakes Dredge and Dock Co.	Vessel mooring.	None.	Whiskey Island Yard Dock
Conrail	Ohio and Western Pennsylvania Dock Co.	Receipt of iron ore.	Four huletts, two front-end loaders.	Ore Dock No. 11

Table 15 - Commercial Dock Data - Cleveland Harbor (Cont'd)

Dock Owner	Dock Operator	Principal Dock Use	Dock-Side Equipment	Dock Name
		Cuyahoga River - Right Bank (2)		
Joseph Waters	Alpha Concrete Corp.	Receipt of stone.	One front-end loader.	Alpha Concrete Corp. Wharf
Cuyahoga County	Not operated.	Not used.	None.	Harbormaster Dock
Ryan Realty and J&R Properties	Beacon-Hausher Marine Co.	Handling of marine supplies.	None.	Beacon-Hausher Marine Co. Wharf
Lois Samsel	Samsel Rope and Marine Supply Co.	Vessel mooring.	None.	Samsel Rope and Marine Supply Co. Dock No. 2
Great Lakes Towing Co.	do	Tug mooring.	None.	Great Lakes Towing Co. Wharf
Samsel Realty Co.	Samsel Rope and Marine Supply Co.	Receipt of marine supplies, vessel mooring.	One crane, two fork-lift trucks.	Samsel Rope and Marine Supply Co., Dock No. 1
Cereal Food Processors, Inc.	do	Receipt of wheat.	Ship unloading building.	Cereal Food Processors Dock
Cuyahoga Lime Co.	do	Receipt of limestone.	One bulldozer, one front-end loader.	Cuyahoga Lime Co. Dock
Medusa Cement Co.	do	Receipt of cement.	Dockside conveyor.	Medusa Cement Co., Cleveland Dock
City of Cleveland	Not operated.	Not used.	None.	Columbus Road Dock
B&O Railroad Co.	Various operators.	Vessel mooring and repairs.	None.	B&O Collision Bend Mooring Dock
Mid-Continent Coal and Coke Co. and City of Cleveland	Mid-Continent Coal and Coke Co.	Export of coke breeze.	One loading tower.	Mid-Continent Coal and Coke Co. Dock
Ford Motor Co.	do	Receipt of limestone and iron ore.	One front-end loader.	Ford Motor Co. Dock
The Cleveland Builders Supply Co.	do	Receipt of sand and limestone.	Three front-end loaders.	Cleveland Builders Supply Co., Dock No. 2
United Garage and Service Corp.	Ontario Stone Corp.	Receipt of limestone.	Four front-end loaders.	Ontario Stone Corp., Dock No. 2
U. S. Steel Corp.	Not operated.	Not used.	None.	U. S. Steel Corp. Furnace Stone and Pig Iron Dock

Table 15 - Commercial Dock Data - Cleveland Harbor (Cont'd)

Dock Owner	Dock Operator	Principal Deck Use	Dock-Side Equipment	Dock Name
		Cuyahoga River - Right Bank (Cont'd) (2)		
U. S. Steel Corp.	Not operated.	Not used.	Two huletts.	U. S. Steel Corp., Central Furnace Ore Wharf
Reiss Oil Terminal Corp.	do	Loading and unloading of petroleum products.	None.	Marine Fueling Wharf
E. I. DuPont de Nemours & Co., Inc.	Not operated.	Not used.	None.	DuPont Acid Plant Sulphur Dock
Republic Steel Corp.	do	Receipt of limestone.	None.	Republic Steel Corp., Lower Dock
Republic Steel Corp.	do	Receipt of fuel oil.	None.	Republic Steel Corp., Fuel Oil Dock
Republic Steel Corp.	do	Receipt of iron ore.	Two traveling bridge cranes, one bulldozer, five front-end loaders.	Republic Steel Corp., Upper Dock
J & L Steel Corp.	do	Receipt of iron ore, limestone, and fuel oil.	Two traveling bridge cranes, two scrapers, two front-end loaders.	J & L Steel Corp., Cleveland Works Wharf
		Cuyahoga River - Left Bank (2)		
Republic Steel Corp.	do	Receipt of iron ore and limestone.	Two traveling bridge cranes.	Republic Steel Corp., West Side Dock
C-I-L Chemicals, Inc	do	Receipt of sulfuric acid.	None.	C-I-L Chemicals Wharf
Koppers Co., Inc.	do	Receipt of ashphalt.	One hand-operated hoist.	E. Koppers Co. Wharf
Cleveland Builders Supply Co.	do	Receipt of sand and stone.	One front-end loader.	Cleveland Builders Supply Co. Dock
Gulf Oil Refining and Marketing Co.	do	Fueling harbor bunkering vessels.	None.	Gulf Oil Corp., Cleveland Terminal Wharf
Mobil Oil Corp.	Clifton Concrete and Supply Co.	Receipt of sand, and stone.	One front end loader.	Clifton Concrete and Supply Co. Wharf
Texaco, Inc.	Not operated.	Not used.	Two hand-operated derricks.	Texaco Wharf

Table 15 - Commercial Dock Data - Cleveland Harbor (Cont'd)

Dock Owner	Dock Operator	Principal Dock Use	Dock-Side Equipment	Dock Name
		Cuyahoga River - Left Bank (Cont'd) (2)		
Shell Oil Co.	do	Deployment of oil spill recovery boat.	One derrick.	Shell Oil Co. Wharf
Cleveland Builders Supply Co.	do	Receipt of sand.	See Cleveland Builders Supply Co., Dock No. 2.	Cleveland Builders Supply Co., "F" Mill Dock
Cleveland Builders Supply Co.	do	Receipt of miscellaneous bulk materials and fuel oil.	See Cleveland Builders Supply Co., Dock No. 2.	Cleveland Builders Supply Co., Dock No. 4
Bradford-Carter Estate	Eagle-Scranton Corp.	Vessel mooring.	None.	Eagle-Scranton Corp. Mooring Dock
City of Cleveland	City of Cleveland	Fireboat mooring.	None.	Eagle Ave. Fireboat Wharf
Scranton-Averell, Inc.	G&W Industries, Inc.	Vessel mooring.	Four cranes.	G&W Industries Wharf
Alpert Bros. Leasing Co., Inc.	G&W Industries, Inc.	Vessel mooring.	None.	Alpert Bros. Leasing Co., Upper Dock
Alpert Bros. Leasing Co., Inc.	Alpha Precast Corp.	Receipt of sand and stone, shipment of dollose.	One hoist, one front end-loader, two forklift trucks.	Alpert Bros. Leasing Co., Lower Dock
B&O Railroad Co.	G&W Industries, Inc.	Vessel mooring.	None.	Sycamore St. Dock
B&O Railroad Co.	Not operated.	Not used.	None.	B&O Railroad Co., Main St. Warehouse Wharf
		Old River - Right Bank (2)		
U. S. Steel Corp.	Various operators.	Receipt of limestone, vessel mooring.	None.	U. S. Steel Corp., Sycamore St. Wharf
National Gypsum Co.	do	Receipt of bulk cement.	None.	Huron Cement, Cleveland Terminal Wharf
Ontario Stone Corp.	do	Receipt of coal and steel scrap.	Three huletts.	Erie-Lackawanna Ore Dock
Forest City Publishing Co.	Great Lakes Towing Co.	Vessel mooring.	Two cranes.	Great Lakes Towing Co., Shipyard Wharf

Table 15 - Commercial Dock Data - Cleveland Harbor (Cont'd)

Dock Owner	Dock Operator	Principal Dock Use	Dock-Side Equipment	Dock Name
		Old River - Right Bank (Cont'd) (2)		
Forest City Publishing Co.	G&W Industries, Inc.	Vessel mooring.	None.	Forest City Publishing Co. Wharf
		Old River - Left Bank (2)		
Dunbar and Sullivan Dredging Co.	do	Vessel mooring.	Eight cranes.	Dunbar and Sullivan Dredging Co. Slip
International Salt Co.	do	Shipment of salt.	One loading tower.	International Salt Co., Cleveland Mine Wharf
Ashland Petroleum Co.	do	Receipt and shipment of petroleum products.	One hand-operated crane.	Ashland Petroleum Co. Wharf
Sand Products Corp.	Brian D. Stickney, Contractor	Receipt of sand.	One front-end loader.	Sand Products Corp., Dock No. 1
Ontario Stone Corp.	do	Receipt of limestoe, manganese ore, and iron ore.	Three front-end loaders.	Ontario Stone Corp., Dock No. 3
Ontario Stone Corp.	do	Receipt of limestone.	See Ontario Stone Corp., Dock No. 3.	Ontario Stone Corp., Dock No. 1

(1) See Plate 1 for location of docks.

(2) See Plate 2 for location of docks.

SOURCE: The Port of Cleveland, Ohio - Port Series No. 43, Revised 1981.

The inadequacy of the stopping distance at the west (main) entrance is not restricted to Class X vessels. Several times Class V and Class VII vessels have entered the harbor at speeds of 6 to 7 mph and have had to drop their stern anchors and throw their engines into full reverse in order to stop before striking the piers flanking the Cuyahoga River. Entering the harbor at a reduced speed would not be practical during adverse weather conditions because a speed of 6 to 7 mph is required to maintain adequate vessel control. Also, deepening of the east entrance to its present authorized depth of 25 feet below LWD was originally authorized in order to allow Class V vessels the use of the east entrance during adverse weather conditions in-lieu-of the west (main) entrance which was considered inadequate as an entrance during storm conditions. However, the depth of the east entrance became inadequate when the allowable draft of the Great Lakes Navigation System was increased to 25.5 feet relative to LWD.

Vessel masters at the 8 April 1981 workshop meeting indicated that obstacles in the vicinity of the west (main) entrance also pose problems for vessel operations. These obstacles include the lighthouses on the ends of the east and west arrowhead breakwaters, the east and west spur breakwaters, and the piers flanking the Cuyahoga River. The vessel masters stated that they lose sight of an object when it is closer than 300 to 400 feet away, and are forced to rely on instruments and/or lookouts stationed at the bow of the vessel. This problem is intensified at Cleveland Harbor due to the strong crosscurrents present at the west (main) entrance. Thus, the obstacles that are present at the west (main) entrance increase the risk of a vessel accident.

Numerous accidents have occurred in the vicinity of the west (main) entrance in the past. The last reported accident occurred in 1979 and involved a bulk cargo vessel which struck the base of the lighthouse on the end of the east arrowhead breakwater due to a sudden wind squall. The accident caused about $250,000 in damages to the lighthouse and about $65,000 in damages to the vessel.

Local interests have also stated that, in their opinion, the existing width of the entrance channel between the ends of the east and west spur breakwaters (750 feet) is inadequate for vessels turning into either the east or west basin during adverse weather conditions, particularly for 1,000-foot vessels. Vessel navigation tests conducted at WES with a scale model of a 1,000-foot vessel confirmed this opinion. It was the opinion of the vessel master conducting the ship navigation tests, and subsequent opinions of other masters who ran ship navigation tests at later dates, that even under ideal weather conditions, there was no margin for error when a vessel entered the harbor and turned into either the east or west basin with the present channel width. However, when entering the harbor under adverse weather conditions, additional leaway (i.e. channel width) would be required to accommodate unforeseen vessel motion caused by such things as sudden bursts of wind, strong cross-currents, etc.

Shipping interests at Cleveland Harbor have provided information regarding the maximum weather conditions above which they would not attempt to enter the harbor through the existing west (main) entrance at the 24 February 1983

Workshop Meeting (see Exhibit G-6 in Appendix G) and by letters dated 15 July 1983, 2 September 1983, 7 January 1983 and 12 May 1983 (Exhibits F-10, F-11, F-12, and F-13 in Appendix F, respectively). They also provided information regarding the maximum weather conditions for which they would still be able to proceed to their destination dock and initiate the unloading cycle, if an adequate harbor entrance was provided. A summary of this information is as follows:

(a) Class V thru Class VII bulk cargo vessels will not attempt to enter the existing harbor when winds exceed 25 knots from the west thru east-northeast directions. However, if an adequate harbor entrance was provided, they would enter the harbor in winds up to 30 knots, the limiting condition for docking at Conrail's iron ore transshipment dock.

(b) Class X bulk cargo vessels, which require more maneuvering room than the smaller Class V thru VII vessels, will not attempt to enter the existing harbor when winds exceed 20 knots from the west thru east-northeast directions. However, if an adequate harbor entrance was provided, they would enter the harbor in winds up to 30 knots, the limiting condition for docking at Conrail's iron ore transshipment dock.

(c) Foreign flag vessels, which are typically six to seven hundred feet in length and which deliver general cargo to the Cleveland Port Authority docks in the Lakefront Harbor, will not attempt to enter the existing harbor when winds exceed 20 knots from the south-southwest thru northeast directions. However, if an adequate harbor entrance was provided, they would enter the harbor in winds up to 40 knots, the limiting condition for docking at the Cleveland Port Authority docks.

(d) On average, vessels experience 15 hours of delay each time they are forced to wait outside Cleveland Harbor due to adverse weather conditions.

The second commercial navigation problem in the Lakefront Harbor is the additional transit time required by vessels loaded to a static draft of 25 feet or greater that arrive from or depart to the east. Presently, due to inadequate depth in the existing east entrance and east basin (25 feet LWD), these vessels must use the deeper west (main) entrance. Thus, general cargo vessels arriving from the east must first travel west of their destination (i.e. the Cleveland Port Authority docks located east of the west (main) entrance), enter the harbor through the west (main) entrance, and then back track to the east. When departing for destinations east of Cleveland they must reverse this procedure. On average, this increases their transit time by one hour each way over and above that which would be required if the east entrance and east basin were usable (i.e. deeper) (see Exhibits F-12 and F-13 in Appendix F). Bulk cargo vessels transporting Canadian iron ore via the St. Lawrence Seaway and the Welland Canal, could also save 1-hour in transit time by using a deepened east entrance and east basin. Use of the east entrance and east basin would eliminate the extra maneuvering time required to transit the confining west (main) entrance (see Exhibit G-6 in Appendix G). It should be noted, though, that vessels arriving from or departing to the west would not experience a transit time savings by using a deeper east entrance and east basin due to the additional 4 miles of travel through the east basin.

During coordination of the Plan of Study, local interests also stated that in addition to modifying the Lakefront Harbor for more efficient vessel operation, there was also a need to provide a harbor-of-refuge for 1,000-foot vessels at some port on the south shore of Lake Erie. However, at the 29 and 30 October 1981 workshop meeting (Exhibit G-3), vessel masters stated that there was no need to provide a harbor-of-refuge since vessels could lay-off Pelee Island at the western end of Lake Erie or the north shore of Lake Erie during storms. They would then proceed into the harbor when the weather moderated. Therefore, no further consideration was given to this aspect during this Phase I study.

(2) Cuyahoga River Navigation Channel - There are four main commercial navigation concerns in the Cuyahoga River navigation channel: whether or not authorized, but uncompleted, improvements are still economically justified; inadequate channel depth; physical restrictions of the navigation channel which cause undue vessel delay; and inadequate depth of the turning basin. These four problems will be discussed separately.

As previously discussed, there are two authorized improvement projects on the Cuyahoga River that have not been completed (see Plate 2): (a) the remaining portion of bank Cut No. 4; and (b) the replacement of Conrail Bridge No. 14 and related bank Cut No. 11, and widening of the navigation channel to within 10 feet of the east bank in the vicinity of Bridge No. 14. The remaining portion of bank Cut No. 4 has been classified as inactive because local interests have not found it possible to budget for funds in the amount that would be required for acquisition of the required upland property under present conditions. Replacement of Bridge No. 14 and related channel widening has been deferred pending resolution of a real estate problem related to the proposed bridge realignment.

Subsequent to authorization of these two improvement plans, a reduction in traffic flow on the Cuyahoga River has occurred. This reduced traffic flow is a result of, among other things, the closing of the U. S. Steel mill, which previously received iron ore and limestone by bulk cargo vessels and the shift of iron ore receipts destined for Republic Steel Corporation's inland steel mills from their Cuyahoga river docks to their new iron ore transshipment facility in Lorain. Thus, there is a question as to whether or not these authorized improvements are still economically justified considering current reduced traffic conditions.

In addition to reduced traffic flow, the requirement to replace the ship unloading building for the Cereal Food Processors, Inc., facility adjacent to bank Cut No. 4 (see Figure 9) may also impact on whether or not this authorized project can be completed. In 1976, the Buffalo District investigated the possibility of deauthorizing the remaining portion of bank Cut No. 4 because it did not appear that local interests would be able to provide the $5 million needed to relocate the buildings at the project site. Subsequently, Cereal Foods Processors, Inc., indicated that they planned on removing, but not replacing, these buildings (including the ship unloading building) and that the $5 million expenditure by the local sponsor was, thus, no longer required. Therefore, the authorized improvement project was not deauthorized at that time. However, by letter dated 11 February 1982

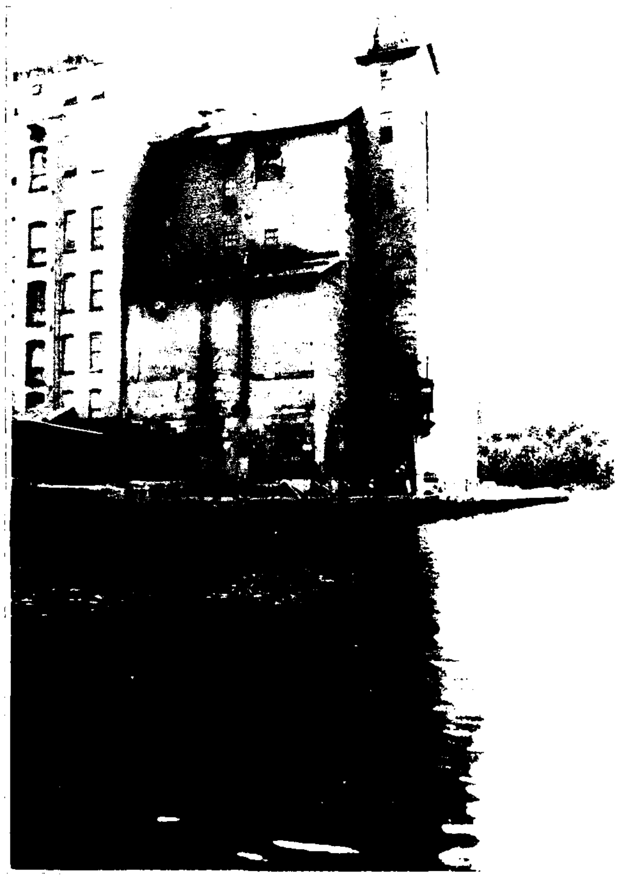


Figure 9 - Cereal Food Processors, Inc. Facility Adjacent to the Cuyahoga River. The ship unloading building is the 6-story addition to the extreme right ([illegible]).

(Exhibit F-14 in Appendix F), Cereal Food Processors, Inc., indicated that they have changed their position in regards to removing the ship unloading building. Therefore, if the remaining portion of bank Cut No. 4 is completed, the ship unloading building will have to be replaced and its cost paid for by local interests, further impacting on the feasibility of completing this authorized project.

In addition to reduced traffic flow, the requirement to replace Conrail Bridge No. 14 may favorably impact on the feasibility of completing the authorized improvements at this location. By letter dated 22 October 1981 (Exhibit F-15), Conrail stated that they plan on abandoning the rail line serviced by Bridge No. 14 and, thus, there would be no need to replace this bridge if the remaining authorized improvements in this area were completed (i.e., bank Cut No. 11 and widening of the navigation channel to within 10 feet of the east bank). It is assumed that when the rail line is abandoned, Conrail will remove the abandoned bridge and its center pier foundation since they hinder navigation. Thus, the cost of the authorized improvements at this location will decrease; however, it is not known if the decrease in project cost will be sufficient to overcome the decrease in benefits resulting from reduced traffic flow on the Cuyahoga River.

Based on the foregoing discussion, it was deemed appropriate to reevaluate the economic feasibility of the two authorized, but uncompleted, improvement projects on the Cuyahoga River as part of this Phase I study.

The second commercial navigation problem in the Cuyahoga River navigation channel is inadequate channel depth. Presently, Class V vessels, the largest vessels that can navigate the Cuyahoga River, are forced to either unload a portion of their cargo in the Lakefront Harbor, with delivery of this cargo to upriver industries by truck, before proceeding upriver or must enter Cleveland Harbor light-loaded initially. This results in additional transportation costs. For example, the estimated transportation cost for a 630-foot vessel transporting iron ore from Duluth-Superior to Cleveland Harbor, assuming a 275-day navigation season, and loaded commensurate with the present authorized channel depth of 23 feet below LWD (i.e., loaded to 21-foot static draft), is approximately $10.00 per ton. Similarly, the transportation cost for the same vessel transporting the same iron ore, but loaded to the maximum Great Lakes System draft of 25.5 feet, is only $8.00 per ton. Thus, there is a potential savings of $2.00 for every ton of iron ore shipped on the Cuyahoga River, if the navigation channel was deepened to allow loading to 25.5 feet. Coordination with local shipping companies indicated that, if the navigation channel was deepened, they would take advantage of this potential savings. In addition, because more vessel trips are required to carry the same amount of tonnage than would be required if the channel was deepened, interference between vessels is more pronounced. Thus, additional delays are incurred by vessels transiting the river at several congested areas of the navigation channel, resulting in additional transportation costs.

The required channel depth for Class V vessels loaded to 25.5 feet is shown in Table 16. As indicated, a channel depth of 28 feet below LWD would be required for a Class V vessel to navigate the Cuyahoga River navigation channel loaded to the maximum Great Lakes System's draft of 25.5 feet.

Table 16 - Required Cuyahoga River Navigation Channel Depth

Class V Vessel	
Static Draft	25.5 feet
Squat (at 2 MPH)	0.7 feet
Roll and Pitch (1)	0
Bottom Clearance	2.0 feet
Required Channel Depth Below LWD	28.2 feet
	say 28 feet

(1) Roll and pitch and heave are induced by wave action. Since vessels traveling in the Cuyahoga River navigation channel will not encounter wave action, the value for these parameters is zero.

The third main commercial navigation problem in the Cuyahoga River is physical restrictions of the navigation channel (congested areas) which cause undue vessel delays. As shown on Plate 2, the Cuyahoga River navigation channel is a winding, narrow channel with numerous bridge crossings and sharp bends which impede vessel movement. In response to a questionnaire developed by the Buffalo District, shipping companies indicated that there were seven locations where vessel delays were more pronounced than at other locations, and that significant savings in vessel transit time would accrue if these restrictions were eliminated. These seven locations are as follows:

(a) Site No. 1 - Conrail Vertical Lift Bridge No. 1 at the mouth of the Cuyahoga River - Shipping companies reported that all size vessels transiting the Cuyahoga River are often forced to wait for this bridge to open before proceeding. This imposes, on average, an additional 30 minutes in transit time for each trip upriver or downriver.

(b) Site No. 2 - Navigation channel in the vicinity of Cut No. 4 (approximate river mile 1.0) - Because of the narrow channel width in this area (approximately 100 feet), Class V vessels (with an average beam of 68 feet) are required to reduce their speed and proceed very cautiously in order to avoid striking the adjacent banks. This causes, on average, an additional 20 minutes in transit time for each trip upriver or downriver. In addition, shipping companies stated that they experience an additional delay whenever a vessel is unloading at the Cereal Food Processors, Inc., dock. Before proceeding, they must wait for the docked vessel to move upriver, causing an additional delay of about 90 minutes. (NOTE: This 90-minute delay includes a 30-minute delay to the transiting vessel while waiting for the docked vessel to move upriver and a 60-minute delay incurred by the docked vessel while moving upriver, allowing the transiting vessel to pass, and moving back to the dock to finish unloading.)

(c) Site No. 3 - Bend in the vicinity of the Union Terminal Railroad Bridge and the Columbus Road Bridge (approximate river mile 1.5) - Because of the narrow channel width in this bend (in some places the width of the channel narrows to about 190 feet), Class V vessels are forced to reduce their speed and proceed very cautiously in order to avoid striking the banks and bridge piers. This causes, on average, an additional 10 minutes in vessel transit time for each trip upriver or downriver. In addition, shipping companies stated that the bend was too narrow for two-way traffic. Thus, if two vessels approach the bend at the same time, one vessel must pull over and wait, causing an additional 90-minute delay.

(d) Site No. 4 - Bend in the vicinity of the Norfolk and Western Railroad Bridge and Inner Belt Freeway Bridge (approximate river mile 3.0) - Because of the narrow channel width in this bend (in some places the width of the channel is only about 200 feet), Class V vessels are forced to reduce their speed and proceed very cautiously in order to avoid striking the banks and bridge piers. This causes, on average, an additional 10 minutes in vessel transit time for each trip. In addition, shipping companies stated that the bend was too narrow for two-way traffic. Thus, if two vessels approach the bend at the same time, one vessel must pull over and wait, causing an additional 90-minute delay.

(e) Site No. 5 - Bend in the channel at river mile 3.6 - As at other locations, Class V vessels are forced to reduce their speed and proceed very cautiously through this bend in order to avoid striking the banks (in some places the channel narrows to about 160 feet). This causes, on average, an additional delay of 10 minutes in vessel transit time each way. In addition, as with the other bends, this bend is too narrow for two-way traffic, causing an additional 90-minute delay when two vessels approach the bend simultaneously.

(f) Site No. 6 - Conrail Bridge No. 14 (approximate river mile 4.0) - As shown in Figure 10, the east rest pier support for this bascule bridge is located near the center of the Cuyahoga River which reduces the navigable width of the channel to about 115 feet. Because of the narrow channel width, Class V vessels are forced to reduce their speed and proceed cautiously in order to avoid striking the bridge pier. This causes, on average, an additional 15 minutes in transit time, each way.

(g) Site No. 7 - Jefferson Avenue Bridge abutments (approximate river mile 4.3) - In 1961, the city of Cleveland removed the former Jefferson Avenue Bridge that spanned the Cuyahoga River. However, the bridge abutments, which jut out into the channel, were left in place and these abutments reduce the navigable width of the channel to about 130 feet (see Figure 11). Because of the narrow channel width, Class V vessels are forced to reduce their speed and proceed cautiously. This produces, on average, an additional 10-minute delay in vessel transit time.

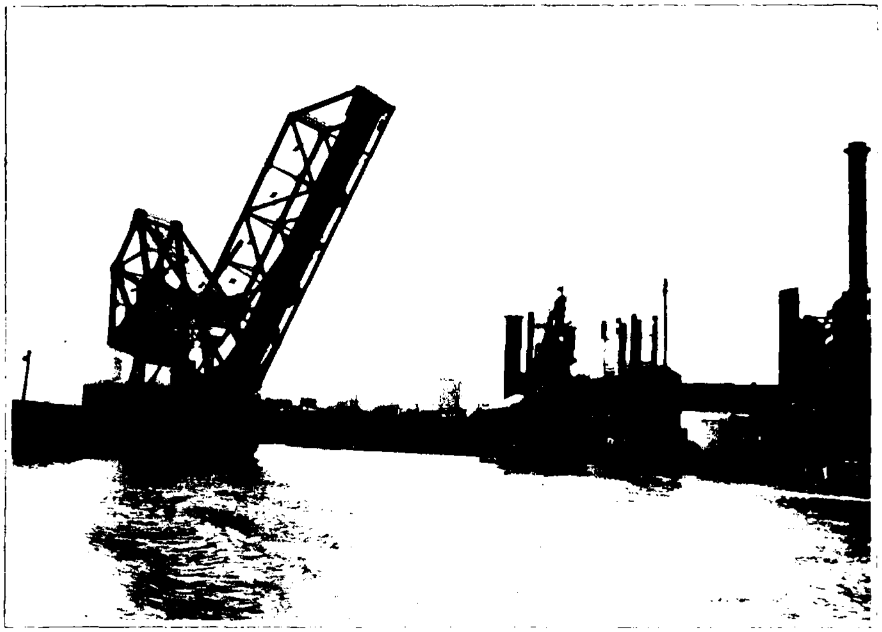


Figure 10 - Conrail Bridge No. 14 (COE - 9/81).

Figure 11 - Jefferson Ave. Bridge Abutments (COE - 9/81).

AD-A139 380 CLEVELAND HARBOR OHIO DRAFT REFORMULATION PHASE I GENERAL DESIGN MEMORAND..(U) CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT FEB 84 2/8

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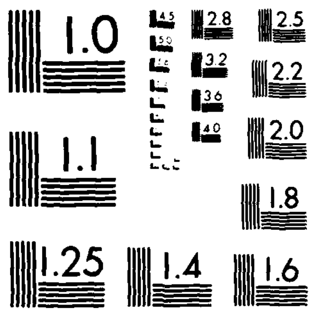


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Although shipping companies also expressed concern about potential accidents at these seven congestion sites, no shipping company originally indicated whether or not vessel accidents had occurred previously. Accordingly, District personnel reviewed the accident reports for Cleveland Harbor compiled by the U. S. Coast Guard, 9th Coast Guard District, for the 10-year period, 1972 to 1981. The results of this review are presented in Table 17. As indicated, Sites 3, 4, and 7 have had accidents in the past involving considerable damage. Conversely, no accidents have been reported for Sites 5 and 6. Based on their review of the data presented in Table 17, local shipping companies also stated that numerous minor accidents occur at Site 7 (Jefferson Avenue Bridge abutments), but are not of sufficient magnitude to be reported to the Coast Guard. Even though each accident involves only minor damages, in total, they represent a significant amount which they estimate to be in the range of $40,000 to $60,000 per year in total (see Exhibit F-16 in Appendix F).

Subsequent to completion of Stage 2 studies, Republic Steel Corporation requested that the Corps investigate the feasibility of deepening the turning basin on the Cuyahoga River from its present 18-foot depth to 23 feet (see Exhibit F-17 in Appendix F). Presently, self-unloading vessels (which unload from the stern) destined for Republic's upriver iron ore dock approach the dock bow first and start to unload their cargo. However, because the upstream bridge (Bridge No. 21) prohibits the vessel from moving upstream such that the stern mounted unloading boom can reach the upstream limits of the iron ore storage pile, these vessels must partially unload their cargo, back down to the turning basin, turn around, and then proceed back to the dock stern first in order to discharge the remainder of their cargo. If the turning basin was deepened to 23 feet, this extra vessel movement would not be necessary since the vessel could turn around during its upstream transit and approach the dock stern first initially. By letter dated 5 April 1983 (Exhibit F-18), Republic Steel Corporation further stated that this effects, on average, five to eight vessel transits per year with an average delay time of 3 to 4 hours per occurrence.

(3) Old River Navigation Channel - As previously discussed, there is presently an authorized, but uncompleted, project for improvement of the Old River navigation channel. Components of this authorized improvement project include: replacement of the B&O Railroad Bridge No. 23; bank Cuts Nos. 12-15; and deepening of the navigation channel to 27-feet below LWD. Implementation of this improvement plan would permit a Class VII vessel (730-foot vessel) to navigate the channel loaded to the maximum Great Lakes System's draft of 25.5 feet. (NOTE: The present dimensions of the Old River navigation channel limit the maximum size vessel to about 649 feet in length. Also, because the channel is maintained at a depth of only 23 feet below LWD, these vessels must travel light-loaded). However, preconstruction planning for this authorized improvement has been suspended since 1971.

Subsequent to authorization of this Old River improvement plan, several docks were closed which may affect the continued economic feasibility of the authorized plan. These closed docks are the old Erie Ore Dock (see Exhibit F-19); and the dock serving the Forest City Publishing Complex (see Exhibit F-20). Since navigation benefits accruing from waterborne commerce crossing these docks were used, in part, to economically justify the authorized project, the continued economic feasibility of the plan is in question. It was, therefore, deemed appropriate to reevaluate the economic feasibility of this authorized project in view of current conditions as part of this Phase I study.

Table 17 - Reported Accidents at Congestion Points on the Cuyahoga River Navigation Channel (1972-1981) (1)

Congestion Point	Description of Accident (Date of Accident)	Amount of Damage
		$
Site No. 1	Small-boat hit bridge (8/79).	5,000
Site No. 2	Class V vessel hit east bank of river.	No Damage
Site No. 3	Class V vessel collided with scow (6/79).	40,000
Site No. 3	Class V vessel hit Columbus Road Bridge (12/77).	6,000
Site No. 3	Class IV vessel hit vessel moored at dock (12/77).	6,000
Site No. 3	Class V vessel hit dock.	Minor Damage
Site No. 4	Bridge tender closed N&WRR Bridge on Class V vessel (11/79).	20,000
Site No. 4	Class V vessel hit both banks of river (12/76).	22,000
Site No. 4	Class V vessel hit N&WRR Bridge (9/72).	4,000
Site No. 5	No reported accidents.	
Site No. 6	No reported accidents.	
Site No. 7	Class V vessel hit bridge abutments (5/78).	20,000
Site No. 7	Class V vessel hit bridge abutments (7/72).	39,000

(1) SOURCE: U. S. Coast Guard accident reports, 1972 through 1981.

b. Recreational Fishing Needs.

During the later stages of the 1972-1976 Cleveland Harbor Feasibility Study, the Ohio Department of Natural Resources (ODNR) and the U. S. Fish and Wildlife Service (USFWLS) indicated that there presently was a need to provide additional recreational breakwater fishing facilities at Cleveland Harbor. The USFWLS reiterated the need for these facilities in their 24 June 1981 "Planning Aid Letter," (Exhibit H-3); and ODNR reiterated the need for these facilities during verbal conversations with District personnel during this Phase I study.

Accordingly, as part of this Phase I study, District personnel conducted a recreational fishing demand analysis to establish the need for additional recreational fishing facilities in the Cleveland Harbor area. This demand forecast was developed using the demand projections for recreational fishing developed by the State of Ohio in their "Outdoor Recreation Plan 1975-1980," modified to reflect more recent population projections provided by the Ohio Department of Economic Development. These modified demand projections were then extrapolated to the year 2040 in 10-year intervals. Additional details on this procedure are provided in Appendix B, "Economic Evaluation" of the Stage 2 Report.

The results of this demand analysis indicated that for the four-county planning region of Cuyahoga, Geauga, Lake, and Lorain Counties, the demand for fishing activity occasions throughout the total evaluation period would not exceed the region's existing supply. However, on a county-by-county basis, Cuyahoga County had a total demand that exceeded the county's existing supply. Therefore, a portion of the Cuyahoga County residents would have to travel to neighboring counties to satisfy their recreational fishing needs.

As with other urban areas in the country, there is a certain percentage of households in the Cleveland area with incomes below the poverty level (7.6 percent). These households, due to their low income, have limited access to private transportation and rely heavily on nearby recreational facilities or facilities near public transportation routes. Assuming that excess fishing occasions demanded by low income families is equal to the percentage of households that have incomes below the poverty level, low income families alone would demand about 122,000 yearly fishing activity occasions in 1990 that Cuyahoga County cannot supply. However, because of their private transportation restrictions, they may not be able to travel to other nearby counties to satisfy their recreational fishing needs. Thus, there is a need to provide additional recreational fishing facilities near public transportation routes in the Cleveland area. Since Cleveland Harbor is readily accessible from public transportation, provision of additional recreational fishing facilities from the west breakwater at Cleveland Harbor would be a major step in meeting this presently unfulfilled demand.

c. Recreational Small-Boat Needs.

Currently there are four active marinas located at Cleveland Harbor. These are the Edgewater and East 55th Street Marinas, administered by the Ohio Department of Natural Resources, and marinas operated by the Lakeside

Yacht Club and the Forest City Yacht Club. However, the existing facilities for recreational boating at these marinas are filled to capacity, with long waiting lists for permanent dock space.

Unfulfilled demand for small-boat berths in Cuyahoga County was estimated at about 2,000 berths in 1990 in a report entitled Development of Recreational Small-Boat Harbors on the Coast of Lake Erie in the Vicinity of Cleveland, OH, - Stage 1 Reconnaissance Report (September 1979), prepared by Betz-Converse-Murdock, Inc., for the Buffalo District. Thus, there is a significant demand for additional small-boat facilities in the Cleveland Harbor area. However, because the Buffalo District presently has the authority to study the potential for Federally constructed small-boat harbors under the Lake Erie Coast Study authorization and the Edgewater Marina Section 107 Study, no further consideration was given to such developments in this Phase I study.

d. Other Recreational Needs.

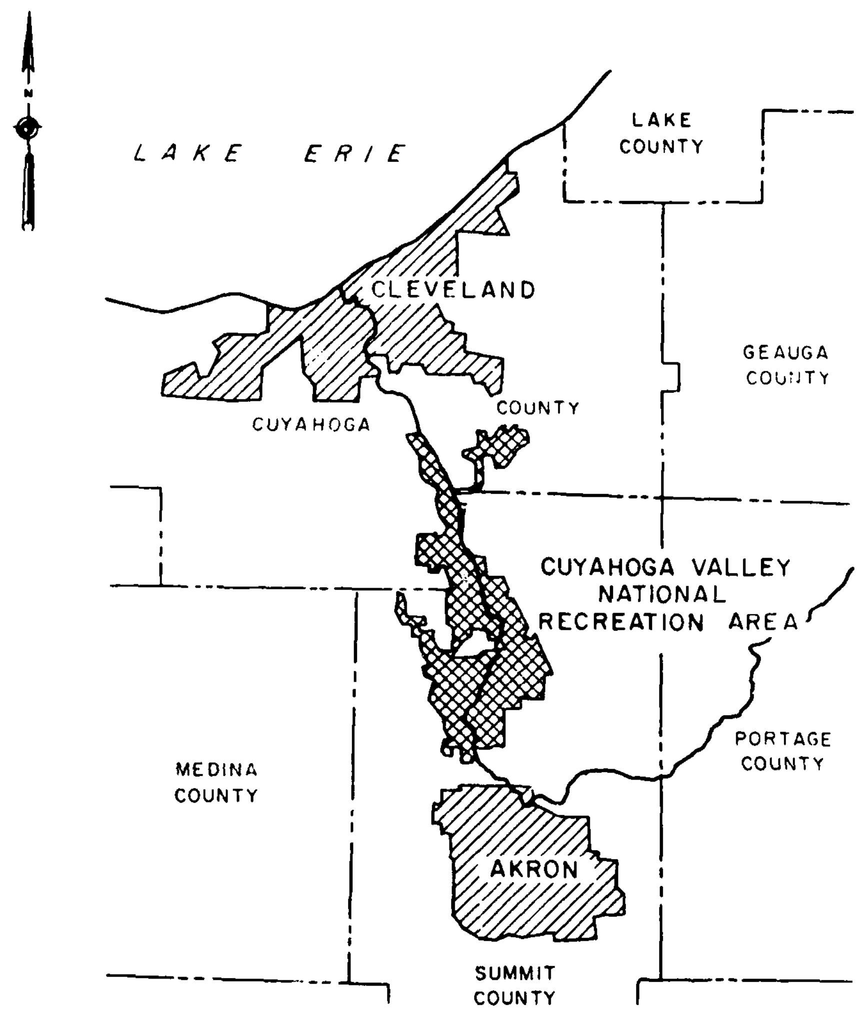
As with other large urban areas, residents of the city of Cleveland need additional facilities to meet their recreational needs. Additional facilities that are required include water-related facilities for boating and fishing, as previously discussed, and for swimming and nonwater-dependent facilities for activities such as hiking, biking, picnicking, and passive and active enjoyment of the natural environment.

Two public agencies have taken the lead in providing for these unmet recreational needs. One agency, the Ohio Department of Natural Resources, has developed plans for the Cleveland Lakefront State Park. Located along the shoreline of Lake Erie and encompassing Cleveland Harbor, the park will provide both water and nonwater related recreational facilities and will be developed over the next several decades. A master development plan for the park is provided as Plate 5 in Appendix I.

The second agency providing additional recreational facilities is the National Park Service under their management of the Cuyahoga Valley National Recreation Area (CVNRA). Authorized by Congress in 1974 (PL 93-555), the CVNRA will preserve for public use and enjoyment some 29,000 acres of rural valley landscape between Cleveland and Akron (see Figure 12). Emphasis in developing the recreation area will be to provide both passive and active enjoyment of the natural environment in a manner which will preserve its scenic, natural, and historic setting for future generations.

In addition to the Ohio Department of Natural Resources and the National Park Service, the city of Cleveland, Cuyahoga County, and the State of Ohio - Cleveland Metropolitan Parks Department maintain an extensive network of parks and recreational facilities for the general public.

In conclusion, although there is a need for additional recreational facilities in the Cleveland area, local agencies have taken the lead in meeting both the immediate and long-term needs of the area. Therefore, no further consideration was given to providing additional recreation facilities (with the exception of additional recreational breakwater fishing facilities) during this Phase I study.



SOURCE:
"CUYAHOGA VALLEY 1975" - PAGE 8

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

CUYAHOGA VALLEY NATIONAL RECREATION AREA LOCATION MAP

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE 12

e. Water Quality.

As previously discussed, the waters of the lower Cuyahoga River are grossly polluted and have high temperatures; low concentrations of dissolved oxygen; intermittent toxicity; and excessive solids, ammonia, BOD, COD, oil, fecal coliform bacteria, zinc, iron, lead, cyanide, phenols, floating debris, odor, and turbidity. Local interests have repeatedly stated the need to improve the water quality of the river.

The Northeast Ohio Areawide Coordinating Agency is currently involved in a Section 208 Study (PL 92-500) in the Cuyahoga River Watershed. The goal of this study is to identify development and management water quality programs that would control point and nonpoint sources of pollution, thereby reestablishing and maintaining the highest practical water quality in the Cuyahoga River. In addition, the Environmental Protection Agency has established discharge limitations for most pollutants with a view towards improving water quality. Thus, to avoid duplication of effort, no further consideration was given to improving water quality in the Cuyahoga River during this Phase I study.

f. Erosion and Sedimentation.

Erosion of the river channel and land surfaces feeds large quantities of sediments to the Cuyahoga River where it impairs water quality, aggravates flooding problems, depresses oxygen levels and alters aquatic life. When the river transports this sediment to the relatively quiet waters of the navigation channel at Cleveland, it is deposited and forms shoals. These shoals must then be removed by maintenance dredging, costing in excess of $4,000,000 annually.

Due to the seriousness of the problem in the Cuyahoga River Watershed, the Buffalo District completed the Cuyahoga River, Ohio Restoration Study - Third Interim Preliminary Feasibility Report on Erosion and Sedimentation. In this report, it was concluded that streambank erosion was a minor contributor (approximately 5 percent) to the Cuyahoga River sediment load and that streambank erosion control plans were not economically justified. Further, it was concluded that upland (sheet and rill) erosion contributes significantly to the Cuyahoga River sediment load (approximately 50 percent) and recommended that local interests implement land management programs to control this erosion. Thus, since the basin's erosion and sedimentation problems were recently studied under the Cuyahoga River Restoration Study, no further consideration was given to erosion and sedimentation problems during this Phase I study.

g. Shoreline Erosion.

By letter dated 9 April 1975, the Mayor of the Village of Bratenahl, located immediately east of Cleveland Harbor, stated that lakefront properties in the village were experiencing considerable beach starvation and shoreline erosion. The Mayor also expressed his concern that the Cleveland Harbor breakwaters were a significant contributing factor to this degrading condition. Accordingly, as previously discussed, the Buffalo District conducted a Section 111 Study from 1982 to 1983 for the Bratenahl area. The purposes of this study were to determine the effects of the harbor structures on shoreline erosion and if mitigation of such damages attributable to the harbor structures was warranted. The study determined that the areas immediately adjacent to the harbor (Bratenahl to the east and Perkins Beach to the west) have been adversely impacted due to denial of sand-sized material from the littoral system as a result of maintenance dredging in the Cuyahoga River. To alleviate these damages, dredged material (primarily sand) from the upper reaches of the Cuyahoga River, which was determined to be suitable for open-lake disposal, will be disposed of offshore of these two areas. The dredged material would then enter the littoral system in sufficient quantity to totally mitigate the Federally induced damages to the shoreline. The plan will be implemented under the Cleveland Harbor O&M Program beginning in 1984, pending preparation and favorable review of an Environmental Assessment, FONSI, Section 404 Evaluation and Public Notice for the recommended program. Thus, no further consideration was given to this aspect under this Phase I study.

h. Artifical Fishery Habitat Development.

In their 24 June 1981 "Planning Aid Letter," (Exhibit H-3), the USFWLS suggested that development of artificial spawning substrate (placement of tires, gravel, drain tiles, rock, rubble, etc.) for selected fish species be investigated as a potential mitigation measure for project-related negative environmental impacts. However, based on subsequent discussions between District and USFWLS personnel, it was concluded that development of such artificial spawning areas would also enhance the natural environment and promote the propagation of desirable fish species. In addition, because of the degraded condition of the environment in the harbor area, any such improvement to the environment was urgently needed. Thus, not only was development of fishery habitat areas considered as a mitigation measure for possible negative fishery impacts of several alternatives, it was also considered as a desirable and needed objective of this Phase I study.

10. PLANNING CONSTRAINTS

During this Phase I study, several planning constraints were identified which impacted on the formulation of alternative plans developed to satisfy the water-related needs of the study area. These planning constraints included: (1) wave activity in the Lakefront Harbor; (2) development of an iron ore transshipment facility in the Lakefront Harbor; and (3) the differing opinions of local interests on which entrance (i.e., west (main) or east entrance) to modify as a "severe-weather" entrance to increase vessel efficiency. These three planning constraints are reviewed below.

a. Wave Activity in the Lakefront Harbor.

Throughout the course of the 1972-1976 Feasibility Study and during this Phase I study, the Cleveland Port Authority, the local sponsor for the navigation project, stated that they would oppose any proposed modification plan to the west (main) entrance which would increase wave activity in the Lakefront Harbor opposite their general cargo docks. The Hanna Mining Company, which operates the existing Conrail iron ore transshipment facility adjacent to the west basin in the Lakefront Harbor, also stated their opposition to any plan that increased wave activity in the west basin. Both interests stated that existing wave activity in the Lakefront Harbor during storm conditions was barely tolerable. Any increase in wave activity would *significantly hinder their operations*, including forcing them to close down their docks during certain periods of time and increasing the costs of maintaining their facilities due to increased damages. In turn, this would produce a corresponding increase in their operating costs which would have to be passed on to the consumer. In addition, local shipping companies stated that any increase in wave activity in the Lakefront Harbor would also significantly affect vessel safety, since vessels operating in the Lakefront Harbor are proceeding at a slow rate of speed. This slow speed is not sufficient to offset the effects of increased wave activity acting on the vessel and may result in additional vessel accidents involving considerable damage to harbor structures and the vessels themselves.

During the course of this Phase I study, every effort was made to prevent an increase in wave activity in the Lakefront Harbor as a result of proposed modifications to the west (main) entrance. In this respect, the hydraulic model study at WES was extensively used. Existing wave activity in the Lakefront Harbor was initially established for a wide spectrum of wave heights and directions. This base condition was then compared to the wave heights that would be present as a result of proposed modifications to the west (main) entrance. When wave heights exceeded existing conditions, modifications to the improvement plan under consideration were made to reduce the resulting wave heights back down to existing conditions, and these mitigative measures were then considered an integral part of the proposed improvement plan.

(NOTE: Although existing wave activity in the Lakefront Harbor is high, it presently does not significantly hinder dock or vessel operations. Thus, little or no benefit would be gained by modifying the existing harbor structures to reduce wave activity in the Lakefront Harbor below present conditions and plans to accomplish this aspect were not investigated for this Phase I study. However, as discussed above, any proposed modification plan to the west (main) entrance must include measures to insure that an increase in wave activity does not result from such modification. Local interests are in agreement with this approach.)

b. Development of an Iron Ore Transshipment Facility.

The economic feasibility of plans to modify the Lakefront Harbor for increased vessel efficiency is dependent, in part, upon the development of an iron ore transshipment facility in the Lakefront Harbor capable of accommodating vessels up to 1,000 feet in length. The Selected Plan recommended in the 1976 Feasibility Report was economically justified under the assumption that two such facilities would be constructed: (1) a local transshipment facility which would receive iron ore in 1,000-foot vessels and transship the iron ore to the three local steel mills adjacent to the Cuyahoga River via a conveyor system or by barges; and (2) upgrading of the existing Conrail iron ore transshipment facility adjacent to the west basin of the Lakefront Harbor which transships iron ore from bulk cargo vessels to inland steel mills in southern Ohio, West Virginia, and Pennsylvania via its rail line. However, as previously discussed, local interests are no longer interested in constructing a transshipment facility to service the local steel mills. In addition, Conrail has not committed itself to modernizing and enlarging its existing transshipment facility. Thus, local development plans for an iron ore transshipment facility in the Lakefront Harbor are uncertain at the present time.

During the course of this Phase I study, it has been assumed that an iron ore transshipment facility, capable of accommodating vessels up to 1,000 feet in length, will be constructed in the Lakefront Harbor. Factors supporting this assumption include the following:

(1) Even though Conrail has made no commitment as to whether or not they will modernize and expand their existing iron ore transshipment facility, they have expended considerable funds in conducting engineering and economic feasibility studies on this aspect. They have also been an active supporter of modifying Cleveland Harbor for increased vessel efficiency, and have provided extensive input to both the 1972-1976 Feasibility Study and this Phase I study. Although this in itself is not a commitment, it indicates Conrail's serious interest in modernizing and upgrading their existing iron ore transshipment facility.

(2) In late 1980, the Cleveland Port Authority authorized and funded the Cleveland Harbor Development Study conducted by the engineering firm of Tippetts-Abbott-McCarthy-Straton. The purpose of this study was to obtain an orderly plan to guide the development of the Port of Cleveland through the end of the century and beyond. The resulting recommended development plan will be discussed in Section III of the Main Report, "Formulation of Preliminary Alternative Plans." However, one recommendation of the study was that the Cleveland Port Authority purchase the existing Conrail iron ore transshipment facility, modernize it, and lease it back to Conrail to operate. This recommendation was made based upon estimated net revenues of about $78,000,000 (present worth in 1981 dollars using a 10 percent interest rate and 20-year economic life) and an estimated investment cost of about $21,000,000, exclusive of property acquisition costs. Iron ore tonnage forecasted to be transshipped at this facility ranged from 5.4 million tons in 1985 to 6.5 million tons in 1995 up to 8.0 million tons in 2005, the end of the 20-year evaluation period. Thus, upgrading of the existing Conrail facility appears to be economically justified.

(3) Other local entities have expressed interest in constructing an iron ore transshipment facility in the Lakefront Harbor. For example, Lake Erie Asphalt Products, Inc., previously applied for a Department of the Army Permit for filling operations and new bulkheading in the vicinity of Dock 20, at the mouth of the Cuyahoga River in conjunction with their proposed new iron ore transshipment facility. However, Lake Erie Asphalt Products, Inc., subsequently filed for bankruptcy and are no longer pursuing such plans.

Based on the foregoing discussion, it is the District's position that there is sufficient justification to support the assumption that an iron ore transshipment facility, capable of accommodating vessels up to 1,000 feet in length, will be constructed in the Lakefront Harbor. However, to fully insure that benefits credited to any recommended Lakefront Harbor modification plan are, in fact, realized, the District proposes to make any such recommendation with the stipulation that no construction be started until written assurances are provided by local interests that an iron ore transshipment facility, capable of accommodating vessels up to 1,000 feet in length, will be constructed in the Lakefront Harbor.

c. Differing Opinions on Which Entrance to Modify for Increased Vessel Efficiency.

Although local shipping interests are unanimous in their support of modification of the Lakefront Harbor for increased vessel efficiency, they are divided as to which entrance (i.e., west (main) entrance or east entrance) should be developed as a "severe-weather" entrance. Support for modifying the west (main) entrance is primarily due to the reduction of shipper's transit time from the upper Great Lakes to the Lakefront Harbor by about 1 to 2 hours. Support for modifying the east entrance is due primarily to safety considerations in that vessels could enter the east entrance during storm conditions under full power and still have sufficient maneuvering room to reduce their speed. Modifying the east entrance would also decrease the possibility of vessels striking physical obstacles, which would not be the case if the west (main) entrance was modified.

During the course of this Phase I study, both the Buffalo District and the Cleveland Port Authority were unsuccessful in their early attempts to develop a unified local position on which entrance to modify. Accordingly, modification plans were formulated at both the west (main) entrance and the east entrance for increased vessel efficiency. Selection of the final recommended plan, however, if economically and environmentally justified, will be based primarily upon the plan that provides the greatest average annual net benefits (difference between a plan's average annual benefits and average annual costs).

11. NATIONAL OBJECTIVE

Current Federal policy, as developed by the President's Water Resources Council, requires that alternative water and related resource plans be formulated in accordance with the national objective of National Economic Development (NED). National Economic Development is achieved by increasing the value of the nation's output of goods and services and improving economic efficiency. Therefore, in accordance with the guidance established in Engineering Regulation 1105-2-30, "General Planning Principles," dated 5 February 1982, this study was consistent with the planning requirements of the Water Resources Council "Principles and Guidelines" (P&G) and related policies.

12. SPECIFIC PLANNING OBJECTIVES

Specific planning objectives are the national, State, and local water and related land resources management needs (opportunities and problems) specific to a study area that can be addressed to enhance National Economic

Development. Based on a review of the directives established by the authorizing legislation for the Cleveland Harbor Phase I study, previous reports for the area, statements by individuals in the private sector, input from officials at many levels of Government and an analysis of the problems and needs of the study area, as discussed previously, the specific planning objectives for the Cleveland Harbor study that have been identified are as follows:

a. Promote the economical movement of bulk and general cargo through Cleveland Harbor by modifying the Lakefront Harbor for increased vessel efficiency.

b. Promote the economical movement of bulk cargo at Cleveland Harbor by modifying the Cuyahoga River navigation channel at historically congested areas where undue vessel delays occur.

c. Promote the economical movement of bulk cargo at Cleveland Harbor by modifying the Cuyahoga River navigation channel such that the navigation channel is compatible with the maximum Great Lakes System's draft of 25.5 feet.

d. Determine if previously authorized but uncompleted improvements to the Cuyahoga River and Old River navigation channels are still justified in-light-of current conditions.

e. Promote the region's ability to meet its unfulfilled needs for additional recreational fishing facilities.

f. Enhance desirable fish habitat in the study area.

g. Ensure that proposed harbor modification plans do not increase shoreline erosion.

h. Ensure that proposed harbor modification plans do not further degrade water quality.

i. Ensure that proposed harbor modification plans are compatible with future contemplated recreational facilities.

j. Ensure that proposed harbor modification plans do not cause an increase in wave activity in the Lakefront Harbor.

k. Ensure that proposed harbor modification plans do not further aggravate the already serious erosion and sedimentation problem in the Cuyahoga River Basin.

13. CONDITIONS IF NO FEDERAL ACTION TAKEN (WITHOUT PROJECT CONDITIONS)

In any formulation, there is always the basic question . . . "Is there a justified need for change?" Therefore, the conditions that would exist if no

Federal action were taken was investigated for this Phase I study. Besides answering the basic question, these conditions will also provide a common basis for comparing alternative plans of improvement.

As a result of no-action, there would be no modifications to the Federally improved harbor at Cleveland, OH. Therefore, bulk and general cargo movement at Cleveland Harbor would not gain the benefit of increased vessel efficiency. In addition, because of inadequate channel depth in the Cuyahoga and Old River navigation channels, vessels transiting these channels would be forced to navigate at less than the Great Lakes System's draft of 25.5 feet. Bulk cargo vessels would also continue to experience undue vessel delays at historically congested areas. The potential for vessel accidents would also remain high.

As a result of no Federal action, there would be no opportunity to enhance recreational fishing opportunities in the Cleveland Harbor area and the unfulfilled demand for such facilities would remain unmet. This would have a particularly severe impact on the local residents who have incomes below the poverty level since these residents do not have the means to travel outside the area to fulfill their recreational fishing needs. No action would also preclude the potential for enhancement of the natural environment since artificial fish habitat areas would not be constructed.

If no Federal action were taken, there would be no need for the monetary investment that would be required to modify Cleveland Harbor. However, since it is expected that at least several of the proposed modification plans would result in benefits greater than their costs, this potential return on investment would be foregone. No Federal action would also result in no disturbance of the existing environment. Thus, the existing water quality, shoreline erosion, and erosion and sedimentation problems of the area would not be further aggravated. In addition, wave activity in the Lakefront Harbor would not increase. The possibility of conflict with proposed local recreational plans would also be avoided.

SECTION 111
FORMULATION OF PRELIMINARY ALTERNATIVE PLANS

The primary purpose of this section is to provide a summary of the Stage 2 planning effort conducted for this Phase I study. The section provides: a brief review of the alternatives investigated during the 1972-1976 Feasibility Study; subsequent events that necessitated reformulation of the authorized plan of improvement; the formulation methodology used during Stage 2 planning; and a discussion on the development and assessment of preliminary alternative plans. The section then concludes with a discussion on plans of others.

14. PLAN FORMULATION RATIONALE

a. Commercial Navigation Alternatives Considered in the 1972-1976 Feasibility Study.

During the 1972-1976 Feasibility Study, as reported in the Cleveland Harbor, Ohio Feasibility Report For Harbor Modification, (June 1976), a total of 64 alternatives for addressing the commercial navigation needs at Cleveland Harbor were investigated. Although a discussion on each alternative is not provided herein, a review of the major concepts/alternatives considered for the economical movement of bulk cargo at Cleveland Harbor are discussed below.

(1) Commercial Navigation Alternatives Initially Eliminated - During the early stages of the Feasibility Study, several alternatives were eliminated from further consideration because of economic and/or technical reasons. These alternatives involved plans for delivery of bulk cargo to Cleveland Harbor other than by bulk cargo vessels. A brief description of these plans, along with the rationale for eliminating them from further consideration, is presented in Table 18. Thus, the first conclusion reached during the 1972-1976 Feasibility Study was that the most economical means for delivery of bulk cargo to Cleveland Harbor was by bulk cargo vessels. This conclusion remains relevant today for the same reasons.

(2) Commercial Navigation Alternatives Developed in Detail - Four main structural commercial navigation alternatives, in addition to the base case (no-action) alternative, were developed for delivery of bulk cargo to Cleveland Harbor by bulk cargo vessels. These alternatives involved the common feature of modifying the Lakefront Harbor to accommodate 1,000-foot vessels delivering iron ore to Conrail's hinterland transshipment facility and either direct delivery of iron ore to upriver docks in various size

Table 18 - Summary of Alternative Plans Involving Delivery of Bulk Cargo Other Than by Bulk Cargo Vessels (1972-1976 Feasibility Study)

Plan Description	Rationale for Eliminating Plan From Further Consideration (1) (2)
Barging from Originating Harbor.	
Interlake movement of bulk cargo with a barging system similar to that used on rivers.	Similar to direct vessel delivery by bulk carriers with the additional cost of modifying the source harbor. The efficiency and safety of barges on the open-lake was also questioned.
LASH Delivery from Originating Harbor.	
Interlake movement of bulk cargo with vessels constructed to carry lighers or barges within their hulls.	Similar to direct vessel delivery by bulk carriers with the additional cost of lighters and barges. There was also technical problems relating to the high unit weights of iron ore and stone cargo.
Railroad Car Ferry Delivery from Shipping Harbor.	
Interlake movement of bulk cargo in vessels capable of carrying railroad cars.	Similar to direct vessel delivery by bulk carriers with the additional cost of the railroad cars. Further, there was questions as to the safety of these vessels during storm conditions. Major terminal changes to handle the railroad cars would also be required.
Rail From Source.	
All rail movement of iron ore from Lake Superior to Cleveland.	Published rail rate of $15.70 per ton was almost three times the cost of $5.60 per ton for an equivalent movement by vessel.
Tractor-Trailer Delivery from Source.	
Direct delivery of iron ore from source to consuming plant by tractor-trailer.	A preliminary analysis indicated a cost of $14.00 per ton of delivered iron ore under this option versus $5.60 per ton for an equivalent movement by vessel.

Table 18 - Summary of Alternative Plans Involving Delivery of Bulk Cargo Other Than by Bulk Cargo Vessels (1972-1976 Feasibility Study) (Cont'd)

Plan Description	Rationale for Eliminating Plan From Further Consideration (1) (2)
Rail Transship from Another Lake Erie Port.	
Transshipping iron ore from other Lake Erie ports by rail.	Would entail an additional overland rail charge of approximately $3.00 per ton and extra handling costs. Further, substantial investments in new facilities to modify the existing rail system would also be required.
Tractor-Trailer Transshipment from Another Lake Erie Port.	
Transshipping iron ore from other Lake Erie ports by tractor-trailers.	Would entail an additional charge of $1.00 per ton, exclusive of overhead and profit of the haul operator and extra loading and unloading costs. In addition, plan would require upgrading and increased maintenance of haul routes.
Tractor-Trailer Transshipment from Cleveland Lakefront Harbor.	
Delivery of iron ore to Lakefront Harbor in bulk cargo vessels with delivery to receiving plants by tractor-trailers.	Anticipated traffic congestion and haul route upgrading and maintenance costs. However, other transshipment plans from the Lakefront Harbor (via rail, barge and conveyor) were considered further.

(1) All costs stated are on August 1975 price levels.
(2) Other alternatives such as airplane, pipeline (slurry-type delivery) or aerial gondolas were preliminarily discounted as being unsuitable, impractical, or too expensive for bulk deliveries.

vessels or transshipment from the Lakefront Harbor. A summary description of these alternatives, along with their costs and benefits, is presented in Table 19.

As indicated in Table 19, all four alternatives had benefit/cost ratios greater than 1 and positive average annual net benefits. However, in terms of both B/C ratios and average annual net benefits, the fourth alternative plan (transshipment of iron ore from the Lakefront Harbor to the three local steel mills via either a conveyor or by barges) was obviously the most economically efficient plan. In addition, the fourth plan avoided the disruption to existing riverfront development along the Cuyahoga River that would be required for the first three plans. The fourth plan, with either the barge option or the conveyor option, was, therefore, identified as the selected plan of improvement.

Based on review of the selected plan by the U. S. Fish and Wildlife Service and the U. S. Environmental Protection Agency, the selected plan was subsequently modified to include provision for dike disposal of dredged bottom material from proposed Lakefront channel improvements that was suspected of being unsuitable for open-lake disposal. This additional item increased the previous cost estimate for the fourth plan by about $6.9 million.

b. Need for Reformulation of Alternatives (Reformulation Phase I General Design Memorandum)

The need for reformulating the authorized plan is discussed in detail in Section I of the Main Report. In summary, additional studies conducted by the Buffalo District, subsequent to completion of the 1972-1976 Feasibility Study, indicated that: (1) proposed modifications to the east entrance, as an added increment to the basic plan of improving the west (main) entrance, could be economically justified, depending on the choice of wind speed criteria limiting the use of the proposed west (main) entrance; (2) if modifications to only one entrance were economically justified, locals interests were in disagreement on which entrance to modify; and (3) regardless of which entrance was modified, proposed modification plans to both the west (main) and east entrances were not totally satisfactory and may not provide the degree of storm protection originally anticipated. In addition, local interests are no longer interested in constructing a Lakefront transshipment facility for delivery of iron ore to the local steel mills. Further, 1,000-foot vessels have recently been placed in regular service delivering iron ore to Conrail's transshipment facility located adjacent to the west basin. These aspects led to the conclusion that reformulation of the authorized plan was required. Also, during coordination of the Plan of Study and subsequent correspondence [illegible] interests expressed the need for additional modifications to the [illegible] avigation project. These additional modifications included: (1) [illegible] he Cuyahoga River navigation channel; (2) modifying the Cuyahoga R[illegible] ion channel at various locations where undue vessel delays occu[illegible] completing authorized but uncompleted improvements on the [illegible] ga River and Old River. Thus, the original study scope was expanded to include formulation, assessment and evaluation of these additional proposed modification plans. Approval to conduct a Reformulation Phase I General Design Memorandum study was provided by the Division Engineer, North Central Division, in November, 1979.

Table 19 - Summary of Four Main Commercial Navigation Improvement Alternatives (1972-1976 Feasibility Study)

Plan Description	First Cost (1) ($1,000,000) Federal	Non-Federal	Total	Annual Costs (2) ($1,000,000)	Annual Benefits (2) ($1,000,000)	Average Annual Net Benefits ($1,000,000)	Benefit-Cost Ratio
1. Common Features of All Structural Commercial Navigation Plans							
a. Modify Lakefront Harbor to Accommodate 1,000-Foot Vessels Delivering Iron Ore to Conrail's Hinterland Transshipment Facility - The plan that was selected to accomplish this objective was similar to the plan authorized by the 1976 WRDA (see Plate 3 in Appendix I) and included providing a "fair-weather" west (main) entrance and an "all-weather" east entrance. The estimated cost of this plan, on mid-1975 price levels, was $16.4 million.							
b. Upgrading of Conrail's Hinterland Transshipment Facility in the Lakefront Harbor - Another common feature was upgrading of the Conrail iron ore transshipment facility located adjacent to the west basin of the Lakefront Harbor. The cost of this upgrading was estimated at $21.4 million. However, because it was assumed that this upgrading would be required to handle the future iron ore receipts destined for inland steel mills in southern Ohio, West Virginia, and Pennsylvania, whether or not an improvement plan was implemented, its cost was not included in the economic evaluation of the four main structural alternatives under consideration.							

Table 19 - Summary of Four Main Commercial Navigation Improvement Alternatives (1972-1976 Feasibility Study) (Cont'd)

Plan Description	First Cost (1) ($1,000,000)			Annual Costs (2) ($1,000,000)	Annual Benefits (2) ($1,000,000)	Average Annual Net Benefits ($1,000,000)	Benefit-Cost Ratio
	Federal	Non-Federal	Total				
2. <u>Plan 1 - The 680-Foot Vessel Option.</u> This plan included: (1) common modifications to the Lakefront Harbor for operation of 1,000-foot vessels delivering iron ore to the upgraded hinterland transshipment facility, and (2) modifications to five bridges spanning the Cuyahoga River and several bank cuts in order to permit a vessel measuring 680 feet in length and 78 feet in width and loaded to a 21-foot static draft to navigate the Cuyahoga River channel.	61.6	25.4	87.0	5.6	11.6	6.0	2.1
3. <u>Plan 2 - The 800-Foot Vessel Option.</u> This plan included: (1) common modifications to the Lakefront Harbor; and (2) modifying the alignment of the Cuyahoga River and deepening the channel to 27 feet in order to accommodate a hypothetical 800-foot by 105-foot vessel loaded to the maximum system's draft 25.5 feet. Also included in this scheme were 11 bridge modifications and various bank cuts.	182.6	75.5	258.1	16.7	20.4	3.7	1.2

Table 19 - Summary of Four Main Commercial Navigation Improvement Alternatives (1972-1976 Feasibility Study) (Cont'd)

Plan Description	First Cost (1) ($1,000,000) Federal	Non-Federal	Total	Annual Costs (2) ($1,000,000)	Annual Benefits (2) ($1,000,000)	Average Annual: Net Benefits ($1,000,000)	Benefit-Cost Ratio
4. Plan 3 - The 1,000-Foot Vessel Option. This plan was formulated to provide direct 1,000-foot vessel delivery of bulk materials to the three upriver steel mills located near the head of the navigation channel. Included in this plan were: (1) common modifications to the Lakefront Harbor; and (2) modifications to 14 bridges and extensive bank cuts. This option also involved considerable disruption to existing riverfront facilities.	249.9	124.8	314.7	24.2	32.2	8.0	1.3
5. Plan 4A - Transship Upriver, Conveyor. This plan, formulated to eliminate the need to modify the Cuyahoga River, included: (1) common modifications to the Lakefront Harbor; and (2) construction of a second transshipment facility in the Lakefront Harbor to handle iron ore destined for the three upriver steel mills. Iron ore would be delivered to the mills via an overland conveyor.	16.4	99.7	116.1	7.5	27.8	20.3	3.7
6. Plan 4B - Transship Upriver, Barge. This plan is similar to Plan 4A except that iron ore would be delivered to the mills via barges.	16.4	31.5	47.9	3.1	20.4	17.3	6.6

(1) Mid-1975 price levels.

(2) Based on mid-1975 price levels, a 50-year economic life and 6-1/8 percent interest rate.

c. Stage 2 Reformulation.

The objective of the Stage 2 investigation was to identify the best general plan(s) for satisfying the commercial navigation and recreational fishing needs at Cleveland Harbor based on physical constraints, the desires and preferences of local interests and being consistent with sound engineering, economic, and environmental principles. In this process, an iterative procedure that provided for increased levels of refinement in design and critique and evaluation by the principal study participants (i. e. - Corps of Engineers; Ohio Department of Natural Resources; U. S. Fish and Wildlife Service; Cleveland Port Authority; and harbor users) was used to narrow the range of alternatives to carry forward into the Stage 3, or, detailed study phase. The procedure also allowed for review and comments by the general public at informal meetings, workshops and public meetings.

Investigation of other water resources problems and needs, such as other types of recreation, water quality, wave activity in the Lakefront Harbor, shoreline erosion and/or erosion and sedimentation was limited to a level of refinement necessary to adequately assess potential impacts on each by proposed modification plans.

15. GENERAL FORMULATION AND EVALUATION CRITERIA

Federal policy on mulitobjective planning, derived from both legislative and executive authorities, establishes and defines the national objective for water resource planning, specifies the range of impacts that must be assessed and sets forth the conditions and criteria which must be applied when evaluating plans. Plans must be formulated to meet the needs of the area with due regard to benefits and costs, both tangible and intangible and effects on the ecology and social well-being of the community.

The formulation of a plan, including the screening of alternatives, must of necessity be within the context of an appropriate framework and set of criteria. The planning framework is established in the Water Resource Council's "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies", which requires the systematic preparation and evaluation of alternative solutions to problems, under the objective of National Economic Development (NED). The process also requires that the impacts of a proposed action be measured and the results displayed or accounted for in terms of contributions to four accounts: NED, Environmental Quality (EQ), Regional Economic Development (RED) and Other Social Effects (OSE). The formulation process must be conducted without bias as to structural and nonstructural measures.

Within the structure of the overall planning framework other more specific criteria relative to general policies, technical engineering, economic principles, social and environmental values and local conditions must be established. These criteria, used during Stage 2 planning and noted as "Technical," "Economic," and "Socio-economic and Environmental" are listed below. Changes to these criteria during Stage 3 planning are discussed in Section IV of the Main Report.

a. Technical Criteria.

(1) Design wave and lake level for design of breakwater crest elevations should be based on the commercial navigation season which is assumed to extend from April to December on Lake Erie.

(2) A coincident 200-year design frequency, using the 20-year recurrence significant deep water wave height in combination with the 10-year lake level, should be used for stability design of breakwater structures.

(3) Overtopping of protective works for the design condition would be permitted to the extent that the residual interior wave shall be limited to a height consistent with safe and efficient operation of the commercial navigation facility. Residual interior wave heights will be established by the hydraulic model study at WES.

(4) Plans for modifying the west (main) entrance shall be formulated such that wave activity in the Lakefront Harbor does not increase, as verified by the hydraulic model study at WES.

(5) Navigability of proposed modification plans will be based on a qualitative assessment, using the scale model of a 1,000-foot vessel.

(6) Breakwaters will be designed to prevent increased starvation to downdrift areas.

(7) Channel width design will be based on criteria established in Draft EM 1110-2-XXXX.

(8) Channel depth design will be based on the best available technical information, input from experienced vessel masters, a static draft of 25.5 feet, and low water conditions which are exceeded 95 percent of the time (i.e.; LWD - 568.6).

(9) Stability of existing bulkheads after channel deepening will be based on analysis of data obtained from available Department of the Army Permits which cover a percentge of all bulkheads. Based on the results of this stability analysis, the results will be expanded to cover the remaining bulkheads for which permit information is not available.

(10) Design of new bulkheads will be based on criteria established in Draft EM 1110-2-2906, dated 16 Novmber 1970.

b. Economic Criteria.

(1) Tangible benefits should exceed project economic costs.

(2) Each separable unit of improvement or purpose should provide benefits at least equal to its cost unless justifiable on a non-economic basis.

(3) Each plan, as ultimately formulated, should provide the maximum net benefits possible within the formulation framework.

(4) The costs for alternative plans of development should be based on preliminary layouts, estimates of quantities, and June 1982 unit prices.

(5) The benefits and costs should be in comparable economic terms to the fullest extent possible.

(6) A 50-year economic life and 7-5/8 percent interest rate are used for the economic evaluation.

(7) The project evaluation period is a 50-year interval beyond the estimated implementation date of 1990.

(8) The base case for comparison of alternative plans is the "do-nothing" (no-action) plan.

(9) A 275-day navigation season will be assumed.

(10) Assume that the present Great Lakes Navigation System will not be substantially altered and that the locks at Sault Ste. Marie will not constrain commodity growth at Cleveland Harbor.

(11) Assume that an iron ore transshipment facility, capable of accommodating 1,000-foot vessels, will be constructed in the Lakefront Harbor irrespective of whether or not harbor modifications are made. On this basis, the cost of the transshipment facility is not chargeable to the cost of the harbor project.

(12) For Stage 2, assume maximum vessel operating draft is based on low water conditions (i.e., LWD). (NOTE: Actual water levels in Lake Erie frequently exceed LWD and shippers take advantage of this extra depth of water to load their vessels deeper. Traditionally, this extra depth of water has not been taken into account in analyzing the economic feasibility of Corps of Engineers navigation projects. However, guidance issued subsequent to completion of Stage 2 planning (EC 1105-2-118 dated 22 July 1983) requires that actual water levels be incorporated into the economic analysis. Thus, for Stage 3 studies, maximum vessel operating drafts were based on actual water levels and not LWD. Also see note below).

(13) For Stage 2, assume that 1,000-foot vessels are not present in the "base" fleet (see note below).

(14) For Stage 2, assume shippers load their vessels based on safe operating drafts (i.e., 22.5 feet relative to LWD for existing conditions - see note below).

(NOTE: During Stage 2 planning, it was assumed that the operational behavior of vessel operators conformed to Corps of Engineers design standards for both the "with" and "without" project conditions. These standards state, among other things, that harbor entrance channels should allow for safe vessel passage under most weather conditions (i.e., under design storm conditions) with a competent pilot or captain. This assumption affected two factors in establishing "without" project conditions: (1) the maximum sized vessel present in the base ("without" project) fleet; and (2) the maximum vessel operating draft.

As discussed in Section II of the Main Report, the configuration of the existing west (main) entrance to Cleveland Harbor will not allow passage of 1,000-foot vessels during storm conditions although these vessels now enter the harbor during relatively calm conditions on a regular basis. Further, even under ideal weather conditions, it was the opinion of vessel masters who ran ship navigation tests at WES that there was no margin for error when a 1,000-foot vessel entered the harbor through the existing west (main) entrance. Since 1,000-foot vessels could not enter the harbor under design storm conditions, and because there was some question as to the adequacy of the existing west (main) entrance even under ideal weather conditions, 1,000-foot vessels were excluded from the "without" project fleet. The maximum sized vessel present in the base fleet was, therefore, assumed to be limited to a Class VII vessel. Change-in-fleet benefits (i.e., the transportation savings that result from using a larger vessel) were then credited to the various Lakefront Harbor modifications plans that provided a safe entrance for 1,000-foot vessels during design storm conditions.

The second factor affected was the maximum operating draft of vessels in the "without" project condition. Stage 2 studies indicated that an entrance channel depth of 32 feet below LWD was required for safe vessel passage under design storm conditions. This depth provides: (1) 4.5 feet of water under the vessel keel to accommodate vessel motion that occurs during the design storm (roll and squat); (2) a vessel static draft of 25.5 feet; and (3) a 2-foot safety clearance. Since the depth of the existing west (main) entrance is only 29 feet below LWD, it was assumed that the maximum static draft of vessels in the "without" project condition was limited to 22.5 feet (25.5-3 feet). Deepening benefits (i.e., the transportation savings that result from increasing the draft of a vessel) were then credited to the various Lakefront Harbor modifications plans that provided a 32-foot deep entrance channel. These two factors, in addition to using LWD as the water level reference plane, resulted in the significant benefits that were credited to the various Lakefront Harbor modification plans during Stage 2 planning, as discussed in subsequent paragraphs of this section.

Subsequent to completion of Stage 2 studies, new guidance was issued (EC 1105-2-118, dated 22 July 1983) which states that the most likely condition expected to exist over the life of the project under both the "without" and "with" project conditions form the basis of the benefit evaluation. This requires that the evaluation be based on actual anticipated operational behavior of the ship operators even if these practices apparently deviate from Corps of Engineers design standards. Therefore, since 1,000-foot vessels presently operate in Cleveland Harbor, they must be included in the "without" project fleet. Further, since vessel operators normally load their vessels deeper than 22.5 feet (to take advangage of actual water levels above LWD and in view of the fact that additional water to accommodate vessel motion is only required during storm conditions), this additional draft must be accounted for in the economic analyses. These changes were incorporated into the Stage 3 economic analysis and resulted in a significant drop in benefits credible to the Lakefront Harbor modification plan still under consideration (i.e., Plan 1). Similar changes, however, were not made in the economic evaluations of the Lakefront Harbor modification plans eliminated from further consideration at the conclusion of Stage 2 planning since the previous rationale for eliminating these plans from further consideration would still be relevant.)

c. Socio-economic and Environmental Criteria.

The criteria for socio-economic and environmental considerations in water resource planning are prescribed by the National Environmental Policy Act of 1969 (PL 91-190) and Section 122 of the River and Harbor Act of 1970, (PL 91-611). These criteria prescribe that all significant adverse and beneficial economic, social and environmental effects of planned developments be considered and evaluated during plan formulation.

d. Design and Other Considerations.

(1) Design weather conditions - Two weather conditions were considered in formulation of harbor modification plans for 1,000-foot vessel operation in the Lakefront Harbor: "all-weather" conditions; and "fair-weather" conditions. "All-weather" conditions are defined as the worst weather conditions for which vessel masters would enter the Lakefront Harbor, proceed to the dock, and initiate the unloading cycle. This condition was further defined as a maximum 8-foot wave and 30-knot wind from the west through northeast at the 8 April 1981 vessel masters workshop meeting. Vessel masters also defined "fair-weather" conditions as a maximum 4-foot wave and 20-knot wind from the west through northeast.

(2) Disposal of Dredged Material - It was assumed that all dredged material was polluted and would be placed in the existing Dike Site 14. (NOTE: As previously discussed, Dike Sites 12 and 14 were authorized to provide containment for 10 years of maintenance dredging. Sizing of these dike disposal areas to meet this authorized life expectancy was based on an anticipated average yearly dredging volume of 975,000 cubic yards. However, over the 8-year period, fall 1974 to spring 1982, an average of only about 625,000 cubic yards of dredging was required to maintain the navigation channels at authorized depths. In addition, private interests dredged about 50,000 cubic yards of sediment annually along private docks. Since this reduced dredging volume is expected to continue for the foreseeable future, Dike Sites 12 and 14 will have excess capacity over the 10 years authorized life of approximately 3 million cubic yards ((975,000 cy/yr - (625,000 cy/yr + 50,000 cy/yr)) X 10 yrs) and this excess capacity will be used to contain dredged material resulting from proposed harbor modification plans. This course of action is consistent with recent attempts by Congressional interests to authorize construction of the east entrance component of the authorized plan, with dredged material being placed in Dike Site 14.)

(3) Mitigation - There was insufficient environmental data during Stage 2 to determine the need for mitigation or the type of mitigation that might be required. Therefore, plans and associated costs for mitigation, with the exception of development of fish habitat areas utilizing stone rubble from the breakwater removal component of several plans, were not included in the estimates for the Stage 2 report. Mitigation was evaluated in Stage 3, as appropriate.

(4) 1,100-foot Vessel Operation - As previously discussed, the Maximum Ship Size Study, conducted by North Central Division, determined that, among other things, the largest economically sized bulk cargo vessel that would use

the Great Lakes Navigation System would be 1,100 feet long by 105 feet wide. However, since no shipping company indicated any long range plans to construct a vessel larger than 1,000 feet in length, plans were not formulated during this Phase 1 study to accommodate a 1,100-foot long vessel. The ability of 1,000-foot vessel plans to accommodate a 1,100-foot vessel was, however, used as an evaluation criteria in the plan selection process.

(5) Cost Sharing - Traditional cost allocation between Federal and non-Federal interests for commercial navigation and recreational fishing projects is established by existing law. However, the Secretary of the Army recently submitted proposed legislation to provide for full recovery of certain operation and maintenance costs for deep draft ports and their connecting channels on or after 1 October 1982 and for full recovery of construction costs for deep draft ports and their connecting channels which receive initial construction funding on or after 1 October 1981. Therefore, Federal and non-Federal costs for commercial navigation modification plans are presented for both traditional and proposed cost allocation methods. (NOTE: Federal and non-Federal costs for authorized but uncompleted improvements on the Cuyahoga River and Old River navigation channels, which received initial construction funding prior to 1 October 1981, are presented under traditional cost allocation only). Federal and non-Federal costs for recreational fishing plans are based on traditional cost allocation, only. Traditional and proposed cost allocation methods are as follows:

(a) Traditional Cost Allocation - Federal costs in commercial navigation projects under traditional cost allocation methods include 100 percent of the design, construction and operation and maintenance costs of breakwaters, navigation channels, and aids to navigation. Federal responsibilities also include cost sharing in the design and construction of bridge alterations when required for navigation improvements under the provisions of Section 6 of Public Law 647, 79th Congress, as amended. Non-Federal responsibilities for commercial navigation projects include 100 percent of the costs for lands, easements, and rights-of-way; building demolition and replacement; removal, replacement and/or relocation of railroad track and utilities; and required bank stabilization and bulkhead construction. Non-Federal interests are also responsible for deepening berthing areas and slips adjacent to general navigation channels and for the design and construction of all docks and related upland facilities. Federal responsibilities for recreational fishing plans include 50 percent of the design and construction costs of these facilities. Non-Federal responsibilities include providing lands, easements, and rights-of-way, and 50 percent of the design and construction costs of these facilities. Non-Federal interests are also responsible for operating and maintaining these facilities.

(b) Proposed Cost Allocation - Non-Federal interests are responsible for 100 percent of the design, construction and operation and maintenance costs of commercial navigation projects for which initial construction funding is received on or after 1 October 1981.

16. DEVELOPMENT OF PRELIMINARY ALTERNATIVE PLANS (POSSIBLE SOLUTIONS)

a. Development of Preliminary Plans.

Within the prescribed planning framework and established criteria, possible solutions were identified and evaluated in a three stage iterative process that addressed the needs of the study area and the overall planning objectives. Each stage included the four functional planning tasks of problem identification, formulation of alternatives, impact assessment and evaluation. Each stage contained essentially the same sequence of tasks but emphasis shifted as the process proceeded.

This section of the Main Report presents the results of the Stage 2 evaluation. The level of study performed was consistent with the Stage 2 objective of evaluating a broad range of possible solutions and identifying the best general plan (or plans) for satisfying the commercial navigation and recreational fishing needs at Cleveland Harbor. (NOTE: The results of the Stage 1 evaluation, which concentrated on problem identification, were reported in the Classification Report and Plan of Study for Cleveland Harbor, OH, February 1979 (revised October 1979).)

The primary water resources needs for which a solution is sought under this authority are to move bulk and general cargo more efficiently and economically through Cleveland Harbor and to provide for unfulfilled recreational fishing needs in the Cleveland Harbor area. As possible solutions to addressing these needs, twenty preliminary structural alternatives and one preliminary non-structural alternative were identified during the initial phase of the Stage 2 investigation in addition to the no-action option. These preliminary alternatives were as follows:

Lakefront Harbor Modification Plans

Alternative Plan Number	Options	Plans
1		"All-Weather" East Entrance
2		"Fair-Weather" West Entrance
3	A	"All-Weather" West Entrance (Modified "L" - Shaped Breakwater)
	B	"All-Weather" West Entrance (1,000-foot Parallel Breakwater Extensions)
	C	"All-Weather" West Entrance (Detached East Arrowhead Extension)
	D	"All-Weather" West Entrance ("L"- Shaped Breakwater)
4		Combined "All-Weather" East Entrance and "Fair-Weather" West Entrance
9		Tug Assistance

Lakefront Harbor Modification Plans (Cont'd)

Alternative Plan Number	Options	Old River Modification Plans
5	A	Authorized Old River Improvements (Replace Bridge No. 23)
	B	Authorized Old River Improvements (Interchange System)
		Cuyahoga River Modification Plans
6	A	Deepen Cuyahoga River to 25.5 Feet
	B	Deepen Cuyahoga River to 28 Feet
7	A	Reduce River Congestion (Site 1)
	B	Reduce River Congestion (Site 2)
	C	Reduce River Congestion (Site 3)
	D	Reduce River Congestion (Site 4)
	E	Reduce River Congestion (Site 5)
	F	Reduce River Congestion (Site 6)
	G	Reduce River Congestion (Site 7)
		Recreational Fishing Plans (1)
8	A	Recreational Breakwater Fishing (Edgewater Marina Breakwater)
	B	Recreational Breakwater Fishing (West Breakwater)
		No-Action
10		No-Action Plan

(1) Development of a recreational fishing plan at Cleveland Harbor is dependent upon the plan of improvement selected to modify Edgewater Marina in the interest of small-boat navigation. However, during Stage 2 planning for this Phase I study, the extent of such modifications were not well defined. Therefore, two recreational fishing plans were developed that paralleled the primary plans then under consideration to modify Edgewater Marina. The first plan (Plan 8A) assumed that the existing entrance to Edgewater Marina would be completely blocked off with a new breakwater and that a new entrance would be provided into the west basin of the Cleveland Lakefront Harbor. Small-boats would use this new entrance to enter the west basin and would then enter Edgewater Marina through the existing gap in the west breakwater. The second plan (Plan 8B) assumed that the existing entrance to Edgewater Marina was only slightly modified to reduce wave energy entering the marina and continued to serve as the main entrance to Edgewater Marina. Selection of the plan to recommend for construction, however, would have to await the results of the Edgewater Marina Section 107 study.

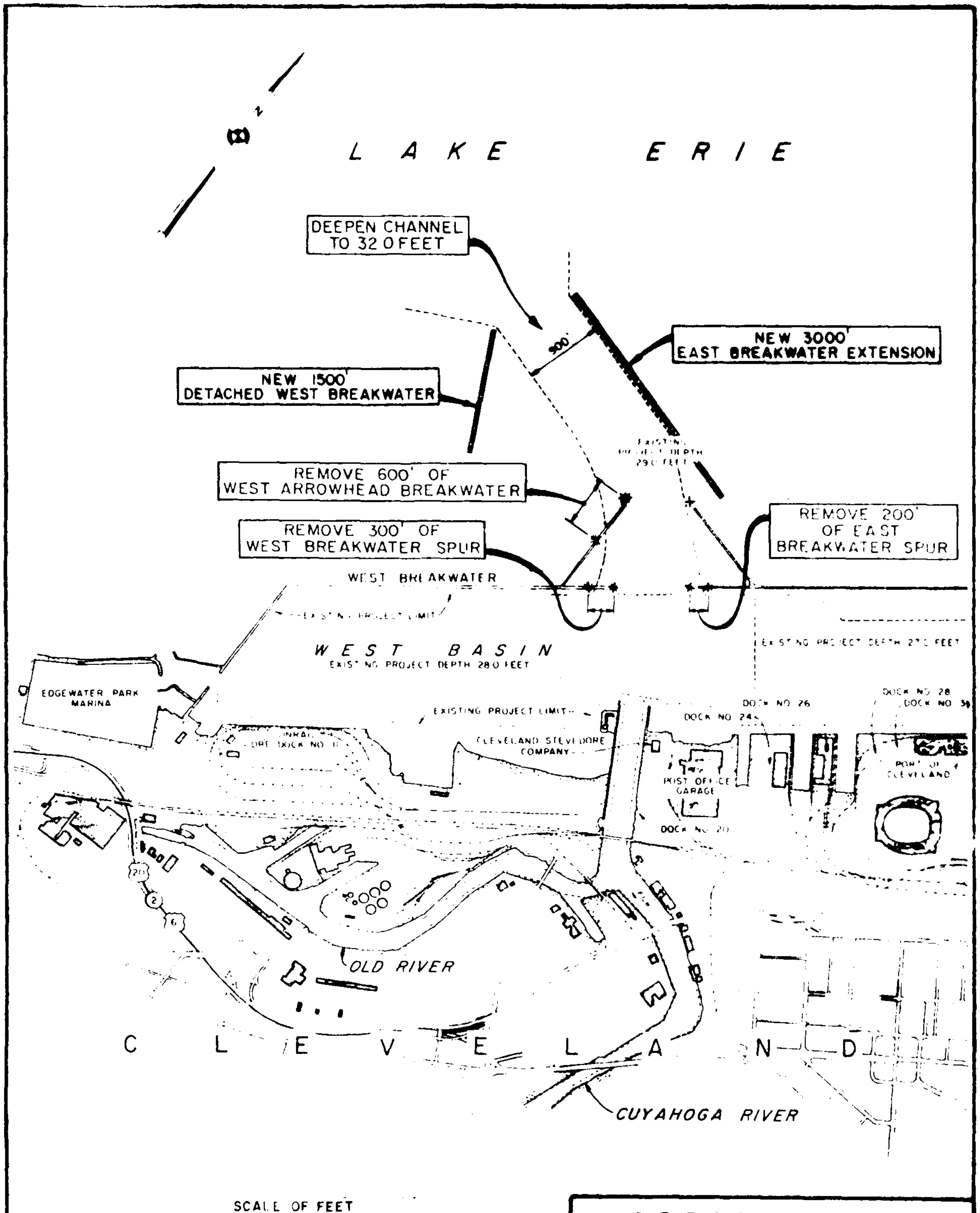
b. Initial Iteration of Alternatives.

Initial evaluation and assessment of the 21 preliminary alternatives, in terms of their contributions to the planning objectives and accounts, indicated that four plans should initially be eliminated from further consideration. These plans were: Plan No. 3C, 3D, 9 and 7A. The reasons for their elimination are discussed below. Initial evaluation and asssessment also indicated that the remaining 17 preliminary structural alternatives and the No-Action option warranted further consideration during Stage 2. The results of this additional evaluation and assessment are discussed in the next paragraph of this section.

Alternative Plans No. 3C, 3D, 9, and 7A were eliminated from futher consideration for the following reasons. Alternative Plan No. 3C (see Figure 13) was originally suggested by vessel masters at the 8 April 1981 workshop meeting as the preferred concept for development of an "all-weather" west entrance plan for safe and efficient operation of 1,000-foot vessels. However, model study tests at WES indicated that this plan could not meet the wave height criteria which were also established by the vessel masters for a plan to be acceptable (i.e., wave heights in the Lakefront Harbor increased over existing conditions and wave heights exceeded 3 feet for an 8-foot incident wave at the existing arrowhead entrance). Therefore, since this plan did not meet wave height criteria, it was eliminated from further consideration.

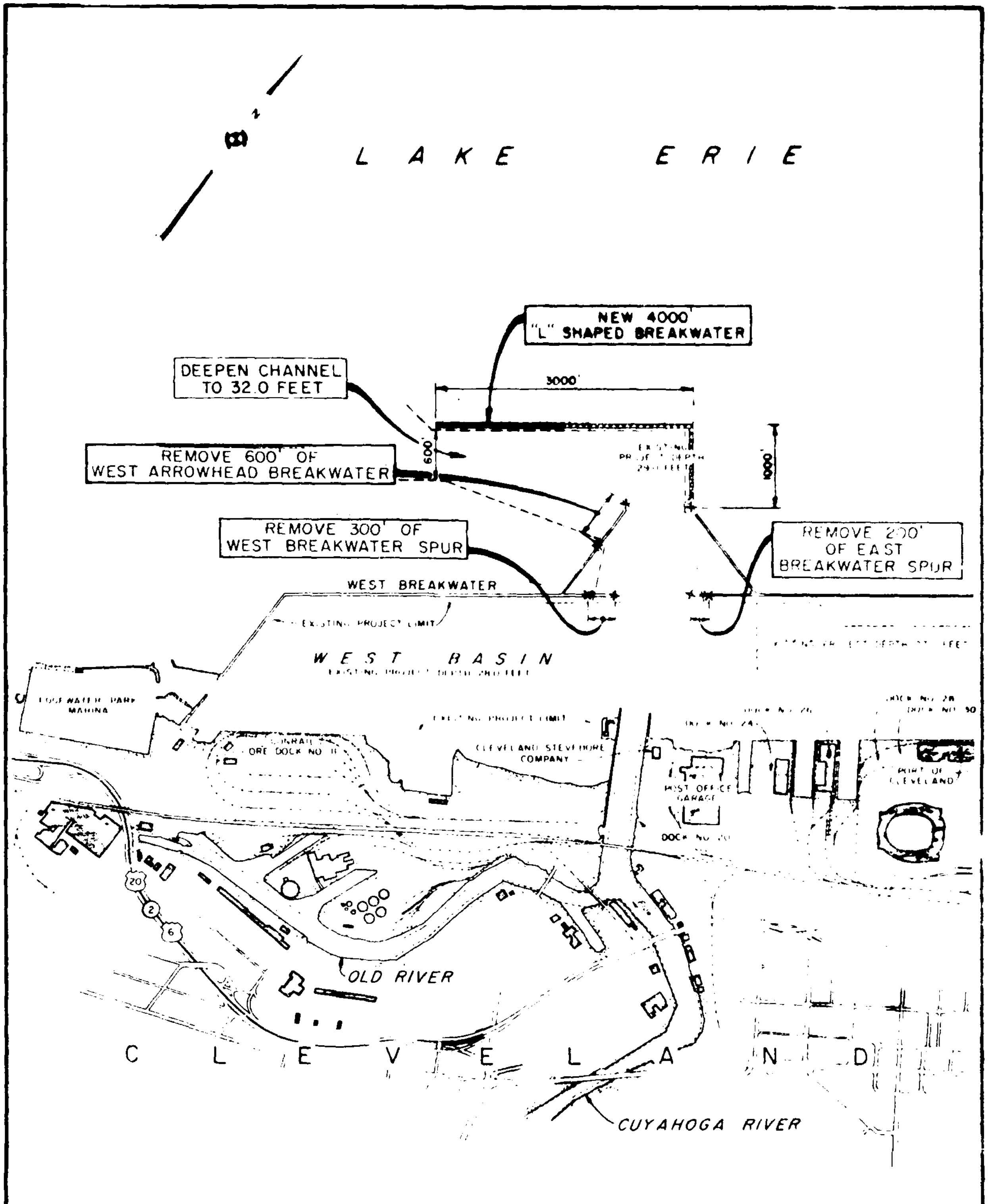
Alternative Plan 3D (see Figure 14) was also suggested by vessel masters at the 8 April 1981 workshop meeting as an alternative concept for development of an "all-weather" west entrance plan for safe and efficient operation of 1,000-foot vessels. Model tests at WES for this plan indicated that wave height criteria, also established by the vessel masters for a plan to be acceptable, were met. However, model testing of a modified version of this concept (Plan 3A), which involved rotating the north leg of the new "L"-shaped breakwater lakeward, indicated that this modified plan, while meeting the wave height criteria, also improved navigability due to the reduced turning angles. Therefore, the modified version was carried forward and Plan 3D was eliminated from further consideration.

Plan 9 (Tug Assistance) was orginally developed as a means of providing for safe and efficient operation of 1,000-foot vessels without the required harbor modifications (i.e., Plan 9 was developed as a nonstructural solution). However, there would be a high potential for serious accidents at the west (main) entrance due to the difficulty tugs would have in controlling the movements of 1,000-foot vessels during rough weather. This problem is further compounded by the narrow opening of the arrowhead breakwaters at the west (main) entrance (i.e.; 600-foot opening). Increasing the width of the opening at the west (main) entrance would not be practical since wave activity in the Lakefront Harbor would increase significantly. Also, no tugs of sufficient size to control the movements of a 1,000-foot vessel (2,000-3,000 horse power) are available on the Great Lakes. For these reasons, Plan 9 was eliminated from further consideration.



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
DETACHED EAST ARROWHEAD EXTENSION CONCEPT FOR "ALL-WEATHER" WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE 13



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
"L" SHAPED BREAKWATER CONCEPT FOR "ALL-WEATHER" WEST ENTRANCE PLAN
U.S ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE 14

Plan 7A, which would eliminate undue vessel delays at Conrail Bridge No. 1 on the Cuyahoga River, was also suggested by shipping interests. The delay at Bridge No. 1 is caused by vessels waiting for the existing vertical lift bridge to open. To eliminate the vessel delays at this site, the existing vertical lift bridge would have to be replaced with a fixed high level bridge providing about 98 feet of vertical clearance. In addition, extensive modifications to the approach tracks on either side of the bridge, including placing about 2 miles of track on trestles, would be required. Since benefits that would accrue from eliminating vessel delays at this site (approximately $675,000 per year which could support a project of about $9,000,000 in construction costs) would not be sufficient to economically justify a project of this scope, Plan 7A was eliminated from further consideration.

17. ASSESSMENT AND EVALUATION OF PRELIMINARY ALTERNATIVE PLANS

a. Formulation and Assessment of Preliminary Plans.

As previously discussed, an initial evaluation and assessment of the 21 preliminary alternatives, in terms of their contributions to the planning objectives and accounts, indicated that 17 alternatives, in addition to the No-Action alternative, warranted further consideration. A brief description of these alternatives, along with their estimated costs and benefits is presented in Table 20. For additional details on these plans, the reader is referred to the Stage 2 Report for this Phase I study.

b. Evaluation of Preliminary Alternative Plans.

In devising the preliminary plans, primary consideration was given to economic considerations, vessel safety considerations, potential adverse environmental impacts and the effects on wave activity in the Lakefront Harbor. From investigations performed as part of the Stage 2 study, there appeared to be no serious adverse environmental impacts from any of the alternatives formulated. In addition, for the Lakefront Harbor modification plans, additional structural modifications were added to the plans, where necessary, to ensure that wave activity in the Lakefront Harbor did not increase above existing conditions. Therefore, the overriding considerations used to determine which alternatives would be carried forward into Stage 3 planning were economic efficiency and vessel safety.

(1) Rationale for Plans Eliminated From Further Study (Plans 2, 3A, 3B, 4, 6A, 6B, 7C, 7D, and 7E) - As stated above, the overriding considerations in choosing which alternatives warranted further study and which alternatives should be eliminated from further consideration were economic efficiency and vessel safety.

(a) Lakefront Harbor Modification Plans (Plans 2, 3A, 3B, and 4) - Although Plans 3A and 3B had benefit/cost ratios above 1, and thus, exhibit economic feasibility, average annual net benefits for each plan were significantly less than for Plan 1 ($14,448,800 for Plan 3A and $15,959,800 for Plan 3B vs. $17,209,100 for Plan 1). In addition, because of the many obstacles in the vicinity of the west (main) entrance, the potential for

Table 20 - Comparison of Stage 2 Alternatives (Plans 1-8, 10)(1)

Plan Description	Total Project Cost (2) (June 1982 Price Levels)	Traditional Cost Allocation		Proposed Cost Allocation		Annual Cost (3)	Annual Benefits (3)	Benefit-Cost Ratio	Average Annual Net Benefits	Carry Forward Into Stage 3
		Federal	Non-Federal	Federal	Non-Federal					
	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)		($1,000)	
1. LAKEFRONT HARBOR IMPROVEMENT PLANS (PLANS 1-4): Purpose is to provide for safe and efficient operation of vessels up to 1,000 feet long by 105 feet wide loaded to the maximum Great Lakes Systems's Draft of 25.5 feet at LWD in the Lakefront Harbor.										
Alternative Plan No. 1 ("All-weather" East Entrance Plan - See Plate 6). This plan includes dredging a fan shaped entrance channel at the existing east entrance and dredging a 500-foot wide channel through the East Basin to the West Basin. Plan is suitable for vessel operation in "all-weather" conditions (maximum 8-foot wave and 30 knot wind from the west through northeast).	5,060	5,060	0	0	5,060	395.9	17,605	44.5	17,209.1	Yes
Alternative Plan No. 2 ("Fair-weather" West Entrance Plan - See Plate 7). This plan includes removal of sections of the spur breakwaters at the west (main) entrance to promote vessel operation during "fair-weather" conditions (maximum 4-foot wave and 20 knot wind from the west through northeast). Also included are breakwater modifications to prevent increased wave activity in the Lakefront Harbor as a result of the spur breakwater removal.	15,100	15,100	0	0	15,100	1,304.0	(4)	(4)	(4)	No
Alternative Plan No. 3A (Modified "L"-shaped Breakwater "All-weather" West Entrance Plan - See Plate 8). This plan consists of providing a new modified "L"-shaped breakwater protected entrance channel, approximately 4,000 feet long, at the existing west (main) entrance and removing portions of the spur breakwaters to promote vessel operation. Plan is suitable for vessel operation during "all-weather" conditions.	33,200	33,200	0	0	33,200	3,160.2	17,605	5.6	14,448.8	No
Alternative Plan No. 3B (1,000-foot Parallel Breakwater Extension "All-weather" West Entrance Plan - See Plate 9). This plan consists of extending and deepening the existing west (main) entrance channel and removing portions of the spur breakwaters to promote vessel operation. Extended entrance channel would be protected by two new 1,000-foot long parallel breakwaters. Plan is suitable for vessel operation during "all-weather" conditions.	18,900	18,900	0	0	18,900	1,645.2	17,605	10.7	15,959.8	No

Table 20 - Comparison of Stage 2 Alternatives (Plans 1-8, 10)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)	Carry Forward Into Stage 3
Alternative Plan No. 4 (Combined "All-weather" East Entrance and "Fair-weather" West Entrance Plan - See Plate 10). This plan combines the features of Plans 1 and 2. The "all-weather" east entrance would be used during rough weather, while the "fair-weather" west entrance would be used during relatively calm conditions. Use of the "fair-weather" west entrance in-lieu-of the "all-weather" east entrance would save 1 to 2 hours in vessel transit time each time a vessel entered or left the harbor.	19,800	19,800	0	0	19,800	(5)	1,699.8	(5)	(5)	No
2. AUTHORIZED BUT UNCOMPLETED IMPROVEMENTS TO THE OLD RIVER NAVIGATION CHANNEL (PLANS 5A AND 5B). Purpose is to determine if authorized but uncompleted improvements to the Old River navigation channel are still economically justified in-light-of current conditions.										
Alternative Plan No. 5A (Replace Bridge No. 23 - See Plates 11 and 12). This plan consists of four bank cuts (Cuts No 12-15) replacing the existing B&O Railroad Bridge at the mouth of the Old River (Bridge No. 23) with a new vertical lift bridge spanning the new channel width and deepening the navigation channel to 28 feet below Low Water Datum (LWD). In addition, new bank cuts would be bulkheaded and existing bulkheads that become unstable due to the channel deepening would be replaced. Implementation of these improvements would allow a vessel up to 730 feet in length to navigate the Old River navigation channel loaded to the maximum Great Lakes System's Draft of 25.5 feet at LWD.	66,687	24,001	42,686	(6)	(6)	6,008.5	2,405.4	0.4	-3,603.1	No (7)
Alternative Plan No. 5B (Interchange System - See Plates 11 and 12). This plan is similar to Plan 5A, except that in-lieu-of replacing the existing B&O Railroad Bridge, the bridge will be removed and a new connection and interchange system to the Conrail trackage on the east side of the Cuyahoga River will be provided. B&O traffic would reach Whiskey Island via this new connection and interchange system and Conrail Bridge No. 1.	54,087	11,263	42,824	(6)	(6)	4,707.5	2,098.5	0.5	-2,609	No (7)

Table 20 - Comparison of Stage 2 Alternatives (Plans 1-8, 10)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)	Carry Forward Into Stage 3
3. CUYAHOGA RIVER DEEPENING PLANS (PLANS 6A AND 6B). The purpose of these plans is to provide a deeper navigation channel in the Cuyahoga River, partially or totally eliminating the need to traverse the channel light-loaded.										
Alternative Plan No. 6A (Deepen the Cuyahoga River to 25.5 feet - See Plate 13). This plan consists of deepening the Cuyahoga River navigation channel from the existing authorized depth of 23 feet to 25.5 feet below LWD. Even with the proposed deepening, however, vessels would still be required to light-load, although at a reduced level from present practice. In addition, existing bulkheads and bridge fendering systems that become unstable due to the river deepening would be replaced. Also, one utility would be relocated (lowered).	213,000	13,496	199,504	0	213,000	20,165.4	8,915.6	0.4	-11,249.8	No
Alternative Plan 6B (Deepening Cuyahoga River to 28 feet - See Plate 14). This alternative is similar to Plan 6A, except that the channel would be deepened to 28 feet below LWD instead of 25.5 feet, and four utilities would be relocated. The deepened channel would allow vessels to load to the maximum Great Lakes System's Draft of 25.5 feet at LWD.	220,000	19,939	200,061	0	220,000	21,154.1	9,745.1	0.5	-11,409	No
4. PLANS TO REDUCE RIVER CONGESTION ON THE CUYAHOGA RIVER (PLANS 7A THROUGH 7G). The purpose of these plans is to eliminate undue vessel delay at seven locations on the Cuyahoga River identified as delay points by shipping companies transiting the river channel.										
Alternative Plan 7A (Site 1 - See Plate 15). This plan was eliminated from further consideration during the early portion of Stage 2 planning due to the high cost of replacing the existing vertical lift Conrail Bridge No. 1 with a new high level bridge and the corresponding approach track modifications required for the new high level bridge. If implemented, a savings of 30 minutes in vessel transit time would have occurred.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	No

Table 20 - Comparison of Stage 2 Alternatives (Plans 1-8, 10)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)	Carry Forward Into Stage 3
Alternative Plan No. 7B (Site 2 - See Plates 15 and 16). This plan consists of completing the remaining portion of Cut No. 4. In addition, the new bank cut would be bulkheaded and the existing bulkheads immediately downstream of Cut No. 4 would be replaced. A savings in vessel transit time of 20 minutes would result.	3,670	247	3,423	(6)	(6)	287.1	501.2	1.8	214.1	No (8)
Alternativ Plan No. 7C (Site 3 - See Plates 15 and 16). This plan consists of new bank Cut No. 16 and replacing the existing Cleveland Union Terminal Bridge and Columbus Road Bridge with new bridges spanning the widened channel. In addition, the new bank cut would be bulkheaded. A savings in vessel transit time of 10 minutes would result.	42,500	31,935	10,565	0	42,500	3,703.7	1,251.7	0.3	-2,452	No
Alternative Plan No. 7D (Site 4 - See Plates 15 and 17). This plan consists of new bank Cuts No. 17 and 18 and replacing the existing N&W Railroad Bridge with a new bridge spanning the widened channel. Again, the new bank cuts would be bulkheaded. A savings in vessel transit time of 10 minutes would result.	39,500	24,912	14,588	0	39,500	3,441.3	708.9	0.2	-2,732.4	No
Alternative Plan No. 7E (Site 5 - See Plates 15 and 17). This plan consists of new bank Cut No. 19 and bulkheading the new bank cut. A savings in vessel transit time of 10 minutes would result.	8,860	1,774	7,086	0	8,860	742.6	436.8	0.6	-305.8	No
Alternative Plan No. 7F (Site 6 - See Plates 15 and 18). This plan consists of bank Cut No. 20 and bulkheading the new bank cut. A savings in vessel transit time of 15 minutes would result.	2,930	175	2,755	(6)	(6)	229.2	369.1	1.6	139.9	No (8)
Alternative Plan No. 7G (Site 7 - See Plates 15 and 18). This plan consists of removing the Jefferson Avenue Bridge abutments, new bank Cuts No. 21 and 22, and bulkheading the new bank cuts. A savings in vessel transit time of 10 minutes would result.	4,000	46	3,954	0	4,000	313	225.8	0.7	-87.2	Yes (9)
5. BREAKWATER FISHING PLANS (PLANS 8A AND 8B). Purpose is to provide recreational fishermen access to harbor breakwaters.										
Alternative Plan No. 8A (See Plate 19). This plan consists of providing fishermen access facilities on the assumed new north breakwater of Edgewater Marina and on a portion of the Cleveland Harbor west breakwater, and expanded parking and restoom facilities. Total fishermen access provided is 1,600 linear feet.	586	275	311	N/A	N/A	57.9	124.8	2.2	66.9	Yes

Table 20 - Comparison of Stage 2 Alternatives (Plans 1-8, 10)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels)	Traditional Cost Allocation: Federal	Traditional Cost Allocation: Non-Federal	Proposed Cost Allocation: Federal	Proposed Cost Allocation: Non-Federal	Annual Cost (3)	Annual Benefits (3)	Benefit-Cost Ratio	Average Annual Net Benefits	Carry Forward Into Stage 3
	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)	($1,000)		($1,000)	
Alternative Plan No. 8B (See Plate 20). This plan consists of providing fishermen access facilities on the Cleveland Harbor west breakwater and the west arrowhead breakwater, and expanded parking and restroom facilities. Total fishermen access provided is 5,725 linear feet.	1,700	794	906	N/A	N/A	196	446.4	2.3	250.4	Yes
6. ALTERNATIVE PLAN NO. 10 (NO-ACTION PLAN). The No-Action alternative represents the base condition for evaluation of the 17 structural plans previously discussed. Under this plan, no modifications would be made to Cleveland Harbor.										Yes

FOOTNOTES:

(1) For additional details on these plans, the reader is referred to the Stage 2 Report for this Phase I study.

(2) Does not include cost for mitigation of adverse environmental impacts that may be required for each alternative. Also, for all alternatives, it has been assumed that dredged material will be placed in Dike Site 14.

(3) Based on June 1982 price levels, a 50-year economic life, and 7-5/8 percent interest rate.

(4) An economic evaluation was not conducted for Alternative Plan No. 2 because Alternative Plan No. 1 provided greater benefits (i.e., vessel operation during "all-weather" conditions versus vessel operation in "fair-weather" conditions only) for one-third the cost. Thus, Plan No. 1 was obviously more economically efficient than Alternative Plan No. 2.

(5) An economic evaluation was not conducted for Atlernative Plan No. 4 since incremental benefits to justify adding the "fair-weather" west entrance component to the "all-weather" east entrance component were obviously insufficient to economically justify the added increment (i.e., the savings in vessel transit time of 1 to 2 hours during calm weather conditions would not result in sufficient incremental benefits to justify an additional expenditure of approximately $15 million).

(6) This alternative was initially funded for construction prior to 1 October 1981 and, as such, cost-sharing is based on traditional cost allocation.

(7) Although this authorized project is not economically justified in-light-of present traffic volume, additional benefits from potential new coal traffic may be sufficient to increase the B/C ratio above 1.0. Therefore, this authorized project will be kept in the inactive category until a final determination has been made on this new business.

(8) Construction of this authorized but uncompleted project will be pursued under its original authorization. Also, no further consideration of this project is warranted as part of the Cleveland Harbor Phase I study.

(9) Although this project does not presently exhibit economic efficiency, local interests have stated that numerous accidents have occurred at this site which would be elimianted if the proposed project was implemented. Even though each accident involves only minor damage, in total, they represent a significant amount of damage which may be sufficient to increase the B/C ratio for this plan above 1.0. These potential additional benefits will be evaluated in Stage 3.

vessel accidents is higher for Plans 3A and 3B than for Plan 1. Further, the stopping distance provided with these plans, although adequate, does not have the margin of safety inherent with the east entrance plan which includes a 4-mile long channel through the east basin. For these reasons, Plans 3A and 3B were eliminated from further consideration.

Plan 2 was eliminated from further consideration because its construction cost was about three times the cost of Plan 1 ($15,100,000 vs. $5,060,000). In addition, Plan 2 would provide significantly less net benefits than Plan 1 since Plan 2 was formulated as a "fair-weather" plan only and the plan would not provide deeper channel depths that would permit vessels to load to the maximum system's draft of 25.5 feet at LWD. Thus, Plan 2 was significantly less economically efficient than Plan 1 and was eliminated from further consideration.

Following the completion of the cost estimate for Plan 4, it was obvious that there were not sufficient incremental benefits available to incrementally justify adding a "fair-weather" west (main) entrance plan to the basic plan of providing an "all-weather" entrance at the existing east entrance (i.e., the savings in vessel transit time of 1 to 2 hours during calm weather conditions would not result in sufficient added benefits to justify an additional expenditure of about $15 million). Therefore, since Plan 4 did not have incremental justification, it was eliminated from further consideration.

(b) Cuyahoga River Modifications Plans (Plans 6A, 6B, 7C, 7D, and 7E) - Plans 6A, 6B, 7C, 7D, and 7E were eliminated from further consideration because they were not economically justified with B/C ratios of 0.4, 0.5, 0.3, 0.2, and 0.6 and average annual net benefits of -$11,249,800, -$11,409,000, -$2,452,000, -$2,732,400, and -$305,800, respectively.

(2) Rationale for Plans Warranting Further Detailed Study (Plans 1, 7G, 8A, 8B, and 10).

(a) Plan 1 - "All-Weather" East Entrance - Plan 1 was economically justified with a B/C ratio of 44.5 and average annual net benefits of $17,209,100. The plan would also provide safer entrance conditions for 1,000-foot vessels (and also for 1,100-foot vessels if such vessels enter the Great Lakes fleet) than any of the west (main) entrance plans. The reason for this is because the 4-mile long protected channel through the east basin would allow vessels to enter Cleveland Harbor at adequate entrance speeds to counteract the wind and wave forces acting on the vessel during storm conditions. Further, due to the absence at the east entrance of the many obstacles that are present at the west (main) entrance, the potential for vessel accidents would be less for Plan 1 than for any of the west (main) entrance plans. It should also be noted that the initial construction cost for Plan 1 ($5,060,000) was significantly less than for any of the other Lakefront Harbor modifications plans considered. For these reasons, it was concluded that Plan 1 warranted further, detailed study, and should be carried forward into Stage 3.

(b) Plan 7G - Reduce River Congestion (Site 7) - Based on the economic evaluation conducted for the Stage 2 study, Plan 7G was not economically justified with a B/C ratio of 0.7 and average annual net benefits of -$87,200. However, shipping interests at the 4 May 1982 workshop meeting indicated that numerous minor accidents occur at this site, but are not of sufficient magnitude to be reported to the Coast Guard. Even though each accident involves only minor damage, in total, they represent a significant amount of damage which was believed to be sufficient to increase the B/C ratio above 1.0 for Plan 7G. It was, therefore, concluded that Plan 7G should be carried forward into Stage 3 planning in order to evaluate these potential additional benefits.

c. Recreational Fishing Plans (Plans 8A and 8B) - Plans 8A and 8B were economically justified with B/C ratios of 2.2 and 2.3 and average annual net benefits of $66,900 and $250,400, respectively. In addition, both plans would contribute significantly to providing additional recreational fishing opportunities for residents of the Cleveland Harbor area who, due to their low incomes, cannot travel to neighboring counties to satisfy their recreational fishing needs. For these reasons, it was concluded that Plans 8A and 8B warranted further, detailed study.

d. Plan 10 - No Action - As with any potential water resources project, the no-action or "do-nothing" plan was carried forward as an alternative course of action in the event that more detailed studies showed that structural and/or non-structural plans could not be implemented because of the absence of engineering, economic, environmental, financial, social, or political viability. Therefore, the no-action Plan 10 was considered further, and was used as the basis-of-comparison in evaluating the structural plans that warranted further, detailed study.

(3) Future Actions on Authorized but Uncompleted Projects at Cleveland Harbor (Plans 5A, 5B, 7B, and 7F).

(a) Old River Modification Plans (Plans 5A and 5B) - Based on a reevaluation of the authorized but uncompleted improvements on the Old River navigation channel (Plans 5A and 5B), it appeared that these improvements were no longer economically justified with B/C ratios of 0.4 and 0.5 and average annual net benefits of -$3,603,100 and -$2,609,000 for Plans 5A and 5B, respectively. Factors that contributed to this change included reduced benefits due to the closing of several docks on the Old River and an increase in construction costs due to an increase in the total length of bulkheads that would have to be replaced for either plan due to channel deepening. However, recent discussions with local interests indicated that Ontario Stone Corporation is in the preliminary discussion stage with a company interested in exporting approximately 2 million tons of coal annually from their dock on the Old River. If this new business materializes, an additional benefit would accrue to the authorized project which preliminary calculations indicated may approach $2.00 per ton, or $4 million annually. These additional benefits would be sufficient to increase the B/C ratio for Plan 5A to about 1.1 and the B/C ratio for Plan 5B to about 1.3. It was, therefore, concluded that, although current traffic volume on the Old River is insufficient to economically justify construction of either Plan 5A or 5B, potential additional traffic may be sufficient to increase the B/C ratio to above 1.0 for these plans. Thus, these authorized improvements will continue to be kept in the inactive category until such time as a final determination has been made on this new business. If this new business materializes, construction of either plan would then be pursued under the existing construction authorization. However, if this new business does not materialize, these improvements would then become candidates for deauthorization. It was also concluded that no further consideration of either plan was warrranted as part of this Phase I study.

(b) Plan 7B - Reduce River Congestion (Site 2) - Plan 7B, an authorized but uncompleted project on the Cuyahoga River navigation channel, continues to be economically justified with a B/C ratio of 1.8 and average annual net benefits of $214,100. However, local interests, who are responsible for a significant portion of the cost of this plan, have stated that they wish to keep this project in its present inactive status until final Federal legislation is passed on new cost-sharing methods for commercial navigation projects (see Exhibit G-5 in Appendix G). Local interests have also stated that the Cereal Food mill is presently in a state of disrepair and may be closed down in the future, although the mill owner disputes this statement. If this mill is closed, it would significantly lower the non-Federal cost of this project since the ship unloading building would not have to be relocated and there would be no need to bulkhead the portion of bank Cut No. 4 opposite their property. It was, therefore, concluded that this authorized but uncompleted project should remain in its present inactive status until final Federal legislation is passed on cost-sharing for commercial navigation projects and the ultimate disposition of the Cereal Food's mill is known. It was also concluded that no further consideration of this plan was warranted as part of this Phase I study.

(c) Plan 7F - Reduce River Congestion (Site 6) - Plan 7F, an authorized but uncompleted project on the Cuyahoga River navigation channel, continues to be economically justified with a B/C ratio of 1.6 and average annual net benefits of $139,900. In addition, because Conrail Bridge No. 14 would not be replaced, related real estate problems associated with the bridge replacement would no longer be a factor. It was, therefore, concluded that this project should be reclassified to the active category and be constructed under its original authorization. The project's perspective local sponsor, the Cleveland Port Authority, is currently preparing a letter requesting that this proposed action be undertaken. It was further concluded that no further consideration of this plan was warranted as part of this Phase I study.

c. Local Response to Stage 2 Evaluation of Alternatives.

On 4 May 1982, a commercial navigation workshop meeting was held with representatives of the Lake Carriers Association, various shipping companies, various dock owners, the Chessie System, the U.S. Coast Guard, the U.S. Fish and Wildlife Service, the city of Cleveland, the Cleveland Port Authority, and the Ohio Department of Natural Resources. At this meeting, participants expressed support for continuation of the study into Stage 3 planning. They also expressed their support for carrying forward Plans 1, 7G and 10, eliminating Plans 2, 3A, 3B, 4, 6A, 6B, 7C, 7D, and 7E from further consideration, keeping authorized Plans 5A or 5B, and 7B in the inactive category and placing authorized Plan 7F in the active category, as previously discussed. Summary minutes of this meeting are provided as Exhibit G-5 in Appendix G.

In regards to the recreational fishing plans (Plans 8A and 8B), the U.S. Fish and Wildlife Service expressed their support for carrying these plans forward into Stage 3 planning in their letter of 3 June 1982 (Exhibit H-4 in Appendix H) and during verbal conversations with the District. The Ohio Department of Natural Resources also expressed their support for carrying forward Plans 8A and 8B into Stage 3 planning during a telephone conversation with District personnel on 17 June 1982. At that time, they also reiterated their intention to act as the recreational fishing project's local sponsor.

A public meeting was also held in Cleveland on 19 April 1983 to present the results of the Stage 2 planning effort and to solicit comments and information from the general public. Comments made at this meeting, with the exception of those that requested additional clarification of study results, indicated strong support for continuation of the study into Stage 3 as outlined above.

Subsequent to completion of Stage 2 plan formulation and evaluation studies, Republic Steel Corporation requested that the Corps investigate the feasibility of deepening the turning basin on the Cuyahoga River from its present 18-foot depth to 23 feet (see Exhibit F-17 in Appendix F). Presently, self-unloading vessels (which unload from the stern) destined for Republic's up-river iron ore dock approach the dock bow first and start to unload their cargo. However, because the upstream bridge (Bridge No. 21) prohibits the vessel from moving upstream such that the stern mounted unloading boom can reach the upstream limits of the iron ore storage pile, these vessels must partially unload their cargo, back down to the turning basin, turn around, and then proceed back to the dock stern first in order to discharge the remainder of their cargo. If the turning basin was deepened to 23-feet, this extra vessel movement would not be necessary since the vessel could turn around during its' upstream transit and approach the dock stern first initially, resulting in a savings of 3 to 4 hours in vessel unloading time. It was, therefore, proposed that an additional alternative to deepen the turning basin to 23-feet be formulated and evaluated during Stage 3 planning (designated Plan 11), in addition to Stage 3 studies on Plans 1, 7G, 8A, 8B, and 10.

18. PLANS OF OTHERS

In order for the Corps of Engineers to effectively develop plans for any water resources project, it is necessary to coordinate these plans with plans being developed by other public and private organizations. Within Cleveland Harbor, local interests who have developed plans for the area include the Cleveland Port Authority, Conrail, Ontario Stone Corporation, Ashland Oil Company, city of Cleveland and the Ohio Department of Natural Resources (ODNR).

In late 1980 the Cleveland Port Authority authorized and funded the Cleveland Harbor Development study conducted by the engineering firm of Tippetts - Abbett - McCarthy - Straton. The purpose of this study was to obtain an orderly plan to guide development of the Port of Cleveland through the end of the century and beyond. The resulting recommended development plan, shown on Figures 15 and 16, included: (1) purchasing and upgrading Conrail's existing iron ore transshipment facility adjacent to the west basin (Figure 15); (2) continuation of the existing iron ore lightering operation at Dock 20 (Figure 16); (3) expansion of facilities in the vicinity of Docks 24 to 26 for "other" dry bulk cargos such as potash, fluoraspar, bauxite, ferro-manganese, pig iron and limestone which are projected to grow from 200,000 tons in 1981 to about 1 million tons in 2005; and (4) continued development of the old Post Office building adjacent to Dock 20 as a Foreign Trade Zone. The Cleveland Port Authority is presently reviewing the recommended plan and a decision on whether to adopt all or part of the plan is expected in the near future.

As previously discussed, Conrail is also studying the feasibility of upgrading and expanding their iron ore transshipment facility adjacent to the west basin. However, they have not publicly released the results of their studies nor have they publicly stated their ultimate development plans. Thus, their future plans remain uncertain. In addition, Conrail has not publicly commented on the Cleveland Port Authority's recommended development plan which includes purchasing their existing facility.

The Ontario Stone Corporation recently purchased the former Erie Ore Dock on the Old River. During discussions with Buffalo District personnel on 16 February 1982 (see Exhibit G-4 in Appendix G), they indicated that they were conducting preliminary discussions with a company interested in exporting approximately 2 million tons of coal per year from their new dock. If this new business materializes, it would significantly increase the tonnage on the Old River navigation channel and may have a significant impact on the economic feasibility of completing authorized but uncompleted improvements on the Old River. However, since Ontario Stone Corporation is still in the preliminary discussion stage, no firm commitment for this activity can be made at this time.

Ashland Petroleum Company presently operates an oil refinery facility on Whiskey Island, adjacent to the Old River. During discussions with District personnel on 11 February 1982, (see Exhibit F-21 in Appendix F), they indicated that they were studying the feasibility of constructing a coal/oil mixing facility on their property. Coal would arrive at this facility by train and oil would be shipped in 450-foot vessels. The coal and oil would then be blended to produce boiler fuel for a local steel mill and would be shipped to this mill by barge. They also indicated that the present navigation channels on the Cuyahoga River and Old River would be sufficient for their needs and that they would not change their operations (i.e., use a larger vessel and/or use a vessel that could load to a deeper draft) if the navigation channels were modified.

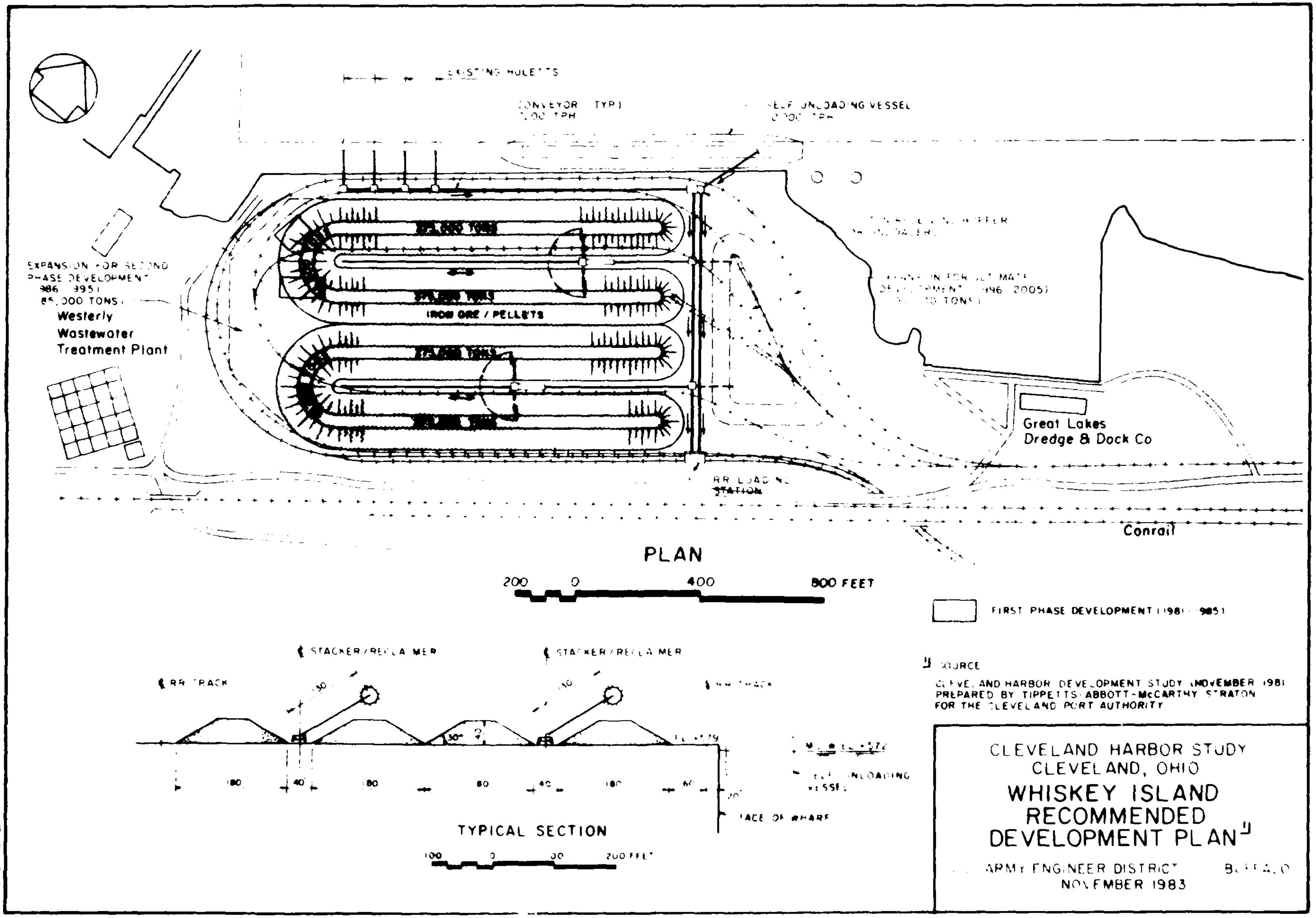

EXISTING HULETTS
CONVEYOR (TYP.)
SELF UNLOADING VESSEL
EXPANSION FOR SECOND PHASE DEVELOPMENT
85,000 TONS
Westerly Wastewater Treatment Plant
IRON ORE / PELLETS
Great Lakes Dredge & Dock Co
RR LOADING STATION
Conrail
PLAN
200 0 400 800 FEET
FIRST PHASE DEVELOPMENT
STACKER/RECLAIMER
STACKER/RECLAIMER
RR TRACK
180 40 180 80 40 180 60
FACE OF WHARF
TYPICAL SECTION
100 0 200 FEET
SOURCE
CLEVELAND HARBOR DEVELOPMENT STUDY (NOVEMBER 1981)
PREPARED BY TIPPETTS-ABBOTT-McCARTHY-STRATON
FOR THE CLEVELAND PORT AUTHORITY
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
WHISKEY ISLAND
RECOMMENDED
DEVELOPMENT PLAN
ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983
FIGURE 15

FIGURE 15

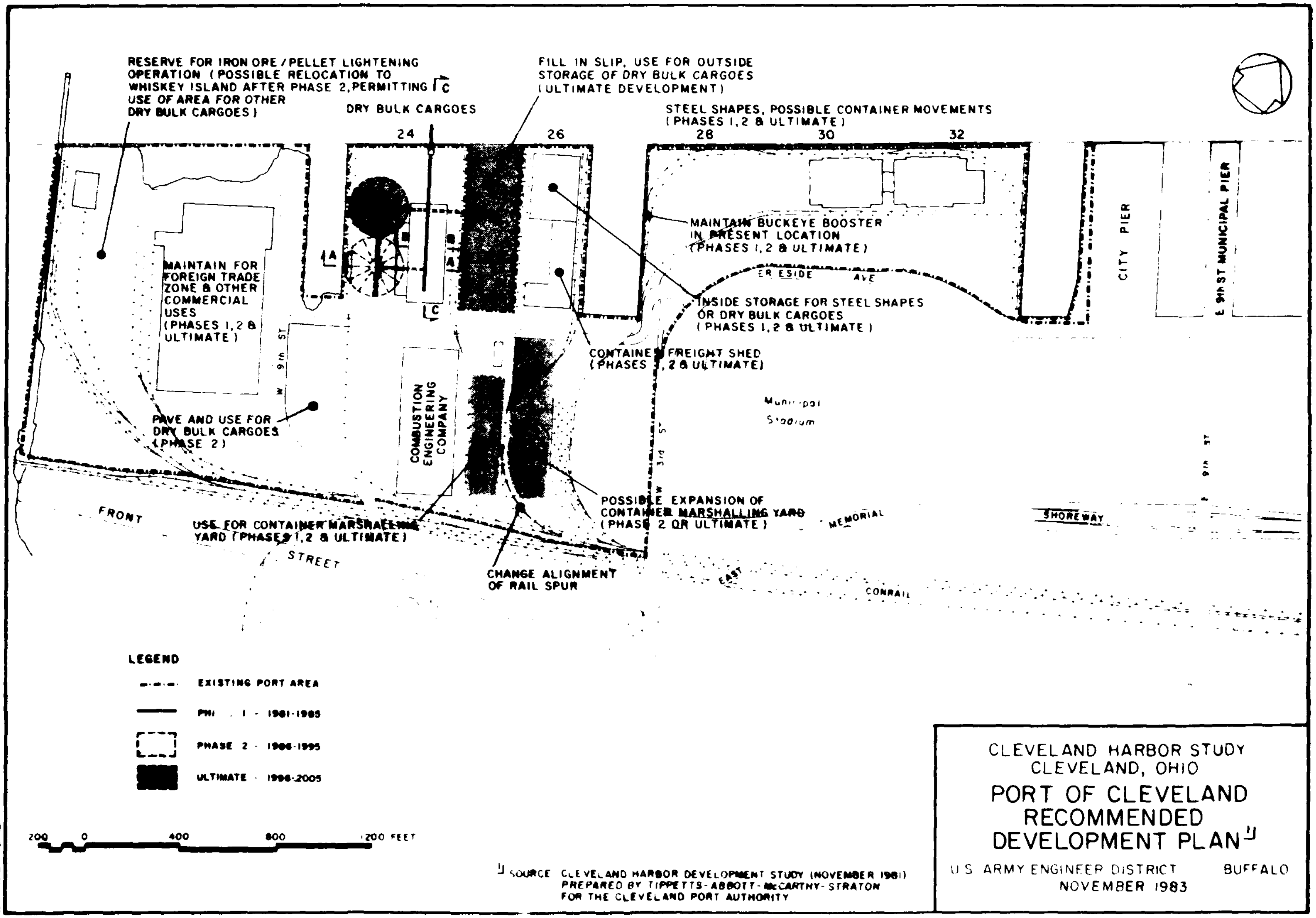


FIGURE 16

FIGURE 16

The city of Cleveland is presently studying the feasibility of expanding Burke Lakefront Airport in the east basin of the Lakefront Harbor (see Plate 1). The plan currently under consideration requires a landfill area adjacent to the harbor side of the present airport. This new landfill area would extend westerly from the east end of the Corps filled dike disposal areas to the west end of the present airport and lakeward to within 100 feet of the present east basin channel. As previously discussed, although city officals are interested in using dredged material from any proposed improvement plan for construction of this proposed landfill area, they are uncertain at this time when these improvements will be made. Therefore, further coordination with the city of Cleveland on this aspect will be conducted prior to construction of any harbor modification plan, if improvement plans involving significant amounts of dredged material are recommended for construction.

As previously discussed, the Ohio Department of Natural Resources has developed plans for the Cleveland Lakefront State Park. Located along the shoreline of Lake Erie and encompassing Cleveland Harbor, the park will provide for both water and non-water related recreational facilities and will be developed over the next several decades. A master development plan for the park is provided as Plate 5 in Appendix I.

As indicated in the development plan, ODNR proposes to develop Whiskey Island as a recreation area. However, Whiskey Island also appears to be the prefered location of local interests for a new iron ore transshipment facility capable of accommodating vessels up to 1,000 feet in length. It is also a prerequisite that such a facility be constructed before plans to modify the Lakefront Harbor for increased vessel efficency be implemented. Therefore, ODNR and local interests will have to decide whether to develop Whiskey Island as a recreational area or as an iron ore transshipment facility. If the decision is for recreational development, an alternative site for an iron ore transshipment facility will have to be selected before a plan to modify the Lakefront Harbor can be implemented.

SECTION IV
ASSESSMENT AND EVALUATION OF DETAILED PLANS

Initially, a total of 21 structural and/or nonstructural plans were considered as possible solutions for meeting the study objectives of moving bulk and general cargo more efficiently and economically through Cleveland Harbor and providing for unfulfilled recreational fishing needs in the Cleveland Harbor area. Of these twentyone plans, four plans were eliminated from further consideration in the initial iteration because of economic and/or technical feasibility. Additional study of the remaining 17 alternatives during Stage 2 planning indicated that only four alternatives warranted further detailed study in Stage 3, primarily due to economic and vessel safety considerations. These four alternatives are:

Alternative Plan No. 1 - "Severe-Weather" East Entrance.

Alternative Plan No. 7G - Remove Jefferson Avenue Bridge Abutments.

Alternative Plan No. 8A - Recreational Breakwater Fishing (Edgewater Marina Breakwater).

Alternative Plan No. 8B - Recreational Breakwater Fishing (West Breakwater).

Further, at the request of local interests at the conclusion of Stage 2 planning, an additional alternative was formulated during Stage 3 planning. This alternative is: Alternative Plan No. 11 - Deepen Turning Basin

The basis of comparison for the above alternative plans is: Alternative Plan No. 10 - No-Action Plan.

This section provides a summary of the Stage 3 engineering design, economic evaluation and environmental assessment associated with these five structual plans. Appendices A through E to this report provide additional details on the engineering and economic analysis. These appendices are:

Appendix A - Geotechnical Design

Appendix B - Economic Evaluation

Appendix C - Coastal Engineering Design

Appendix D - Design

Appendix E - Cost Estimates

19. SUBSEQUENT ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS RECOMMENDED FOR DETAILED STAGE 3 STUDY

At the initiation of Stage 3 planning, the Ohio Department of Natural Resources (ODNR) requested that Plan 8B be dropped from futher consideration in order to maintain small-boat access between Edgewater Marina and the Cleveland Lakefront Harbor via the gap in the west breakwater (see Exhibit F-22 in Appendix F). As previously discussed, Plan 8B (see Plate 20 in Appendix I) includes a pedestrian bridge to span the gap in the west breakwater. This pedestrian bridge would be at the same elevation as the crest of the west breakwater (ie; 12 feet above LWD) and would effectively sever access between Edgewater Marina and the Cleveland Lakefront Harbor to all but the smallest of power boats. Discussions with local boating groups by ODNR indicated a desire to maintain this access. Access between Edgewater Marina and the Lakefront Harbor is required to eliminate the need for small boats to negotiate the narrow lake entrance to Edgewater Marina, particularly during stormy conditions. In addition, the gap in the west breakwater provides access to the calmer waters of the Lakefront Harbor for recreational craft when severe weather makes boating in Lake Erie hazardous. Therefore, any plan that severs access between Edgewater Marina and the Lakefront Harbor is unacceptable to the local boating community. In order to maintain small boat access, a pedestrian bridge, providing 80 to 85 feet of vertical clearance to accommodate the larger sailboats berthed at Edgewater Marina, would be required. However, this is not a viable solution since it is unrealistic to assume that fishermen will climb an 80-85-foot bridge to fish off the west breakwater. Therefore, based on the above, Plan 8B was subsequently eliminated from further consideration.

As previously stated, Plan 8A (see Plate 19) was formulated under the assumption that the existing entrance to Edgewater Marina would be completely blocked off with a new breakwater and that a new entrance would be provided into the west basin of the Lakefront Harbor in the interest of small boat navigation. Small boats would use this new entrance to enter the west basin and would then enter Edgewater Marina through the existing gap in the west breakwater. However, at the 1 April 1983 Section 107 Edgewater Marina workshop meeting between ODNR and the Buffalo District, a plan to modify the existing entrance to Edgewater Marina was selected as the preferred alternative for modifying Edgewater Marina and the plan involving construction of a new entrance into the west basin of Cleveland Harbor was dropped from further consideration. This automatically eliminated Plan 8A from further consideration under the Cleveland Harbor Phase I study. Therefore, based on the above, both recreational fishing plans (Plans 8A and 8B) were dropped from further consideration subsequent to completion of Stage 2 planning and no further consideration was given to providing for unfulfilled recreational fishing needs in the Cleveland Harbor area.

20. STAGE 3 FORMULATION AND EVALUATION CRITERIA

Subsequent assessment and evaluation of plans recommended for additional detailed study at the conclusion of Stage 2 planning indicated that only Plan 1 ("Severe-Weather" East Entrance), Plan 7G (Remove Jefferson Avenue Bridge Abutments) and Plan 11 (Deepen Turning Basin) should be carried foward into

Stage 3 planning and that Plans 8A and 8B should be eliminated from further consideration. Therefore, the emphasis in Stage 3 was limited to refining Plans 1, 7G and 11. Principal considerations in this refinement were: establishing required entrance and interior channel depth requirements for Plan 1; a determination of whether or not dredged material is suitable for open-lake disposal for Plans 1, 7G and 11, a determination of whether or not existing bulkheads would fail if the channel in the immediate vicinity was deepened for Plans 7G and 11; reanalyzing the economic feasibility of Plan 1 in-light-of recent guidance (EC 1105-2-118, dated 22 July 1983); and preparation of an Environmental Impact Statement Supplement to update the previous EIS prepared in conjunction with the 1972-1976 Feasibility Study.

The refinement of Plans 1, 7G and 11 during Stage 3 planning was conducted in accordance with Federal policy on multiobjective planning as previously discussed in Section III of the Main Report. Within this overall planning framework, other more specific criteria relative to general policies, technical engineering, economic priciples, social and environmental values, and local conditions were also established. These specific criteria, except as noted below, were identical to the criteria established during Stage 2 planning (discussed in Section III of the Main Report). The <u>changes</u> to Stage 2 criteria during Stage 3 planning are as follows:

a. <u>Technical Criteria</u>.

(1) Channel width design will be based on criteria established in EM 1110-2-1613 dated 8 April 1983, and ER 1110-2-1404.

(2) Channel depth design will be based on the best available technical information, input from experienced vessel masters, results of vessel motion tests conducted at Waterways Experiment Station, an average static draft of 26 feet, and average water levels (2.3 feet above LWD for the 9-month navigation season).

(3) Channel depths will be <u>referenced</u> to the Low Water Datum reference plan.

b. <u>Economic Criteria</u>.

(1) The costs for alternative plans of development should be based on refined layouts, estimates of quantities and October 1983 unit prices.

(2) A 50-year economic life and 8-1/8 percent interest rate are used for the economic evaluation.

(3) Vessel operating drafts will be based on observed operating procedures and variable lake levels (ie; average static draft of 26 feet).

(4) 1,000-foot vessels will be included in the "base" (without-project) fleet.

(5) It is asummed that the Poe Lock at Sault Ste. Marie will not constrain the use of 1,000-foot vessels at Cleveland Harbor.

(6) Assume that Cleveland Harbor will be maintained, as authorized, throughout the 50-year evaluation period. (NOTE: Of particular importance to this Phase I study is rehabilitation of the east breakwater which presently is in a state of disrepair. Based on the results of a reconnaissance study conducted in 1983, the cost to rehabilitate the east breakwater is estimated at $30.0 million (February 1983 price levels). With average annual benefits of $23.9 million, the resulting benefit/cost ratio is 9.7. Therefore, the assumption that the east breakwater will be maintained as authorized appears reasonable. For further details on the proposed rehabilitation project see Reconnaissance Report - Major Rehabilitation Program, Cleveland East Breakwater. It should also be noted that navigation benefits credited to the rehabilitation project are for maintenance of existing commerce only. Since plans developed for this Phase I study address improving the efficiency of moving existing commerce, double counting of benefits is avoided.)

(7) It is assumed that iron ore destined for Jones and Laughlin Steel Corporation's steel mill in Aliquippa, PA will continue to be transshipped through Conrail's transshipment facility in Cleveland even if the proposed merger of Republic Steel Corporation and J&L occurs.

c. Socio-economic and Environmental Criteria.

No change from Stage 2 criteria.

d. Design and Other Considerations.

(1) Design vessel - The design vessel used to determine required channel depths, widths, and lengths is a Class X vessel (1,000 feet in length and 105 feet in width), the largest vessel expected to use the channels.

(2) Design weather conditions - Design weather conditions for the design vessel (ie; "all-weather" conditions) were renamed "severe-weather" conditions. As previously discussed, "all-weather" conditions were defined as the worst weather conditions for which vessel masters would enter the Lakefront Harbor, proceed to the dock and initiate the unloading cycle (further defined as a maximum 8-foot wave and 30-knot wind). However, shipping interests at the 4 May 1982 workshop meeting (see Exhibit G-5) requested that the term "all-weather" be changed since it was misleading to those not totally familiar with the definition of "all-weather" conditions. Substituting the term "severe-weather" conditions conveys the correct impression that the design was based on storm conditions but that there may be infrequent, more violent storm conditions (such as hurricane force winds) that exceed the design storm conditions. In addition, design storm conditions (ie; "severe-weather" conditions) were slightly modified to a maximum 30 knot wind and 9-foot wave. (NOTE: Based on the recent wave monitoring program conducted at Cleveland Harbor and theoretical wave prediction techniques (see Exhibit H-1 in Appendix H) it was estimated that a 30-knot wind from the west through east-northeast would generate a 9-foot wave. Therefore, the 8-foot design wave used during Stage 2 was revised to a 9-foot design wave during Stage 3).

(3) Disposal of Dredged Material - Dredged material for Plans 1, 7G and 11 is polluted and, as such, will be placed in Dike Site 14. However, prior to actual construction, additional coordination with the city of Cleveland will be conducted to ascertain the current status of plans to expand Burke Lakefront Airport. At that time, if the city is in a position to use this material, the material will be used to construct additional land fill areas required by the proposed expansion. If not, the material would then be placed in Dike Site 14. (NOTE: Corps of Engineers regulations (ER 1165-2-27) requires that consideration be given to using dredged material for creation of wetlands provided that the increased cost for this aspect does not exceed $400,000. However, since the dredged material for Plans 1, 7G and 11 is polluted and unsuitable for open water disposal, the material would have to be placed in a confined disposal area at an estimated increase in project cost of $5-10 million. Further, wetlands created within the confined disposal area would not provide most of the environmental benefits associated with natural wetland areas along Lake Erie such as benefits to fisheries, flood control, flushing action, etc. Thus the environmental benefits resulting from such a project would not justify the significant increase in project cost of $5-10 million and no further consideration was given to this aspect).

(4) Mitigation - As will be discussed in subsequent paragraphs of this section, the negative environmental impacts of Plans 1, 7G and 11 are not of sufficient magnitude to warrant mitigative measures. Therefore, no mitigative features were formulated for Plans 1, 7G and 11.

21. ALTERNATIVE PLAN NO. 1 - "SEVERE-WEATHER" EAST ENTRANCE

a. Description of Plan 1

Plan 1 would provide a "severe-weather" entrance into the Lakefront Harbor for bulk and general cargo vessels at the existing east entrance. As such, bulk cargo vessels, delivering iron ore to Conrail's transshipment facility adjacent to the west basin, would be able to enter the harbor in winds up to 30 knots. Further, foreign flag vessels, delivering general cargo to the Cleveland Port Authority docks, would be able to enter the harbor in winds up to 40 knots. The plan would also provide deeper channel depths which would allow vessels loaded to a 25-foot or greater static draft to enter Cleveland Harbor via the east entrance, thereby reducing the transit time of vessels arriving from or departing to the east. The layout and project features for Plan 1 are shown on Plate 21 in Appendix I.

Components of Plan 1 include a fan-shaped entrance channel at the existing east entrance and an interior channel through the east basin. The fan-shaped entrance channel, dimensioned by vessel masters during the 1972-1976 Feasibility Study and reaffirmed at the 14 March 1979 and 8 April 1981 workshop meetings, was sized to allow vessels up to 1,000 feet in length arriving at Cleveland Harbor from the west, sufficient maneuvering room to turn into the east entrance. After making the turn, the width of the entrance channel narrows to 900 feet. The 900-foot width is required since vessels would still be under the influence of wave action during the design "severe-weather" conditions, especially when the waves were from the north through northeast directions. Once the vessels are completely into the protected harbor and are no longer subject to wave attack, the width of the channel narrows to 500 feet, sufficient for two-way traffic through the remainder of the east basin. In addition, a triangular area east of the Cleveland Port Authority docks would also be dredged to facilitate vessel approach and/or exit to the docks, as requested by the Lakes Pilots Association in their letter of 7 January 1983 (Exhibit F-12). (NOTE: The Lakes Pilots Association originally requested that the triangular area extend 2,500 feet east of the Cleveland Port Authority docks. However, since this would have increased the cost of Plan 1 by about $1.5 to 2 million, the length was scaled back to 775 feet, as indicated on Plate 21).

As shown in Table 21, depths of the entrance channel and interior channel would be 30 feet and 26 feet below LWD, respectively. The 30-foot LWD depth of the entrance channel (which provides about 32 feet of water at average lake levels) is required in order to provide sufficient depth of water for vessels experiencing roll under the design "severe-weather" conditions (i.e., 4° roll for a Class X vessel for a 9-foot wave). Once the vessels are completely into the protected harbor and are no longer under wave attack (and thus do not experience any roll), the depth of the channel decreases to 26 feet LWD (which provides about 28 feet of water at average lake levels).

As the vessels enter the protected east and west basins, the existing 27 and 28-foot depths, respectively, are sufficient for vessel operations. The principal construction item for Plan 1 would be approximately 628,000 cubic yards of polluted dredged material. (Note: Entrance and interior channel depths for Plan 1 during Stage 2 planning were estimated to be 32 feet below LWD and 28 feet below LWD, respectively. These depths were determined based on, among other things, a design water level of LWD. However, during Stage 3, the design water level was changed to the average water level of Lake Erie for the navigation season which is about 2 feet above LWD. Since the other factors remained essentially the same, this changed the required channel depths by a corresponding 2 feet.)

Table 21 - Required Channel Depths For Alternative Plan No. 1

	East Entrance Channel (feet)	East Basin Interior Channel (feet)
Static Draft	26.0	26.0
Squat	0.5 (1)	0.6 (2)
Roll	3.7	0
Bottom Clearance	2.0	2.0
Required Depth of Water	32.2 (3)	28.6
Design Water Level	570.9	570.9
Channel Bottom Elevation (4)	538.7	542.3
Channel Depth Referenced to LWD (Elevation 568.6) (5)	29.9 feet below LWD, say 30.0 feet below LWD	26.3 feet below LWD say 26.0 feet below LWD

(1) Based on a vessel speed of 6 mph.
(2) Based on a vessel speed of 2 mph.
(3) Does not include value for pitch and heave since roll value is greater.
(4) Design water level minus required depth of water.
(5) Elevation 568.6 (LWD) minus channel bottom elevation.

The main navigational advantage of Plan 1 is that the 4-mile long channel through the east basin provides unlimited stopping distance for vessels entering Cleveland Harbor under storm conditions. Thus, vessels entering the harbor can enter at whatever speed is required to maintain vessel control and still have sufficient room to slow down before approaching their destination dock. For this reason, Plan 1 is also considered adequate for operation of 1,100-foot vessels, if such vessels enter the Great Lakes fleet. The second main advantage of Plan 1 is the low potential for vessel accidents due to the absence of the many obstacles that are present at the west (main) entrance.

b. Cost Estimate for Plan 1.

The detailed cost estimate for Plan 1 is presented in Table E1 of Appendix E. Tables 22 and 23, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs under both the traditional cost allocation method and the Secretary of the Army's new proposed cost allocation method. From these tabulations, it is seen that the total project cost for Plan 1 is $2,420,000 on October 1983 price levels (Table 22) and the total investment cost, including interest during construction, is $2,478,100 (Table 23). The total annual charges, including additional annual maintenance costs over and above existing annual maintenance costs for Cleveland Harbor, are $205,500. (Note: As discussed in Section III of the Main Report, the cost of Plan 1 during Stage 2 was about $5.1 million. However, since required channel depths for Plan 1 were revised (re; reduced) during Stage 3, a corresponding decrease in the cost of the plan occurred.)

c. Economic Evaluation of Plan 1.

The detailed discussion of the projected commercial navigation benefits that would be realized from implementation of Plan 1 is presented in Appendix B, "Economic Evaluation." In summary, commercial navigation benefits that would be realized include: (1) storm delay savings that would accrue as a result of bulk cargo vessels delivering iron ore to Conrail's transshipment facility being able to enter Cleveland Harbor in winds up to 30 knots in-lieu-of the present practice of waiting for the rough weather to subside (annual benefits of $351,300 - see Table B24 in Appendix B); (2) storm delay savings that would accrue as a result of foreign flag vessels delivering general cargo to the Cleveland Port Authority docks being able to enter Cleveland Harbor in winds up to 40 knots in-lieu-of the present practice of waiting for the rough weather to subside (annual benefits of $50,100); and (3) transit time savings that would accrue for vessels arriving from or departing to the east and which are loaded to a static draft of 25 feet or greater, being able to enter Cleveland Harbor via the east entrance in-lieu-of the present practice of entering through the west (main) entrance (annual benefits of $154,400). The average annual commerical navigation benefits for Plan 1 total $555,800.

Table 22 - Estimate of Total Project Cost for Alternative Plan No. 1 (October 1983 Price Levels)

Item	Total Project Cost	Traditional Cost Allocation: Federal Share	Traditional Cost Allocation: Non-Federal Share	Proposed Cost Allocation: Federal Share	Proposed Cost Allocation: Non-Federal Share
	$	$	$	$	$
1. Dredging	1,695,600	1,695,600	-	-	1,695,600
2. Mobilization and Demobilization	8,000	8,000	-	-	8,000
Subtotal	1,703,600	1,703,600	-	-	1,703,600
3. Contingencies (25 percent ±)	426,400	426,400	-	-	426,400
Subtotal	2,130,000	2,130,000	-	-	2,130,000
4. Engineering and Design (1)	100,000	100,000	-	-	100,000
5. Supervision and Administration	190,000	190,000	-	-	190,000
Total Project Cost	2,420,000	2,420,000	0	0	2,420,000

(1) Preparation of Plans and Specifications only.

Table 23 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 1 (October 1983 Price Levels) (1)

Item	Total	Traditional Cost Allocation		Proposed Cost Allocation	
	Project Cost	Federal Share	Non-Federal Share	Federal Share	Non-Federal Share
	$	$	$	$	$
Total Investment for the Project					
Total Project Cost, Excluding Lands	2,420,000	2,420,000	-	-	2,420,000
Interest During Construction (2)	58,100	58,100	-	-	58,100
Lands and Damages	0	-	0	-	0
Total Investment, Including Lands	2,478,100	2,478,100	0	0	2,478,100
Annual Charges for the Project					
Interest and Amortization	205,500	205,500	-	-	205,500
Additional Maintenance	0 (3)	0	-	-	0
Total Annual Charges	205,500	205,500	0	0	205,500

(1) 8-1/8 percent interest rate, 50-year life.
(2) 1-year construction period.
(3) Since the volume of annual maintenance dredging for Plan 1 is not expected to increase over existing conditions, the additional maintenance cost for this plan is zero.

Table 24, following, summarizes the annual benefits, annual charges, net benefits and benefit-to-cost ratio for Plan 1. Net commercial navigation benefits are $350,300 annually and the B/C ratio is 2.7.

Table 24 - Summary of Benefits and Costs for Alternative Plan No. 1 (1)

	Average Annual Benefits	Average Annual Charges	Net Average Annual Benefits	Benefit/Cost Ratio
	$	$	$	
Total Project	555,800	205,500	350,300	2.7

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.

d. Environmental Features/Assessement of Plan 1.

This plan would provide long-term benefits to regional development and would contribute to economic stability. In addition, this plan would save fuel and reduce the likelihood of accidents.

The new harbor entrance and deepened channel would require annual maintenance dredging although Plan 1 should produce only relatively minor net impacts on the long-term annual maintenance costs, the duration of dredging, and the volumes of material dredged. Both the initial and annual maintenance dredging may cause temporary inconveniences to commercial navigation, would destroy benthic populations in the area dredged, and would disperse fish from the immediate work area. Repeated maintenance dredging would result in periodic disruption of the benthic community structure at the dredging sites. After each dredging operation, benthic recolonization and fish movement into the area should occur. However, since the volume of maintenance dredging for Plan 1 is not expected to increase over existing practices, the net impacts of Plan 1 would be relatively minor. Studies to date have identified no threatened or endangered species that would be affected by the project.

Dredging would result in temporary increases in water turbidity and suspended solids. Temporary releases of pollutants and/or nutrients associated with the harbor sediments would also be expected. Temporary impacts to water drawn through nearby water supply intakes might also occur. Turbidity caused by dredging would decrease light penetration, causing short-term reductions in plankton productivity. Elevated levels of suspended solids and pollutants may cause temporary adverse fishery impacts. Temporary changes in water color, turbidity, and odor may cause minor aesthetic impacts during dredging. The extent of water quality effects would be determined by the current, waves, wind action, and background water quality conditions that exist during the actual dredging period.

Since sediment test results indicate that the material to be dredged is polluted, the dredgings would be placed in Dike Disposal Faciltiy Site No. 14, which has sufficient capacity to handle the additional material dredged.

In general, confined dredged material disposal in Site No. 14 would hasten the conversion of aquatic habitat to terrestrial habitat. The impacts associated with construction and operation of Dike Disposal Facility Site No. 14 are discussed in the Final Environmental Impact Statement for that project (U. S. Army Corps of Engineers, 1975), and in the Supplemental Information Report and Section 404(b)(1) Evaluation (revised) for operation of the facility (U. S. Army Corps of Engineers, 1983).

Dredging activities would have temporary impacts on some recreational activities in the project area. Recreational boating, water skiing, and sport fishing in the Lakefront Harbor may be temporarily disrupted due to the operation of dredging equipment. Temporary water quality impacts may also affect sport fishing and swimming at nearby sites outside the Lakefront Harbor. The operation of dredging equipment would create minor visual impacts and would cause minor increases in noise and exhaust emissions at the work site.

Changes in the travel routes of commercial vessels in Cleveland Harbor would be associated with this plan (i.e., greater use of the east basin by commercial vessels). However, although commercial vessels would occasionally inconvenience recreational boaters in the east basin, the overall impact to recreational boating should be minor. Also, since the Lakefront Harbor is heavily commercialized, no significant adverse aesthetic impacts would be expected. The general appearance of structures in the Lakefront Harbor would also be unaltered.

No impacts on cultural resources in the Cleveland Harbor area would be expected to result due to implementation of this plan.

e. Conclusions.

Plan 1, exclusively a simple dredging project, offers an economical and environmentally acceptable solution to reducing storm delays and transit times at Cleveland Harbor. In addition, the potential for vessel accidents would be reduced due to the absence of obstacles that are present at the west (main) entrance. Plan 1 would also accommodate 1,100-foot vessels, if such vessels enter the Great Lakes fleet. For these reasons, it is concluded that Plan 1 should be considered for implementation. (Note: As will be discussed in Section V of the Main Report, Plan 1 was not selected as the Tentatively Selected Plan. Rather, Plan 1B, a modified version of Plan 1, which provides entrance and interior channels 1-foot deeper than those in Plan 1, was selected. Plan 1B was selected as the Tentatively Selected Plan because it maximizes average annual net benefits.)

22. ALTERNATIVE PLAN 7G - REMOVE JEFFERSON AVENUE BRIDGE ABUTMENTS

a. Description of Plan 7G

Plan 7G would eliminate undue vessel delay at the site of the Jefferson Avenue Bridge abutments (river mile 4.3) identified by shipping interests as causing, on average, an additional 10 minutes in transit time for each trip upriver or downriver. The plan would also eliminate the potential for vessel accidents at this site due to the increase in channel width. (NOTE: As shown on Table 17, over the 10-year period 1972-1981, two vessel accidents have occurred at this site that were reported to the Coast Guard with damages totalling about $59,000. In addition, local shipping interests have stated that numerous minor accidents occur at this site with total damages averaging between $40,000 to $60,000 per year). The layout and project features for Plan 7G are shown on Plates 22 and 23 in Appendix I.

Components of Plan 7G include relocating an existing utility, removing the former Jefferson Avenue Bridge abutments which protrude into the navigation channel and new bank Cuts No. 21 and 22. Concrete rubble from the abutment removal would be used to create a fishery habitat area offshore of Edgewater Park. Removing the bridge abutments and bank Cuts No. 21 and 22 would increase the width of the navigation channel at this site from its present 130-foot width to about 190 feet. This 190-foot width is considered adequate to eliminate the 10-minute vessel delay and prevent a repetition of the numerous accidents that have occurred at this site. In addition, the unprotected banks left by the removal of the abutments and the river bank upstream of the east abutment, which would become unstable due to the channel widening, would be bulkheaded.

b. Cost Estimate for Plan 7G.

The detailed cost estimate for Plan 7G is presented in Table E2 of Appendix E. Tables 25 and 26, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs under both the traditional cost allocation method and the Secretary of the Army's new proposed cost allocation method. From these tabulations, it is seen that the total project cost for Plan 7G is $2,480,000 (Table 25) and the total investment cost, including interest during construction, is $2,522,000 (Table 26). The total annual charges are $209,100.

c. Economic Evaluation of Plan 7G.

The detailed discussion of the projected commercial navigation benefits that would be realized from implementation of Plan 7G is presented in Appendix B, "Economic Evaluation." In summary, benefits that would be realized include: (1) benefits that would accrue due to elimination of the 10-minute delay at this site; (2) advanced replacement benefits that would accrue for early replacement of the existing bulkheads; and (3) vessel damages avoided. From Table B24 in Appendix B, these benefits total $148,400 annually.

Table 27, following, summarizes the annual benefits, annual charges, net benefits, and B/C ratio for Plan 7G. Net commercial navigation benefits are $-60,700 annually and the B/C ratio is 0.7.

Table 25 - Estimate of Total Project Cost for Alternative Plan No. 7G
(October 1983 Price Levels)

Item	Total Project Cost	Traditional Cost Allocation: Federal Share	Traditional Cost Allocation: Non-Federal Share	Proposed Cost Allocation: Federal Share	Proposed Cost Allocation: Non-Federal Share
	$	$	$	$	$
1. Dredging	31,175	31,175	0	-	31,175
2. Clearing and Grubbing	4,670	0	4,670	-	4,670
3. Removal of Bridge Abutments	759,300	0	759,300	-	759,300
4. Bulkhead Replacement	694,588	0	694,588	-	694,588
5. Mobilization and Demobilization	143,000	2,825	140,175	-	143,000
6. Lands and Damages	4,000	0	4,000	-	4,000
Subtotal	1,636,733	34,000	1,602,733	-	1,636,733
7 Contingencies (25 percent ±)	409,267	9,000	400,267	-	409,267
Subtotal	2,046,000	43,000	2,003,000	-	2,046,000
8. Engineering and Design	225,000	5,000	220,000	-	225,000
9. Supervision and Administration	209,000	4,000	205,000	-	209,000
Total Project Cost	2,480,000	52,000	2,428,000	0	2,480,000

Table 26 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 7G
(October 1983 Price Levels) (1)

Item	Total Project Cost	Traditional Cost Allocation		Proposed Cost Allocation	
		Federal Share	Non-Federal Share	Federal Share	Non-Federal Share
	$	$	$	$	$
Total Investment for the Project					
Total Project Cost, Excluding Lands	2,476,000	52,000	2,424,000	-	2,476,000
Interest During Construction (2)	42,000	900	41,100	-	42,000
Lands and Damages	4,000	0	4,000	-	4,000
Total Investment, Including Lands	2,522,000	52,900	2,469,100	0	2,522,000
Annual Charges for the Project					
Interest and Amortization	209,100	4,400	204,700	-	209,100
Additional Maintenance	0	0	0	-	0
Total Annual Charges	209,100	4,400	204,700	0	209,100

(1) 8-1/8 percent interest rate, 50-year life.
(2) 1-Year construction period.

Table 27 - Summary of Benefits and Costs for Alternative Plan 7G (1)

	Average Annual Benefits	Average Annual Charges	Net Average Annual Benefits	Benefit/Cost Ratio
	$	$	$	
Total Project	148,400	209,100	-60,700	0.7

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.

d. Environmental Features/Assessment of Plan 7G.

The decrease in delay time under this plan would reduce the quantity of fuel consumed, the shipping time, and the cost of transportation per unit of cargo shipped through the site. The increase in channel width would also contribute to vessel safety on the Cuyahoga River.

The widened channel would require annual maintenance dredging, although the plan should produce only minor impacts on the long-term annual maintenance cost, the duration of dredging, and the volumes of material dredged. Both the initial and maintenance dredging would result in the same general types of water quality, benthic and fishery impacts described previously in the Environmental Assessment for Plan 1, with the greatest impacts occuring at the dredging site and in adjacent areas of the Cuyahoga River. Although maintenance dredging would cause periodic disruptions to the benthic community structure, an additional 0.1 acre of aquatic habitat would be created due to the bridge abutment removal associated with this plan. Replacement of the existing bulkheads would result in the permanent loss of a very limited quantity of relatively low value benthic habitat.

Since sediment tests indicate that the material to be dredged under this plan is polluted, the dredgings would be placed in Dike Disposal Facility Site No. 14, which has sufficient capacity to handle the additional material dredged. In general, confined dredged material disposal in Site No. 14 would hasten the conversion of aquatic habitat to terrestrial habitat as stated previously in this report under the discussion of Environmental Features/Assessment of Plan 1.

Although short-term disturbances to aquatic life would occur during the placement of material for fishery habitat improvement, the completed project would be rapidly colonized with benthic macroinvertebrates and would provide valuable fish cover, spawning sites, and feeding areas within an area 110 yards long by 50 yards wide. The area would be located adjacent to the Edgewater Park breakwater and would be located about 100 yards east of the eastern boundary of an artificial reef, to be constructed by the Ohio Department of Natural Resources at their new fishing pier. The placement of material for fishery habitat improvement under Plan 7G would be expected to provide long-term benefits to angler success at Edgewater Park.

The operation of heavy machinery for the bulkhead work, utility relocation and removal of the bridge abutments would produce short-term increases in water turbidity and would temporarily disperse fish from the work area. Additional short-term benthic disturbances would also occur. The operation of machinery may cause temporary inconveniences to commercial vessels and small boats passing through the work area.

Removal of the bridge abutments would result in the permanent conversion of about 0.1 acre of concrete to low value aquatic habitat in the areas waterward of the proposed bulkheads. The areas landward of the proposed bulkheads would be permanently filled. The operation of machinery for the utility relocation, dredging, bulkhead work, and removal of the bridge abutments would create minor visual impacts and would cause minor increases in noise and exhaust emisisons at the work site. Since the area is already heavily commercialized, the total permanent aesthetic impacts associated with this plan would be minor.

No presently known cultural resources would be adversly affected due to implementation of this plan.

e. Conclusions.

Plan 7G is not economically justified, with a B/C ratio of 0.7 and net average annual commercial navigation benefits of -$60,700. It is therefore concluded that Plan 7G should be eliminated from further consideration.

23. ALTERNATIVE PLAN NO. 11 - DEEPEN TURNING BASIN

a. Description of Plan 11.

Plan 11 would eliminate the need for bulk cargo vessels transiting the Cuyahoga River to unload a portion of their cargo before turning around. Therefore, vessels destined for upriver ore docks would be able to approach these docks stern first initially and unload their cargo without experiencing undue delay time. The layout and project features for Plan 11 are shown on Plates 22 and 23 in Appendix I.

The main feature of Plan 11 involves deepening the turning basin, presently dredged to 18 feet below LWD, to a depth of 23 feet below LWD, commensurate with the present depth of the Cuyahoga River navigation channel. In addition, existing bulkheads lining the banks, which would become unstable due to the basin deepening, would be replaced.

b. Cost Estimate for Plan 11.

The detailed cost estimate for Plan 11 is presented in Table E3 of Appendix E. Tables 28 and 29, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs under both the traditional cost allocation method and the Secretary of the Army's new proposed cost allocation method. From these tabulations, it is seen that the total project cost for Plan 11 is $8,010,000 (Table 28) and the total investment cost, including interest during construction, is $8,147,000 (Table 29). The total annual charges are $675,500.

Table 28 - Estimate of Total Project Cost for Alternative Plan No. 11 (October 1983 Price Levels)

Item	Total Project Cost	Traditional Cost Allocation		Proposed Cost Allocation	
		Federal Share	Non-Federal Share	Federal Share	Non-Federal Share
	$	$	$	$	$
1. Dredging	507,500	507,500	-	-	507,500
2. Bulkhead Replacement	4,703,588	-	4,703,588	-	4,703,588
3. Mobilization and Demobilization	143,000	13,500	129,500	-	143,000
4. Lands and Damages	22,000	-	22,000	-	22,000
Subtotal	5,376,088	521,000	4,855,088	-	5,376,088
5. Contingencies (25 percent ±)	1,343,912	130,000	1,213,912	-	1,343,912
Subtotal	6,720,000	651,000	6,069,000	-	6,720,000
6. Engineering and Design	670,000	65,000	605,000	-	670,000
7. Supervision and Administration	620,000	60,000	560,000	-	620,000
Total Project Cost	8,010,000	776,000	7,234,000	0	8,010,000

Table 29 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 11
(October 1983 Price Levels) (1)

Item	Total Project Cost	Traditional Cost Allocation: Federal Share	Traditional Cost Allocation: Non-Federal Share	Proposed Cost Allocation: Federal Share	Proposed Cost Allocation: Non-Federal Share
	$	$	$	$	$
Total Investment for the Project					
Total Project Cost, Excluding Lands	7,988,000	776,000	7,212,000	-	7,988,000
Interest During Construction (2)	137,000	13,300	123,700	-	137,000
Lands and Damages	22,000	0	22,000	-	22,000
Total Investment, Including Lands	8,147,000	789,300	7,357,700	0	8,147,000
Annual Charges for the Project					
Interest and Amortization	675,500	65,400	610,100	-	675,500
Additional Maintenance	0	0	0	-	0
Total Annual Charges	675,500	65,400	610,100	0	675,500

(1) 8-1/8 percent interest rate, 50-year life.
(2) 1-Year construction period.

c. Economic Evaluation of Plan 11.

The detailed discussion of the projected commercial navigation benefits that would be realized from implementation of Plan 11 is presented in Appendix B, "Economic Evaluation." In summary, benefits that would be realized include: (1) benefits that would accrue due to the elimination of the 3 to 4 hours of extra vessel time involved in unloading a portion of the cargo, backing down to the turning basin, turning around and then returning to the dock stern first to complete the unloading cycle instead of turning around and proceeding to the dock stern first initially; and (2) advanced replacement benefits that would accrue for early replacement of the existing bulkheads. From Table B24 in Appendix B, these benefits total $320,600 annually.

Table 30, following, summarizes the annual benefits, annual charges, net benefits and B/C ratio for Plan 11. Net commercial navigation benefits are - $354,900 annually and the B/C ratio is 0.5

Table 30 - Summary of Benefits and Costs for Alternative Plan No. 11 (1)

	Average Annual Benefits	Average Annual Charges	Net Average Annual Benefits	Benefit/Cost Ratio
	$	$	$	
Total Project	320,600	675,500	-354,900	0.5

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.

d. Environmental Features/Assessment of Plan 11.

Although this plan would not allow an increase in vessel size, the decrease in delay time associated with this plan would reduce the quantity of fuel consumed, the shipping time, and the cost of transportation per unit of cargo shipped through the site.

The deepened turning basin would continue to require annual maintenance dredging, although the plan should produce no major impacts on the long-term annual maintenance costs, the duration of dredging, or the volumes of material dredged. Both the initial and maintenance dredging would result in the same general types of water quality, benthic, and fishery impacts in the Cuyahoga River dredging area as were previously described in the Environmental Assessment for Plan 1, with the greatest impacts occurring in the vicinity of the turning basin.

Since sediment tests indicate that the material to be dredged under this plan is polluted, the dredgings would be placed in Dike Disposal Facility Site No. 14, which has sufficient capacity to handle the additional material dredged. In general, confined dredged material disposal in Site No. 14 would hasten the conversion of aquatic habitat to terrestrial habitat as stated previously in this report in the Environmental Assessment for Plan 1.

The operation of heavy machinery for bulkhead replacement would produce short-term increases in water turbidity and would temporarily disperse fish from the work area. Temporary disturbances to benthic communities would also occur. Replacement of the existing bulkheads would result in the permanent loss of a very limited quantity of low value benthic habitat. The operation of construction machinery and dredging equipment may cause temporary inconveniences to commercial vessels and small boats passing through the work area. The operation of machinery would also create minor visual impacts and would result in minor increases in noise and exhaust emissions at the work site. Since the work area associated with this plan is heavily commercialized and industrialized, the aesthetic impacts associated with this plan would be minor.

No presently known cultural resources would be adversely affected by this plan.

e. Conclusions.

Plan 11 is not ecomonically justified, with a B/C ratio of 0.5 and net average annual comercial navigation benefits of $-354,900. It is therefore concluded that Plan 11 should be dropped from further consideration.

24. ALTERNATIVE PLAN 10 - NO-ACTION PLAN

The No-Action or "do-nothing" plan represents the base condition for evaluation of the structural plans previously described. This option, although not favored by the local sponsors and local interests (i.e., shipping companies, area fishermen, dock operators, etc.), avoids both the monetary investments and potential adverse impacts associated with the structural improvements. However, bulk and general cargo movement at Cleveland Harbor would not gain the benefit of increased vessel efficiency. Also, because of inadequate channel depth in the Cuyahoga and Old River navigation channels, vessels transiting these channels would be forced to navigate at less than the maximum Great Lakes System's draft of 25.5 feet at LWD. Bulk cargo vessels would also continue to experience undue vessel delays at historically congested areas. The potential for vessel accidents would remain high. Further, the opportunity to construct artificial fish habitat areas would be foregone. In addition, the No-Action Plan would not meet any of the needs of recreational fishermen in the Cleveland Harbor area. Problems stated earlier in this report would remain unchanged. The No-Action Plan would also not meet the planning objectives to move bulk and general cargo more efficiently and economically through Cleveland Harbor and to provide for unfulfilled recreational fishing needs in the Cleveland Harbor area.

25. SUMMARY EVALUATION OF IMPACTS DURING CONSTRUCTION - PLANS 1, 7G, 10, AND 11

a. Social Impacts.

(1) Noise. Under all plans except the No-Action Plan, construction noises would occur which could be disturbing to persons near the work area. Relatively continuous motor noise would be expected when water and/or land based equipment would remove bridge abutments, perform dredging, replace

existing structures, and perform new construction. Activities in the Lakefront Harbor would probably produce the least noise impacts since relatively few persons would be near the work sites. Construction noises would be most noticeable near work sites on land and along the shores of the Cuyahoga River. The noise effect for all plans is expected to be relatively minor since any work would be performed in areas which are currently used by heavy industrial, commercial, and/or transportation equipment.

(2) Aesthetics. Construction activities would present an obstruction to the view of the individual work sites. However, since work sites for all of the plans are located in areas which are used by heavy industrial, commercial and/or transportation equipment, the aesthetic impacts associated with the various alternatives would be minor.

(3) Displacement of People, Businesses, and Farms. None of the alternatives would affect area residences or result in the relocation of businesses. No farms would be affected by any of the plans.

(4) Community Cohesion, Community Growth, and Regional Growth. The short-term construction impacts associated with all of the various plans except the No-Action Plan would have no significant impacts on community cohesion, community growth, or regional growth.

b. Economic Impacts.

(1) Business and Industrial Activity. Implementation of any of the construction plans would constitute a business activity of an industrial nature. Each of the plans should produce a positive effect which would be directly proportional to the project cost.

(2) Tax Revenues and Property Values. Implementation of any of the plans except the No-Action Plan should result in a minor and temporary increase in income tax revenues due to the increase in employment associated with the work. Sales taxes would also be received for materials purchased for the work.

(3) Public Facilities and Services. Local business establishments such as restaurants, service and repair shops, motels, and retail stores may derive benefits from the presence of construction workers involved in carrying out all plans except the No-Action Plan. This effect is expected to be slight due to the limited size of the work crews for each plan. Similarly, the demand for public services in the form of police, rescue, and medical services would not rise appreciably due to the presence of the workers.

(4) Employment/Labor Force. The input of capital for all of the construction plans would result in a temporary increase in employment and the labor force during construction. These impacts would be relatively minor and of short duration since no construction alternative would employ more than 25-30 construction workers or require a time span exeeding 1 year.

c. Environmental Impacts.

(1) Air Quality. Air quality in the project area would be temporarily affected by dust, noise, odors, and vehicle emmissions from the operation of construction equipment under all plans except the No-Action Plan. The construction Contractor would be required to control such emissions and effects where practical.

(2) Water Quality. Some short-term reversible impacts on water quality would occur during implementation of any of the construction plans associated with the project. The operation of construction and dredging equipment would cause considerable elevations in levels of suspended solids and turbidity, as well as the release of pollutants and/or nutrients associated with the bottom sediments. These impacts would be of relatively high magnitude and short duration, disappearing soon after the construction and/or dredging was completed. Some accidental spillage of fuels, oil, and grease could occur due to the operation of both land-based and marine construction equipment.

(3) Natural Resources. Certain aspects of all the implementable plans, except the No-Action Plan, would require the commitment of natural resources in the form of construction materials and energy expended during the construction process. These include steel, which would be required for steel sheet piling, and petroleum products, which would be used in all phases of construction by vehicles and machinery.

(4) Ecosystems. Some destructive impacts to aquatic populations would occur due to dredging and the placement of structures in Cleveland Harbor and the Cuyahoga River. Although some impacts would be temporary, the aquatic areas occupied by the placement of structures and fill in the Cuyahoga River would lead to the permanent destruction of a very limited quantity of aquatic habitat. Although the placement of a fish habitat development area associated with Plan 7G would result in the covering of existing benthic habitat, the new benthic substrate associated with this structure would be rapidly colonized with benthic macroinvertebrates. The fish habitat development area would encourage the growth of attached algae, increase the diversity and abundance of benthic macroinvertebrates, and provide valuable cover, spawning sites, and feeding areas for fish populations in the Cleveland Harbor area. The use of Diked Disposal Facility Site No. 14 for the confinement of dredged material would hasten the conversion of aquatic habitat to terrestrial habitat. The removal of bridge abutments associated with Plan 7G would result in the creation of about 0.1 acre of relatively low value aquatic habitat. Replacement of existing bulkheads under Plans 7G and 11 would result in the permanent loss of a limited quantity of low value benthic habitat.

(5) Man-Made Resources. Construction activities under all plans except the No-Action Plan would result in the renovation and/or improvement of commercial navigation facilities in the Cleveland Harbor area. Bridge abutments would be demolished under Plan 7G. An underwater utility relocation would be required under Plan 7G, and a fishery habitat improvement area would also be provided.

(6) Cultural Resources. No presently known cultural resources would be adversely affected due to implementation of any of the proposed plans.

26. SUMMARY EVALUATION OF IMPACTS FOR FUTURE CONDITIONS - PLANS 1, 7G, 10, AND 11

This section of the environmental assessment will attempt to identify impacts that would occur to the Cleveland area after plan implementation. The output of Plans 1, 7G, and 11 would be to provide long-term benefits to the area economy, vessel safety, and shipping efficiency. Plan 10 would allow continuation of the base case and would not provide the project benefits associated with the various construction plans.

a. Social Impacts: Noise, Aesthetics; Displacement of People, Businesses, and Farms; Community and Regional Growth; and Community Cohesion.

Noise levels at each construction site would return to normal levels after the construction phase is complete. Minor noise increases and visual impacts would occur during periodic maintenance dredging activities. The permanent visual changes associated with Plans 1, 7G, and 11 would be expected to provide negligible or minor aesthetic impacts. No residences or farms would be affected under any of the plans. No long-term impacts to community cohesion would be associated with any of the project plans. Plans 1, 7G, and 11 may encourage regional growth by providing long-term economic benefits associated with permanent increases in shipping efficiency.

b. Economic Impacts: Business and Industrial Activity; Tax Revenues and Property Values; and Employment/Labor Force.

The increase in shipping efficiency and the economic benefits associated with Plans 1, 7G, and 11 may encourage the growth and/or efficiency of business and industrial activity in the Cleveland area. The potential benefits to business and industry may in turn stimulate employment opportunities, although a decrease in transportation-related employment may occur due to the increase in shipping efficiency. Any benefits to business, industrial activity, and employment may increase tax revenues. No significant impacts to local property values would be expected to result due to implementation of any of the plan alternatives.

c. Environmental Impacts: Air Quality; Water Quality; Natural Resources; Ecosystems; Man-Made Resources; and Cultural Resources.

Aquatic and terrestrial habitat would be permanently modified and/or destroyed as discussed in the environmental assessments for each of the individual project plans, except the No-Action Plan. All modifications to man-made resources associated with Plans 1, 7G, and 11 should be permanent, lasting the entire life of the project. Maintenance activities would cause periodic air quality, water quality, aquatic organism, and disposal impacts which would be similar to those occurring during the construction phase. Project maintenance would require the use of additional petroleum products and any additional natural resources such as steel which may be required for the repair of project structures. No cultural resources impacts are expected.

27. COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES

The following paragraphs will present a brief description of the Buffalo District's proposed methods for compliance with all applicable environmental statutes for all structural recommendations which may result from this study.

a. National Environmental Policy Act.

A Final Environmental Impact Statement (EIS) for the Cleveland Harbor Navigation Project was filed with the U. S. Environmental Protection Agency on 26 October 1978. However, project reformulation has resulted in new project alternatives which are significantly different from those discussed in the Final EIS. Therefore, the Buffalo District has prepared a Draft Supplement to the Final EIS which is included within this Draft Reformulation Phase I GDM. A Final Supplement to the Final EIS will be included with the Final Reformulation Phase I GDM.

b. Various Acts, Executive Orders, Etc., Concerning the Preservation of Cultural Resources.

Appropriate cultural resources coordination has been performed during preparation of this report and the Draft Supplement to the Final EIS. Copies of the Draft and Final Supplements to the Final EIS will be provided to the Ohio State Historic Preservation Officer and the National Park Service for review and comment.

c. Clean Air Act, as Amended.

Copies of the Draft and Final Supplements to the Final EIS will be sent to the appropriate Regional Administrator of the U. S. Environmental Protection Agency requesting agency comments in compliance with the Clean Air Act.

d. Clean Water Act.

This act requires the evaluation of the effects of the placement of dredged and/or fill materials into waters of the United States Since Plans 1, 10, and 11 do not involve the placement of fill, only Plan 7G would be subject to this evaluation. However, due to lack of economic feasibility, Plan 7G will not be implemented and, therefore, a Section 404 (b)(1) Evaluation is not required. The placement of dredged material in Dike Disposal Site No. 14 has been addressed in the Cleveland Harbor, OH, Dike Disposal Site No. 14 Supplemental Information Report and Section 404(b)(1) Evaluation which was prepared by the Buffalo District in October 1982 and revised in January 1983.

e. Coastal Zone Management Act.

The State of Ohio does not have an approved Coastal Zone Management Plan and the Ohio Department of Natural Resources is no longer participating in the Coastal Zone Management Program. There are, therefore, no consistency requirements to be met with respect to the Coastal Zone Management Act for the Cleveland Harbor study.

f. Endangered Species Act.

Coordination with the U. S. Fish and Wildlife Service indicates that except for occasional transient species, no Federally listed or proposed threatened or endangered species are known to exist in the project area.

g. Federal Water Project Recreation Act and Land and Water Conservation Fund Act.

During project planning, full consideration has been given to opportunities afforded for outdoor recreation and fish and wildlife enhancement. Appropriate coordination will be accomplished as necessary to insure compliance with this act.

h. Fish and Wildlife Coordination Act.

This act requires early and continual coordination of project planning with the U. S. Fish and Wildlife Service to assure equal consideration of fish and wildlife values and resources in the development of alternatives. This coordination was initiated early in the Cleveland Harbor study and will be continuous through further project planning.

i. River and Harbor Act of 1970.

The requirements of this act have been fulfilled by Corps planning actions. All 17 points identified in Section 122 of this act (PL 91-611) have been addressed in this report for Plans 1, 7G, 10, and 11.

j. Wild and Scenic Rivers Act.

The Cuyahoga and Old Rivers are not considered either wild or scenic in the vicinity of the existing Federal project.

k. Executive Order 11988, Flood Plain Management, 24 May 1977.

The existing Federal navigation project at Cleveland Harbor is partially located in the base flood plain of the Cuyahoga and Old Rivers. If structural improvements to these portions of the existing project were required, there would be no practicable alternative to performing work in the base flood plain. The work would, therefore, be in compliance with Executive Order 11988, Flood Plain Management.

l. Executive Order 11990, Protection of Wetlands, 24 May 1977.

Since no wetlands would be affected by any of the project alternatives, they would be in compliance with Executive Order 11990, Protection of Wetlands.

m. Analysis of Impacts on Prime and Unique Farmlands, CEQ Memorandum, 30 August 1976.

Since none of the project alternatives would affect prime or unique farmlands in any manner, they would be in compliance with this memorandum.

SECTION V
COMPARISON OF DETAILED PLANS

Subsequent assessment and evaluation of plans recommended for additional detailed study at the conclusion of Stage 2 planning indicated that only commercial navigation Plans 1, 7G, and 11 should be developed in detail during Stage 3 planning and that the recreational fishing plans, Plans 8A and 8B, should be eliminated from further consideration. In addition, the basis of comparison for Plans 1, 7G, and 11 is Plan 10 (No-Action). This section compares the impacts of Plans 1, 7G, and 11 with the impacts of Plan 10 and discusses the rationale for designating the NED plan and the Tentatively Selected Plan.

28. COMPARISON OF DETAILED PLANS

Table 31, following, compares the impacts of Plans 1, 7G, and 11 and the No-Action Plan (Plan 10). Impacts are measured and the results displayed or accounted for in terms of contributions to four accounts: National Economic Development (NED); Environmental Quality (EQ); Regional Economic Development (RED); and Other Social Effects (OSE). As indicated, of the structural plans under consideration (Plans 1, 7G, and 11), only Plan 1 would accrue positive net benefits and, as such, is the only structural plan that can be considered for implementation.

29. TRADE-OFF ANALYSIS OF STRUCTURAL VS. NONSTRUCTURAL ALTERNATIVES

With the exception of the No-Action Plan, the initial screening of alternatives indicated that the greatest potential for meeting the primary planning objectives of promoting the economical movement of bulk and general cargo at Cleveland Harbor and providing additional recreational fishing facilities in the Cleveland Harbor area, involved structural modifications to existing harbor facilities (i.e., structural plans). One primarily nonstructural plan (Plan 9 - Tug Assistance) was formulated during the initial phase of the study. However, initial evaluation and assessment of this plan indicated that it should be eliminated from further consideration due to operational difficulties associated with the plan. Thus, with the exception of the No-Action Plan, no nonstructural plan was carried forward beyond the initial iteration. (NOTE: As previously discussed, an array of non-structural plans (such as rail delivery of iron ore from its source or another Lake Erie port and truck delivery of iron ore from its source or another Lake Erie port) were formulated to promote the economical movement of bulk cargo at Cleveland Harbor during the 1972-1976 Feasibility Study. However, because of economic and/or technical reasons, these non-structural plans were eliminated from further consideration during the initial phase of that study. The initial phase of the Feasibility Study also determined that the most economical means for delivery of bulk cargo to Cleveland Harbor was by bulk cargo vessels. Since these conclusions remain relevant today, no further consideration was given to these non-structural plans during this Phase I study).

Table 31 - Summary of Effects for Alternative Plans Nos. 1, 7G, 11, and 10

	Plan 1	Plan 7G	Plan 11	Plan 10
PLAN DESCRIPTION	This plan consists of dredging a fan shaped entrance channel at the existing east entrance and dredging a 500-foot wide channel through the east basin to the west basin. Plan is suitable for vessel operation in "severe-weather" conditions.	This plan consists of removing the Jefferson Avenue Bridge abutments, new bank Cuts Nos. 21 and 22, and bulkheading the new bank cuts as required. A savings in vessel transit time of 10 minutes would result.	This plan consists of deepening the turning basin and replacing the existing bulkheads that become unstable due to the basin deepening. Bulk cargo vessels would then be able to turn around while fully loaded, resulting in a savings in vessel unloading time.	Do-nothing.
SIGNIFICANT IMPACTS				
1. National Economic Development				
a. Beneficial Impacts				
(1) Total Annual Benefits	$ 555,800	$ 148,400	$ 320,600	None
b. Adverse Impacts				
(1) Total Investment Cost - Traditional Cost Allocation 1/				
(a) Federal	$2,478,100	$ 52,900	$ 789,300	None
(b) Non-Federal	0	2,469,100	7,357,700	None
Total	$2,478,100	$2,522,000	$8,147,000	
(2) Annual Charges - Traditional Cost Allocation 2/				
(a) Federal	$ 205,500	$ 4,400	$ 65,400	None
(b) Non-Federal	0	204,700	610,100	None
Total	$ 205,500	$ 209,100	$ 675,500	
(3) Total Investment Cost - Proposed Cost Allocation 1/				
(a) Federal	$ 0	$ 0	$ 0	None
(b) Non-Federal	2,478,100	2,522,000	8,147,000	None
Total	$2,478,100	$2,522,000	$ 8,147,000	

Table 31 - Summary of Effects for Alternative Plans Nos. 1, 7G, 11, and 10

	Plan 1	Plan 7G	Plan 11	Plan 10
(4) Annual Charges - Proposed Cost Allocation 2/				
(a) Federal	$ 0	$ 0	$ 0	None
(b) Non-Federal	205,500	209,100	675,500	None
Total	$ 205,500	$ 209,100	$ 675,500	
c. Economic Efficiency				
(1) Net Annual Benefits	$ 350,300	$ -60,700	$ -354,900	None
(2) B/C Ratio	2.7	0.7	0.5	None
2. Environmental Quality				
a. Beneficial Impacts				
(1) Biological Impacts				
(a) Aquatic Habitat	None	0.1 acre created from removal of bridge abutments.	None.	None
(b) Benthic and Fishery Habitat	None	Creation of 1.1 acre fishery habitat area.	None.	None
(2) Air Quality	Slight increase due to more efficient use of vessels.	Slight increase due to reduced transit time.	Same as Plan 7G.	None
(3) Water Quality	None	None	None	None
(4) Fuel Savings	Slight savings.	Slight Savings	Slight savings.	None
b. Adverse Impacts				
(1) Biological Impacts				
(a) Aquatic Habitat	Degradation during construction and maintenance dredging. Hasten conversion of 68 acres of aquatic habitat to terrestrial habitat (Dike 14).	Same as Plan 1.	Same as Plan 1.	None

Table 31 - Summary of Effects for Alternative Plans Nos. 1, 7G, 11, and 10

	Plan 1	Plan 7G	Plan 11	Plan 10
(b) Benthic and Fishery Habitat	Degradation during construction and maintenance dredging.	Degradation during construction and maintenance dredging. Destruction of minor amount of low value habitat due to placement of bulkheads.	Same as Plan 7G.	None
(c) Terrestrial Area Destroyed	None	0.1 acre.	None	None
(2) Air Quality	Slight decrease during construction and maintenance operations.	Same as Plan 1.	Same as Plan 1.	None
(3) Water Quality	Decrease during construction and maintenance operations.	Same as Plan 1.	Same as Plan 1.	None
3. <u>Regional Economic Development</u>				
<u>a</u>. Beneficial Impacts				
(1) Tax Revenues	Slight increase during construction.	Same as Plan 1.	Same as Plan 1.	None
(2) Employment/Labor Force	Slight increase during construction.	Same as Plan 1.	Same as Plan 1.	None
(3) Property Values and Tax Base	None	None	None	None
(4) Public Facilities and Services	None	None	None	None
(5) Business and Industrial Activity	Slight increase during construction.	Same as Plan 1.	Same as Plan 1.	None
(6) Displacement of Farms	None	None	None	None
(7) Man-made Resources	None	None	None	None
(8) Regional Growth	Amenable to desired regional growth.	Same as Plan 1.	Same as Plan 1.	None
<u>b</u>. Adverse Impacts				
(1) Tax Revenues	None	None	None	None
(2) Employment/Labor Force	Slight decrease due to more efficient use of vessels.	None	None	None

Table 31 - Summary of Effects for Alternative Plans Nos. 1, 7G, 11, and 10

	Plan 1	Plan 7G	Plan 11	Plan 10
(3) Property Values and Tax Base	None	N ne	None	None
(4) Public Facilities and Services	None	None	None	None
(5) Business and Industrial Activity	None	None	None	Delivery of bulk and general cargo confined to less efficient vessels.
(6) Displacement of Farms	None	None	None	None
(7) Man-made Resources	None	None	None	None
(8) Regional Growth	None	None	None	Not amenable to regional growth.
4. <u>Other Social Effects</u>				
<u>a</u>. Beneficial Impacts				
(1) Noise	Slight decrease due to more efficient use of vessels.	None	None	None
(2) Aesthetic Values	None	None	None	None
(3) Community Cohesion	None	None	None	None
(4) Cultural Resources	None	None	None	None
(5) Vessel Safety	Moderate increase.	Same as Plan 1.	None	None
(6) Recreational Opportunities	None	None	None	None
<u>b</u>. Adverse Impacts				
(1) Noise	Slight increase during construction and maintenance activities.	Same as Plan 1.	Same as Plan 1.	None
(2) Aesthetic Values	Minor impact during construction.	Same as Plan 1.	Same as Plan 1.	None
(3) Community Cohesion	None	None	None	None
(4) Cultural Resources	None	None	None	None
(5) Vessel Safety	None	None	None	Potential for accidents remains high.
(6) Recreational Opportunities	Increased interference with small boats in east basin.	None	None	None

1/ Based on October 1983 price levels. Includes lands and damages and interest during construction.
2/ Based on October 1983 price levels, 8-1/8 percent interest rate, and 50-year economic life.

30. RATIONALE FOR DESIGNATION OF NED PLAN

In selecting the National Economic Development (NED) Plan, candidate plans must not only satisfy the specific planning objectives and evaluation criteria, they must also reasonably maximize net benefits. Based on the results of the Stage 3 evaluation previously discussed, the plan that best fulfills these criteria is Plan 1, the "Severe-Weather" East Entrance Plan, with average annual net benefits of $350,300. However, before designating Plan 1 as the NED Plan (i.e., the plan that reasonably maximizes net benefits), an incremental cost/incremental benefit analysis must be conducted. This analysis will compare the costs and benefits of plans that provide channel depths 1-foot less and 1-foot greater than Plan 1. (Note: Plan 1 would provide a 30-foot LWD entrance channel and a 26-foot LWD interior channel through the east basin - see Plate 21 in Appendix I.)

Plan 1A would provide channel depths 1-foot less than Plan 1. Therefore, the entrance channel would be dredged to 29 feet below LWD. The interior channel through the east basin would remain at its authorized depth of 25 feet below LWD. The cost of this plan, on October 1983 price levels, is $1,500,000. Benefits for Plan 1A include only a portion of the $351,300 average annual storm delay savings for domestic bulk cargo vessels credited to Plan 1 (see Table B24 in Appendix B), since Plan 1A would only provide adequate channel depths when water levels on Lake Erie exceed Elevation 571.9 (1 foot above average lake levels (the design water level for Plan 1), or, 3.3 feet above LWD). Since water levels on Lake Erie equal or exceed Elevation 571.9 only 15 percent of the time during the navigation season versus 50 percent of the time for average water levels, 35 percent of the storm delay savings for domestic bulk cargo vessels credited to Plan 1 would not be realized under Plan 1A. Thus, average annual benefits for Plan 1A total $228,300 (65 percent of the storm delay savings for domestic bulk cargo vessels of $351,300 for Plan 1). It should also be noted that no storm delay benefits for general cargo vessels nor transit time savings for Canadian bulk and foreign flag general cargo vessels, loaded to a static draft of 25 feet or greater, would accrue due to implementation of Plan 1A, since the depth of the channel through the east basin would not be increased above its presently authorized depth of 25 feet below LWD. Vessel operators have stated that this channel depth is inadequate for their operations since they only use channels based on their charted depth and not based on actual water levels present.

Plan 1B would provide channel depths 1-foot greater than Plan 1. As such, the entrance channel would be dredged to 31 feet below LWD and the interior channel would be dredged to 27 feet below LWD. The cost of this plan would be $3,680,000, on October 1983 price levels. Benefits for Plan 1B include all the storm delay savings ($401,400) and transit time savings ($154,400) for bulk and general cargo vessels credited to Plan 1, or $555,800 annually (see Table B24 in Appendix B). In addition, Plan 1B would provide adequate channel depths when water levels on Lake Erie fall up to 1 foot below average lake levels (Elevation 569.9, or, 1.3 feet above LWD). Since water levels on Lake Erie exceed Elevation 569.9 about 85 percent of the time during the navigation season versus 50 percent of the time for average water levels, Plan 1B would accrue additional storm delay savings of $140,500 annually (35 percent of the storm delay savings of $401,400 for Plan 1). Thus, average annual benefits for Plan 1B total $696,300.

Table 32, compares, among other things, the costs and benefits of Plans 1, 1A, and 1B. As indicated, the plan that provides the maximum average annual net benefits is Plan 1B. However, an additional analysis must be conducted to ensure that a plan providing channel depths 1-foot greater than Plan 1B, designated Plan 1C, does not provide even greater average annual net benefits.

Plan 1C would provide channel depths 1-foot greater than Plan 1B, or 2 feet greater than Plan 1. As such, the entrance channel would be dredged to 32 feet below LWD, and the interior channel would be dredged to 28 feet below LWD. The cost of this plan, on October 1983 price levels, is $5,330,000. Benefits for Plan 1C include all of the storm delay savings ($401,400) and transit time savings ($154,400) for bulk and general cargo vessels credited to Plan 1, or $555,800 annually. In addition, Plan 1C would provide adequate channel depths when water levels on Lake Erie fall up to 2 feet below average lake levels (Elevation 568.9 or 0.3 feet above LWD). Since water levels on Lake Erie exceed Elevation 568.9 about 99 percent of the time during the navigation season versus 50 percent of the time for average water levels, Plan 1C would accrue additional storm delay savings of $196,700 annually (49 percent of the storm delay savings of $401,400 for Plan 1). Thus, average annual benefits for Plan 1C total $752,500.

Table 32 also compares the costs and benefits of Plan 1C with Plans 1, 1A, and 1B. As indicated, average annual net benefits for Plan 1C are less than those for Plan 1B. Therefore, the plan that reasonably maximizes average annual net benefits is Plan 1B, the Modified "Severe-Weather" East Entrance Plan, and, as such, Plan 1B is designated the NED Plan.

31. RATIONALE FOR TENTATIVELY SELECTED PLAN (PLAN 1B)

Alternative Plan 1B, the Modified "Severe-Weather" East Entrance Plan is economically justified and environmentally viable. It is also the plan that reasonably maximizes average annual net benefits and, as such, has been designated the NED Plan. For these reasons, Plan 1B is the Tentatively Selected Plan.

Table 32 - Incremental Cost/Incremental Benefit Analysis (1)

	Total Project Cost	Average Annual Charges (2)	Average Annual Benefits	Incremental Average Annual Charges	Incremental Average Annual Benefits	Incremental Benefit/Cost Ratio	Overall Benefit/Cost Ratio	Overall Net Average Annual Benefits
	$	$	$	$	$			$
Plan 1A	1,500,000	127,400	228,300				1.8	100,900
				78,100	327,500	4.2		
Plan 1	2,420,000	205,500	555,800				2.7	350,300
				104,900	140,500	1.3		
Plan 1B	3,680,000	310,400	696,300				2.2	385,900
				141,600	56,200	.4		
Plan 1C	5,330,000	452,000	752,500				1.7	300,500

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.
(2) Includes interest during construction.

SECTION VI
CONCLUSIONS

The primary purpose of this section is to provide a summary of the significant conclusions reached during this Phase I study.

32. CONCLUSIONS

Cleveland Harbor accommodates the waterborne movement of bulk and general cargo to and from the city of Cleveland and inland portions of the State of Ohio, and adjacent States. During the 10-year period, 1972 to 1981, an average of about 18,300,000 net tons of cargo entered the harbor and about 700,000 net tons of cargo were shipped from the harbor, ranking it as one of the major harbors on the Great Lakes. Vessel movement of bulk iron ore, limestone, sand and gravel, and salt accounted for about 93 percent of the total cargo. The configuration of the breakwaters and navigation channels, however, limit the effective utilization of the vessels which can move these commodities. Significant transportation savings could be realized if the harbor were modified to permit more efficient use of these vessels.

The primary water resources needs for which a solution is sought under the Cleveland Harbor study authority are to move bulk and general cargo more efficiently and economically through Cleveland Harbor and to provide for unfulfilled recreational fishing needs in the Cleveland Harbor area. As possible solutions to addressing these needs, 20 preliminary structural alternatives and one prelimininary non-structural alternative were identified during the initial phase of the study in addition to the No-Action Plan. Of the 20 structural alternatives developed, four plans (Plans 5A, 5B, 7B, and 7F) were previously authorized but uncompleted projects on the Old and Cuyahoga River navigation channels.

Initial evaluation and assessment of the 21 preliminary alternatives, in terms of their contributions to the planning objectives and accounts, indicated that four plans (Plans 3C, 3D, 7A, and 9) should be eliminated from further evaluation due to technical and/or economic considerations.

Additional evaluation and assessment of the 17 remaining preliminary alternatives during Stage 2 indicated that:

a. Alternative Plans 1 ("All-Weather" East Entrance), 7G (Reduce River Congestion - Site 7), 8A (Recreational Breakwater Fishing - Edgewater Marina Breakwater), and 8B (Recreational Breakwater Fishing - West Breakwater) in addition to the No-Action Plan (Plan 10) warranted further, detailed study in Stage 3.

b. Alternative Plans 2, 3A, 3B, 4, 6A, 6B, 7C, 7D, and 7E should be eliminated from further consideration due to vessel safety and/or economic considerations.

c. Alternative Plans 5A and 5B, previously authorized but uncompleted improvements on the Old River navigation channel, were not economically justified in light of present traffic volumes. However, additional benefits from potential new coal traffic may be sufficient to increase the B/C ratio for either plan to above 1.0. It was, therefore, concluded that these authorized improvements should be kept in the inactive category until a final determination has been made on this new business. It was also concluded that no further consideration of either plan was warranted as part of this Phase I study.

d. Alternative Plans 7B and 7F, previously authorized but uncompleted improvements on the Cuyahoga River navigation channel, remain economically justified in light of present conditions and should be constructed under their present authorizations. It was also concluded that no further consideration of these plans was warranted as part of this Phase I study.

Subsequent to completion of Stage 2 plan formulation and evaluation studies, local interests requested that an additional plan to deepen the existing turning basin on the Cuyahoga River to 23 feet (designated Plan 11) be formulated and evaluated in Stage 3. It was therefore concluded that an additional plan to deepen the turning basin to 23 feet should be formulated and assessed during Stage 3 planning, in addition to Stage 3 studies on Plans 1, 7G, 8A, 8B, and 10.

At the initiation of Stage 3 planning, the recreational fishing plans, Plans 8A and 8B, were dropped from further consideration. Plan 8A was dropped from further consideration due to the decision to improve the existing entrance to Edgewater Marina under the Edgewater Marina Section 107 study in-lieu-of developing a new entrance for small boats into the west basin of Cleveland Harbor. Plan 8B was dropped from further consideration because the pedestrian bridge associated with this plan would have to provide 80-85 feet of vertical clearance, making the plan unfeasible. Therefore, all plans addressing the recreational fishing needs of the Cleveland Harbor area were dropped from further consideration, and the need for such facilities will remain unmet.

Evaluation and assessment of the remaining alternatives (Plans 1, 7G, 11, and 10) in Stage 3 indicated that:

a. Alternative Plan 1 ("Severe-Weather" East Entrance) was economically justified with a benefit-cost ratio of 2.7 and average annual net benefits of $350,300. However, a modified version of this plan, Plan 1B (Modified "Severe-Weather" East Entrance) provided greater average annual net benefits of $385,900.

b. Alternative Plans 7G (Remove Jefferson Avenue Bridge Abutments) and Plan 11 (Deepen Turning Basin) were not economically justified and should be dropped from further consideration.

c. Plan 1B was the NED Plan and, as such, was designated as the Tentatively Selected Plan.

33. TENTATIVELY SELECTED PLAN (PLAN 1B - MODIFIED "SEVERE-WEATHER" EAST ENTRANCE)

a. Description of Plan 1B.

Plan 1B would provide a "severe-weather" entrance into the Lakefront Harbor for bulk and general cargo vessels at the existing east entrance. As such, bulk cargo vessels, delivering iron ore to Conrail's transshipment facility adjacent to the west basin, would be able to enter the harbor in winds up to 30 knots. Further, foreign flag vessels, delivering general cargo to the Cleveland Port Authority docks, would be able to enter the harbor in winds up to 40 knots. The plan would also provide deeper channel depths which would allow vessels loaded to a 25-foot or greater static draft to enter Cleveland Harbor via the east entrance, thereby reducing the transit time of vessels arriving from or departing to the east. The layout and project features for Plan 1B are shown on Plate 24 in Appendix I.

Components of Plan 1B include the following:

(1) Deepening to the 31-foot depth contour, a fan-shaped lake approach channel, and a 900-foot wide entrance channel extending 2,900 feet into the east basin;

(2) Deepening of the existing 14,600-foot long, 500-foot wide east basin channel to 27.0 feet in depth;

(3) Deepening to 27 feet in depth a triangular area 775 feet by 775 feet immediately east of the Cleveland Port Authority docks in the east basin.

b. Cost Estimate for Plan 1B.

The detailed cost estimate for Plan 1B is presented in Table E4 of Appendix E. Tables 33 and 34, following, summarize the estimated project costs and annual charges and provide a breakdown of the Federal and non-Federal share of these costs under both the traditional cost allocation method and the Secretary of the Army's new proposed cost allocation method. From these tabulations, it is seen that the total project cost for Plan 1B is $3,680,000 on October 1983 price levels (Table 33) and the total investment cost, including interest during construction, is $3,743,000 (Table 34). The total annual charges, including additional annual maintenance costs over and above existing annual maintenance costs for Cleveland Harbor, are $310,400.

c. Economic Evaluation of Plan 1B.

Commercial navigation benefits that would be realized from implementation of Plan 1B are similar to those that would accrue due to implementation of Plan 1 which included the following: (1) Storm delay savings that would accrue as a result of bulk cargo vessels delivering iron ore to Conrail's transshipment facility being able to enter Cleveland Harbor in winds up to 30 knots in-lieu-of the present practice of waiting for rough weather to subside (annual benefits of $351,300); (2) Storm delay savings that would accrue as

Table 33 - Estimate of Total Project Cost for Alternative Plan No. 1B
(October 1983 Price Levels)

Item	Total Project Cost	Traditional Cost Allocation		Proposed Cost Allocation	
		Federal Share	Non-Federal Share	Federal Share	Non-Federal Share
	$	$	$	$	$
Dredging	2,581,200	2,581,200	-	-	2,581,200
Mobilization and Demobilization	8,000	8,000	-	-	8,000
Subtotal	2,589,200	2,589,200	-	-	2,589,200
Contingencies (25 percent +)	650,800	650,800	-	-	650,800
Subtotal	3,240,000	3,240,000	-	-	3,240,000
Engineering and Design (1)	150,000	150,000	-	-	150,000
Supervision and Administration	290,000	290,000	-	-	290,000
Total Project Cost	3,680,000	3,680,000	-	-	3,680,000

(1) Preparation of Plans and Specifications.

Table 34 - Estimated Investment Cost and Annual Charges for Alternative Plan No. 1B
(October 1983 Price Levels) (1)

Item	Total Project Cost	Traditional Cost Allocation: Federal Share	Traditional Cost Allocation: Non-Federal Share	Proposed Cost Allocation: Federal Share	Proposed Cost Allocation: Non-Federal Share
	$	$	$	$	$
Total Investment for the Project					
Total Project Cost, Excluding Lands	3,680,000	3,680,000	-	-	3,680,000
Interest During Construction (2)	63,000	63,000	-	-	63,000
Lands and Damages	0	-	0	-	0
Total Investment, Including Lands	3,743,000	3,743,000	0	-	3,743,000
Annual Charges for the Project					
Interest and Amortization	310,400	310,400	-	-	310,400
Additional Maintenance	0(3)	0	-	-	0
Total Annual Charges	310,400	310,400	-	-	310,400

(1) 8-1/8 percent interest rate, 50-year life.
(2) 1-year construction period.
(3) Since the volume of annual maintenance dredging for Plan 1B is not expected to increase over existing conditions, the additional maintenance cost for this plan is zero.

a result of foreign flag vessels delivering general cargo to the Cleveland Port Authority docks being able to enter Clevland Harbor in winds up to 40 knots in-lieu-of the present practice of waiting for rough weather to subside (annual benefits of $50,100); and (3) transit time savings that would accrue for vessels arriving from or departing to the east and which are loaded to a static draft of 25 feet or greater, being able to enter Cleveland Harbor via the east enterance in-lieu-of the present practice of entering through the west (main) entrance (annual benefits of $154,400). In addition, since Plan 1B would provide channel depths 1-foot greater than Plan 1, Plan 1B would provide adequate channel depths when water levels on Lake Erie fall up to 1-foot below average lake levels, the design water level for Plan 1. Therefore, Plan 1B would accrue additional storm delay savings of $140,500 annually over and above those credited to Plan 1. Thus, the average annual commercial navigation benefits for Plan 1B total $693,300.

Table 35, following, summarizes the annual benefits, annual charges, net benefits and benefit-to-cost ratio for Plan 1B. Net commercial navigation benefits are $385,900 annually and the B/C ratio is 2.2.

Table 35 - Summary of Benefits and Costs for Alternative Plan No. 1B (1)

	Average Annual Benefits	Average Annual Charges	Net Average Annual Benefits	Benefit/Cost Ratio
	$	$	$	
Total Project	696,300	310,400	385,900	2.2

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.

d. Environmental Features/Assessment of Plan 1B.

This plan would provide long-term benefits to regional development and would contribute to economic stability. In addition, this plan would save fuel and reduce the likelihood of accidents.

The new harbor entrance and deepened channel would require annual maintenance dredging although Plan 1B should produce only relatively minor net impacts on the long-term annual maintenance costs, the duration of dredging, and the volumes of material dredged. Both the initial and annual maintenance dredging may cause temporary inconveniences to commercial navigation, would destroy benthic populations in the area dredged, and would disperse fish from the immediate work area. Repeated maintenance dredging would result in periodic disruption of the benthic community structure at the dredging sites. After each dredging operation, benthic recolonization and fish movement into the area should occur. However, since the volume of maintenance dredging for Plan 1B is not expected to increase over existing practices, the net impacts of Plan 1B would be relatively minor. Studies to date have identified no threatened or endangered species that would be affected by the project.

Dredging would result in temporary increases in water turbidity and suspended solids. Temporary releases of pollutants and/or nutrients associated with the harbor sediments would also be expected. Temporary impacts to water drawn through nearby water supply intakes might also occur. Turbidity caused by dredging would decrease light penetration, causing short-term reductions in plankton productivity. Elevated levels of suspended solids and pollutants may cause temporary adverse fishery impacts. Temporary changes in water color, turbidity, and odor may cause minor aesthetic impacts during dredging. The extent of water quality effects would be determined by the current, waves, wind action, and background water quality conditions that exist during the actual dredging period.

Since sediment test results indicate that the material to be dredged is polluted, the dredgings would be placed in Dike Disposal Facility Site No. 14, which has sufficient capacity to handle the additional material dredged.

In general, confined dredged material disposal in Site No. 14 would hasten the conversion of aquatic habitat to terrestrial habitat. The impacts associated with construction and operation of Dike Disposal Facility Site No. 14 are discussed in the Final Environmental Impact Statement for that project (U.S. Army Corps of Engineers, 1975), and in the Supplemental Information Report and Section 404(b)(1) Evaluation (revised) for operation of the facility (U.S. Army Corps of Engineers, 1983).

Dredging activities would have temporary impacts on some recreational activities in the project area. Recreational boating, water skiing, and sport fishing in the Lakefront Harbor may be temporarily disrupted due to the operation of dredging equipment. Temporary water quality impacts may also affect sport fishing and swimming at nearby sites outside the Lakefront Harbor. The operation of dredging equipment would create minor visual impacts and would cause minor increases in noise and exhaust emmissions at the work site.

Changes in the travel routes of commercial vessels in Cleveland Harbor would be associated with this plan (i.e., greater use of the east basin by commercial vessels). However, although commercial vessels would occasionally inconvenience recreational boaters in the east basin, the overall impact to recreational boating should be minor. Also, since the Lakefront Harbor is heavily commercialized, no significant adverse aesthetic impacts would be expected. The general appearance of structures in the Lakefront Harbor would also be unaltered.

No impacts on cultural resources in the Cleveland Harbor area would be expected to result due to implementation of this plan.

34. IMPLEMENTATION OF TENTATIVELY SELECTED PLAN (PLAN 1B)

a. Schedule of Major Activities Through Construction.

The schedule of major activities, assuming the final recommendation of this Phase I study is to implement Plan 1B (the Tentatively Selected Plan), is shown on Figure 17. As indicated, following completion of the Phase I GDM in 1984, the report will be sent forward for Washington level review and Congressional authorization. Preparation of Plans and Specifications would follow in FY 88, with construction projected to start in FY 89. (Note: As indicated on Figure 17, a Phase II GDM, or final design document, will not be prepared if Plan 1B is implemented. Because Plan 1B is a simple dredging project, essentially located within a portion of the Lakefront Harbor already dredged, and because all dimensions of the plan have been established, a Phase II GDM would serve no useful purpose for this project. Therefore, to avoid unnecessary cost, a Phase II GDM will not be prepared.)

b. Division of Plan Responsibilities.

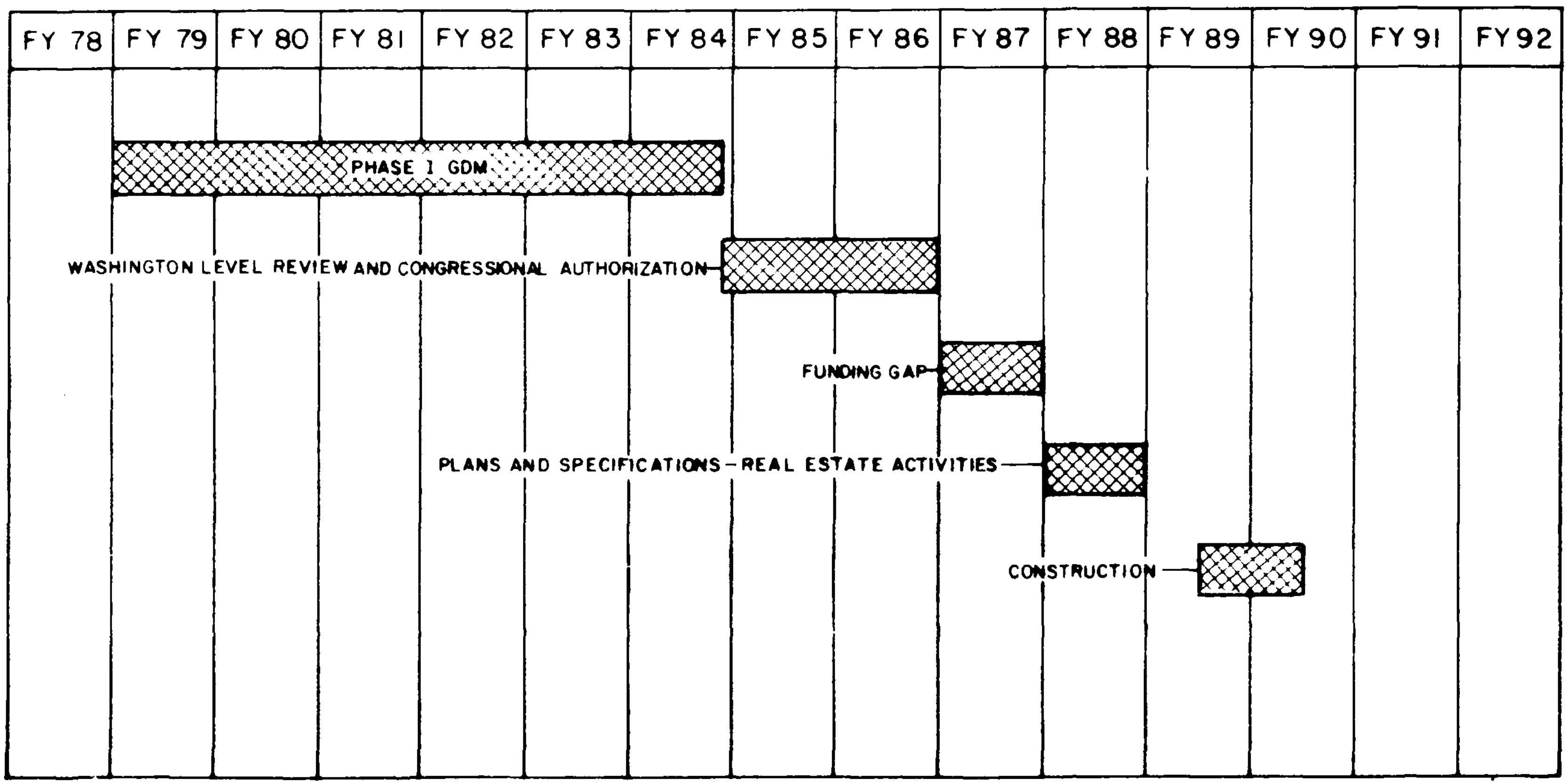
As previously discussed, the Secretary of the Army recently submitted legislation to provide for full recovery of certain operation and maintenance costs for deep draft ports and their connecting channels on or after 1 October 1982 and for full recovery of construction costs for deep draft ports and their connecting channels which receive initial construction funding on or after 1 October 1981. Therefore, division of plan responsibilities is presented under both traditional and proposed cost allocation methods.

Under traditional methods, the Federal Government would be responsible for designing, constructing, and maintaining the Tentatively Selected Plan (Plan 1B) at 100 percent Federal cost. Non-Federal responsibilities include providing, at no cost to the Federal Government, all lands, easements, and rights-of-way, provide and maintain berthing areas and slips adjacent to the general navigation channel, and provide and maintain a transshipment facility capable of accommodating vessels up to 1,000 feet in length in the Lakefront Harbor. Under proposed cost allocation methods, division of plan responsibilities would remain essentially the same. However, non-Federal interests would be required to reimburse the Federal Government for 100 percent of the cost to design, construction, and maintain the Tentatively Selected Plan.

35. COMPARISON OF TENTATIVELY SELECTED PLAN WITH AUTHORIZED STUDY PLAN

Table 36 compares the Tentatively Selected Plan (Plan 1B) with the plan proposed in the 1976 Feasibility Report. As indicated, the cost of the recommended modifications have decreased from $40.86 million to $9.18 million (including $5.5 million to improve Edgewater Marina under the Section 107 Edgewater Marina project). Principal factors that contributed to this decrease are: (1) elimination of recreational fishing facilities from the Tentatively Selected Plan (-$2.32 million); (2) elimination of the 1,200-foot long breakwater and accompanying aids to navigation included in the 1976 plan because they are no longer needed, and reduced dredging volume in the east basin and east entrance channel (-$17,250,000); (3) elimination of proposed modifications to the west (main) entrance because east entrance modifications resulted in greater benefits at a significant reduction in cost (-$6.21 million); and (4) elimination of a new dike disposal facility since existing Dike Disposal Facility 14 will be used to contain polluted dredged material (-$11,400,000).

PROPOSED SCHEDULE OF MAJOR ACTIVITIES
CLEVELAND HARBOR



PREPARED NOVEMBER 1983

FIGURE 17

FIGURE 17

Table 36 - Comparison of Tentatively Selected Plan with Authorized Study Plan (1)

Project Feature	Tentatively Selected Plan (See Plate 24 in Appendix I) ($ - millions)	Authorized Study Plan (See Plate 3 in Appendix I) ($ - millions)	Reason for Change
Recreational Fishing Facilities	0	2.32	Plan would require that the pedestrian bridge spanning the gap in the west breakwater provide 80-85 feet of vertical clearance in order to maintain small-boat access between Edgewater Marina and Cleveland Harbor, making the plan unfeasible.
East Entrance Modifications	3.68	20.93	1,200-foot long breakwater, with accompanying aids to navigation, not required for vessels up to 1,000 feet in length to enter the harbor under design storm conditions (i.e., "severe-weather" conditions) - reduced cost of plan by $9.23 million. Entrance and interior channel depths of 32 feet and 28 feet, respectively, for the authorized study plan reduced to 31 feet and 27 feet, respectively. Also, recent sounding information indicated reduced dredging volume. Together, these two factors, in addition to reduced unit price for contract dredging based on recent bid prices, decreased the cost for dredging from $11,700,000 to $3,680,000.
West Entrance Modifications	0	6.21	Proposed modifications would provide an adequate entrance for "fair-weather" conditions only. However, modifications to the east entrance would provide an adequate entrance for "severe-weather" conditions at considerably reduced cost. Therefore, since the east entrance modifications would provide greater benefits at a reduced cost, the west entrance modifications were eliminated from further consideration. It should also be noted that, based on the results of the hydraulic model study conducted during the Phase I study, the cost of the west entrance modifications would be in excess of $15,000,000 due to the need to mitigate increased wave activity in the Lakefront Harbor as a result of removing a portion of the spur breakwaters, not $6,210,000 as originally estimated.
Dike Disposal Facility	0	11.4	Use of Dike Disposal Facility 14 to contain polluted dredged material negates the need to build an additional dike disposal facility for the proposed modifications. However, it should be noted that this does not negate the need to build additional dike disposal areas to contain polluted dredged material resulting from annual maintenance activities at Cleveland Harbor.
Edgewater Marina Improvements	5.5	0	Improvements to Edgewater Marina, in the interest of small boat navigation, were not included in the authorized study plan. However, recent studies conducted under the Section 107 Edgewater Marina study, have indicated that such improvements are needed and economically justified. Such improvements will be constructed under authority of Section 107 of the 1970 River and Harbor Act.
Total	9.18	40.86	

(1) Based on October 1983 price levels.

36. NEED FOR FUTURE DIKE DISPOSAL FACILITIES AT CLEVELAND HARBOR

As previously discussed, material dredged to maintain authorized project depths at Cleveland Harbor is polluted and, as such, is disposed of in a dike disposal area. Since the fall of 1979, Dike Site 14 has been the disposal facility used, receiving about 550,000 cubic yards of material annually. Dike Site 14 will also be used to contain dredged material resulting from construction of Plan 1B (about 1 million cubic yards). However, with a design capacity of approximately 6.2 million cubic yards and assumming continued maintenance dredging volumes of about 0.5 million cubic yards per year, Dike 14 will be filled to capacity by about 1990.

At the present time, it is not known if additional dike disposal areas will be required to contain sediment dredged from Cleveland Harbor after 1990. Reasons for this uncertainty are as follows:

a. Although the sediment dredged from Cleveland Harbor is currently polluted, the quality of the sediment has improved dramatically since it was originally analyzed in 1977. For example, sediment dredged from the upper 1,000 feet of the Cuyahoga River navigation channel is now suitable for open-lake disposal. With the continued efforts by local interests to control point sources of pollution, such as the ongoing expansion and upgrading of the Southerly Wastewater Treatment Plant by the city of Cleveland and the Akron Wastewater Treatment Plant, both of which discharge into the Cuyahoga River, and continued efforts by local industry in meeting EPA pollutant discharge limitations, a continued improvement in sediment quality is anticipated. However, it is not known if this continued improvement will be sufficient to permit open-lake disposal of all or a significant portion of the sediment dredged.

b. Proposed legislation has been introduced into Congress which would authorize and fund upland erosion control plans in the Cuyahoga Valley National Recreation Area. If this legislation is passed and the program implemented, a significant decrease in the quantity of sediment dredged from Cleveland Harbor is expected since the park area is a major source of sediment from upland erosion. However, it is not known at the present time if this proposed legislation will become law.

c. As previously discussed, the city of Cleveland has long range plans to expand Burke Lakefront Airport. Sediment dredged from Cleveland Harbor could be used to construct landfill areas required by this proposed expansion, if a suitable dike is provided. However, it is not known at the present time if this proposed expansion will take place prior to 1990.

Based on the above, it is deemed appropriate to conduct a separate study to determine the need for additional dike disposal areas at Cleveland Harbor.

Further, since it typically takes about 3 years to plan and 2 years to construct a dike disposal facility, this study should be initiated no later than the beginning of 1985 in the event that future dike disposal areas are required. This study will be carried out under the existing Operations and Maintenance authority for Cleveland Harbor. It should be noted, however, that if a new dike disposal facility is required at Cleveland Harbor, it would be required whether or not Plan 1B is constructed.

SECTION VII
TENTATIVE RECOMMENDATIONS

After consideration of environmental, social, and economic effects as well as engineering feasibility, I have concluded that the best plan for accomplishing the planning objectives of promoting the economical movement of bulk and general cargo through Cleveland Harbor and providing for unfulfilled recreational fishing needs in the Cleveland Harbor area is Alternative Plan 1B - Modified "Severe-Weather" East Entrance. I, therefore, recommend that the Tentatively Selected Plan, Alternative 1B, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, be authorized for implementation as a Federal project subject to cost-sharing and financing arrnagements, with the responsible non-Federal sponsor, which are satisfactory to the President and to Congress. The first cost of this plan is currently estimated at $3,680,000 (October 1983 price levels) entirely at Federal expense. This recommendation is made provided that prior to consruction, non-Federal interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and maintenance of the harbor improvements upon the request of the Chief of Engineers including suitable areas determined by the Chief of Engineers to be required in the general public interest for the disposal of dredged materials resulting from construction of the project;

b. Comply with the applicable provisions of the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970," Public Law 91-646, approved 2 January 1971, in acquiring lands, easements, and rights-of-way for construction and subsequent maintenance of the project and inform affected persons of pertinent benefits, policies, and procedures in connection with said Act;

c. Accomplish without cost to the United States all utility and other relocations or alterations made necessary by the project, except for aids to navigation;

d. Hold and save the United States free from damages due to the construction and maintenance of the project, not including damages due to the fault or negligence of the United States or its Contractors;

e. Provide and maintain without cost to the United States depths in berthing areas and local access channels commensurate with depths provided in related project areas;

f. Provide without cost to the United States, terminal, transfer, and transshipment facilities in the Lakefront Harbor, plans and schedules for construction of these facilities must be approved by the Chief of Engineers;

g. Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (PL 88-352) and Department of Defense Directive 5500.11, issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations, in connection with the maintenance and operation of the project.

It is also recommended that a study be initiated in FY 1985 to determine the need for a new dike disposal faulty at Cleveland Harbor. This study will be conducted under the current Operations and Maintenance authority for Cleveland Harbor.

ROBERT R. HARDIMAN
Colonel, Corps of Engineers
District Commander

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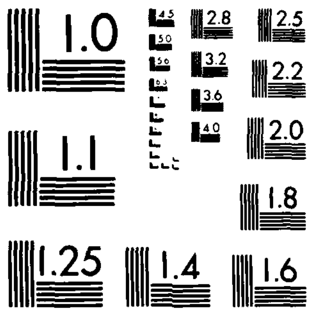

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DRAFT SUPPLEMENT I

TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

Cleveland Harbor Navigation Project, Cleveland, Ohio

The responsible lead agency is the United States Army Engineer District, Buffalo, New York.

Abstract: This supplement to the Final Environmental Impact Statement (FEIS) for Cleveland Harbor describes a new, proposed plan which was developed during the Reformulation Phase I General Design Memorandum (GDM) study. The plan originally proposed in the FEIS would have provided two entrances to Cleveland Harbor for 1,000-foot vessels, modified harbor breakwater configurations, deepened portions of the existing Lakefront Harbor, and provided fishermen access to the Cleveland West Breakwater. However, shipping interests revised their concept and development preferences concerning 1,000-foot vessel operations since the Buffalo District completed its basic Feasibility Study and FEIS. Reformulation of the study has resulted in the rejection of the plan discussed in the FEIS and in the proposal of a new alternative, designated as Plan 1B. Plan 1B consists of improvements to the Lakefront Harbor and provides many of the benefits to commercial navigation that were associated with the plan discussed in the FEIS, but with reduced construction impacts and project costs. Plan 1B would provide a single "severe-weather" entrance into the Lakefront Harbor for Class V through Class X vessels at the existing east entrance. Components of Plan 1B include dredging a fan-shaped entrance channel and deepening portions of the east basin. This supplement describes the resultant environmental impacts of the currently proposed plan.

Draft Statement filed with CEQ	27 February 1976
Revised Draft Statement filed with CEQ	14 September 1977
Final Statement filed with EPA	26 October 1978

Send Your Comments to the District Commander By: 7 May 1984
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SUMMARY

The original plan proposed in the FEIS would have provided two entrances to Cleveland Harbor for 1,000-foot vessels. This plan would have modified the present arrowhead entrance to provide safe and efficient passage during relatively calm weather conditions. The entrance at the easterly end of the east breakwater would have been modified for use during storm conditions. The original plan would have consisted of the following components:

a. Construction of a 1,200-foot rubblemound breakwater spur at the east end of the east breakwater to absorb and deflect wave generated currents which occur along the east breakwater, and to provide a protected area for vessel entry during strong north-westerly winds. Construction of the spur would have required 31,600 tons of quarry stone.

b. Dredging a 32-foot deep lake approach channel to the east basin. This channel, shaped like an irregular quadrangle, would have fanned out 1,500 feet lakeward and 2,500 feet landward from the 1,000-foot wide proposed entrance channel to a 2,000-foot wide lakeward entrance.

c. Dredging of a 32-foot deep, 1,000-foot wide entrance channel extending 2,900 feet into the east basin.

d. Deepening of the existing 500-foot wide east basin channel to a depth of 28 feet.

e. Incremental removal of 500 feet of the existing west breakwater spur and 400 feet of the existing east breakwater spur to facilitate turning movements. Initially, 200 feet would have been removed from the west spur, and 100 feet from the east spur. Additional increments would have been removed only if actual vessel operations indicated that a greater gap width was required.

f. Widening the existing main entrance channel and dredging this channel to a depth of 32 feet.

g. Construction of an elevated pedestrian bridge across the 200-foot gap between the Cleveland west breakwater and the Lake Erie shore.

Shipping interests revised their concept and development preferences concerning vessel operations in the Cleveland Lakefront Harbor since the Buffalo District completed its basic Feasibility Study and FEIS. Therefore, the originally proposed plan was reformulated and ultimately rejected. Corps planning during the Reformulation Phase I GDM study considered a wide range of alternatives which included plans for Lakefront Harbor modifications, Old River modifications, Cuyahoga River modifications, fishery habitat improvement, and fishermen access. The No-Action alternative continued to be considered during the Reformulation Phase I GDM study.

As a result of the Reformulation Phase I GDM study, Plan 1B is currently proposed. Plan 1B would provide a single "severe-weather" entrance into the

Lakefront Harbor for Class V through Class X vessels by dredging a fan-shaped entrance channel at the existing east entrance and deepening portions of the east basin. Plan 1B would provide many of the benefits to commercial navigation which were associated with the originally proposed plan, but with reduced construction impacts and project costs.

No significant areas of controversy or unresolved issues have developed due to reformulation of the originally proposed Cleveland Harbor plan. Compliance with environmental protection statutes applicable to Plan 1B has been attained as described in Section IV of the Draft Reformulation Phase I GDM Main Report.

Table S1 - Relationship of Plan 1B to Environmental Protection Statutes and Other Environmental Requirements

	Alternative 1B
Federal Statutes	
Archeological and Historic Preservation Act, as amended, 16 USC 469, et. seq.	Full
National Historic Preservation Act, as amended, 16 USC 470a, et. seq.	Full
Fish and Wildlife Coordination Act, as amended, USC 661, et. seq.	Full
Endangered Species Act, as amended, 16 USC 1531, et. seq.	Full
Clean Air Act, as amended, 42 USC 7401, et. seq.	Full
Clean Water Act, as amended (Federal Water Pollution Control Act), 33 USC 1251, et. seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC 460-1(12), et. seq.	Full
Land and Water Conservation Fund Act, as amended, 16 USC 4601-4601-11, et. seq.	Full
National Environment Policy Act, as amended, 42 USC 4321, et. seq.	Full
Rivers and Harbors Act, 33 USC 401, et. seq.	Full
Wild and Scenic Rivers Act, as amended, 16 USC 1271, et. seq.	N/A

Table S1 continued

	Alternative 1B
Federal Statutes (Cont'd)	
Coastal Zone Management Act, as amended, 16 USC 1451, et. seq.	N/A
Estuary Protection Act, 16 USC 1221, et. seq.	N/A
Marine Protection, Research and Sanctuaries Act, 22 USC 1401, et. seq.	N/A
Watershed Protection and Flood Prevention Act, 16 USC 1001, et. seq.	N/A
Executive Orders, Memoranda, Etc.	
Flood Plain Management (EO 11988)	Full
Protection of Wetlands (EO 11990)	N/A
Environmental Effects Abroad of Major Federal Actions (EO 12114)	N/A
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 30 Aug 76)	N/A
Local Land Use Plans (See Flood Plain Management EO 11988, also)	Full

The compliance categories used in this table were assigned based on the following definitions:

a. Full Compliance - All requirements of the statute, EO, or other policy and related regulations have been met for this stage of the study.

b. Partial Compliance - Some requirements of the statute, EO, or other policy and related regulations, which are normally met by this stage of planning, remain to be met.

c. Noncompliance - None of the requirements of the statute, EO, or other policy and related regulations have been met.

d. N/A - The statute, EO, or other policy and related regulations are not applicable for this study.

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SECTION 1 - NEED FOR AND OBJECTIVES OF THE ACTION

S1.01 Introduction - The overall objectives and determination of the need for improvement of the Federal Harbor at Cleveland, OH, have been described in the Final Environmental Impact Statement (FEIS) and the Buffalo District's 1976 Feasibility Report for the project. The purpose of this supplement is to address the new plan being proposed due to the Reformulation Phase I GDM study.

S1.02 Study Authority - A resolution passed by the Committee on Public Works of the House of Representatives on 2 December 1970, authorized the Corps of Engineers to conduct a feasibility study to determine if modifications to the general navigation features of Cleveland Harbor were needed in the interest of commercial navigation and to determine if such improvements were economically justified and environmentally acceptable. A feasibility study was conducted from 1972 to 1976 and the results of this study were documented in the Cleveland Harbor, Ohio Feasibility Report for Harbor Modifications, June 1976. Based on the Feasibility Report, the Phase I General Design Memorandum (GDM) stage of advanced Engineering and Design was subsequently authorized by Section 175 of the 1976 Water Resources Development Act (Public Law 587, 94th Congress), approved 22 October 1976.

S1.03 Planning Objectives - Section II of the Draft Reformulation Phase I GDM for Cleveland Harbor describes the planning objectives that were developed for the study.

SECTION 2 - ALTERNATIVES

S2.01 Introduction - Numerous alternative plans were considered in the FEIS, in the 1976 Feasibility Report, and during Stage 2 and Stage 3 planning for the Reformulation Phase I GDM study. The plan proposed in the FEIS and Feasibility Report would have provided two entrances to Cleveland Harbor to accommodate vessels up to 1,000 feet in length and 105 feet in beam. Under this plan, the present arrowhead entrance would have been modified to permit safe and efficient passage during relatively calm conditions, while the entrance at the easterly end of the east breakwater would have been modified for use during storm conditions. Lakefront Harbor deepening and recreational fishermen access would have also been provided under this plan. A discussion of the plan proposed in the FEIS and Feasibility Report and the reasons for reformulating the originally proposed Cleveland Harbor plan are contained in Section I of the Draft Reformulation Phase I GDM.

S2.02 Stage 2 planning efforts for the Phase I study considered a wide range of alternatives which included plans for Lakefront Harbor modifications, Old River modifications, Cuyahoga River modifications, fishery habitat improvement, and fishermen access. The No-Action alternative was considered in both the FEIS and during subsequent Stage 2 and Stage 3 planning. A detailed discussion of plans considered during Stage 2 is presented in Section III of the Draft Reformulation Phase I GDM.

S2.03 Each alternative considered during Stage 2 planning was studied to determine its technical feasibility, economic costs and benefits, and impacts on the natural and human environment. The alternatives proposed for further study as a result of Stage 2 planning included Plans 1 ("Severe-Weather " East Entrance) subsequently modified to Plan 1B (Modified "Severe-Weather" East Entrance), 7G (Remove Jefferson Avenue Bridge Abutments), 8A (Recreational Breakwater Fishing - Edgewater Marina Breakwater), 8B (Recreational Breakwater Fishing - West Breakwater), and 10 (No-Action). The Stage 2 effort also determined that Alternative Plans 7B and 7F, previously authorized but uncompleted improvements on the Cuyahoga River navigation channel, remain economically justified in light of present conditions and should be constructed under their present authorizations. All other alternatives considered during Stage 2 planning were eliminated from further consideration due to vessel safety, and/or economic reasons.

S2.04 Since the Stage 2 effort concluded that no further consideration of Plans 7B and 7F was warranted as part of the Phase I study, these plans will not be addressed in this Draft Supplement to the FEIS. In the event that a future decision is made to implement one or both of these plans, appropriate actions to insure compliance with the National Environmental Policy Act (NEPA) will be required.

S2.05 As discussed in Section IV of the Draft Phase I GDM, the development of fishermen access plans was dependent on the outcome of the Edgewater Marina Section 107 Study. Structural measures associated with the improvement plan selected for the Edgewater Marina Study subsequent to completion of Stage 2 planning, negate the possibility of constructing Plan 8A. Plan 8B was also eliminated early in Stage 3 since the Ohio Department of Natural

Resources is opposed to the low level bridge associated with this plan. This bridge would have restricted the passage of recreational boats through the existing gap in the Cleveland west breakwater. Construction of a high level bridge instead of the low level structure would not be realistic since fishermen would be forced to climb an 85-foot high bridge in order to gain access to the west breakwater. Since Plans 8A and 8B were eliminated from consideration early in Stage 3, they will not be discussed futher in this Draft Supplement.

S2.06 The possibility of providing fishery habitat improvements at Cleveland Harbor was thoroughly explored by the Buffalo District during Stage 2 planning efforts. Corps regulations allow for fishery habitat improvements if they are required for mitigation or if they consist of enhancement which must be related to, or take advantage of, opportunities created by a water resources development. Several of the Outer Harbor plans considered during Stage 2 planning would have provided significant quantities of stone due to removal of portions of the existing harbor breakwaters. Although this stone could have been utilized for development of an artificial reef for fishery habitat improvement, the Outer Harbor plans that would have provided this material have been rejected for economic and/or vessel safety reasons. Also, since all fishermen access plans have been rejected for the reasons cited above, the possibility of purchasing stone and constructing habitat improvements in conjuction with fishermen access plans is also eliminated.

S2.07 Under Plan 7G, a limited quantity of broken concrete would have been generated due to removal of the Jefferson Avenue bridge abutments. Components of Plan 7G included the use of this material for fishery habitat improvement along the Lake Erie shoreline at Edgewater Park. However, since information obtained during late Stage 3 planning activities indicated economic infeasibility, Plan 7G, with its associated habitat improvements, was eliminated.

S2.08 Plan 1B does not provide stone or yield other opportunities for habitat improvement. Further, the limited aquatic impacts associated with this plan do not provide justification for mitigation in the form of fishery habitat improvement. Therefore, no fishery habitat improvements are currently proposed.

S2.09 Subsequent to completion of Stage 2 plan formulation and evaluation studies, local interests requested that an additional plan be formulated and evaluated to deepen the turning basin in the Cuyahoga River to 23 feet (designated Plan 11). This alternative is discussed in Section IV of the Draft Reformulation Phase I GDM. However, since this plan is not being recommended due to economic considerations, it will not be discussed further in this Draft Supplement.

S2.10 In summary, the only action alternative being considered in detail for the Cleveland Harbor Study is Plan 1B. This plan is currently proposed for implementation.

S2.11 Description of Plan 1B - Plan 1B would provide a "severe-weather" entrance into the Lakefront Harbor for Class V through Class X vessels at the existing east entrance. The layout and project features for Plan 1B are shown on Plate 24 of the Draft Reformation Phase I GDM.

S2.12 Components of Plan 1B include a fan-shaped entrance channel at the existing east entrance and an interior channnel through the east basin to the west basin. West of the fan-shaped area, the width of the entrance channel narrows to 900 feet. The 900-foot width is required since vessels would still be under the influence of wave action during "severe-weather" conditions, especially when waves were from the north through northeast directions. Further inside the harbor, the channel would narrow to 500 feet, which is sufficient for two-way traffic through the more protected portions of the east basin.

S2.13 The entrance channel would be dredged to a depth of 31 feet below LWD. The interior channel would be dredged to a depth of 27 feet below LWD. About 956,000 cubic yards of polluted dredged material would be generated during construction of Plan 1B. This material would be placed in Dike Disposal Facility No. 14, which has sufficient capacity to handle this additional material.

S2.14 Plan 1B provides unlimited stopping distance for vessels entering Cleveland Harbor during storm conditions. It also provides a lower potential for vessel accidents and is considered adequate for use by 1,100-foot vessels, should they enter the Great Lakes fleet.

S2.15 Plan Implementation Responsibilities - Project construction and maintenance would be performed by the Federal Government. Costs for the work would be either entirely paid for by the Federal Government under traditional cost allocation or entirely paid for by local interests under the Secretary of the Army's proposed cost allocation, depending on the legislation in effect at the time of construction.

S2.16 National Economic Development (NED) Plan - The NED plan is that plan which reasonably maximizes net national economic development benefits, consistent with the Federal objective. The plan that best fulfills these criteria is Plan 1B, with average annual net benefits of $385,900.

S2.17 Comparative Impacts of the Plan Proposed in the FEIS and Plan 1B - Table S2 of this section describes in a comparative manner the significant environmental impacts of the original plan proposed in the FEIS and Plan 1B. The reader should refer to Section 4 of this supplement for a more detailed discussion of the impacts of Plan 1B. Section 4 of the FEIS describes in detail the impacts of the originally proposed plan.

Table S2 - Comparative Impacts of Alternatives

Parameter	Alternative Proposed in FEIS	Plan 1B
1. Commercial Navigation	Increased vessel safety; modified navigation patterns in Lakefront Harbor; reduced shipping costs.	Increased vessel safety; modified navigation patterns in Lakefront Harbor; reduced shipping costs.
2. Water Quality	Temporary impacts during construction and maintenance dredging.	Temporary impacts during construction and maintenance dredging.
3. Dredged Material Disposal	Disposal of 1,450,000 cubic yards of dredged material (sediment tests required to determine pollutional classification); potential placement of polluted sediments in some undesignated confined disposal site. Probably minimal changes in maintenance dredging quantities and cost.	Disposal of 956,000 cubic yards of polluted material in Dike Site 14 during construction; no significant change in maintenance dredging quantities or cost.
4. Fishery and Benthos	Creation of open water and loss of good quality fishery and benthic habitat associated with removal of 900 feet of breakwater; covering of aquatic/benthic habitat with 1,200 feet of breakwater and improvement of benthic habitat along the sides of this breakwater; additional temporary aquatic disturbances during construction; slight increase in the size of the area to be disturbed during maintenance dredging; possible use of new dredged material disposal site.	Temporary disturbance of aquatic habitat during construction; slight increase in size of the area to be disturbed during maintenance dredging.
5. Recreation	Provision of fishermen access to Cleveland West Breakwater; possible impacts to recreational boating due to change in commercial navigation patterns; temporary impacts to water-dependent recreation during construction and maintenance dredging.	Temporary impacts to water-depend[illegible] [illegible]reation during construction and maintenance dredging; possible minor inconveniences to small boats due to change in commercial navigation patterns.

SECTION 3 - AFFECTED ENVIRONMENT

S3.01 Introduction - Section 2 of the FEIS for the Cleveland Harbor Navigation Project provided an extensive description of existing environmental conditions in the project area. Additional, updated baseline data is contained in Section II of the Draft Reformulation Phase I GDM. The significant environmental resources associated with Plan 1B which were not addressed in the FEIS or for which new data exists are described below.

S3.02 Sediments - Sediments reaching Cleveland Harbor and the lower Cuyahoga River consist primarily of medium to fine grained materials and generally contain high concentrations of iron, nitrogen, phosphates, oils, grease, and other pollutants. Based on 1977 sediment test results, the U.S. Environmental Protection Agency (USEPA) classified the sediments within the entire Cuyahoga River section of the Cleveland Federal Navigation Project as heavily polluted. The USEPA classified the sediments outside the east entrance light as borderline unpolluted/moderately polluted. Sediments within the existing Federal project which would be dredged under Plan 1B were classified by the USEPA as heavily polluted.

S3.03 Sediments in the Cuyahoga River, the Old River, and the Cleveland Lakefront Harbor were analyzed for sediment grain size by the Ohio River Division (ORD) Laboratory of the U.S. Army Corps of Engineers in late 1982. Sediments from these areas are currently being analyzed for the Buffalo District by EG&G, Bionomics with respect to toxicity, bulk chemistry, and elutriate characteristics. A final sediment test report has not yet been submitted by EG&G and approved by the Buffalo District. However, the ORD and preliminary EG&G test results indicate that sediments to be dredged under Plan 1B consist primarily of fine-grained material which is heavily polluted and unsuitable for open-lake disposal.

S3.04 For a more detailed discussion of sediment testing in the Cleveland Harbor area, the reader is referred to Chapter 2 of the Final EIS and Section II of the Draft Reformulation Phase I GDM. The more recent, preliminary sediment test information cited in paragraph 3.03 above should be confirmed upon completion and approval of the final EG&G sediment test report. The results of this report will be available for inclusion in the Final Supplement to the FEIS.

S3.05 Fishery Resources - Limited fishery sampling was performed in 1983 by the U.S. Fish and Wildlife Service (USF&WS) in the Outer Harbor and in the Cuyahoga River near the Jefferson Avenue bridge abutments. As expected, the most common species collected in the Outer Harbor were freshwater drum, yellow perch, white bass, and spottail shiner. A complete species list is contained in the June 1983 Draft Fish and Wildlife Coordination Act Report (see Exhibit H-6 in Appendix H of the Draft Reformulation Phase I GDM). Sampling in the vicinity of the Jefferson Avenue bridge abutments yielded a total of only four small white bass and one carp. The USF&WS sampling results were in general agreement with previous fishery studies cited in the FEIS.

S3.06 Recreational Fishing - Recreational fishing from harbor structures is an important activity for Cleveland area residents. Angler creel surveys performed by the Ohio Department of Natural Resources (ODNR) in 1980, 1981, and 1982, and surveys performed by the USF&WS in 1982 indicate that the three most frequently caught recreational species are yellow perch, white bass, and freshwater drum. Records compiled by the ODNR indicate that in 1982, about 135,819 angler hours of fishing were realized in the Edgewater Park Area (West Cleveland Harbor), while about 249,692 angler hours were realized in the area of the Niki Site Pier and East 72nd Street Pier (East Cleveland Harbor).

S3.07 Cultural Resources - Coordination with the U.S. Department of the Interior and the State Historic Preservation officer indicates that no historic sites are located in the proposed work area.

SECTION 4 - ENVIRONMENTAL CONSEQUENCES

S4.01 <u>Introduction</u> - This section describes the environmental consequences of Plan 1B. Due to the similarity of the plan described in the FEIS and Plan 1B, only those impacts that have either changed significantly or have resulted in new, critical environmental resources being affected, are presented in this Draft Supplement. The reviewer of this section may therefore wish to first read Chapter 4 of the FEIS for a more complete understanding of the environmental impacts of the redesigned Outer Harbor plan.

S4.02 <u>Commercial Navigation</u> - No increase in total harbor tonnage is expected to result due to implementation of Plan 1B. Implementation of this plan would contribute to vessel safety and would result in modified commercial navigation patterns in the Lakefront Harbor. The primary advantage of this plan is the reduction of transportation costs due to elimination of vessel storm delays and transit time saved for those vessels departing to or arriving from the east. In addition, this plan would save fuel. No increase in total harbor tonnage or traffic would be expected.

S4.03 <u>Water Quality</u> - The proposed dredging would result in temporary increases in water turbidity and suspended solids. Temporary releases of pollutants and/or nutrients associated with the harbor sediments would also be expected. Short-term alterations in water color, turbidity, and odor may cause minor aesthetic impacts during construction and maintenance activities. The extent of water quality effects would be determined by the current, waves, wind action, and background water quality conditions that exist during the actual construction and maintenance dredging periods. The water quality impacts cited above presently occur during regular maintenance dredging operations. Although the areas for dredging would be modified slightly due to implementation of Plan 1B, only minor water quality impacts would be expected. It should also be noted that implementation of the proposed plan would not result in an increase in harbor tonnage nor induce a change in the fleet carrying this tonnage. Thus, there would be no impact on water quality due to the project for either an increase or decrease in traffic. Water quality impacts associated with the disposal of dredged material are discussed in paragraphs S4.05, S4.06, and S4.07 below.

S4.04 <u>Dredged Material Disposal</u> - The 1977 and preliminary 1983 sediment test results indicate that the material to be dredged under Plan 1B is polluted. Since the material is not suitable for open-lake disposal, it would be placed in Dike Disposal Facility Site No. 14, which has sufficient capacity to accommodate the additional material. Plan 1B should produce only relatively minor net impacts on the long-term annual maintenance costs, the duration of dredging and disposal, and the volumes of material dredged. The impacts associated with the continued operation of Dike Disposal Facility Site No. 14 are addressed in the Buffalo District's 1983 (revised) Supplemental Information Report and Section 404 (b)(1) Evaluation for the facility. In general, the continued use of Dike Disposal Facility Site No. 14 would ultimately result in the conversion of the area to dry land.

S4.05 Although sediments presently within Dike Disposal Facility Site No. 14 are heavily polluted, the results of 1981 water quality monitoring studies by the Great Lakes Laboratory during and after a typical disposal operation at Dike Disposal Site 14 suggest that operation of the disposal area has no significant effect on Lake Erie waters. The Great Lakes Laboratory Water Quality Monitoring Report concluded that if any disposal material is being transported through the dike to Lake Erie, the concentrations of these materials are diluted to such an extent 200 feet from the dike that most water quality criteria and objectives are not violated.

S4.06 The Great Lakes Laboratory report indicated that inside the Site 14 confinement area, the 1976 USEPA Guidelines for Water Quality Criteria and the 1978 International Joint Commission (IJC) Water Quality Objectives for chemical parameters were exceeded on many occasions during disposal. The monitoring program indicated that after disposal, some concentrations of mercury, zinc, ammonia, cyanide, and phenol also exceeded water quality objectives. The study indicated that significant alterations in temperature, conductivity, and pH probably do not occur within Site 14 during disposal. The waters in the facility were, however, found to have depleted oxygen concentrations and increased suspended solid levels during disposal.

S4.07 The overflow structures are not currently in operation at Dike 14. A Nationwide Permit (No. 330.5 (a)(16)) covering this activity was issued on 22 March 1982. This permit is conditioned to state that the effluent may not contain toxic materials and that State water quality certification under Section 401 of the Clean Water Act is required. In the event that the overflow structures at Dike Site 14 are to be utilized, water quality certification will be requested from the Ohio Environmental Protection Agency. The Buffalo District anticipates that conditions of the Nationwide Permit would be met.

S4.08 Fishery and Benthos - Both the initial and maintenance dredging associated with Plan 1B would destroy benthic populations in the area dredged, and would result in the periodic disruption of benthic community structure at the dredging site. Increased levels of turbidity, suspended solids, and pollutants or nutrients could cause short-term alterations in plankton productivity, and could cause temporary fishery and benthic impacts. Although the above periodic disturbances presently occur during routine harbor maintenance, the impact area would be enlarged slightly due to implementation of the proposed alternative. After construction and each maintenance dredging operation, benthic recolonization and fish movement into the impact area should occur.

S4.09 Wave - Induced Storm Damages - No significant increase in wave heights would be associated with Plan 1B, since the area outside the existing east breakwater is nearly the proposed project depth. Also, the area inside the breakwater would continue to be protected from wave action. No increases in storm damages to marinas or other shoreline property should therefore occur.

S4.10 Recreation - Dredging activities under Plan 1B may cause temporary disturbances to recreational boating, water skiing, and sport fishing in the Lakefront Harbor. Temporary water quality impacts may also affect sport fishing and swimming at other sites nearby. Changes in the travel routes of commercial vessels in Cleveland Harbor would be associated with Plan 1B. Although commercial vessels would occasionally inconvenience recreational boaters in the east basin, the overall impact to recreational boating should be minor.

LIST OF PREPARERS

The following people were primarily responsible for preparing this Draft Supplement:

Name	Discipline/Expertise	Experience	Role in Preparing Draft Supplement
Mr. Richard Aguglia	Civil Engineer	6 years U.S. Army Engineer District Buffalo - Project Manager	Project Manager, Formulation of Alternatives, Needs Assessment
Mr. Philip E. Berkeley	Biology/Aquatic Biology	8 years Environmental Impact Analysis Studies, Buffalo District	General Draft Supplement Review. Impacts on Biological Resources.
Mr. David W. Heicher	Biology/Natural Resource Management	3 years, Graduate Teaching Assistant (Biology) Indiana University of Pennsylvania; 1/2 year, Aquatic Biologist, Ichthyological Associates, Inc.; 6 years, Environmental Impact analysis and EIS studies, Buffalo District.	Draft Supplement coordinator. Effects on Biological and Natural Resources.
Mr. William E. Butler	Geography/Physical, Social	4 years, EIS Studies, Buffalo District	Socioeconomic Impacts.
Mr. Timothy T. Daly	Social Scientist	5 years Social Impact Analysis, EIS Studies and Cultural Resources Studies.	Effects on Cultural Resources.

SECTION 5 - PUBLIC INVOLVEMENT (COORDINATION)

S5.01 Introduction - The Draft and Final EIS and Feasibility Report were coordinated with Federal, State, and local agencies as well as the general public to insure compliance with all applicable environmental protection statutes. A Notice of Intent to prepare a Draft Supplement to the Final EIS was published in the Federal Register on 29 March 1983. Additional coordination was performed before and during the preparation of this Draft Supplement. The following paragraphs describe the results of this coordination to date.

S5.02 Coordination with the Ohio Department of Natural Resources (ODNR) - The ODNR participated in a 15 March 1982 Workshop Meeting held by a telephone conference call between the Buffalo District, the U.S. Fish and Wildlife Service, and the ODNR during Stage 2 planning for the Reformulation Phase I GDM study. A major area of discussion at this meeting was the development of fishermen access plans to the west breakwater at Cleveland Harbor. Based on continued coordination with the ODNR, fishermen access Plan 8B was ultimately rejected as discussed in paragraph S2.05 of this Draft Supplement and in Section IV of the Draft Phase I GDM.

S5.03 In a letter dated 3 June 1983, the ODNR expressed concerns over possible increases in wave-induced storm damages which they felt might be associated with Plan 1B. The Buffalo District has considered this concern and determined that no increase in storm damages should occur as discussed in paragraph S4.09 of this document. The fishery habitat development associated with Plan 7G was discussed in telephone conversations with ODNR officials on 6, 7, and 8 July 1983. The ODNR was in general agreement with this habitat development, which would have been located east of a fishing pier and an artificial reef to be constructed by the ODNR.

S5.04 Coordination with the U.S. Fish and Wildlife Service (USF&WS) - In addition to their participation in the 15 March 1982 Workshop Meeting, the Columbus Field office of the USF&WS prepared planning aid letters dated 24 June 1981 and 3 June 1982, which were utilized by the Buffalo District during Stage 2 planning efforts. A supplement to their 24 June 1981 letter was provided on 13 October 1982. A Draft Fish and Wildlife Coordination Act Report (revised) was forwarded to the Buffalo District on 15 June 1983. The information and recommendations provided by the USF&WS were utilized in preparing this Draft Supplement and in developing fishery habitat improvements which were considered under Plan 7G.

S5.05 Coordination with the U.S. Environmental Protection Agency (USEPA) - In a letter dated 1 June 1983, the USEPA identified three issues which they believed should be discussed in this Draft Supplement. These three issues concered the environmental effects of dredging and disposal of harbor sediments, the project's effect on water quality due to ship movements, and the potential for enhancement of fish habitat. All three of these issues have been addressed as recommended by the USEPA.

S5.06 Cultural Resources Coordination - Based on letters from the National Park Service dated 2 March 1982 and 27 June 1983, as well as input provided by the Ohio State Historic Preservation Office on 17 March 1982 and 8 July 1983, no cultural resources were identified in the proposed work area associated with Plan 1B.

S5.07 Section 404 - Section 404 of the Clean Water Act requires that the environmental effects associated with the discharge of dredged or fill materials into navigable waters of the United States be evaluated, in accordance with specific evaluation parameters. The placement of dredged material in Dike Disposal Site 14 was previously addressed in the January 1983 (revised) Section 404 (b)(1) Evaluation Dredged Material Disposal at Diked Disposal Site 14 Cleveland, Ohio. No other discharges of dredged or fill materials would be performed under Plan 1B.

S5.08 Public Views - In addition to coordinating with the agencies cited above, a description of Plan 1B was forwared to the U.S. Department of Housing and Urban Development, the U.S. Soil Conservation Service, the U.S. Department of the Interior's Office of Environmental Project Review, the Cleveland City Planning Commission, and the Cuyahoga Regional Planning Commission. Questions regarding project alternatives were raised by the Cleveland City Planning Commission and were addressed in a 7 June 1983 letter from the Buffalo District. Baseline information was provided by the Cuyahoga Regional Planning Commission and the Cleveland Greater Growth Association, which was contacted by phone regarding the preparation of this Draft Supplement. In addition, the views of area shipping interests were solicited during several public workshop meetings which were held during project planning. The minutes of these workshop meetings are summarized in Appendix G of the Draft Reformulation Phase I GDM. In addition, this Draft Supplement will be forwarded to the concerned public for review and comment during the official 45-day review period.

S5.09 Recipients of this Supplement - The following agencies, groups and individuals will receive copies of this Draft Supplement for review and comment:

Federal

Advisory Council on Historic Preservation
Federal Emergency Management Administration
Federal Highway Administration
Federal Maritime Commission
National Oceanic and Atmospheric Administration
National Park Service
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency
U.S. Geological Survey
U.S. Office of Coastal Zone Management

State

Ohio State Clearinghouse
Ohio Department of Health (1)
Ohio Department of Natural Resources (1)
Ohio Department of Energy (1)
Ohio Department of Transportation (1)
Ohio Environmental Protection Agency (1)
Ohio Historic Preservation Office (1)
Ohio Sea Grant

Local

Cleveland Chamber of Commerce
Cleveland City Planning Commission
Cleveland-Cuyahoga County Port Authority
Cleveland Department of Port Control
Cleveland Deputy Commissioner of Airports
Cleveland Director of Planning
Cleveland Greater Growth Association
Cuyahoga County Commissioners
Cuyahoga County Regional Planning Commission
Lake County Planning Commission
Lorain County Board of Commissioners
Northeast Ohio Areawide Coordinating Agency
Summit County Executive

Public Officials

Honorable Richard F. Celeste, Governor
Honorable John Glenn, U.S. Senator
Honorable Howard M. Metzenbaum, U.S. Senator
Honorable Edward F. Feighan, U.S. Representative
Honorable Mary Rose Oakar, U.S. Representative
Honorable Louis Stokes, U.S. Representative
Mayor, City of Cleveland

Other

Citizens, Land and Water Use
Cleveland League of Women Voters
Cuyahoga County League of Women Voters
Great Lakes Tomorrow
Lake Carriers Association
Lake Pilot's Association
National Audubon Society
National Wildlife Federation
Sierra Club
Private Companies, Organizations, and Concerned Public

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(1) Agency will receive copy of the DEIS Supplement through the Ohio State Clearinghouse.

DRAFT SUPPLEMENT I
TO THE FINAL ENVIRONMENTAL STATEMENT
CLEVELAND HARBOR NAVIGATION PROJECT, CLEVELAND, OH

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Cleveland Harbor, OH

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

CLEVELAND HARBOR, OH
DRAFT REFORLMULATION PHASE I
GENERAL DESIGN MEMORANDUM

APPENDIX A
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GEOTECHNICAL DESIGN

A1. REGIONAL GEOTECHNICAL INFORMATION

A1.1 Physiography.

Cleveland Harbor is located within the Lake Plains Section of the Central Lowlands Physiographic Province (Figure A1). The Lake Plains Section is characterized by a narrow strip of relatively flat terrain lying along the south shore of Lake Erie. The region is mantled by lake deposits and crossed by beach ridges associated with former glacial lakes. South of the Central Lowlands Province, the glaciated Allegeny Plateau section of the Appalachian Plateaus Province rises gradually to an elevation of about 1,200 feet. The boundary between the two provinces is the Portage Escarpment which crosses the region in an approximately northeast-southwest line. The northwestern edge of the Allegeny Plateau has been deeply dissected by streams that flow across the Portage Escarpment. The Cuyahoga River drains an area of about 810 square miles and enters Lake Erie at Cleveland, OH.

A1.2 Bedrock Geology.

Bedrock underlying northeastern Ohio consists of a thick sequence of Paleozoic age sedimentary strata. The predominant rock types are shale, sandstone and conglomorates of the Devonian, Mississipian and Pennsylvanian Systems (Figure A2). The Upper Devonian rocks in northeastern Ohio consist of shales of the Ohio Formation. These shales are prominently displayed in cliffs along Lake Erie and in the walls of major river valleys. The Ohio Formation represents fine clastic sediments that were deposited in the western portions of the Appalachian Basin, a subsiding shallow sea trough. Most of the accumulated sediments were derived from a narrow belt of mountains that occupied the eastern margin of North America during the Late Devonian. Overlying the Devonian shales are Mississippian age rocks including the Bedford Shale, Berea Sandstone and Cuyahoga Group (shales). Szmuc (1970) describes the Mississippian rock units in northern Ohio as having a composite thickness of about 1,000 feet and consisting of fine to coarse grained clastics that were deposited in the northwestern part of the Appalachian Basin. The most prominent of the Mississippian strata is the Berea Sandstone which attains a maximum thickness of about 200 feet. The youngest exposed rocks in northern Ohio are a succession of sedimentary sequences including sandstones, shales, limestones, and coals of Pennsylvanian age. In northeastern Ohio, the Pennsylvanian System is about 1,100 feet thick but thickens considerably to the south. Of the various Pennsylvanian age rocks present in northeastern Ohio, the Sharon Conglomorate is probably the best known because of its widespread distribution and exposure.

A1.3 Surficial Geology.

The primary unconsolidated surficial deposits overlying bedrock in northeastern Ohio are of glacial origin, having been deposited either directly by ice sheets, by meltwater streams flowing from retreating ice, or in glacial lakes that were predecessors to present Lake Erie. Localized deposits of alluvium are found filling the major river valleys and were formed by present day streams that flow into Lake Erie.

Northeastern Ohio has been covered by continental glaciers at least four times during the Pleistocene Epoch. These four predominant glacial advances have been classified, in order of decreasing age, as the Nebreaskan, Kansan, Illinoian, and Wisconsinan stages. Glacial ice flowed southwest into the basins of the Great Lakes and spread south into northeastern Ohio from the Erie Basin. Variations in worldwide climatic temperatures were responsible for the repetitive advances and retreat of continental glaciers. As the climate warmed between glacial stages, the ice completely dissappeared and resulted in weathering the erosion of previously deposited glacial materials. During the Wisconsinan, considered to be the last glacial stage of the Pleistocene Epoch, the ice front fluctuated, advancing and retreating for distances of several hundred miles (White, 1982). Several prominent till units have been mapped in the region. The greatest bulk of glacial deposits in northeastern Ohio are of the Wisconsian Stage (White, 1982). The glacial deposits consist of till which can vary in texture, mineral composition, color, and weathering characteristics. Tills of the region can range from sandy tills with a low clay content to clayey tills with a low sand content. Tills in northern Cuyahoga County are generally clayey or silty with few cobbles and rare boulders.

During the warmer interglacial periods, meltwater accumulated between the retreating ice front and the higher land surface to the south of the Erie Basin. Numerous lake stages well above the present 571-foot elevation of Lake Erie existed and resulted in the formation of wave cut cliffs and terraces as well as the deposition of beach ridges. These features represent strandlines which have a linear northeast-southwest trend across northern Ohio, and are parallel to the existing shoreline of Lake Erie. Three prominent wave cut cliffs and terraces are present south of Lake Erie, each of which is capped by two to six beach ridges (White, 1982). Two of the more prominent lake stages recognized in northern Ohio have been termed the Whittlesey and Warren strandlines. The Whittlesey strandline consists of the prominent cliff and terrace formed during a major standstill of the lake level at about an elevation of 715 feet. The Whittlesey terrace is capped by a bench ridge deposit which has a crest elevation of 730 feet. The Whittlesey beach ridge has been generally regarded as the most prominent beach in northeastern Ohio. The Warren strandline consists of two closely related set of cliffs and terraces the lowest of which has a base elevation of about 650 feet. The wave cut cliffs associated with Warren Lake stage are also capped by a series of beach ridges having crest elevations between 670 and 686 feet. The linear deposits of sand and gravel represented by beach ridges were formed at the margins of glacial lakes, whereas fine grained silts and clays were deposited in deeper waters. These fine grained deposits are represented by a blanket of glaciolacustrine silts and sands which cover the region immediately adjacent to the present Lake Erie shoreline.

A2. LOCAL GEOTECHNICAL INFORMATION

A2.1 Subsurface Explorations.

No subsurface explorations were performed during this phase or any earlier phase of this study. However, a survey was conducted to collect available information on soil and rock in this study area. Subsurface explorations were available from other studies performed by Buffalo District. In addition, information was obtained from public and private offices with interests in the study area. The plan of subsurface explorations is shown on Plates A1 and A2.

a. Corps of Engineers Programs - Borings from other Corps of Engineers harbor studies and projects were used in analyzing the subsurface conditions for Alternative No. 1, "Severe-Weather" East Entrance Plan. These studies and projects include: Cleveland Harbor, OH, Subsurface Exploration, April, 1978 and East Breakwater Major Rehabilitation, February 1979.

For Alternative Plan No. 7G, "Remove Jefferson Avenue Bridge Abutments" and, Alternative Plan No. 11, "Deepen Turning Basin," a total of three borings from another Corps of Engineers project were used in analyzing the subsurface conditions. This project is: Cuyahoga and Old River Spring 1978 Dredging.

b. Programs by Others - A total of 26 borings obtained from public offices were used in analyzing the subsurface conditions for this report. These offices include: Bessemer and Lake Erie Railroad Company, P.O. Box 750, Greenville, PA, 16125; Consolidated Rail Corporation, 15 North 32nd Street, Philadelphia, PA, 19104; Ohio Department of Transportation, District 12, Box 05188 Newburgh Station, Cleveland, OH, 44105; City of Cleveland, Division of Engineering and Construction, Room 518, City Hall, Cleveland, OH, 44114; Cleveland Builders Supply Co., 2100 West 3rd Street, Cleveland, OH 44113; Republic Steel Corporation, Cleveland District, 3100 East 45th Street, Cleveland, OH 44127.

A2.2 Test Data.

a. Corps of Engineers Programs - Field and laboratory testing was performed as outlined below.

(1) Field Testing - Penetration tests were performed in conjunction with most of the subsurface explorations by the Corps of Engineers. In addition, field vane shear tests were performed during subsurface explorations for the Cleveland Harbor, OH, East Breakwater Major Rehabilitation, Design Memorandum. These test results are not presented in this report due to the preliminary nature of this study.

(2) Laboratory Testing - A variety of laboratory tests were run on samples obtained during programs for other studies. A summary of these test results and their utilization is provided in Section A3.3, subsurface conditions and soil properties.

b. Programs by Others - Field and laboratory testing was performed as outlined below.

(1) Field Testing - Penetration tests were performed in conjunction with most of the subsurface explorations obtained from public and private offices. Results of these tests are presented on Geologic Profiles F-F, G-G, I-I, and Geologic Sections H-H, J-J. Utilization of these test results is discussed in Section A3.3, subsurface conditions and soil properties.

(2) Laboratory Testing - A limited number of laboratory tests were also performed and are presented on the above mentioned geologic profiles and sections. Utilization of any laboratory test results is discussed in Section A3.3, subsurface conditions and soil properties.

A2.3 Surficial Geology.

Using available boring information, subsurface conditions were investigated for the various project features involving deepening of the East Entrance Channel, removal of the Jefferson Avenue bridge abutments, and deepening of the river turning basin. Borings drilled within the East Entrance Channel indicate that the bottom sediments consist of soft, laminated silts, and clays of lacustrine origin (see Plates A3 through A5 for geologic profiles in this reach). The source of recent bottom sediments within the East Entrance channel is believed to be from the Cuyahoga River. Discharge of the river sediment is carried into the East Entrance Channel by the predominant direction of littoral drift, from west to east.

Borings drilled within the Cuyahoga River channel indicate that valley has been filled with a thick sequence of glacial and post-glacial deposits. Bedrock exists well below the project limits; at about 200 feet below LWD in the vicinity of the Jefferson Avenue bridge abutments (see Plate A6). Lying directly above bedrock is a thick sequence of glacial till. Deep borings indicate that glacial deposits average about 170 feet thick. This soil stratum consists of stiff to very stiff gravelly, silty clay. The till deposits are unsorted and unstratified and were deposited directly by glacial ice. It is presumed that the stratum identified as glacial till in the Cuyahoga River channel represents drift deposited by more than one glacial advance. Directly above till is a blanket of lacustrine deposits consisting of clays silts and fine sands. Deposition of this soil material occurred within glacial lakes which formed during retreat of glacial ice during the late Wisconsinan. Alluvium lies above lacustrine deposits in areas directly adjacent to the Cuyahoga River. These deposits generally consist of silts and sands, with some gravel. The uppermost soil stratum encountered by field borings consists of fill materials of variable composition and thickness.

Due to the variable quality of boring logs compiled from several sources, correlation of surficial deposits is approximate at best. Surface fill deposits were generally well identified. Underlying fill, the uppermost native soils consist of sands and silty sands classified as alluvium. Lacustrine deposits lying beneath alluvium consist of clays, silts and fine sands with some laminated clays. Due to the similarity of the alluvial and lacustrine deposits, they were grouped together for correlation purposes. Beneath the alluvial/lacustrine deposits is glacial till. Till in this region consists of stiff to very stiff silty clay with some gravel which, in general, has a standard penetration resistance exceeding 15 blows per foot.

A2.4 Bedrock Geology.

Bedrock underlying the project limits is the Chagrin Shale of the Ohio Formation. The Chagrin Shale has been described by Szmuc (1970) as a soft blue-grey shale interbedded with a few siltstone layers. Outcrop and well data show that the formation in the vicinity of Cleveland has a total thickness of about 500 feet. South of the project area, the Cleveland Member of the Ohio Shale overlies the Chagrin Shale. The Cleveland Member is described as a black, fissile bituminous shale, varying from 20 to 50 feet in thickness in the Cleveland area.

Bedrock in the area dips to the south at about 30 feet per mile. The rocks contain few structural features other than small monoclinical folds and minor faults.

The existing Cuyahoga River Valley is underlain by a pre-glacial buried valley which has been cut into the underlying bedrock to a depth of more than 300 feet below sea level. Winslow, et. al., (1970) reports that the buried valley underlying the present Cuyahoga River system was formed by a north flowing river and was subsequently filled with a complex and very thick sequence of interbedded sands, silts, clays, and till. The approximate contours on top of rock from existing maps were utilized with available boring data in determining depth to bedrock for the project alternatives.

A2.5 Sedimentation.

The principal source of sediment deposited within Cleveland Harbor is delivered by the Cuyahoga River. The Cuyahoga River is approximately 100 miles in overall length and drains a watershed of about 810 square miles. As shown on Figure A3, numerous tributaries feed into the river over its entire length. The major portion of the basin lies within the glaciated Allegeny Plateau which is underlain by predominantly end and ground moraine. As the river flows north towards Cleveland Harbor, it crosses the Portage Escarpment where it enters the Lake Plains Section of the Central Lowland Province underlain primarily by lacustrine deposits of silt and clay. The lower 5.8 miles of the river is part of the existing Federal navigation project at Cleveland Harbor. River elevations vary from lake elevations at the mouth to an elevation of approximately 1,290 feet at its headwaters. The average rate of fall of the river is 7.1 feet per mile.

A study of erosion and sedimentation within the watershed was conducted as part of the Cuyahoga River Restoration Study. In this study, a 1-year sediment sampling program was conducted on the river by the U.S. Geological Survey. The results of the sediment sampling program indicated that approximately 20,000 tons of suspended sediment passed a gage established at Old Portage, OH, (river mile 40), whereas 235,000 tons was measured at a permanent gage at Independence, OH, (river mile 13.8). The drainage area between these two gages is about 300 square miles and has been described as the most prolific source area of sediment within the watershed (Figure A3). The study identified two primary sources of sediment within this reach of the river. These are: (1) sediment contributed by streambank erosion and (2) sediment contributed by sheet and rill erosion in the upland areas of the watershed. Intensive studies of each of these natural sediment sources was performed. Results of these studies revealed that upland (sheet and rill) erosion contributes significantly to the total quantity of dredged sediment (about 50 percent) while streambank erosion is a minor contributor (about 5 percent). Other major sources of sediment within the watershed are discharges of municipal and industrial waste.

A3. GEOTECHNICAL DESIGN

A3.1 General.

Several different alternatives were considered in the previous Cleveland Harbor, Stage 2, Phase I GDM Report. For the Stage 3 report, several of these alternatives have been eliminated from further consideration. The remaining alternatives being considered for this report are for improvements to the outer harbor (Alternative No. 1) and improvements to the Cuyahoga River (Alternatives No. 7G and No. 11). In the design and analysis of these alternatives, presumptive values were used for the soil properties based on material description, penetration tests and limited laboratory test results.

A3.2 Project Elements.

Listed below are brief descriptions of the remaining alternatives being addressed in this study.

a. Alternative Plan No. 1 - "Severe-Weather" East Entrance Plan - This plan would provide a "Severe-Weather" entrance into the Lakefront Harbor for Class V through Class X vessels at the existing east entrance. The layout of the project features and the plan of subsurface explorations for this plan is shown on Plate A1.

b. Alternative Plan No. 7G - "Remove Jefferson Avenue Bridge Abutments" - This alternative is located at Jefferson Avenue at approximately River Mile 4.3 and includes the removal of the Jefferson Avenue bridge abutments, widening the navigation channel, replacing bulkheads and relocating the City of Cleveland power cable. This plan would eliminate undue vessel delay and the potential for vessel accidents associated with the abandoned, Jefferson Avenue Bridge Abutments. The layout of the project features and the plan of subsurface explorations for this plan are shown on Plate A2.

c. Alternative Plan No. 11 - "Deepen Turning Basin" - This plan considers deepening the turning basin from its present 18-foot depth to 23 feet, and replacement of the existing bulkheads with new sheetpile bulkheads to accommodate the deepened turning basin. Presently, self-unloading vessels (which unload from the stern) destined for Republic's upriver iron ore dock approach the dock bow first and start to unload their cargo. However, because the upstream bridge (Bridge No. 21) prohibits the vessel from moving upstream such that the stern mounted unloading boom can reach the upstream limits of the iron ore storage pile, these vessels must partially unload their cargo, back down to the turning basin, turn around, and then proceed back to the dock stern first in order to discharge the remainder of their cargo. If the turning basin was deepened to 23 feet, this extra vessel movement would not be necessary since the vessel could turn around during its' upstream transit and approach the dock stern first initially, resulting in a savings of 3-4 hours in vessel unloading time. The layout of the project features and plan of subsurface explorations for this plan is shown on Plate A2.

A3.3 Subsurface Conditions and Soil Properties.

Presumptive soil parameters for use in the design of the bulkheads along the Cuyahoga River in the area of the Jefferson Avenue bridge abutments and turning basin were developed based on boring log descriptions, blow counts, and limited laboratory test results. The results of the field and laboratory test results are shown on Plates A3 through A9.

The standard Penetration resistence, N, is defined as the number of blows required to advance a 2-inch OD by 1-3/8 inch ID split spoon sampler 12 inches by a 140 lb. hammer. The standard penetration resistence (N) was then used to determine the relative density of the cohesionless soils and consistency of the cohesive soils encountered within the study area. The relative density and textural composition of the cohesionless soils were used along with Tables A3, A4, and A5 to determine its unit weight and angle of internal friction.

Laboratory test values supplemented by field consistencies (standard penetration test results) were used to determine the unit weight and shear strength of the cohesive soils. Although the use of the standard penetration test to determine the shear strength of cohesive soils may be unreliable, it was only used as an approximation of the shear strength where laboratory test values are absent. Table A5 relates the standard penetration resistence with the unconfined compressive strength and unit weight of cohesive soils. In an unconfined compression test, the cohesion (shear strength) is equal to one half (1/2) of the unconfined compressive strength.

Following is a brief description of the subsurface conditions and presumed soil properties used in the design analysis for each of the various project alternatives.

a. Alternative Plan No. 1 - "Severe-Weather" East Entrance Plan - A geologic profile and sections showing the subsurface conditions are presented on Plates A3 thru A5. The subsurface materials to the depth of dredging generally consists of lacustrine silts, clays and appreciable amounts of organics with very soft to soft consistencies (standard penetration resistances

0 to 2 blows/feet). Due to the soft consistency and textural composition of these materials the channel sideslopes are expected to obtain a nominal slope of IV on 5H after dredging.

b. Alternative Plan No. 7G - "Remove Jefferson Avenue Bridge Abutments" - Geologic profiles and a section showing the subsurface conditions are presented in Plates A6 and A7. The subsurface material generally consists of an uppermost stratum of fill with variable composition and thickness overlying alluvium and lacustrine deposits of clays, silts, sands and some gravel. Directly beneath is a stratum of glacial till which has an average thickness of about 170 feet. This till consists of stiff to very stiff silty clay with some gravel. A few isolated borings indicate that bedrock underlies the glacial till at a depth well below the project limits (-200 feet LWD). The sheet pile bulkheads will be driven predominantly into the alluvium and lacustrine deposits (from approximately +10 feet LWD to -35 feet LWD) and 15 feet (-35 feet LWD to -50 feet LWD) into stiff to very stiff glacial till clay. Since the bedrock is well below the bottom of the sheet pile bulkheads, it is not anticipated that there will be any difficulty in driving through these soils, however, it may be necessary to clear the driving line of any obstructions. The recommended soil parameters that were used in the design of the sheet bulkheads are presented in Table A2.

c. Altarnative Plan No. 11 - "Deepen Turning Basin" - A geologic profile and section the subsurface conditions at the turning basin are presented in Plates A8 and A9. The subsurface materials generally consists of an uppermost stratum of fill with variable composition and thickness overlying alluvium and lacustrine deposits consisting of sand, silty sand, silt and some clay and gravel. Directly beneath the alluvium and lacustrine deposits is glacial till consisting of stiff to very stiff silty clay which was encountered to a depth of at least -100 feet below LWD. No bedrock was encountered in any of the available borings within the area. With the exception of the central portion of the turning basin, the sheet pile bulkheads will be driven predominantly into the alluvium and lacustrine deposits (from approximately +10 feet LWD to -30 feet LWD) and 15 feet (from -30 feet LWD to -45 feet LWD) into the stiff to very stiff silty clay glacial till. At the central portion of the turning basin the sheet bulkheads will be driven an additonal 20 feet into the glacial till. Since bedrock was not encountered in any of the available borings, it is not anticipated that there will be any difficulty in driving the sheet pile bulkheads through these soils, however, it may be necessary to clear the driving line of any obstructions. The recommended soil parameters used in the design of the sheet pile bulkheads is presented in Table Al.

A3.4 Sedimentation Analysis.

An analysis of sediment deposition within Cleveland Harbor was performed in order to assess the impacts of the various project alternatives involving deepening on projected annual maintenance dredging requirements.

Cleveland Harbor consists of a Lakefront Harbor area and an Inner Harbor consisting of the lower deep draft section of the Cuyahoga River. The Lakefront Harbor is formed by the East and West Breakwaters and is divided into an East and West Basin. The Inner Harbor includes the improved lower 5.8 miles of the Cuyahoga River and approximately 1 mile of the Old River, the former outlet of the Cuyahoga River. Two entries to the harbor exist. The west (main) entrance is known as the Lake Approach Entrance Channel and is located between the East and West Arrowhead Breakwaters. The second entrance is located at the east end of the East Basin.

The Corps of Engineers is responsible for dredging Cleveland Harbor to authorized depths as shown on Table A6. The dredging operations have historically been divided into contract dredging of the Cuyahoga and Old Rivers and Government hopper dredging in the Lakefront Harbor. A summary of the dredging volumes at Cleveland Harbor between 1950 and 1979 are shown on Table A7.

The principal source of sediment which deposits in Cleveland Harbor is delivered by the Cuyahoga River. As the river enters the relatively quiet waters of the upper navigation channel, bedload primarily consisting of sand, settles out very rapidly due to the decreased transport capacity of the river. As the sediment laden waters moves through the 5.8 miles of navigation channel and into the Lakefront Harbor, progressively finer grained sediments consisting of the river's suspended load, are deposited. Only the finest suspended particles are capable of being transported completely through the harbor into Lake Erie.

At Cleveland Harbor, several factors have contributed to long-term variations in dredging requirements, many of which are independent of the total quantity of sediment actually deposited in a given year. These factors include fluctuations in lake levels, improved methods of measuring dredged quantities, availability of funds for dredging in a particular year, reduction in municipal and industrial waste input in recent years, and others. All of these factors, in combination, complicate any analysis of harbor modifications on predicting future maintence dredging requirements.

At the present time, there is no known or commonly accepted method of estimating channel dredging requirements at alternative project depths other than by extrapolating historical trends and detailed design level studies based on hydrographic survey (National Waterways Study Report on Engineering Analysis of Waterways Systems, 1981). The second method can provide only a very rough indication of the level of maintenance dredging with increasing project depth. The NWS report presents the following general relationship between dredging volumes and project depth:

$$\left(\frac{D_1}{D_2}\right)^m = \left(\frac{V_1}{V_2}\right)$$

where: D_1 = present project depth

D_2 = alternative project depth

V_1 = present shoaling volume

V_2 = shoaling volume at alternative project depth

m = a variable which usually ranges between 3 and 5.

Generally this relationship has been applied to inland waterways (rivers) having a sandbed, and where there is an abundant supply of sediment available for deposition.

It is assumed that as a result of harbor deepening at Cleveland, an increased fraction of sediment load carried by the Cuyahoga River which would normally be carried into Lake Erie will settle out. However, since only the river's suspended load would be affected by deepening, it is assumed that any increases in future dredging requirements would be minor. Following are the projected impacts to annual maintenance dredging requirements as a result of the various project alternatives.

a. Alternative Plan No. 1 - "Severe-Weather" East Entrance Plan - The Lakefront Harbor was deepened in 1965 from 25 feet to present project depths of 27 to 29 feet. Figure A4 presents a plot of annual dredging volumes in the Lakefront Harbor before and after deepening. As shown, annual dredging have actually been decreasing since deepening in 1965. Based upon the dredging records of the individual work areas in the Outer Harbor, it has been determined that since the deepening of the East Entrance Channel in 1965, dredging has not been required to maintain the project depth. This strongly suggests that deposition does not occur in measurable quantities in the East Entrance Channel. In light of this fact, and since the East Entrance alternative will not result in an increase in sediment supplied by the river, it is assumed that there will be no increase in annual maintenance dredging as a result of the proposed deepening.

b. Alternative Plan No. 7G. - "Remove Jefferson Avenue Bridge Abutments and Alternative Plan No. 11 - "Deepening Turning Basin" - Alternative 11 involves deepening the Turning Basin from its present 18-foot depth to a new project depth of 23 feet. In addition, as part of Alternative 7G, some minor dredging would be accomplished at the site of the Jefferson Avenue Bridge in conjunction with removal of the bridge abutments. The Stage 2 report for the Cleveland Harbor Study provided estimated increases in annual dredging volumes resulting from deepening of the entire Cuyahoga River and Old River navigation channels. Alternative depths considered were 25.5 and 28 feet. The present river alternatives involve only minor deepening primarily within the Turning Basin. Since the Turning Basin and the immediate area in the vicinity of the Jefferson Avenue Bridge Abutments represent just a small part of the 5.8 mile long navigation channel, the impact of their deepening on river sedimentation is presumed to be negligible.

Table A1 - Recommended Design Parameters for Soils at Turning Basin*

	Parameters				
Soil Types	Typical Range (N) Values	Consistency	Unit Weight (PCF)	Friction Angle (DEG)	Cohesion (PSF)
Alluvium - Sand and Silty Sand Silt, Some Clay and Gravel	5-10	Loose	115 (Sat) 110 (Mst)	30	0
Glacial Till - Silty Clay Stiff to Very Stiff Consistency, w/some Gravel	15-30	Stiff to Very Stiff	130	0	2,000++

* Values are derived from Tables A3, A4, and A5 based on descriptions given in boring logs, blow counts, and limited test data.
++ Lower limit of Laboratory unconfined compression test values.

Table A2 - Recommended Design Parameters for Soils at Jefferson Avenue Bridge Abutments *

	Parameters				
Soil Types	Typical Range (N) Values	Consistency	Unit Weight (PCF)	Friction Angle (DEG)	Cohesion (PSF)
Alluvium - Silty Sand, Clay, Silt, and Some Gravel	2-10	Very Loose to Loose	110 (Sat) 100 (Mst)	28	100
Glacial Till - Silty Clay, Stiff to Very Stiff Consistency, w/some Gravel	15-30	Stiff to Very Stiff	130	0	2,000

* Values are derived from Tables A3, A4, and A5 based on descriptions given in boring logs, blow counts, and limited test data.
++ Lower limit of Laboratory unconfined compression test values.

Table A3 ♣♣

Typical Values of Soil Index Properties

	Approx. Size Range (mm.) D_{max}	Approx. Size Range (mm.) D_{min}	Approx. D_{10} (mm.)	Approx. Range Unif. Coef. C_u	Void Ratio e_{max} (loose)	Void Ratio e_{cr}	Void Ratio e_{min} (dense)	Porosity (%) n_{max} (loose)	Porosity (%) n_{min} (dense)	Dry Wt. γ_d Min. (loose)	Dry Wt. γ_d 100% Mod. AASHO	Dry Wt. γ_d Max. (dense)	Wet Wt. γ_{sat} Min. (loose)	Wet Wt. γ_{sat} Max. (dense)	Sub. Wt. γ' Min. (loose)	Sub. Wt. γ' Max. (dense)
Granular Materials																
1. Uniform Materials																
a. Equal spheres (theoretical values)	–	–	–	1.0	0.92		0.35	47.6	26.0	–	–	–	–	–	–	–
b. Standard Ottawa SAND	0.84	0.59	0.67	1.1	0.80	0.75	0.50	44	33	92	–	110	93	131	57	69
c. Clean, uniform SAND (fine or medium)	–	–	–	1.2 to 2.0	1.0	0.80	0.40	50	29	83	115	118	84	136	52	73
d. Uniform, inorganic SILT	0.05	0.005	0.012	1.2 to 2.0	1.1	–	0.40	52	29	80		118	81	136	51	73
2. Well graded Materials																
a. Silty SAND	2.0	0.005	0.02	5 to 10	0.90	–	0.30	47	23	87	122	127	88	142	54	79
b. Clean, fine to coarse SAND	2.0	0.05	0.09	4 to 6	0.95	0.70	0.20	49	17	85	132	138	86	148	53	86
c. Micaceous SAND	–	–	–	–	1.2	–	0.40	55	29	76	–	120	77	138	48	76
d. Silty SAND & GRAVEL	100	0.005	0.02	15 to 300	0.85	–	0.14	46	12	89	–	146	90	155	56	92
Mixed Soils																
1. Sandy or silty CLAY	2.0	0.001	0.003	10 to 30	1.8		0.25	64	20	60	130	135	100	147	38	85
2. Skip graded silty CLAY with stones or rk. frag.	250	0.001	–	–	1.0		0.20	50	17	84	–	140	115	151	53	89
3. Well graded GRAVEL, SAND, SILT & CLAY mixture	250	0.001	0.002	25 to 1000	0.70		0.13	41	11	100	140	148	125	156	62	94
Clay Soils																
1. CLAY (30 to 50% clay sizes)	0.05	0.5μ	0.001	–	2.4	–	0.50	71	33	50	105	112	94	133	31	71
2. Colloidal CLAY (-0.002 mm ≥ 50%)	0.01	10Å		–	12	–	0.60	92	37	13	90	106	71	128	8	66
Organic Soils																
1. Organic SILT				–	3.0	–	0.55	75	35	40		110	87	131	25	69
2. Organic CLAY (30 to 50% clay sizes)				–	4.4	–	0.70	81	41	30		100	81	125	18	62

♣♣ From: Hough, B.K., Basic Soils Engineering, John Wiley & Sons, New York, 1969.

♣ From: Bowles, Joseph E., Foundation Analysis and Design, McGraw Hill Book Company, New York, 1977.

Table A4 ♣♣

Typical Values of Unit Weights, Equivalent Fluid

Classification	Friction Angle φ (deg.)	Density or Consistency	Unit Soil Weight, γ (lb./cu. ft.)	Unit Wt. of Equivalent Fluid, γ_e (lb./cu. ft.) Active Case	Passive Case
Coarse sand or sand and gravel	45 38 32	Compact Firm Loose	140 120 90	24 29 28	820 510 290
Medium sand	40 34 30	Compact Firm Loose	130 110 90	28 31 30	600 390 270
Fine sand	34 30 28	Compact Firm Loose	130 100 85	37 33 31	460 300 280
Fine, silty sand or sandy silt	32 30 28	Compact Firm Loose	130 100 85	40 33 31	420 300 280
Fine, uniform silt	30 28 26	Compact Firm Loose	135 110 85	45 38 33	400 300 220
Clay-silt	20	Medium Soft	120 90	59 44	245 183
Silty clay	15	Medium Soft	120 90	71 53	204 153
Clay	10	Medium Soft	120 90	84 63	170 153
Clay	0	Medium Soft	120 90	120 90	120 90

Table A5 ♣

Empirical values for φ, D_r, and unit weight of granular soils based on the standard penetration number with corrections for depth and for fine saturated sands

Description		Very loose		Loose		Medium		Dense		Very dense	
Relative density D_r*	0		0.15		0.35		0.65		0.85		1.00
Standard penetration no. N			4		10		30		50		
Approx. angle of internal friction φ †	25–30		27–32		30–35		35–40		38–43		
Approx. range of moist unit weight, (γ) pcf (kN/m³)		70–100 (11–16)		90–115 (14–18)		110–130 (17–20)		110–140 (17–22)		130–150 (20–23)	

* USBR [Gibbs and Holtz (1957)]

† After Meyerhof (1956) $\phi = 25 + 15D_r$ with more than 5 percent fines and $\phi = 30 + 15D_r$ with less than 5 percent fines. Use larger values for granular material with 5 percent or less fine sand and silt.

Empirical values for q_u* and consistency of cohesive soils based on the standard penetration number

Consistency		Very soft		Soft		Medium		Stiff		Very stiff		Hard
q_u, ksf	0		0.5		1.0		2.0		4.0		8.0	
N, standard penetration resistance	0		2		4		8		16		32	
γ_{sat}, pcf (kN/m³)			100–120 (16–19)			110–130 (17–20)			120–140 (19–22)			

* These values should be used as a guide only. Local cohesive samples should be tested and the relationship between N and the unconfined compressive strength q_u established as $q_u = kN$.

O – Indicates Range of Presumptive Soil Values for Predominant Soil Types Found within Project Area.

Table A6 - History of Authorized Depth Changes

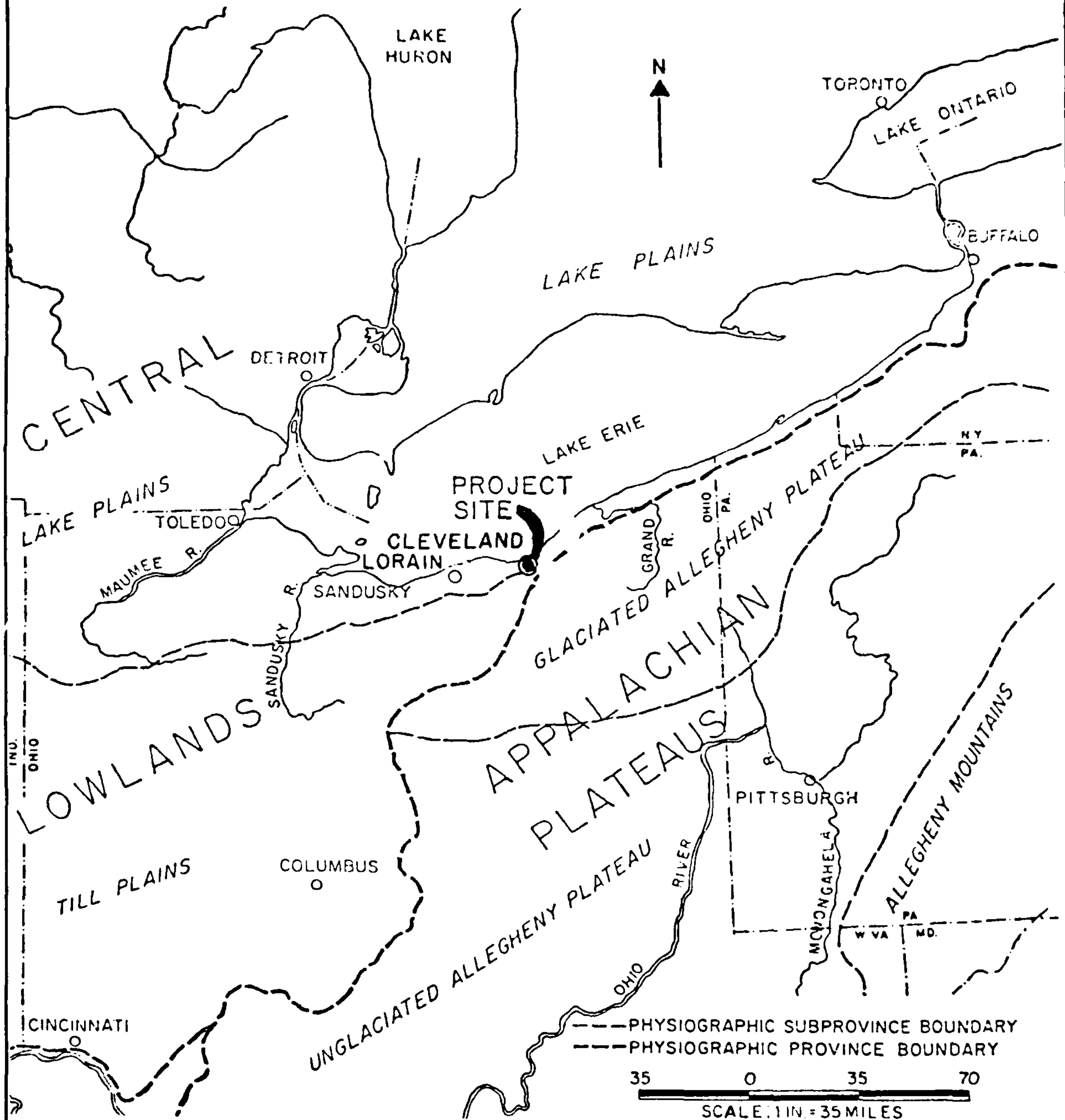
Harbor Element	Authorized Depth Change	Date Authorized	Date Completed
Outer Harbor	a. Outer Harbor and Channel between piers deepened to 19 feet	1902	*
	b. East Channel of East Basin deepened to 25 feet	1958	1965
	c. Lake Approach Channel deepened to 29 feet	1960	1965
	d. Entrance Channel deepened to 28 feet	1960	1965
	e. West Basin deepened to 28 feet	1960	1965
	f. Easterly Dock Channel deepened to 25 feet	1962	1965
Inner Harbor	a. Cuyahoga and Old Rivers deepened to 23 feet	1946	1952
	b. Lower Cuyahoga River, to Old River, deepened to 27 feet	1960	Incomplete
	d. Old River deepened to 27 feet	1966	Incomplete

*Information not available.

Table A7 - Dredged Volume in Cleveland Harbor 1950 to 1979

Year	West Basin, East Basin: Entrance Channel and River Entrance	Cuyahoga and Old Rivers	Advance Maintenance: Dredging in Upper Portion of Cuyahoga: River to Depth of 26 Feet	Total
1950	177,500	672,700	-	850,200
1951	222,700	598,800	-	821,500
1952	345,500	899,700	-	1,242,200
1953	199,300	448,600	-	647,900
1954	265,300	614,400	-	879,700
1955	158,200	550,800	200,000	909,000
1956	244,300	449,300	196,000	893,600
1957	471,700	573,000	259,000	1,303,700
1958	528,000	495,000	200,000	1,223,000
1959	762,400	615,000	200,000	1,577,400
1960	479,000	734,000	153,500	1,366,500
1961	630,300	557,000	186,000	1,373,300
1962	446,600	524,000	200,000	1,170,600
1963	393,400	508,000	230,000	1,131,400
1964	331,800	534,400	143,000	1,009,200
1965	560,200	495,000	200,000	1,255,200
1966	629,000	539,000	200,000	1,368,000
1967	510,300	525,000	200,000	1,235,300
1968	427,900	377,000	171,000	975,900
1969	233,400	277,700	199,600	710,700
1970	310,000	851,100	75,000	1,236,100
1971	177,900	369,900	187,000	734,800
1972	193,600	400,000	154,300	747,900
1973	-	308,400	-	308,400
1974	88,400	269,600	-	358,000
1975	-	597,100	-	597,100
1976	73,300	705,700	-	779,000
1977	157,900	598,500	-	756,400
1978	166,000	387,300	-	553,300
1979	69,400	720,300	-	789,700

NOTE: Values rounded to nearest 100 cy.
SOURCE: U.S. Army Corps of Engineers Annual Reports

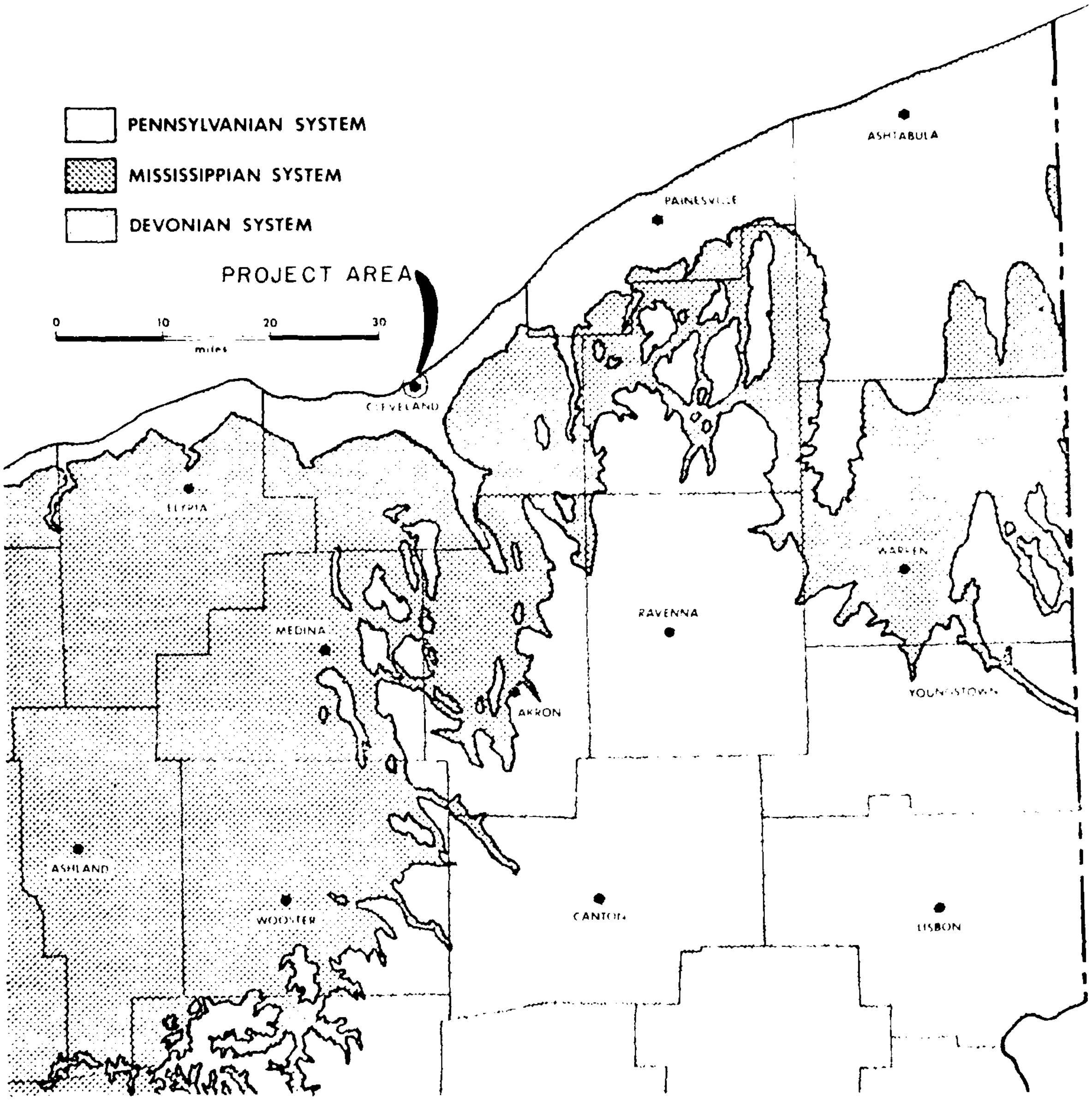


CLEVELAND HARBOR, STUDY
CLEVELAND, OHIO

PHYSIOGRAPHIC PROVINCES

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE A 1



CLEVELAND HARBOR, STUDY
CLEVELAND, OHIO

BEDROCK GEOLOGY OF NORTHEASTERN, OHIO

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE A 2

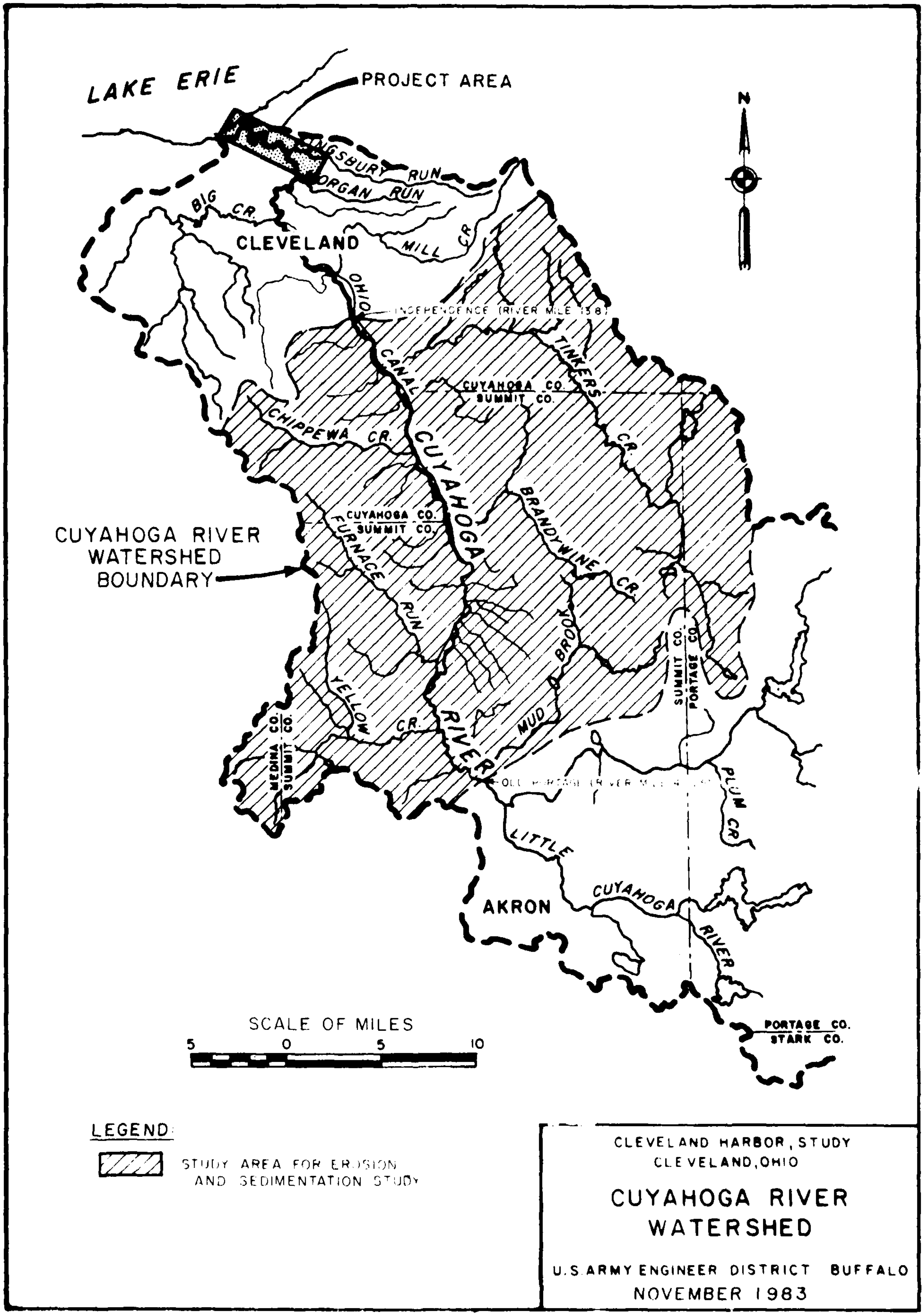
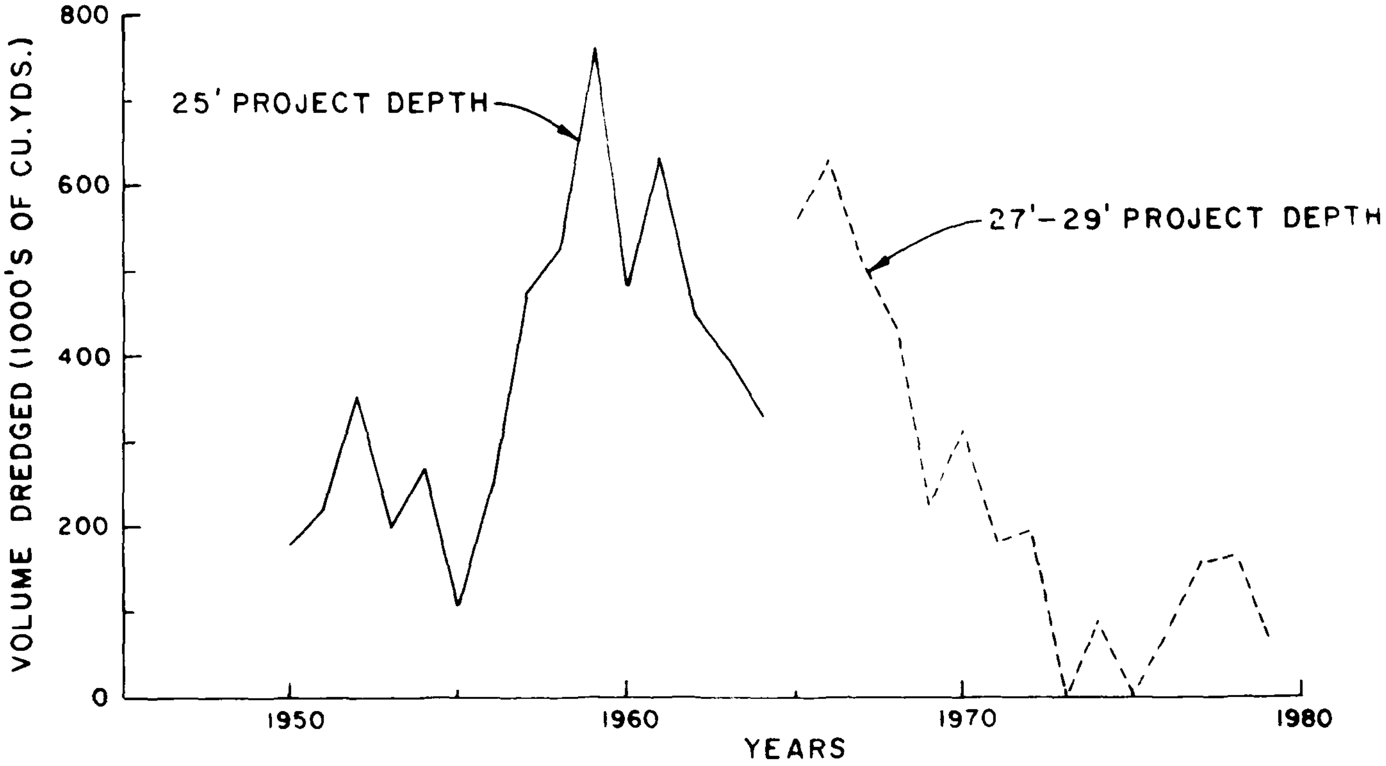

LAKE ERIE
PROJECT AREA
KINGSBURY RUN
MORGAN RUN
BIG CR.
CLEVELAND
MILL CR.
OHIO CANAL
INDEPENDENCE (RIVER MILE 13.8)
TINKERS CR.
CUYAHOGA CO.
SUMMIT CO.
CHIPPEWA CR.
CUYAHOGA RIVER
BRANDYWINE CR.
CUYAHOGA CO.
SUMMIT CO.
FURNACE RUN
CUYAHOGA RIVER WATERSHED BOUNDARY
MUD BROOK
YELLOW CR.
MEDINA CO.
SUMMIT CO.
SUMMIT CO.
PORTAGE CO.
PLUM CR.
LITTLE CUYAHOGA RIVER
AKRON
PORTAGE CO.
STARK CO.
SCALE OF MILES
5 0 5 10
LEGEND:
STUDY AREA FOR EROSION AND SEDIMENTATION STUDY
CLEVELAND HARBOR, STUDY
CLEVELAND, OHIO
CUYAHOGA RIVER WATERSHED
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE A3



CLEVELAND HARBOR, STUDY
CLEVELAND, OHIO

DREDGING VOLUMES – CLEVELAND OUTER HARBOR 1950 – 1979

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE A4

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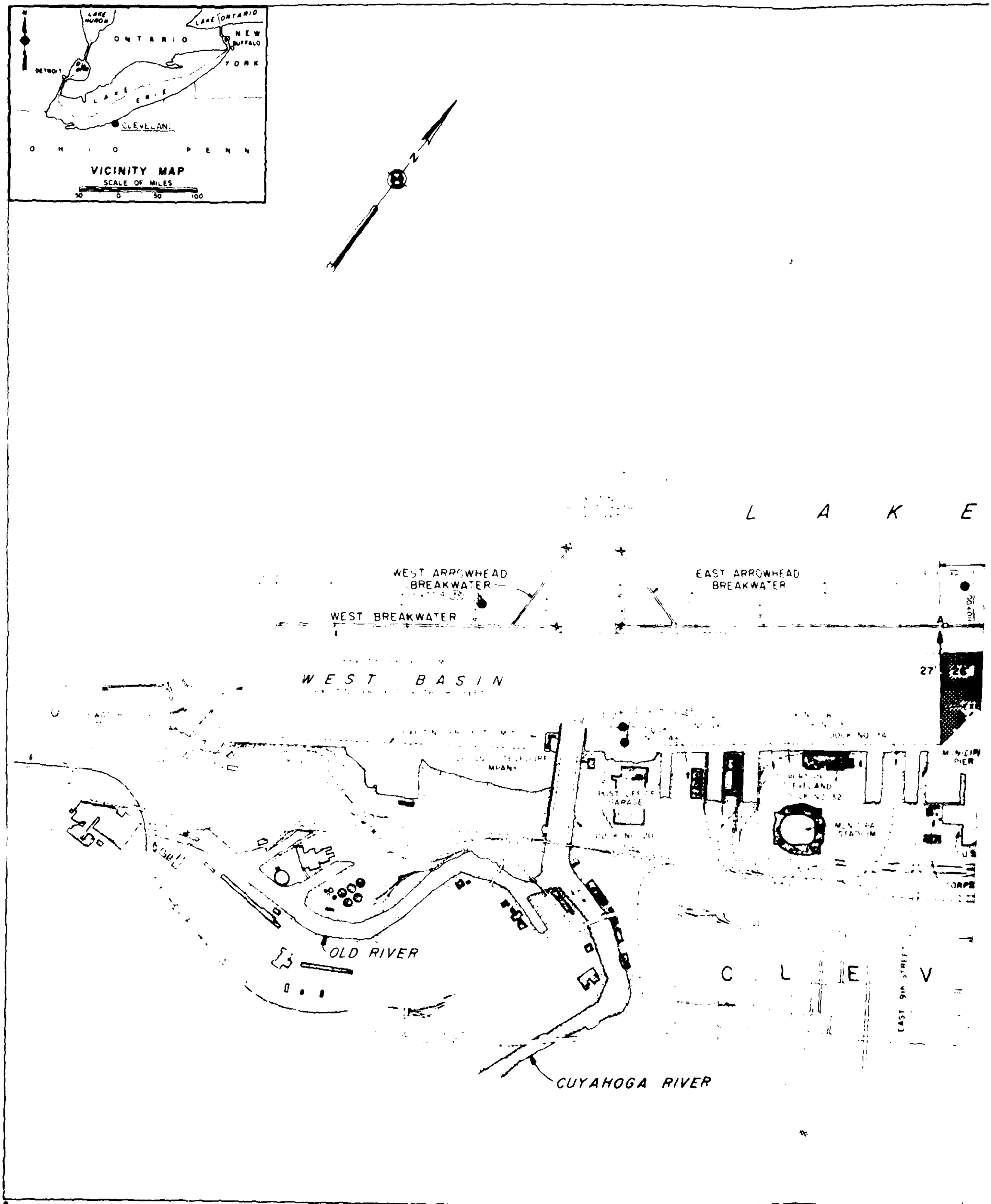

LAKE HURON
LAKE ONTARIO
ONTARIO
NEW YORK
BUFFALO
DETROIT
LAKE ERIE
CLEVELAND
OHIO
PENN
VICINITY MAP
SCALE OF MILES
50 0 50 100
N
L A K E
WEST ARROWHEAD BREAKWATER
EAST ARROWHEAD BREAKWATER
WEST BREAKWATER
WEST BASIN
27'
DOCK NO. 20
MUNICIPAL PIER
MUNICIPAL STADIUM
OLD RIVER
CUYAHOGA RIVER
C L E V
EAST 9th STREET

TABLE OF BORINGS		
BORING NUMBER	STATION	OFFSET
136	A 40 + 05	900' L
137	A 60 + 00	760' R
139	A 60 + 00	980' R
138	A 108 + 75	1,170' L
140	A 120 + 90	10' R
157	A 150 + 75	700' L
151	A 155 + 00	270' L
158	A 174 + 75	800' R
159	A 184 + 80	360' R
154	A 190 + 00	10' R
141	A 190 + 25	750' L
160	A 195 + 25	350' L
42	A 200 + 00	510' L
161	A 206 + 50	380' R
143	A 210 + 50	750' L
162	A 218 + 00	500' R
144	A 220 + 00	510' L
145	A 221 + 25	525' L
155	A 225 + 00	0
146	A 230 + 00	700' L
156	A 234 + 75	1170' R
147	A 240 + 00	530' L
148	A 250 + 25	730' L
152	A 257 + 00	370' R
149	A 261 + 00	530' L
53	A 268 + 00	60' L
150	A 271 + 00	700' L

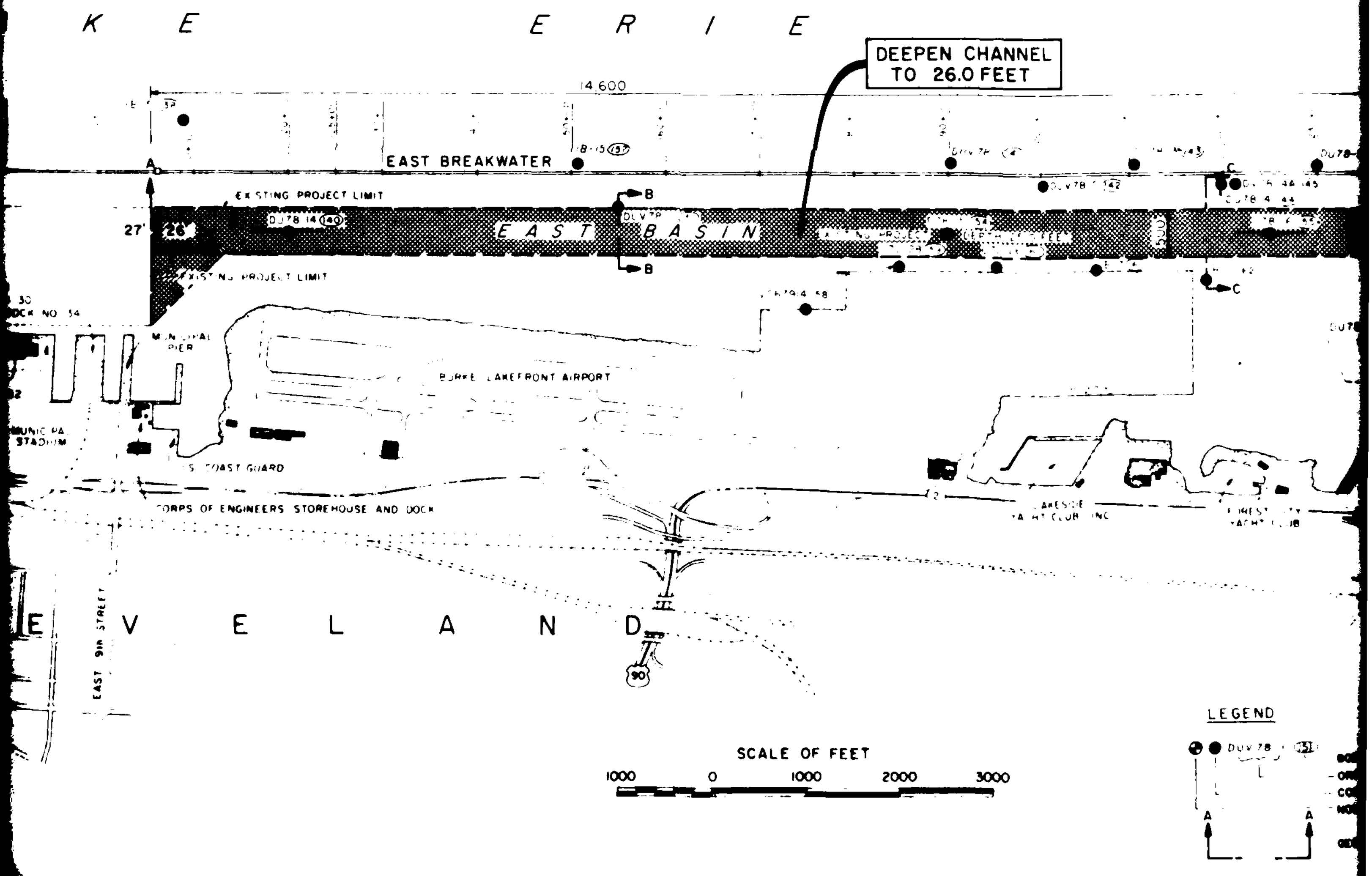
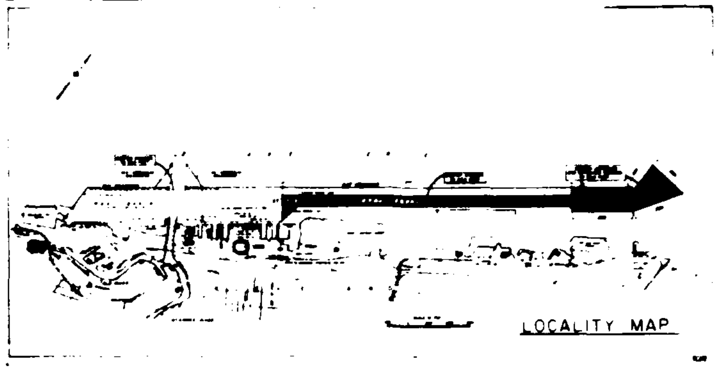


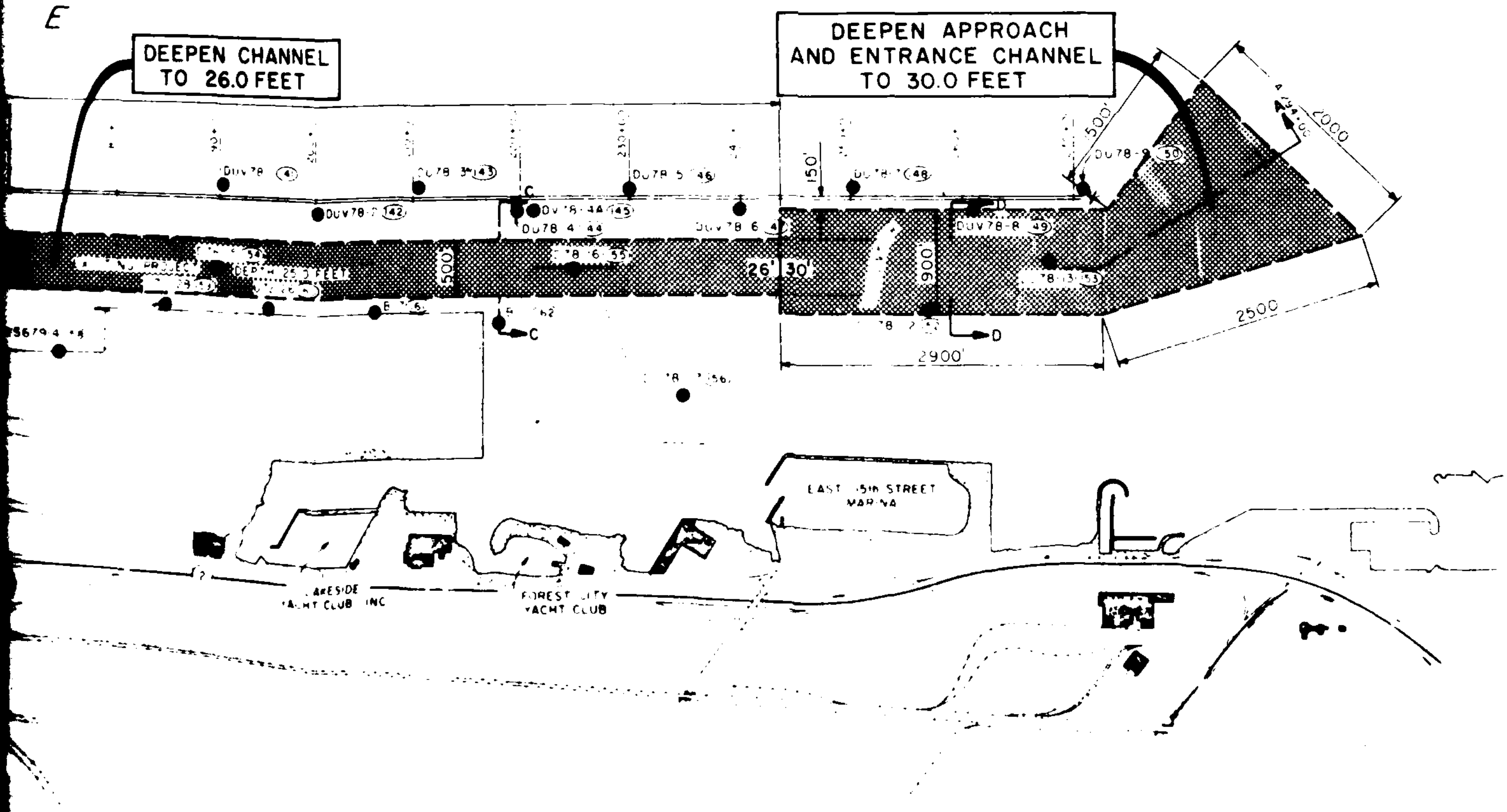
TABLE OF BORINGS

STATION	OFFSET
A 40 + 05	900' L
A 60 + 00	760' R
A 60 + 00	980' R
A 108 + 75	1,170' L
A 120 + 00	10' R
A 150 + 75	700' L
A 155 + 00	270' L
A 174 + 75	800' R
A 184 + 80	360' R
A 190 + 00	10 R
A 190 + 25	750' L
A 195 + 25	350' L
A 200 + 00	510' L
A 206 + 50	380' R
A 210 + 50	750' L
A 218 + 00	500' R
A 220 + 00	510' L
A 221 + 25	525' L
A 225 + 00	0
A 230 + 00	700' L
A 234 + 75	1170' R
A 240 + 00	530' L
A 250 + 25	730' L
A 257 + 00	370' R
A 261 + 00	530' L
A 268 + 00	60' L
A 271 + 00	700' L



NOTES:

1. FOR GEOLOGIC PROFILE A-A, SEE PLATES A3 AND A4
2. FOR GEOLOGIC SECTIONS B-B, C-C, D-D, SEE PLATE A5
3. FOR PLAN OF SUBSURFACE EXPLORATIONS FOR THE CUYAHOGA RIVER SEE PLATE A2
4. ALL ELEVATIONS ARE REFERRED TO LOW WATER DATUM (L.W.D.) ELEVATION 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (I.G.L.D. 1955)
5. THE LOCATIONS OF BORINGS ARE NOT SHOWN TO SCALE
6. ADDITIONAL BORINGS ARE AVAILABLE IN THE CLEVELAND AREA BUT ARE NOT INCLUDED HERE. THEY ARE AVAILABLE FOR INSPECTION AT THE U.S. ARMY ENGINEER DISTRICT, BUFFALO



LE OF FEET

1000 2000 3000

LEGEND

DUV 78-11 (51)

BORING DESIGNATION FOR THIS PROJECT

ORIGINAL BORING DESIGNATION

CORPS OF ENGINEERS BORING

NON CORPS OF ENGINEERS BORING

A — A GEOLOGIC PROFILES OR SECTIONS

CLEVELAND HARBOR STUDY

CLEVELAND, OHIO

ALTERNATIVE PLAN NO. 1

"SEVERE-WEATHER EAST ENTRANCE PLAN"

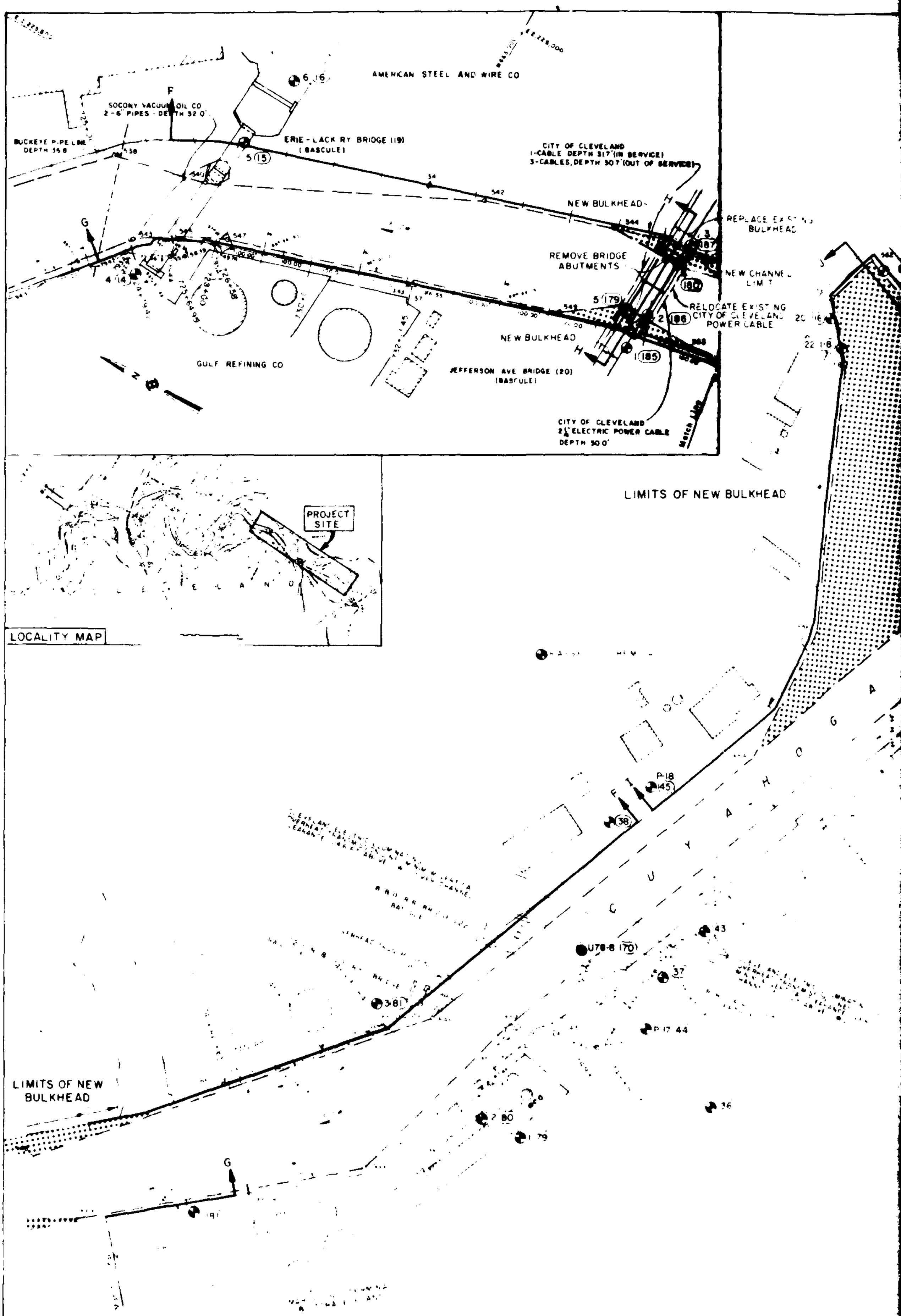
PLAN OF SUBSURFACE EXPLORATIONS

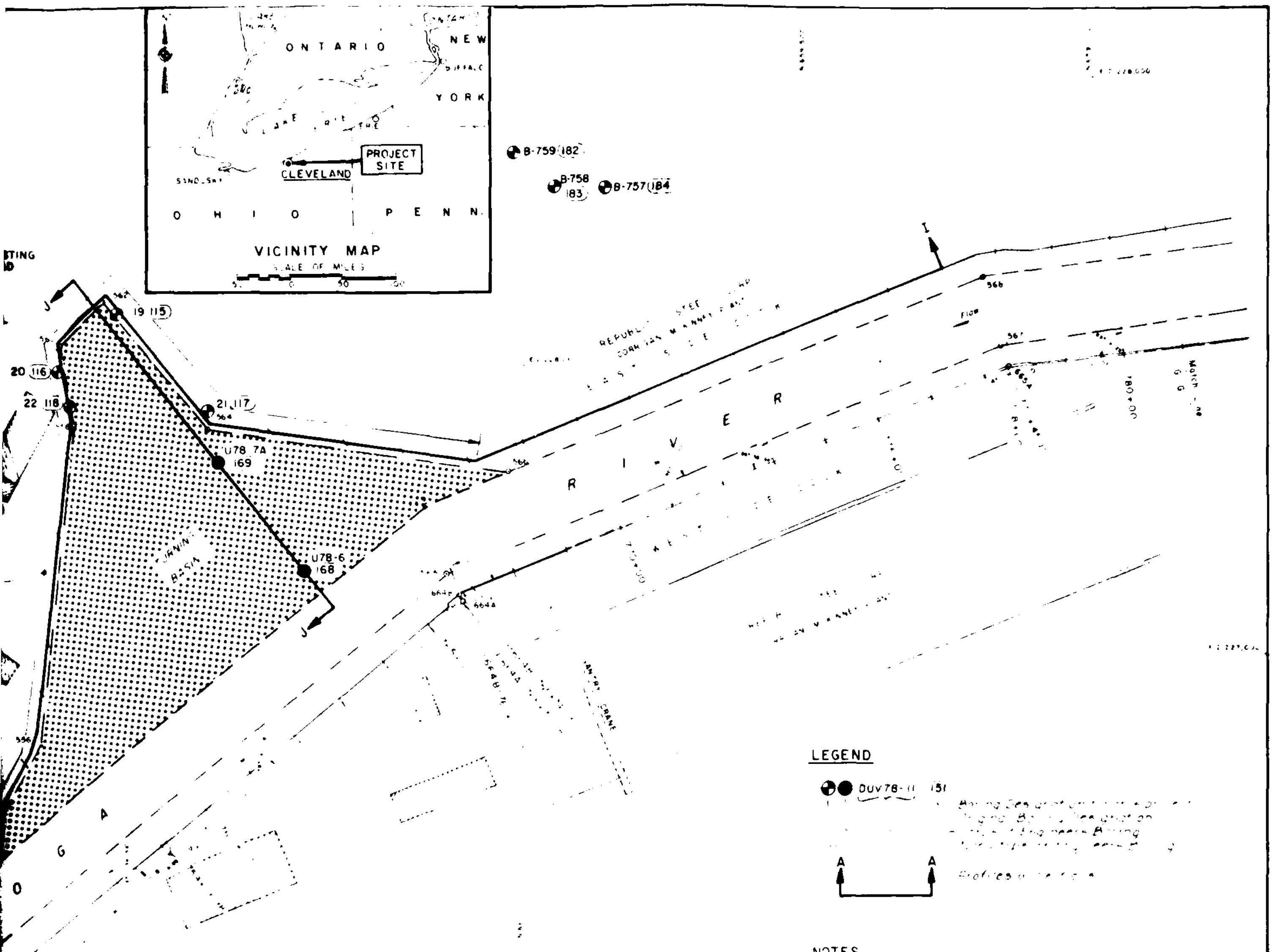
U.S. ARMY ENGINEER DISTRICT, BUFFALO

NOVEMBER, 1983

3

PLATE A1


AMERICAN STEEL AND WIRE CO
SOCONY VACUUM OIL CO
2-6" PIPES - DEPTH 32.0'
BUCKEYE PIPE LINE
DEPTH 35.8
ERIE-LACK RY BRIDGE (19)
(BASCULE)
CITY OF CLEVELAND
1-CABLE DEPTH 31.7' (IN SERVICE)
3-CABLES, DEPTH 30.7' (OUT OF SERVICE)
NEW BULKHEAD
REPLACE EXISTING BULKHEAD
REMOVE BRIDGE ABUTMENTS
NEW CHANNEL LIMIT
RELOCATE EXISTING CITY OF CLEVELAND POWER CABLE
NEW BULKHEAD
GULF REFINING CO
JEFFERSON AVE BRIDGE (20)
(BASCULE)
CITY OF CLEVELAND
2" ELECTRIC POWER CABLE
DEPTH 30.0'
PROJECT SITE
LOCALITY MAP
LIMITS OF NEW BULKHEAD
LIMITS OF NEW BULKHEAD
CUYAHOGA



LEGEND

OUV78-11 (151) Boring Designation [illegible]

A — A Profiles [illegible]

NOTES

1. FOR GEOLOGIC PROFILE [illegible] SEE PLATE A[illegible]
2. FOR GEOLOGIC PROFILE [illegible] SEE PLATE A7
3. FOR GEOLOGIC PROFILE [illegible] SEE PLATE A8
4. FOR GEOLOGIC SECTION H-H, SEE PLATE A[illegible]
5. FOR GEOLOGIC SECTION [illegible] SEE PLATE A[illegible]
6. ALL ELEVATIONS ARE REFERRED TO LOW WATER DATUM [illegible] ELEVATION 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC [illegible]
7. THE LOCATION OF EXPLORATIONS ARE NOT SHOWN TO SCALE
8. ADDITIONAL EXPLORATIONS ARE AVAILABLE IN THE CLEVELAND HARBOR AREA [illegible] ARE NOT INCLUDED HERE. THEY ARE AVAILABLE FOR INSPECTION AT THE [illegible] ARMY ENGINEER DISTRICT, BUFFALO

TABLE OF EXPLORATIONS

BORING NUMBER	STATION	OFFSET
5	F [illegible]+50	8[illegible] R
16	F 2+30	150 R
180	F [illegible]+00	45[illegible] L
87	F [illegible]+00	[illegible]0 R
8[illegible]	F 18+40	50 R
80	F 18+50	270 L
79	F 18+90	350 L
36	F 22+20	550 L
44	F 22+30	340 L
170	F 22+40	130
37	F 23+50	285 L
38	F 24+50	40 R
43	F 24+70	280 L
14	G 0+50	50 L
79	G [illegible]+20	40 R
85	G [illegible]+50	40 L
86	G [illegible]+70	40 R
8[illegible]	G 15+[illegible]0	20 L
4[illegible]	I 0+30	40 R
18	I 10+30	8 L
116	I [illegible]+85	7 R
168	I [illegible]3+20	590 L
169	I [illegible]3+20	350 L
[illegible]5	I [illegible]4+00	8 L
[illegible]7	I [illegible]6+20	[illegible] R
8[illegible]	I 23+70	470 R
83	I 24+00	390 R
184	I 24+95	350 R

CLEVELAND HARBOR STUDY

CLEVELAND, OHIO

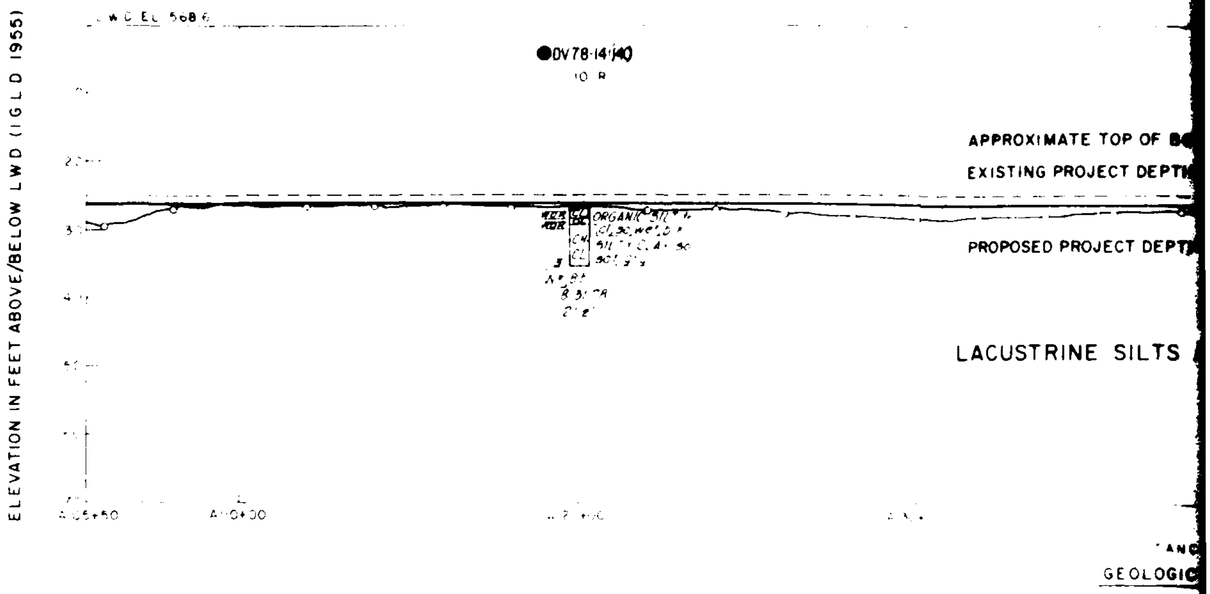
ALTERNATIVE PLANS NO 7G AND NO 11

PLAN OF SUBSURFACE EXPLORATIONS CUYAHOGA RIVER

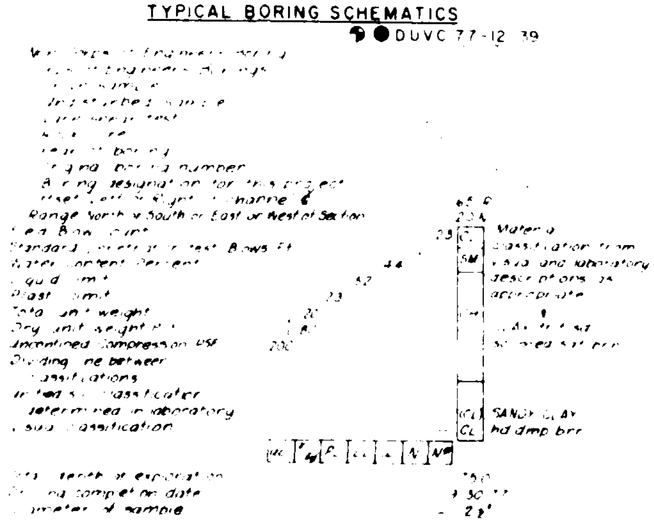
U.S. ARMY ENGINEER DISTRICT, BUFFALO

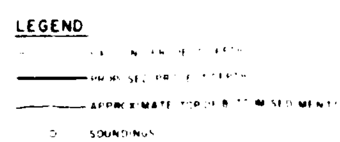
NOVEMBER, 1983

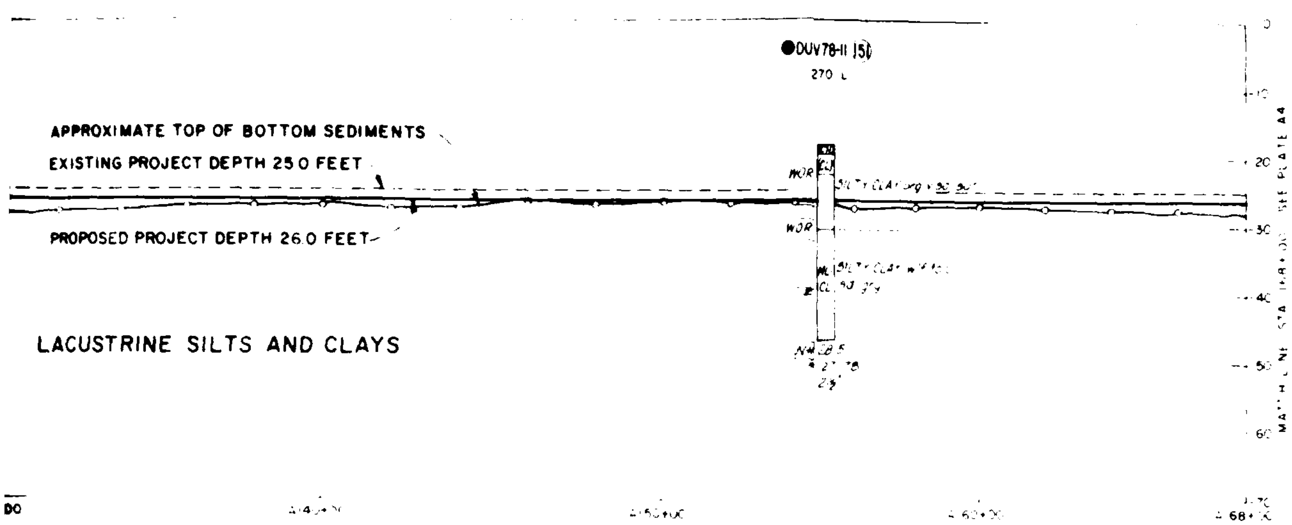
2



TYPICAL BORING SCHEMATICS



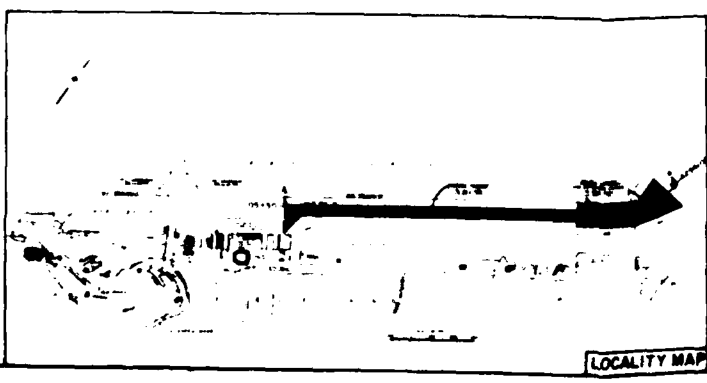




GEOLOGIC PROFILE A-A

NOTES

[illegible] see Plate A[illegible]
[illegible] Abbreviations, see Plate A5
[illegible] Legend see Plate A[illegible]
4. [illegible] Range of Standard Penetration Resistance Values see Plate A6
[illegible] Notes, see Plate A[illegible]
[illegible] Geologic Origin Classification Legend see Plate A5.



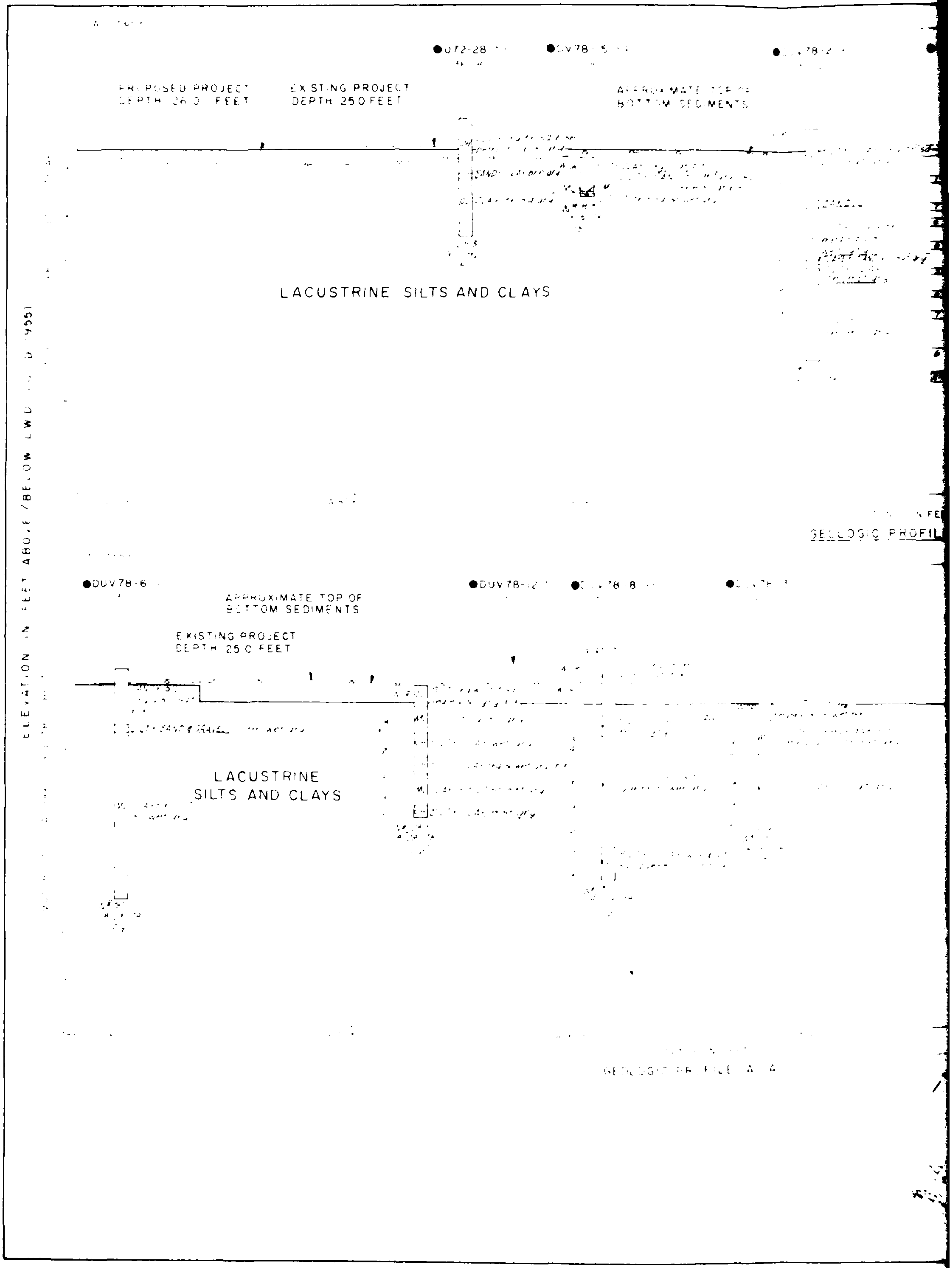
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE PLAN NO 1
"SEVERE-WEATHER EAST ENTRANCE PLAN"

GEOLOGIC PROFILE A-A
STA 105+50 TO STA 168+00

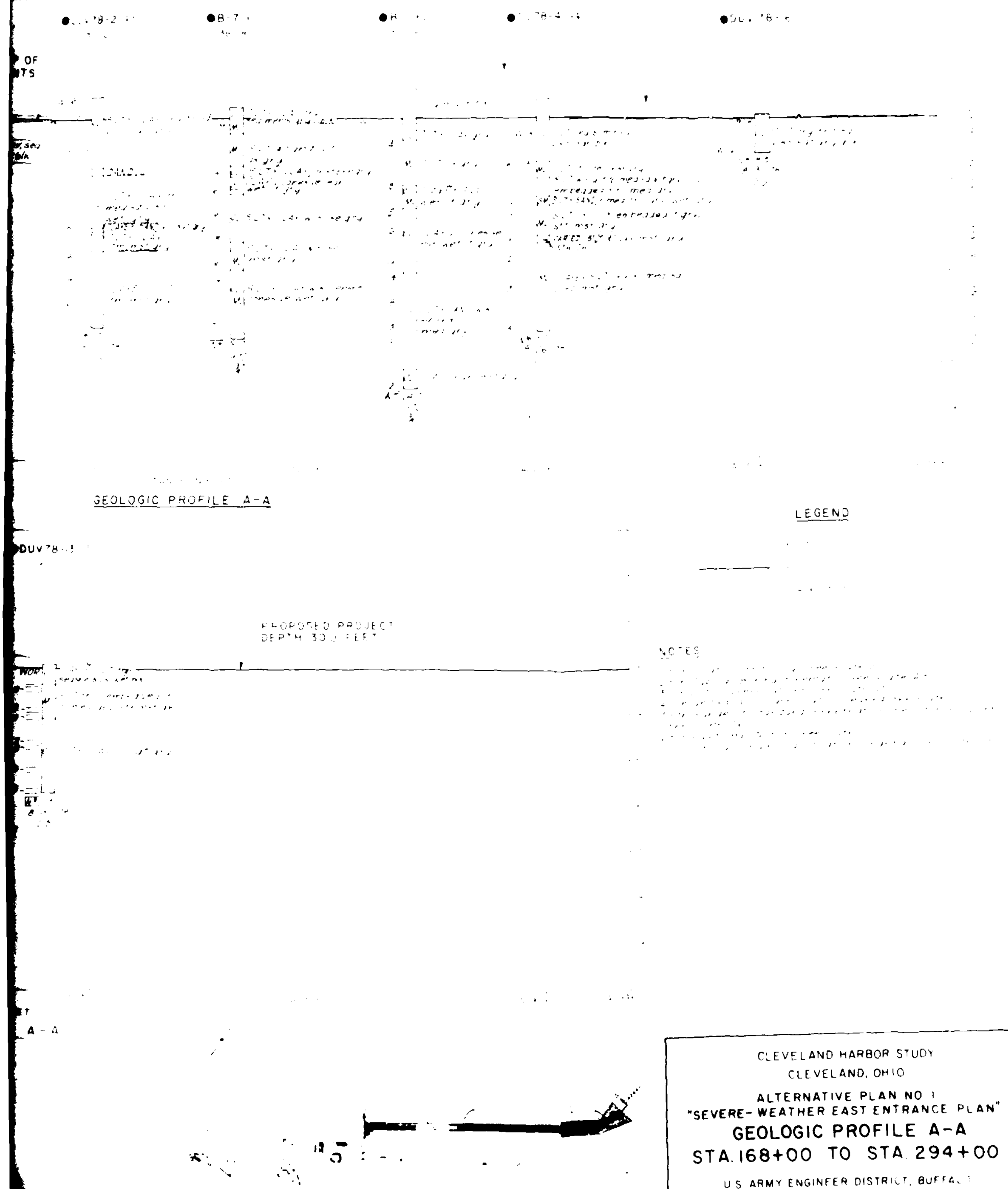
U.S. ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

2

PLATE A3



EXISTING PROJECT
DEPTH 25.0 FEET
LACUSTRINE SILTS AND CLAYS
DUV78-6
APPROXIMATE TOP OF
BOTTOM SEDIMENTS
EXISTING PROJECT
DEPTH 25.0 FEET
LACUSTRINE
SILTS AND CLAYS



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

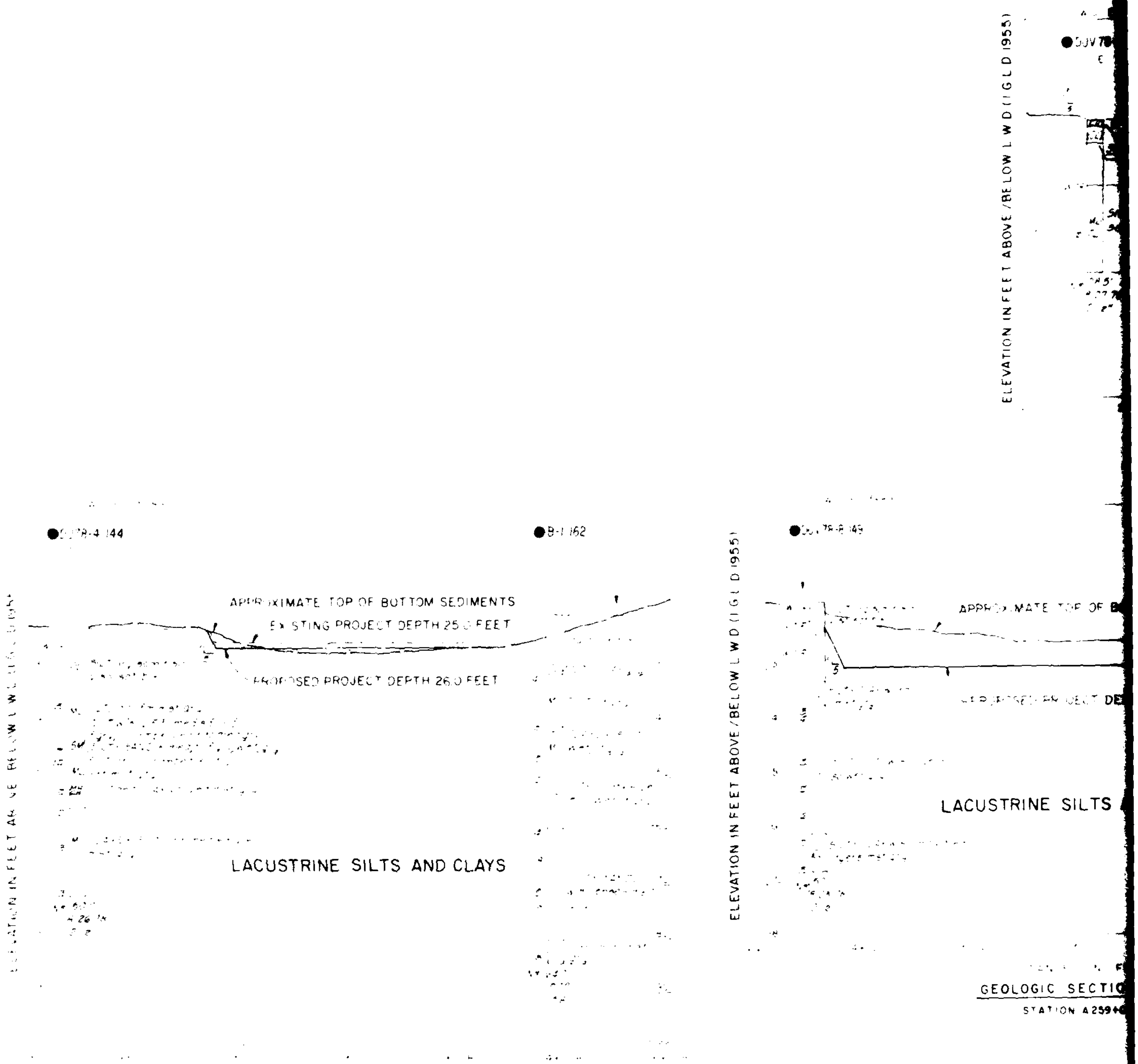
ALTERNATIVE PLAN NO 1
"SEVERE-WEATHER EAST ENTRANCE PLAN"

GEOLOGIC PROFILE A-A
STA. 168+00 TO STA. 294+00

U.S. ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

PLATE A4

2



GEOLOGIC SECTION C-C

STATION A218+20

LEGEND (GEOLOGIC CLASSIFICATION)

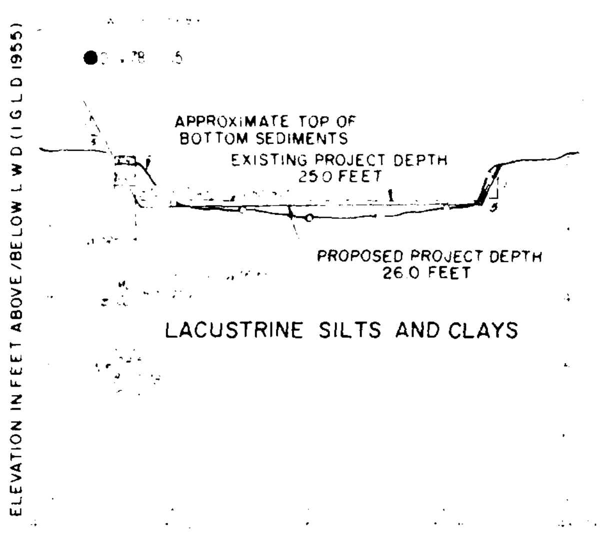
FILL DEPOSITS: gravelly silty sands containing variable amounts of cinders, gravel, brick and concrete fragments

LACUSTRINE SILTS AND CLAYS: ... soft ... silts ... and silty clays ... found predominantly in the Cleveland Outer Harbor

... AND LACUSTRINE DEPOSITS: predominantly loose silty sands and gravel ... SM ...

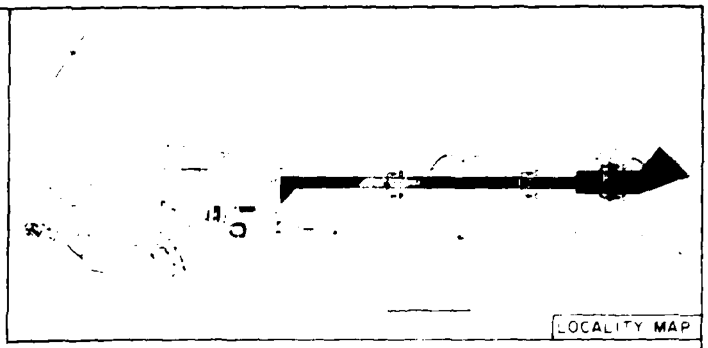
... containing small ...

LEGEND (UNIFIED SOIL CLASSIFICATION SYSTEM)

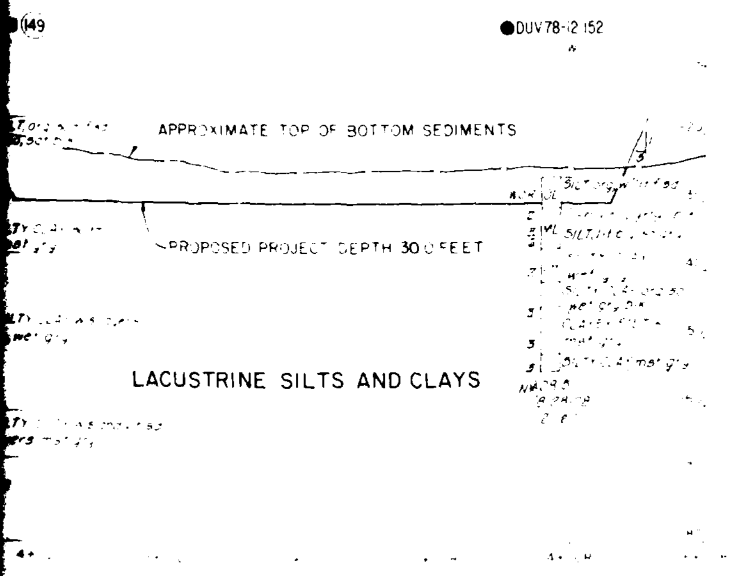


GEOLOGIC SECTION B-B

STATION A 55+00



LEGEND



NOTES

GEOLOGIC SECTION D-D

STATION A 259+00

ABBREVIATIONS

ASSIFICATION SYSTEM)

CLEVELAND HARBOR STUDY

CLEVELAND, OHIO

ALTERNATIVE PLAN NO. 1

"SEVERE-WEATHER EAST ENTRANCE PLAN"

GEOLOGIC SECTIONS

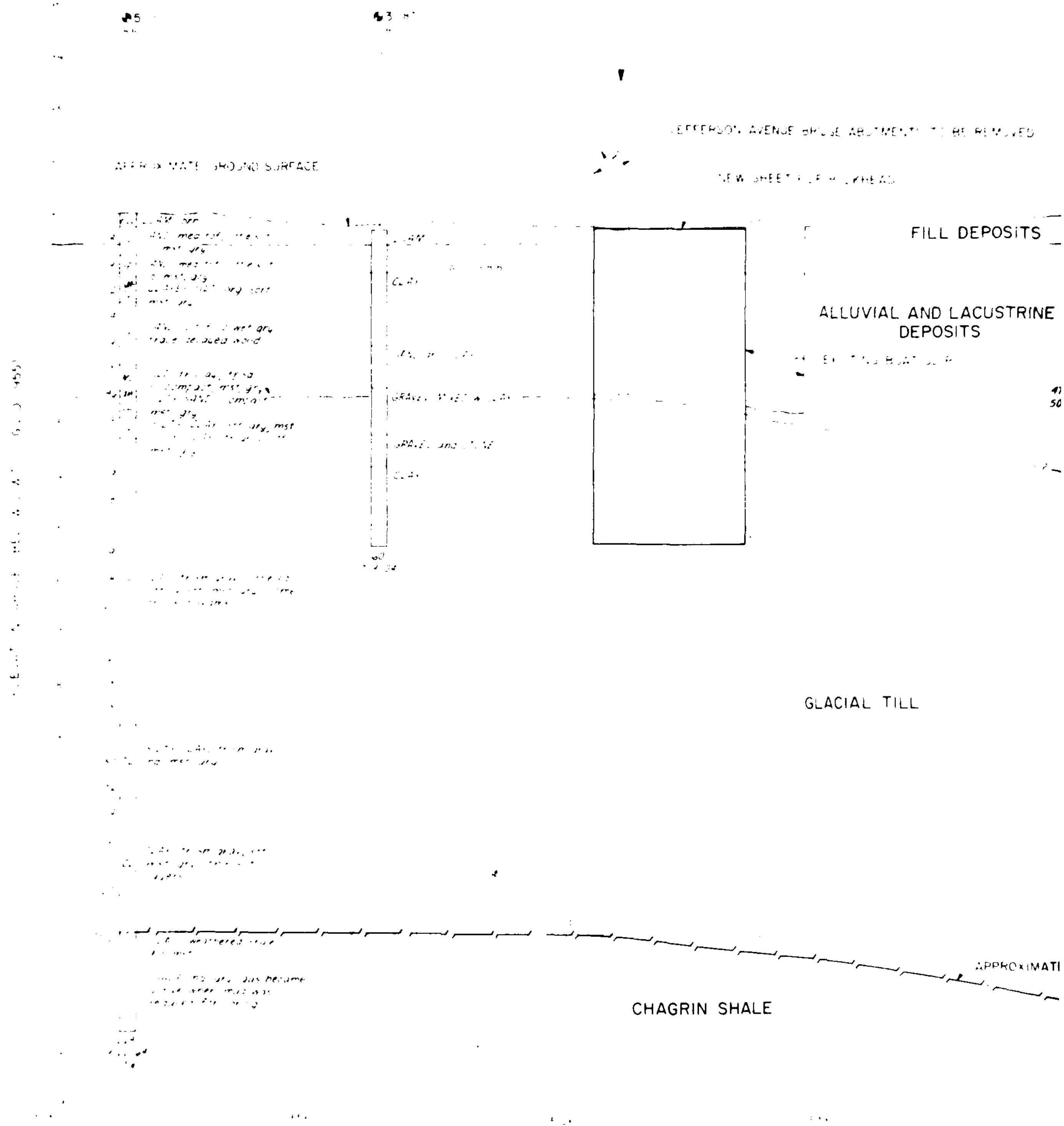
B-B, C-C AND D-D

U.S. ARMY ENGINEER DISTRICT, BUFFALO

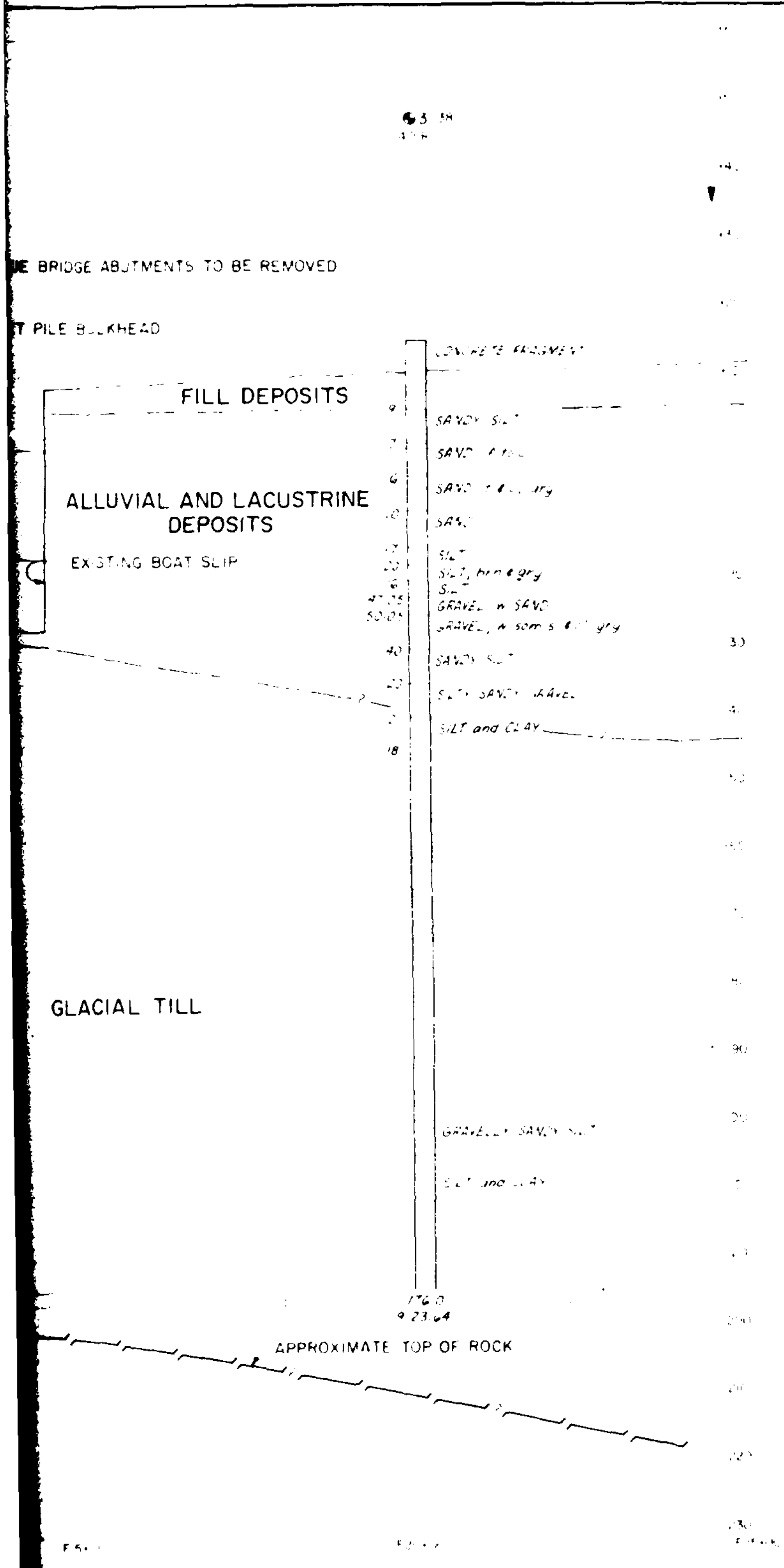
NOVEMBER, 1983

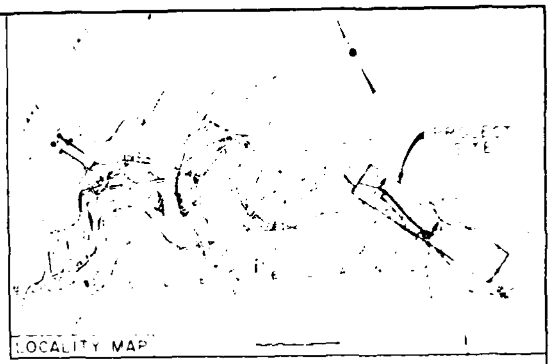
2

PLATE A5



GEOLOGIC PROFILE F-F





TERMS FOR RELATIVE DENSITY AND CONSISTENCY

[illegible]	[illegible]	< 2	[illegible]
4 - [illegible]	[illegible]	2 - 4	Soft
[illegible]	Medium Dense	4 - 8	Medium
30 - [illegible]	[illegible]	[illegible]	[illegible]
> [illegible]	Very Dense	[illegible]	Very Stiff
		[illegible]	Hard
< 5	Very Loose	[illegible]	[illegible]
5 - 17	[illegible]	[illegible]	[illegible]
[illegible] - 45	Med Dense	4 - 8	Medium
45 - 70	[illegible]	8 - [illegible]	[illegible]
> 70	Very Dense	[illegible] 35	Very Stiff
		> 35	[illegible]

NOTES

6. For Geologic Origin Classification Legend see Plate A5

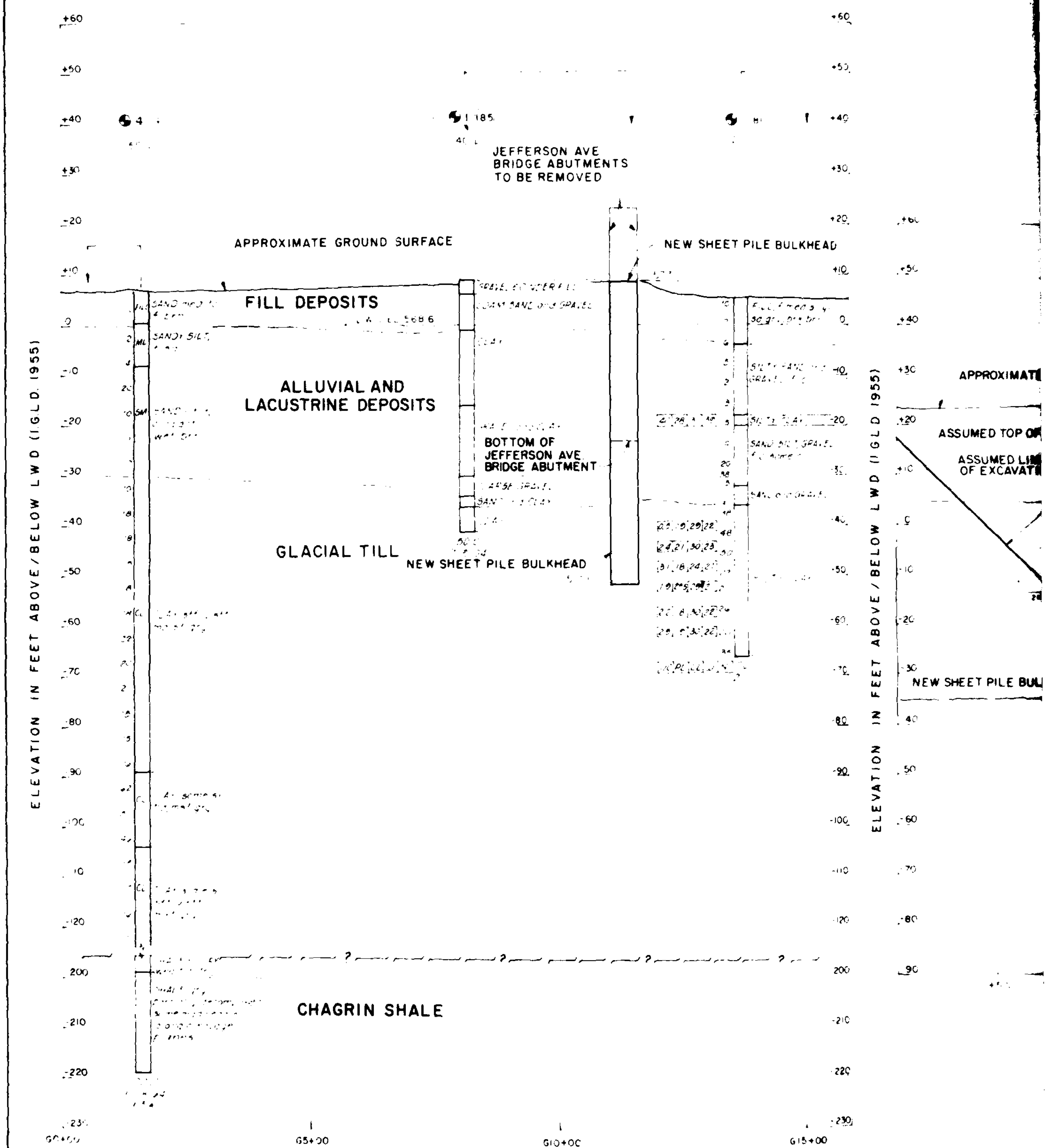
LEGEND

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE PLAN NO 7G
"REMOVE JEFFERSON AVE BRIDGE ABUTMENTS"

GEOLOGIC PROFILE F-F
STA. F0+00 TO STA. F25+00

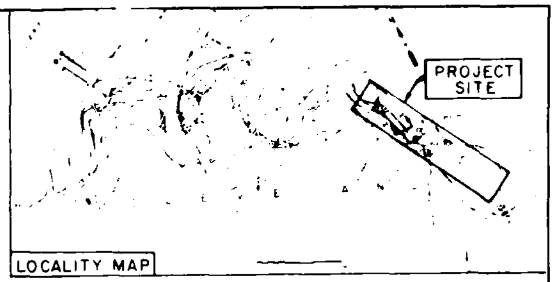
U.S. ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

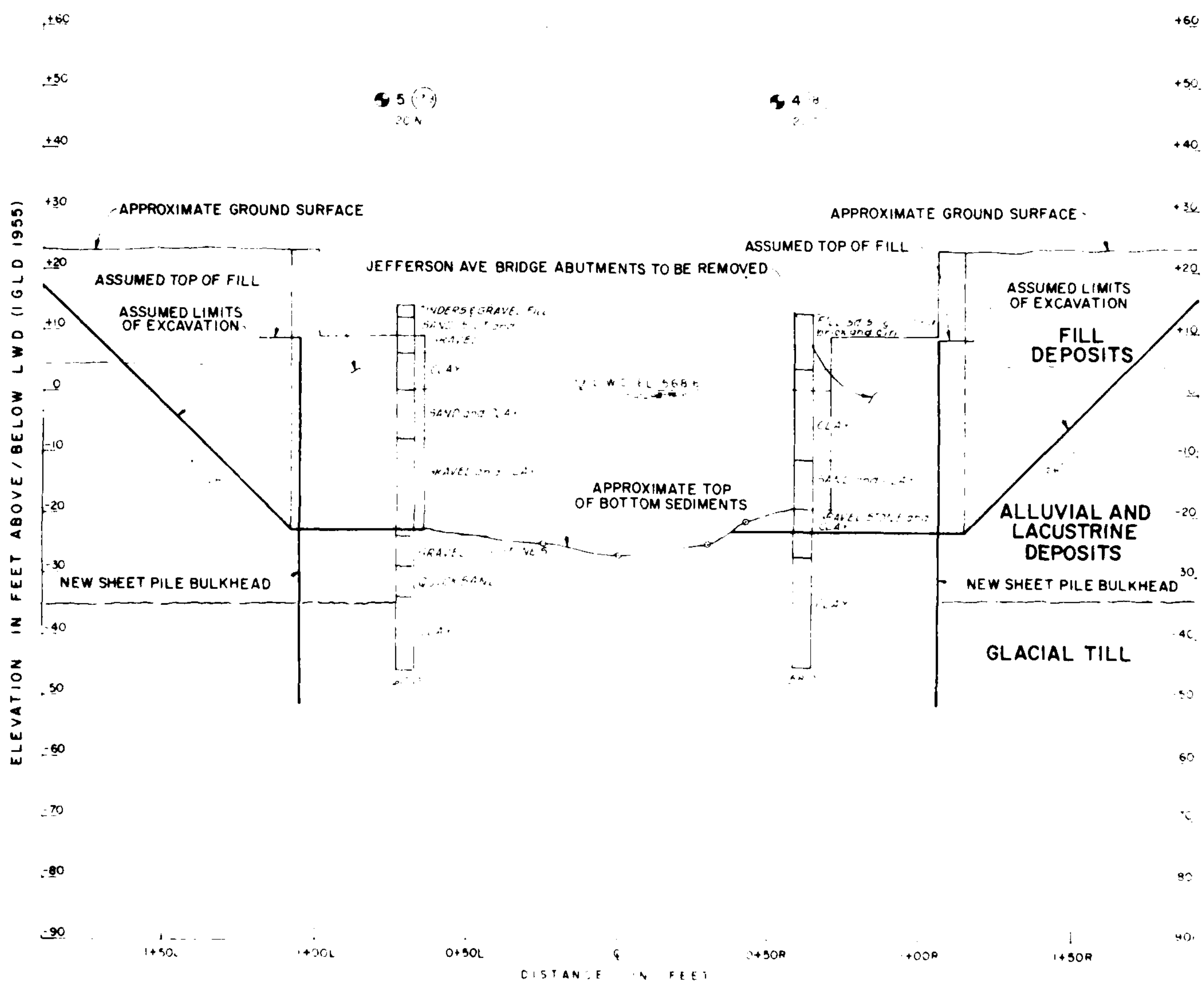
2



GEOLOGIC PROFILE G-G

LEGEND





GEOLOGIC SECTION H-H

NOTES

1. ... see Plate ...
2. ... Boring ... see Plate A3
3. For List of Abbreviations see Plate ...
4. ... Legend see Plate A5
5. For Range of Standard Penetration ... Values, see Plate A6
6. For Additional Notes see Plate ...
7. For Geologic Origin Classification Legend, see Plate A5

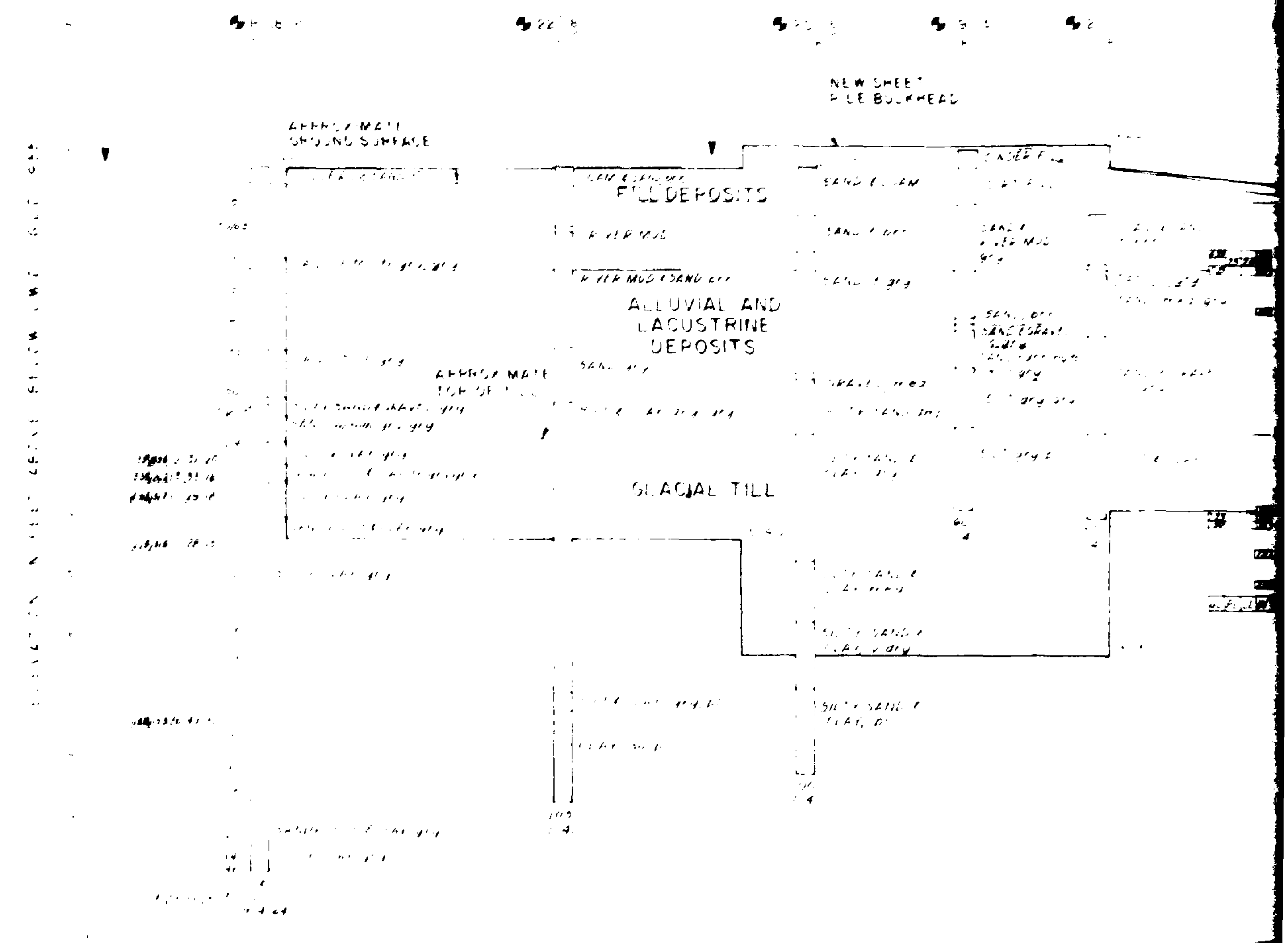
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE PLAN NO 7G
"REMOVE JEFFERSON AVE BRIDGE ABUTMENTS"

GEOLOGIC PROFILE G-G
STA. 60+00 TO STA. 616+00
AND GEOLOGIC SECTION H-H

U S ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

2

PLATE A

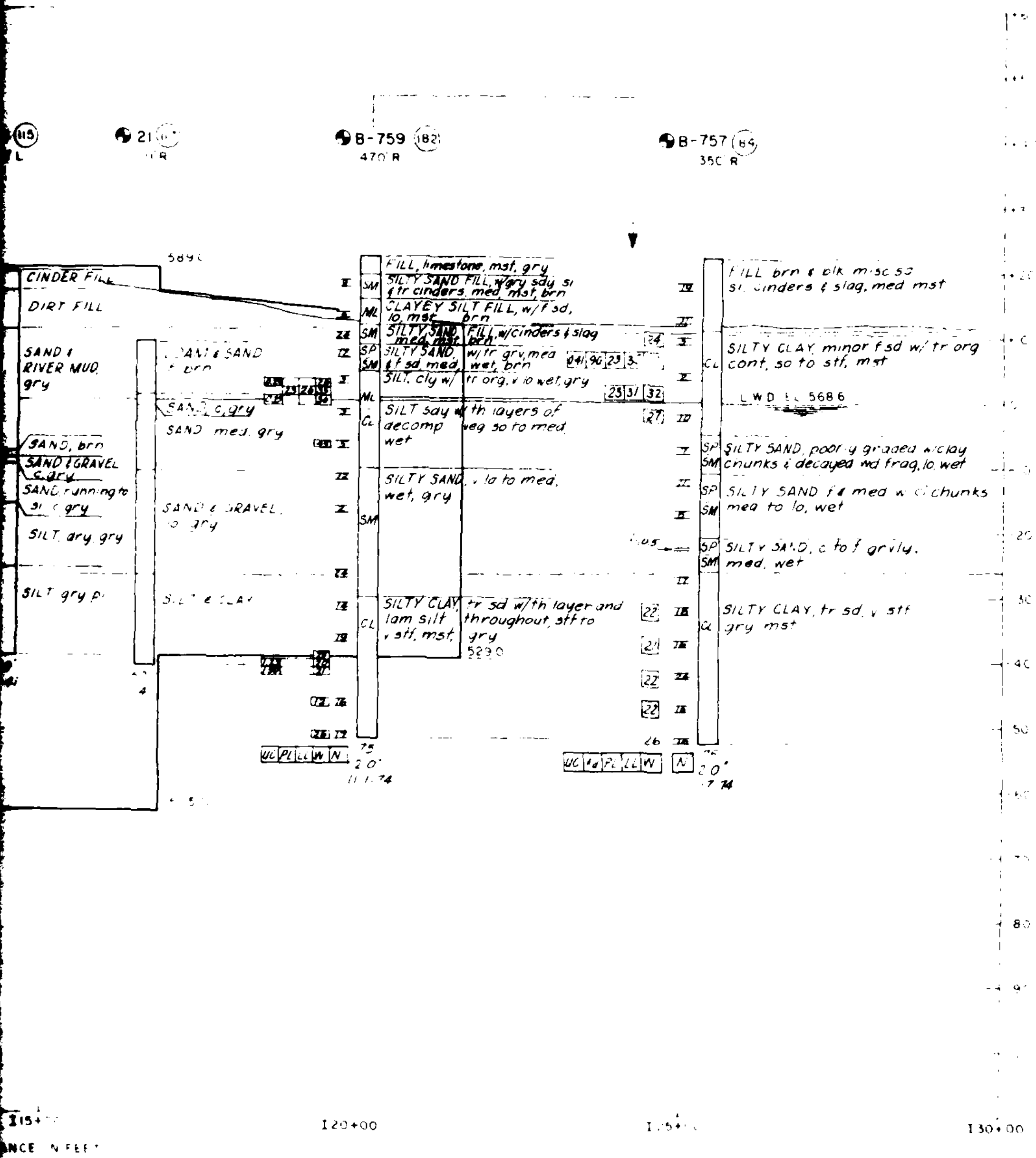


GEOLOGIC PROFILE I-I

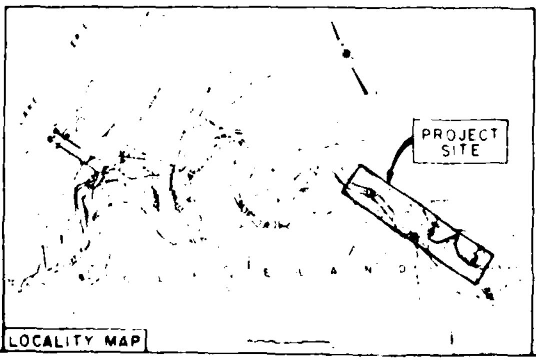
LEGEND

NOTES

1. [illegible]
2. For Typical Boring Sheets, etc. see Plate A3
3. For List of Abbreviations see Plate A[illegible]
4. For Unified Soil Classification [illegible] see Plate A[illegible]
5. For Range [illegible] see Plate A6
6. For Additional Notes see Plate A[illegible]
7. For Geologic Classification Legend, see Plate A5



PROFILE I-I



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

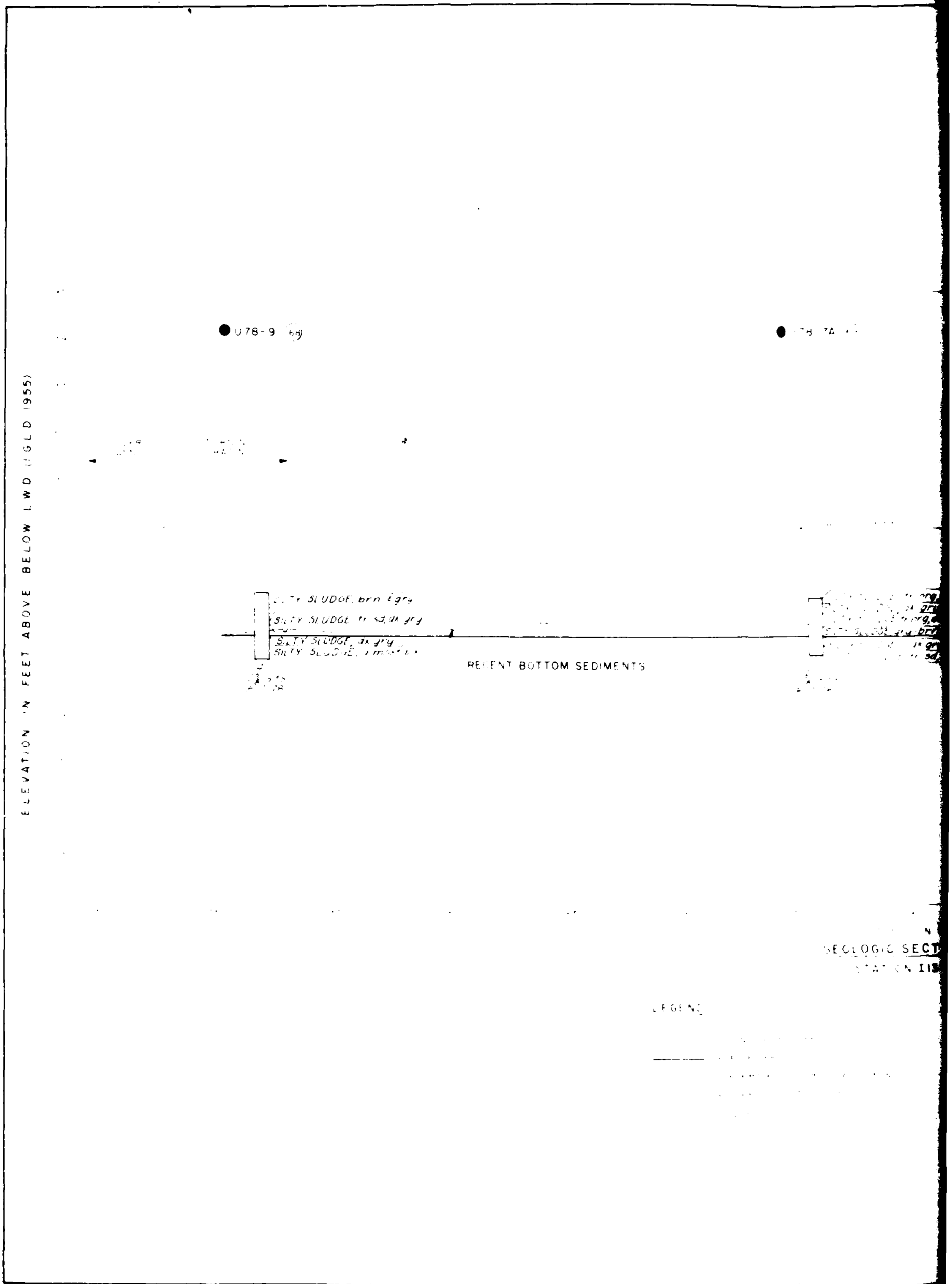
ALTERNATIVE PLAN NO II
"DEEPEN TURNING BASIN"

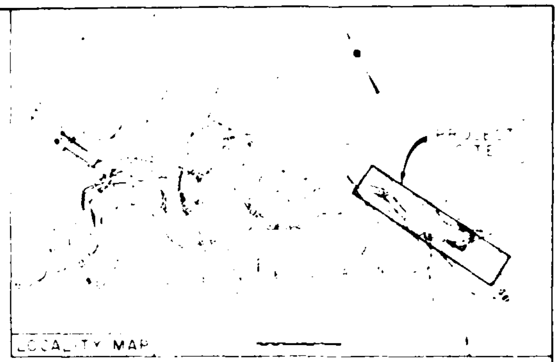
GEOLOGIC PROFILE I-I
STA. 10+00 TO STA. 130+00

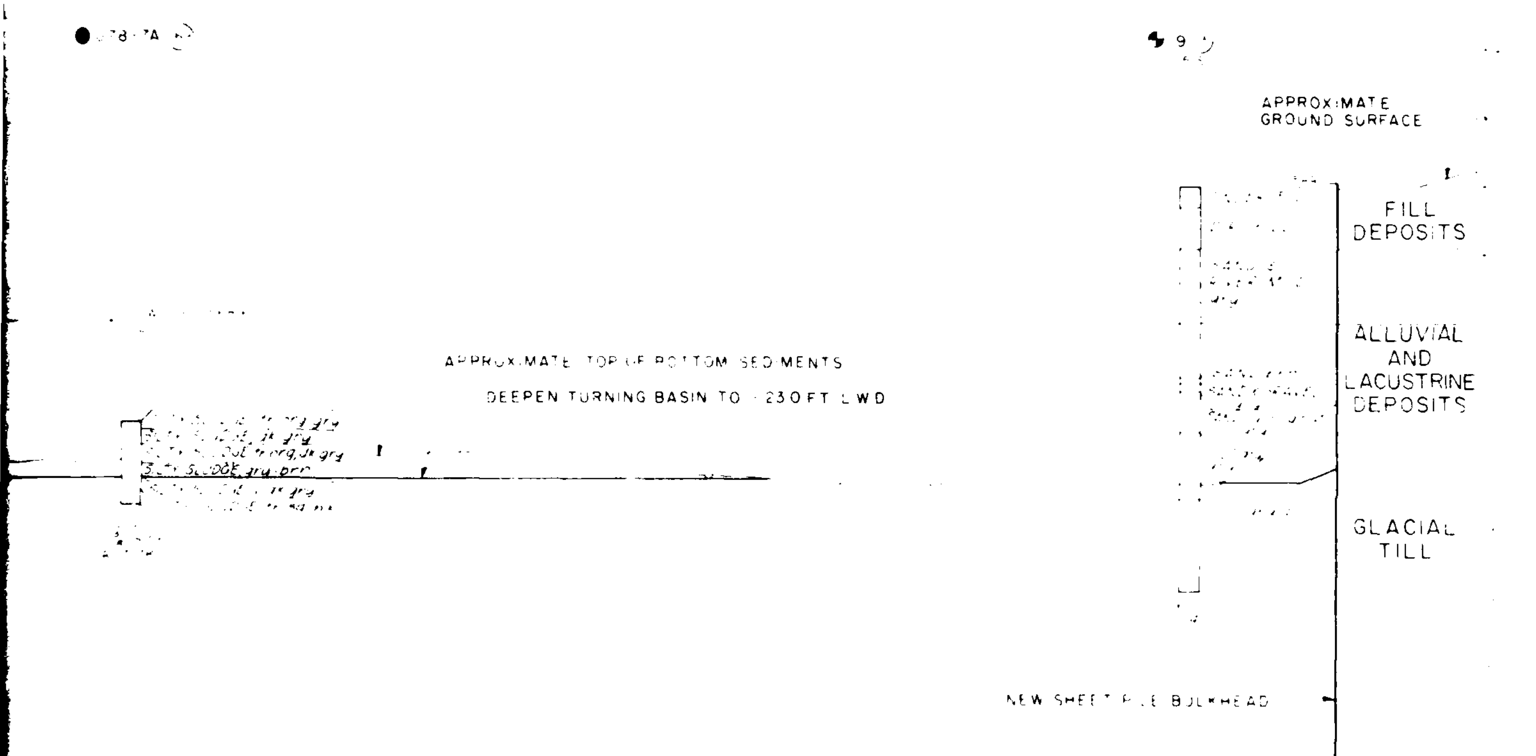
U S ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

2

PLATE A8


ELEVATION IN FEET ABOVE BELOW LWD (IGLD 1955)
U78-9
SILTY SLUDGE, brn & gry
SILTY SLUDGE, dk gry
RECENT BOTTOM SEDIMENTS





GEOLOGIC SECTION J-J
STATION 113+20

NOTES

For Geologic Origin Classification Legend see Plate A5

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

ALTERNATIVE PLAN NO. II
"DEEPEN TURNING BASIN"

GEOLOGIC SECTION J-J
STATION 113+20

U.S. ARMY ENGINEER DISTRICT, BUFFALO
NOVEMBER, 1983

2

PLATE A

APPENDIX B

ECONOMIC EVALUATION

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

CLEVELAND HARBOR, OHIO
DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

APPENDIX B

ECONOMIC EVALUATION

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLES

TABLE OF CONTENTS (Cont'd)

FIGURES

ECONOMIC EVALUATION
APPENDIX B

B1. ECONOMIC STUDY AREA

a. Physical Description.

Cleveland, OH, is the largest city on the south shore of Lake Erie and the third largest city on the Great Lakes. Located at the mouth of the Cuyahoga River, its early importance as a commercial and industrial port was based on natural assets: a protected harbor, a navigable river, and direct access to the Great Lakes transportation system. The economic vitality of the Cleveland, OH, metropolitan area is still dependent upon these assets.

Briefly, the Port of Cleveland presently consists of an Outer Harbor and an Inner Harbor. The Outer Harbor consists of a 5-mile long breakwall protected lakefront. The Inner Harbor, consists of the lower, deep-draft section of the Cuyahoga River, and the Old River.

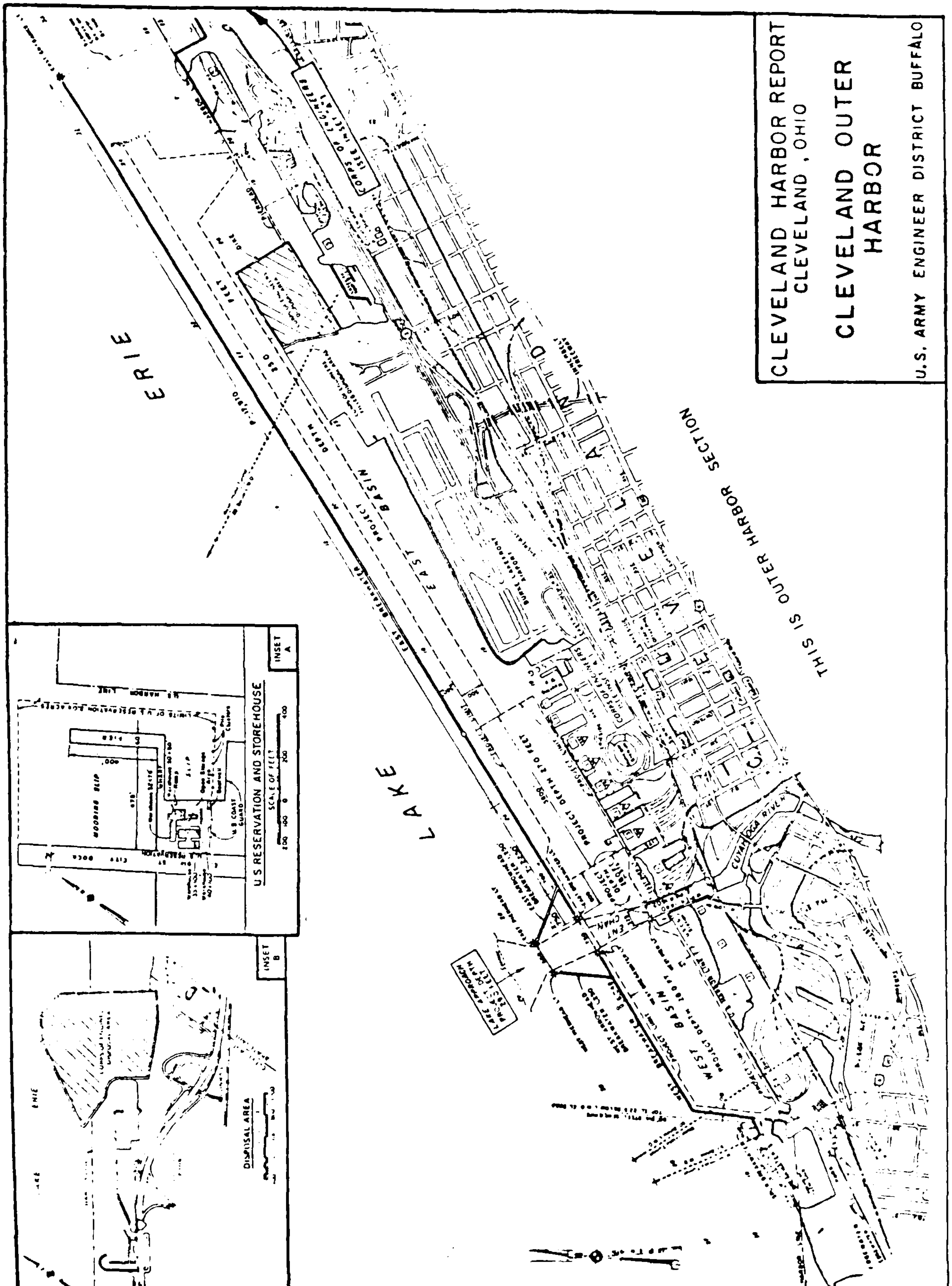
The Outer Harbor has two entrances from Lake Erie. The west (main) entrance is through a dredged channel at the west end of the Outer Harbor. This entrance is between the outer ends of two converging breakwaters (east and west arrowhead breakwaters) extending outward from the east and west basin breakwaters. The other entrance is at the east end of the Outer Harbor area between the breakwater and the shore. (See Figure B1)

The Inner Harbor includes about 5.8 miles of the Cuyahoga River and about 1 mile of the Old River, the former outlet of the Cuyahoga River. (See Figure B2)

b. Historical Development.

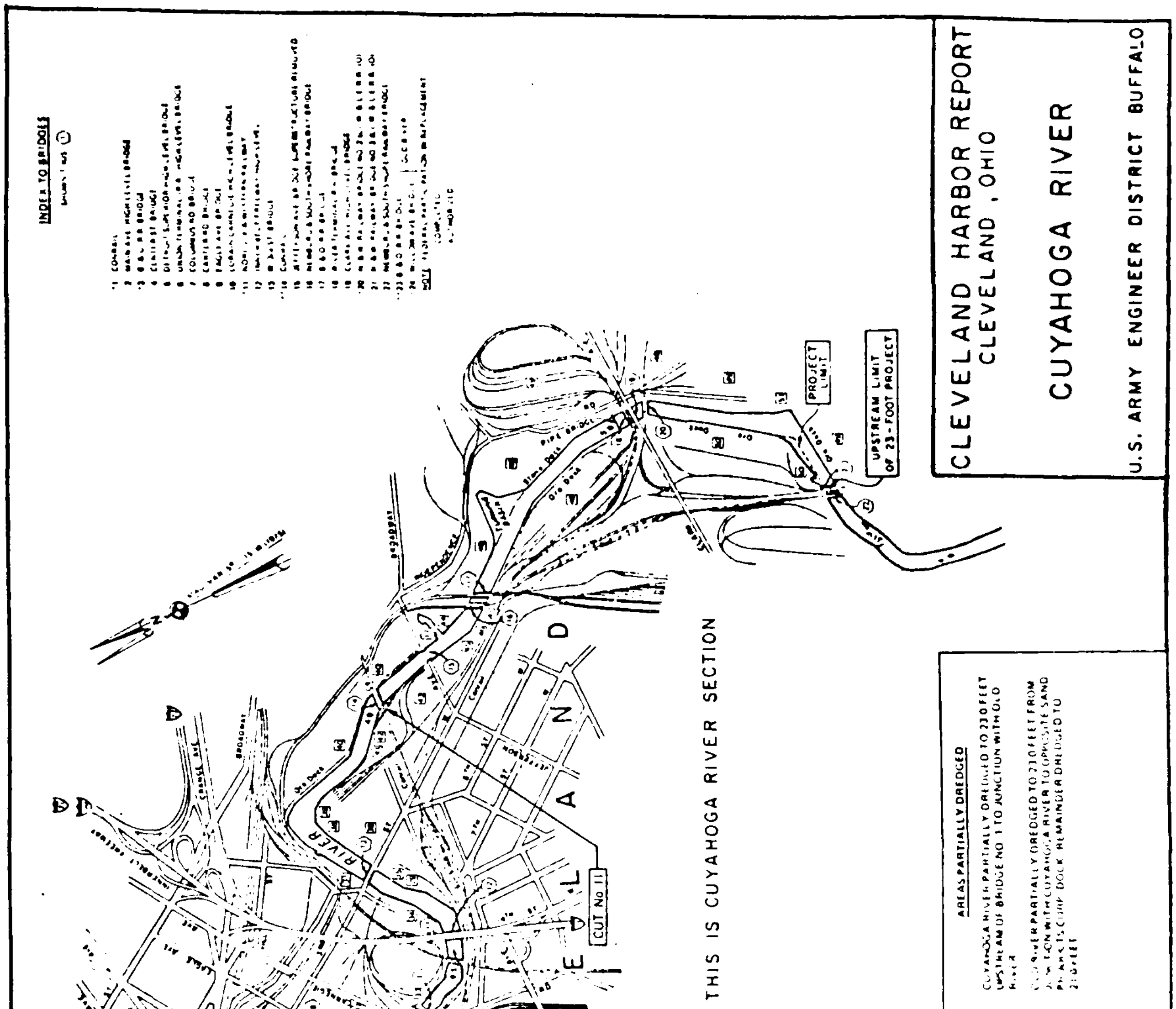
The iron and steel industries have molded the character of Cleveland, OH, just as the grain merchants and millers molded Buffalo, NY, and the automobile manufacturers formed the patterns of Detroit, MI. The channels and shipways of the Great Lakes and the ports on Lake Erie are the lifeline of the steel industry. Physical improvements to them with the resultant increase in carrying capacity of the ore fleets have been essential to the survival of the iron and steel industry.

In the mid-19th century the demands of the Civil War, the Reconstruction Period, and the subsequent westward movement of the population required large amounts of iron and steel. This demand for steel quickly outran the resources and capacities of the charcoal furnaces and the bog-iron deposits in Pennsylvania and southeastern Ohio. Consequently, the mines of Michigan and Minnesota experienced long-term development and expansion which has continued to the present day. A geographic overview of the Great Lakes transportation system and the location of U.S. iron ore deposits is provided in Figure B3.



CLEVELAND HARBOR REPORT
CLEVELAND, OHIO
CLEVELAND OUTER HARBOR
U.S. ARMY ENGINEER DISTRICT BUFFALO
THIS IS OUTER HARBOR SECTION
LAKE
ERIE
EAST BASIN
WEST BASIN
CUYAHOGA RIVER
U.S. RESERVATION AND STOREHOUSE
INSET A
INSET B
DISPOSAL AREA

FIGURE B1



CLEVELAND HARBOR REPORT
CLEVELAND, OHIO
CUYAHOGA RIVER
U.S. ARMY ENGINEER DISTRICT BUFFALO
THIS IS CUYAHOGA RIVER SECTION
CLEVELAND
CUYAHOGA
RIVER
INDEX TO BRIDGES
AREAS PARTIALLY DREDGED
NOTES
CUT No 11
CUT No 12
CUT No 13
CUT No 14
CUT No 15
CUT No 4
UPSTREAM LIMIT OF 27-FOOT PROJECT
UPSTREAM LIMIT OF 23-FOOT PROJECT
PROJECT LIMIT
PIPE BRIDGE

FIGURE B2

The ore had little industrial application until it was smelted and processed. The small, mid-century steel producing furnaces had used coal for smelting, however, quantity production required enormous amounts of coal. Coal veins lay in quantities equal to the Lake Superior ore fields in the hills of Pennsylvania, West Virginia, Kentucky, and southeastern Ohio. The two primary ingredients for making iron and steel were separated by a thousand miles, but they were joined by the Great Lakes system. The relative distances between each of the critical raw materials was the key to the development of commercial harbors along Lake Erie.

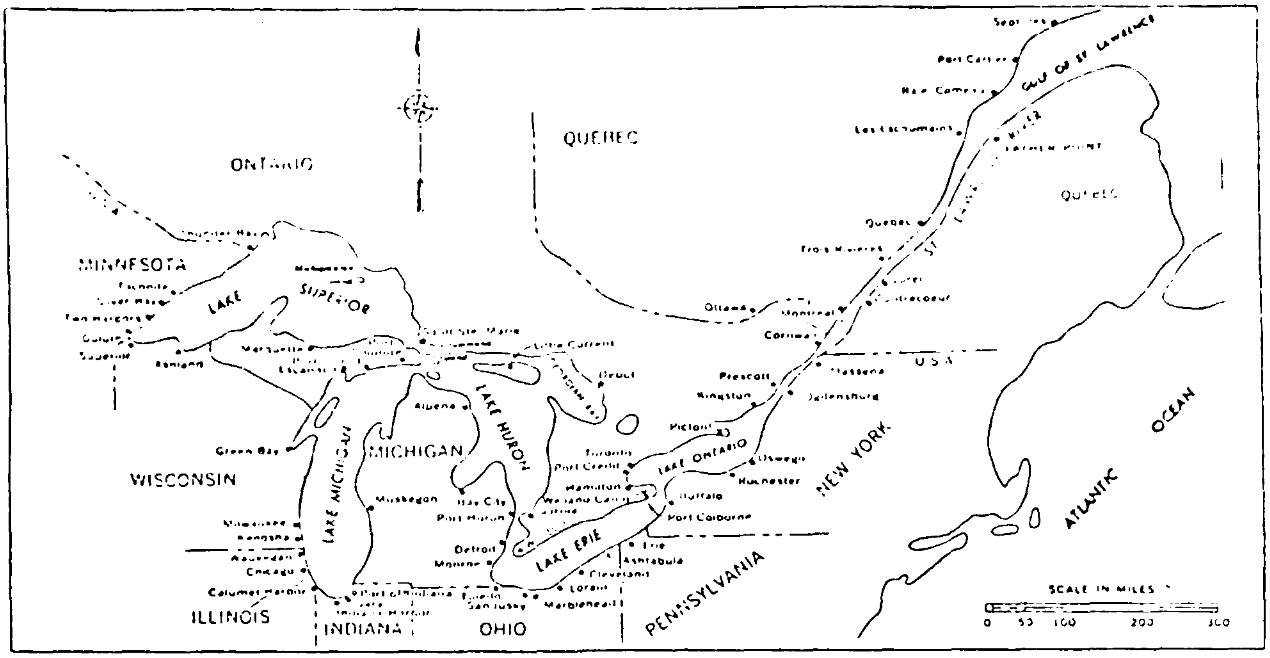
The question became whether it was more efficient to smelt the ore at its source or transport it via the Great Lakes to established furnaces. Both schemes were attempted. The proportion of coal to ore required to make iron and steel at that time was about four to one. Furnaces already in extensive operation near the coal fields were in close proximity to the manufacturers and markets. The least costly procedure finally adopted was to bring the ore to the coal, meeting inevitably along the south shore of Lake Erie.

A canal to bypass the St. Mary's Falls at Sault Sainte Marie and the State of Michigan Lock, the first ship lock at Sault Sainte Marie, were constructed in 1855, completing a 9-foot navigable channel from Lake Superior to Lake Erie. Entrepreneurs from Cleveland saw that the ore for the "steel age" would come from Lake Superior and would be transported down the lakes to meet the coal from the Appalachian coal fields somewhere along Lake Erie. These conditions represented a unique opportunity for investors to make Cleveland, OH, the strategic center for controlling the shipping of these basic raw materials.

Cleveland has been actively involved in the receipt and transshipment of iron ore for 125 years. From the day when ore was discovered on the Lake Superior ranges, Cleveland has been in the forefront of mining and shipping. The historical relationship between Cleveland Harbor and other competing harbors along Lake Erie is provided in Table B1.

c. Waterborne Transportation.

The Great Lakes form an efficient and geographically extensive transportation network for the raw material industrial inputs found in the Midwest. Large volumes of dry bulk materials are transported in Great Lakes vessels each year. Raw materials for the U.S. and Canadian steel industry and steam coal consumption by U.S and Canadian electric utilities constitute the majority of the commercial activity.



GREAT LAKES-ST LAWRENCE SEAWAY NAVIGATION SYSTEM

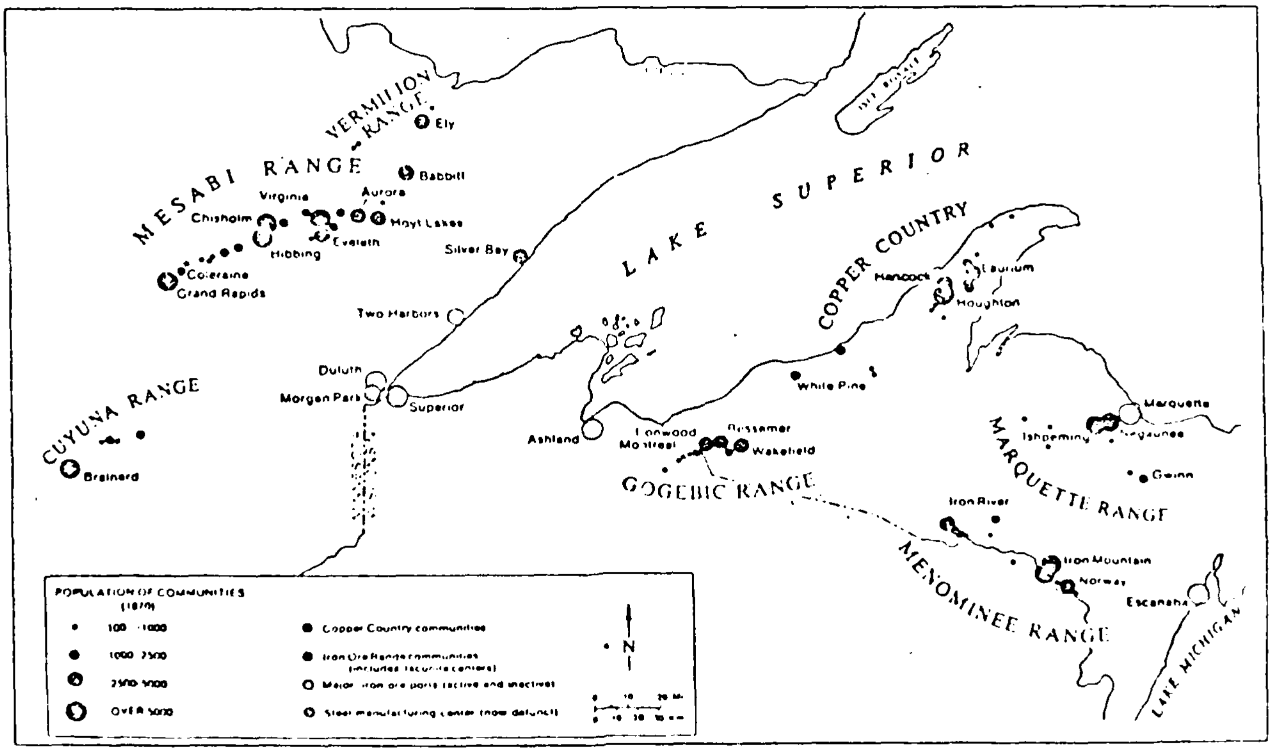


FIGURE B3 LOCATION OF GREAT LAKES IRON ORE DEPOSITS

Table B1 - Historical Iron Ore Receipts for Selected Great Lake Ports
(Millions of Net Tons)

Year	Buffalo		Conneaut		Ashtabula		Cleveland		Lorain		Huron		Toledo		Detroit		Gary		Burns Waterway		Indiana Harbor		Chicago		Total	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
1972	4.2	5	6.3	8	4.9	6	17.5	21	4.2	5	2.7	3	6.3	8	9.9	12	7.0	9	3.5	4	6.8	8	8.4	10	81.7	100
1973	7.7	8	7.6	8	5.3	6	18.1	19	5.6	6	2.9	3	6.5	7	11.1	12	8.1	8	4.5	5	10.2	11	8.6	9	96.2	100
1974	5.3	6	7.7	9	5.8	7	15.6	18	4.7	5	2.6	3	5.5	6	10.0	11	8.4	10	4.6	5	9.6	11	8.4	10	88.2	100
1975	3.1	4	9.3	12	3.5	4	13.3	17	4.3	5	1.4	2	4.0	5	9.8	12	8.1	10	4.6	6	10.2	13	7.6	10	79.2	100
1976	7.0	8	8.4	10	5.9	7	13.4	16	4.6	5	1.9	2	4.8	6	9.7	11	7.9	9	4.1	5	9.4	11	8.5	10	85.6	100
1977	4.0	6	5.3	8	5.4	8	10.5	16	3.1	5	1.2	2	3.5	5	7.8	12	6.6	10	3.1	5	8.3	13	5.6	9	64.4	100
1978	4.5	5	7.6	8	6.8	8	13.8	15	5.6	6	1.4	2	5.7	6	9.7	11	6.4	7	5.5	6	13.8	15	9.7	11	90.5	100
1979	4.9	6	9.4	10	7.2	8	14.5	16	3.0	3	2.7	3	5.3	6	10.1	11	6.8	8	6.1	7	11.9	13	8.5	9	90.4	100
1980	2.0	3	9.3	13	4.0	6	10.0	14	6.6	10	1.2	2	2.8	4	7.6	11	5.9	9	4.8	7	10.6	15	9.4	6	69.2	100
1981	3.2	4	6.8	9	4.4	6	9.5	13	9.3	12	1.5	2	4.6	6	7.7	10	6.3	8	5.3	7	12.2	16	5.3	7	76.1	100

SOURCE: Waterborne Commerce of the U. S., Part 3, Great Lakes - Corps of Engineers.

Bulk transportation via the Great Lakes can be provided at very competitive prices per ton. However, during the winter period raw materials are transported by alternate transportation networks at much higher average costs per ton. Railroads are frequently the next most competitive mode for movement of the raw materials required by the steel industry.

Table B2 below shows the published all-rail iron ore freight rate to Cleveland Harbor plants from the Mesabi Range in the upper lakes. Despite an allowance for an average stockpiling interval of 3 months, an inland steel company can realize substantial economic benefits when shopping via the Great Lakes.

Table B2 - Iron Ore Freight Rates from the Mesabi Range to Cleveland, OH

Description of Movement	Freight Rate/Short Ton
	$
All-Rail, Mesabi Range to Consuming Plant	34.80
Water, Tranship to Inland Plant	27.86

SOURCE: Skillings Mining Review.

Total transportation costs for a Great Lakes routing usually involves the cost of related transportation services in addition to the waterborne portion of the origin-destination-commodity movement. These costs usually consist of terminal, storage and related costs plus overland line-haul charges, if required. A typical Great Lakes routing and related service costs are illustrated in Table B3. The cost breakdown shows a wide range of service costs, however, not all service costs are applicable in all cases.

d. Problems and Plans.

The fundamental navigation issue in Cleveland is the modification of existing harbor dimensions. Delivery and shipment of bulk commodities are now restricted and the optimum utilization of bulk vessels is not possible. Hazards to navigation along the Cuyahoga River are also being investigated.

A number of alternatives have been formulated during the planning process. A reformulation of earlier plans, plus an evaluation of existing authorized improvements not yet constructed, was completed in the Stage 2 Report. However, after several workshops and public meetings, a number of preliminary plans were dropped from further consideration. The remaining plans to be evaluated are summarized below:

Plan Number	Plan Name
1	"Severe-Weather" East Entrance
7G	Remove Jefferson Avenue Bridge Abutments
11	Deepen Turning Basin

Most commercial vessels enter and exit Cleveland Harbor through the west entrance between the arrowhead breakwaters. This location is also known as the "Main Entrance" by vessel operators servicing docks within the Federal project limits. The lake approach channel is maintained to a depth of 29 feet LWD and has a width at the lakeward end of 600 feet. This width increases to 750 feet between the spur breakwaters. The spurs are potential hazards to large vessels, particularly during storm conditions. The existing channel depths and resulting underkeel clearances may also be inadequate for vessel clearance under severe pitching and rolling conditions.

Table B3 - Transportation Cost Components - Iron Ore

	Activity	Rate Per Short Ton
		$
1.	Rail haul of taconite which has been beneficiated (pelletized at the mining operation on the Mesabi Range) in a unit train of 180 90-gross ton capacity hopper cars, to Duluth-Superior.	6.26
1a.	Winter ground storage at Duluth-Superior, if required, per month.	0.051
2.	Handling and transfer of pellets to vessel.	0.87
3.	Lake Freight Movement.	7.13 (1)
4.	Dockage.	0.23 (1)
5a.	If vessel is a self-unloader, transfer of ore from dock receiving area into rail cars or to storage and then into rail cars.	1.53
5b.	If vessel is a bulker, transfer from the hold of vessel to rail of vessel.	0.92
5b1.	Transfer from rail of vessel into rail car.	1.02
5b2.	Transfer from rail of vessel into storage yard.	2.22
5b2a.	Storage, per month.	0.71
5b2b.	Transfer from storage into rail car.	1.41
6.	Rail haul to consuming plant.	8.85

(1) Variable by lower lakes destination.

SOURCE: Skillings Mining Review, February 1982.

B2. TYPES AND VOLUMES OF COMMODITY FLOW

a. Overview.

The vast majority of waterborne traffic at Cleveland Harbor consists of domestic and Canadian bulk cargo movements. Table B4 shows the relative importance of iron ore, limestone, sand and gravel, and salt commodity flows. Salt tonnage, although relatively small, is the largest commodity shipped from the harbor. Overseas traffic is not significant, generally comprising less than 4 percent of total harbor tonnage. The analysis will concentrate on iron ore and limestone, receipts. Other commodities at the port of Cleveland include wheat, residual fuel oil, building cement, and general cargo tonnage handled at the port authority docks.

b. Iron Ore.

Iron ore receipts from domestic and Canadian sources constitute 70 to 75 percent of the total annual waterborne traffic in Cleveland. The ore is consumed at two integrated steel mills on the Cuyahoga River or transhipped to inland steel plants in Ohio, Pennsylvania, and West Virginia. The intermediate or finished steel products produced includes bars, sheets, plates, pipes and tubes, and structural shapes. The major sources and eventual areas of distribution for iron ore moving through Cleveland Harbor are presented in Figure B4.

A transhipment dock in the west Outer Harbor handles all the transhipped tonnage. Ore is stockpiled at the terminal and railed to inland companies. Another ore dock, located on the east bank at the river mouth, is part of a lightering operation which services an upriver steel plant. The Republic Steel plant, located 6 miles upstream on the Cuyahoga River, receives all its ore from a transfer facility in Lorain, Ohio, 28 miles west of the harbor.

Location of Docks and Harbor Users

Dock Name	Location
C&P	Lakefront
Dock 20	Lakefront
Jones & Laughlin Steel Corp.	Cuyahoga River
Republic Steel Corp.	Cuyahoga River

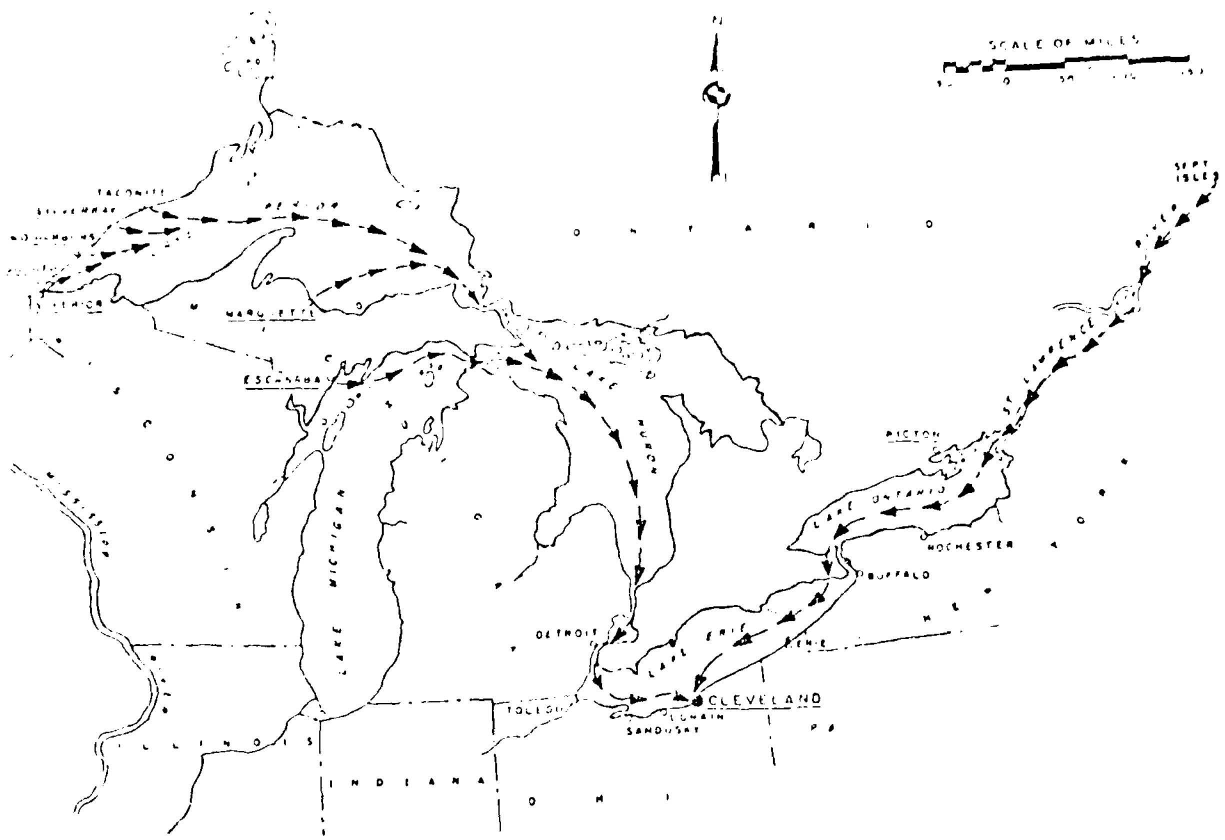
Major Inland Steel Companies	Location
Jones & Laughlin Steel Corp.	Aliquippa, PA
National Steel Corp.	Weirton, WV
Wheeling-Pittsburg Steel Corp.	Steubenville, OH

Table B4 - Selected Commodity Movements at Cleveland Harbor, OH
(Thousands of Short Tons)

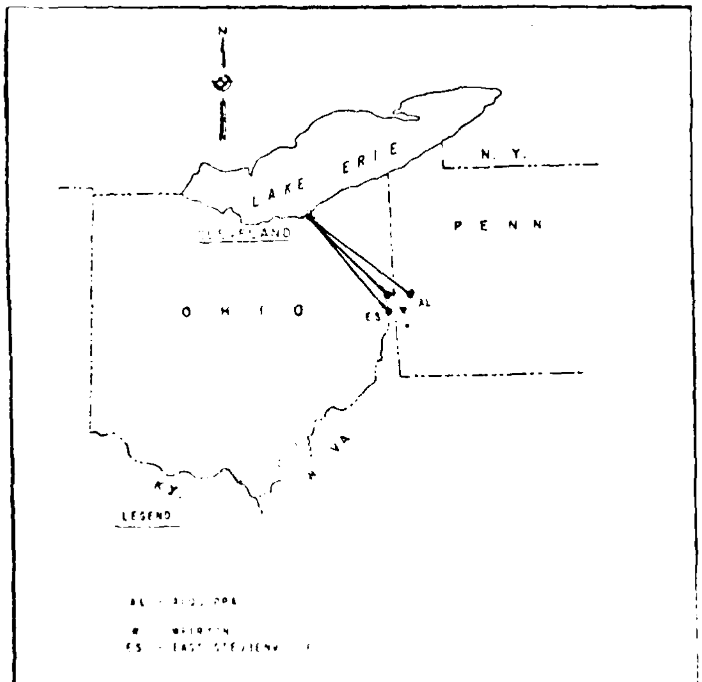
Year	Iron Ore		Limestone		Sand & Gravel		Salt		Selected Commodities Sub-Total		Harbor Total
	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	Tonnage	% Total	
1972	17,450	73.1	2,477	10.4	1,378	5.8	871	3.6	22,176	92.6	23,866
1973	18,080	72.8	2,826	11.4	1,615	6.5	575	2.3	23,096	93.0	24,828
1974	15,635	71.3	2,590	11.8	1,404	6.4	964	4.4	20,593	93.9	21,934
1975	13,263	73.1	1,906	10.5	966	5.3	1,010	5.6	17,145	94.5	18,145
1976	13,396	73.7	1,935	10.7	823	4.5	804	4.4	16,958	93.3	18,168
1977	10,526	65.4	2,280	14.2	922	5.7	647	4.0	14,375	89.3	16,104
1978	13,770	70.0	2,653	13.5	1,225	6.2	534	2.7	18,182	92.5	19,659
1979	14,473	74.3	2,025	10.4	1,066	5.5	449	2.3	18,013	92.5	19,470
1980	10,040	71.5	1,436	10.2	1,023	7.3	508	3.6	13,007	92.6	14,045
1981	9,494	68.3	1.405	10.1	1,110	8.0	956	6.9	12,965	93.2	13,904
10 Year: Average	13,613	71.6	2,153	11.3	1,153	6.1	732	3.9	17,651	92.8	19,012

SOURCE: Waterborne Commerce Statistics, Part 3 - Great Lakes, Corps of Engineers, 1972-1981.

FIGURE B4 CLEVELAND IRON ORE SOURCES AND FINAL DISTRIBUTION AREAS



IRON ORE TRAFFIC TO CLEVELAND



DESTINATION OF IRON ORE TRANSSHIPPED FROM CLEVELAND, OHIO

The iron ore reserves of Minnesota and Michigan are the major source of domestic movements to Cleveland. Canadian ore is mined in Quebec-Labrador mines and railed to deep-water ports along the Gulf of St. Lawrence. The origin ports and historical tonnages for Cleveland iron ore receipts are listed in Table B5.

Iron ore has a low value and is dense relative to other commodities. It is not susceptible to damage and is amenable to efficient bulk handling methods. Because of its low value, transportation decisions regarding ore are extremely price sensitive. Also, the transportation costs frequently comprise a high percentage of the value per ton. The advantage of water transportation is especially significant for bulk commodities such as iron ore.

There is a distinction between crude iron ore and beneficiated iron ore in terms of transportation characteristics. As-mined crude ore has a high moisture content, is low grade in terms of iron content, and is susceptible to freezing. Beneficiated ore, predominantly in pellet form, is low in moisture content. It has more than three times as much iron content per ton than crude ore. Pellets do not freeze or cake in cold conditions and are better suited for the most efficient handling techniques. Virtually all of the furnace capacity at Cleveland consists of the basic oxygen variety. Iron content is important because these furnaces require high percentages of high grade ore to steel and scrap in the steel-making process. There are no crude ore receipts at Cleveland. Therefore, the discussion of ore shipments to Cleveland concerns only high grade iron bearing pellets.

The efficient transfer of iron ore from the orginating mine to the processing mill depends upon a highly coordinated transportation sequence. This system is comprised of railroads, ships, and dock transfer equipment. The sequence involves moving the crude ore to a beneficiation facility at the mine or origin port. The crude ore or pellets is then moved via rail from the mine site to the origin port. Here the ore is transferred to dry bulk carriers which deliver it to the receiving port.

There are three major stages in the steel-making process. The first of these stages centers on the blast furnace. The blast furnace uses three basic raw materials: iron ore, coke, and limestone.

Coke provides heat, which releases carbon monoxide and carbon dioxide from the limestone. The carbon monoxide acts on the iron ore so that the iron is separated from the sands and clays and other impurities that are present in the ore. The carbon dioxide can be led off to the coke oven to assist in converting coal to coke. Residual impurities combine to form a slag and can be used as construction aggregates or a raw material for the cement industry. The molten iron is led off into pigs, hence the name pig iron. The iron may be used by forges which produce wrought iron, by foundries which make castings; or by a steel converter which produces steel.

Table B5 – Historical Iron Ore Tonnages from Origin Ports to Cleveland, OH
(Millions of Short Tons)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	(1) Percent
American Ports											
Duluth, MN	1.0	1.5	1.6	1.9	1.3	1.1	0.8	0.9	0.4	0.1	7.5
Escanaba, MI	2.2	2.7	2.4	2.0	2.6	2.7	2.4	2.5	1.7	2.2	16.5
Lorain, OH	0	0	0	0	0	0	0	0	0	0.3	–
Marquette, MI	0.1	0	0	0	0	0	0	0	0	0	–
Presque Isle, MI	1.4	1.3	1.4	1.5	1.0	0.9	0.4	1.3	0.9	0.2	7.3
Silver Bay, MN	4.3	5.7	5.6	5.5	3.8	4.9	2.3	4.2	4.1	2.1	30.1
Superior, WI	1.6	2.4	1.9	2.0	1.5	0.7	1.3	1.7	1.6	1.1	11.2
Taconite, MN	0.5	1.2	0.9	0.4	0.4	0.5	2.3	0.4	2.9	2.2	8.3
Two Harbors, MN	0.1	(2)	0.1	0.1	0.1	0.1	0.1	0.1	(2)	0	0.4
Canadian Ports											
Lake Superior	0.1	0	0.1	0.1	0	0	0	0	0	0	0.2
Lake Huron	0.3	0.2	0.4	0.4	0.2	0.2	0.1	0.4	(2)	0	1.6
Lake Erie	0.1	(2)	0	0	0	0	(2)	0	0	(2)	–
Lake Ontario/ St. Lawrence	3.1	2.4	3.7	1.7	2.3	2.7	3.1	2.2	2.7	1.8	18.2
Harbor Total (3)	14.7	17.5	18.1	15.6	13.3	13.4	10.5	13.8	14.5	10.0	

(1) Percentage shown is derived by dividing 10-year average of origin total by 10-year average of harbor total (excluding Marquette, Lorain, and Canadian ports on Lake Erie).

(2) Less than 50,000 tons.

(3) Total may not equal sum of components due to rounding.

SOURCE: Unpublished waterborne commerce statistics of the United States, Annual Port-to-Port Summary, 1971-1980.

Until the invention of the basic oxygen process, there were three types of steel converters in use in the world. The first was invented in 1856 by Henry Bessemer. The Bessemer converter requires an input of hot pig iron. Air is blown through the pig iron to burn off carbon. This technique is a small batch process, with a short conversion time, and poor quality control, however a Bessemer converter has low capital and operating costs. A converter lined with dolomite is ideal for removing phosphorus from ores. Phosphoric ores charged into Bessemer converters produce basic or Thomas steel (after the inventor of the phosphorus-removing process). This kind of converter is virtually nonexistent today.

The Open Hearth converter was invented in 1864. Hot and cold pig and scrap iron can all be placed into this converter. It produces large batches of steel and works slowly as air and methane are passed over the metal to provide heat. Advantages of this type of converter include the ability to charge cold scrap metal without prior heating and a high degree of quality control. Approximately 40 percent of the metal moving through an average steel mill is scrap that arises within the plant. This scrap is call circulating scrap.

A third steel converter is the Electric Arc. This converter is used mostly for producing special alloy steels. It uses large amounts of electric power, scrap steel and pig iron. This production of specialty steel also uses alloy metals such as chrome (for resistance to abrasion), vanadium (for flexibility), manganese (for hardness), tungsten (for "high-speed" steels), and molybdenum (for toughness).

The latest entry into the steel-making process is the basic oxygen process (BOP), which was developed in Austria as the Linz-Donawitz (L-D) process. It was introduced to the United States in the early 1950's and is now the dominant steel-making process in this country. A jet of pure oxygen is injected into the molten metal by a lance of regulated height in a basic refractory-lined converter. Excess carbon, silicon, and other reactive elements are oxidized during the controlled blows. Fluxes are subsequently added to form a slag. A "heat" of up to 350 tons of steel can be produced in approximately 45 minutes. Under present practice, the charge consists of about 28 percent scrap with the balance molten pig iron.

Steel moves from the converter to the cogging mill and forging press. Here it is shaped into wheels, axles, etc., or it moves to the finishing mill where plates, sheets, tubes and rails are produced. These products then go to the automotive, construction, container, and engineering industries. These industries constitute the main consumers of the products of the steel industry. Figure B5 presents an overview of the steel-making process, from raw material inputs to finished products.

c. Limestone.

Limestone receipts comprise the second greatest commodity tonnage movement in the harbor. The majority of limestone is consumed as a flux in blast and open-hearth furnaces. Flux helps remove impurities from molten metal.

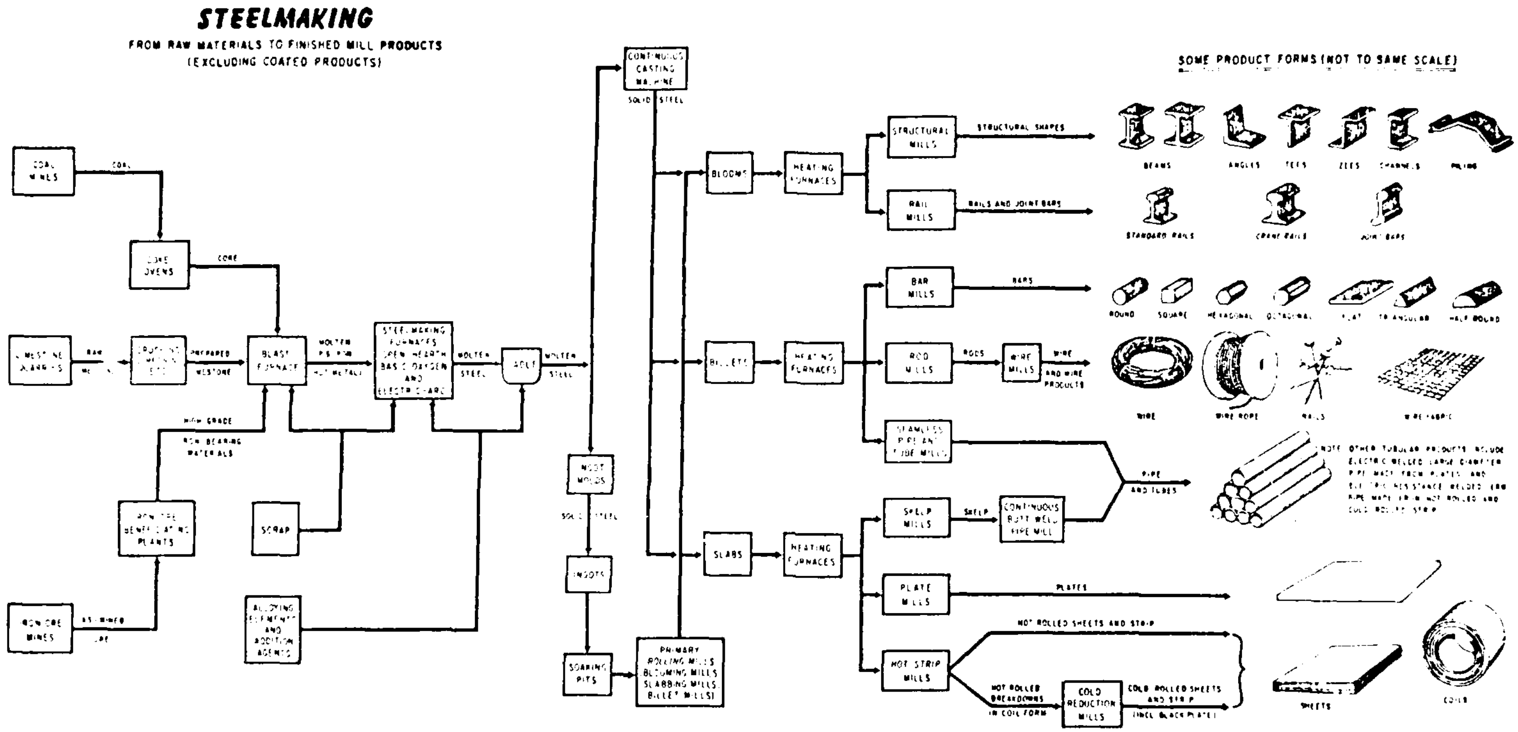


FIGURE B5 BASIC STEPS IN PRODUCING STEEL PRODUCTS

CLEVELAND HARBOR REPORT
CLEVELAND, OHIO

STEEL PRODUCT
FLOW CHART

U.S. ARMY ENGINEER DISTRICT BUFFALO

The limestone is crushed, screened, and prepared at the steel-making facilities. Table B6 provides a summary of the relative importance of Great Lakes ports that supply limestone to Cleveland, OH. It also indicates the percent of those receipts consumed by the steel companies. The balance of limestone receipts are used as construction aggregates in the local area.

Stone, like iron ore, is a low-valued product with transportation as the major component of the total cost. Therefore, minimizing total transportation costs becomes critical in determining supply sources. Consequently, virtually all of the limestone moving into Cleveland is consumed locally. Transshipment to inland steel plants is not economical due to the railroad line-haul charge, handling charges, and competition from alternate inland sources.

Table B6 - Origin of Historical Limestone Receipts to Cleveland Harbor, OH (Millions of Short Tons)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Percent (1)
Calcite, MI	0.08	0.11	0.25	0.23	0.09	0.11	0.31	0.43	0.14	0.03	8.3
Drummond Island, MI	0.01	0	0.05	0.06	0.10	0.09	0.19	0.25	0.16	0.11	4.6
Kelleys Island, OH	0.26	0.31	0	0	0	0	0	0	0	0	-
Marblehead, OH	0.30	0.33	0.80	0.31	0.24	0.28	0.47	0.54	0.29	0.26	17.6
Port Dolomite, MI	0.06	0.19	0.16	0.13	0.10	0.11	0.17	0.20	0.15	0.12	6.5
Port Inland, MI	0.38	0.37	0.40	0.46	0.38	0.33	0.38	0.37	0.36	0.30	17.1
Stoneport, MI	0.99	1.17	1.14	1.39	0.99	1.01	0.77	1.86	0.93	0.61	45.8
Harbor Total	2.1	2.5	2.8	2.6	1.9	1.9	2.3	2.7	2.0	1.4	

(1) Percentage shown is derived by dividing 10-year average of origin total by 10-year average of harbor total (excluding Kelleys Island). Harbor totals may not equal sum of components due to rounding.

SOURCE: Unpublished waterborne commerce statistics of the United States, 1971-1980.

d. Sand and Gravel.

Sand and gravel movements comprise the third major commodity flow within the Federal project area. This material is used primarily as a filler material in concrete. Sand and gravel is received in the greatest quantities by the construction aggregates companies located along the Old River and Cuyahoga River. An automobile manufacturer on the Cuyahoga River formerly consumed substantial amounts of sand for use in metal casting but now receives this commodity by land-based transportation modes.

Table B7 compares the geographic sources for sand and gravel products destined for Cleveland. Canadian origins presently supply over 72 percent of the annual consumption.

Sand and gravel is also a low-value bulk commodity. Inventory costs are a low percentage and transportation costs a high percentage of total delivered costs. Construction materials movement is predominantly local in nature with service being an important factor. The movement of sand and gravel from the dock to inland construction sites is performed by truck hauling firms.

e. Salt.

Ohio ranks fifth in terms of national salt production, accounting for 9 percent of the United States output in 1978. Most of the national salt production is used for the production of chlorine, caustic soda, and soda ash. A substantial amount is used in the northern climes for highway deicing. Salt shipments are the largest commodity movement originating from Cleveland. Only one dock is involved in the salt traffic and is located on the Old River. However, as a result of an evaluation of authorized but uncompleted improvements for the Old River during Stage 2 planning, no plan for harbor improvements that would result in transportation savings for this commodity is economically justified at this time. Therefore, no benefits have been considered in this Stage 3 Report for this segment of the harbor.

B3. WATERBORNE COMMERCE PROJECTIONS

a. Overview.

Traffic projections are necessary to conduct the economic evaluation of proposed harbor improvements. For purposes of the National Economic Development (NED) Analysis, the project evaluation period is based on the lesser of (a) the period of time over which the project would serve a useful purpose; or (b) the period of time after which further discounting of beneficial and adverse effects would have no appreciable impact. Traditionally, the evaluation period has been 50 years for general navigation features.

The procedure for constructing traffic projections for the commodity groups identified in the preceding section is to relate the traffic base to an index over time. Assessment of secondary data, surveys of relevant users, shippers, carriers, and port officials, opinions of industry consultants and experts and the historical traffic patterns described earlier form a basis for the projected waterway traffic. Traffic forecasts for individual commodity groups are presented below.

Table B7 - Historical Sand and Gravel Tonnages from United States and Canadian Origins to Cleveland Harbor, OH

	Hundred-Thousands of Short Tons										
	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Percent (1)
American Ports											
East Lake Michigan (Ferrysburg, MI, Ludington, MI and Manistree, MI)	4.72	3.91	3.94	3.82	5.09	2.96	0.40	1.12	1.43	1.54	21.9
East Lake Erie (Fairport, OH and Presque Isle, PA dredge areas)	1.55	1.03	0.67	0.24	0.26	0.40	0.36	0.34	0.36	0.75	4.5
West Lake Erie (Marblehead, OH)	0	0	0	0	0	0.02	0	0.34	0	0	0.3
Canadian Ports											
East Lake Erie (Port Colborne, Ont. and Fort Erie, Ont.)	8.76	6.71	6.56	6.35	7.24	8.39	6.11	4.85	5.76	7.94	51.9
West Lake Erie (Point Pelee dredge area, Leamington, Ont., Wheatley, Ont., and Windsor, Ont.)	4.30	3.57	3.04	3.36	3.23	2.23	2.00	1.50	1.68	1.90	20.3
Lake Ontario and Vicinity	0.02	0.01	0.09	0	0.31	0.05	0	0	0	0	0.4
Total (2)	19.44	15.24	14.31	13.77	16.15	14.04	9.66	8.23	9.22	12.25	

(1) Percentage shown is derived by dividing 10-year average of origin total by 10-year average of harbor total.

(2) Totals may not equal sum of components due to rounding.

SOURCE: Unpublished waterborne commerce statistics of the United States annual port-to-port summaries, 1969-1978.

b. Iron Ore.

The major bulk commodity movements on the Great Lakes are associated with the production of iron and steel. Studies concerning input flows to this industry are abundant. Since iron ore receipts are the most important commodity flow at this harbor, the processes of ore production and transportation and steel production were presented. A general description of the steel producing process and the particular origin-destination commodity flows (O/D/C's) that Cleveland steelmakers are currently involved in was discussed in Section B2, Identification of Types and Volumes of Commodity Flow. The physical production capacities of the Cleveland Harbor "hinterland" facilities discussed below will be used to further refine the commodity forecasts. The physical production capabilities presented were aggregated to prevent the disclosure of site-specific information which might pertain to any one individual firm.

(1) Blast Furnaces - The five plants served by Cleveland Harbor possess 24 blast furnaces. These furnaces have a total capacity production of 15.3 million net tons of pig iron per year. Blast furnaces constitute the basic building blocks of the steel-making process. The pig iron they produce is then purified in other furnaces called steel converters.

(2) Steel Converters - Virtually all of the steel-making capacity served by Cleveland Harbor is based on basic oxygen furnaces. One company also operates two electric furnaces. There are no open-hearth operations. The raw steel capacity within the geographic area served by the harbor is 19.4 million net tons.

(3) Finished Products - As mentioned above, all of the plants served are integrated plants. The cogging mills, forging presses, and finishing mills are located in the same industrial complex as the blast furnaces.

Several regional studies were examined to determine the magnitude of future ore movements expected on the Great Lakes in general, and at Cleveland, in particular. Among the analyses reviewed were the Great Lakes St Lawrence Seaway Traffic Forecast Study (North Central Division, COE, 1976), the Great Lakes Traffic and Competition Study (Marad, 1980), National Waterways Study Traffic Forecasting Methodology and Demand Projections (IWR, 1980), and OBERS projections for the Cleveland SMSA. These and other studies were then used for Cleveland along with information obtained from harbor users to develop long-range commodity forecasts.

Annual growth rates for iron ore tonnage, obtained from secondary data, range from 1.4 percent to 2.1 percent. A recent survey of current harbor users reflect lower traffic expectations. The National Waterways Study (NWS) commodity analysis was the most steel district-specific secondary source. This study reflected changing ore beneficiation and steel producing technologies. It contained forecasts which were more compatible with projections obtained from individual dock operators. Therefore, the National Waterway Study was chosen as the basis for ore forecasts. The NWS analysis was subsequently "fine-tuned" to Cleveland Harbor by constraining the projections to reflect the present steel-making capacities. This adjustment reflects the lack of capital investment for new blast furnace capacity during the last 15 years. This approach also assumes that new capacity added will consist of electric furnaces which rely primarily upon scrap steel. To determine plant steel-making capacities, liberal assumptions about raw material inputs were made to recognize the possibilities of unforeseen productivity increases. As such, a 1.5:1 ore to pig iron ratio was assumed along with a 1.2:1 BOF input to BOF output ratio. It was also assumed that the BOF charge is 70 percent pig iron and 30 percent scrap. Figure B6 presents the iron ore projections employed in the analysis as "Most Probable Future." The original NWS projections are shown as "Unconstrained." Long-term annual iron ore growth rates for the "most probable future" (i.e., constrained by plant capacities) is approximately 1 percent. The NWS forecasts presume a 1.37 percent annual rate of change.

c. Limestone.

Limestone movements into Cleveland Harbor are heavily linked with iron ore movements. Over 50 percent of this traffic is destined for the steel industry, however, the consensus of nonsteel limestone receivers is a no-growth scenario. Therefore, limestone receipts of the Cuyahoga River steel plants were projected to increase at the same rate as iron ore while receipts by nonsteel consumers were held constant. Figure B6 presents the limestone forecasts employed in the analysis. This forecast is also labeled "Most Probable Future."

d. Sand and Gravel.

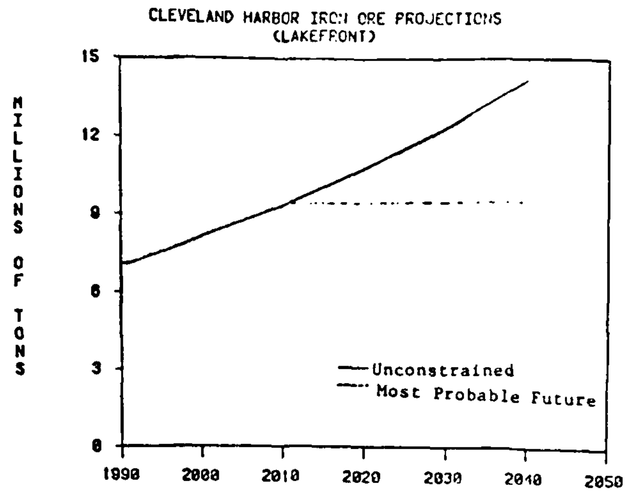
Sand and gravel traffic, received primarily by the construction supply firms, was also assumed to be in a no-growth situation. This future scenario is based upon field surveys and coordination with individual dock operators.

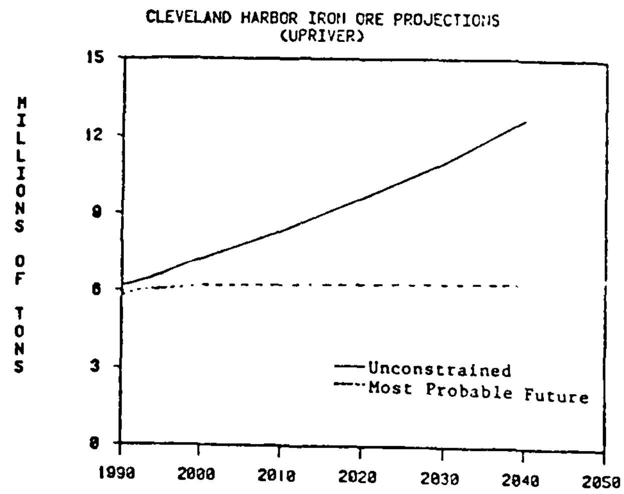
e. Traffic Projections.

Table B8 summarizes the major commodity projections for Cleveland Harbor. The economic analysis of all of the alternatives will be based upon the waterborne commerce projections presented in this section.

Because of the multitude of iron ore transhipment facilities currently operating on the south shore of Lake Erie, no project-induced traffic can reasonably be foreseen. Therefore, the growth forecasts shown, constrained only by nonwaterway facilities or waterway facilities not in Cleveland Harbor, will be the basis for the economic evaluation of this report.

Figure B6-Cleveland Harbor Iron Ore And Limestone Projections





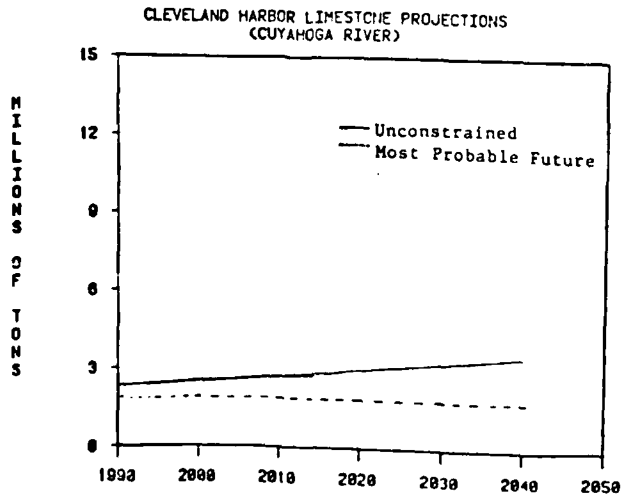


Table B8 - Projected Commodity Tonnages - Cleveland Harbor

Commodity and Harbor Reach	Project Year 1990	1995	2000	2010	2020	2030	2040
Iron Ore (1)							
Lakefront Domestic	4,260	4,760	5,460	6,750	6,750	6,750	6,750
Lakefront Canadian	2,700	2,700	2,700	2,700	2,700	2,700	2,700
Lakefront Subtotal	6,960	7,460	8,160	9,450	9,450	9,450	9,450
Cuyahoga River	5,720	5,890	6,050	6,050	6,050	6,050	6,050
Total Iron Ore	12,680	13,350	14,210	15,500	15,500	15,500	15,500
Limestone (1)							
Cuyahoga River (Steel)	1,140	1,180	1,210	1,210	1,210	1,210	1,210
Cuyahoga River (Nonsteel)	620	620	620	620	620	620	620
Total Limestone	1,760	1,800	1,830	1,830	1,830	1,830	1,830
Total Harbor	14,440	15,150	16,040	17,330	17,330	17,330	17,330

(1) Iron ore and limestone consumption by local and inland steel plants based upon long-term utilization of 75 percent of currently installed steel capacity.

B4. EVALUATION PROCEDURES

Transportation savings may result from using larger vessels, using existing vessels more efficiently, reducing transit times, reducing vessel delays resulting from adverse weather and reducing cargo handling or tug assistance costs.

Information developed during the course of this study has concentrated upon volume of traffic demand, composition of existing and future fleet mix, and unit transportation costs. Changes in any single transportation variable could significantly reduce total transportation costs. Reductions in transporation costs represent an NED benefit since these resources could be utilized elsewhere within the national economy.

During Stage 2, measurement of these reductions were based upon application of design criteria to the existing fleet using the Federal channels. However, during the majority of the shipping season, vessel operators experience average operating conditions. Therefore, during Stage 3 the economic analysis incorporated operating procedures expected to be used during the majority of the year. Utilization of high lake levels and the navigation procedures which have been identified by vessel masters (i.e., vessel delays instead of attempting a direct entry via the west entrance channel) have been utilized to measure tangible economic benefits.

B5. VESSEL FLEET COMPOSITION AND UNIT TRANSPORTATION COSTS

a. Vessel Fleet Composition.

The future fleet composition of Cleveland Harbor is based upon past trends in vessel sizes and fleet composition illustrated in Table B10 and the observed increasing use of 1,000-foot vessels in the Outer Harbor during recent navigation seasons. Table B9 is a summary of recent Class 10 vessel movements. Coordination with fleet operators have indicated that an increasing percent of annual iron ore tonnage received at Cleveland Harbor will be shipped in Class 10 vessels. New vessel construction since 1970 has been dominated by the Class 10 (1,000 X 105 feet) self-unloading bulk carrier. However, several shipping companies have continued to order smaller vessels to service harbors with draft restrictions or customers which might be located on river channels. A summary of new ship construction is provided in Table B10.

Since no firm data is available to determine what the future fleet composition would be, observed past trends in fleet composition was heavily relied upon. Future fleet composition was based on the current age of the total Great Lakes fleet, the present composition of the American fleet, fleet characteristics obtained from statistics based upon individual dock activity, vessel construction trends over the past 10 years (Table B10), shipper survey responses, and an evaluation of the Great Lakes fleet conducted by Arctec, Inc. in support of GL/SLS lock capacity studies completed in 1982.

No measureable change in fleet composition is expected to occur in the immediate future at the Outer Harbor iron ore docks. Availability of investment capital to construct new 1,000-foot X 105-foot bulk carriers and the recent downturn in the economic climate within the steel industry has discouraged new vessel construction. Shipyards in the Great Lakes have not received recent orders for this vessel size and the outlook for the future is very weak. No forecasts of ship construction were available from fleet operators, therefore, the future fleet composition was considered to be similar to vessels now in service to Cleveland, OH.

Table B9 - 1,000-Foot Vessel Entries Into Cleveland Harbor

Navigation Season	Vessel Name	Number of Trips	Net Tons Delivered	Draft (Feet)
1979	JAMES BARKER	2	129,512	27
	MESABI MINER	1	61,254	26
	GEORGE STINSON	1	64,701	27
1980	JAMES BARKER	1	63,450	27
	LEWIS WILSON FOY	1	64,168	28
	GEORGE STINSON	3	104,764	27/28 (1)
1981	BURNS HARBOR	1	64,740	27
	GEORGE STINSON	14	871,551	27/28 (2)

(1) Two of the trips were at 27-foot draft and the other trip was at 28 feet.

(2) Two of the trips were at 28-foot draft and twelve were at 27 feet.

SOURCE: Unpublished Monthly Waterborne Statistics, dock to dock data, 1979-1981, Corps of Engineers.

Average Age of Great Lakes Fleet by Class

	Average Age in Years					
	CLASS					
	4	5	6	7	8	10
Total Great Lakes Fleet (1)	66	44	28	25	25	4
Cleveland Harbor Fleet (2)	69	38	27	25	25	4

(1) Includes U.S. and Canadian vessels.

(2) Based upon domestic movements recorded in 1980 navigation season.

Individual vessel activity was reviewed at each dock location. The following observations are based upon this information. The usage of Class 8 vessels for iron ore movements to the Outer Harbor has decreased from 24 percent to 20 percent between 1973 and 1980 (Table B10a). The U.S. fleet currently has 13 Class 8 vessels; six of these vessels are lengthened Class 5, 6, and 7's. The availability of Class 5 and 6 vessels in the future for lengthening will be restricted by their current advanced age and their present use in delivering coal, grain, and stone.

American shippers servicing Cleveland Harbor have historically relied upon Class 7 vessels (Table B10a) and the percent of total Outer Harbor iron ore transported in Class 7 vessels has risen from 34 percent to 50 percent between 1973 and 1980. The U.S. bulk fleet currently has 10 Class 7 vessels,

Table B10 - New Vessel Construction - U.S. Great Lakes Fleet

Vessel Name	Length (feet)	Type	Year Built
BLOUGH, ROGER	858.0	Self Unloader	1972
CORT, STEWART J.	1,000.0	Self Unloader	1972
KYES, ROGER M.	680.0	Self Unloader	1973
MESABI MINER	1,004.0	Self Unloader	1973
PRESQUE ISLE	1,000.0	Self Unloader	1973
ROESCH, WILLIAM R.	630.0	Self Unloader	1973
THAYER, PAUL	630.0	Self Unloader	1973
WILSON, CHARLES E.	680.0	Self Unloader	1973
WHITE, H. LEE	704.0	Self Unloader	1974
WOLVERINE	630.0	Self Unloader	1974
LAUD, SAM	634.8	Self Unloader	1975
BARKER, JAMES R.	1,004.0	Self Unloader	1976
BLOCK, JOSEPH L.	728.0	Self Unloader	1976
ST. CLAIR	770.0	Self Unloader	1976
BELLE RIVER	1,000.0	Self Unloader	1977
FOY, LEWIS WILSON	1,000.0	Self Unloader	1978
STINSON, GEORGE A.	1,004.0	Self Unloader	1978
GOTT, EDWIN H.	1,004.0	Self Unloader	1979
WHITE, JR., FRED R.	636.0	Self Unloader	1979
AMERICAN MARINER	730.0	Self Unloader	1980
BURNS HARBOR	1,000.0	Self Unloader	1980
SPEER, EDGAR B.	1,004.0	Self Unloader	1980
AMERICAN REPUBLIC	634.9	Self Unloader	1981
BEEGHLY, CHARLES M.	806.0	Self Unloader	1981
COLUMBIA STAR	1,000.0	Self Unloader	1981
DELANCEY, WILLIAM J.	1,013.6	Self Unloader	1981
INDIANA HARBOR	1,000.0	Self Unloader	1981

Table B10a - Historical Tonnage Distribution by Vessel Class
Cleveland Harbor, OH

Harbor Segment - Commodity	1973	1975	1977	1979	1980	1981
			(Percent)			
Lakefront (Domestic Iron Ore)						
Class 10	0	0	0	6	5	38
Class 8	24	19	12	21	20	1
Class 7	34	62	48	49	50	38
Class 6	8	13	21	8	10	2
Class 5	25	6	19	15	15	21
Class 4	6	0	0	0	0	
Class 3	2	1	0	0	0	
Class 2	1	0	0	0	0	
Cuyahoga River (Domestic Iron Ore)						
Class 5	94	99	95	100	100	100
Class 4	2	1	3	0	0	0
Class 3	4	0	2	0	0	0
Cuyahoga River (Limestone)						
Class 6	1	5	7	8	10	10
Class 5	59	75	60	63	65	79
Class 4	40	20	33	29	25	9
Class 3	0	0	0	0	0	2
Old River (Salt)						
Class 5	40	74	81	88	75	3
Class 4	46	22	15	12	20	97
Old River (Sand)						
Class 5	100	75	84	100	90	27
Class 4	0	25	16	0	10	0
Class 3	0	0	0	0	0	21
Class 1	0	0	0	0	0	52

SOURCE: Unpublished monthly waterborne commerce statistics, dock-to-dock, 1973-1980, Corps of Engineers.

9 of these vessels are lengthened Class 3, 4, 5, and 6's. The availability of Class 3 and 4 vessels and the high vessel construction costs induced shipowners to lengthen and remodel smaller sized vessels rather than build new, larger ships. Lengthening of smaller sized vessels to approximate Class 7 dimensions and new vessel construction to carry iron ore is expected to continue in the future. This is based upon the presumed availability of Class 3 and 4 vessels for lengthening and the continuing need to service small harbors or to transit the Welland Canal. This will give shippers greater flexibility in meeting industrial demand for iron ore since these fleets will not be captive to the Upper Great Lakes.

Class 5 and 6 vessels have been carrying a decreasing percentage of Outer Harbor iron ore between 1973 and 1980 (Table B10a). This trend is expected to continue in the future. The displacement of these vessels by larger self unloading vessels is expected to continue through 2010.

Canadian iron ore receipts at the Outer Harbor have historically relied on Class 7 vessels. This pattern is expected to continue in the future since most of the Canadian iron ore is sourced from ports below the Welland Canal. Also, Class 7 vessels comprise an increasing percent of the Great Lakes Canadian fleet.

Finally, Class 5 vessels are expected to carry 100 percent of the iron ore shipments moving on the Cuyahoga River. This assumption is based on the historical use of Class 5 vessels to deliver upriver iron ore and the physical restrictions of the Cuyahoga River. The present fleet composition reflects the most efficient means of transporting Cuyahoga River bulk commodities given the origin port locations and present maximum operating draft and the physical restrictions in the Cuyahoga River.

All of the historical changes were related to field interviews completed during the summer months of 1983. All major companies were contacted in regards to the effects of harbor modifications on future fleet composition. Although physical improvements would more fully provide Corps design criteria, no single operator might be induced to upgrade their existing fleets. A forecast of the distribution of total annual volume by ship size is provided in Table B11.

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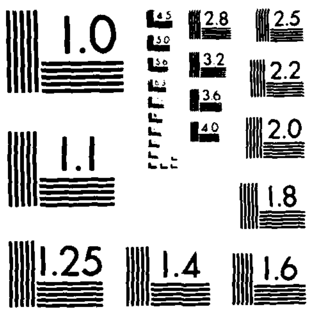

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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Table B11 - Percent Distribution of Annual Tons by Vessel Class
Cleveland Harbor, OH

	1990	1995	2000	2010	2020	2030	2040
Lakefront							
Domestic Iron Ore							
Class 10	25	40	50	75	100	100	100
Class 8	5	0	0	0	0	0	0
Class 7	60	60	50	25	0	0	0
Class 6	5	0	0	0	0	0	0
Class 5	5	0	0	0	0	0	0
Canadian Iron Ore							
Class 7	100	100	100	100	100	100	100
J&L Iron Ore:							
Class 5	100	100	100	100	100	100	100
Upriver							
Republic Iron Ore:							
Class 5	100	100	100	100	100	100	100
Upriver Limestone							
Class 5	75	75	75	75	75	75	75
Class 4	25	25	25	25	25	25	25

NOTE: There will be no change in future fleet mix between existing (without project conditions) and future conditions (with habor improvements conditions).

Major trade routes have not changed since the preparation of the last planning report. The economic analysis requires that representative physical and financial characteristics be developed to measure potential reductions in transportation costs. A transportation cost program was developed to relate selected changes in either fleet composition, traffic forecasts, and changes in channel depths relative to an existing condition (i.e., without project). A summary of this information is provided in Tables B12 and B13.

B6. CHANGE IN WATERBORNE TRANSPORTATION COSTS

a. Overview.

Federal improvments to existing deep draft harbor projects must currently be formulated and evaluated such that during the majority of the navigation season a tangible economic benefit will be realized by vessel operators. Current practices within the GL/SLS system are based upon utilization of available water levels and operation of bulk carriers at minimal underkeel clearences. In most instances, vessel operators maximize physical capacity for each trip in light of the available channel depths between specific harbor pairs and each trade route.

The majority of the raw materials for the steel industry move under long term contracts where each party to the contract is fully aware of the penalities for inadequate performance and the incentives and revenues associated with each shipment. Specific vessels are selected by the fleet owner from the corporation's total fleet to maximize the firms net revenues in light of the forecasted raw material requirements. Vessels in service each year can be considered to be the most efficient fleet for that particular year. An unexpected removal of a vessel from service would result in another more costly ship or an inactive laid-up ship being pressed into service. The economic consequences which might result from an accident in the entrance channel or damage caused by a severe marine storm is well known to each Great Lakes transportation company. Therefore, any extreme risk-taking behavior occurs very infrequently. Vessels choose to anchor along the north shore of Lake Erie rather than attempt a harbor entry during marginal operating conditions.

A review was made of the physical characteristics of the origin harbors, intermediate connecting channels and destination harbors to identify the most frequently constraining point. Channel depths, water level fluctuations and operating characteristics can vary significantly between the upper lakes and Cleveland Harbor, OH. After the ship arrives at the harbor entrance, a secondary decision point is reached where either a direct entry is made or a delay is incurred until navigation conditions improve. Although all Federal channels and breakwaters have been constructed based upon very specific design parameters, private users infrequently attempt to use them under such severe conditions. This distinction was subsequently carried into the economic analysis.

A transportation cost program has been developed which utilizes channel depths, underkeel clearence and variable water levels in estimating total transportation costs to move iron ore and limestone to the harbor. A range of physical and financial characteristics are combined with individual trade routes to derive unit transportation costs on a monthly basis. This cost is combined with monthly volumes to estimate transportation costs. Total annual costs represent the summation of all individual months (April-December) of the navigation season.

Each point within the trade route is uniquely represented within the transportation cost model. Stage-duration frequency curves are transformed, after identification of an average channel bottom elevation and a representative underkeel clearance, into draft-frequency relationships. All locations below Lake Superior are combined into a composite draft-frequency curve and each point of the origin harbor draft-frequency curve is related to a range of points (ie., Drafts) along the composite draft-frequency curve. The resulting value is defined as an average operating draft and is plotted at its respective origin harbor frequency interval to construct a "Trade Route

Table B12 - Trade Route and Vessel Characteristics Cleveland Harbor, OH

Vessel Prototype (1)	Vessel Class	Length (Feet)	Beam (Feet)	MS Draft (Feet)	Capacity MS Draft (NT)	Tons Per Inch Immersion (NT)	Harbor Maneuvering (Hours) Orig.	Harbor Maneuvering (Hours) Dest.	Loading Rate (Tons/Hr)	Unloading Rate (Tons/Hr)	Average Speed (MPH)	Time in Locks (Hr)	Lock Delay (Hr)
Lakefront Domestic Iron Ore													
George A. Stinson	10	1,004	105	28.0	66,900	265	1	1	3,000	10,000	14	2.8	10
Armco	8	767	70	27.0	29,100	129	1	1	3,000	5,000	14	2.0	10
Middletown	7	730	75	29.1	29,500	120	1	1	3,000	5,000	14	2.0	10
Courtney Burton	6	690	70	27.5	25,000	112	1	1	3,000	5,000	14	1.5	10
Fred R. White Jr.	5	636	68	27.9	26,700	106	1	1	3,000	5,000	14	1.5	10
Lakefront Canadian Iron Ore													
Algosoo	7	730	75	29.1	31,300	119	1	1	3,000	5,000	12	10	15
Upriver Iron Ore From Lake Superior													
Fred White	5	636	68	27.9	26,700	106	1	1	3,000	5,000	14	15	17
Upriver Iron Ore From Lake Erie													
American Republic	5	635	68	27.9	23,200	96	1	8(2)	3,000	5,000	14	0	0
Limestone													
Fred White	5	636	68	24.9	26,700	106	1	1	3,000	5,000	14	0	7
E.B. Barber	4	574	59	24.9	13,200	66	1	1	3,000	5,000	14	0	7

(1) Vessel prototypes selected based upon a review of actual vessels in service to docks adjacent to Federal project limits.
(2) Include 7 hours on Cuyahoga River.

Table B13 - Summary of financial Characteristics Cleveland Harbor, OH

Commodity:	Lakefront Domestic Ore					Lakefront Canadian Iron Ore	Upriver Iron Ore From Lake Superior	Upriver Iron Ore from Lake Erie	Limestone	
Vessel Class:	10	8	7	6	5	7	5	5	5	4
Construction ($M) (1)	62.0	40.0	34.0	32.0	28.0	34.0	28.0	28.0	28.0	26.0
Amortization Rate (2)	.15014	.15014	.15014	.15014	.15014	.15014	.15014	.15014	.15014	.15014
Annual Fixed Cost/Year($)	9,308,680	6,005,600	5,104,760	4,804,480	4,203,920	5,104,760	4,203,920	4,203,920	4,203,920	3,903,640
Season Length (Days)	275	275	275	275	275	275	275	275	275	275
Fixed Cost/Day ($)	33,850	21,839	18,563	17,471	15,287	18,563	15,287	15,287	15,287	14,195
Profit Factor	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Total Daily Fixed Cost($)	38,927	25,114	21,347	20,091	17,580	21,347	17,580	17,580	17,580	16,324
Daily Variable Cost($)	25,300	19,700	18,700	18,300	17,300	18,700	17,300	17,300	17,300	16,700
Overhead Factor	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Total Daily Variable Cost ($)	28,336	22,064	20,944	20,496	19,376	20,944	19,376	19,376	19,376	18,704
Daily Vessel Cost ($)	67,263	47,178	42,291	40,587	36,956	42,291	36,956	36,956	36,956	35,028

(1) October 1983 prices - based on cost estimates of the Maritime Administration, letter dated 3 December 1982.

(2) Economic life cycle of 50 years and 15 percent cost of capital and all equity investment.

Draft-Frequency" curve. This method allows a range of potential fluctuations of depths and drafts at locations below Lake Superior to be related to a single physical condition in Lake Superior. Each location can also be related to a percent of the time that it can control ship loadings. The relative importance of each point is affected by the desired clearance under the vessel. For example, for a location which has 28 feet of water depth and minimal potential changes in water stage, a requirement for 3 feet of clearance is very likely to be more restrictive than another point of equal channel depth which has larger/sustained fluctuations in water stage the majority of the time. An illustration of the relationships between each point is shown in Table B14.

Actual practice clearances established at the major constraint points within the trade route for this study indicate that the destination port (i.e., Cleveland Harbor, OH) is not a major constraint relative to existing channel depths. However, the configuration of the main entrance (ie., west entrance) is very restrictive during marginal weather conditions for vessels 600 feet or greater (class 5). Vessel delays during storm conditions result in additional transportation costs which could be eliminated by implementation of Alternative 1 which deepens the east entrance.

Vessel delays are calculated based upon an estimated number of annual trips which reflect an average operating draft and storm factors that reflect the percent of the year when wind and waves create delays to ships attempting to enter the harbor via the west entrance. Maximum wind and wave conditions were identified from interviews of fleet operations based upon physical conditions which might preclude use of the transhipment dock. A detailed discussion of these wind and wave conditions are presented in Section II, of the Main Report.

B7. CONGESTION ANALYSIS ON THE CUYAHOGA RIVER

a. Introduction.

In its review of the Cleveland Harbor Final Feasibility Report in August 1977, the Board of Engineers for Rivers and Harbors (BERH) identified congestion on the Cuyahoga River with concomitant vessel delays and hazards to navigation. The congestion study for this report investigates the need for and justification of improvements to the Cuyahoga River that would alleviate the difficulties in navigation. Congestion on the Cuyahoga River may be affected by the implementation of project alternatives that remove congestion sites on the river.

For purposes of the study, river congestion is defined as either: (1) vessel delay as a result of physical constrictions (i.e., delay due to movement of a vessel past a fixed object); or (2) vessel delay as a result of vessel-to-vessel interference. Vessel-to-vessel interference can be further divided into (a) vessel delay as a result of two vessels passing (which results in one vessel yielding the right-of-way); or (b) vessel delay as a result of one vessel moving past another which is unloading at a dock.

First of all, the congestion study identified the location of specific bottlenecks along the river. Secondly, an estimate of the increase in yearly

Table B14 - Trade Route Restrictions Lake Superior - Lake Erie Iron Ore

Vessel Class	Percent Time - Constrains Shipping - Months								
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
					Duluth Harbor				
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Vidal Shoals				
5	99.13	99.08	98.18	95.85	69.97	90.80	82.83	70.54	76.70
6	99.13	99.08	98.18	95.85	69.97	89.15	75.23	62.34	72.63
7	99.13	99.08	98.18	95.85	70.80	90.80	87.53	86.56	86.33
8	92.03	99.08	95.98	93.70	63.49	63.93	31.53	21.81	33.84
10	99.13	99.08	98.18	95.85	69.97	90.80	87.53	86.56	86.33
					Livingston Channel				
5	.87	.92	1.82	4.15	15.03	9.20	11.67	11.46	13.20
6	.87	.92	1.82	4.15	12.30	9.05	10.97	10.50	12.93
7	.87	.92	1.82	4.15	26.87	9.20	12.47	13.44	13.67
8	.78	.92	1.81	4.10	8.15	7.18	4.64	4.40	15.51
10	.87	.92	1.82	4.15	15.36	9.20	12.47	13.44	13.67
					Cleveland Harbor				
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Coast Guard Limit				
5	0.00	0.00	0.00	0.00	15.00	0.00	5.50	18.00	10.10
6	0.00	0.00	0.00	0.00	17.73	1.80	13.81	27.15	14.43
7	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00
8	7.19	0.00	2.21	2.19	28.36	28.89	63.83	73.79	50.65
10	0.00	0.00	0.00	0.00	14.67	0.00	0.00	0.00	0.00

NOTE: Percent of each month that each individual location may restrict operating draft. Coast Guard limit is defined as maximum seasonal load line limit.

vessel operating costs due to vessel congestion or related delays on the Cuyahoga would be needed for the "with" and "without-project" conditions. The annual differences between the "without" and "with-project" conditions over the evaluation period would be the vessel operating costs avoided due to the implementation of site specific improvement plans.

The location of the congestion areas on the river were determined by a survey of harbor users conducted during the 1981 navigation season. The survey identified the location of the delays, type or size of vessels affected and duration of the delays encountered at each location on the Cuyahoga River.

Seven fixed object delay points were initially identified by harbor users:

(1) Site No. 1 - ConRail Bridge No. 1,

(2) Site No. 2 - the Cereal Food Processors Dock,

(3) Site No. 3 - Turn No. 2 of the river,

(4) Site No. 4 - Turn No. 4 of the river,

(5) Site No. 5 - Turn No. 5 of the river,

(6) Site No. 6 - ConRail Bridge No. 14,

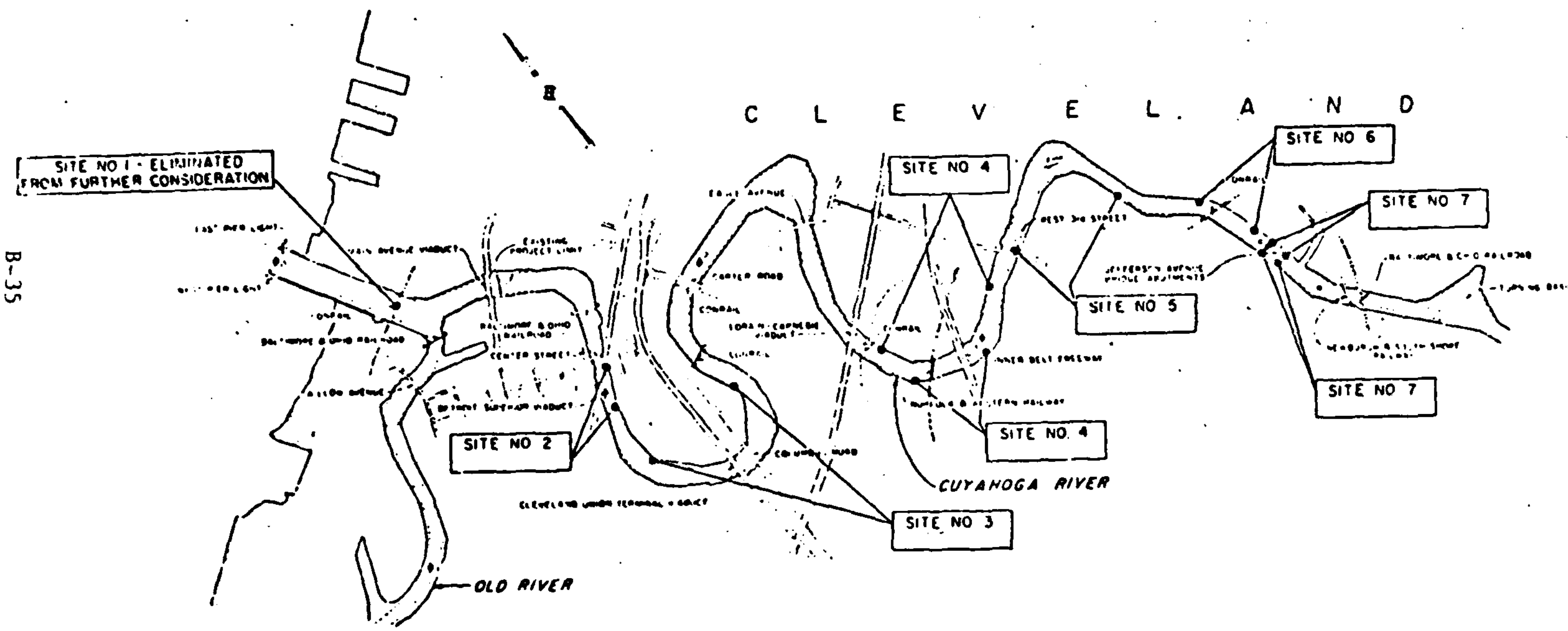
(7) Site No. 7 - Jefferson Avenue Bridge abutments.

Each location is shown in Figure B7. Four of these areas were also identified as a source of vessel-to-vessel interference: the channel adjacent to the Cereal Food Processors Dock and Turns 2, 4 and 5.

The study assumed delays accrue primarily to Class 5 vessels since these are the largest vessels that can navigate the Cuyahoga River in its present configuration. Also, harbor users identified these vessel sizes as incurring the majority of transit delays during preliminary field surveys. Therefore, only the tonnages expected to move in Class 5 vessels to riverside destinations were used in the analysis.

Delay times in minutes for upbound and downbound traffic were determined for each of the seven delay points for each type of vessel congestion. Vessel-to-fixed object upbound and downbound delays ranged from 10 to 30 minutes at each congestion point. The simulation model calculated the vessel-to-vessel delay for ships based upon a decision rule of zero minutes for upbound and 90 minutes for downbound traffic at each applicable congestion point. Vessel-to-vessel delay for a downbound ship passing a docked vessel was 30 minutes. If an upbound vessel encountered another vessel unloading at a dock, the upbound vessel would wait if the vessel at the dock could finish the unloading cycle in less time than would be required to move the vessel at the dock.

FIGURE B7 -CONGESTION AREAS UNDER CONSIDERATION



b. Traffic Simulation Model.

(1) Description - The second major task of the Cuyahoga River congestion study concerns the measurement of the increase in yearly vessel operating costs due to congestion under "with" and "without-project" conditions.

A computer model, developed by support staff in North Central Division, Corps of Engineers, developed the framework for an evaluation of the increases in yearly vessel operating costs due to congestion on the Cuyahoga River. The model was designed to simulate traffic patterns on the Cuyahoga River for a typical 30-day period. Analytical inputs included location of the delay points along the river; vessel sizes affected by these obstructions; delay times incurred by vessels at each congestion point; traffic forecasts for Cuyahoga River docks; vessel operating characteristics (i.e., loading/unloading rates, average river speeds, etc); and maximum operating drafts. The simulation program output from the computer model consisted of the total hours of vessel delay (i.e., sum of the vessel-to-fixed object and vessel-to-vessel delays) that would accrue to vessels for a 30-day simulation period. Total vessel delays for a 275-day navigation season were obtained by converting the simulation period into an annual value.

(2) Input Components - Information on the location of the congestion areas, the vessel sizes affected by congestion, and the duration of the delays at each congestion point by vessel size were previously discussed. Tonnage projections obtained during a re-survey of dock operators was used to evaluate the hourly vessel delays accrued due to each of the project alternatives under "with" and "without-project" conditions. Only the tonnage carried by Class 5 vessels to nine docks along the Cuyahoga River was used. Annual commodity forecasts for five time periods (1990, 1995, 2000, 2010, 2020-40) were made for each of the nine docks. The annual traffic forecasts by dock were divided into nine 30-day simulation periods which have equal amounts of tonnage distributed evenly among the nine periods.

(3) Model Output - The output of each computer run is a forecast by time period, by plan alternative, of the total delays for a 30-day simulation period. Documentation explaining the inputs of the computer model and a sample computer output run has been provided as Supplement 1 to Appendix B.

c. Cuyahoga River Congestion Delay Costs.

A sequence of computer runs were needed to evaluate the "with" and "without-project" condition to accurately reflect the tonnage projection intervals (i.e., 1990, 1995, 2000, 2010, 2020-2040). Delay hours for each simulation period were then converted to an equivalent 275-day navigation season. Annual delay hours were multiplied by a weighted average hourly vessel delay cost of $1540 per hour which includes fixed and variable costs for Class 5 vessels. Changes in future delay costs are presented in Table B15.

d. Congestion Elimination - Alternative 7.

(1) Overview - The 1981 harbor user survey identified seven locations along the Cuyahoga River that caused congestion because of some physical obstruction to vessel traffic.

The evaluation of preliminary feasibilty for all seven sites in Stage 2 indicated that only two sites (Cereal Food Processors Dock and ConRail bridge No. 14) were economically feasible. A third site (Jefferson Avenue Bridge abutments) was marginally feasible, although vessel owner/operators indicated that more information may be available to document additional damages experienced at this location. Further information on the authorized, yet uncompleted improvements, is presented in Section III, Main Report. Therefore, only Plan 7G (Site 7) has been carried into the final evaluation.

There are two categories of economic benefits for congestion elimination at each site on the river. Congestion delays avoided will consist of "vessel-to-vessel" and "vessel to-fixed-object" time savings and physical damages avoided which have been provided by transportation companies.

(2) Traffic Simulation Model - Annual vessel movements have been estimated by using maximum operating vessel drafts for the Cuyahoga River to reflect the long-term variation of historical lake levels above Low Water Datum. This adjustment also reflects the expectation that no river deepening would take place and the liklihood that shipping companies will use actual water levels available to them.

Vessel delays for the baseline condition were obtained by developing a network of distances, channel restrictions, operating drafts, and other operating rules for vessels transporting limestone, iron ore, sand, and gravel and miscellaneous dry bulk commodities to docks adjacent to the Cuyahoga River. Total delays for each interval in the planning period are estimated and comprise the reference point for measuring future economic benefits. The base case traffic simulation runs were then modified to determine future transportation delay times for each of the improvement alternatives.

(3) Delay Costs - Hourly delay times were then converted to a 275-day navigation season. These values were multiplied by a weighted Class 5 hourly vessel cost of $1,540, which resulted in total annual transportation delay costs at each site.

Table B15 - Cuyahoga River Delay Savings Cleveland Harbor, OH

Site 7	1990 (Hours)	1995 (Hours)	2000/ 2040 (Hours)	Average (Hours)
Jefferson Avenue Bridge Abutments				
a. Existing Conditions:				
Vessel-to-Fixed Object	350.8	355.4	355.4	
Vessel-to-Vessel	9.8	22.9	0.0	
Total Delay Hours-Existing	360.6	378.3	355.4	364.8
b. Future Conditions:				
Vessel-to-Fixed Object	329.4	333.9	333.9	
Vessel-to-Vessel	9.8	22.9	0.0	
Total Delay Hours-Future (1)	339.2	356.8	333.9	343.3
Reduction in Total Delays	21.4	21.5	21.5	21.5
Annual Financial Savings (2)				$33,110

(1) Includes all other delays at intermediate points below site 7; reductions in vessel delays are based upon iron ore and limestone volumes to Republic and J&L Steel Corp.

(2) Product of average vessel operating costs per hour of $1540 and decrease in hourly delays.

B8. VESSEL DAMAGES

a. Overview.

Numerous accidents and related physical damages to commercial and recreational craft have occurred on the Cuyahoga River. Accident reports filed with the local Coast Guard office were examined to determine the magnitude of this problem and to identify specific sites which could be physically modified. A review of accident reports between 1972 and 1981 indicated that several areas of the river could be considered as hazardous to navigation. Historical descriptions of these accidents are included in Table B16. Geographic locations (i.e., site numbers) have been related to specific river locations previously identified during the vessel congestion analysis.

Several accidents, such as when a bridge was accidentally lowered on a vessel, may have occurred as a result of bridge operator error. Therefore, accident report data for Site Number 1 (August 1979) and the lowering of a bridge at Site Number 4 (November 1979) were deleted from the evaluation.

The remaining accident data indicates that vessel damages can be associated with improvement Sites 3, 4 and 7. These accidents were presumed to reoccur

Table B16 - Historical Vessel Damages - Cuyahoga River

Location	Description of Accident	Date of Accident	Estimated Damages - at Date of Accident (1)	Estimated Damages - at October 1983 Price Levels(2)
			$	$
Site No. 1	Small boat hit bridge	August 1979	5,000	7,010
Site No. 2	Class 5 vessel struck east bank of river	Not recorded	No reported damage	-
Site No. 3	Class 5 vessel collided with scow	June 1979	40,000	56,060
Site No. 3	Class 5 vessel hit Columbus Road bridge	December 1977	6,000	9,950
Site No. 3	Class 4 vessel struck another vessel at dock	December 1977	6,000	9,950
Site No. 3	Class 5 vessel hit dock	December 1977	Minor damages only	-
Site No. 4	N&W Bridge was lowered on Class 5 vessel	November 1979	20,000	33,160
Site No. 4	Class 5 vessel strikes east and west banks of river	December 1976	22,000	39,190
Site No. 4	Class 5 vessel struck N&W railroad bridge	September 1972	4,000	9,650
Site No. 5	No reported accidents	-	-	-
Site No. 6	No reported accidents	-	-	-
Site No. 7 (3)	Class 5 vessel hit bridge abutments	May 1978	20,000	32,370
Site No. 7 (3)	Class 5 vessel struck bridge abutments	July 1972	39,000	94,130

(1) SOURCE: U.S. Coast Guard accident reports, 1972 through 1981.

(2) The adjustment factor to October 1983 price levels is based on the ENR Common Labor Index at Cleveland, OH.

(3) Future accidents of this type at this site would be avoided if Plan 7G was implemented.

at specified intervals in the future if no modifications were made to the Cuyahoga River.

b. Average Annual Vessel Damages Associated With Alternative 7G.

The congestion elimination plan formulated for Site 7G (Plan 7G) was considered to eliminate all of the average annual vessel damages that have been reported to the US Coast Guard. The present value of future vessel damages for each site were calculated and subsequently amortized at the project interest rate of 8.125 percent. Although the frequency of future vessel damages at each site may increase over the project evaluation period as a result of increases in the volumes of iron ore and limestone and/or recreational boating activity, no adjustment was made to the initial calculations. A summary of the estimated physical damages reported to the Coast Guard and the resultant average annual damages avoided at Site 7 are shown in Table B17.

In addition to damages that have been reported to the US Coast Guard, shipping interests have stated that numerous minor accidents occur at Site 7, which are not of sufficient magnitude to be reported to the Coast Guard, but that would be eliminated by Plan 7G. Even though each accident involves only minor damages, in total they represent a significant amount which they estimate to be about $50,000 per year. Thus total vessel damages avoided as a result of Plan 7G total $57,300 annually.

Table B17 - Future Vessel Damages Avoided
Alternative 7G

Future Time Period	Present Worth Factor (1)	Site 7G: Estimated Physical Damages(2)	Site 7G: Present Value
		$	$
Project Year 10	0.458	108,860	49,858
Project Year 20	0.209	108,860	22,751
Project Year 30	0.096	108,860	10,450
Project Year 40	0.044	108,860	4,789
Project Year 50	0.020	108,860	2,177
Total Present Value of Future Damages		-	90,025
Average Annual Damages Avoided (3)		-	7,300

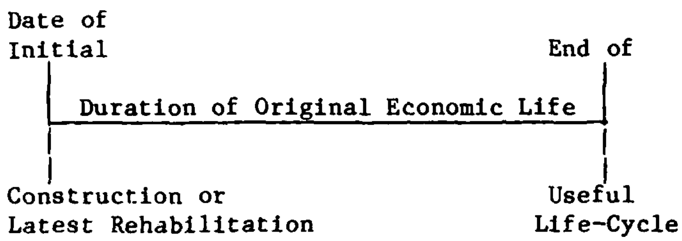
(1) Project interest rate is 8.125 percent.
(2) October 1983 price levels.
(3) The amortization factor for 50 years at 8.125 percent is .08292. Average annual damages are rounded to the nearest hundred dollars.

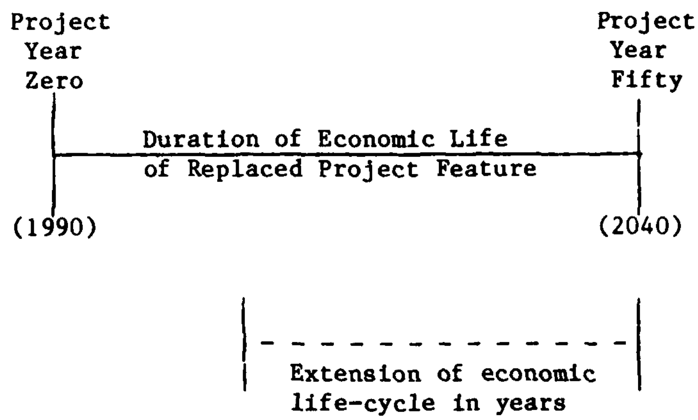
B9. ADVANCE REPLACEMENT

a. <u>Overview</u>.

Federal improvements may also extend the remaining economic life of existing project features. Whenever a project improvement involves replacement of an existing project related feature, thus extending the period during which benefits will be realized beyond that for which the existing improvement would have continued to function, an adjustment should be made to include these beneficial economic impacts in project feasibility studies.

Traditionally, the full cost of the replaced feature is included as a project cost. However, a cost offset (or economic credit) should be added to the analysis. Frequently, future "replacement-costs-in-kind" are used as a proxy for these benefits. These costs are based on the extension of the useful life as outlined below.





A number of bridges and bulkheads along the Cuyahoga River and Old River were identified in the Stage 2 Report for modification to accommodate general navigation interests. Bridge alterations are required because they constrain the navigable width of the rivers. Widening of restricted turns and bends of the Cuyahoga may also require the placement of new steel sheet pile bulkheads along the modified shoreline.

Also inherent in this evaluation of average annual "replacement-costs-in-kind" are a 50-year planning period and a 8.125 percent interest rate.

Table B18 - Summary of Advance Replacement Calculations

Project Alternative	Assumed Useful Life	Remaining Life After PY-zero	Extended Useful Life	Replacement Costs in Kind (2)	Average Annual Costs	Present Worth of $1 per Period	Present Worth Factor	Amortization Factor	Average Annual Advance Replacement Costs
				$	$				$
Alternative (Jefferson Bridge Ab...)									
Bulkheads	50	0 years (1)	50 years	700,000	58,040	12.060	1.000	.08292	58,000
Alternative 11 (Upriver Turning Basin)									
Bulkheads	50	10 years	40 years	7,200,000	597,020	11.766	0.4578	.08292	266,700

(1) Existing physical condition of bulkheads is expected to deteriorate such that no remaining useful life remains beyond 1990.
(2) October 1983 price levels.

b. Derivation of Average Annual Advance Replacement Costs.

Advance replacement benefits have been computed for bridge and bulkhead replacements for Alternative 7G. This required estimating "replacement-costs-in-kind" and the remaining useful life after the date of project implementation. Extended useful life is the difference between the useful life-cycle of the project feature (i.e., usually 100 years for railroad bridges, 60 years for automobile bridges and 50 years for steel bulkheads) and the remaining life after Project Year zero (1990). A summary of the inputs and intermediate calculations used to compute average annual replacement costs are shown in Table B18.

B10. TRANSIT TIME SAVINGS

a. Overview.

Traffic at Cleveland Harbor was examined to determine whether a benefit, in the form of time savings, would result from deepening the east entrance channel which has an authorized depth of 25 feet LWD. Therefore, vessels with a maximum operating draft of 25 feet or greater are unable to use the east entrance. If the channel was deepened, these vessels could use the east entrance resulting in decreased transit times. It was determined that approximately 1 hour could be saved per trip if the vessels inbound from and outbound to harbors east of Cleveland could utilize the east entrance. Domestic traffic statistics for the latest three years (1980-1982) was the basis for this analysis. Shallow draft vessels were presumed to have the option of using the existing east entrance channel. Most of the domestic traffic (about 94 percent) consists of inbound trips to the harbor, of these trips, practically all have origins west of Cleveland. With respect to the domestic traffic outbound to points east of Cleveland, there were no trips made by deep draft (25 feet or greater) which would benefit by deepening the east entrance. As a result of these observations, it is assumed that there would be no time saved by vessels carrying domestic traffic if the east entrance was modified. A summary of the historical vessel movements are shown below.

Table B19 - Total Domestic Traffic Vessel Movements
1980 and 1981 Navigation Seasons

Inbound				Outbound			
West		East		West		East	
Deep Draft (1)	Shallow Draft (2)	Deep Draft	Shallow Draft	Deep Draft	Shallow Draft	Deep Draft	Shallow Draft
487	192	0	2	1	30	0	9

(1) 25 feet of draft or greater
(2) Less than 25 feet

Unlike domestic traffic, foreign traffic could benefit from a deeper east entrance channel. According to the following table, more than half of the trips were made by vessels that could have used the east entrance (i.e, vessels originating from or destined to harbors east of Cleveland). Vessel pilots have estimated that about one hour per trip could be saved with an east entrance.

Table B20 - Total Foreign Traffic Vessel Movements
1980-1982 Navigation Seasons

Inbound				Outbound			
West		East		West		East	
Deep Draft (1)	Shallow Draft (2)	Deep Draft	Shallow Draft	Deep Draft	Shallow Draft	Deep Draft	Shallow Draft
7	73	106	83	43	137	11	72

(1) 25 feet of draft or greater
(2) Less than 25 feet

SOURCE: Department of the Treasury, U.S. Customs Service, "Record of Vessels Engaged in Foreign Trade," Form No. 1400 & 1401.

Based on the period 1980-82, an annual average of 106 trips inbound from the east and 11 trips outbound to the east were made by deep draft vessels that are currently prohibited from using the east entrance because of the draft restrictions of the channel and the existing charted depths which are published for lake pilots and vessel masters. As a result, approximately 117 hours annually could be saved in transit time for foreign traffic if the east entrance was deepened.

b. Benefit Evaluation.

Of the 117 trips made by deep draft vessels engaged in foreign trade that either entered Cleveland Harbor from the east or departed to the east, approximately 60 percent were Canadian, 35 percent were "other foreign" vessels (excluding Canadian), and 5 percent were U.S. vessels. Based on a review of foreign traffic statistics of Cleveland Harbor, it was determined that the majority of the Canadian receipts are via Seaway-size Class 7 vessel. It is assumed that 80 percent are vessel Class 7 and the remaining 20 percent are vessel Class 4. The "other foreign" vessels are assumed to be dry bulk vessels with equivalent characteristics equal to a mix of 80 percent Class 4 and 20 percent Class 5. It is assumed that the domestic ships are 50 percent vessel Class 3 and 50 percent Class 4.

The following table reflects the derivation of the three weighted average hourly operating costs for the Canadian, "all other foreign" and U.S. vessels.

	Canadian (1)		All Other Foreign (3)		United States (1)	
Vessel Class	4	7	4	5	3	4
	$	$	$	$	$	$
Construction Cost ($M)	26.0	34.0	21.2	26.0	22.5	26.0
Daily Fixed Cost (3)	16,324	21,347	7,167	10,030	14,127	16,324
Daily Operating Cost (2)	18,704	20,944	4,751	5,320	15,200	18,704
Total Hourly Cost	1,460	1,762	496	640	1,222	1,460
Percent Vessel Mix (%)	20	80	80	20	50	50
Weighted Average Hourly Cost ($/Hr)	1,700		670		1,340	

(1) Financial Operating Statistics Provided by Maritime Administration, U.S. Department of Transportation adjusted to October 1983 price levels. All other foreign vesels based upon information provided by Corps of Engineers, Washington, DC adjusted to 1983 price levels.

(2) Included wages, fuel, subsistence, stores, supplies, repairs, tug charges, lay-up expenses, etc.

(3) Foreign flag vessel fixed costs budgeted at 365 days/year and Great Lakes capital costs distributed across 275 days/year.

To arrive at an overall hourly cost, these costs were weighted according to the percent each group contributed to the 117 trips that would be affected by deepening the east entrance. (Canadian = 60 percent, "all other foreign" = 35 percent, U.S. = 5 percent). Therefore, the overall hourly cost representative of the vessels which might use the east entrance is $1,320/hour.

c. Conclusions.

An average of 117 hours could be saved in transit time each year by deepening the east entrance channel. The annual benefit of this modification to Cleveland Harbor was estimated to be $154,400 based upon 117 hours/year and estimated unit costs per hour.

Table B21 - Estimated Storm Delays - Cleveland Harbor, OH

Lake Level Assumption (V):	PROJECT PLANNING PERIOD 1990	1995	2000	2010	2040 2030 2020	Average Annual Equivalent ($000)
Lakefront Traffic						
Domestic Iron Ore:						
Class 5 Trips/Year	9	0	0	0	0	
Class 6 Trips/Year	9	0	0	0	0	
Class 7 Trips/Year	101	113	108	67	0	
Class 8 Trips/Year	8	0	0	0	0	
Class 10 Trips/Year	18	32	45	83	111	
Subtotal Trips	145	145	153	150	111	
Subtotal Tonnage	4,260,000	4,760,000	5,460,000	6,750,000	6,750,000	
Canadian Iron Ore:						
Class 7 Trips/Year	101	101	101	101	101	
Subtotal Tonnage	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000	
Vessel Delays						
Domestic:						
Class 8 and Below	103,585	92,585	88,490	54,900	0	73,820
Class 10 Vessels	65,840	117,050	164,600	303,600	406,030	194,730
Subtotal Domestic	169,425	209,635	253,090	358,500	406,030	268,550
Canadian:						
Class 7 Vessels	82,750	82,750	82,750	82,750	82,750	82,750
						351,300

NOTE 1: Storm affected transits are estimated to be 3.1 percent for Class 8 vessels or below and 8.7 percent for Class 10 vessels; Average storm duration of 15 hours and estimated vessel hourly operating costs shown below:

Class 5	$1,540/hour	Class 8	$1,965/hour
Class 6	$1,690/hour	Class 10	$2,800/hour
Class 7	$1,760/hour		

NOTE 2: Physical and financial charateristics are based upon information in Table B12 and Table B13 .

NOTE 3: October 1983 price levels and 8.125 percent interest rate and 50-year project life.

B11. STORM DELAY SAVINGS

a. Great Lakes Bulk Carriers.

Storm delay costs are presently incurred by dry bulk carriers which arrive at the lakefront entrance coincidental with weather conditions (wind speeds and wave heights) which are sufficiently marginal to preclude a direct entry. Vessel masters can either lay-off in the open lake or proceed directly to the north shoreline where they seek refuge on the lee-side of Pelee Point, Ontario, until the storm subsides. Vessels would proceed into the harbor after the adverse weather conditions disminish. Total annual delay costs incurred by vessel owners varies from year to year and is a function of open-lake weather conditions, total annual transits and judgement exercised by each vessel master during each approach to the Outer Harbor.

An evaluation of storm-related vessel delays was conducted to identify the beneficial effects of an improved east entrance. Wind and wave conditions which would preclude entry of vessels via the existing west entrance channel were identified by major fleet operators during field interviews in 1983. Under present conditions, domestic shippers will not enter when winds exceed 20 knots from the west through east-northeast directions in Class X vessels and when winds exceed 25 knots from the same directions for smaller vessels. It was also estimated that for each time a vessel is delayed due to weather conditions, an average delay duration of 15 hours occurs. However, with a modified east entrance in place, domestic shippers would enter the harbors in winds up to 30 knots, the limiting operating conditions at the lakefront iron ore transhipment dock.

Variable and fixed operating costs for U.S. and Canadian dry bulk carriers which were summarized in Tables B12 and B13 were used to estimate storm delay reduction benefit. Traffic forecasts to the lakefront ore dock and average operating drafts were used to calculate future annual transits. A percent of each category of ship size (i.e., Class 8 and below and Class 10) was based upon the additional amount of time that these ships would be able to enter the harbor without delays. A summary of storm delay reduction benefits are provided in Table B21.

b. Foreign Flag Break-Bulk Vessels.

The majority of the commercial activity at the public lakefront docks consists of receipts of steel products and shipments of miscellaneous general cargo. A portion of the activity is transported in containers, although none of these vessels are dedicated container vessels but usually have containers on deck with dry bulk cargo below. Activity levels have fluctuated with regional and national economic indicators and, in recent years, there has been an increase in the volumes of steel products which have been unloaded at the public docks in recent years. These events have been directly related to the substantial decline in production levels within the domestic steel industry. Accurate forecasts of future general cargo receipts and shipments are difficult to make since a large number of external variables affect the decision to route cargo via the Great Lakes : international trade policies (free trade vs. protectionist legislation), monetary strength of the U.S.

currency, availablility of backhaul cargo (export grain) and demand/supply of foreign flag vessels. A recent study of Great Lakes traffic potential for steel and non-steel general cargo was developed to support lock capacity planning studies (Regional Transporation Study, Booz-Allen & Hamilton, Inc. - 1982) and is provided as Table B22.

Foreign traffic activity for Cleveland Harbor, OH was indexed to the base year (1978) and rates of change were applied to the average number of deep-draft (i.e., 25 feet or greater) foreign flag vessel transits recorded by U.S. Customs Service, U.S. Department Dept. of Treasury. Although there has been a substantial increase in foreign flag activity in the last two years, there has been an annual average of 35 to 40 transits during the period 1980-1982.

An evaluation by Great Lakes pilots of the critical wind and wave conditions has indicated that the upper limit of safe navigation is 20 knot winds from the south-southwest through northeast directions. It is estimated that each time a vessel is delayed due to weather conditions, it is forced to wait outside the harbor approximately 15 hours on average. However, with a modified east entrance channel vessels could enter up to 40 knots. During the navigation season, winds in excess of 20 knots but less than 40 knots from the south-southwest through northeast directions occur about 13.9 percent of the time. Therefore, 13.9 percent of the expected annual foreign flag transits could be affected by storm delays. Estimated delay durations of 15 hours and weighted operating costs were used to quantify storm delay savings which might be credited to Alternative 1. A summary of the storm delay calculations are provided in Table B22.

B12. MODIFICATION OF UPRIVER TURNING BASIN

Modification of the upriver turning basin to accommodate the Class 5 shuttle vessel was investigated in Alternative 11. A navigation problem was identified by the operator of this vessel as a result of insufficiant depth. The existing authorized depth in this turning basin is 18 feet and is not presently sufficient to accommodate maneuvering of a fully loaded 635 feet shuttle vessel. Upriver stockpiles at the Republic Steel Corp. Plant location requires that the vessel initially lighter a portion of its cargo, back into the turning basin, reverse direction and back upriver to the uppermost stockpile and unload the balance of its cargo.

Deepening the turning basin to 23 feet to accommodate a fully loaded vessel would eliminate several hours of delay and result in tangible financial savings. Transportation benefits are measured as the product of vessel operating hours which could be saved and the frequency and duration of the shuttle vessel moving to the upriver stockpile. Coordination with the maritime operating staff at the steel plant has indicated that only a fraction of the total annual iron ore receipts must be unloaded in the uppermost stockpile. Therefore, historical vessel movements and stockpiling requirements were reviewed during the analysis.

Total vessel delay savings were estimated based upon expected shipments from the Lorain Harbor transfer dock to the Republic Steel plant adjacent to the Cuyahoga River, average operating drafts and expected tons per trip.

Table B22 - Foreign Flag Storm Delays Cleveland Harbor, OH

Commodity Type	1978	1985	1990	2000	2010	2020	2030	2040	Average Annual Equivalent
Group 14 - (Tonnage) Steel Products	63,193	68,914	73,322	83,003	93,963	106,370	120,414	136,314	
Group 15 - (Tonnage) Non-Steel Products	524,585	1,230,291	996,385	1,014,966	1,236,503	951,887	1,495,531	1,910,161	
Total Foreign Traffic	587,778	1,299,205	1,069,707	1,097,969	1,330,466	1,058,257	1,615,745	2,046,475	
Vessel Transits	N/A	40(1)	33	34	41	33	50	63	
Storm Delay (2) Savings			$46,100	$47,500	$57,300	$46,100	$69,880	$88,000	$50,100

(1) Average number of loaded vessels which required 25 feet of channel depth or greater for the period 1980-1982.

(2) Storm percentage of 13.9 percent; average duration of 15 hours and weighted operating costs of $670/hour.

SOURCE: Commodity Flow Forecasts, "Regional Transportation Study For US Army Engineers," Booz, Allen & Hamilton, Inc., September 1981.

Approximately 6 percent of the annual iron ore vessel movements would be affected with average savings of 3.5 hour/trip if the turning basin was modified. Vessel operating costs per year were derived based upon physical and financial characteristics described in Table B12 and B13. Total average annual vessel delays were estimated to be $53,900. Advance replacement benefits were previously calculated to be $266,700. A summary of the annual benefits and costs are shown below. Average annual costs exceed annual benefits by a sustantial margin. Therefore, this plan will not be considered for further study.

Table B23 - Summary of Benefits and Costs
Alternative 11

	$
Total Contractor's Earnings Plus Contingencies (25 percent) (1)	6,720,000
Engineering & Design	670,000
Supervision & Administration	620,000
Total First Cost of Construction	8,010,000
Interest During Construction	137,000
Total Investment Costs	8,147,000
Amortization Factor (.08292) (2)	
Average Annual Benefits	320,600
Average Annual Costs (3)	676,000
Benefit-Cost Ratio	0.47

(1) October 1983 price levels.
(2) 50-year life cycle and 8.125 discount rate.
(3) No increase above expected annual maintenance expenses.

B13. BENEFIT-COST ANALYSIS

a. Introduction.

The benefits associated with the proposed alternative are based on the commodity projections for the most probable future presented in Table B8. All calculations assume a 50-year project life and a 8.125 percent interest rate.

(1) Benefits - Benefits for the various project alternatives consisted of a decrease in average annual transportation costs between the base case without project and future improved conditions; a decrease in traffic-related delay costs; advance replacement benefits; and the elimination of physical damages expected to occur due to river congestion. All future benefit streams have been converted to equivalent average annual values and are presented in Table B24.

Table B24 - Summary of Benefits - Cleveland Harbor, OH

Alternative	Reach/Commodity	Storm Delay Savings FOR.	Storm Delay Savings DOM.	Transit Time Savings	Vessel Damages Avoided	Advance Replacement Benefits	Total Benefits (1)
Alternative 1 "Severe-Weather" East Entrance Plan	West Basin - Outer Harbor						
	Domestic Iron Ore	0	268,500	0	0	0	
	Canadian Iron Ore	0	82,800	100,400	0	0	
	Total	0	351,300	100,400	0	0	(451,700)
	East Basin - Outer Harbor						
	Port Authority Docks	50,100	0	54,000 (2)	0	0	(104,100)
Alternative 7G							555,800
Remove Jefferson Avenue Bridge Abutments		0	0	33,100	57,300	58,000	148,400
Alternative 11							
Deepen Turning Basin		0	0	53,900	0	266,700	320,600

(1) Estimated benefits are based upon October 1983 price levels, 8.125 percent interest rate and 50-year project life.
(2) Estimated benefits are based upon an average 117 trips per year of which 60 percent are Canadian, 35 percent Foreign, and 5 percent United States and a weighted hourly operating cost of $1,320. Time savings contributed to the port authority docks came from foreign traffic.

(2) Costs - Costs for Alternatives 1, 7G, and 11 were developed by the Buffalo District. Project first costs included such components as Outer Harbor deepening; railroad interchange trackage; new bulkheads; building relocations; bridge replacement; and utility relocations. Also included in first costs were contingencies for construction and engineering and supervision. Interest during construction was calculated, and added to total first costs to obtain total investment costs.

These investment costs were then converted to average annual equivalent costs based on an interest rate of 8.125 percent and 50-year project life. Annual maintenance costs as a result of each plan, over and above existing maintenance costs, were added to the above. Total average annual cost for various project alternatives are presented in Table B25.

(3) Summary and Conclusions - Benefits, costs, benefit cost ratios, and net benefits for the three alternatives are presented in Table B26. The proposed plan is Alternative 1, the "Severe-Weather" East Entrance Plan. This plan would allow domestic shippers to enter the harbor in winds up to 30 knots and foreign shippers in winds up to 40 knots. These resulted in storm delay savings of $401,400 in average annual dollars.

Also foreign traffic could benefit from a deepen east entrance channel in the form of time savings per transit. If vessels with a maximum operating draft of 25 feet or greater were able to use the east entrance, approximately 1 hour could be saved per trip by vessels inbound from and outbound to harbors east of Cleveland. Theses transit time savings came to $154,400 in average annual dollars.

In summary, Alternative 1 had average annual benefits of $555,800, average annual costs of $205,500, net average annual benefits of $350,300, and a 2.70 benefit cost ratio.

B14. SELECTION OF NED PLAN

In selecting the National Economic Development (NED) Plan, candidate plans must not only satisfy the specific planning objectives and evaluation criteria, they must also reasonably maximize net benefits. Based on the results of the Stage 3 evaluation previously discussed, the plan that best fulfills these criteria is Plan 1, the "Severe-Weather" East Entrance Plan, with average annual net benefits of $350,300. However, before designating Plan 1 as the NED Plan (i.e., the plan that reasonably maximizes net benefits), an incremental cost/incremental benefit analysis must be conducted. This analysis will compare the costs and benefits of plans that provide channel depths 1-foot less and 1-foot greater than Plan 1. (Note: Plan 1 would provide a 30-foot LWD entrance channel and a 26-foot LWD interior channel through the east basin - see Plate 21 in Appendix I.)

Plan 1A would provide channel depths 1-foot less than Plan 1. Therefore, the entrance channel would be dredged to 29 feet below LWD. The interior channel through the east basin would remain at its authorized depth of 25 feet below LWD. The cost of this plan, on October 1983 price levels, is $1,500,000. Benefits for Plan 1A include only a portion of the $351,300 average annual storm delay savings for domestic bulk cargo vessels credited to Plan 1 (see Table B24), since Plan 1A would only provide adequate channel depths when water levels on Lake Erie exceed Elevation 571.9 (1 foot above average lake levels (the design water level for Plan 1), or, 3.3 feet above LWD). Since water levels on Lake Erie equal or exceed Elevation 571.9 only 15 percent of the time during the navigation season versus 50 percent of the time for average water levels, 35 percent of the storm delay savings for domestic bulk cargo vessels credited to Plan 1 would not be realized under Plan 1A. Thus, average annual benefits for Plan 1A total $228,300 (65 percent of the storm delay savings for domestic bulk cargo vessels of $351,300 for Plan 1). It should also be noted that no storm delay benefits for general cargo vessels nor transit time savings for Canadian bulk and foreign flag general cargo vessels, loaded to a static draft of 25 feet or greater, would accrue due to implementation of Plan 1A, since the depth of the channel through the east basin would not be increased above its presently authorized depth of 25 feet below LWD. Vessel operators have stated that this channel depth is inadequate for their operations since they only use channels based on their charted depth and not based on actual water levels present.

Plan 1B would provide channel depths 1-foot greater than Plan 1. As such, the entrance channel would be dredged to 31 feet below LWD and the interior channel would be dredged to 27 feet below LWD. The cost of this plan would be $3,680,000, on October 1983 price levels. Benefits for Plan 1B include all the storm delay savings ($401,400) and transit time savings ($154,400) for bulk and general cargo vessels credited to Plan 1, or $555,800 annually (see Table B24). In addition, Plan 1B would provide adequate channel depths when water levels on Lake Erie fall up to 1 foot below average lake levels (Elevation 569.9, or, 1.3 feet above LWD). Since water levels on Lake Erie exceed Elevation 569.9 about 85 percent of the time during the navigation season versus 50 percent of the time for average water levels, Plan 1B would accrue additional storm delay savings of $140,500 annually (35 percent of the storm delay savings of $401,400 for Plan 1). Thus, average annual benefits for Plan 1B total $696,300.

Table B27, compares, among other things, the costs and benefits of Plans 1, 1A, and 1B. As indicated, the plan that provides the maximum average annual net benefits is Plan 1B. However, an additional analysis must be conducted to ensure that a plan providing channel depths 1-foot greater than Plan 1B, designated Plan 1C, does not provide even greater average annual net benefits.

Plan 1C would provide channel depths 1-foot greater than Plan 1B, or 2 feet greater than Plan 1. As such, the entrance channel would be dredged to 32 feet below LWD, and the interior channel would be dredged to 28 feet below LWD. The cost of this plan, on October 1983 price levels, is $5,330,000. Benefits for Plan 1C include all of the storm delay savings ($401,400) and transit time savings ($154,400) for bulk and general cargo vessels credited to Plan 1, or $555,800 annually. In addition, Plan 1C would provide adequate channel depths when water levels on Lake Erie fall up to 2 feet below average lake levels (Elevation 568.9 or 0.3 feet above LWD). Since water levels on Lake Erie exceed Elevation 568.9 about 99 percent of the time during the navigation season versus 50 percent of the time for average water levels, Plan 1C would accrue additional storm delay savings of $196,700 annually (49 percent of the storm delay savings of $401,400 for Plan 1). Thus, average annual benefits for Plan 1C total $752,500.

Table B27 also compares the costs and benefits of Plan 1C with Plans 1, 1A, and 1B. As indicated, average annual net benefits for Plan 1C are less than those for Plan 1B. Therefore, the plan that reasonably maximizes average annual net benefits is Plan 1B, the Modified "Severe-Weather" East Entrance Plan, and, as such, Plan 1B is designated the NED Plan.

Table B25 - Summary of Costs - Cleveland Harbor, OH
Alternatives 1, 7G, 11

	Alternatives		
	1	7-G	11
Total Contractors Earnings Plus Contingencies (25%) (1)	2,130,000	2,046,000	6,720,000
Engineering and Design	100,000	225,000	670,000
Supervision and Administration	190,000	209,000	620,000
Total First Cost of Construction	2,420,000	2,480,000	8,010,000
Interest During Construction	58,100	42,000	137,000
Total Investment Costs	2,478,100	2,522,000	8,147,000
Amortization Factor (.08292) (2)			
Average Annual Costs (3)	205,500	209,100	675,500

(1) October 1983 price levels.
(2) 50-year life cycle and 8.125 percent discount rate.
(3) No increase above existing annual maintenance expenses.

Table B26 - Benefit Cost Comparison
Alternatives 1, 7G, 11

Alternatives	Average Annual Benefits	Average Annual Costs	Net Average Annual Benefits	Benefit Cost Ratio
	$	$	$	
1. East Entrance Plan	555,800	205,500	350,300	2.70
7G. Jefferson Avenue Bridge	148,400	209,100	-60,700	.71
11. Upriver Turning Basin	320,600	675,500	-354,900	.47

Table B27 - Incremental Cost/Incremental Benefit Analysis (1)

	Total Project Cost	Average Annual Charges (2)	Average Annual Benefits	Incremental Average Annual Charges	Incremental Average Annual Benefits	Incremental Benefit/Cost Ratio	Overall Benefit/Cost Ratio	Overall Net Average Annual Benefits
	$	$	$	$	$			$
Plan 1A	1,500,000	127,400	228,300				1.8	100,900
				78,100	327,500	4.2		
Plan 1	2,420,000	205,500	555,800				2.7	350,300
				104,900	140,500	1.3		
Plan 1B	3,680,000	310,400	696,300				2.2	385,900
				141,600	56,200	.4		
Plan 1C	5,330,000	452,000	752,500				1.7	300,500

(1) Based on October 1983 price levels, 8-1/8 percent interest rate and 50-year economic life.
(2) Includes interest during construction.

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SUPPLEMENT 1

COMPUTER MODEL INPUT AND OUTPUT

Attached are the base case computer model inputs and outputs for the initial project year, 1990. The components of the input file are divided into six sections:

I Dock Location and Vessel Delay Points

II Location of Delay Zones and Their Delay Times

III Vessel Operating Characteristics

IV Upbound and Downbound Delay Times by Vessel Class

V Vessels Affected by Congestion

VI Tonnage Projections by Dock - Also Vessel Operating and Arrival Characteristics

The content of these sections is described in further detail.

A sample model output of total delay times is also provided.

LISTING OF INPUT DATA FILE

```
***** TRAFFIC FORECASTS FOR PROJECT YEAR  0 *****
 15   30
  N        30   30            HARBOR ENTRANCE
  D  720    4    2          2.5LEAP DOCK 20
  C         4    2    1   2   CONRAIL BRIDGE #1
  D  716   24   14          2.5ALPHA CEMENT
  D* 700    8    5   15   7 2.5MERWIN AVE (CEREAL)
  C  700    1    1    3   4 2.5MERWIN AVE (CEREAL)
  N         8    5            DELAY ZONE 1 START
  D  680   14    8          2.5CUYAHOGA LIME
  N        32   19            DELAY ZONE 1 END
  D  275   10    6          2.5M-C-C
  N         6    4            DELAY ZONE 2 START
  D  598    6    4          2.5FORD MOTOR
  D  590    6    4          2.5CBS DOCK #1
  N         6    4            DELAY ZONE 2 END
  D  327    5    3          2.5CBS DOCK #2
  D  329    6    4          2.5CBS DOCK #3
  D  580    6    4          2.5ONTARIO STONE
  N        12    7            DELAY ZONE 3 START
  N         6    4            DELAY ZONE 3 END
  D  360    6    4          2.5CLIFTON CONCRETE
  C         8    5    5   6   CONRAIL BRIDGE #14
  D  378    3    2          2.5CBS DOCK #4
  C        28   17    8   9   JEFF AVE BRIDGE
  D  410   10    1          2.5REPUBLIC DOCK #1
  D  495   16   10          2.5REPUBLIC DOCK #2
  D  435   12    7          2.5J&L STEEL
  D  440   10   10          2.5REPUBLIC DOCK #3
```

I. Dock Location and Vessel Delay Points.

```
*****
   7    9   15   15    0   90
  11   14   15   15    0   90
  18   19   15   15    0   90
```

II. Location of Delay Zones and Delay Times.

```
*****
 5A         23200 27.9 1152  5.0 AMERICAN REPUBLIC
 5B         26700 27.9 1272  5.0 FRED WHITE
```

III. Vessel Operating Characteristics.

```
*****
   1   30   30
   2   30   30
   3   20   20
   4   20   20
   5   15   15
   6   15   15
   7   30   30
   8   10   10
   9   10   10
```

IV. Upbound and Downbound Delay Times (by Vessel Class).

```
*****
 700    5B    5A    5B
```

V. Vessels Affected by Congestion.

```
*****
 700      99000 0.11 26.5   5B 1.00R
 680     363000 0.11 24.5   5B 1.00R
 598      15000 0.11 24.5   5B 1.00R
 580      53300 0.11 24.5   5B 1.00R
 410     680000 0.11 24.5   5B 1.00R
 495    1700000 0.11 24.5   5A 1.00R
 435    2760000 0.11 24.5   5B 1.00R
 440    1700000 0.11 24.5   5A 1.00R
```

VI. Tonnage Projections by Dock; and Fleet Mix Characteristics.

I. Dock Location and Vessel Delay Points.

Column 1 - Indicates whether the location is a node (N), dock (D), a constraint area (C), or a vessel-to-fixed object delay point where the fixed object is a vessel unloading at a dock (D^*).

Column 2 - Dock Code Number.

Column 3 - Time between points in minutes for upbound vessels.

Column 4 - Time between points in minutes for downbound vessels.

Column 5 - Line reference number in the function descriptor matrix where the upbound vessel delay by class is stored. The delay times are presented in Section 4 by vessel class.

Column 6 - Line reference number in the function descriptor matrix where the downbound vessel delay by class is stored. The delay times by vessel class are presented in Section 4.

Column 7 - Unloading rate in thousands of tons per hour and names of each point in the harbor network.

II. Location of Delay Zones and Delay Times. Line number in the network description where a delay zone begins and ends; fixed delay in the upbound and downbound directions; delays incurred whenever vessels pass each other within the zone. More detail is shown below:

Column 1 - Network line number where delay zone begins.

Column 2 - Network line number where delay zone ends.

Column 3 - Vessel-to-fixed object delay time for all upbound vessels.

Column 4 - Vessel-to-fixed object delay time for all downbound vessels.

Column 5 - Vessel-to-vessel delay time for all upbound vessels.

Column 6 - Vessel-to-vessel delay time for all downbound vessels.

III. Vessel Operating Characteristics.

Column 1 - Vessel class.

Column 2 - Maximum deadweight carrying capacity.

Column 3 - Maximum vessel midsummer draft.

Column 4 - Immersion factor defined as short tons per foot of vessel draft.

Column 5 - Unloading rate per hour (thousands of tons).

IV. Upbound and Downbound Delay Times by Vessel Class.

Column 1 - A card locator row number which contains the upbound or downbound delay times incurred by each vessel class. If the row number appears in Column 5 of Section 1, the values are upbound delay times by vessel class. If the row number appears in Column 6 of Section 1, the values are downbound delay times by vessel class.

Column 2 - Upbound and downbound delay times for vessel 5A.

Column 3 - Upbound and downbound delay times for vesesl 5B.

V. Vessels Affected by Congestion.

Column 1 - Dock code number.

Column 2 - The vessel size (Designated as 5B).

Column 3 - Vessels that incur delay times whenever a 5B vessel is unloading at Dock 700.

VI. Tonnage Projections by Dock.

Column 1 - Dock code number.

Column 2 - Annual tonnage forecast.

Column 3 - Percentage of annual volume expected to be accommodated during the simulation period.

Column 4 - Maximum operating draft at each dock.

Column 5 - Vessel class servicing each dock.

Column 6 - Percent of tonnage moved by vessel class.

DELAY TYPE/LOCATION	6	5A	5B	5C	5D	5E	5F	5G	5H	N/A	TOTAL DELAY
	DELAYS BY VESSEL CLASS										
TOTAL VESSEL TO FIXED OBJECT											
MERWIN AVE (CFP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0
CONRAIL #1	2.0	2.0	14.0	25.0	1.0	1.0	4.0	4.0	0.0	0.0	53.0
MERWIN AVE (CFP)	1.3	1.3	9.3	16.7	0.0	.7	2.7	2.7	0.0	0.0	34.7
CONRAIL #14	0.0	0.0	7.0	12.3	0.0	0.0	1.5	2 0	0.0	0.0	22.8
JEFF AVE BRIDGE	0.0	0.0	4.7	8.2	0.0	0.0	1.0	1.3	0.0	0.0	15.2
DELAY ZONE I START	.3	.3	4.7	8.3	0.0	.3	1.3	1.3	1.0	0.0	17.7
DELAY ZONE II START	0.0	0.0	4.7	8.2	0.0	.3	1.2	1.3	1 0	0.0	15.7
DELAY ZONE III START	0.0	0.0	4.7	8.2	0.0	0.0	1.0	1.3	1.0	0.0	16.2
TOTAL VES TO FXD	3.7	3.7	49.0	86.8	1.0	2.3	12.7	14.0	3.0	0.0	176.3
TOTAL VESSEL TO VESSEL											
MERWIN AVE (CFP)	0.0	0.0	19.0	41.5	0.0	0.0	0.0	9.6	0.0	0.0	70.0
DELAY ZONE I START	0.0	0.0	3.0	4.5	0.0	0.0	1.5	3.1	0.0	0.0	12.1
DELAY ZONE II START	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
DELAY ZONE III START	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5
TOTAL VES TO VES	0.0	0.0	23.5	47.5	0.0	0.0	1.5	12.7	0.0	0.0	85.1
TOTAL DELAY											261.4

APPENDIX C

COASTAL ENGINEERING DESIGN

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

APPENDIX C
COASTAL ENGINEERING DESIGN

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APPENDIX C

COASTAL ENGINEERING DESIGN

C1. INTRODUCTION

The fundamental commercial navigation issue in the Cleveland Harbor study is the evaluation of modifications to existing harbor features in order to provide more efficient and safer movement of waterborne commerce through the Port of Cleveland. This appendix presents the design criteria, assumptions, and detailed design of the harbor modifications required to permit operation of Great Lakes bulk cargo vessels up to 1,000 feet in length with a draft of 26.0 feet at average water levels in the Lakefront Harbor of the Port of Cleveland. Also included in this appendix is a discussion of improvements required on the Cuyahoga River at the site of the former Jefferson Avenue bridge (river-mile 4.3) to reduce congestion among vessels in the present fleet (up to 630 feet in length).

Most commercial vessels use the main (west) entrance from Lake Erie into Cleveland Harbor (see existing Lakefront Harbor area shown on Plate C1). The main entrance consists of a dredged channel between the outer ends of the west and east arrowhead breakwaters which extend outward from the east basin and west basin breakwaters. The lake approach channel is presently maintained to a depth of 29 feet below low water datum and has a width of 600 feet at the outer ends of the arrowhead breakwaters and increases to 750 feet between the east and west breakwater spurs. The dimensions of the entrance features at the main entrance are depicted on Plate C2.

The east and west breakwater spurs represent hazards to vessels, particularly during storm conditions. The channel depths are also inadequate for vessel clearance under storm conditions. Therefore, alternative "severe-weather" entrance plans for operation of vessels in the Lakefront Harbor of the Port of Cleveland were developed at both the main (west) and east entrances during Stage 2 planning. However, as discussed in the Main Report, the only entrance plan currently under consideration in Stage 3 is at the east entrance. Only deepening and enlargement of existing channels is required at the east entrance location.

C2. DESIGN CRITERIA AND ASSUMPTIONS

This section will address the criteria and assumptions for the detailed design of the channels for improvement of the east entrance to Cleveland Harbor. The entrance plan is designed to create a safe navigation entrance channel from Lake Erie into the Port of Cleveland for bulk cargo vessels up to 1,000 feet in length under storm conditions.

A workshop was held in Cleveland, OH, on 8 April 1981, with vessel masters of 1,000-foot long bulk cargo vessels operating on the Great Lakes. The purpose of the workshop was to obtain information on vessel operating characteristics in order to establish design criteria for safe and efficient entrance into the Lakefront Harbor. A "severe-weather" entrance was defined as an entrance that would allow 1,000-foot long vessels to enter the Lakefront Harbor under all weather conditions for which they would be able to dock and unload their cargo in the Lakefront Harbor. According to the vessel masters, for a "severe-weather" entrance, regardless of the improvements implemented, they would not attempt to enter Cleveland Harbor with 1,000-foot long vessels when winds exceed 30 knots from the west through north to northeast, the limiting condition for safe docking of these vessels at Conrail's dock in the Lakefront Harbor, nor when wave heights in the lake approach channel exceed 8.0 feet. These design conditions were slightly modified to 30-knot winds from the west through east-northeast directions with a corresponding 9 to 10-foot wave produced by these waves. The vessel masters also indicated that wave heights in the protected area of the entrance channel must not exceed 2 to 3 feet in order for vessel control to be maintained with side thrusters as the vessel slows down. Under the "severe-weather" wind and wave conditions defined above, the 1,000-foot long vessel would have to enter into the protected area of the entrance channel traveling at a speed of about 6 miles per hour to maintain vessel controllability. When entering at 6 miles per hour under design conditions (9 to 10-foot waves and 30-knot winds), a vessel roll value of 3-5 degrees can be expected on a 1,000-foot long vessel. For determination of required channel depth, a 4-degree value for roll will be used for 1,000-foot long vessels. The vessel masters stated that smaller vessels (vessels 730 feet in length and less) could probably enter under more severe weather conditions than a 1,000-foot long vessel and that the degree of roll would be 1-1/2 times the roll of the 1,000-foot long vessel for the corresponding wave condition, or between 5-7 degrees for a 9 to 10-foot wave. For determination of required channel depth, a 6-degree value for roll will be used for vessels less than 1,000 feet in length.

When conditions are more severe than those listed for the "severe-weather" plan, the vessel masters stated that the conditions at Conrail's dock in the Lakefront Harbor would be too severe to unload and therefore, they would lay up offshore until conditions subsided.

The design of a deep draft navigation project must result in a safe, efficient, reliable, and least cost plan with appropriate consideration of environmental and social aspects. However, the factors of safety, efficiency, and reliability must be accommodated before the cost is optimized. The channels required for safe and efficient navigation of ships at Cleveland Harbor are based on applicable Engineer Manuals (EM 1110-2-1613), Regulations (ER 1110-2-1404) and Technical Letters (ETL), as well as model ship tests, interviews and meetings with vessel masters, and other research papers which were used as guidance in the design.

NATURAL FACTORS AFFECTING DESIGN AND NAVIGATION CONDITIONS

C3. EXPOSURE TO AND EFFECT OF STORMS

Cleveland Harbor is exposed to storm waves generated by winds from the west-southwest through north to east-northeast directions. Storm wa from the north-northeast through east-northeast directions have the greatest fetch and cause severe wave action at the harbor. Although storms from the northeastly directions are more intense, they occur less frequently than storms from the westerly directions. A wind diagram showing the relative directional frequency and intensity of winds at Cleveland, Ohio, based on United States Coast Guard recorded observations, is shown on Figure C1. The wind diagram is considered to reflect, reasonably well, the conditions that prevail at Cleveland Harbor.

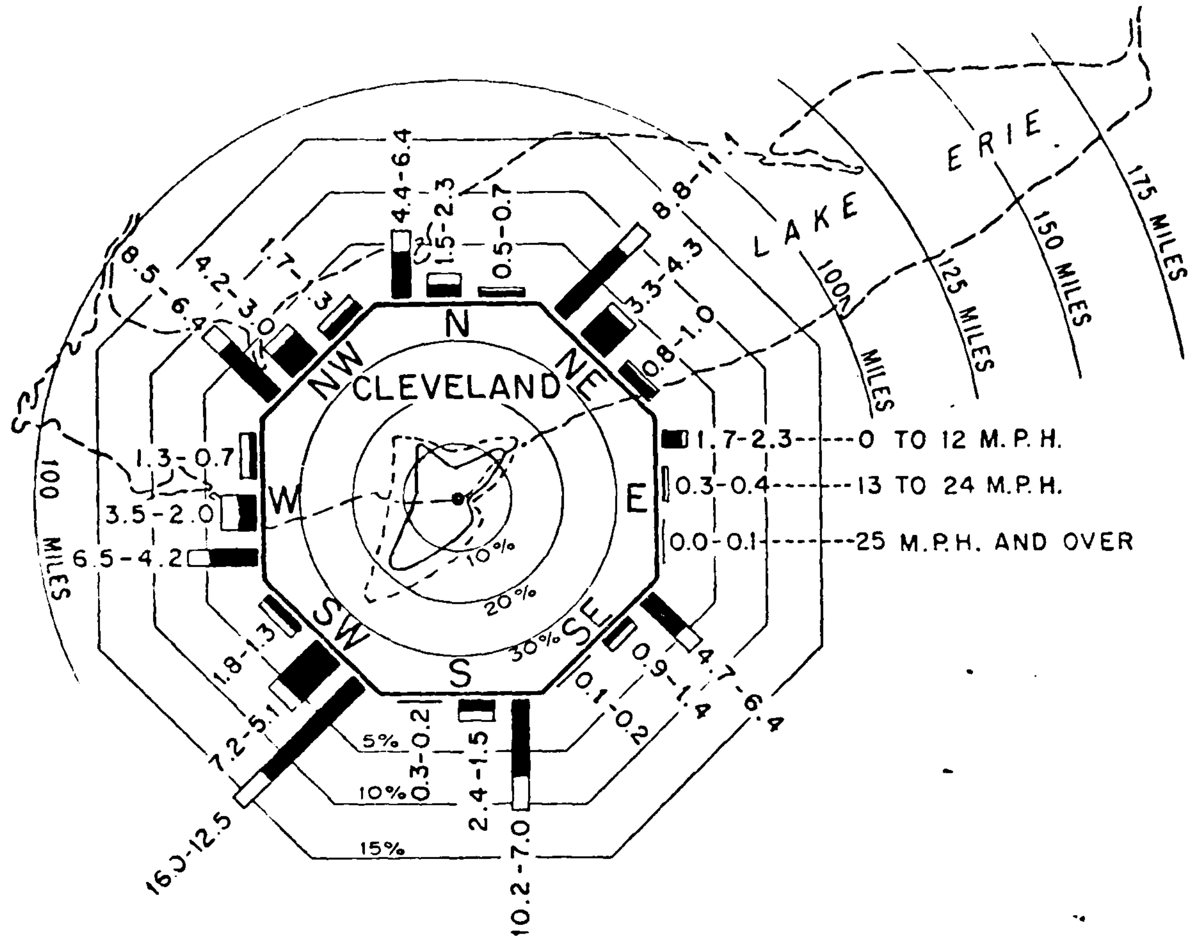
C4. WATER LEVELS AND FLUCTUATIONS

Water levels on the Great Lakes vary from year to year and from month to month. Locally, water levels vary from day to day and from hour to hour. The lake level is subject to a seasonal rise and fall usually consisting of high levels in May and June and low levels in January and February. Yearly and seasonal fluctuations are caused by variations in precipitation rates within the Great Lakes Basin. Short-term fluctuations lasting from a few hours to several days are caused by meteorological disturbances. Differences in barometric pressure and winds blowing over the surface of the lake create temporary water level fluctuations which vary locally. Astronomical tides are assumed to have a negligible influence on water levels at the project site. Low water datum for Lake Erie is elevation 568.6 feet above mean water level at Father Point, Quebec, International Great Lakes Datum (IGLD, 1955).

Continous records of water levels in Lake Erie have been monitored at Cleveland, Ohio by the Lake Survey Center and National Oceanic and Atmospheric Administration (NOAA) since 1860. The gage at Cleveland serves as the master gage for Lake Erie. Table C1 summarizes the average and extreme water levels recorded by the Cleveland water level gage. In the 122 years of record at the Cleveland gage, from 1860 to 1981 inclusive, the level of Lake Erie has fluctuated from a high monthly mean of 573.5 feet in June 1973 to a low monthly mean of 567.5 feet in December 1934 and again in February 1936. The greatest annual fluctuation, as shown by the highest and lowest monthly mean of the year, was 2.75 feet in 1947, and the least annual fluctuation was 0.87 foot in 1895.

C5. DESIGN MINIMUM WATER LEVEL

The design minimum water level is used for channel depth evaluation. In accordance with the Corps of Engineers applicable Engineer Regulation (ER-1110-2-1404) and Engineer Manual (EM-1110-2-1613) for design of deep draft navigation projects, the design water level condition must reflect conditions which are infrequently exceeded during the navigation season. Therefore, a design water level exceeded 95 percent of the time (LWD, elevation 568.6) was used during Stage 2. However, recent guidance provided by North Central Division has indicated that the design water level should reflect average conditions occurring during the navigation season. Accordingly, the design water level for channel depth evaluation at Cleveland Harbor during Stage 3 was elevation 570.9, the average monthly water level of Lake Erie during the navigation season.



WIND DIAGRAM FOR CLEVELAND, OHIO

NOTES

▬ INDICATES DURATION FOR ICE-FREE PERIOD (MAR. TO DEC. INCL.) IN PERCENT OF TOTAL DURATION.

▭ INDICATES DURATION FOR ICE PERIOD (JAN. TO FEB. INCL.) IN PERCENT OF TOTAL DURATION

—— INDICATES PERCENT OF TOTAL WIND MOVEMENT OCCURRING DURING ICE-FREE PERIOD

------ INDICATES PERCENT OF TOTAL WIND MOVEMENT OCCURRING DURING COMBINED ICE AND ICE-FREE PERIODS.

FIGURES AT ENDS OF BARS INDICATE PERCENT OF TOTAL WIND DURATION FOR ICE-FREE PERIOD AND COMBINED ICE-FREE AND ICE PERIODS, RESPECTIVELY.

WIND DATA BASED ON RECORDS OF THE U.S. COAST GUARD AT CLEVELAND HARBOR, OHIO FOR PERIOD 1 JAN. 1936 TO 31 DEC. 1971.

FIGURE C1

Table C1 - Average and Extreme Water Levels

LAKE ERIE WATER LEVEL DATA
AT
CLEVELAND, OH
PERIOD 1860-1981

STAGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1972	1972
HIGH	572.39	572.53	572.88	573.30	573.25	573.51	573.34	573.03	572.51	572.14	572.17	572.35
MEAN	569.98	569.94	570.18	570.71	571.04	571.18	571.14	570.95	570.67	570.34	570.08	570.01
	1935	1936	1934	1934	1934	1934	1934	1934	1934	1934	1934	1934
LOW	567.62	567.49	567.65	568.20	568.43	568.46	568.46	568.36	568.23	567.95	567.60	567.53

CHANGES

	Jan-Feb	Feb-Mar	Mar-Apr	Apr-May	May-Jun	Jun-Jul	Jul-Aug	Aug-Sep	Sep-Oct	Oct-Nov	Nov-Dec	Dec-Jan
	1952	1976	1913	1947	1892	1902	1915	1926	1926	1917	1927	1949-50
MAXIMUM RISE	+0.67	+1.12	+1.57	+0.95	+0.76	+0.63	+0.26	+0.13	+0.28	+0.14	+0.52	+0.78
AVERAGE	-0.04	+0.24	+0.53	+0.32	+0.15	-0.04	-0.19	-0.28	-0.33	-0.27	-0.06	-0.03
	1886	1931	1891	1891	1977	1890	1868	1937	1871	1924	1882	1917-18
MAXIMUM FALL	-0.73	-0.31	-0.13	-0.18	-0.24	-0.38	-0.52	-0.57	-0.67	-0.64	-0.51	-0.67

Ave. 1860-1981 570.52
Ave. 1900-1981 570.38

LWD 568.6

November 1983

C6. DEEP WATER WAVE CHARACTERISTICS

a. General. Cleveland Harbor, OH, can be subjected to waves spanning approximately 135 degrees of Lake Erie from the west-southwest through north to east-northeast directions. Measured clockwise from the west, this range extends from approximately 275 degrees to 50 degrees. Three angle classes can be defined as viewed by an observer standing on shore and are depicted on Figure C2 and distinguished below:

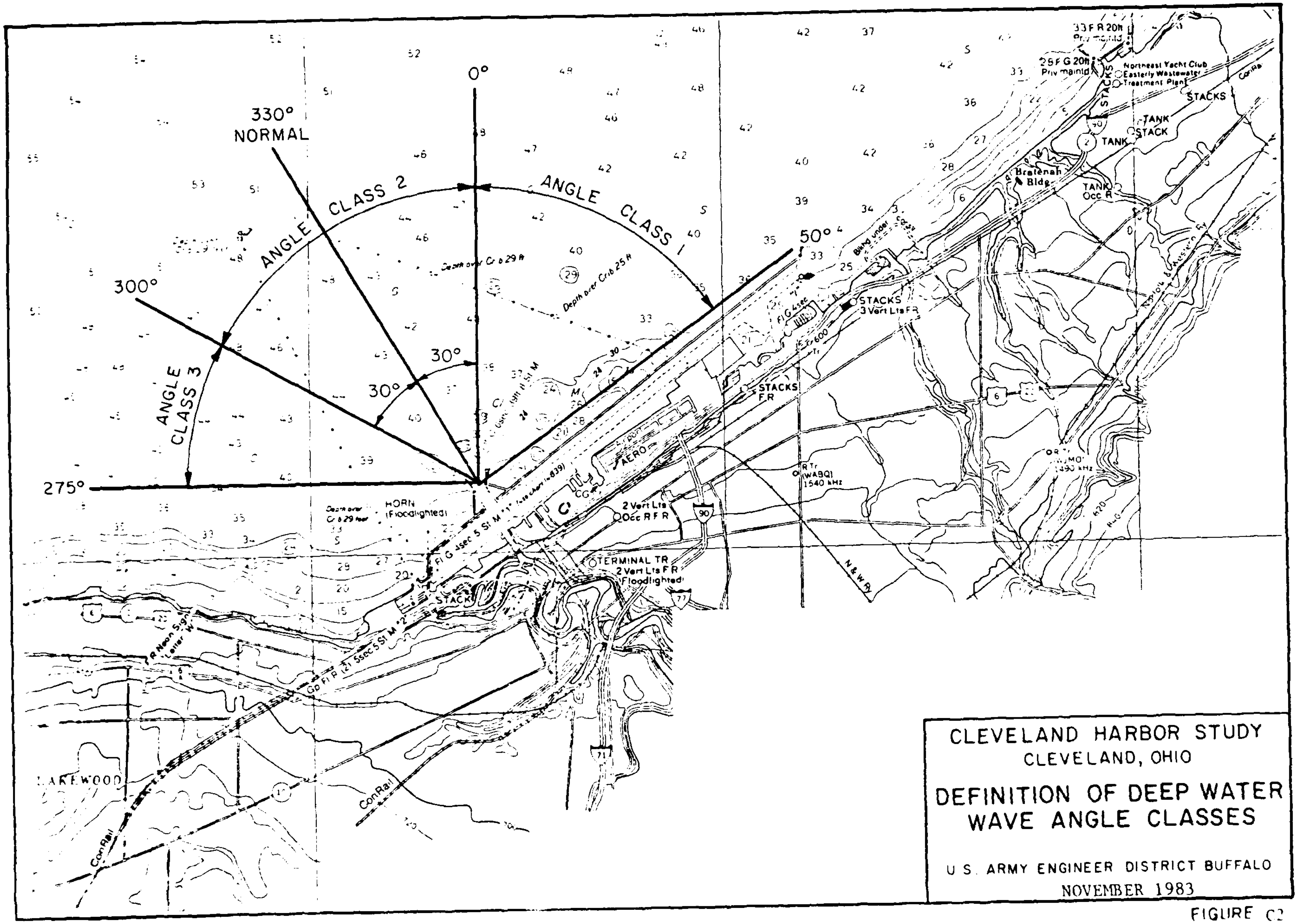
(1) Angle Class 1 - Mean wave approach angle greater than 30 degrees to the right of a normal to shore (north through east-northeast);

(2) Angle Class 2 - Mean wave approach angle within 30 degrees to either side of a normal to shore (west-northwest through north);

(3) Angle Class 3 - Mean wave approach angle greater than 30 degrees to the left of a normal to shore (west-southwest through west-northwest).

b. Significant Deep Water Wave Heights (H_o) - The significant deep water wave heights which can be expected at Cleveland, OH were determined by Waterways Experiment Station and published in Technical Report H-76-1, entitled "Design Wave Information for the Great Lakes - Report 1," dated January 1976. Table C2 presents the significant deep water wave heights at Cleveland, OH, for three angle classes as distinguished above, for each season of the year, and for various recurrence intervals.

c. Wave Period (T_o) - Table C3 presents the wave periods associated with each significant deep water wave height at Cleveland, OH, as a function of angle class and wave height as presented in Technical Report H-76-1.



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

DEFINITION OF DEEP WATER
WAVE ANGLE CLASSES

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

FIGURE C2

FIGURE C2

Table C2 - Significant Deep Water Wave Heights at Cleveland, OH

Recurrence Interval (Years)	Angle Classes 1 Wave Height (Feet)	Angle Classes 2 Wave Height (Feet)	Angle Classes 3 Wave Height (Feet)
Winter			
5	8.2	11.2	10.8
10	10.2	12.1	11.5
20	11.5	13.4	12.1
50	13.8	14.8	13.1
100	15.1	15.7	13.8
Spring			
5	3.9	5.2	6.9
10	4.9	6.6	7.9
20	6.2	7.5	8.9
50	7.5	9.2	10.2
100	8.5	10.2	11.2
Summer			
5	4.9	5.6	6.2
10	5.9	6.2	7.2
20	7.5	7.2	8.2
50	10.2	8.5	9.5
100	12.1	9.2	10.5
Fall			
5	8.9	9.5	9.8
10	9.8	10.8	10.5
20	10.5	11.8	11.2
50	11.5	13.1	12.1
100	12.1	14.4	12.8

Table C3 - Significant Deep Water Wave Periods at Cleveland, OH

Wave Height (Feet)	Angle Class 1: Wave Period (Seconds)	Angle Class 2: Wave Period (Seconds)	Angle Class 3: Wave Period (Seconds)
1	2.5	2.4	2.5
2	3.8	3.8	3.9
3	4.7	4.7	4.9
4	5.4	5.3	5.6
5	6.0	5.9	6.1
6	6.3	6.3	6.5
7	6.7	6.6	6.9
8	7.0	6.9	7.4
9	7.4	7.3	7.8
10	7.7	7.6	8.2
11	8.0	8.0	8.6
12	8.4	8.4	9.0
13	8.7	8.7	9.5
14	9.1	9.0	9.9
15	9.4	9.4	10.3
16	9.7	9.8	10.7
17	10.1	10.1	11.1
18	10.4	10.5	11.6
19	10.8	10.8	12.0
20	11.1	11.1	12.4
21	11.4	11.5	12.8
22	11.8	11.9	13.2
23	12.1	12.2	13.7
24	12.5	12.6	14.1
25	12.8	12.9	14.5

DETAILED DESIGN - "SEVERE-WEATHER" EAST ENTRANCE PLAN

C7. GENERAL

The primary objective of a "severe-weather" east entrance plan is to provide improvements required for a safe and efficient entrance into the Cleveland Lakefront Harbor through the existing east entrance and east basin by bulk cargo vessels up to 1,000 feet in length. A "severe-weather" entrance is defined as an entrance that would allow 1,000-foot long vessels to enter the Lakefront Harbor under all weather conditions for which they would be able to dock and unload their cargo. These conditions were further defined as 30-knot winds from the west through east-northeast directions with a corresponding 9 to 10-foot wave produced by these winds. A "severe-weather" east entrance primarily involves deepening and enlarging the existing east entrance channel and east basin channel. The vessel masters agreed that under design conditions (i.e., 9 to 10-foot waves and 30-knot winds), breakwater improvements at the east entrance are not required.

At the 8 April 1981 workshop, the vessel masters were unanimous in their preference for the east entrance for 1,000-foot long vessels and in their opinion, it is far superior to any west entrance plan. The vessel masters' main reason for their east entrance preference is the potential damage to the vessel that could be caused by striking any of the many obstacles at the west entrance (i.e., pierhead lights, breakwater arms, etc.), especially since the masters lose sight of an object when it is closer than 300 to 400 feet away. The master is then forced to rely on instruments and/or lookouts at the bow of the vessel. The problem is intensified at Cleveland due to strong crosscurrents at the existing arrowhead (west) entrance.

C8. CHANNEL DESIGN

Adequate channel depths and widths are required for safe and efficient navigation of ships. Therefore, at the 8 April 1981 workshop in Cleveland, vessel masters were requested to provide their professional and expert views on 1,000-foot long vessel operating characteristics that are required for the design of a "severe-weather" east entrance at Cleveland Harbor. According to the vessel masters, when entering Cleveland Harbor under design "severe-weather" conditions (i.e., 9 to 10-foot waves and 30-knot winds), a 1,000-foot long vessel would have to be traveling at a speed of approximately 6 miles per hour in order to maintain proper vessel control. Once in the protected east basin channel, the vessel would slow down to 2 to 3 miles per hour. When entering at a speed of 6 miles per hour under the design conditions, an angle of roll of 3 to 5 degrees can be expected on a 1,000-foot long vessel. The vessel masters also indicated that the angle of roll for smaller vessels would be about 1-1/2 times the angle of roll of a 1,000-foot long vessel, or between 5 to 7 degrees. The masters also agreed that their vessel would not experience roll in the protected east basin for the design "severe-weather" conditions. However, the vessel masters indicated that a 1,000-foot vessel can be expected to roll up to 2 to 3 degrees as the ship passes between the existing main entrance to the harbor and the Cuyahoga River entrance piers. This 2 to 3 degrees of roll would be the result of storm waves which would propagate into the harbor between the arrowhead breakwaters and also due to discharge from the Cuyahoga River. The vessel masters also stated that they need sufficient water under their vessel in order to be able to use their engines without rupturing oil and air lines due to excessive vibration of the vessel.

a. Channel Depth. The design water level of 570.9, which represents average lake levels during the navigation season, will be used for channel depth evaluation and will allow for safe design vessel passage under average water levels. The channel depth requirements will include consideration of the following significant criteria: (1) The static draft of the vessel at rest; (2) The sinkage or squat of the vessel underway; (3) The amount of vessel roll; (4) The effect of vessel pitch and heave; and (5) Nominal bottom clearance.

The channel depths were selected to safely and efficiently accommodate the passage of the design vessel which is normally the largest vessel (length, beam, and draft) expected to use the channel during the project life. At Cleveland Harbor, the largest vessel expected to use the port is the Class 10

(1,000 feet X 105 feet) bulk cargo vessel. However, the combined effect of roll and squat for smaller vessels is greater than for larger vessels and if loaded drafts are identical, the channel depth requirements may be based upon criteria for the smaller Great Lakes vessels. Therefore, the channel depth requirement for entrance into the Lakefront Harbor was evaluated for the Class 5 vessel (600-649 feet X 68 feet), the Class 6 vessel (650-699 feet X 72 feet), the Class 7 vessel (700-730 feet X 75 feet), the Class 8 vessel (731-849 feet X 70 feet), and the Class 10 vessel (950-1,000 feet X 105 feet). The numerical calculations of required depths were developed from practical and theoretical information in technical reports and papers. The calculations are attached to the end of this appendix and are based on a 26-foot average static draft at average water levels. The following paragraphs discuss the significant criteria which were considered in determining the required channel depths. The results of the channel depth evaluation are summarized in Table C4. The depth requirements include the greater of the values for either vessel roll or the combination of pitch and heave.

(1) Vessel Squat. Vessel squat is the lowering of the water surface around a moving vessel which produces a relative change in the ship's position with respect to the channel bottom. Vessel squat was calculated on the basis of procedures outlined in Chapter 5 of Engineer Manual (EM 1110-2-1613) entitled "Hydraulic Design of Deep Draft Navigation Projects" dated 8 April 1983 (see Figure C3) and also by an empirical method recommended in the "Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels" prepared by Detroit District, Corps of Engineers using the following formula:

$$S = \frac{V_i^2}{2g} \left[\left(1.01 \frac{A_i}{A_w} \right)^2 - 0.84 \right]$$

Where: S = Squat at speed V_i (ft)
V_i = Ship velocity (ft/sec) relative to water
A_i = Channel cross-sectional area (sq ft)
A_w = Channel cross-sectional area less ship cross-sectional area (sq ft)
g = 32.2 ft/sec

Pertinent parameters include: static draft of 26.0 feet; vessel beam widths, entrance speed at 6 mph, reduced speed of 3 mph, waterway width of 900 feet for the lake approach channel and entrance channels, waterway width of 500 feet in the east basin channel and channel depth (assumed). The computed squat values are 0.5-foot for the 1,000-foot long vessel and 0.4-foot for the smaller class vessels in the lake approach and entrance channels. In the east basin channel, the squat value for 1,000-foot long vessels is about 0.6-foot, except in the area of the existing main entrance where vessel squat will be about 0.2-foot.

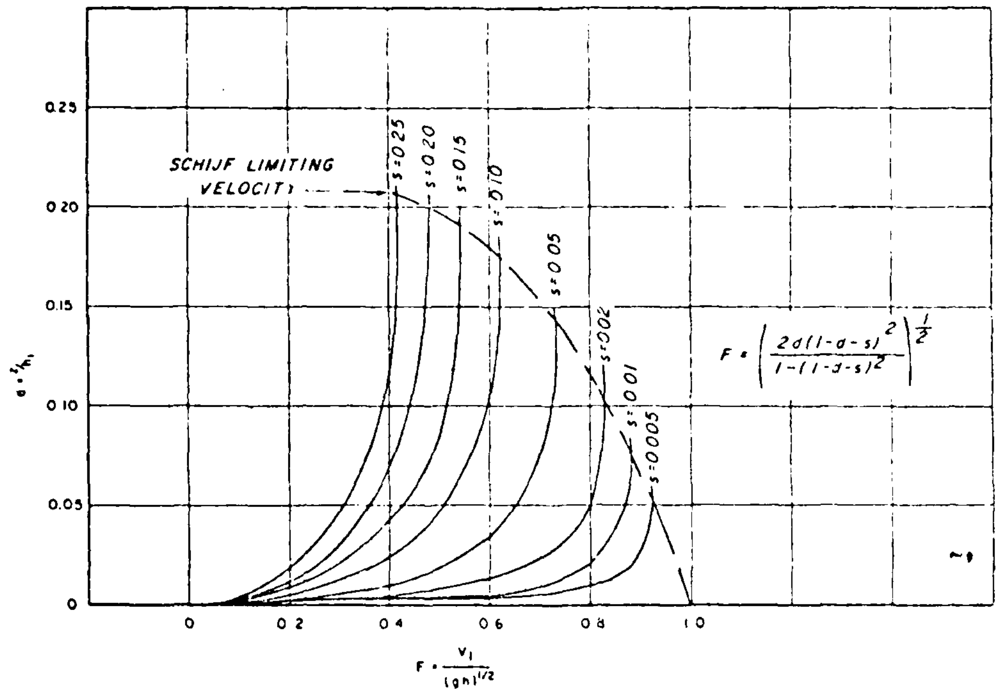


FIGURE C3- Dimensionless squat as a function of the Froude number

$S = \frac{A}{WH}$ where

S = ratio of ship cross section to channel cross section
A = vessel cross sectional area
W = channel width
H = channel water depth

$F = \frac{V}{\sqrt{gh}}$ where

F = the Froude Number
V = speed of the ship relative to the water
g = acceleration of gravity
h = depth of water in the channel

(2) Vessel Roll. Vessel roll is rotation of a vessel around its longitudinal axis as a result of waves, wind, and turn angle. Roll is greatest when the vessel hull is parallel to the wave crests. According to vessel masters, an angle of roll of between 3 and 5 degrees can be expected on the Class 10 vessel and 1-1/2 times that amount or between 5 to 7 degrees for smaller vessels in the lake approach and entrance channels. The vessel masters also indicated that the 1,000-foot long vessel will roll between 2 to 3 degrees as the vessel passes the existing main entrance to the harbor. This analysis will use an angle of 4 degrees of roll for the Class 10 vessel and an angle of 6 degrees of roll for Class 5 through Class 8 vessels in the lake approach and entrance channels and 2 degrees of roll for the Class 10 vessels as they pass the existing main entrance to the harbor. The following formula is used to compute vessel roll:

$$Y = \frac{B}{2} \text{ sine } \theta$$

Where: Y = Depth requirement due to roll (ft)
B = Vessel beam
θ = Angle of roll in degrees

The computed roll values were 3.7 feet for the 1,000-foot long vessel and ranged from 3.6 feet to 3.9 feet for the smaller class vessels in the lake approach and entrance channels. Once in the east basin channel, the breakwater will provide a protected channel such that the vessels will not experience roll until passing the existing arrowhead entrance where a Class 10 vessel will roll about 1.8 feet.

(3) Vessel Pitch and Heave. Vessel pitch is rotation of a vessel about its transverse axis and heave is the vertical body motion of a vessel. These motions are caused by waves and are greatest when a vessel hull is normal to wave crests. The equations presented in the "Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels" prepared by Detroit District of the Corps of Engineers were used to compute the depth requirement due to pitch and heave. These equations are as follows:

$$\frac{\theta L}{2} = 0.1 H$$

and

$$\frac{\text{Heave}}{H} = 0.1$$

Where:

$\frac{\theta L}{2}$ = Pitch amplitude in feet

H = Wave amplitude in feet

The pitch and heave value was determined to be 0.9 feet for each class vessel. However, the maximum values of roll, or pitch and heave are not additive since their occurrence is a function of hull and wave crest orientation (i.e., if the vessel hull is parallel to the wave crest, roll is maximum and pitch and heave approach zero). Therefore, the larger of the values of roll, or pitch and heave are used in determining the required channel depth. For the "severe-weather" east entrance plan at Cleveland, the depth requirement for roll governs over the value of pitch and heave.

(4) Nominal Bottom Clearance. After all depth requirements are made for vessel squat, roll, and pitch and heave, it is desirable to design for additional bottom clearance for vessel safety and efficiency. The common allowances for bottom clearance are 2 feet in soft material and 3 feet in hard material. This additional clearance under the vessel is required to avoid damage to ship propellers from sunken timbers and debris and to reduce displacement of bottom material. The added clearance will also allow greater vessel operating efficiency and improve vessel maneuverability. At Cleveland harbor, all material is considered to be soft, and therefore, a nominal bottom clearance value of 2 feet will be included in the channel depth requirement. In addition, this additional clearance will provide sufficient water under the vessel to reduce excessive ship vibrations caused by operation of the engines in shallow water.

(5) Physical Model Tests of Vessel Motion. A commercial navigation project design conference and physical model testing program were conducted at Waterways Experiment Station during 11-14 April 1983. In attendance were vessel masters of 1,000-foot long vessels and Corps representatives from Buffalo District, Detroit District, North Central Division, Office of the Chief of Engineers, and Waterways Experiment Station. The purpose of the model testing program was to investigate the degree of roll that 1,000-foot long vessels would experience when entering the east entrance at Cleveland Harbor during design storm conditions and to qualitatively assess the affect of various underkeel clearances on ship maneuverability. A Memorandum for the Record (MFR) which was concurred in by all attendees, is attached to this Appendix as Exhibit C-1. The MFR presents the details of the design conference and testing program. The following paragraphs summarize the results of the physical model tests.

The 10-foot long model ore carrier (representing a 1,000-foot long prototype vessel) was dynamically balanced at the David Taylor Naval Ship Research and Development Center. The vessel was loaded to a 25.5-foot static draft and subjected to various broadside wave spectras and simulated wind fields in the new spectral basin at WES. The physical model tests were conducted to determine if vessel roll resulted in the ore carrier striking the bottom of the model floor for various wave and wind conditions. Ship speed of 6 miles per hour were simulated during the testing conditions. The test results indicated that for 8.2 second, 10-foot significant wave spectra (irregular waves), the model ore carrier struck bottom for depths of 29-32 feet with no wind. The vessel did not strike bottom with the depth at 33 feet and no wind, but did strike with the 30-knot wind imposed. For the 7.3 second, 8-foot significant wave spectra (irregular waves), the vessel did not touch bottom at water depths of 27-29 feet and no wind. With 20-knot winds imposed (those that correspond to 8-foot waves), the vessel did not strike bottom for the 27 and 28-foot depths. Tests were also conducted using 8 second, 8-foot, and 10 second, 8-foot monochromatic waves with water depths

Table C4 - Summary of Channel Depths Required for the "Severe-Weather" East Entrance Plan

Vessel Class	Static Draft (ft)	Squat Requirement (ft)	Roll Requirement (ft)	Pitch and Heave Requirement (ft)	Nominal Bottom Clearance (ft)	Required Channel Depth (ft)
	LAKE APPROACH AND ENTRANCE CHANNELS					
10	26.0	0.5	3.7	0.9	2.0	32.2
8	26.0	0.4	3.7	0.9	2.0	32.1
7	26.0	0.4	3.9	0.9	2.0	32.3
6	26.0	0.4	3.8	0.9	2.0	32.2
5	26.0	0.4	3.6	0.9	2.0	32.0
	EAST BASIN CHANNEL					
10	26.0	0.6	0.0	0.0	2.0	28.6
	EAST BASIN CHANNEL AT EXISTING ARROWHEAD					
10	26.0	0.2	1.8	0.0	2.0	30.0

NOTE: The channel depths are those required below the design minimum water level which for this analysis is elevation 570.9.

of 28 and 30 feet. These tests yielded results comparable to the irregular wave tests in that the vessel did not strike bottom at either depth for the 8 second waves but did strike at both depths with the 10 second waves.

The test results, for both the spectral and monochromatic waves, verified that the significant wave period is critical with respect to vessel roll motion. It appears that as the wave period approaches the natural frequency of roll of the vessel, the roll of the vessel increases thereby requiring deeper bottom depths. As a result of the testing program, the design storm entrance conditions at Cleveland Harbor were established as being 30-knot winds and 9-foot, 7.8 second waves from the northwest (approximately a 3-year event). This design storm entrance condition represents the critical condition for vessel roll. A 4-foot underkeel allowance for roll which would correspond to design storm conditions of 9-foot, 7.8 second wave spectra, was deemed reasonable. In addition, based on previous discussions with vessel masters, a 4-foot allowance for vessel roll during the design storm condition was considered to be adequate.

The physical model tests conducted at WES can be considered to yield a conservative approximation of the roll value. However, as indicated in paragraph 11 of WESHH Memorandum for Record (MFR) dated 27 April 1983 (see Exhibit H-1), care should be exercised in interpreting the test results. Although the vessel simulated the correct mass and was dynamically balanced, viscous scale effects were not considered. Therefore, according to the WESHH MFR, due to viscous scale effects, the model vessel may roll slightly less than that of the prototype ship.

b. East Basin Channel Width. The width of the navigation channel is measured at the bottom of the channel that is required for safe navigation of the design vessel. The design vessel for determining the required width of the channels for Cleveland Harbor will be the Class 10 (950-1,000 feet X 105 feet) bulk cargo vessel. Some of the factors that will be given consideration in determining the proper width of the channel are: whether the design vessel must pass another vessel; the controllability of the vessel; the normal speeds of the vessel relative to the channel bottom; current velocities and directions; wave action or wind that will cause the vessel to yaw; the depth of water under the keel of the vessel; whether the channel occupies the entire waterway or is in a wide waterway; and the characteristics of the banks of the channel. The guidance presented in Chapter 7 of the Engineer Manual (EM 1110-2-1613) entitled "Hydraulic Design of Deep Draft Navigation Projects" dated 8 April 1983 was used in the channel width evaluation for Cleveland Harbor. Since the length of channel comprising the "severe-weather" east entrance plan is over 4 miles long, the channels will be designed to accommodate passing vessels. The required widths for the entrance channel and east basin channel will be determined by computing the widths of two maneuvering lanes, a ship clearance lane, and two bank clearance lanes for the design vessel.

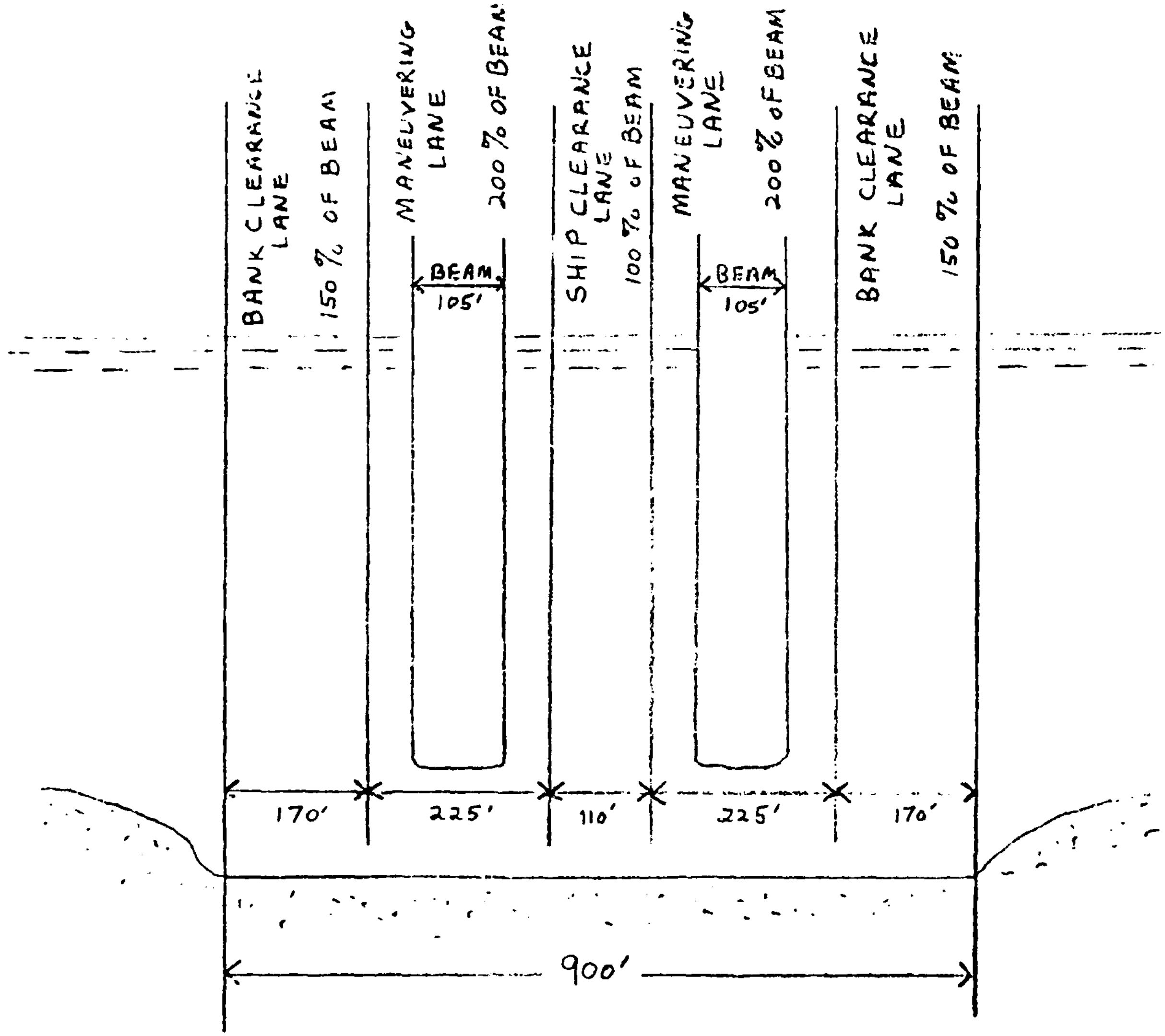
(1) Maneuvering Lane. The maneuvering lane width is defined as that portion of the channel within which the ship may maneuver without encroaching on the channel bank or without approaching another ship so closely that dangerous interference between ships will occur. The recommended minimum

maneuvering lane width is 160 percent of the design vessel beam (105 feet) for a vessel with no yawing forces and with good controllability. In the case of Cleveland Harbor, under the design "severe-weather" condition (i.e., 9 to 10-foot waves and 30-knot winds), the 1,000-foot long design vessel will experience yawing forces due to the winds and waves which in turn will affect the movement and controllability of the ship. Therefore, a maneuvering lane equivalent to 200 percent of the vessel beam, or about 210 feet, was selected as the minimum width for each of the maneuvering lanes in the entrance channel. Once in the protected area behind the east breakwater, the controllability of the vessel will be improved. The yawing forces will be reduced with only the winds acting on the side of the vessel, therefore, a maneuvering lane equivalent to 180 percent of the beam, or about 190 feet, was selected as the minimum width for each of the maneuvering lanes in the east basin channel.

(2) Ship Clearance Lane. Since the channel width of the "severe-weather" east entrance is being designed to accommodate two-way traffic, a ship clearance lane must be provided between the inner boundaries of the two maneuvering lanes. The recommended minimum width of the ship clearance lane is set at 80 percent of the beam of the design vessel assuming no yawing forces. The east entrance into Cleveland Harbor will be subjected to strong yawing forces under the design "severe-weather" condition. Therefore, a ship clearance lane equal to 100 percent of the beam of the design vessel, or 105 feet, will be used as the minimum width for this lane in the entrance channel. Once in the protected area behind the east breakwater, the yawing forces will be reduced and therefore, a ship clearance lane equal to 90 percent of the beam of the design vessel, or 95 feet, will be used as the minimum width for this lane in the east basin channel.

(3) Bank Clearance Lane. The bank clearance lane is the horizonal distance between the outer boundary of the maneuvering lane and the bottom of the channel sideslope. The recommended minimum width of the bank clearance lane is 60 percent of the design vessel beam for vessels with very good controllability in channels with no yawing forces. Since strong yawing forces are expected under the design "severe-weather" condition at the east entrance to Cleveland Harbor, the minimum width of each bank clearance lane in the entrance channel will be equal to 150 percent of the beam of the design vessel, or approximately 160 feet. Once in the protected area behind the east breakwater, the vessel will be traveling at a slow speed where the vessel's side thrusters will be effective in improving controllability of the vessel. Also, the waterway is much wider than will be needed in the east basin and the adjacent material is a soft silty material. Therefore, a minimum bank clearance lane equal to 60 percent of the beam of the design vessel, or 65 feet, will be used for each bank clearance lane through the east basin channel.

Based on the guidance presented in Chapter 7 of Engineer Manual (EM 1110-2-1613) entitled "Hydraulic Design of Deep Draft Navigation Projects," the channel width required in the east basin channel is approximately 600 feet (see Figure C-5). However, at the 8 April 1981 workshop, the vessel masters stated that only a 500-foot wide east basin channel is needed. Therefore, based on experience of the vessel masters, a 500-foot wide east basin channel was incorporated into the "severe-weather" east entrance plan.



ELEMENTS OF ENTRANCE CHANNEL WIDTH FOR "SEVERE WEATHER" EAST ENTRANCE PLAN

FIGURE C4

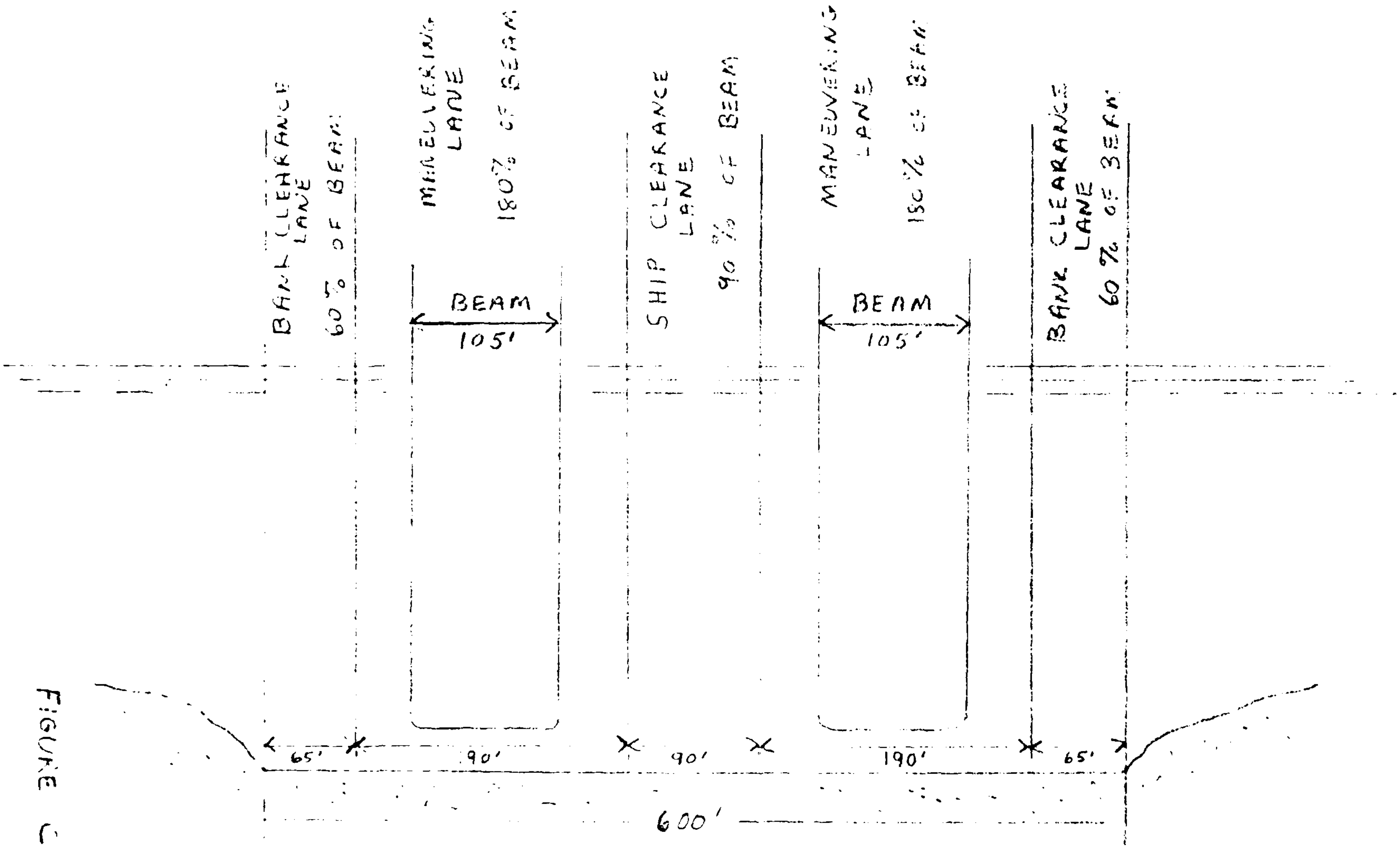


FIGURE C5

ELEMENTS OF EAST BASIN CHANNEL WIDTH FOR "SEVERE WEATHER" EAST ENTRANCE PLAN

Note: The 600-foot wide channel is based on design guidance per Engineer Manuals however, the actual channel width will be 500 feet per vessel masters stated needs based on experience

c. "Severe-Weather" East Entrance Channel Dimensions. The plan for a "severe-weather" entrance is shown on Plate C3 and includes the following improvements:

(1) Deepening to the 30-foot LWD depth contour, a fan-shaped lake approach channel and a 900-foot wide (rounded up from the required minimum 845 feet) entrance channel (see Figure C4) extending 2,900 feet into the east basin.

(2) Deepening of the existing 14,600-foot long, 500-foot wide east basin channel to 26.0 feet LWD in depth.

CUYAHOGA RIVER CONGESTION

C9. GENERAL

The harbor area of the Port of Cleveland includes the lower 5.8 miles of the Cuyahoga River (see Plate 2 in Appendix I). Vessels up to 630 feet in length and with a beam of 68 feet navigate the river destined for upriver docks. The Cuyahoga River channel is a winding narrow channel and the numerous bridge crossings and bends impede vessel movement and prohibit passage of larger vessels. The sharp bends and narrow channels also impose slow speeds of about 2 miles per hour on vessels and make navigation hazardous. Shipping companies have reported that vessels frequently run into the banks and bulkheads, come in contact with bridge piers, and have had mishaps with small boats moored along the banks. This section will address congestion along the Cuyahoga River at the site of the former Jefferson Avenue bridge and present the assumptions and criteria used to develop alternatives to alleviate the restriction and facilitate passage of vessels.

C10. CONGESTION AT THE JEFFERSON AVENUE BRIDGE ABUTMENTS

This congestion area on the Cuyahoga River is at the bridge abutments of the former Jefferson Avenue bridge. The bridge abutments are located approximately 4.3 miles upriver from the outer ends of the river entrance piers. The Jefferson Avenue bridge which crossed the river at this location has been removed, however, the bridge abutments located on each side of the navigation channel were left in place and restrict the navigation channel to a width of about 130 feet. This restriction is a hazard to navigation and has been the site of several vessel mishaps. The restriction also causes vessels to reduce their speed while moving past the abutments. To reduce delay time at the congestion area, eliminate the hazard to navigation, and facilitate navigation through this area, it would be necessary to remove the Jefferson Avenue Bridge abutments and widen the navigation channel. During this study, a new channel limit was established whereby the width of the navigation channel would be increased to about 190 feet, which is the present width of the navigation channel immediately upstream and downstream of the existing restriction. To widen the channel, the bridge abutment on each side of the river would be removed, a bank cut would be made on each side of the channel and existing bulkheads would be replaced, as appropriate. The details of the restriction and proposed widening are shown on Plate 23 in Appendix I.

DEPARTMENT OF THE ARMY

WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
PO BOX 631
VICKSBURG, MISSISSIPPI 39180

REPLY TO
ATTENTION OF

NCBPD/NCBED-DC

14 April 1983

MEMORANDUM FOR RECORD:

SUBJECT: Commercial Navigation Project Design Conference, 11-14 April 1983 at WES

1. A commercial navigation project design conference and model testing program were conducted at Waterways Experiment Station during 11-14 April 1983. In attendance were:

NCB
Major Creeden (part time)
Don Liddell
Chuck Gilbert
Denton Clarke
Richard Gorecki
Dick Aguglia

NCD
Zane Goodwin
Al Behm (part time)
Larry Hiipakka
Charles Johnson

NCE
Bob Meehan

OCE
Sam Powell
Bill Counce (part time)

WES
Gene Chatham
Ray Bottin
Carl Huval (part time)
Glenn Pickering (part time)
Bob Jensen (part time)

Vessel Masters (part time)
Al Haines
Vic Chamberlain
Vic Anderson

2. The purpose of the model testing program was to investigate the degree of roll 1,000-ft ships would experience during a design storm condition(s) and to qualitatively assess the effect of various underkeel clearances on ship maneuverability. The purpose of the conference was to quantitatively determine channel depths given OCE design guidance and the results of the model test at the east entrance channel to Cleveland Harbor and, insofar as possible, for Lorain and Buffalo.

3.a. Test Results: A dynamically balanced scale model (1:100) 1,000-ft ore carrier was subjected to various broadside wave spectras and simulated wind fields in the new spectral basin at WES. Monochromatic wave tests also were conducted at the existing Cleveland Harbor model. Tests were run at water depths ranging from 27 ft to 33 ft in 1-ft increments for specific wave conditions at Cleveland Harbor. The degree of roll was estimated by holding the wave spectra constant and increasing the water depth until the vessel no longer touched the floor of the model as a result of the vessel roll motions. Results of these tests are presented on Tables 1 and 2. A simplified turning test also was conducted for various underkeel clearances without wind and waves. Results of these tests are shown on Table 3. For all tests, the model ore carrier was loaded to a 25.5-ft static draft with a natural roll frequency of about 1.0 sec which equates to about 10 sec in the prototype. The testing program verified that the wave period is critical in causing the roll motion on the vessel. For the Class X vessel (105-ft beam), the ship struck bottom for all tests performed with a 10.0-ft, 8.2-sec significant wave spectra (irregular waves) with water depths of 29 through 32 ft and no wind. For the 8-ft, 7.3-sec significant wave spectra (irregular waves), the Class 10 vessel did not touch bottom at water depths of 27 through 29 ft and no wind. Corresponding results were obtained for monochromatic waves at 28- and 30-ft water depths. The results from the turning test also verify the need for having sufficient water under the vessel for vessel maneuverability.

3.b. Scale Effects: Reynolds similarity could not be satisifed with the scale model. Most of the effects of this dissimilarity appear in the damping ratio, C/C_c . If the exciting frequency is much larger than the ship's natural roll frequency, the amplitude of the response is little dependent on the value of the damping ratio. For values of ω/ω_n greater than about 1.5, we can have very large changes in C/C_c due to scale effects without affecting the amplitude of the motion by more than a few percent. For the model, in 28 to 30-ft depths, the impulse response required from 7 to 14 cycles to damp out, gives a damping ratio of about 0.25. As ω/ω_n is decreased from 1.5 toward 1.0, the response amplitude increases rapidly and becomes much more sensitive to the value of the damping ratio. Referring to Figure 1, we see that for $\omega/\omega_n = 1.35$, a change in C/C_c from 0.35 to 0.25 increases the amplitude by about 5 percent. For $\omega/\omega_n = 1.12$, the same change in C/C_c increases the amplitude by about 40 percent. Thus, if we choose design conditions of low recurrence frequency, we not only must increase the channel depth by many feet on the basis of this test series, we also must make a larger allowance for experimental error due to scale effects.

3.c. Natural Periods. According to R. A. Stearns, Naval Architect, designer of several Great Lakes Class X self-unloading bulk carriers, the ships have the following natural periods when loaded to 25.5 ft draft:

11 sec - stone cargo
16 sec - iron ore
8-9 sec - plugged ballast

The 1:100 scale model was balanced to a natural period of about 10 sec. Hence the test results are very conservative for ships carrying iron ore.

4. Entrance Channel Depth Design Conditions: As per ER 1110-2-1404, channel depth design conditions must reflect weather and hydraulic conditions which are infrequently exceeded during the navigation season and allow for safe passage of the design vessel under these conditions with a competent pilot or captain. In accordance with this rationale, the following design criteria will be considered when developing entrance channel depths:

Static depth of Design Vessel.
Roll or pitch and heave of design vessel during the design storm conditions, whichever is greater.
Squat.
Underkeel clearance (2 ft in soft bottom material and 3 ft in hard, or as modified by specific site conditions, as appropriate).

The water level deemed appropriate for channel depth elevation at Cleveland Harbor is that level which is exceeded about 95 percent of the time during the navigation season. For Lake Erie, this design water level is el 568.6 or 0.0 LWD. The design storm should be selected based on site specific conditions at each harbor and may be different for different harbors. It should be noted that, although the basic design conditions are the same, site specific wind and wave data, harbor orientation and configuration, etc., at each individual harbor may produce entrance channel depths that are not the same.

5. Design Entrance Channel Depth for the East Entrance of Cleveland Harbor:

a. The design vessel is a 1,000-ft-long by 105-ft-wide bulk cargo vessel.

b. The design storm conditions are 30 knot winds and 9-ft, 7.8-sec waves from the northwest (approximately a 3-year event) which represents the critical conditions for vessel roll. These are also the maximum operating conditions for the C&P ore dock in the Lakefront Harbor.

c. The design water level with a 95 percent exceedance frequency is LWD for Lake Erie.

d. Entrance channel depth as per design criteria established in paragraph 4 is as follows:

Static draft	- 25.5 ft	
Allowance for roll	- 4.0 ft	(≈4 deg of roll)*
Allowance for squat	- 0.5 ft	
Underkeel clearance	- 2.0 ft	

Thus, the total depth required at Cleveland Harbor is 32 ft LWD.

* Based on previous discussions with vessel masters, a 4-ft allowance for vessel roll during the design storm condition was considered adequate. Model tests conducted at WES, which are considered a conservative approximation, indicated that this was a reasonable allowance. Thus, although model tests indicated that a 6.5 ft allowance was required for a 10-ft, 8.2-sec wave spectra (12-year occurrence), a 4-ft allowance, which would correspond to design storm conditions of 9-ft, 7.8-sec wave spectra, was deemed reasonable. In addition, since the design water level is exceeded about 95 percent of the time, extra depth of water will be available most of the time.

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SUBJECT: Commercial Navigation Project Design Conference, 11-14 April 1983 at WES

6. Design Entrance Channel Depth for Lorain Harbor: The required entrance channel depth analysis for Lorain Harbor is the same as for Cleveland Harbor except that the critical direction of the wind and waves are from the north. The Lorain Harbor entrance channel has an east-west orientation, thus Class X vessels entering the harbor are subject to beam seas creating maximum vessel roll. Thus, the required entrance channel depth is 32 ft. (Note: Spectral analyses of wave gage data from the Cleveland Harbor wave gage indicated that the wave spectras from the west and from the north were nearly identical. Further, since Lorain Harbor is only 26 miles west of Cleveland, the wave spectra from the north at these two harbors are assumed to be the same. NCB will verify this assumption during detailed planning. Thus, the results of the Cleveland Harbor model testing program with wave spectra from the west are representative of conditions that would occur at Lorain Harbor during the northerly design storm (i.e., use 4-ft allowance for roll).) NCB also will verify with local shipping companies that maximum dock operating conditions in the Lorain Lakefront Harbor are about 30 knot winds.

7. Design Entrance Channel Depth for Buffalo Harbor: Because of the orientation of the harbor entrance at Buffalo, vessel roll may not be the critical factor at this harbor. Rather, pitch and heave may govern. There is insufficient information available at the present time to estimate the appropriate allowance for pitch and heave with a design storm from the west (the critical design conditions). NCB will develop this information during the detailed planning stage of the Buffalo Harbor Study. It should be noted, however, that at the present time it does not appear that Buffalo Harbor will need an entrance channel depth greater than the current 30-ft-deep channel since allowances for pitch and heave are normally not as large as those required for roll. In addition, a westerly storm which would cause significant vessel pitch, normally increases the water level at Buffalo Harbor. Thus calculated depth allowances for pitch would be obviated by storm set-up.

8. Concurrence in this MFR is indicated by the following:

Donald M. Liddell
for NCB: Don Liddell

Robert V. Meehan, noted
for NCE: Bob Meehan

Zane Goodwin
for NCD: Zane Goodwin

S. M. Powell
for OCE: Sam Powell

EXHIBIT C1 (Continued)

Test Results

Table 1 - Irregular Waves

Draft 25.5 ft
yes indicates ship struck bottom

Depth (LWD)	$\omega_n = 1/10$ sec $H_s = 8$ ft $T_s = 7.3$ sec 22 knot winds ≃ 1 yr event $\frac{\omega}{\omega_n} = \frac{10}{7.3} = 1.34$	$\omega_n = 1/10$ sec $H_s = 10$ ft $T_s = 8.2$ sec 30 knot winds ≃ 12 yr event $\frac{\omega}{\omega_n} = \frac{10}{8.2} = 1.22$	$\omega_n = 1/10$ sec $H_s = 12$ ft $T_s = 8.8$ sec 43 knot winds ≃ 150 yr event $\frac{\omega}{\omega_n} = \frac{10}{8.8} = 1.14$
27	no 22.5 knot wind - no 31 knot wind - yes	no test	no test
28	no 22.5 knot wind - no 31 knot wind - yes	no test	no test
29	no	yes	no test
30	no test	yes	no test
31	no test	yes	no test
32	no test	yes	no test
33	no test	no 0 wind - no 31 knot wind - yes	yes

continued

Test Results (Concluded)

Table 2 - Monochromatic Waves

Draft 25.5 ft
yes indicates ship struck bottom

Depth (LWD)	H_s - 8 ft T_s - 10 sec	H_s - 8 ft T_s - 8 sec
28	yes	no
30	yes	no

Table 3 - Simplified Radius Test

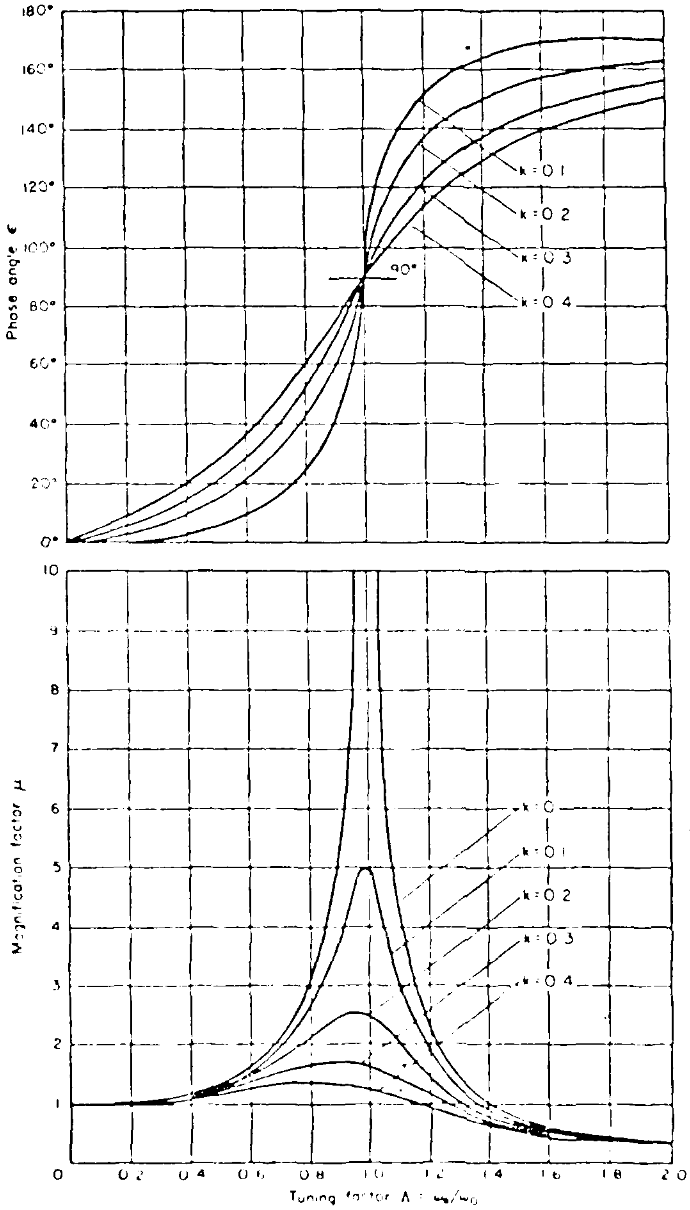
6 knot speed
Draft of 25.5 ft
Model Rudder angle 30 deg (45 deg prototype)

Water Depth (LWD)	Radius (ft)* Starboard Turn	Port Turn
27	38.6	34.9
28	28.7	27.6
30	25.2	23.4

* 1:100 scale

These simplified radius tests indicate that the depth of water under the keel has an impact on the ship response.

ship, leading to a ship at sea rolling predominantly at frequencies close to its natural frequency.



← Figure 1

Fig. 12.5 Phase angle and magnification factor

BY RJG DATE 9/83 SUBJECT Cleveland Harbor, OH SHEET NO 1
CHKD BY RGA DATE 11/83 Channel Depth Requirements for JOB NO
Lake Approach and Entrance Channels

A) "SEVERE WEATHER" EAST ENTRANCE PLAN

1) Class 10 Vessels (950'-1,000' x 105')

a) Squat - Graphical Method

A = vessel cross-sectional area = 105' x 26.0' = 2730 ft^2

W = chanel width = 900 feet (Note: The actual waterway width is wider however it will be much shallower beyond the channel limits).

H = Channel water depth = 32 feet (assumed depth)

$$S = \frac{A}{WH} = \frac{2730}{(900)(32)} = 0.09$$

V = 6 mph = 8.8 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH)

g = acceleration due to gravity = 32.2 ft/sec^2

$$F = \frac{V}{\sqrt{gH}} = \frac{8.8}{\sqrt{(32.2)(32)}} = 0.27$$

$$D = \frac{Z}{H} = 0.007 \text{ (From Figure C 3)}$$

$$Z = (0.01)(32) = 0.3 \text{ feet}$$

Squat - Empirical Method

V_1 = ship velocity relative to water = 6 mph = 8.8 ft/sec

A_1 = Cross-sectional area of channel = 900 x 32 = 28,800 ft^2

A_2 = Cross-sectional area of vessel = 105' x 26.0 = 2730 ft^2

$A_w = A_1 - A_2 = 28,800 - 2730 = 26,070$ ft^2

g = 32.2 ft/sec^2

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{(8.8)^2}{(2)(32.2)}\left[\left(1.01\left(\frac{28,800}{26,070}\right)\right)^2 - 0.84\right]$$

S = 0.5 feet

b) Nominal Bottom Clearance: Use 2.0 feet

c) Roll: According to the Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels prepared by Michael Baker, Inc for Detroit District, the maximum roll on 1,000-foot vessels is in the range of 2-3 degrees. At an 8 April 1981 workshop held in Cleveland, the vessel masters of 1,000 ft vessels indicated that the maximum roll on a 1,000 foot long vessel entering Cleveland Harbor would be in the range of 3-5 degrees. Physical model tests of vessel motion which were conducted by WES in April 1983 indicate that a value of 4 degrees of roll is reasonable for 1,000 ft long vessels. Therefore, 4° will be used

Y = depth requirement due to roll
B = Vessel Beam = 105 feet

θ = Maximum roll in degrees = 4°

$Y = \frac{1}{2} B \sin\theta = (\frac{1}{2})(105)(\sin 4°) = 3.7$ feet

d. Pitch and Heave – Vessel masters of 1,000 foot vessels which are presently operating on the Great Lakes stated that they would not attempt to enter Cleveland Harbor when wave conditions at the entrance exceed 9 to 10 feet. Therefore, the pitch and heave will be determined based on a 9 foot wave height.

Pitch $= \frac{\theta L}{2} = 0.1H$ $\quad \frac{Heave}{H} = 0.1$ $\quad$ where H = wave amplitude
$H = \frac{1}{2}(9) = 4.5$ feet

$\frac{\theta L}{2} + Heave = (2)(0.1)(H) = (2)(0.1)(4.5) = 0.9$ feet

e. Required depth in the Lake Approach and Entrance Channel at the East Entrance for the "Severe Weather" Condition by the Class 10 vessel (950′–1,000′ × 105′):

Case 1 utilizes the squat value from Graphical Method
Case 2 utilizes the squat value from Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.3	0.5
Roll	3.7	3.7
Pitch and Heave	*	*
Nominal Clearance	2.0	2.0
Required Depth	32.0 feet	32.2 feet

* Roll @ 3.7 feet > Pitch & Heave @ 0.9 feet ∴ Roll governs

Use an approach and entrance channel depth of 32 feet below the design minimum water level.

2) Class 8 Vessels (731'-849' x 70')

a) Squat - Graphical Method

A = vessel cross-sectional area = $70 \times 26.0 = 1820\ ft^2$

w = Channel width = 900 feet (Note: the actual waterway width is wider however it will be much shallower beyond the channel limits).

H = Channel water depth = 32 feet (assumed depth)

$$S = \frac{A}{wH} = \frac{1820}{(900)(32)} = 0.06$$

V = 6 mph = 8.8 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH)

g = acceleration due to gravity = $32.2\ ft/sec^2$

$$F = \frac{V}{\sqrt{gH}} = \frac{8.8}{\sqrt{(32.2)(32)}} = 0.27$$

$$D = \frac{Z}{H} = 0.007 \text{ (From Figure C 3)}$$

$$Z = 0.007\,H = (0.007)(32) = 0.2 \text{ feet}$$

Squat - Empirical Method

V_1 = ship velocity relative to water = 6 mph = 8.8 ft/sec

A_1 = cross-sectional area of channel = $900' \times 32' = 28{,}800\ ft^2$

A_2 = cross-sectional area of vessel = $70' \times 26.0 = 1820\ ft^2$

$A_w = A_1 - A_2 = 28{,}800 - 1820 = 26{,}980\ ft^2$

$g = 32.2\ ft/sec^2$

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{(8.8)^2}{(2)(32.2)}\left[\left(1.01\left(\frac{28{,}800}{26{,}980}\right)\right)^2 - 0.84\right]$$

$$S = 0.4 \text{ feet}$$

b) Nominal Bottom Clearance: Use 2.0 feet

c) Roll: According to the Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels prepared by Michael Baker, Inc for Detroit District the roll on vessels less than 1,000 feet in length is greater than that for 1000 foot long vessels, with a value of about 5 degrees. At the 8 April 1981 workshop held in Cleveland, the vessel masters of the 1,000 foot vessels indicated that the roll on smaller vessels is about 1½ time that of the 1,000 foot vessels or approximately 5 to 7 degrees. This analysis will use 6°

Y = depth requirement due to roll
B = vessel beam = 70 feet
θ = maximum roll in degrees = 6

$Y = \frac{1}{2} B \sin\theta = \frac{1}{2}(70)(\sin 6^\circ) = 3.7$ feet

d) Pitch and Heave: Vessel masters of 1,000 foot vessels which are presently operating on the Great Lakes stated that they would not attempt to enter Cleveland Harbor when wave conditions at the entrance exceed 9 to 10 feet. Therefore, the pitch and heave will be determined based on a 9 ft wave height.

pitch $= \frac{\theta L}{2} = 0.1\ H$ $\quad \frac{Heave}{H} = 0.1$ $\quad$ where H = wave amplitude
$H = \frac{1}{2}(9) = 4.5$ feet

$\frac{\theta L}{2} + Heave = (2)(0.1) H = (2)(0.1)(4.5) = 0.9$ feet

e) Required depth in the Lake Approach and Entrance Channels at the East Entrance for the "Severe Weather" Condition by the Class 8 vessel (731'-849' x 70'):

Case 1 utilizes squat value from Graphical Method
Case 2 utilizes squat value from Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.2	0.4
Roll	3.7	3.7
Pitch and Heave	*	*
Nominal Clearance	2.0	2.0
Required Depth	31.9 ft	32.1 feet

* Roll @ 3.7 feet > Pitch and Heave @ 0.9 ft ∴ Roll governs

Use an approach and entrance channel depth of 32 feet below the design minimum water level.

3) Class 7 Vessels (700'-730' x 75'):

a) Squat - Graphical Method

A = Vessel cross-sectional area = 75' x 26.0' = 1950 ft^2
W = Channel width = 900 feet (Note: the actual waterway width is wider however it will be much shallower beyond the channel limits),
H = Channel water depth = 32 feet (assumed depth)

$$S = \frac{A}{WH} = \frac{1950}{(900)(32.0)} = 0.07$$

V = 6 mph = 8.8 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH)
g = acceleration due to gravity = 32.2 ft/sec^2

$$\check{F} = \frac{V}{\sqrt{gH}} = \frac{8.8}{\sqrt{(32.2)(32)}} = 0.27$$

$$D = \frac{Z}{H} = 0.009 \text{ (From Figure C3)}$$

$$Z = (0.009)(H) = (0.009)(32) = 0.3 \text{ feet}$$

Squat - Empirical Method

V_1 = Ship velocity relative to water = 6 mph = 8.8 ft/sec
A_1 = cross sectional area of channel = 900' x 32' = 28,800 ft^2
A_2 = cross sectional area of vessel = 75' x 26.0' = 1950 ft^2
$A_w = A_1 - A_2$ = 28,800 - 1950 = 26,850 ft^2
g = 32.2 ft/sec^2

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{8.8^2}{2(32.2)}\left[\left(1.01\left(\frac{28800}{26,850}\right)\right)^2 - 0.84\right]$$

S = 0.4 feet

b) Nominal Bottom Clearance: Use 2.0 feet

C) Roll: According to the Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels prepared by Michael Baker, Inc for Detroit District, the roll on vessels less than 1,000 feet in length is greater than that for 1,000 foot long vessels, with a value of about 5 degrees. At the 8 April 1981 workshop held in Cleveland the vessel masters of the 1,000 foot vessels indicated that the roll on smaller vessels is about 1½ times that of the 1,000 foot vessels or approximately 5 to 7 degrees. This analysis will use 6°.

Y = depth requirement due to roll
B = vessel beam = 75 feet
θ = maximum roll in degrees = 6

$$Y = \tfrac{1}{2} B \sin\theta = \tfrac{1}{2}(75)(\sin 6) = 3.9 \text{ feet}$$

d) Pitch and Heave: Vessel masters of 1,000 foot vessels which are presently operating on the Great Lakes stated that they would not attempt to enter Cleveland Harbor when wave conditions at the entrance exceed 9 to 10 feet. Therefore, the pitch and heave will be determined based on a 9 foot wave height.

$$\text{pitch} = \frac{\theta L}{2} = 0.1H \qquad \frac{\text{Heave}}{H} = 0.1$$ where H = wave amplitude, $H = \tfrac{1}{2}(9) = 4.5$ feet

$$\frac{\theta L}{2} + \text{Heave} = (2)(0.1)H = (2)(0.1)(4.5) = 0.9 \text{ feet}$$

e) Required depth in the Lake Approach and Entrance Channels at the East Entrance for the "Severe Weather" Condition by the Class 7 vessel (700'-730' × 75'):

Case 1 Utilizes squat value from Graphical Method
Case 2 utilizes squat value from the Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.3	0.4
Roll	3.9	3.9
Pitch and Heave	*	*
Nominal Clearance	2.0	2.0
Required Depth	32.2 ft	32.3 feet

* Roll @ 3.9 feet > Pitch and Heave @ 0.9 feet ∴ Roll Governs

Use an approach and entrance channel depth of 32 feet below the design minimum water level

4) Class 6 Vessels (650'-699' x 72')

a) Squat - Graphical Method

A = Vessel cross-sectional area = 72' x 26.0' = 1872 ft²
W = Channel width = 900 feet (Note: the actual waterway width is wider however it will be much shallower beyond the channel limits).

H = Channel water depth = 32 feet (assumed depth)

$$S = \frac{A}{WH} = \frac{1872}{(900)(32)} = 0.06$$

V = 6 mph = 8.8 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH)

g = acceleration due to gravity = 32.2 ft/sec²

$$F = \frac{V}{\sqrt{gH}} = \frac{8.8}{\sqrt{(32.2)(32)}} = 0.27$$

$$D = \frac{Z}{H} = 0.007 \quad \text{(from Figure C 3)}$$

$$Z = 0.007H = (0.007)(32) = 0.2 \text{ feet}$$

Squat - Empirical Method

V_1 = Ship velocity relative to water = 6 mph = 8.8 ft/sec
A_1 = cross-sectional area of channel = 900' x 32' = 28,800 ft²
A_2 = cross-sectional area of vessel = 75' x 26' = 1872 ft²

$A_W = A_1 - A_2 = 28,800 - 1872 = 26,928$ ft²

g = 32.2 ft/sec²

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_W}\right)\right)^2 - 0.84\right] = \frac{8.8^2}{(2)(32.2)}\left[\left(1.01\left(\frac{28,800}{26,928}\right)\right)^2 - 0.84\right]$$

S = 0.4 feet

b) Nominal Bottom Clearance: Use 2.0 feet

c) Roll: According to the Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels prepared by Michael Baker, Inc for Detroit District, the roll on vessels less than 1,000 feet in length is greater than that for 1,000 foot long vessels, with a value of about 5 degrees. At the 8 April 1981 workshop held in Cleveland the vessel masters of the 1,000 foot vessels indicated that the roll on smaller vessels is about 1½ times that of the 1,000-foot vessels or approximately 5 to 7 degrees. This analysis will use 6°.

Y = depth requirement due to roll
B = vessel beam = 72 feet
θ = maximum roll in degrees = 6°

$Y = \frac{1}{2} B \sin\theta = (\frac{1}{2})(72)(\sin 6) = 3.8$ feet

d) Pitch and Heave: Vessel masters of 1,000 foot vessels which are presently operating on the Great Lakes stated that they would not attempt to enter Cleveland Harbor when wave conditions at the entrance exceed 9 to 10 feet. Therefore, the pitch and heave will be determined based on a 9 foot wave height.

$\text{pitch} = \frac{\theta L}{2} = 0.1 H; \quad \frac{\text{Heave}}{H} = 0.1$ where H = wave amplitude, $H = \frac{1}{2}(9) = 4.5$ ft

$\frac{\theta L}{2} + \text{Heave} = (2)(0.1) H = (2)(0.1)(4.5) = 0.9$ feet

e) Required depth in the Lake Approach and Entrance Channels at the East Entrance for the "Severe Weather" Condition by the Class 6 Vessel (650'-699' x 72'):

Case 1 utilizes the squat value from Graphical Method
Case 2 utilizes the squat value from Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.2	0.4
Roll	3.8	3.8
Pitch and Heave	*	*
Nominal Clearance	2.0	2.0
Required Depth	32.0 ft	32.2 ft

* Roll @ 3.8 feet > Pitch and Heave @ 0.9 feet ∴ Roll governs

Use an approach and entrance channel depth of 32 feet below the design minimum water level.

5) Class 5 Vessels (600'-649' x68'):

a) Squat - Graphical Method

A = Vessel Cross-sectional Area = 68' x 26.0' = 1768 ft^2
W = Channel width = 900 ft (Note: The actual waterway width is wider however it will be much shallower beyond the channel limits).
H = Channel water depth = 32 feet (assumed depth)

$$S = \frac{A}{WH} = \frac{1768}{(900)(32)} = 0.06$$

V = 6 mph = 8.8 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH).
g = acceleration due to gravity = 32.2 ft/sec^2

$$F = \frac{V}{\sqrt{gH}} = \frac{8.8}{\sqrt{(32.2)(32)}} = 0.27$$

$$D = \frac{Z}{H} = 0.007 \text{ (from Figure C3)}$$

$$Z = 0.007H = (0.007)(32) = 0.2 \text{ feet}$$

Squat - Empirical Method

V_1 = Ship velocity relative to water = 6 mph = 8.8 ft/sec
A_1 = Cross-sectional area of channel ≐ 900' x 32' = 28,800 ft^2
A_2 = Cross-sectional area of vessel = 68' x 26.0 = 1768 ft^2
$A_w = A_1 - A_2$ = 28,800 ft^2 - 1768 ft^2 = 27,032 ft^2
g = 32.2 ft/sec^2

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{(8.8)^2}{(2)(32.2)}\left[\left(1.01\left(\frac{28,800}{27,032}\right)\right)^2 - 0.84\right]$$

S = 0.4 feet

b) Nominal Bottom Clearance: Use 2.0 feet

c) Roll: According to the Study Report of Vessel Clearance Criteria for the Great Lakes Connecting Channels prepared by Michael Baker, Inc for Detroit District, the roll on vessels less than 1,000 feet in length is greater than for 1,000 foot long vessels, with a value of about 5 degrees. At the 8 April 1981 workshop held in Cleveland, the vessel masters of the 1,000 foot vessels indicated that the roll on smaller vessels is about 1½ times that of the 1,000 foot vessels or approximately 5 to 7 degrees. This analysis will use 6°.

Y = depth requirement due to roll
B = vessel beam = 68 feet
θ = maximum roll in degrees = 6°

$Y = \frac{1}{2} B \sin\theta = \frac{1}{2}(68)(\sin 6°) = 3.6$ feet

d) Pitch and Heave: Vessel masters of 1,000 foot vessels which are presently operating on the Great Lakes stated that they would not attempt to enter Cleveland Harbor when wave conditions at the entrance exceed 9 to 10 feet. Therefore, the pitch and heave will be determined based on a 9 foot wave height.

$\text{pitch} = \frac{\theta L}{2} = 0.1H$; $\frac{\text{Heave}}{H} = 0.1$ where H = wave amplitude, $H = \frac{1}{2}(9) = 4.5$ ft

$\frac{\theta L}{2} + \text{Heave} = (2)(0.1)H = (2)(0.1)(4.5) = 0.9$ feet

e) Required depth in the Lake Approach and Entrance Channels at the East Entrance for the "Severe Weather" Condition by the Class 5 vessel (600'-649'-68'):

Case 1 utilizes the squat value from Graphical Method
Case 2 utilizes the squat value from Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.2	0.4
Roll	3.6	3.6
Pitch and Heave	*	*
Nominal Clearance	2.0	2.0
Required Depth	31.8 ft	32.0 feet

* Roll @ 3.6 feet > Pitch and Heave @ 0.9 feet ∴ Roll governs

Use an approach and entrance channel depth of 32 feet below the design minimum water level.

B) "SEVERE WEATHER" EAST ENTRANCE PLAN

1) Class 10 Vessels (950'-1,000' x 105')

a) Squat-Graphical Method

A = Vessel Cross-Sectional Area for Two-way traffic (assuming vessels will meet) = 105' x 26.0' x 2 vessels = 5,460 ft^2

w = channel width = 500 feet (Note: the actual waterway width is wider however it will be much shallower beyond the channel limits).

H = Channel depth = 28 feet (assumed depth)

$$S = \frac{A}{wH} = \frac{5{,}460}{(500)(28)} = 0.39$$

V = 3 mph = 4.4 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland, OH)

g = acceleration due to gravity = 32.2 ft/sec^2

$$F = \frac{V}{\sqrt{gH}} = \frac{4.4}{\sqrt{(32.2)(28)}} = 0.15$$

The curves on Figure C3 cannot be used ∴ Use the equation for "F" on Figure C3 and solve for d

$$F = \left(\frac{2d(1-d-S)^2}{1-(1-d-S)^2}\right)^{1/2} \quad \text{where } F = 0.15,\ S = 0.38$$

$$0.15 = \left(\frac{2d\,(1-d-0.39)^2}{1-(1-d-0.39)^2}\right)^{1/2} = \left(\frac{2d\,(0.62-d)^2}{1-(0.62-d)^2}\right)^{1/2}$$

$$d = \frac{Z}{h} = 0.02$$

$$Z = 0.02\,h = (0.02)(32) = 0.6 \text{ feet}$$

Squat - Empirical Method

V_1 = Ship velocity relative to water = 3 mph = 4.4 ft/sec
A_1 = Cross-sectional area of channel = 500' x 28' = 14,000 ft^2
A_2 = Cross-sectional area of vessel (assuming two way traffic and that vessels will meet) = 105' x 26.0' x 2 = 5460 ft^2

$A_w = A_1 - A_2$ = 14,000 - 5,460 = 8540 ft^2

g = 32.2 ft/sec^2

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{(4.4)^2}{(2)(32.2)}\left[\left(1.01\left(\frac{14{,}000}{8540}\right)\right)^2 - 0.84\right]$$

S = 0.6 feet

b) Nominal Bottom Clearance: Use 2.0 feet

c) Roll: According to the vessel masters of 1,000-foot vessels at the 8 April 1981 workshop, it was indicated that under the conditions which would exist for the 1,000 foot vessel to be able to enter Cleveland Harbor (ie. maximum 9 to 10 foot wave heights in the entrance channel), there would be no roll in the east basin channel.

d) Pitch and Heave: The east basin channel is in the lee of the east breakwater and therefore wave action would be insignificant, except during periods of severe wave overtopping of the breakwater. These waves caused by overtopping would be parallel to the hull of the vessel and therefore, pitch and heave would be minimal. This analysis will assume no pitch or heave.

e) Required Depth in the East Basin Channel for the "Severe Weather" East Entrance Plan by Class 10 vessels (950'-1000' x 105')

Case 1 utilizes squat value from Graphical Method
Case 2 utilizes squat value from Empirical Method

	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.6	0.6
Roll	0.0	0.0
Pitch and Heave	0.0	0.0
Nominal Clearance	2.0	2.0
Required Depth	28.6 ft	28.6 ft

Use an east basin channel depth of 28 feet below the design minimum water level.

BY RJG DATE 9/83 SUBJECT Cleveland Harbor, OH SHEET NO. 13
CHKD. BY RCA DATE 11/83 Channel Depth Requirements for the East Basin Channel at the Existing Arrowhead

C) "Severe Weather" EAST ENTRANCE PLAN

1) Class 10 Vessels (950'-1,000' X 105'):

a) Squat - Graphical Method

A = Vessel cross-sectional area for two-way traffic (assuming vessels will meet) = 105 X 26.0 X 2 vessels = 5,460 ft^2

W = Channel Width = 1150 feet (distance between east and west breakwater spurs and river piers)

H = Channel depth = 30 feet (for 500 ft wide navigation channel lane) and 30 feet (for 650 ft wide basin area). Depths are assumed depths based on the design minimum water level.

$$S = \frac{A}{WH} = \frac{5460}{(500)(30)+(650)(30)} = 0.16$$

V = 3 mph = 4.4 ft/sec (per vessel masters at 8 April 1981 workshop held in Cleveland)

g = acceleration due to gravity = 32.2 ft/sec^2

$$F = \frac{4.4}{\sqrt{gH}} = \frac{4.4}{\sqrt{(32.2)(30)}} = 0.14$$

$$D = \frac{Z}{H} = 0.007\,H = (0.007)(30) = 0.2 \text{ feet}$$

Squat - Empirical Method

V_1 = Ship velocity relative to water = 3 mph = 4.4 ft/sec

A_1 = Cross Sectional area of channel = (500 X 30) + (650 X 30) = 34,500 ft^2

A_2 = Cross Sectional area of vessel (assuming two way traffic and that vessels will meet) = 105' X 26.0' X 2 = 5460 ft^2

$A_w = A_1 - A_2$ = 34,500 - 5,460 = 29,040 ft^2

g = 32.2 ft/sec^2

$$S = \frac{V_1^2}{2g}\left[\left(1.01\left(\frac{A_1}{A_w}\right)\right)^2 - 0.84\right] = \frac{4.4^2}{(2)(32.2)}\left[\left(1.01\left(\frac{34{,}500}{29{,}040}\right)\right)^2 - 0.84\right]$$

S = 0.2 feet

b) Nominal Bottom Clearance: Use 2.0 feet

C) Roll: According to the vessel masters at the 8 April 1981 workshop held in Cleveland, a 1,000 foot long vessel can be expected to roll up to 2-3 degrees as the ship passes the existing main entrance and Cuyahoga River piers as a result of waves entering between the arrowhead breakwaters and due to the discharge from the Cuyahoga River. This analysis will use 2 degrees.

Y = depth requirement due to roll
B = Vessel Beam = 105 ft
θ = maximum roll in degrees = 2°

$Y = \frac{1}{2} B \sin\theta = (\frac{1}{2})(105)(\sin 2) = 1.8$ feet

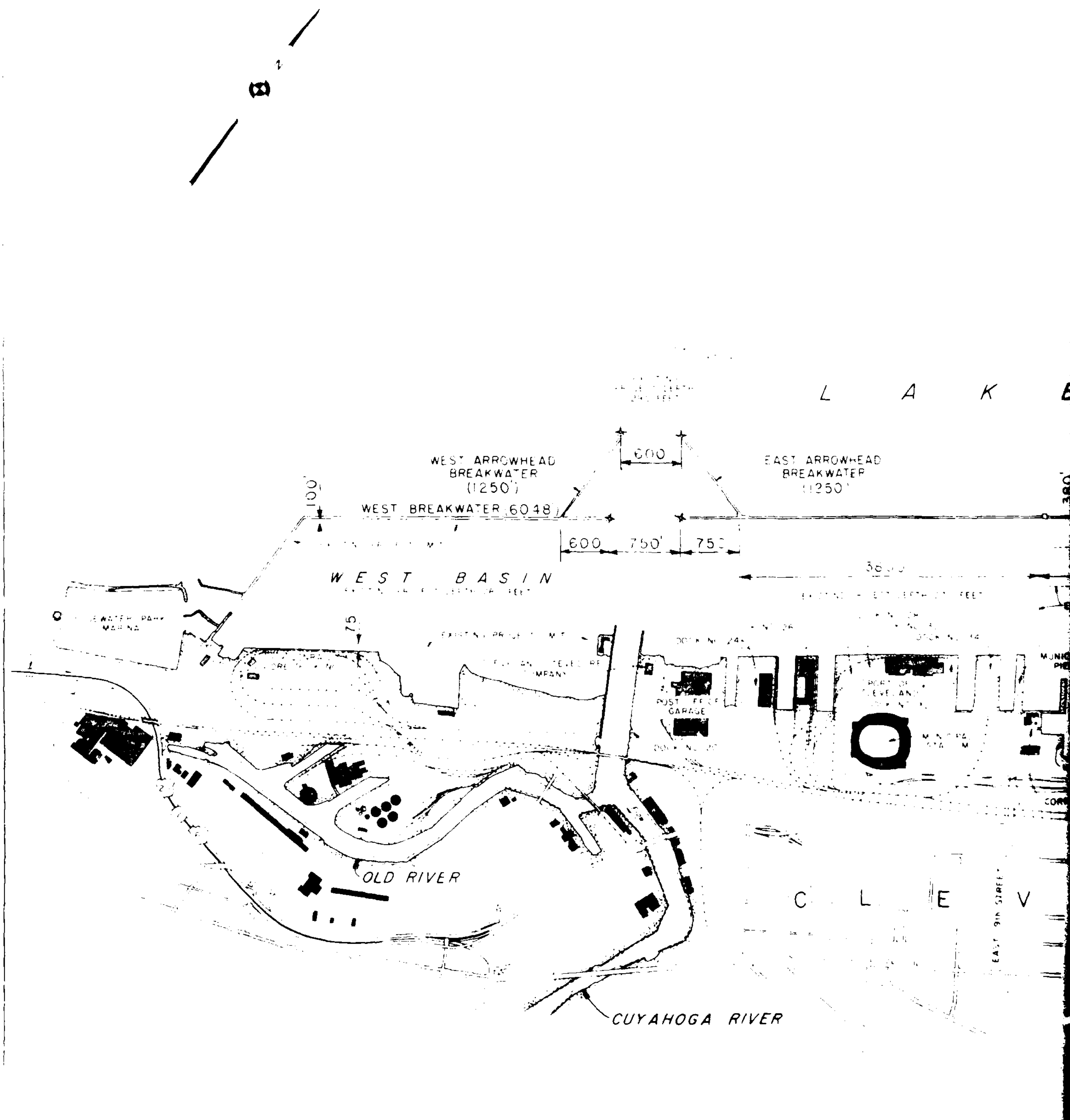
d) Pitch and Heave: The waves which will enter through the existing arrowhead (main) entrance would be parallel to the hull of the vessel and therefore pitch and heave would be minimal. This analysis will assume zero for pitch and heave

e) Required depth in the east basin channel at the existing arrowhead for the east entrance plan by Class 10 Vessels (950'-1,000' x 105'):

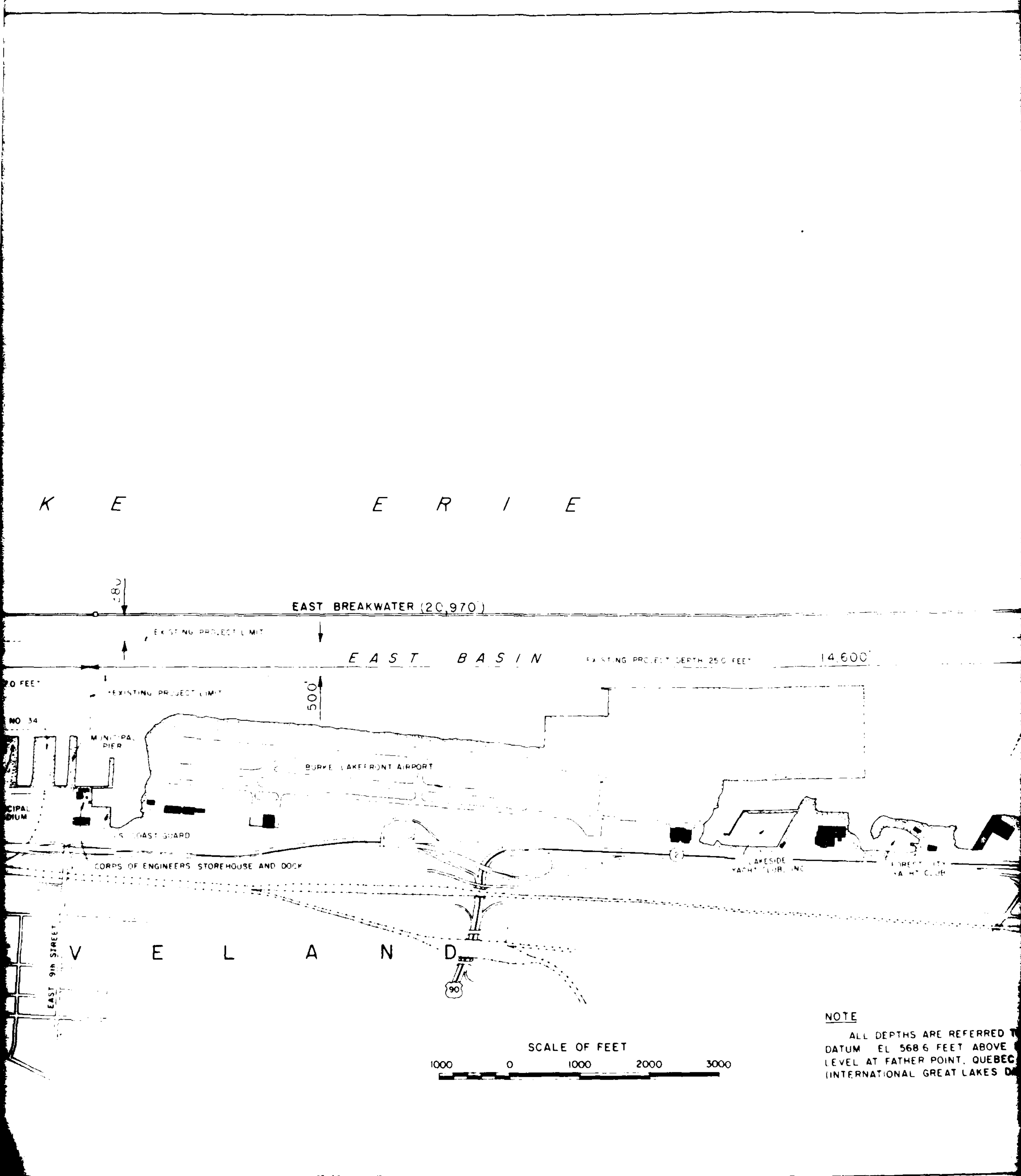
Case 1 utilizes squat value from Graphical Method
Case 2 utilizes squat value from Empirical Method

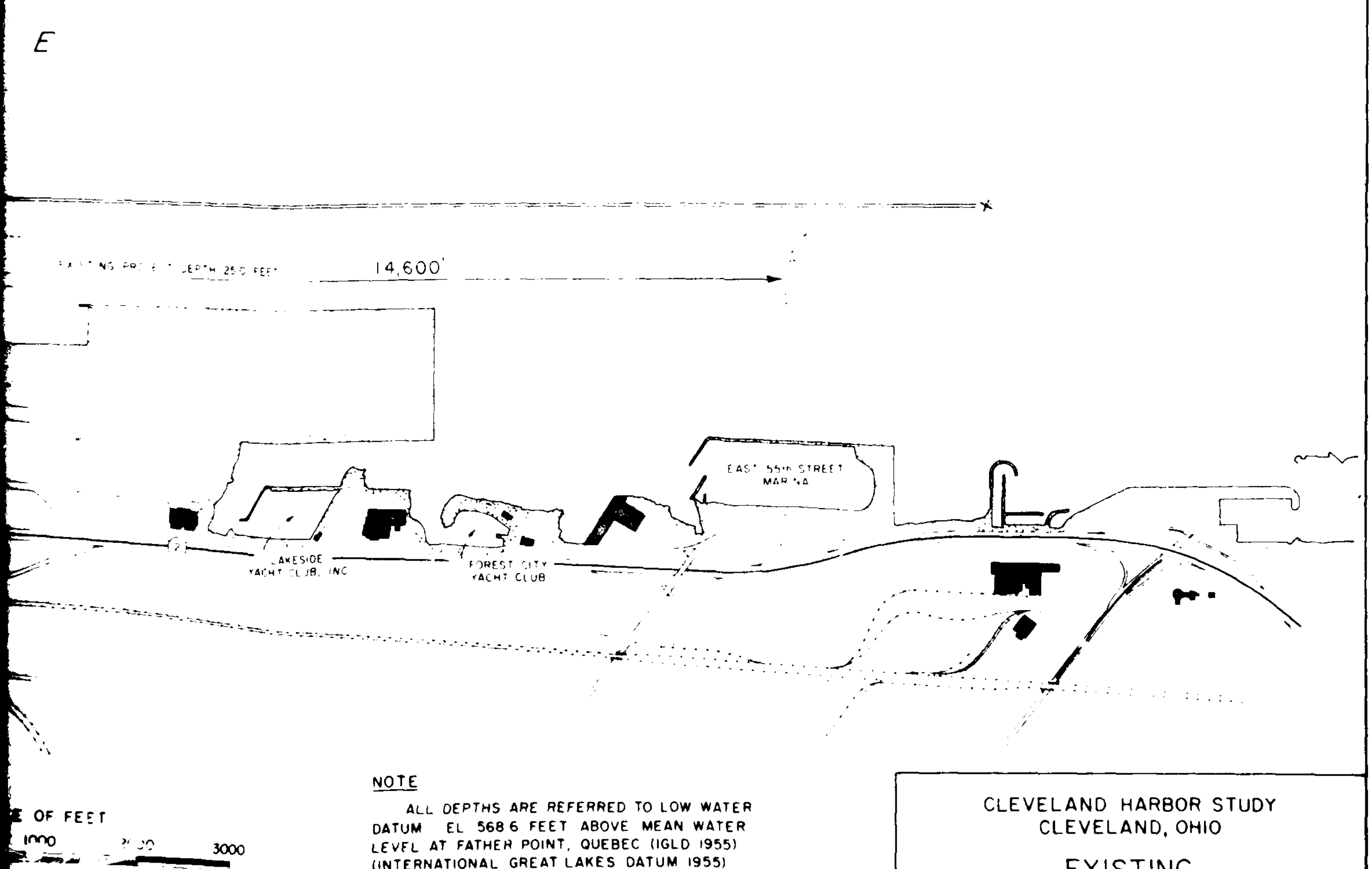
	Case 1	Case 2
Static Draft	26.0	26.0
Squat	0.2	0.2
Roll	1.8	1.8
Pitch and Heave	0	0
Nominal Clearance	2.0	2.0
Required Depth	30.0 ft	30.0 ft

Use an east basin channel depth of 30 feet below the design minimum water level in the east basin at the existing arrowhead entrance.



L A K E
WEST ARROWHEAD BREAKWATER (1250')
EAST ARROWHEAD BREAKWATER (1250')
600
100'
WEST BREAKWATER (6048')
600
750'
750
WEST BASIN
75
POST OFFICE GARAGE
OLD RIVER
CUYAHOGA RIVER
C L E V
EAST 9th STREET


K E E R I E
EAST BREAKWATER (20,970')
EXISTING PROJECT LIMIT
EAST BASIN
EXISTING PROJECT DEPTH 25.0 FEET
14,600'
500'
NO. 34
MUNICIPAL PIER
BURKE LAKEFRONT AIRPORT
U.S. COAST GUARD
CORPS OF ENGINEERS STOREHOUSE AND DOCK
LAKESIDE YACHT CLUB, INC
EAST 9th STREET
V E L A N D
90
NOTE
ALL DEPTHS ARE REFERRED
DATUM EL 568.6 FEET ABOVE
LEVEL AT FATHER POINT, QUEBEC
(INTERNATIONAL GREAT LAKES
SCALE OF FEET
1000 0 1000 2000 3000
2



NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

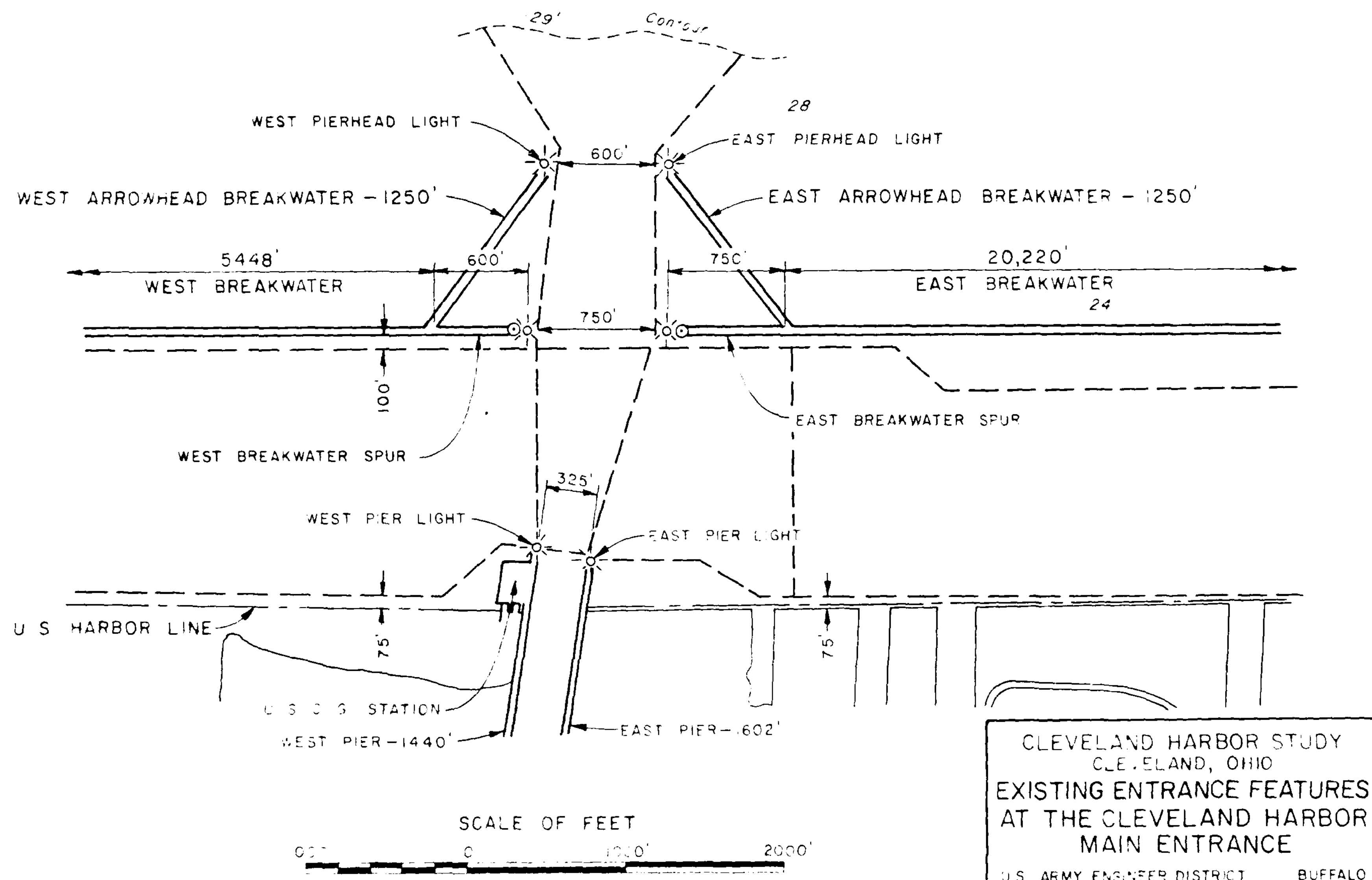
EXISTING
LAKEFRONT HARBOR AREA

U.S. ARMY ENGINEER DISTRICT BUFFALO

NOV 1983

3

PLATE C1



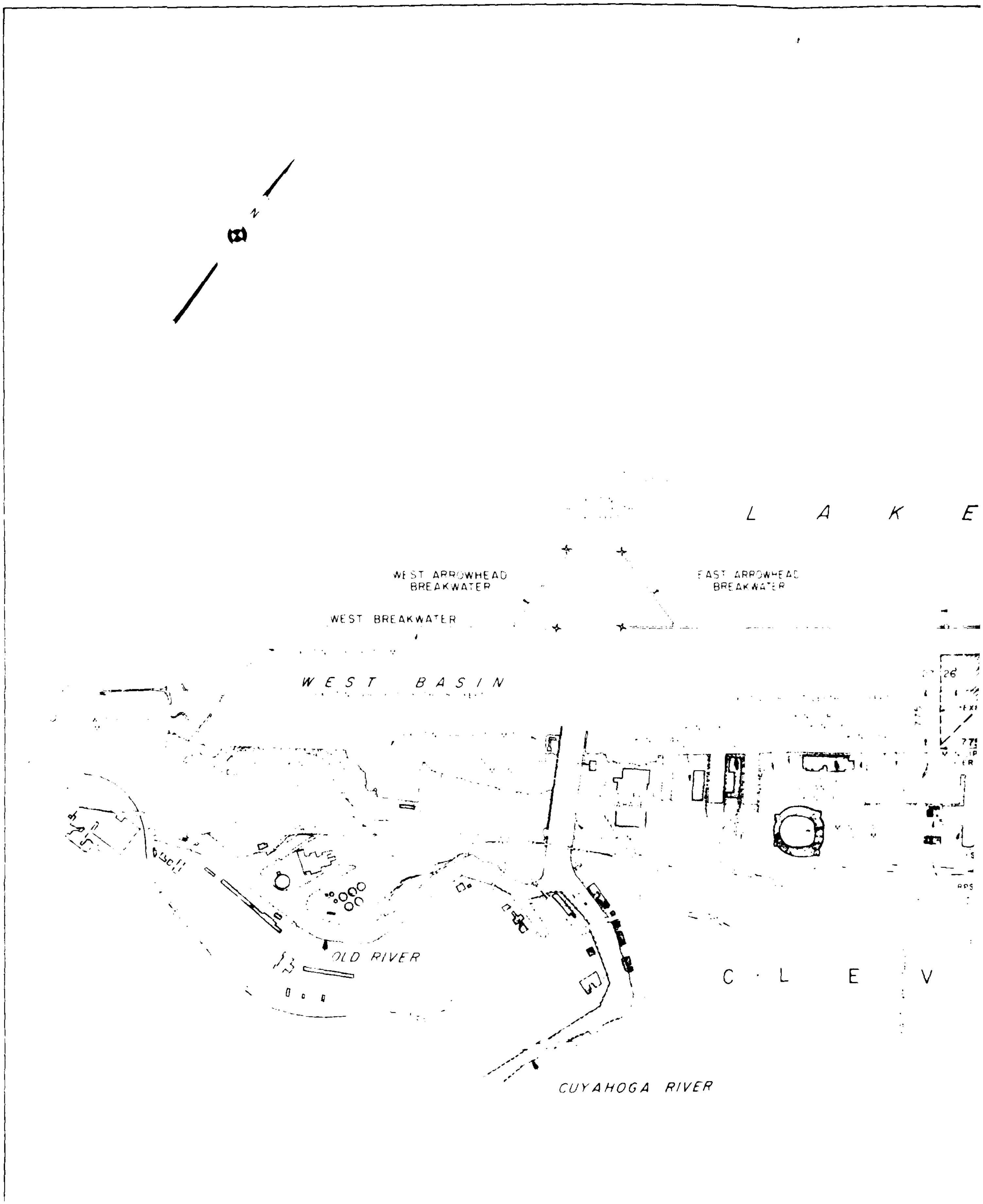
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

EXISTING ENTRANCE FEATURES AT THE CLEVELAND HARBOR MAIN ENTRANCE

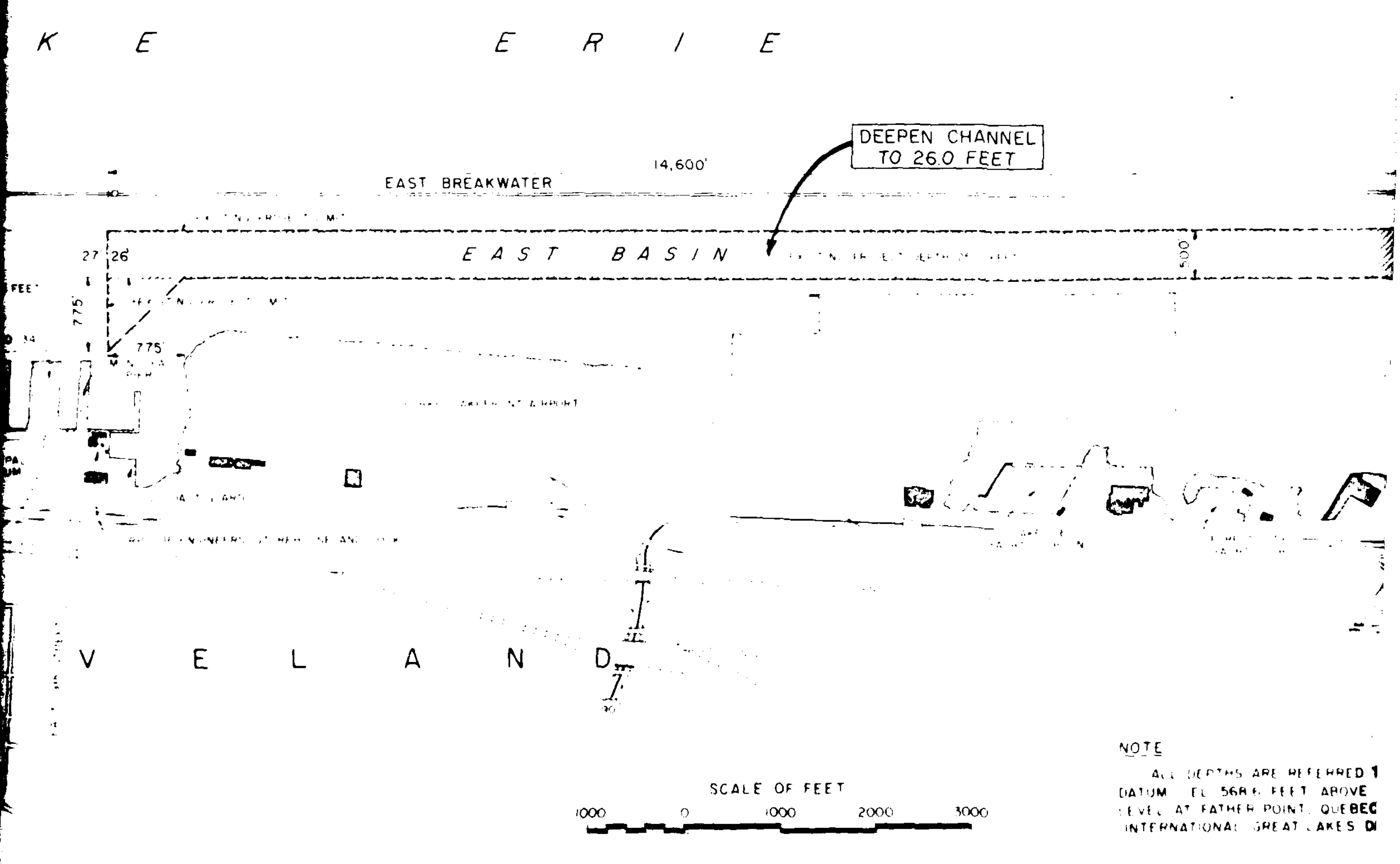
U S ARMY ENGINEER DISTRICT BUFFALO

NOVEMBER 1985

PLATE C2

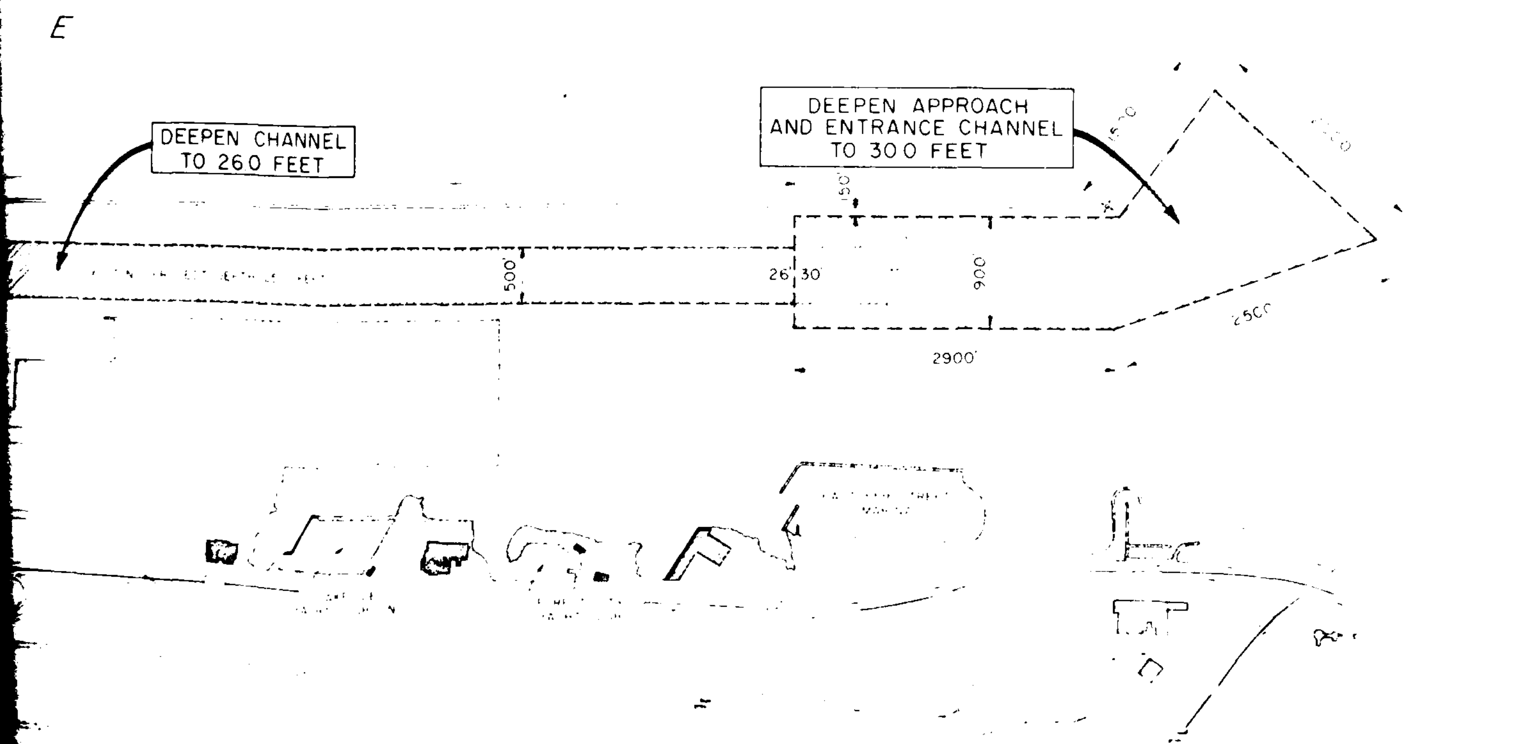


L A K E
WEST ARROWHEAD BREAKWATER
EAST ARROWHEAD BREAKWATER
WEST BREAKWATER
WEST BASIN
OLD RIVER
C L E V
CUYAHOGA RIVER



K E E R I E
DEEPEN CHANNEL TO 26.0 FEET
14,600'
EAST BREAKWATER
E A S T B A S I N
27
26'
775'
775'
500
V E L A N D
NOTE
DATUM EL 568.6 FEET ABOVE
INTERNATIONAL GREAT LAKES
SCALE OF FEET
1000 0 1000 2000 3000

2



LE OF FEET
1000 2000 3000

NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE I
"SEVERE-WEATHER"
EAST ENTRANCE PLAN

U.S. ARMY ENGINEER DISTRICT BUFFALO

NOVEMBER

3

PLATE C3

APPENDIX D

DESIGN

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

CLEVELAND HARBOR, OHIO
DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

APPENDIX D
DESIGN

TABLE OF CONTENTS

TABLES

APPENDIX D - DESIGN

D1. Introduction

The structural design involved in the Cleveland Harbor, Stage 3 study is concerned only with the anchored steel sheet pile walls or bulkheads for two navigation improvement alternatives in the Cuyahoga River.

The first alternative, No. 7G, is the removal of the Jefferson Avenue bridge abutments, dredging in the immediate area and construction of new anchored steel sheet pile walls to replace the abutments. On the right bank upstream of, and immediately adjacent to the east abutment, an additional 200 linear feet of existing bulkhead will be replaced because of its deteriorated condition.

The second alternative, No. 11, is the deepening of the turning basin to the same depth as the navigation channel (23 feet below low water datum plus an additional overdepth of up to 3 feet), and replacement of the anchored steel sheet pile walls in the turning basin that become unstable due to the increased depth of the turning basin bottom.

The design for each of the alternatives is presented and discussed separately in the following paragraphs.

D2. Alternative No. 7G - Jefferson Avenue Bridge Abutment Removal

This alternative is the only river navigation improvement proposal carried forward from the Stage 2 study. The proposal originally involved removal of only those portions of the bridge abutments that project out into the river, and dredging in the vicinity of the removed abutments to a depth of 26.0 feet (23 feet authorized depth plus 3 feet overdepth) below low water datum.

The intent of these modifications was to increase the width of the navigation channel from 130 feet to 190 feet. The unprotected banks left by the removal of the abutments would be supported by anchored steel sheet pile bulkheads. In addition, the existing walls on both banks, upstream and downstream of the abutments would be replaced with new steel sheet pile bulkhead walls, since it was assumed that dredging of the river bottom would tend to make these walls unstable.

In the more detailed study and analysis of this alternative during Stage 3, new information was obtained that resulted in several changes to the Stage 2 plan for improvements. Part of the new information was in the form of plans of the Jefferson Avenue bridge substructure, received from the city of Cleveland Engineering Department. From these plans it was evident that the abutments could not be partially removed, i.e. back to the dock line, without leaving the remainder of the abutments in an unstable condition. Therefore, it has been found necessary to remove the bridge abutments in their entirety. The other new information received, included site-specific soil parameters (see Table D1) and more detailed information concerning the existing bulkhead owned by the Cleveland Builders Supply Company and located immediately upstream

TABLE D1 - Soil Parameters for Plan No 7G - Remove Jefferson Avenue Bridge Abutments

Soil Type	Elevation	Parameters
Alluvium - silty sand, sand, clay, silt and some gravel	Ground surface to El 535	γ_{moist} = 100 lb/ft^3 $\gamma_{saturated}$ = 110 lb/ft^3 Cohesion (c) = 100 lb/ft^2 ϕ = 28°
Glacial Till	El 535 and below	$\gamma_{saturated}$ = 130 lb/ft^3 Cohesion (c) = 2000 lb/ft^2 ϕ = 0°

of the bridge abutment on the left bank. The new information concerning surcharge loads imposed on the wall by stockpiled sand and gravel, permitted a reanalysis of the existing bulkhead wall with the result that the wall was found to be stable for the improved channel bottom. Consequently, with the exception of the new bulkhead walls required to fill the spaces left by the removal of the abutments, the only bulkhead replacement for this alternative is on the right bank upstream of the bridge, where the existing bulkhead appears to be in a state of deterioration, or perhaps even in a state of failure. It has been assumed, based on the reanalysis of the Cleveland Builders Supply Company's bulkhead, that the bulkhead walls on both banks downstream of the bridge are also stable for the increased channel depth adjacent to them and would not require replacement.

As in Stage 2, a Computer Aided Structural Engineering (CASE) program entitled "CSHTWAL - Design or Analysis of Cantilever or Anchored Sheet Pile Walls by Classical Methods" was used to analyze the existing wall (computer program file name "JEFAVA"), and to design a replacement wall (computer program file name "JEFAVD"). For the existing bulkhead wall along the Cleveland Builders Supply Company's river frontage, an analysis was made assuming: a 3-foot hydrostatic head differential between the river surface elevation and the saturation level in back of the wall; improved channel bottom 26.0 feet (23.0 feet plus 3.0 feet overdepth) below low water datum; and a surcharge load consisting of a stone pile, triangular in cross section and infinite in length, with its toe at the edge of the wall. The "equivalent beam" method of solution gave a factor of safety of 1.51 for the wall under the assumed loading conditions (see Table D2). Consequently, the same pile section, anchor elevation, height of wall and embedment would be used for the replacement bulkheads on both banks of the river. The PZ38 sheet piles would require reinforcement between El 565.0 and El 539.0 to resist the high bending stresses and deflections caused by the heavy surcharge loading. On the right bank where no heavy surcharge loads are anticipated, the reinforcement would not be required.

Two alternate methods of anchorage for the walls were designed. Where topography and space allow, tie rods connected to an anchor wall would be used. For the bulkhead walls replacing the bridge abutments, a battered tension pile method of anchorage has been designed because of the difficulty of installing anchor rods and an anchor wall.

The computer output values for the new bulkheads are shown in Table D2. The final detailed design computations for the bulkheads including cover (reinforcing) plates, determination of tie rod and wale sizes, location and depth of anchor wall and size, length and embedment of battered tension piles, are contained in the working papers for this study on file at the District Office and are not included herein. Sketches of the replacement bulkhead walls for Alternative 7G are shown on Plate 22 in Appendix I.

TABLE D2 - Computer Program Output Data for Alternative No 7G.

ANALYSIS	Bulkhead File Name	Factor of Safety	Max Bending Moment (lb-ft)	Maximum Deflection (in)	Anchor Force (lbs)
	JEFAVA	1.51	235,505	.763	23775

DESIGN	Bulkhead File Name	Wall Pen (Ft)	Bottom Elev. (Ft.)	Max. Bending Moment (Lb-Ft.)	Max. Scaled Deflection (lb-in^3)	Anchor Force (lbs)
	JEFAVD	25.48	517.12	235,443	6.21×10^{10}	23770

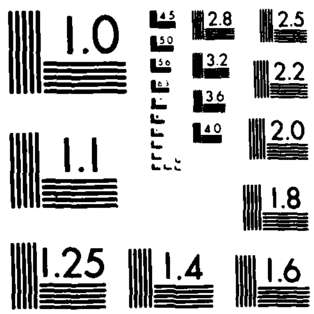
D3. Alternative No. 11 - Deepen Turning Basin

This alternative was included in the Stage 3 study as the result of a request by the Republic Steel Corporation during the evaluation of the Stage 2 alternatives. It would involve deepening of the turning basin from a depth of 21.0 feet (18.0 feet plus 3.0 feet overdepth) below low water datum to 26.0 feet (23.0 feet plus 3.0 feet overdepth) below LWD to permit loaded ore carriers to turn in the basin prior to unloading at docks upstream of the turning basin. As a result of this increase in depth, all of the existing bulkhead walls in the turning basin would become unstable and require replacement. Three typical sections of existing bulkhead walls (file names TURBA3, TURBA4, and TURBA5) in the turning basin were analyzed for stability under the condition of improved channel depth. Two of these sections (TURBA3 and TURBA4) were on the southern face of the turning basin and were selected due to the varying ground elevation and surcharge loading in that area. The third section, TURBA5, was taken on the north face of the turning basin, where surcharge loads were less severe and the ground elevation more uniform. Each of these bulkheads would have factors of safety less than 1.5 for the assumed loading conditions (see Table D3) and would require replacement. For the replacement bulkheads, designs were made assuming: a 3-foot hydrostatic head differential between the water surface in the river and saturation line in the backfill behind the wall; several different types of surcharge loadings, including uniform loads and vertical line loads; and the soil design parameters listed on Table D4.

The same sections used in the analysis of the existing walls, were used in the design of new bulkhead walls. On the southern wall or face of the turning basin, two bulkhead designs were developed, TUBAD1 and TUBAD2. These design sections have the same surcharge loads, soil parameters, hydrostatic head differential and channel bottom. The major differences are in the ground elevation and location of the anchor rod, which for TUBAD2 are 6 to 8 feet higher than for TUBAD1. This difference results in the need for reinforcing cover plates for the piling of TUBAD2 and approximately 24 more feet of embedment than TUBAD1. The surcharge loads assumed for these two wall sections include a uniform surcharge of 100 psf and two vertical line loads representing a single-track railroad spur adjacent to the wall. The track is assumed to be parallel to the wall and each track rail carries a load of 6.0 kips per linear foot of rail, corresponding to a Coopers E-60 loading. For the typical wall section on the north face of the turning basin, TUBAD3, where there is no railroad trackage, the only surcharge load assumed is a 100 psf uniform load. For this wall section and wall section TUBAD2, an alternate method of anchorage was designed for areas where proximity to multiple trackage or buildings made the use of anchor walls and tie rods impractical. The alternate anchorage system utilizes battered tension piles that depend on friction between the pile and the surrounding soil to resist the anchor pull normally taken by the anchor rods. This method of anchorage would be used primarily along the north and east faces of the turning basin. The computer output data for the new bulkheads are shown on Table D3. The final detailed design computations for cover plates, tie rod and wale sizes, location and depth of anchor walls and length and embedment of batter piles are contained in the working papers for this study on file at the District Office and are not included herein. Sketches of the bulkhead designs for the turning basin are shown on Plate 22 in Appendix 1.

AD-A139 380 CLEVELAND HARBOR OHIO DRAFT REFORMULATION PHASE I 5/8
GENERAL DESIGN MEMORAND..(U) CORPS OF ENGINEERS BUFFALO
NY BUFFALO DISTRICT FEB 84

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

TABLE D3 - Computer Program Output Data for Alternative No. 11

	Bulkhead File Name	Factor of Safety		Max. Bending Moment (lb-ft)	Maximum Deflection (in.)	Anchor Force (lbs)
ANALYSIS	TURBA 3	1.10		107,419	2.67	18170
	TURBA 4	0.87		162,656	3.30	20398
	TURBA 5	1.29		117,884	-3.39	19902
	Bulkhead File Name	Wall Pen (ft.)	Bottom Elev. (ft.)	Max. Bending Moment (lb-ft)	Max. Scaled Deflection ($lb\text{-}in^3$)	Anchor Force (lbs.)
DESIGN	TUBAD1	13.44	529.16	128,279	2.03×10^{10}	21220
	TUBAD2	36.98	505.62	239,693	5.63×10^{10}	29053
	TUBAD3	17.74	524.86	131,573	-2.41×10^{10}	22040

TABLE D4 - Soil Parameters for Plan No 11 - Deepen Turning Basin

Soil Type	Elevation	Parameters
Alluvium - sand & silty sand	Ground surface to El. 545	γ_{moist} = 110 lb/ft^3 $\gamma_{saturated}$ = 115 lb/ft^3 Cohesion (c) = 0 ϕ = 30°
Glacial Till - silty clay stiff to very stiff consistency with some gravel	El 545 to El. 505	$\gamma_{saturated}$ = 130 lb/ft^3 Cohesion (c) = 2000 lb/ft^2 ϕ = 0°
Lacustrine Clay - soft, plastic clay	El. 505 to El. 485	$\gamma_{saturated}$ = 115 lb/ft^3 Cohesion (c) = 800 lb/ft^2 ϕ = 0°

D4. Useful Life of Existing Bulkheads

To determine advance replacement benefits for the bulkheads being replaced under Alternatives 7G and 11, the remaining useful life of these structures was estimated. For the turning basin bulkheads, information obtained from permit applications, covering about half of the total linear feet of the wall in the turning basin, and supplemental information received from the Republic Steel Corporation that covered the remainder, provided a fairly accurate estimate of the age of these structures. Using the approximate date that the bulkheads were constructed, as obtained from the permit applications, assuming a total useful life of 50 years and using the year 1990 as the reference year, a "weighted" average remaining useful life of 9.8 or 10 years was obtained. The weighted average was obtained by considering the linear feet of each different age bulkhead. The average compares favorably with the average remaining useful life of 12 years for bulkheads in this reach of the river determined in Stage 2. The difference is the result of the supplemental information received from the Republic Steel Corporation on sections of the turning basin walls not available from permit information. A tabulation of all the bulkheads in the turning basin for which either permit information or owner information is available is shown on Table D5, together with the computation for the weighted average remaining useful life.

The bulkhead wall upstream of the Jefferson Avenue bridge abutment on the right bank, that would be replaced under Alternative 7G, is in a reach of the river where, in the Stage 2 study, the average remaining useful life of the bulkheads was estimated to be 11 years. There is no permit information for this bulkhead, however, visual observations from the river indicate that there are some old timber piles that may be the remains of an old dock. If there is a sheet pile bulkhead there, it is either in a state of failure or very badly deteriorated. The Great Lakes Towing Company, owner of the property, advised that whatever is there has been there at least as far back as 1941. Due to the lack of information and the apparent deteriorated condition of the dock or bulkhead, it is assumed that it has no remaining useful life.

D5. Summary and Conclusions

Alternative No. 7G - Removal of the Jefferson Avenue bridge abutments, including any remaining superstructure supported by the abutments, would leave about 65 feet of riverbank on both sides of the river unsupported. These unprotected sections would be supported by new PZ38 steel sheet piling, 60 feet in vertical length and anchored by means of battered tension piles. The sheet piling on the left bank of the river would require reinforcing cover plates due to the higher bending moments induced in the sheet piling by the surcharge loads resulting from stockpiled sand and gravel at the Cleveland Builders Supply Company. On the right bank upstream from the east abutment, approximately 200 linear feet of bulkhead wall, owned by the Great Lakes Towing Company, would be replaced with PZ38 sheet piling 60 feet in length and anchored by a system of tie rods and anchor wall. Due to the fact that this property is vacant and no surcharge loads are anticipated, the tie rod - anchor wall anchorage system would be more practical and economical than the tension pile anchorage system. The total length of new sheet pile wall for Alternative No. 7G is 330 linear feet.

TABLE D5 - Remaining Useful Life of Existing Bulkhead Walls for Alternative No. 11

OWNER	PERMIT No. (If Applicable)	TOTAL L.F.	YEAR BUILT	RUL [1]	WEIGHTED RUL [1]
E.I. DUPONT	941210003	487	1941	1	487
" "	941210004	357	1941	1	357
REPUBLIC STEEL	-	504	1941	1	504
" "	-	115	1979	39	4485
" "	-	167	1981	41	6847
" "	974210003	130	1975	35	4550

$$\frac{\text{Total Weighted RUL}}{\text{Total Linear Feet}} = \frac{487+357+504+4485+4550+6847}{487+357+504+115+167+130}$$

$$\text{Average Weighted RUL} = \frac{17230}{1760} = 9.79 \text{ years}$$

[1] RUL - Remaining Useful Life

Assumptions:

1. The year of reference is 1990. Therefore, remaining useful life is calculated from this year foreward.
2. Where pemit information is used to determine year of construction, it is assumed that the bulkhead was built within one calendar year of the date of the permit.
3. The total useful life will not exceed fifty (50) years.

Alternative No. 11 - The dredging required to deepen the turning basin by 5 feet would require the replacement of all the existing bulkhead walls in the basin. The new bulkhead walls would be PZ38 steel sheet piling varying in length from 50 to 85 feet. At the eastern end of the turning basin, due to the combination of wall height and surcharge loads, the piling would require reinforcing. Two methods of anchorage would be required. Where space permits, a system of the rods and a PZ38 SSP anchor wall would be used. In areas where proximity to railroad trackage or buildings does not permit this method of anchorage, battered tension piles would be used instead. The battered tension piles are bearing or "H" piles (CBP103), with a one vertical on one horizontal batter and vary in length from 70 to 90 feet, depending on location. Approximately 1,755 linear feet of new sheet pile wall would be required in the turning basin.

APPENDIX E
COST ESTIMATES

CLEVELAND HARBOR, OH

DRAFT REFORMULATION PHASE 1
GENERAL DESIGN MEMORANDUM

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

CLEVELAND HARBOR, OH
DRAFT REFORMULATION PHASE I

GENERAL DESIGN MEMORANDUM

APPENDIX E
COST ESTIMATES

TABLE OF CONTENTS

APPENDIX E
COST ESTIMATES

E1. PURPOSE

This appendix presents the detailed estimates of cost for the alternatives considered in detail during Stage 3 planning for the Cleveland Harbor, Ohio, Phase I GDM study.

E2. COST DATA SOURCES

All cost data presented in this appendix are at October 1983 price levels. Unit prices shown in the various alternatives were developed from similar construction projects and updated by use of the Engineering News Record (ENR) Construction Cost Index projected to October 1983.

a. Bridge Abutment Removal. Costs to remove the Jefferson Avenue Bridge Abutments (Plan 7G) were extracted from the September 1977 *Section 107 Jefferson Avenue Bridge Abutment Removal Reconnaissance Report*.

b. Lands and Damages. Lands and Damage costs were developed by the North Central Division Real Estate Office. These costs are discussed in Attachment 1 of this appendix.

c. Contingencies. A contingency factor has been applied to the first cost of construction to account for variations in material unit prices, quantities, methods of construction, and material storage and disposal.

E3. TOPOGRAPHIC AND SUBSURFACE INFORMATION

Information available at the District Office to prepare the estimates, consisted of 1978, 1980, and 1982 Project Condition Soundings for Cleveland Harbor including the Cuyahoga and Old Rivers, a 1981 Lake Survey Chart provided by the National Oceanic and Atmospheric Administration, and 1978 Aerial Topography conducted by Chicago Aerial Survey and provided by the Cuyahoga County Sanitary Engineer's office. As discussed in Appendix A, "Geotechnical," rock will not be encountered during dredging operations for any of the alternatives considered.

E4. QUANTITY ESTIMATES

a. Dredging. Outer harbor dredged material quantities are based on Spring 1978 and Spring 1982 Project Condition Soundings for deepening existing channels, and a 1981 Lake Survey Chart for dredging new channels. Cuyahoga River quantities are based on Spring 1980 Project Condition Soundings for deepening existing channels, and new bank cuts. An overdepth allowance of 1 foot and 1V on 2H sideslopes have been incorporated into the dredging quantity calculations. As discussed in the Main Report, it has been assumed that all dredged material will be placed in Cleveland Diked Disposal Area 14.

b. Existing Bulkhead Modifications. Quantities and existing conditions used to determine the cost of modifying existing bulkheads along the Cuyahoga River were developed from Department of Army Permit applications available at the District Office and from as-built drawings supplied by the owner.

c. New Bulkheads. Quantities associated with the new bulkheads have been developed from typical sections shown on Plate 22.

E5. ESTIMATE OF FIRST COST OF CONSTRUCTION AND ANNUAL OPERATION AND MAINTENANCE COSTS

The estimated first costs of construction for the alternatives considered in detail during Stage 3 planning for the Phase I study, at October 1983 price levels, are presented in Tables E1 through E4. Since annual operation and maintenance costs will not increase above existing conditions for any of the alternatives considered in Stage 3, additional operation and maintenance costs for each alternative is zero.

Table E1 - Estimate of Cost - Alternative No. 1

Alternative No. 1				
Item	Estimated Quantity	Unit	Unit Cost	Estimated Cost
			$	$
1. Dredging	628,000	C.Y.	2.70	1,695,600
2. Mobilization & Demobilization	-	L.S.	-	8,000
Total Contractor's Earnings				1,703,600
Contingencies at 25% ±				426,400
Total Contractor's Earnings Plus Contingencies				2,130,000
Engineering & Design				100,000
Supervision & Administration				190,000
Total First Cost of Construction				2,420,000

Table E2 - Estimate of Cost - Plan 7G

Item	Estimated Quantity	Unit	Unit Cost	Estimated Cost
			$	$
1. Dredging	4,300	C.Y.	7.25	31,175
2. Clearing and Grubbing	2.0	Acre	2,335	4,670
3. Existing Bulkhead Modifications	-	L.S.	-	8,800
4. Bridge Demolition	-	L.S.	-	759,300
5. SSP Bulkhead Replacement				
a. Excavation	2,865	C.Y.	3.85	11,030
b. Backfill	2,865	C.Y.	1.50	4,298
c. SSP PZ-38	22,800	S.F.	18.70	426,360
d. Wales	25,500	LB.	2.45	62,475
e. Tie Rods	34,600	LB.	1.55	53,630
f. Battered Tension Piles	1,600	LB.	44.45	71,120
g. Cover Plates	45,500	LB.	1.25	56,875
6. Mobilization & Demobilization	-	L.S.	-	143,000
7. Lands	-	L.S.	-	4,000
Total Contractor's Earnings				1,636,733
Contingencies at 25% ±				409,267
Total Contractor's Earnings Plus Contingencies				2,046,000
Engineering & Design				225,000
Supervision & Administration				209,000
Total First Cost of Construction				2,480,000

Table E3 - Estimate of Cost - Plan II

Item	Estimated Quantity	Unit	Unit Cost	Estimated Cost
			$	$
1. Dredging	70,000	C.Y.	7.25	507,500
2. SSP Bulkheads				
a. Excavation	57,500	C.Y.	3.85	221,375
b. Backfill	57,500	C.Y.	1.50	86,250
c. SSP PZ-38	139,100	S.F.	18.70	2,601,170
d. Wales	131,600	LB.	2.45	322,420
e. Tie Rods	273,700	LB.	1.55	424,235
f. Battered Tension Piles (CBP 103)	10,600	L.F.	44.45	471,170
g. Cover Plates	459,000	LB.	1.25	573,750
3. Modification of Existing Bulkhead	1,170	L.F.	2.75	3,218
4. Mobilization & Demobilization	-	L.S.	-	143,000
5. Lands	-	L.S.	-	22,000
Total Contractor's Earnings				5,376,088
Contingencies at 25% ±				1,343,912
Total Contractor's Earnings Plus Contingencies				6,720,000
Engineering & Design				670,000
Supervision & Administration				620,000
Total First Cost of Construction				8,010,000

Table E4 - Estimate of Cost - Alternative No. 1B

Alternative No. 1				
Item	Estimated Quantity	Unit	Unit Cost	Estimated Cost
			$	$
1. Dredging	956,000	C.Y.	2.70	2,581,200
2. Mobilization & Demobilization	-	L.S.	-	8,000
Total Contractor's Earnings				2,589,200
Contingencies at 25% ±				650,800
Total Contractor's Earnings Plus Contingencies				3,240,000
Engineering & Design				150,000
Supervision & Administration				290,000
Total First Cost of Construction				3,680,000

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGO

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCDRE-B	Cleveland Harbor Phase I GDM

TO	FROM	DATE	CMT 1
NCBPD-PF ATTN: R. Aguglia	NCDRE-B	27 April 1983	

Real Estate Estimates for Plans 7G and 11 (October 1983 price levels), as per your request dated 18 February 1983, are as follows:

Plan 7G

Temporary Easements (annual rate) 1/		
0.6 acre x $50,000/acre x 12%	=	$3,600
Contingencies at 20%	=	720
Total real estate and contingencies		$4,320
	say	$4,000

Plan 11

Temporary Easements (annual rate) 1/		
3.0 acre x $50,000/acre x 12%	=	$18,000
Contingencies at 20%	=	3,600
Total real estate and contingencies		$21,600
	say	$22,000

1/ The value of temporary work easements to be estimated at 12 percent per annum of the fee value based on the typical rate of return of investment in the Cleveland area.

ROBERT DRAGONETTE
NCDRE - Buffalo Field Office

CF:
NCDRE-E

ATTACHMENT 1

APPENDIX F
PERTINENT CORRESPONDENCE

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

APPENDIX F
PERTINENT CORRESPONDENCE

Exhibit	Description
F-1	7 May 1976 Resolution of the Cleveland-Cuyahoga County Port Authority regarding the Port Authority's intent to act as local cooperator for the Cleveland Harbor modifications as outlined in the Draft Feasibility Report for Harbor Modifications, Cleveland, Ohio.
F-2	21 June 1976 Resolution of the Cleveland-Cuyahoga County Port Authority regarding the Port Authority's intent to act as local cooperator for a possible spoil disposal dike, as specified in the 1976 Feasibility Report for Harbor Modifications.
F-3	11 June 1976 letter from Dr. Teater of the Ohio Department of Natural Resources to the Buffalo District Engineer regarding ODNR's intent to be the local cooperator for the proposed West Breakwater fishing access plan at Cleveland Harbor.
F-4	17 February 1982 telephone conversation between Buffalo District and Mr. F. S. Albarano of the Jones and Laughlin Steel Corp. regarding J & L's position on a Lakefront transshipment facility for delivery of iron ore to their upriver steel mill.
F-5a	15 October 1981 letter from Mr. Eric Johannesen, Preservation Officer to Buffalo District regarding the eligibility of the west arrowhead breakwater lighthouse at Cleveland Harbor for the National Register.
F-5b	2 March 1982 letter from Mr. David H. Shank, Chief, Ann Arbor Office, National Park Service to Buffalo District regarding potential impacts of project plans on significant cultural resources in the Cleveland Harbor area.
F-5c	17 March 1982 letter from Mr. W. Ray Luce, State Historic Preservation Officer to Buffalo District regarding potential impacts of project plans on significant cultural resources in the Cleveland Harbor area.
F-5d	27 June 1983 letter from Mr. J.L. Dunning, Regional Director - Midwest Region, National Park Service to Buffalo District regarding impacts of project plans on significant cultural resources in the Cleveland Harbor area.
F-5e	8 July 1983 letter from Mr. W. Ray Luce, State Historic Preservation Officer to Buffalo District regarding impacts of project plans on significant cultural resources in the Cleveland Harbor area.

Exhibit	Description
F-6	3 June 1983 letter from Mr. Myrl Shoemaker, Director, Ohio Department of Natural Resources to Buffalo District outlining issues that should be addressed in the Draft Supplement to the Environmental Impact Statement.
F-7	1 June 1983 letter from Ms. Barbara Taylor Backley, Chief, Environmental Review Branch, U.S. EPA - Region V to Buffalo District outlining issues that should be addressed in the Draft Supplement to the Environmental Impact Statement.
F-8	19 May 1983 letter from Mr. Hunter Morrison, Planning Director, Cleveland City Planning Commission to Buffalo District expressing concern over elimination of recreational fishing plans from further consideration.
F-9	7 June 1983 letter from Buffalo District to Mr. Hunter Morrison, Planning Director, Cleveland City Planning Commision explaining why the recreational fishing plans were eliminated from further consideration.
F-10	15 July 1983 letter from Mr. George Ryan, President, Lake Carriers Association to Buffalo District regarding vessel delays presently experienced at Cleveland Harbor by bulk cargo vessels during adverse weather conditions.
F-11	2 September 1983 letter from Mr. George Ryan, President, Lake Carriers Association to Buffalo District further clarifying his letter of 15 July 1983 (Exhibit F-10).
F-12	7 January 1983 letter from Messers H.E. Mac Dermid, President and Victor H. Anderson, Chairman, Navigation Committee, Lake Pilots Association to Buffalo District regarding vessel delays presently experienced at Cleveland Harbor by foreign flag vessels during adverse weather conditions.
F-13	12 May 1983 letter from Commander, Ninth Coast Guard District to Buffalo District endorsing the Lake Pilots Association's 7 January 1983 letter (Exhibit F-12).
F-14	11 February 1982 letter from Mr. David F. Mattson of Cereal Food Processors, Inc. to Buffalo District regarding their future plans for their ship unloading building adjacent to the Cuyahoga River.
F-15	22 October 1981 letter from Mr. Donald E. Yerks of Conrail to Buffalo District regarding Conrail's proposed plans to abandon their Railroad Bridge No. 14 over the Cuyahoga River.

Exhibit	Description
F-16	4 August 1983 letter from Mr. George Ryan, President, Lake Carriers Association to Buffalo District regarding vessel damages caused by the Jefferson Avenue Bridge Abutments.
F-17	19 May 1982 letter from Mr. Patrick A. Manley of Republic Steel Corporation to Buffalo District regarding their concern about three areas of the Cuyahoga River which inhibit vessel transits.
F-18	5 April 1983 letter from Mr. Ronald R. Hostelley, Supervisor, Marine Transportation, Republic Steel Corporation to Buffalo District regarding benefits of a deepened turning basin.
F-19	1 May 1981 letter from Mr. John F. Duink of Conrail to Buffalo District regarding Conrail's sale of the Erie Ore Dock on the Old River.
F-20	7 October 1981 telephone conservation record between Buffalo District and Mr. Hal Mawhey, Cleveland Plain Dealer Publishing Company, regarding their abandonment of plans to develop a newspaper publishing complex adjacent to the Old River.
F-21	11 February 1982 telephone conservation record between Buffalo District and Mr. Robert W. Moore, Ashland Petroleum Company regarding a proposed coal-oil mixing facility on their property adjacent to the Old River currently under consideration.
F-22	2 September 1982 letter from Mr. Roger D. Hubbell, Chief, Office of Outdoor Recreation Services, Ohio Department of Natural Resources to Buffalo District regarding the need to maintain small-boat access between the Lakefront Harbor and Edgewater Marina via the gap in the west breakwater.

RESOLUTION NO. 1976-30

A RESOLUTION SUPPORTING THE IMPLEMENTATION OF IMPROVEMENTS RECOMMENDED IN FEASIBILITY REPORT FOR HARBOR MODIFICATIONS, CLEVELAND HARBOR, OHIO; AUTHORIZING THE CLEVELAND-CUYAHOGA COUNTY PORT AUTHORITY TO ACT AS THE LOCAL COOPERATOR FOR SUCH IMPROVEMENTS PROVIDED LOCAL FINANCING IS PROVIDED FROM LOCAL INDUSTRY OR OTHER SOURCES AND AUTHORIZING THE CHAIRMAN TO TRANSMIT THIS INFORMATION TO THE UNITED STATES OF AMERICA THEREFOR.

WHEREAS, the Port Authority has been advised by the United States Army Corps of Engineers by letter dated April 12, 1976 that it will recommend authorization of navigation improvements described in the Feasibility Report for Harbor Modifications, Cleveland Harbor, Ohio; and

WHEREAS, the Port Authority has been further advised by the United States Army Corps of Engineers by such letter that the designation of a Local Cooperator for the Cleveland Harbor navigation improvements is necessary before the improvements can be recommended for authorization;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Cleveland-Cuyahoga County Port Authority, Cleveland, Ohio:

Section 1. The Cleveland-Cuyahoga County Port Authority will consent and has the legal authority to be the local cooperator for the Cleveland Harbor modifications proposed by the United States Army Corps of Engineers as outlined in the "Draft Feasibility Report for Harbor Modifications,Cleveland, Ohio" as submitted to the Port Authority in March, 1976 and as detailed in a letter from Colonel Bernard Hughes to Chairman Albert Bernstein dated April 12, 1976, provided that the Cleveland-Cuyahoga County Port Authority can obtain financing for the project from local industry or other sources.

Section 2. That this Resolution shall take effect immediately upon its adoption.

ADOPTED: May 7, 1976

CHAIRMAN

ATTEST:

Asst. SECRETARY

Exhibit F-1

RESOLUTION NO. 1976-37

A RESOLUTION SUPPLEMENTING RESOLUTION NO. 1976-30 AUTHORIZING THE CLEVELAND-CUYAHOGA COUNTY PORT AUTHORITY TO ACT AS THE LOCAL COOPERATOR FOR A POSSIBLE SPOIL DISPOSAL DIKE IF SUCH DIKE IS REQUIRED TO COMPLETE THE HARBOR IMPROVEMENTS AS SPECIFIED IN FEASIBILITY REPORT FOR HARBOR MODIFICATIONS.

WHEREAS, the Port Authority Board of Directors has passed Resolution No. 1976-30 supporting the implementation of improvements recommended in Feasibility Report for Harbor Modifications, Cleveland Harbor, Ohio, provided that the Cleveland-Cuyahoga County Port Authority can obtain financing for the project from local industry or other sources; and

WHEREAS, the Port Authority has now received a letter dated June 7, 1976 from Colonel Hughes, District Engineer of the Corps of Engineers, setting forth modifications which he proposes to recommend in the final Feasibility Report, which modifications may require construction of a spoil disposal project West of existing Dike #10; and

WHEREAS, it is a requirement that a Local Cooperator of the proposed possible spoil disposal dike be named now for the submission to move forward for approval;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Cleveland-Cuyahoga County Port Authority, Cleveland, Ohio:

Section 1. The Cleveland-Cuyahoga County Port Authority agrees to be the Local Cooperator for a spoil disposal dike area in accordance with the terms outlined in the letter of Colonel Hughes dated June 7, 1976 provided that the Port Authority continues to be eligible for the waiver of cost of the local share pursuant to the provisions of Section 123 of Public Law 91-611 and provided further, that the City of Cleveland agrees to furnish the Port Authority all lands, easements and rights-of-way required for construction and maintenance of the Harbor improvements and for aids to navigation requested by the Chief of the Corps of Engineers which are not now controlled by the Port Authority.

Section 2. That this Resolution shall take effect immediately upon its adoption.

ADOPTED: June 21, 1976

CHAIRMAN

Exhibit F-2

ATTEST:

Ass't SECRETARY

ODNR
Ohio Department of Natural Resources

Fountain Square · Columbus Ohio 43224 · (614) 466-3770

June 11, 1976

Colonel Bernard C. Hughes
U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207

Re: Your 2 June 1976 letter;
Cleveland Harbor fishing access

Dear Colonel Hughes:

This is to assure that this Department is willing and capable of sharing one-half of the estimated $1.3 million cost to construct west breakwater fishing facility. However, we need to look to a local government entity for operation and maintenance. The estimated annual benefit is $945,000.

Our benefit forecast is based on:

(1) fishing access to about 7,000 feet of breakwater,

(2) an estimated annual usage of 150,000 fishing trips, and

(3) $6.30 value per fishing trip based upon the 1970 National Survey of Fishing and Hunting.

Sincerely,

Robert W. Teater

ROBERT W. TEATER
Director

S A RHODES Governor • ROBERT W TEATER Director

Exhibit F-3

TELEPHONE OR VERBAL CONVERSATION RECORD For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office	DATE 17 February 1982

SUBJECT OF CONVERSATION

Cleveland Harbor Study - J&L Steel Corporation's Future Lakefront Transshipment Plans

INCOMING CALL

PERSON CALLING	ADDRESS	PHONE NUMBER AND EXTENSION
PERSON CALLED	**OFFICE**	**PHONE NUMBER AND EXTENSION**

OUTGOING CALL

PERSON CALLING	OFFICE	PHONE NUMBER AND EXTENSION
Richard Aguglia	NCBPD-WB	2263
PERSON CALLED	**ADDRESS**	**PHONE NUMBER AND EXTENSION**
Mr. F.S. Albarano (Shipment Planner)	Pittsburgh, PA	412-227-4305

SUMMARY OF CONVERSATION

1. On 17 February 1982, I called Mr. Albarano about their future lakefront transshipment plans at Cleveland Harbor. Mr. Albarano replied as follows:

a.) J&L Steel Corporation is not interested in building their own iron ore transshipment facility in the Lakefront Harbor. However, if economically justified, they would consider using such a facility if built by others (i.e., Conrail, Cleveland Port Authority, etc.).

b.) They recently stopped feasibility studies by Lake Erie Asphalt Products due to the depressed demand for steel (Note: LEAP was studying the feasibility of building a Lakefront Iron Ore Transshipment facility to serve, among others, J&L Steel.)

c.) They are very interested in using a deepened Cuyahoga River navigation channel.

RICHARD E. AGUGLIA
Project Manager

Exhibit F-4

DA FORM 1 APR 66 751 REPLACES EDITION OF 1 FEB 58 WHICH WILL BE USED.

WRHS
THE WESTERN RESERVE HISTORICAL SOCIETY
10825 EAST BOULEVARD / CLEVELAND, OHIO 44106 / (216) 721-5722

October 15, 1981

Mr. Charles E. Gilbert
Buffalo District Corps of Engineers
1776 Niagara Street
Buffalo, NY 14207

Dear Mr. Gilbert:

In response to your letter of October 13, 1981, The West Pierhead Lighthouse in Cleveland Harbor was built in 1909-1910, with additions in 1916. It was included in a survey of lighthouses on the Great Lakes conducted by the U. S. Coast Guard and HAER in 1979. It was subsequently included in a thematic resource nomination to the National Register and submitted to the National Park Service in August, 1980.

I do not know whether this thematic resource group has been listed, and I suggest that you contact the National Register office directly. The State Historic Preservation Officer for Ohio has concurred in the eligibility of the structure for the National Register.

Sincerely,

Eric Johannesen

Eric Johannesen
Preservation Officer

United States Department of the Interior

NATIONAL PARK SERVICE
MIDWEST REGION
ANN ARBOR OFFICE
FEDERAL BUILDING
ANN ARBOR, MICHIGAN 48107

IN REPLY REFER TO:
March 2, 1982

1201-02(a)

Mr. Charles E. Gilbert
Chief, Engineering Division
Department of the Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Gilbert:

Thank you for your February 25, 1982, letter concerning the study to provide various navigation improvements to Cleveland Harbor, Ohio.

We are not aware of any significant cultural resources which would be affected by this project, except for the West Pierhead Lighthouse mentioned in the letter by Eric Johannesen, Preservation Officer, The Western Reserve Historical Society.

We suggest you write for the comments of Dr. W. Ray Luce, Ohio State Historic Preservation Officer, The Ohio Historical Society, Interstate 71 at 17th Avenue, Columbus, OH 43211.

Thank you for giving us this opportunity to comment on the project. If you have any questions, call Dr. Harry G. Scheele, FTS 378-2007.

Sincerely,

David H. Shonk

David H. Shonk, Chief
Ann Arbor Office

Exhibit F-5b

Ohio Historic Preservation Office
Ohio Historical Center I-71 & 17th Avenue Columbus, Ohio 43211 (614) 466-1500

March 17, 1982

U.S. Army Corp. of Engineers, Buffalo
Environmental Resources Branch
1776 Niagara Street
Buffalo, New York 14207

Attention: Kathleen McDermott

Re: Navigation Improvements
Cleveland Harbor

Dear Ms. McDermott:

This is in reply to your letter of 25 February 1982, requesting our preliminary comments on various proposed alternative actions to improve navigation at Cleveland Harbor.

Of the different entrance plans, it appears that only Alternative 1 ("All-Weather" East Entrance Plan) will not involve the Cleveland West Pierhead Light, which should be considered eligible for inclusion in the National Register of Historic Places (see enclosed). If this light is involved and adversely affected it will be necessary to prepare a Preliminary Case Report and request the comments of the Advisory Council on Historic Preservation. If Alternative 1 is selected, there will be no effect on cultural resources.

The various improvements for to the Cuyahoga River and the Old River including new bulkheads, deepening, and reducing river congestion must take into consideration the National Register or eligible properties along the river. These properties include the Center Street Swing Bridge, the Old Superior Avenue Viaduct, the Columbus Road Vertical Lift Bridge (currently scheduled for reconstruction by ODOT but indicated for replacement in Alternative 7), The Union Terminal Groups, and the Lorain Carnegie Bridge. As plans for these various proposals progress, you should continue to coordinate with this office. As necessary, you should request determinations of eligibility or determinations of effect and initiate consulation with the National Park Service and the Advisory Council.

Thank you for requesting our early imput on this project and we look forward to continued coordination.

Sincerely,

W. Ray Luce

W. Ray Luce
State Historic Preservation Officer

WRL/BD:vb
Enclosures
X.c: Charlene Dwin, ACHP

Exhibit F-5c

Ohio Historic Preservation Office
Ohio Historical Center I-71 & 17th Avenue Columbus, Ohio 43211 (614) 466-1500

August 5, 1980

U. S. Nichols
Chief, Logistics & Property Branch
Ninth Coast Guard District
1240 East 9th Street
Cleveland, Ohio 44199

Dear Mr. Nichols:

Enclosed is the National Register of Historic Places nomination form you forwarded for the U.S. Coast Guard Lighthouses. I have signed the document at the appropriate place indicating my concurrence in their nomination. I feel these Ohio properties are eminently qualified for the National Register.

We appreciate your initiating these efforts to meet your E.O. 11593 responsibilities, and are pleased to work with you in recognizing these important Ohio landmarks. Please let us know if we can be of any assistance in your future preservation endeavors.

Sincerely,

David L. Brook

David L. Brook
State Historic Preservation Officer

DLB:DAS:cw

X. c; Eric Johannesen
Ted Ligibel

FOR NPS USE ONLY
RECEIVED
DATE ENTERED

NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

Illinois

Chicago Harbor Light Station

Michigan

Big Sable Point Light Station
Detroit River Light Station
Eagle Harbor Light Station
Forty Mile Point Light Station
Grand Traverse Light Station

Granite Island Light Station
Gull Rock Light Station
Harbor Beach Light
Isle Royale Light Station
Little Sable Point Light Station

Manitou Island Light Station
Marquette Harbor Lighthouse
Pointe Betsie Light Station
Port Sanilac Light Station
Presque Isle Light Station

Rock of Ages Light Station
Saginaw River Light Station
Seul Choix Point Light Station
Skillagallee (Ile Aux Galets) Light Station
Sturgeon Point Light Station

St. Martin Island Light Station
Tawas Point Light Station
Thunder Bay Island Light Station
Waugoshance Light Station
White Shoal Light Station

Minnesota

Duluth South Breakwater Inner Light
Two Harbors Light Station

New York

Buffalo Main Light
Buffalo North Breakwater South End Light
Dunkirk Light
Fort Niagara Light
Galloo Island Light
South Buffalo North Side Light
Thirty Mile Point Light
Tibbetts Point Light

Ohio

Ashtabula Harbor Light
Cedar Point Light
Cleveland West Pierhead Light
Toledo Harbor Light
West Sister Island Light

Pennsylvania

Presque Isle Light

Wisconsin

Ashland Breakwater Light
LaPointe Light Station
North Point Light Station
Plum Island Rear Range Light
Rawley Point Light Station
Sherwood Point Light Station
Sturgeon Bay Canal Light
Wind Point Light Station

FIELD NO

CLASSIFICATION: ...NS:MARINE:Navigational aids | 5 5 0 1 | PRIORITY: 2

DATE: 1909-1910; 1916

DANGER OF DEMOLITION? ☐ YES ☒ NO ☐ UNKNOWN

GOVT SOURCE OF THREAT: OWNER / ADMIN

OWNER/ADMIN: Department of Transportation, U. S. Coast Guard

OWNER'S ADDRESS: Ninth District, 1240 East 9th Street, Cleveland, Ohio 44199 — PHONE: 216/522-2950

NAME OF STRUCTURE: ...veland West Pierhead Light

STATE 0 | COUNTY NAME: Cuyahoga | CITY/VICINITY: Cleveland | CONG DIST

ADDRESS (STREET & NO): west pierhead at main entrance to Cleveland Harbor, on Lake Erie

EXISTING SURVEYS: ☐ NR ☐ NHL ☐ HABS ☐ HAER-I ☐ HAER ☐ NPS ☐ CLG ☐ CONF ☐ STATE ☐ COUNTY ☐ LOCAL ☐ OTHER

SPECIAL FEATURES (DESCRIBE BELOW): ☒ INTERIOR INTACT ☒ EXTERIOR INTACT ☒ ENVIRONS INTACT

UTM ZONE	EASTING	NORTHING
17	440100	4595300

SCALE: ☒ 1:24 ☐ 1:25 ☐ OTHER — QUAD NAME: Cleveland North

CONDITION: ☐ EXCELLENT ☐ GOOD ☒ FAIR ☐ DETERIORATED ☐ RUINS ☐ UNEXPOSED ☐ ALTERED ☐ DESTROYED ☐ DEMOLISHED

RECORDED BY: ...ol Poh Miller | AFFILIATION: HAER-Great Lakes Lighthouse Survey | DATE: May 1979

DESCRIPTION AND BACKGROUND HISTORY, INCLUDING CONSTRUCTION DATE(S), HISTORICAL DATA, PHYSICAL DIMENSIONS, MATERIALS, EXTANT EQUIPMENT, AND IMPORTANT BUILDERS, ENGINEERS, ETC

...gether with a small metal beacon on the east breakwater, the Cleveland West Pierhead Light marks ... main entrance to Cleveland Harbor. The arrowhead breakwaters were built 1904-1909 to protect ... harbor from prevailing northerly winds. In 1908, $45,000 was appropriated for two "light-...tions" to mark the channel into the harbor. The West Pierhead Light, erected 1909-1910, consists ... a 4-story brick tower sheathed with wood. The conical tower, painted white, features windows with ...mental architraves and an entrance vestibule with three-part entablature. There is a basement, ...ley on the first floor, and living quarters on the second, third, and fourth floors (no longer ...upied). Above this is a watchroom with a circular gallery supported on brackets. The circular ...tern rises above the watchroom. Although the light was converted to electric lens drive in (CONT OVER)

ORIGINAL USE: ...bor light & fog signal | PRESENT USE: Harbor light & fog signal | ADAPTIVE USE

REFERENCES—HISTORICAL REFERENCES, PERSONAL CONTACTS, AND/OR OTHER

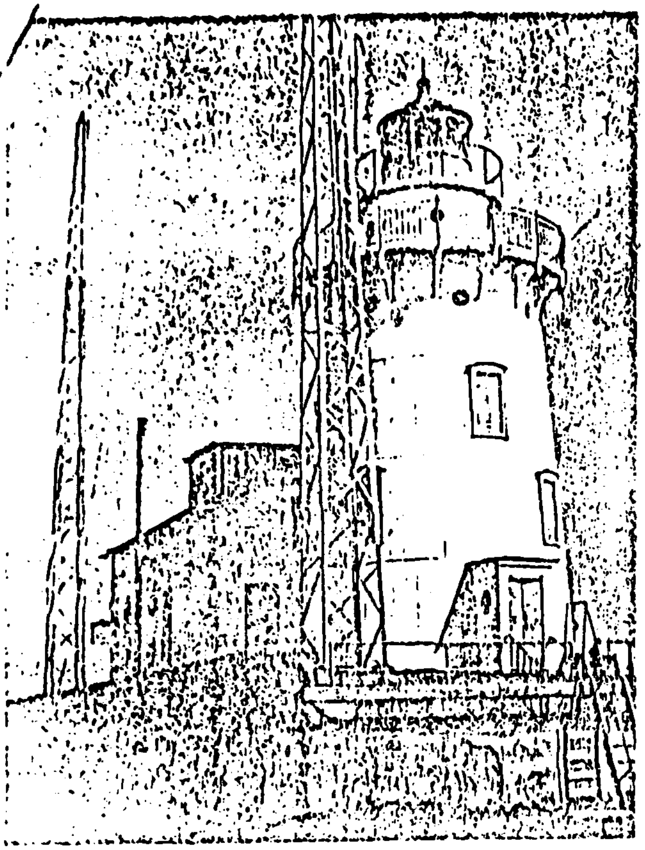
...wing and photograph files, United States Coast Guard Ninth District Headquarters, Cleveland, Ohio.
...ords of the United States Coast Guard, Record Group 26, National Archives, Washington, D.C.
..., Department of Transportation, United States Coast Guard, Light List, vol. 4, Great Lakes (1979), p. 38.
(CONT OVER)

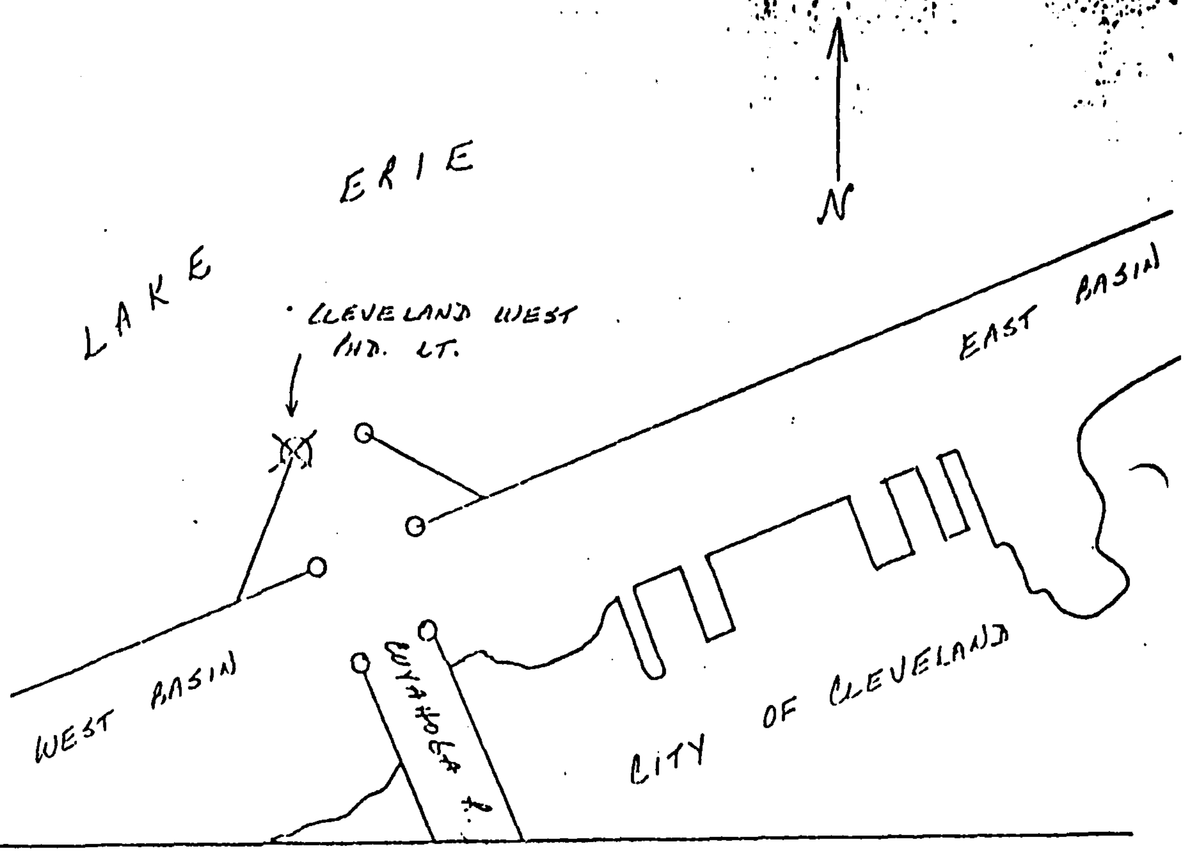
...CAN AREA 50,000 ...? ☒ YES ☐ NO | 21 HCRS REGION | 22 PUBLIC ACCESSIBILITY: ☒ YES, LIMITED ☐ YES UNLIMITED ☐ NO ☐ UNKNOWN | 23 EDITOR / INDEXER

...ATED IN A HISTORIC DISTRICT? ☐ YES ☒ NO | NAME | DISTRICT I.D. NO

...10 1/79

PHOTOS AND SKETCH MAP OF ... ATION





DESCRIPTION (CONTINUED)

1960, it is still shone through a 4th-order Fresnel lens bearing the marking of "Barbier & Benard, Paris, 1884." The light, which has a focal plane height of 63' above mean lake level, shows an alternating white and red flash. On the north side of the light, a covered passage connects the tower to a $1\frac{1}{2}$-story steel-framed fog signal house, built in 1916. The gable-roofed building, 29' 31', is clad with $\frac{1}{4}$" steel plates. New fog signal apparatus was installed in 1964.

REFERENCES (CONTINUED)

VUD: includes lighthouse and its foundation, approx. .25 acres

This lighthouse played an important role in the development of Cleveland harbor.

United States Department of the Interior

NATIONAL PARK SERVICE

MIDWEST REGION
1709 JACKSON STREET
OMAHA, NEBRASKA 68102-2571

IN REPLY REFER TO:

L7619(MWR-PQ)

JUN 27 1983

Colonel Robert R. Hardiman
District Engineer
U.S. Army Engineer District, Buffalo
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Hardiman:

This is in response to your request for early coordination review in relation to preparation of the Draft Supplement to the Final Environmental Impact Statement for the construction of improvements to the existing commercial navigation project at Cleveland, Ohio.

Based on the information in your letter and attachments of May 5, and our general knowledge of the area, it does not appear that implementation of the proposed project will adversely affect any area or jurisdiction of the National Park Service.

We urge that you continue coordination with the State Historic Preservation Officer (SHPO) to ensure that you comply with all mandates pertaining to the identification and protection of cultural resources.

These comments are provided as informal technical assistance and are not intended to reflect our probable comments on the forthcoming Draft Supplement.

Sincerely,

for J. L. Dunning
Regional Director

Ohio Historic Preservation Office

Ohio Historical Center I-71 & 17th Avenue Columbus, Ohio 43211 (614) 466-1500

July 8, 1983

Mr. David Heicher
Environmental Services Branch
Army Corps of Engineers
Buffalo District
1776 Niagara St.
Buffalo, New York 14207

Dear Mr. Heicher:

This letter is in response to your telephone call of July 7, 1983, regarding the alternatives presently under consideration for the Cleveland Harbor Reformulation Project. I find that Alternative 1, deepening the dredging of the harbor entrance and Alternative 7G, removal of the Jefferson Avenue Bridge Abutments will have no effect on any properties listed, or eligible for listing, on the National Register of Historic Places. Alternative 11, deepening of the turning basin at mile 4.8, would also have no effect upon cultural resources, however we understand that this portion of the project is no longer under current consideration. In sum. I find that the proposed project will not effect any significant cultural resources and that no further coordination with this office will be necessary.

If you need further information or clarification, please contact Richard Boisvert at the number above.

Sincerely,

W. Ray Luce

W. Ray Luce
State Historic Preservation Officer

WRL/RB:jb

11 JUL 83 11 43
OFC. MGMT. OAS

EXHIBIT F-5e

ODNR

OHIO DEPARTMENT OF
NATURAL RESOURCES

Fountain Square
Columbus, Ohio 43224
(614) 265-6886

June 3, 1983

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

Re: Draft Supplement to the Final Environmental Impact Statement (FEIS) for the Cleveland Harbor Navigation Project, Cleveland, Ohio

Dear Colonel Hardiman:

The Department has considered your request for coordination and comments as part of an early "scoping" of issues project for the draft supplement referenced above.

We have reviewed the summary of alternatives presently under consideration for the Cleveland Harbor Reformulation Phase I GDM Study. None of the alternatives described seems likely to significantly affect nearby threatened or endangered species or natural areas. Further, three of the alternatives should cause no shoreline erosion problems: No Action, Alternative 7G (removal of Jefferson Avenue Bridge abutments), and Alternative 11 (deepening of the turning basin).

However, Alternative 1 ("severe weather" east entrance plan) will widen and deepen the eastern 3000 feet of the channel. This part of the channel will be widened to 900 feet (an increase of 400 feet) and deepened to 32 feet (an increase of 7 feet). The increased width and depth may allow larger waves from the north and northeast to travel farther into the eastern part of the harbor. Several marinas located at this end of the harbor sustained extensive wave damage during an April 1982 storm. Any changes which allow larger waves to enter the harbor could result in greater storm damage to these marinas. We are aware that this plan is the least expensive and has the support of the Cleveland/Cuyahoga County Port Authority, the "local sponsor".

The Department has no other specific comments at this time. We would, however, be willing to address specific issues related to the harbor improvements plan development as they arise.

Colonel Robert R. Hardiman
June 3, 1983
Page -2-

Regarding plans for development by the Department in the project vicinity, our principal concern, of course, is Cleveland Lakefront State Park. We urge continued close coordination as the Corps' new alternatives are developed in detail. We need to take full advantage of multiple benefits which may be derived from harbor improvements or project mitigation features.

Thank you for your consideration.

Sincerely,

Myrl H Shoemaker

MYRL H. SHOEMAKER
Director

MHS:slb

cc: Ron James, Deputy Director
Resource Management, ODNR

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

REPLY TO ATTENTION OF:

1 JUN 1983

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

NEPA-SC-COE-F42038-OH(83051)

Dear Colonel Hardiman:

Thank you for your May 5, 1983 letter asking us to "scope" the significant issues surrounding the proposed Cleveland Harbor Navigation project at Cleveland, Ohio. We note that four alternatives are being given serious consideration. These are the no-action alternative, the severe weather east entrance alternative, the removal of the Jefferson Avenue bridge abutments alternative, and the deepening of the turning basin at river mile 4.8 alternative. After reviewing the information we presently have on file, we have identified three issues which we believe should be discussed in detail in the draft supplement to the final Environmental Impact Statement (EIS) for the project. The three issues concern the environmental effects of dredging and disposal of harbor sediments, the project's effect on water quality due to ship movements, and the potential for enhancement of fish habitat in the harbor.

The three action alternatives involve dredging harbor sediments and, of course, their disposal. We believe a thorough assessment of the environmental effects of these actions is necessary. In order to understand the effects, we suggest that the assessment include an analysis of past and present sediment quality and dredging requirements. The assessment should also consider the quality of the sediments in the existing confined disposal facility, and the ability of the facility to confine the pollutants (effluent monitoring results). With this information, a prediction of future sediment quality and dredging requirements for each alternative may be made and plans for appropriate disposal alternatives for the dredged sediments, now and in the future, can be evaluated.

The second issue of concern to us is the project's effect on water quality, especially that effect produced by increased ship traffic. Since the project's purpose is primarily to improve commercial navigation at the harbor, we must assume that ship traffic may increase, yet we also realize that the project may decrease congestion in the harbor allowing more traffic with less movement. In any event, we believe the project may effect water quality negatively if more ships use the harbor and increase the disturbance of the bottom sedimetns, or positively if the project results in more efficient ship movements with less disturbance of the bottom sediments. A discussion of each alternatives' effects should be included in the EIS.

Finally, the issue of providing habitat improvements in the harbor should be thoroughly discussed in the EIS. The objective of the Clean Water Act is to restore and maintain the chemical, physical and biological integrity of the nation's waters. Biological integrity is dependent upon both chemical and physical integrity. While the harbor's water quality has been steadily improving over the years, the physical integrity of the harbor is not well suited for supporting a diverse and abundant biological community. The EIS should discuss the feasibility of providng some habitat improvements along with the improvements for commercial navigation.

The above are our major concerns with the Cleveland Harbor commercial navigation project. If you have any questions about our comments on what we consider to be significant issues, please call Mr. James Hooper of my staff at 312/886-6694 (FTS 886-6694).

Sincerely yours,

Barbara Taylor Backley

Barbara Taylor Backley, Chief
Environmental Review Branch
Planning and Management Division

CLEVELAND CITY PLANNING COMMISSION

501 CITY HALL CLEVELAND, OHIO 44114 216 / 664-2210

OFC. MGMT. OAS
25 MAY 83 11 09

May 19, 1983

Colonel Robert R. Hardiman
U.S. Army Corps of Engineers
1773 Niagara Street
Buffalo, N.Y. 14207

Dear Col. Hardiman:

In response to your May 5 letter requesting our reaction to your Draft Supplement - FEIS - Cleveland Harbor Study, we concur with your three improvement proposals, Alternatives 1,7C, and 11. However, we note the omission of Alternates 8A and 8B, the Edgewater Marina Breakwater Fishing Improvement and strongly urge their retention.

Also, while we concur with your inclusion of Alternate 11, Deepen Turning Basin at river mile 4.8, we are curious as to why it was added after not being mentioned at your April 19 Information Meeting at Cleveland Public Library. An explanation would be appreciated.

Sincerely,

Hunter Morrison
Planning Director

HM/LW:kjc
CC: David W. Heicher
C.O.E. Planning Division
Richard Agnglier
C.O.E. Planning Division

EXHIBIT F-8

jeg/2273

' ? . 1983

NCBPD-PF

SUBJECT: Stage 3 Plans for Cleveland Harbor Study

Mr. Hunter Morrison
Planning Director
Cleveland City Planning Commission
501 City Hall
Cleveland, OH 44114

Dear Mr. Morrison:

This is in response to your letter of 19 May 1983 regarding eliminating recreational fishing plans 8A and 8B from the subject study and why inclusion of Plan 11 (Deepen Turning Basin) was not mentioned at the 19 April 1983 Public Information Meeting.

During Stage 2 planning, two scenarios were considered when developing plans to provide fishermen access on the west breakwater at Cleveland Harbor. The first scenario (Plan 8A - see Enclosure 1) assumed that the existing entrance to Edgewater Marina would be completely blocked off with a new breakwater, and that a new entrance would be provided into the west basin of the Cleveland Lakefront Harbor. Small boats would use this new entrance to enter the west basin and would then enter Edgewater Marina through the existing gap in the west breakwater. The second scenario (Plan 8B - see Enclosure 2) assumed that the existing entrance to Edgewater Marina would be only slightly modified to reduce wave energy entering the marina, and would continue to serve as the main entrance to Edgewater Marina. Further, since the modified marina entrance would be usable in stormy weather as well as good weather, the existing interior access channel between Edgewater Marina and the west basin of Cleveland Harbor via the gap in the west breakwater could be severed. Selection of the plan to recommend for construction, however, would await the results of my ongoing Section 107 study for Edgewater Marina which will determine the feasibility of modifying Edgewater Marina and the extent of these modifications.

Subsequent to completion of Stage 2 planning, the Ohio Department of Natural Resources (ODNR), the local sponsor for both the Edgewater Marina and the recreational fishing projects, stated that the existing interior access channel between Edgewater Marina and the west basin of Cleveland Harbor must be maintained for both Plans 8A and 8B. Thus, the pedestrian bridge included in Plan 8B and spanning the gap in the west breakwater would have to provide about 85 feet of vertical clearance to allow sail boaters direct access to the west basin from Edgewater Marina. Since it is unrealistic to assume fishermen will climb an 85-foot high bridge to fish off the west breakwater, Plan 8B was dropped from further consideration. ODNR concurred in this approach.

jeg/2273

NCBPD
SUBJECT: Stage 3 Plans for Cleveland Harbor Study

Further, at the 1 April 1983 Edgewater Marina Workship Meeting with ODNR, the plan to modify the existing entrance to Edgewater Marina was selected as the preferred alternative for modifying Edgewater Marina and the plan involving construction of a new entrance into the west basin of Cleveland Harbor was dropped from further consideration. This automatically eliminated Plan 8A from further consideration. Therefore, based on the above, both Plans 8A and 8B have been dropped from further consideration subsequent to completion of Stage 2 planning.

In regards to Plan 11 (Deepen Turning Basin), this plan was suggested by Republic Steel Corporation at the conclusion of Stage 2 planning, and will be investigated during the current Stage 3 or detailed planning phase. Although I did not discuss this plan in detail at the 19 April 1983 Public Information Meeting (since we had not completed our studies on this plan at that time), I did mention that I would be considering the plan during Stage 3 planning. I expect to complete my analysis shortly, and will review the results with you and other local interests at a workshop meeting to be held later this summer.

I trust this adequately responds to your inquiry. My point of contact for this action is my Project Manager, Mr. Richarg Aguglia, (716)876-5454, extension 2263 of my Planning Division.

Sincerely,

ROBERT R. HARDIMAN
Colonel, Corps of Engineers
District Engineer

Aguglia ____
Kelly ____
Zorich/Hallock ____
DDE ____
DE ____

2 Enclosures CF
as stated

CF:
NCBPD
NCBPD-PF
NCBPD-ER

7 JUN 83 11 02
OFC. MGMT. OAS

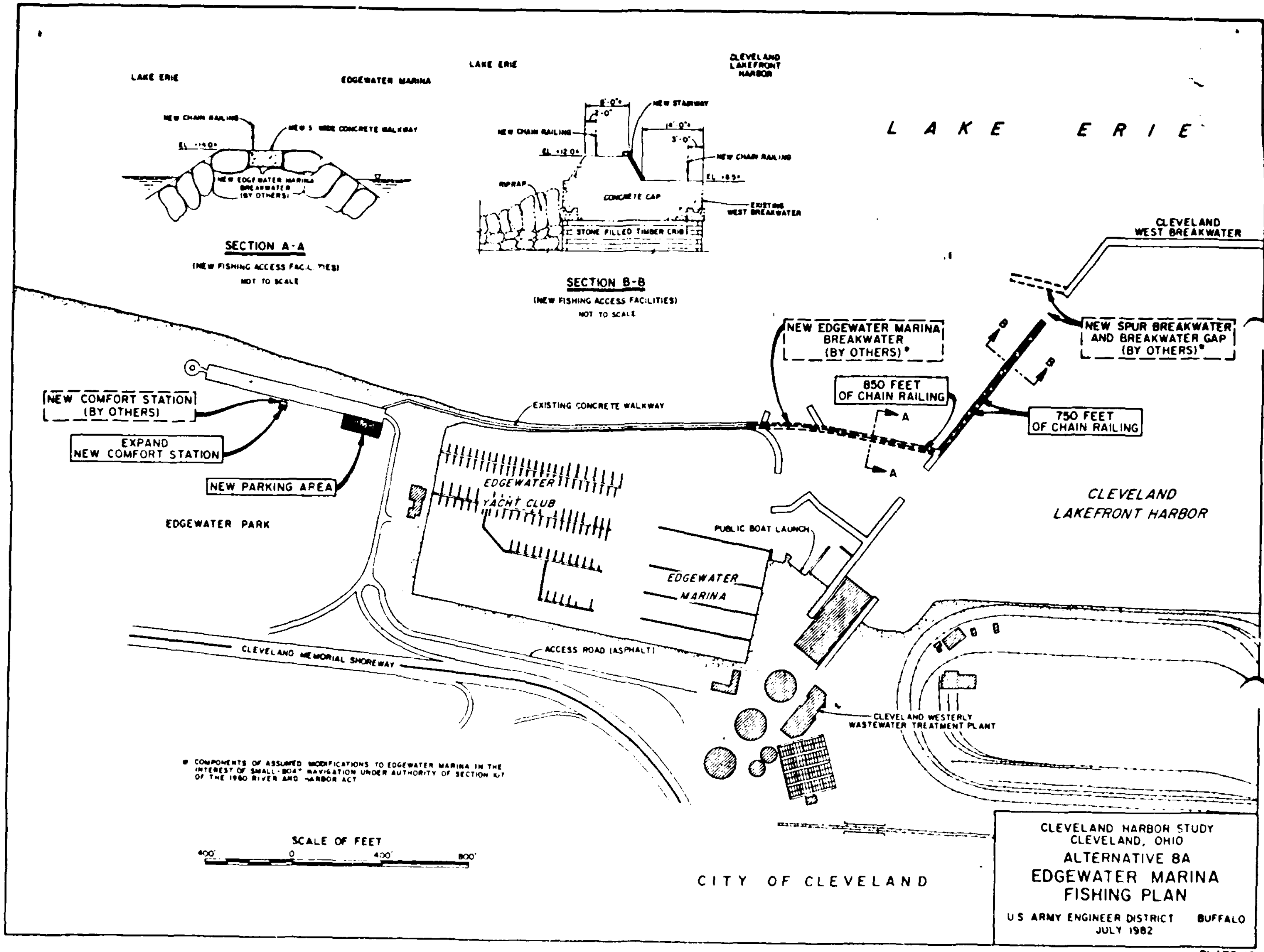
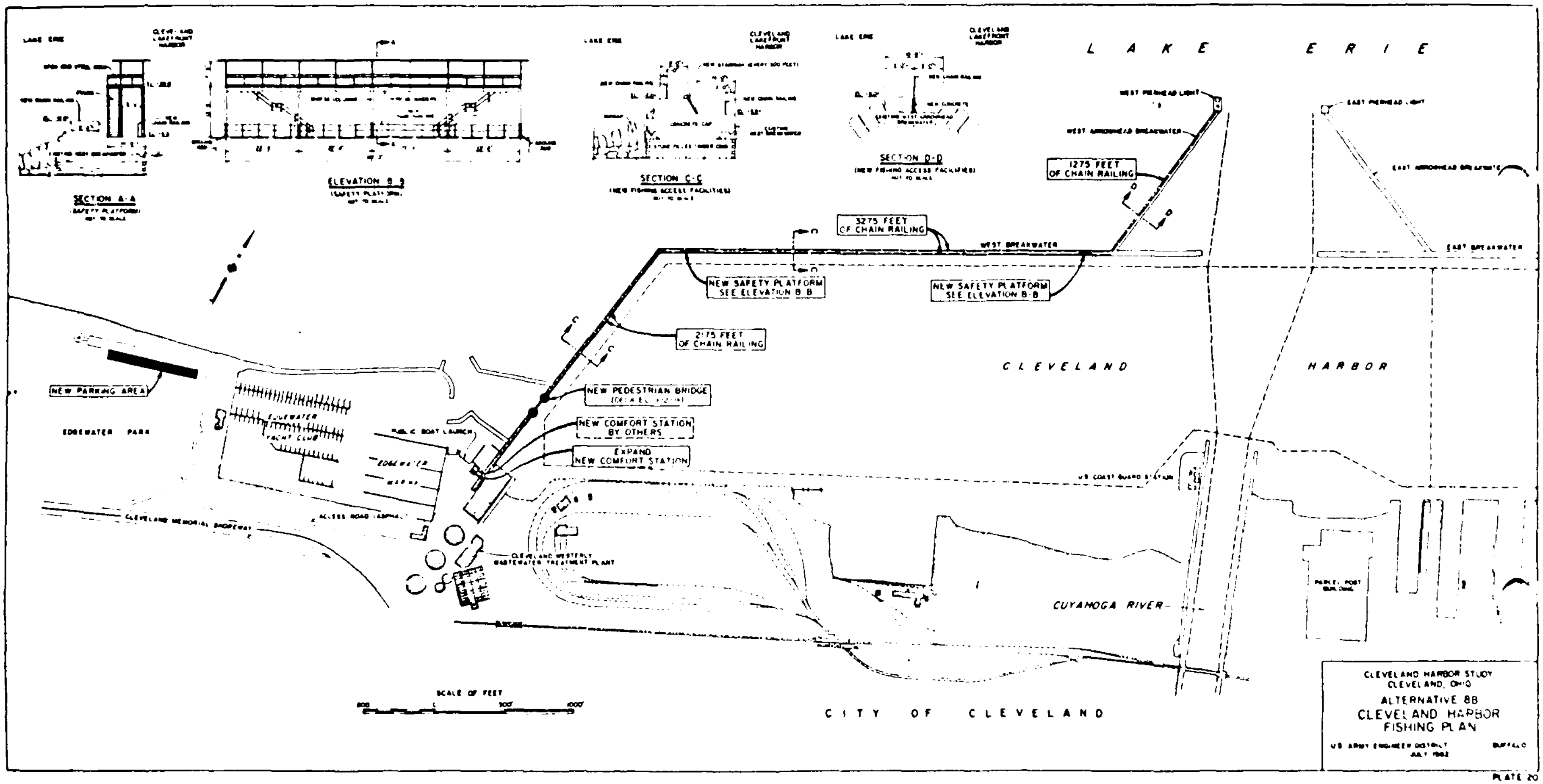


PLATE 19

Incl 1


LAKE ERIE
SECTION A-A
(SAFETY PLATFORM)
NOT TO SCALE
ELEVATION B-B
(SAFETY PLATFORM)
SECTION C-C
(NEW FISHING ACCESS FACILITIES)
SECTION D-D
(NEW FISHING ACCESS FACILITIES)
WEST PIERHEAD LIGHT
WEST ARROWHEAD BREAKWATER
EAST PIERHEAD LIGHT
EAST ARROWHEAD BREAKWATER
EAST BREAKWATER
WEST BREAKWATER
1275 FEET OF CHAIN RAILING
3275 FEET OF CHAIN RAILING
2175 FEET OF CHAIN RAILING
NEW SAFETY PLATFORM SEE ELEVATION B-B
NEW SAFETY PLATFORM SEE ELEVATION B-B
CLEVELAND
HARBOR
NEW PARKING AREA
EDGEWATER PARK
EDGEWATER YACHT CLUB
PUBLIC BOAT LAUNCH
EDGEWATER MARINA
NEW PEDESTRIAN BRIDGE
NEW COMFORT STATION BY OTHERS
EXPAND NEW COMFORT STATION
U.S. COAST GUARD STATION
CLEVELAND MEMORIAL SHOREWAY
ACCESS ROAD (ASPHALT)
CLEVELAND WESTERLY WASTEWATER TREATMENT PLANT
CUYAHOGA RIVER
PARCEL POST BUILDING
SCALE OF FEET
500 0 500' 1000'
CITY OF CLEVELAND
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 8B
CLEVELAND HARBOR
FISHING PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982
PLATE 20

GEORGE J. RYAN, President
DAVID L. BUCHANAN, Vice President

WILLIAM J. CONROY, Secretary Treasurer
THOMAS O. MURPHY, General Counsel

LAKE CARRIERS' ASSOCIATION

1411 ROCKEFELLER BUILDING
CLEVELAND, OHIO 44113
(216) 621-1107

July 15, 1983

21 JUL 83 11 04
OFC. MGMT. OAS

Colonel Robert R. Hardiman
District Engineer
Buffalo District
Corps of Engineers
1776 Niagara St.
Buffalo, NY 14207

Dear Colonel Hardiman:

At a meeting on the Cleveland Harbor Study held in Cleveland on February 24, 1983, Richard Aguglia, project manager, asked the association to gather further details on damage to vessels at the Jefferson Avenue bridge abutment and transit time savings projected through use of an improved east entrance.

Concerning the east entrance improvements, it has been the position of the association to recommend carrying alternate plan 1 into Stage 3 planning. However, the association's final position on whether to support construction of the improvements will be dependent upon the needs of the steel and construction industry in the mid-1980's and beyond. Our position will also take into consideration the congressional action on imposition of user fees or taxes on maintenance and improvement of commercial harbors.

At the present time, the majority of our members who use the Cleveland harbor do not believe that east entrance improvements will substantially reduce delays to vessels. There is concern that wind conditions which would dictate use of the east entrance would also be severe enough to force a vessel out of the channel once inside the breakwater because of the high freeboard exposed to the wind. There is also concern that once in the harbor and approaching the Cuyahoga River, the wind would be too strong to permit a safe turn up the river. As you know, most of our members trade up the river as opposed to lakefront docks.

EXHIBIT F-10

You have asked us to provide quantitative data on limiting weather conditions which would prevent harbor entry through the existing west entrance. Each of our members takes a safe, conservative approach when it comes to vessel navigation in close waters. Further, each captain must exercise judgment based upon individual vessel characteristics and weather conditions. When conditions are deemed unsafe by the captain, he will go to a safe anchorage. The best estimate we can give you is that the maximum wind acceptable for a Class V to VII vessel entry is 25 miles per hour when the wind direction is from west to east-northeast. Some masters, of course, will choose to go to anchor when wind is less than 25 mph if other circumstances dictate. Certainly a Class X vessel probably would not proceed through the west entrance when the wind exceeds 20 mph.

Your question as to what maximum weather condition would permit a vessel to enter an improved east entrance does not allow an unequivocal answer. Our reply must be conjectural at best -- a fair estimate. The variables include other traffic, visibility, weather forecast, freeboard, vessel propulsion, including thrusters and many other factors. Considering wind alone, I would offer that if the wind exceeded 30 mph, no vessel would attempt entry. For a Class X vessel, if the wind exceeded 25 mph, a master may decide not to enter. The above are merely estimates, and after consideration of all relevant navigation conditions, a captain could prudently choose to enter the harbor with wind in excess of the estimates.

Concerning average vessel delay time, our members provide this data to you.

Concerning savings in vessel transit time, we will rely on your studies. Under normal circumstances, the savings will be for salties and Canadians.

At a later date we will provide you with estimates of costs of damage to vessels through striking the abutments of the Jefferson Street bridge.

Please call me if there are questions about our reply.

Sincerely,

George J. Ryan

George J. Ryan
President

GEORGE J. RYAN, *President*
DAVID L. BUCHANAN, *Vice President*

WILLIAM J. CONROY, *Secretary Treasurer*
THOMAS O. MURPHY, *General Counsel*

LAKE CARRIERS' ASSOCIATION

1411 ROCKEFELLER BUILDING
CLEVELAND, OHIO 44113
(216) 621 1107

OFC. MGMT. OAS
8 SEP 83 11 05

September 2, 1983

Colonel Robert R. Hardiman
District Engineer
U. S. Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Hardiman:

On August 5, 1983 Messrs. Augulia and Hallock visited our office to discuss the Cleveland Harbor Study and to seek clarification of some of the data presented in our July 15, 1983 letter.

First, I must clarify that the unit of measurement I refer to in that letter for wind speed was miles per hour. In all cases, I was referring to nautical miles per hour when referring to wind speed.

Next, in our discussion I mentioned the extremely conservative nature of our response when it came to estimating the possible wind condition which would permit a class 10 vessel to enter the improved east entrance. I have discussed this further with the Masters who enter the harbor frequently to dock at the lakefront facilities. I find that there is a strong opinion that class 10 vessels could enter through the east entrance when the wind speed was up to 30 knots in a channel dredged to 32 feet and, under certain circumstances, some Masters would enter with a wind at a higher speed.

Please revise our submission accordingly.

Paragraph three of the July 15th letter should be clarified to indicate that it was the majority of our members who trade up the Cuyahoga River who do not believe the east entrance improvements will substantially reduce delays to their vessels.

Sincerely yours,

George J. Ryan
President

GJR:cal

EXHBIIT F-11

LAKES PILOTS ASSOCIATION, INC.
P. O. Box 902
PORT HURON, MICHIGAN 48060

Phone AREA CODE 313
984-2541

January 7, 1983

OFC. USNIT.OAS
11 JAN 83 09 11

Colonel Robert R. Hardiman
U.S. Army Corps of Engineers
Buffalo District
1776 Niagara Street
Buffalo, N.Y. 14207

Dear Colonel Hardiman:

The Great Lakes Pilots Association requests that the following information be considered by the Buffalo District, Corps of Engineers in the development of their recommendations for improvements at Cleveland Harbor, OH. Although a number of improvements have been considered by your agency, we believe that modifications to the existing east entrance would be most beneficial to foreign flag vessels which utilize the public docks in the Outer Harbor. An outline of the expected benefits of a modified east entrance channel follow:

a. Reduction in transit time per trip of one hour when ships are loaded to a draft of 25' or greater when arriving from or departing to the east.

b. Storm-related vessel delays (caused because ships will not attempt a harbor entry when winds are greater than 20 knots from the SSW to NE directions due to restrictive existing harbor entrances) can range from 12 hours duration in the spring months (April and May) to a maximum of 72 hours in the fall months (October, November and December). An overall average vessel delay of 15 hours per occurrence for each vessel affected would be representative of expected annual benefits. Delays would be eliminated when wind speeds vary between 20-40 knots and originate between the south-southwest through northeast compass headings if the east entrance were modified.

c. Another intangible benefit expected is the assurance that, whichever direction the bow of a vessel turns to when leaving a lakefront slip, either harbor exit location (east or west) could be utilized. Reliance upon the existing west arrowhead opening only frequently requires tug-assistance expenses, tug-related delays or additional vessel maneuvering times before proper positioning of the vessel is

LAKES PILOTS ASSOCIATION, INC.

P. O. Box 902

PORT HURON, MICHIGAN 48060

Phone AREA CODE 313 984-2541

accomplished which would be eliminated if the east entrance was modified.

The Association would also like to identify an unmet need of most foreign flag vessels. Dredging of a triangular area east of the port authority docks should be considered by the Corps in order to facilitate safe and obstructed approach/exit to the docks in the Outer Harbor. This area is shown on the attached project map. Increased use of the east entrance channel and the greater need to make a left turn into the lakefront slips is the basis for the additional dredging.

Existing authorized depths in the east entrance channel of 25' at low water datum precludes entry of a Seaway draft vessel despite high water levels for Lake Erie. Vessel charter contract terms commonly specify terms such as "free afloat" and "safe berthing". These contractual restrictions, and a concern for maritime liability on the part of the Pilot's Association, prevent use of available water depths over and above authorized depths. Our Association believes that your recommendation should be a 32' entrance channel depth at LWD to accomodate all possible ship motions (roll,pitch,heave,etc.) when entering during storm conditions and wind speeds between 20 to 40 knots. Cleveland Harbor should also be considered unique among Great Lakes Harbors due to its exposed location and because ships would attempt to enter under heavier sea conditions relative to other Lake Erie/ Great Lakes ports with a modified east entrance in place.

Thank you for the opportunity to provide information about our concerns for modifications of Cleveland Harbor.

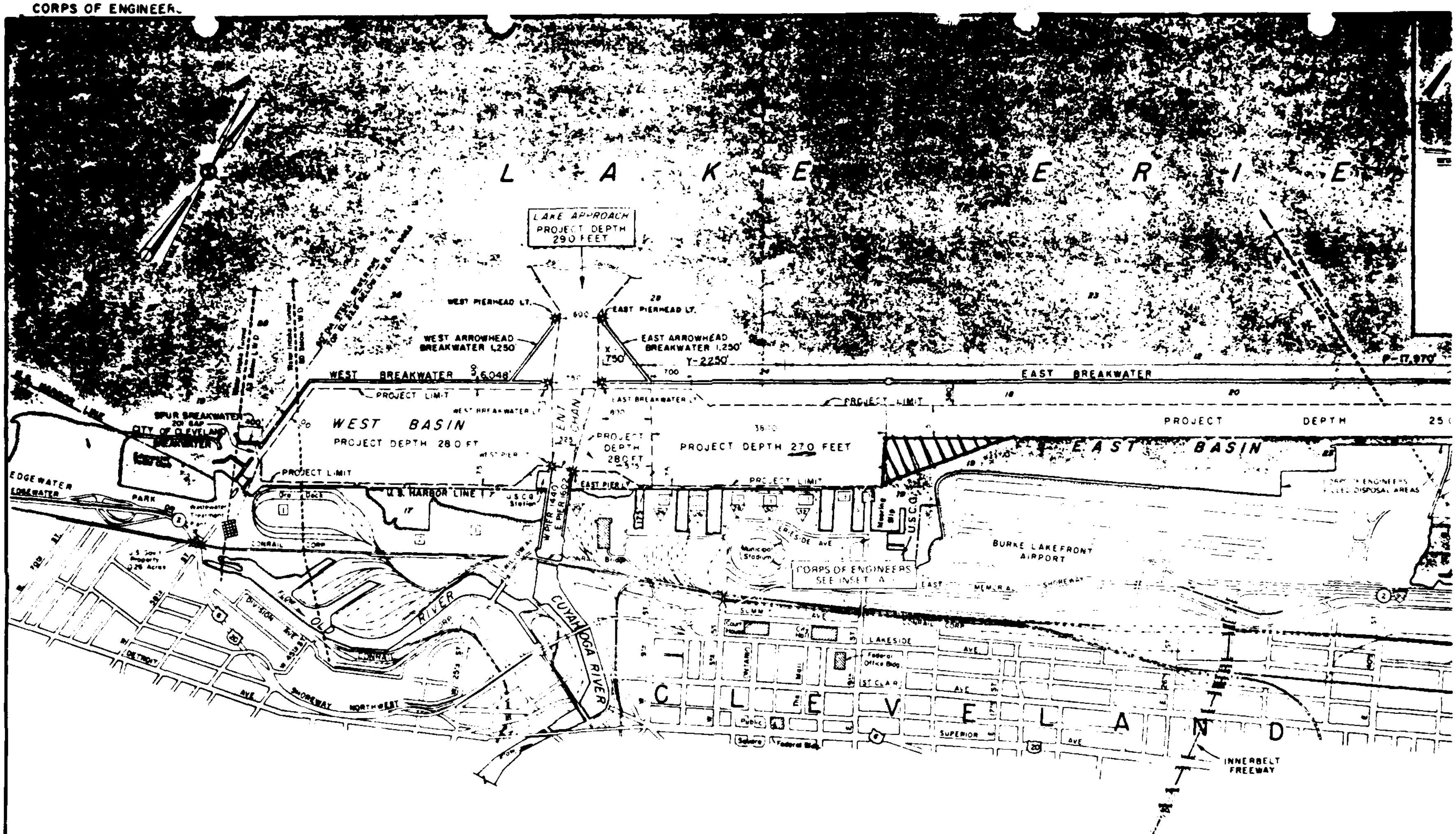
H E MacDermid

H.E.MacDermid, President
Lakes Pilots Association, Inc.

Victor H. Anderson

Victor H. Anderson,Chairman
Navigation Committee

CORPS OF ENGINEERS



THIS IS OUTER HARBOR SECTION
(For Cuyahoga River section, see Map 6 A)

WATERFRONT OWNERSHIP

1 CONRAIL
2 GREAT LAKES DREDGE AND DOCK CO (L) CONRAIL (O)
3 CITY OF CLEVELAND (O)
4 NICHOLSON CLEVELAND TERMINAL CO (O)
5 EAST 55th ST MARINA CITY OF CLEVELAND (O)
6 CLEVELAND ELECTRIC ILLUMINATING CO (O)

NOTES

PROJECT DEPTHS AND SOUNDINGS A
TO LOW WATER DATUM, EL. 568.6
MEAN WATER LEVEL AT FATHER PC
(IGLD 1955) (INTERNATIONAL GREAT

6 INDICATES U.S. ROUTE
2 INDICATES STATE ROUTE
INDICATES INTERSTATE ROU
INDICATES CITY OF CLEVEL
NUMBERING SYSTEM

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to: (dgp)
COMMANDER
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199

Phone: (216) 522-3930

3100/2
12 May 1983

From: Commander (dgp), Ninth Coast Guard District
1240 E. Ninth Street, Cleveland, Ohio 44199
To: District Engineer, Buffalo District Corps of Engineers
1776 Niagara Street, Buffalo, New York 14207

Subj: Cleveland Harbor Improvements

Ref: (a) NCBPD-WB dtd 3 May 1983

1. After reviewing the minutes of the 24 February 1983 Workshop Meeting, I would like to add my endorsement to the position of Lakes Pilots Association as expressed in their letter of 7 January 1983.

2. I also concur in Lakes Pilots Association's request to dredge a triangular area east of the Port Authority docks as part of the project. Accomplishment of this work would significantly reduce the risk of accidental grounding of vessels using these facilities.

George R. Skuggen
GEORGE R. SKUGGEN
By direction

OFC. MGMT. OAS
16 MAY 83 12 39

EXHIBIT F-13

Cereal Food Processors, Inc.

4901 MAIN ST., SUITE 400
P.O. BOX 11336
KANSAS CITY, MO. 64112

PHONE: (816) 561-4271

February 11, 1982

Mr. Richard Aguglia
Project Manager
Department of the Army
Buffalo District
Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Aguglia:

In reply to the letter of October 7, 1981, and our phone conversation this week, we have, as you indicated, removed the North building as planned. However, the ship unloading building is still very much in use. The discussions we had in 1976 were based on the premise that self unloaders were to be employed in grain transportation. This projection has not taken place.

Therefore, if we were to remove the ship unloading building for implementing the construction of Cut No. 4. The following steps would have to be taken:

a.)	Replace marine leg	$350,000
b.)	Replace tempering bins	250,000
c.)	Install grain conveying equip.	100,000
	Total	$700,000

The costs shown are estimates and not firm prices.

At the present time, we have no plans for carrying out these modifications.

We hope to see you next month at your meeting in Cleveland. In the meantime, if you desire further information, please contact me.

Sincerely,

CEREAL FOOD PROCESSORS, INC.

David F. Mattson

David F. Mattson
Vice President - Operations

DFM:skk

EXHIBIT F-14

CONRAIL

October 22, 1981

Mr. Richard Agvglia
Army Corps of Engineers-Buffalo District
1776 Niagara Street
Buffalo, New York 14207

Dear Sir:

This is to confirm our phone conversation of October 16, 1981 regarding Bridge 14 over the Cuyahoga River in Cleveland, Ohio.

Bridge 14 is part of the former Erie Lackawanna main line now known as the River Bed line. The River Bed line is targeted for abandonment. Conrail anticipates filing for abandonment before December 1, 1981.

Conrail will have no further use for a railroad bridge at the location of Bridge 14.

Sincerely,

Donald E. Yerks

Donald E. Yerks

EXHIBIT F-15

LAKE CARRIERS' ASSOCIATION

1411 ROCKEFELLER BUILDING
CLEVELAND, OHIO 44113
(216) 621-1107

August 4, 1983

Col. Robert R. Hardiman
Buffalo District Engineer
U.S. Army Corps of Engineers
1776 Niagara St.
Buffalo, NY 14207

Dear Colonel Hardiman:

Pursuant to your request for information in connection with Plan 7G of the Cleveland Harbor Study to remove the Jefferson Avenue bridge abutments, contact was made with vessel companies trading up the Cuyahoga River. In order to appreciate the vessel exposure to this hazard to navigation, the number of vessel passages past this bridge during the past five years will be enlightening:

1978	460
1979	434
1980	370
1981	578
1982	466
Total	2,308

Although no single, major damage from striking these obstructions occurred, there have been countless contacts which have contributed to the wear and tear and the accumulated damage to vessels in this Cuyahoga River trade.

One company conservatively budgets approximately $14,000 at today's prices per year, per ship for repairs to bow plating in way of contact areas when they undergo their five-year Special Survey. These figures can be higher or lower, but it is an average for accumulated damage on one strake.

Vessel companies report that inspection of vessels that traverse the Cuyahoga River provides simple proof that damage is incurred in the river as compared to larger vessels which cannot operate in the

EXHIBIT F-16

Cuyahoga because of their size. A large portion of the damage can be attributed to striking abutments in the river.

Companies do not have a record of each time a vessel comes in contact with the bridge abutments. The company that uses the aforementioned budgeting procedure for accumulated damage reports that, based on total damage to their vessels over a five-year period amounting to approximately $560,000, 20 to 25 percent or between $100,000 to $140,000 of damage occurs because of the Jefferson Avenue bridge abutments. If the same formula was used by other companies whose vessels navigate the Cuyahoga River, the five-year damage estimate attributable to the abutments at a minimum would be a total of $200,000 to $280,000.

We trust that this information will be helpful to you in the evaluation and analysis of Plan 7G.

Sincerely yours,

George J. Ryan

George Ryan
President

GJR:dma

Republicsteel

Republic Steel Corporation
General Office: Republic Building
Raw Materials Department
PO Box 6778
Cleveland, OH 44101

May 19, 1982

PA Manley
Manager
Resource Business Development

Charles E. Gilbert
Chief, Planning Division
Department of the Army
Corps of Engineers
1776 Niagara Street
Buffalo, NY 14207

Dear Mr. Gilbert:

Thank you for providing us the opportunity to discuss improvements to the Cleveland Harbor and Cuyahoga River with you and Mr. Richard Aguglia. As you know, our interest in these matters has been quite active for severals years.

We take particular note of your revised plans and estimate for a suitable passage for the 1,000 ft. ships bound for the Cleveland Harbor. You may recall that this was also the recommendation of the consultant that we hired in the late '70's to determine what modifications were necessary in order for the Cleveland Harbor to safely accommodate the transit of the new super-sized ships on the Great Lakes.

We have previously communicated our concerns to you involving three areas of the Cuyahoga River requiring attention in order to provide a safer transit for these vessels serving the Cuyahoga Valley industries

1. Bridge 19 -- the former Erie Lackawana Bridge - Removal of Bridge and Abutments

2. Jefferson Avenue Bridge -- Removal of abutments

3. The deepening of the turning basin to 23 ft draft.

EXHIBIT F-17

We note these items have been on your agenda for quite some time and we were pleased to learn that some resolutions to the problems may be near at hand. We are hopeful that a sufficient amount of attention and effort will be forcused on this in order to expedite the improvements.

Again, We would like to thank you for your continuing cooperation.

Patrick A. Manley
Manager
Resource Business Development

PAM/sdw

cc: R. R. Hostelley
C. T. Burke

((

Republicsteel

Republic Steel Corporation
General Offices Republic Building
Energy and Minerals Group
PO Box 6846
Cleveland OH 44101

AA Apotsos
Director
Raw Materials Purchasing

April 5, 1983

Mr. Richard E. Aguglia
Project Manager
U. S. Army Engineers District, Buffalo
1776 Niagara Street
Buffalo, New York

OFC. MGMT. OAS
11 APR 83 13 20

Dear Mr. Aguglia:

Re: Cuyahoga River Turning Basin

During the 1981 navigation season, it was necessary to turn the M/V American Republic in the Cuyahoga River Turning Basin approximately eight times, while in a loaded condition. This required lightering cargoes at our lower dock prior to turning, for stern first deliveries at our upper dock. The delay time incurred for lightering and turning averaged approximately 3-4 hours per cargo. During the 1982 season, we were required to turn the American Republic approximately five times.

During normal navigation seasons, we anticipate turning the American Republic on an average of five to eight times a year, with the average delay time remaining at 3-4 hours.

Very truly yours,

R. R. Hostelley

Ronald R. Hostelley
Supervisor
Marine Transportation

RRH/jmk jmk

cc: Mr. John F. Cave - American Steamship Company

EXHIBIT F-18

CONRAIL

May 1, 1981

Mr. Donald M. Liddell
Chief, Engineering Section
Department of the Army
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Sir:

This is in reply to yours of April 24, 1981, concerning Conrail's plans for two sites in the Cleveland area.

I have asked our Mr. G. M. Williams, Assistant Vice President, Regional Market Development, to respond directly to you, regarding the status of our line of track crossing the Cuyahoga River at Bridge 14.

Regarding the Erie Ore Dock in the Old River, we expect title to pass to new owners within the next six months. While we cannot speak for these people, we would imagine that their use of the property will require continued marine activity although not as an iron ore dock.

Very truly yours,

J. F. Duink

John F. Duink
Director
Coal & Ore Sales

EXHIBIT F-19

CONSOLIDATED RAIL CORPORATION [illegible] PENN CENTER PLAZA PHILADELPHIA PA [illegible]

TELEPHONE OR VERBAL CONVERSATION RECORD

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office

DATE: 10/7/81

SUBJECT OF CONVERSATION
Proposed Plans of Forest City Publishing Company for Expansion of their facilities in Cleveland, Ohio.

INCOMING CALL

PERSON CALLING	ADDRESS	PHONE NUMBER AND EXTENSION
PERSON CALLED	**OFFICE**	**PHONE NUMBER AND EXTENSION**

OUTGOING CALL

PERSON CALLING	OFFICE	PHONE NUMBER AND EXTENSION
RICHARD AGUGLIA	NCBPD-WB	ext. 2263
PERSON CALLED	**ADDRESS**	**PHONE NUMBER AND EXTENSION**
HAL MAWHEY	CLEVELAND PLAIN DEALER PUBLISHING COMPANY	216-344-4500

SUMMARY OF CONVERSATION

1. On 7 October 1981 I called Mr. Hal Mawhey of the Cleveland Plain Dealer Publishing Company (formerly the Forest City Publishing Company) regarding their proposed plans to develop a newspaper publishing complex on their property adjacent to the Old River. Prospective waterbourne commerce to this facility was used, in part, to justify deepening of the upper portion of the Old River from 21-feet to 27-feet below LWD, as proposed in the "Detailed Project Report on Improvement on Old River Channel - Cleveland Harbor, Ohio", subsequently approved by OCE for construction on 6 December 1966.

2. Mr. Mawhey stated that his company no longer plans on developing this property and, in fact, the property is currently up for sale. Thus there will be no need to deepen the Old River for their use.

Richard E. Aguglia
RICHARD E. AGUGLIA
Project Manager

EXHIBIT F-20

DA FORM 1 APR 66 751 REPLACES EDITION OF 1 FEB 58 WHICH WILL BE USED.

TELEPHONE OR VERBAL CONVERSATION RECORD For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.		DATE 11 February 1982
SUBJECT OF CONVERSATION Cleveland Harbor Study - Ashland Petroleum Company's proposed Oil-Coal Mixing Facility on their Old River Site in Cleveland		
INCOMING CALL		
PERSON CALLING Robert W. Moore, Manager of Facilities of Engineering	ADDRESS Ashland Petroleum Company AT-4 P.O. Box 391 Ashland, KY 41014	PHONE NUMBER AND EXTENSION 606-329-5124
PERSON CALLED Richard Aguglia Roger Haberly	OFFICE NCBPD-WB NCBPD	PHONE NUMBER AND EXTENSION ext. 2263 ext. 2178
OUTGOING CALL		
PERSON CALLING	OFFICE	PHONE NUMBER AND EXTENSION
PERSON CALLED	ADDRESS	PHONE NUMBER AND EXTENSION

SUMMARY OF CONVERSATION

1. On 11 February 1982, Mr. Robert Moore of the Ashland Petroleum Company called Roger Haberly and myself. The purpose of the call was to discuss their proposed plans to construct an Oil-Coal Mixing Facility on their property in Cleveland adjacent to the Old River.

2. Mr. Moore explained that his company is presently conducting a preliminary investigation to determine if a coal-oil mixing facility is economically feasible. However, until this study is completed, he cannot make a commitment on when or if this facility would actually be constructed. The concept currently under consideration involves receiving coal by rail and oil by vessel on the Old River and mixing the oil and coal together to produce boiler fuel for Republic Steel's operations in Cleveland. The boiler fuel would be delivered to Republic by barge. The proposed plant would require approximately 126,000 gallons of oil per day which would be recieved from either North Tonawanda, NY or from Canada. Mr. Moore also stated that if water rates for coal delivery become competitive with rail rates, they would also consider receiving their coal by ship.

3. Mr. Moore stated that Ashland would probably use their own vessels to deliver the oil to this plant. However, he did not know what size these vessels would be or what draft they could be loaded to. He said he would check on this, and call us back in a day or two with the information. Mr. Moore also stated that he would find out if they would increase the size of their vessel or load to a deeper draft if the authorized but uncompleted improvements on the Old River were constructed (NOTE: These authorized improvements would allow a larger vessel to use the Old River navigation channel (increase in size from a maximum 649-foot long vessel to a 730 foot long vessel) and would allow vessels to load to the systems draft of 25.5 feet versus the restricted draft of 20.5 feet which currently exists). Mr. Moore also stated that the existing Old River navigation Channel is sufficient for the barge they would use to deliver the boiler fuel to Republic.

4. Roger Haberly asked what the current production at their plant on the Old River was. Mr. Moore replied that they currently process about 35 to 40 million gallons of oil per year, however, they are only operating at about 20% capacity.

EXHIBIT F-21

DA FORM 1 APR 66 751 REPLACES EDITION OF 1 FEB 58 WHICH WILL BE USED

5. Mr. Moore also expressed an interest in attending the Cleveland Harbor workshop meeting in late March or early April.

RICHARD E. AGUGLIA
Project Manager

(NOTE: Via telephone call on 27 April 1981, Mr. Moore indicated that his company would use a 450-foot vessel to ship oil to their proposed facility and the existing 23-foot channel depth of the Old River navigation channel was sufficient for their needs. Also, they would not increase the size of their vessel if authorized but uncompleted improvements on the Old River were completed.)

ODNR
Ohio Department of Natural Resources
OFFICE OF OUTDOOR RECREATION SERVICES
Fountain Square • Columbus, Ohio 43224 • (614) 265-6395

September 2, 1982

Mr. Dick Aguglia
U.S. Department of the Army
Buffalo District
Army Corps of Engineers
1776 Niagara Street
Buffalo, New York 14207

Dear Mr. Aguglia:

This letter is a follow-up to our phone conversation regarding your study of the Edgewater Fishing Plans for the Cleveland Harbor Study.

As we discussed there is heavy power boat and sailboat use of the inner harbor so we will need to maintain access from the boat basin into the inner harbor. Discussions with local boating groups have indicated this access is needed for easy entry into the boat basin without negotiating the narrow lake entrance. An entrance into the inner harbor provides access to the calmer waters when the lake is choppy and it provides a safer access when severe weather happens. Therefore, any modification of the channel to the inner harbor that reduces its current use would be unacceptable to them.

As you can see from the above, we believe a tall bridge, 80-85 feet, would be necessary to preserve good access for all boaters. We agree with your position that a bridge of this height is not a viable solution to the problem and should be dropped from further consideration. We recommend you proceed with Plan 8A as the preferred choice since it will maintain boating activity and will increase fishing opportunity within the park.

I hope I have adequately explained our position and please let me know if you have any questions.

Sincerely,

Roger D. Hubbell

Roger D. Hubbell, Chief
Office of Outdoor Recreation Services

RDH/dh

EXHIBIT F-22

APPENDIX G
PUBLIC INVOLVEMENT

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

APPENDIX G
PUBLIC INVOLVEMENT

Exhibit	Description
G-1	Summary Minutes of 14 March 1979 Workshop Meeting
G-2	Summary Minutes of 8 April 1981 Workshop Meeting
G-3	Summary Minutes of 29 and 30 October 1981 Workshop Meeting
G-4	Summary Minutes of 16 February 1982 Workshop Meeting with Ontario Stone Corporation
G-5	Summary Minutes of 4 May 1982 Workshop Meeting
G-6	Summary Minutes of 24 February 1983 Workshop Meeting
G-7	Summary Minutes of 26 February 1980 Workshop Meeting with Cleveland-Cuyahoga County Port Authority
G-8	Summary Minutes of 16 September 1981 Workshop Meeting with U.S. Coast Guard, Ninth Coast Guard District
G-9	Summary Minutes of 15 March 1982 Workshop Meeting

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBED-PW	Cleveland Harbor, OH - Lorain Harbor, OH, Vessel Masters Meeting, 14 March 1979

TO

FROM J. Henry, Proj. Mgr., Cleveland
R. Simonsen, Proj. Mgr., Lorain

DATE 22 Mar 79 CMT 1

Henry/bb/2263
Simonsen/bb/2276

1. The purpose of the meeting was to obtain expert opinions of experienced vessel masters on needed harbor improvements at Cleveland and Lorain for safe and efficient operation of the 1,000-foot vessel and an 1,100-foot hull. An attendance list is attached (Incl 1). A summary of discussion relative to general vessel operating characteristics and to harbor improvement at Cleveland follows. Separate notes have been prepared for discussion related to Lorain Harbor.

2. Vessel Operating Characteristics.

a. Vertical Ship Movements - Squat, Pitch, Roll, and Heave at Lakefront Harbor Entrance - The vessel masters do not know the extent of vertical vessel movements and have no measuring instruments aboard ship. They agree that 1,000-foot vessels do not squat appreciably, particularly at three or four mile speeds in river channels and there is not much pitch. However, roll is much greater than pitch and is significant when turning into a position parallel to wave troughs. In rough open-lake conditions, masters have experienced up to an estimated 45° of roll in small boats. Captain Allen said even the Steamship Charles M. Beeghly (806 feet X 75 feet) experiences considerable roll in open sea conditions. The broad beam of the 1,000-foot vessel reduces the roll effect. Captain Brabender said that for some reason the Steamship Stewart J. Cort rolls relatively little. Although vertical movements are not quantifiable, the masters concluded the proposed 32-foot depth below LWD would be satisfactory harbor entrance depth at Cleveland to account for vertical movements.

b. Instrumentation of Vertical Ship Movements - The pendulum-type roll meter aboard ship is not sensitive and masters are too busy to read the roll meter. They agreed that any new instrumentation should be self-recording. Captain Brabender commented that the Naval Researach Lab has a wave recorder on the Stewart J. Cort, which measures wave heights.

c. Stopping Distance vs. Speed - Weather, currents, traffic are the primary factors external to the ship which influence stopping distance. The Captains feel that each ship handles differently depending on type of engine and other factors. They have tables which relate stopping distance and speed, under load and ballasted conditions, but these apply only on calm, deep water situations. For example, a twin screw 1,000-footer could stop in 500 feet at a speed of four mph.

d. Turning in Confined Areas - Wind and wave condition affect turning. Although thrusters are effective only at very slow speed of about three or four mph, in a following sea it is difficult to control and turn a vessel at slow speeds. With respect to turning a vessel around, in calm conditions the vessel can turn in a circle with a diameter about equal to the ship length. Turning is made more difficult as wind speeds increase and at about 20 mph the thrusters will not turn the bow into the wind.

Exhibit G-1

NCBED-PW
SUBJECT: Cleveland Harbor, OH - Lorain Harbor, OH, Vessel Masters Meeting, 14 March 1979

e. Tug Assistance - The Captains agreed that Great Lakes tugs are not powerful enough to effectively maneuver a 1,000-foot vessel in most situations where a 1,000-footer could use assistance. Captain Brabender thought that the large tugs such as those at Seven Islands, Quebec, might sometimes be a help. Captain Brabender commented that he did not use a tug last season. The Captains generally feel that because of the size of the 1,000-footer it is difficult to coordinate a tug assistance operation. They also commented a tug assistance operation is expensive and that there are problems with tug crew personnel and labor union requirements. However, foreign general cargo vessels use tugs because the general cargo vessel is not as maneuverable as bulk cargo vessels with twin engines and thrusters.

f. Limiting Wave and Wind Conditions - The Captains feel that 30-mile per hour winds with a full sea condition from northeasterly through north to northwesterly direction prevent entry to all the Lake Erie harbors. They must wait off Canadian shore or hold up above southeast shoals. If the Cleveland east entrance were deepened, they might try Cleveland at wind speeds and full seas up to about 35 mph.

3. Study Background and Review of Alternatives - Cleveland Harbor. Jim Henry explained that the Corps is presently conducting a detailed study of Cleveland following a six-year feasibility study completed in March 1977. The feasibility study included workshops in 1975 with the Lake Carriers Association, the Port Authority, Coast Guard, active and retired vessel masters, and representatives from steamship companies. Jim Henry reviewed the six lakefront harbor improvement alternatives which the workshop participants considered, and the decision to more thoroughly study two of the alternatives:

a. The east entrance alternative involving deepening of the east basin channel and an extension to the east breakwater.

b. The west entrance alternative involving a large "L" shaped breakwater extension from the easterly arrowhead structure and deepening through the new entrance.

The 1975 workshop participants then reevaluated these two alternatives and concluded that the east entrance alternative was the better plan. The Corps March 1977 report proposed a plan involving minor structural changes to the west entrance in combination with these east entrance alternative. However, that report recommended that the plan be reformulated. In July of 1977, a meeting of the Lake Carriers Association, the Port Authority, and several representatives from steamship companies and industry concluded: that the east basin channel should be improved as the primary entrance, that the proposed east breakwater extension could be excluded, and that the west entrance should be modified to permit 1,000-foot vessels to exit in relatively calm conditions and to reduce wave transmission into the lakefront harbor. The recent decision by Republic Steel to receive 1,000-foot vessel delivery of ore requirements at Lorain has reduced the urgency for moving rapidly to construction at Cleveland and some interests wish reconsideration of the other harbor entrance alternatives involving the west entrance.

4. Views and Opinion of Masters on Necessary Harbor Improvements at Cleveland. The Captains unanimously favor development of the east basin channel and minor change to the west entrance essentially as agreed to by participants in the July 1977 meeting. They consider it far superior to any of the alternatives involving the west entrance and do not think anything could be done to west entrance to make it a comparable point of entry. They also estimate additional transit time from southeast shoals via east entrance would only be about one-half hour. Seaway traffic could use the east entrance and vessel congestion and delays would be reduced having two optional entrances with Seaway depths. They agreed on the following points related to harbor improvements.

a. Extension of the East Breakwater (Proposed During Previous Study) - They would like a breakwater extension but do not consider it a necessity. They would like this considered if actual 1,000-foot vessel operation proves that it is needed.

b. Depth and Width of East Entrance Channel - They agree with the dimensioning of the 2,900-foot long X 1,000-foot wide entrance and that this section of channel should be located close to the east breakwater as shown in study plan. They also agree that this section of channel should be 32 feet deep below LWD to make the east entrance operational in 30 mph winds and full sea conditions. At a depth of 29 feet below LWD, the east basin would not be operational in storm conditions. A 500-foot wide, 28-foot deep channel through the remainder of the east basin is adequate considering present channel depths in the Great Lakes interconnecting channels.

c. Anchorage - They proposed an anchorage in the east basin for boats to hold while waiting for a dock, particularly when storms are

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forecasted. They also feel that an anchorage is needed as a refuge and safety feature. It was agreed that an anchorage in the Nicholson approach channel at a depth of 28 feet should be considered (assume 90 feet of anchorage chain). A pile cluster mooring east of the breakwater would not be acceptable in foul weather. (However, a similar concept in an area protected by the breakwater should probably be considered).

d. Modification to the West Entrance - The Captains thought that parts of the spur breakwaters inside the arrowhead might be removed but cautioned against any major change to the arrowhead entrance which would adversely effect wave action in the lakefront. They agreed with a model study and suggested that the model study should consider removal of the inner end of the arrowhead arms to create a gap between the arrowhead structures and the main breakwater. The 29-foot depth in arrowhead entrance is sufficient. The 1,000-foot vessel would exit only during fair weather and would be ballasted to a draft of about 24.5 feet.

e. The West Basin - The Captains proposed no change to the west basin and considered the 1,500-foot basin width adequate for a vessel turnaround under its own power in winds up to about 20 mph.

5. Lorain Harbor-Purpose of Meeting. The purpose of the Lorain portion of the meeting was to discuss improvements to be considered for the safe and efficient operation of 1,000-foot vessels within the Lorain Federal project limits. Suggested improvements were discussed in regards to the outer harbor, the lower river channel, and the upper river channel.

6. Outer Harbor. The masters discussed the limiting conditions of the present harbor and suggested two alternative breakwater arrangements. Under the existing breakwater arrangement, the 1,000-foot vessel masters would attempt entry of their ship only under good weather conditions (winds under 25 mph) and would attempt stern entry only under "most ideal" weather conditions. One alternative suggested by the vessel masters included: removing 500 feet from the north end of the west breaker to allow a larger entrance for 1,000-foot vessels (Area 1 of project map), extending the area dredged in outer harbor as shown on project map (Area 2 on project map) and dredge to 25 feet to allow 1,000-foot vessels to turnaround in ballast safely, and dredging the turnaround area in the outer harbor to 28 feet to allow the 1,000-foot vessels to turnaround fully loaded. The second alternative suggested by the vessel masters was

NCBED-PW
SUBJECT: Cleveland Harbor, OH - Lorain Harbor, OH, Vessel Masters Meeting, 14 March 1979

to reorient the west breaker as shown on the attached project map (Area 3) and again dredge turning area to 28 feet. This alternative would provide the larger entrance and needed turning area for 1,000-foot vessels, plus minimize the amount of dredging needed for a fully loaded 1,000-footer.

7. Lower Black River Channel (from river mouth to just above Norfolk and Western Railroad Bridge). Several points and suggestions were established for the lower Black River Channel.

a. It was established that 1,000-foot vessels could navigate the Federal Channel below Erie Avenue Bridge. (Area 4)

b. It was established that 1,000-foot vessels could not operate through the Erie Avenue Bridge constriction on a regular basis safely if the bridge and channel alignment were left in their existing condition.

c. Two options were presented to improve the Erie Avenue Bridge constriction. One, to realign channel to go through the City Park area (Area 5 on project map) and leave the bridge as it exists now. Two, replace the bridge with a high level bridge or tunnel.

d. A 200-foot wide channel constructed normal to the existing Erie Avenue Bridge through the City Park (Area 5 on project map) and construction of a cut south of the Erie Avenue Bridge (Area 6 on project map) would allow a 1,000-foot vessel to pass through the Erie Avenue Bridge constriction safely on a regular basis.

e. The vessel masters indicated that the maneuverability of a 1,000-foot vessel would be a problem in the Black River because of the size of the 1,000-foot vessels in the narrow channel. As the vessel moves upstream into the turns, it in effect, temporarily "dams" the river flow.

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NCBED-PW
SUBJECT: Cleveland Harbor, OH - Lorain Harbor, OH, Vessel Masters Meeting, 14 March 1979

f. A cut in the river channel (Area 6 on project map) is not only necessary to enable a 1,000-foot vessel through the bridge, but also to maneuver through the next bend. The vessel masters also suggested it would also allow smaller vessels to maneuver through the congestion associated with the American Shipbuilding Company operation more safely.

g. The masters indicated a cut in the river (Area 6 on project map) would be necessary not only for the alternative of a new channel through the park, but also for the alternative of a new high level bridge structure for the Erie Avenue crossing.

h. The vertical clearance of a new high level bridge would need to be Seaway clearance (about 120 feet). Also, the masters indicated Seaway clearance is sufficient to clear a 1,000-foot vessel under the bridge.

i. Seven hundred and thirty-foot vessels presently handle stone deliveries on the Black River.

j. The vessel masters pointed out that the proximity of the ship to the bank greatly affects the control and maneuverability of the ship. Propellor suction draws the stern towards the river bank. The more sharp turns in the channel, the more of a problem control of the ship becomes. Also, the masters indicated that stern thrusters are not that effective in counteracting this effect.

k. The masters indicated that bow and stern thrusters are powerful, that bank erosion could be a major problem. Masters indicated that riprap would probably not stop bank erosion by thrusters, and that sheet piling would be needed all along the riverbanks suspectable to erosion. The only way around the erosion problem with thrusters would be to straighten the channel to the point that you could just float the ship upriver.

l. Vessel masters indicated a need for a cut across from the American Shipbuilding Company operation (Area 7 on project map) to enable 1,000-foot vessels to make the turn and line up the vessel to go through the Norfolk and Western Bridge.

m. Vessel masters mentioned that storage of American Shipbuilding Company hulls encroach on the Federal navigation channel. Existing size vessels have difficulty operating through this area presently. It was indicated that the problem of encroachment along Federal navigation channels is not unique to Lorain, but occurs along the entire Great Lakes System.

n. Corps personnel indicated that the Federal channel is not designed for the purpose of storing vessels, but is designed for the purpose of moving vessels. The vessel masters indicated that generally the Coast Guard does not enforce encroachment violations.

o. The masters indicated that the horizontal clearance (205 feet) and vertical clearance (Seaway height) of the Norfolk and Western Railroad Bridge is sufficient for 1,000-foot vessels.

8. Upper Black River Channel (from just above Norfolk and Western Railroad Bridge to river mile 3). Several points and suggestions were established concerning the upper river channel.

a. Vessel masters indicated additional cuts (Areas 8 and 9 on project map) would have to be made to enable safe passage of 1,000-foot vessels.

b. Vertical clearance of 21st Street Bridge is 98.7 feet above LWD. It was not clearly established whether this vertical clearance would be sufficient for the height 1,000-foot vessels. Vessel masters indicated that water level fluctuations of the Black River could affect whether a 1,000-foot vessel would be able to pass under the 21st Street Bridge.

c. Two options concerning the 21st Street Bridge were discussed. One, if the vertical clearance was enough. And two, if the vertical clearance was not enough.

d. If the vertical clearance was sufficient for the 21st Street Bridge, the vessel masters indicated additional cuts (Areas 10 and 11 on project map) would be needed for 1,000-foot vessels to navigate to the upstream limit of the Federal project and provide sufficient turning area for the 1,000-foot vessel. The 1,000-foot vessel masters indicated a need for an area approximately 1,200 feet in diameter to turn safely.

e. If the vertical clearance of the 21st Street Bridge is not sufficient, the bridge could be raised or replaced with a new high level bridge.

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SUBJECT: Cleveland Harbor, OH - Lorain Harbor, OH, Vessel Masters Meeting, 14 March 1979

f. If the vertical clearance of the 21st Street Bridge is not sufficient, a transshipment facility could be constructed below the 21st Street Bridge. With this alternative, the masters indicated a need for an additional cut in lower turning basin (Area 12 on project map) to provide sufficient area to turn a 1,000-foot vessel.

g. An additional point brought up was that U.S. Steel is the only company which receives iron ore about the 21st Street Bridge. The Corps Division representative then commented that this may be a single user situation requiring local cost-sharing.

h. The Corps indicated that U.S. Steel has expressed an interest in expanding their Lorain facility.

i. Assuming that changes were made to the Black River channel to allow 1,000-foot vessels to navigate up to river mile 3, the masters indicated that all other vessel traffic would have to stop and be clear of the channel to enable 1,000-foot vessels to get up the channel and that it would take at least three hours to navigate from the breakwaters to river mile 3.

9. Miscellaneous.

a. Traffic Control at St. Mary's River Locks - The Captains experience serious congestion problems above the locks because traffic control, split between the Corps of Engineers and the Coast Guard, is ineffective. These problems are resulting in vessel delays and create a major accident potential. This condition is intensifying with the increasing number of boats which must use the new Poe Lock. Dave Buchanan said the Lake Carriers Association is following up on this matter.

b. Ashtabula Harbor - Mr. Allen and Mr. Anderson indicated that the Ashtabula Outer Harbor should be widened for 1,000-foot vessel traffic at Slip No. 1 and Seaway traffic at Slip No. 2. They also indicated that operation in the Ashtabula lakefront is complicated when Coast Guard removes channel markers in the fall. Jim Henry will bring this to the attention of the appropriate persons in the Buffalo District Office.

c. Burns Harbor - Captain Brabender operates the Steamship Stewart J. Cort regularly at Burns Harbor and feels strongly that a breakwater extension similar to the Buffalo south entrance is definitely needed. Jim Henry will bring this to the attention of the appropriate Corps of Engineers Office.

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d. Charts - Mr. Allen commented that the new NOAA harbor charts are difficult to read. NOAA tabulates recent soundings on the lower left part of the page but a reader cannot correlate these soundings with a map location.

2 Incl
as

FRANK J. HENRY, Project Manager, Cleveland

ROLF SIMONSEN, Project Manager, Lorain

LIST OF ATTENDEES

Name	Representing
Robert A. Brabender	Bethlehem Steel Corporation Vessel Master of STEWART J. CORT
Leonard V. Olsen	Pickands Mather & Co. Vessel Master of JAMES R. BARKER
Eldon Allen	Pickands Mather & Co. Vessel Master of HERBERT C. JACKSON
Victor Anderson	Pilots Association
David Buchanan	Lake Carriers Association
Max Janairo	Michael Baker Jr., Inc.
John Kurgan	Michael Baker Jr., Inc.
William Flick	Michael Baker Jr., Inc.
James Beirs	U.S. Army Corps of Engineers, North Central Division
Frank J. Henry	U.S. Army Corps of Engineers, Buffalo District
Michael Pelone	U.S. Army Corps of Engineers, Buffalo District
Richard Gorecki	U.S. Army Corps of Engineers, Buffalo District
Rolf Simonsen	U.S. Army Corps of Engineers, Buffalo District

Cleveland Harbor Study
Summary Minutes of 8 April 1981
Vessel Masters Workshop Meeting
Cleveland-Cuyahoga County Port Authority Office
Cleveland, Ohio

1. A meeting was held on 8 April 1981, at the Cleveland-Cuyahoga County Port Authority's Office, Cleveland, Ohio, to establish design criteria for an "all-weather" entrance for 1,000-foot vessels at the arrowhead (west) entrance to Cleveland Harbor and to review an "all-weather" east entrance plan and a "fair-weather" west entrance plan for safe and efficient operation of 1,000-foot vessels prepared by the Buffalo District. The names of those persons in attendance are shown on the attached list (Incl 1). Mr. John Zorich opened the meeting at approximately 1:30 p.m. by welcoming all meeting participants. Following introduction of the persons in attendance, Mr. Zorich stated that the purpose of this meeting was to obtain professional and expert information on 1,000-foot vessel operating characteristics with a view towards design of an "all-weather" west (arrowhead) entrance at Cleveland Harbor for such vessels. Another stated objective was the review of an "all-weather" east entrance plan and a "fair-weather" west entrance plan that were developed based on input received from vessel masters and steamship companies at previous workshop meetings. Mr. Zorich then turned the meeting over to Mr. Richard Aguglia.

2. Mr. Aguglia stated that the Cleveland Harbor Study is presently in Stage 2 of the planning process in which a wide array of preliminary alternatives are formulated to meet the water resources needs of the area. Through a process of assessment and evaluation, these preliminary alternatives are then screened down to two or three plans which appear most feasible. These plans are then developed in detail so that a rationale choice can be made among them and, if appropriate, an alternative could be recommended for implementation. Mr. Aguglia also stated that there are four main areas of study in the Cleveland Harbor investigation, however, this meeting is only concerned with the development of a safe and efficient entrance into the Lakefront Harbor for 1,000-foot vessels. It is anticipated that these vessels would dock at either the C & P dock on Whiskey Island and/or at a new Port Authority dock. Mr. Aguglia then stated that the Corps is studying three entrance concepts for 1,000-foot vessels: (1) an "all-weather" east entrance which primarily involves deepening of the existing east entrance and east basin; (2) an "all-weather" west entrance which involves major structural changes to the existing west entrance; and (3) a "fair-weather" west entrance which involves minor structural changes to the west entrance with the realization that vessels would not be able to enter the Lakefront Harbor under storm conditions. An "all-weather" entrance was defined as an entrance that would allow 1,000-foot vessels to enter the Lakefront Harbor under all weather conditions for which they would dock and unload their cargo. Based on discussions during the meeting, this "all-weather" condition was further defined as waves less than 8 feet in height and winds under 30 knots from the west through the northeast.

3. Mr. Aguglia then stated that the first item for discussion was development of an "all-weather" west entrance plan for 1,000-foot vessels. This plan would then be tested in the hydraulic model of the Lakefront Harbor at the Corps Waterways Experiment Station to insure that all design criteria are met. Included in the model tests will be a series of navigation tests using a scale model 1,000-foot vessel. This vessel has been operated by both Captain McSweeney and Captain Chamberlain and they feel that the model ship adequately simulates operating characteristics of the prototype vessel with the exception of roll and stopping response. Mr. Aguglia then briefly reviewed the five "all-weather" west entrance concepts developed by the Buffalo District (see Incls 2-6). The vessel masters did not feel that any of these concepts would provide an adequate entrance and suggested two alternate concepts: (1) an "L" shaped breakwater concept similar to the entrance plan studied during the feasibility study of the early 1970's (see Incl 7); and (2) a detached east arrowhead extension concept similar to the breakwater arrangement at Lorain Harbor (see Incl 8). Because the "L" shaped breakwater concept would require more breakwater than the detached east arrowhead extension concept, and consequently a higher construction cost, the detached east arrowhead extension concept was selected as the preferred concept for development of an "all-weather" west entrance. Mr. Aguglia then led a general discussion to refine this concept. The results of this discussion are as follows:

a. The vessel masters are unanimous in their preference for an east entrance for 1,000-foot vessels and feel it is far superior to any west entrance plan. Their main concern is the potential damage from striking the many obstacles at the west entrance (i.e., pierhead lights, breakwater arms, etc.), especially since they lose sight of an object when it is closer than 300 to 400 feet away. They are then forced to rely on instruments and/or lookouts at the bow of the vessel. This problem is intensified at Cleveland due to the strong cross-currents at the arrowhead entrance.

b. "All-weather" conditions were defined as a maximum 8-foot wave at the entrance and 30-knot winds from the west through northeast. Under these conditions, 1,000-foot vessels would have to enter at 6 mph in order to be under proper control. The required stopping distance at this speed is 1,700-1,800 feet. Captain Anderson stated that smaller vessels (vessels 730 feet in length or less) could probably enter under worse weather conditions. Captain Anderson also stated that, based on his experience in piloting vessels (vessels 730 feet or less in length), the only time he could not enter Cleveland Harbor due to adverse weather conditions was during "Agnes" on 22 June 1972.

c. Captain Anderson asked what the current schedule was for construction at Cleveland Harbor. Mr. Aguglia replied that based on the current schedule, which assumes adequate funding, the earliest construction could start would be 1987 and construction would probably take two construction seasons.

d. Captain Anderson also asked what the possibility was for constructing a dual entrance for 1,000-foot vessels at Cleveland. Mr. Aguglia replied that at the present time it does not appear that a dual entrance would be economically justified because there would not be enough incremental benefits to justify a second entrance once the first entrance was in place. We will, however, investigate a dual entrance plan during Stage 2 planning.

e. Captain Tereki asked if the Corps was taking into account the possibility of 1,200-foot vessels on the Great Lakes. Mr. Aguglia replied that this possibility would be used in assessing each entrance plan. Admiral Trimble stated that he sees no increase in ship size beyond 1,000-footers before the turn of the century and their use would be dependent on the construction of larger locks capable of handling these ships.

4. The "All-Weather" West Entrance-Detached East Arrowhead Extension concept was refined as follows (see Incl 9):

(1) The length of the detached breakwater, parallel to the east arrowhead breakwater, was set at 3,000 feet. This length was selected since it allows adequate room for a 1,000-foot vessel, entering at 6 mph as required under design conditions, to slow down before making the turn into the Lakefront Harbor (Note: Stopping distance at 6 mph is approximately 1,700-1,800 feet after the vessel is completely into the protected entrance). It was also decided that this detached breakwater would be located 300 feet off the existing east arrowhead breakwater.

(2) To facilitate vessel maneuvering, 600 feet of the west arrowhead breakwater, 300 feet of the west spur breakwater, and 200 feet of the east spur breakwater will be removed.

(3) A second detached breakwater will be required to prevent increased wave activity in the Lakefront Harbor as a result of the breakwater removals. The length of the detached breakwater will be determined based on model tests at WES.

(4) The opening between the new detached breakwaters will be 900 feet, which is similar to the entrance at Lorain Harbor.

(5) The new detached breakwaters should be designed to limit wave heights in the entrance channel to 2 to 3 feet during design conditions (8-foot waves and 30-knot winds) at the location of the existing arrowhead entrance. This would allow the masters to slow their vessels down to 2 to 3 mph before making the turn into the Lakefront Harbor. By slowing down to 2 to 3 mph, the masters would also be able to use their thrusters in turning their vessel. (Note: Above 2 to 3 mph, thrusters lose their effectiveness in controlling a vessel).

(6) When entering at 6 mph under design conditions (8-foot waves and 30-knot winds) a roll of 3-5 degrees can be expected in a 1,000-foot vessel. For the determination of required channel depths, use 4 degrees of roll. Captain Anderson stated that roll for smaller vessel (vessels 730 feet in length or less) would be about 1-1/2 times the roll of a 1,000-foot vessel, or between 5 to 7 degrees (use 6 degrees for required depth determinations). The vessel masters also stated that they need sufficient water under their vessel in order to be able to use their engines without rupturing oil and air

lines due to vibrations. The vessel masters feel a 32-foot channel depth would be adequate to prevent this.

5. Mr. Aguglia then reviewed the "all-weather" east entrance plan that was developed based on input received from vessel masters and steamship companies at previous workshop meetings. This plan included (see Incl 10): (1) an entrance channel, varying in width from 2,000 feet to 1,000 feet, and 32-feet deep; and (2) an interior channel, 500-feet wide and 28-feet deep. Mr. Aguglia then led a general discussion on this plan. The results of this discussion are as follows:

a. Captain Tereki stated that he feels a 1,000-foot long breakwater extension, at the end of the east breakwater and parallel to the proposed entrance channel, is required to break up wave action caused by a northwest wind. However, all vessel masters agreed that under the design entrance conditions (8-foot waves and 30-knot winds), this breakwater extension would not be required.

b. Entrance speed and vessel roll under design conditions would be 6 mph and 3-5 degrees (use 4 degrees in determination of required channel depths), respectively.

c. All vessel masters agreed that a 28-foot depth for the interior channel was adequate since their vessels would not roll in the protected channel. However, it was decided that the 500-feet wide interior channel should be extended across the west entrance and dredged to 30 feet. This extra depth is required since a 1,000-foot vessel can be expected to roll up to 2 to 3 degrees as a result of waves entering between the arrowhead breakwater.

d. Mr. Bowser of the city of Cleveland stated that the city is studying the possibility of expanding Burke Lakefront Airport and would be interested in using the dredged material as fill if this plan was implemented. Use of the dredged material as fill would also result in an extra benefit for this plan. The Corps and the city will coordinate on this matter as the study progresses.

6. Mr. Aguglia than reviewed the "fair-weather" west entrance plan which was developed at the Corps Waterways Experiment Station using the scale model 1,000-foot vessel operated by Captain McSweeney. The plan that was developed (see Incl 11) included removal of 300 feet of the west spur breakwater and 200 feet of the east spur breakwater and deepening the approach channel to 30 feet and the interior entrance channel to 29 feet. To compensate for increased wave activity in the Lakefront Harbor due to the spur breakwater removal, the plan also includes two 300-foot parallel piers at the lakeward end of the existing arrowhead breakwaters and raising of the west arrowhead breakwater from +8 LWD to +14 LWD. Mr. Aguglia also showed a short movie of the model at WES illustrating this "fair-weather" west entrance plan and the

scale model 1,000-foot vessel. Mr. Aguglia then led a general discussion on this plan, the results of which are as follows:

a. "Fair-weather" conditions were defined as a maximum 4-foot wave and 20-knot winds from the west through northeast. Under these conditions, 1,000-foot vessels would enter at 2 to 3 mph and would experience no vessel roll. Because there would be no vessel roll under the "fair-weather" design condition, the existing depths in the approach channel and interior entrance channel (29 feet and 28 feet, respectively) are considered adequate.

b. The vessel masters also stated that the two 300-foot parallel piers are required for safe navigation of 1,000-foot vessels in addition to being required to compensate for increased wave activity in the Lakefront Harbor as a result of the spur breakwater removal.

7. Althougn not on the original agenda, Mr. Aguglia then reviewed the results of the channel depth calculations for 730-foot vessels recently completed by the Buffalo District. Based on a 12 mph entrance speed, 7 degree roll, 25.5-foot draft and 2-foot underkeel clearance, the required channel depth for a 730-foot vessel is 33 feet. This required depth is 4 feet more than the existing entrance depth of 29 feet at the arrowhead entrance. Mr. Aguglia asked the vessel masters if the 33-foot depth appeared excessive and did they experience problems entering Cleveland Harbor under storm conditions during the low water period of the early 60's. The masters replied that the entrance speed should be a maximum of 6 mph and roll would be between 5 to 7 degrees at the entrance (use 6 degrees for depth calculations). Mr. Aguglia replied that even using these new values, the required depth would be 31 to 32 feet which is still more than the existing 29-foot depth. The masters stated that this appeared reasonable since they did come into Cleveland 2 to 3 feet lighter in the early sixties than they currently do.

8. Mr. John Zorich then thanked all the meeting participants and adjourned the meeting at 5:00 p.m.

Richard E. Aguglia

RICHARD AGUGLIA
Project Manager

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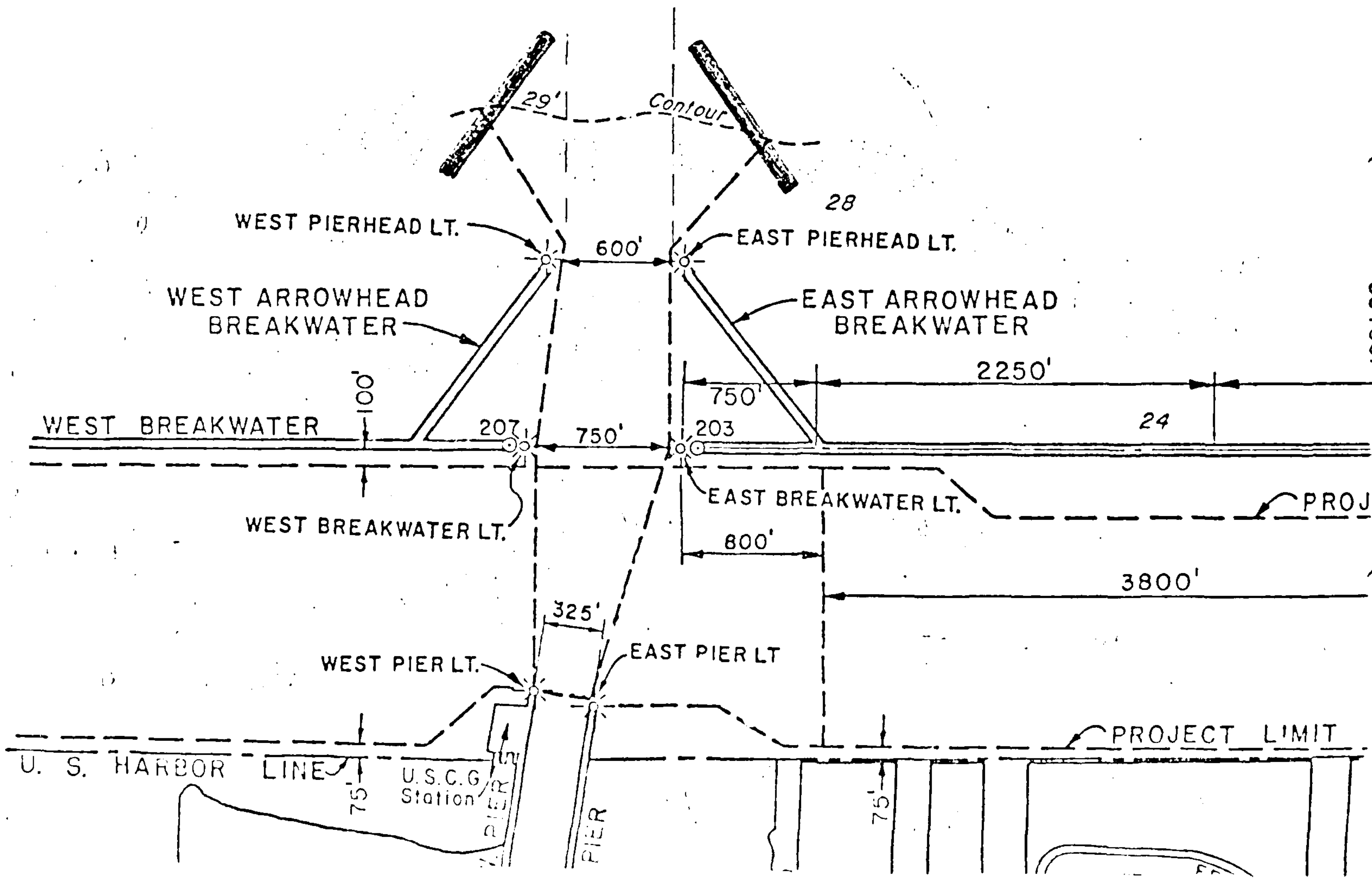
Cleveland Harbor Study
Summary Minutes of 8 April 1981
Vessel Masters Workshop Meeting
Cleveland-Cuyahoga County Port Authority Office
Cleveland, Ohio

ATTENDANCE

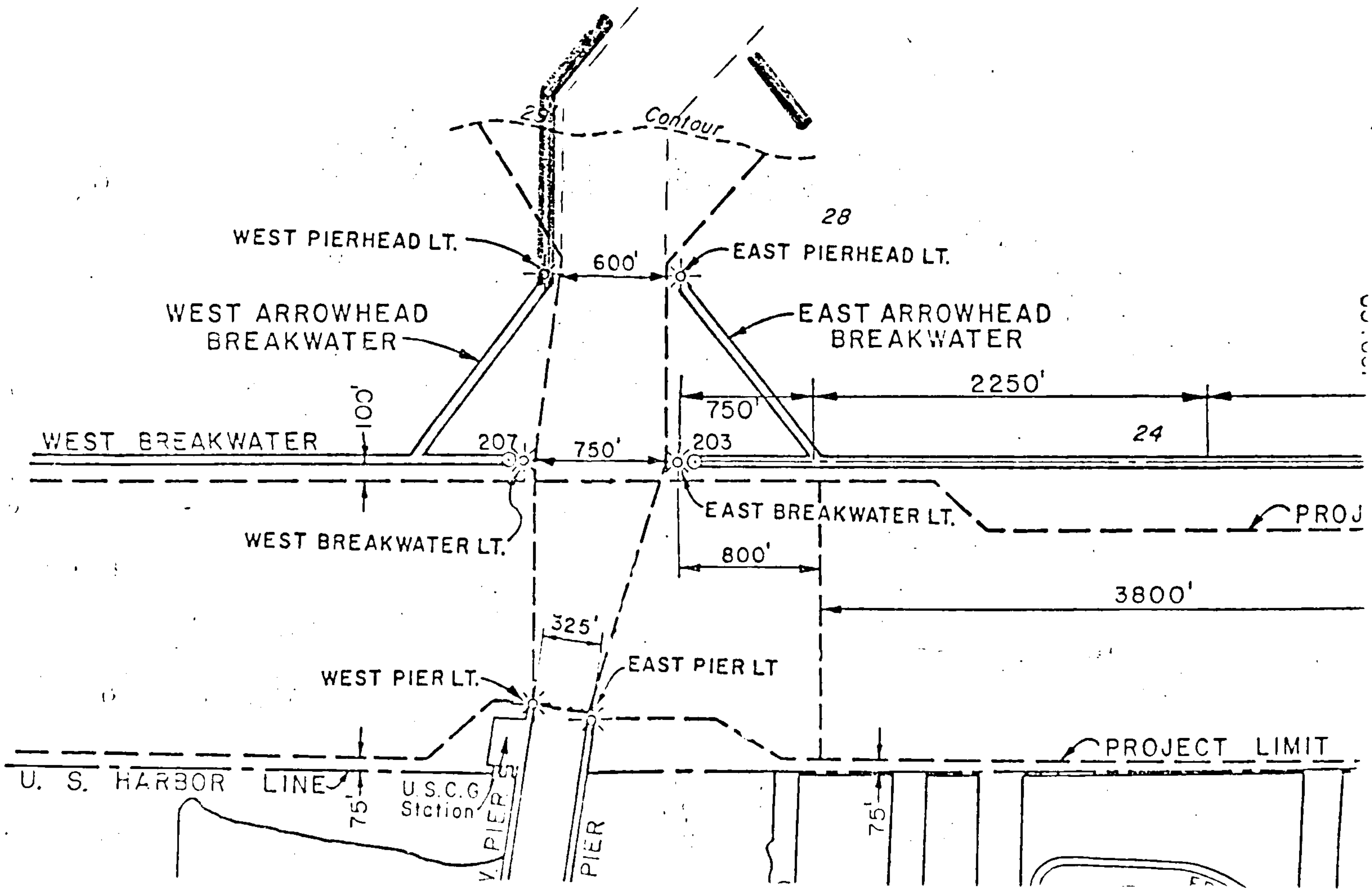
Name	Organization
Anthony Russo	Acting Director, Cleveland-Cuyahoga County Port Authority
Harry Gard	Chief Engineer, Cleveland-Cuyahoga County Port Authority
Captain Alton Hayves	American Steamship Company
Captain Vic Chamberlain	Hanna Mining Company
Captain Paul D. Lyon	American Steamship Company
Captain William McSweeney	Interlake Steamship Company
Captain Joseph J. Tereki	Columbia Transportation Company
Captain Vic Anderson	Lake Pilots Association, Inc.
Captain Edgar M. Jacobsen	Oglebay Norton
Admiral Paul E. Trimble	Lake Carriers Association
John Townley	Cleveland Cliffs Iron Company
John Horton	Cleveland Cliffs Iron Company
John D. Baker	ILA
Brian Bowser	City of Cleveland
John Zorich	Corps of Engineers, Buffalo District
Henry Gartner	Corps of Engineers, Buffalo District
Richard Gorecki	Corps of Engineers, Buffalo District
Mike Pelone	Corps of Engineers, Buffalo District
Robert Webster	Corps of Engineers, Buffalo District
Richard Aguglia	Corps of Engineers, Buffalo District
Charlie Johnson	Corps of Engineers, North Central Division

Incl 1

"All-weather" West Entrance Concept No. 1: Detached Arrowhead
(not to scale)



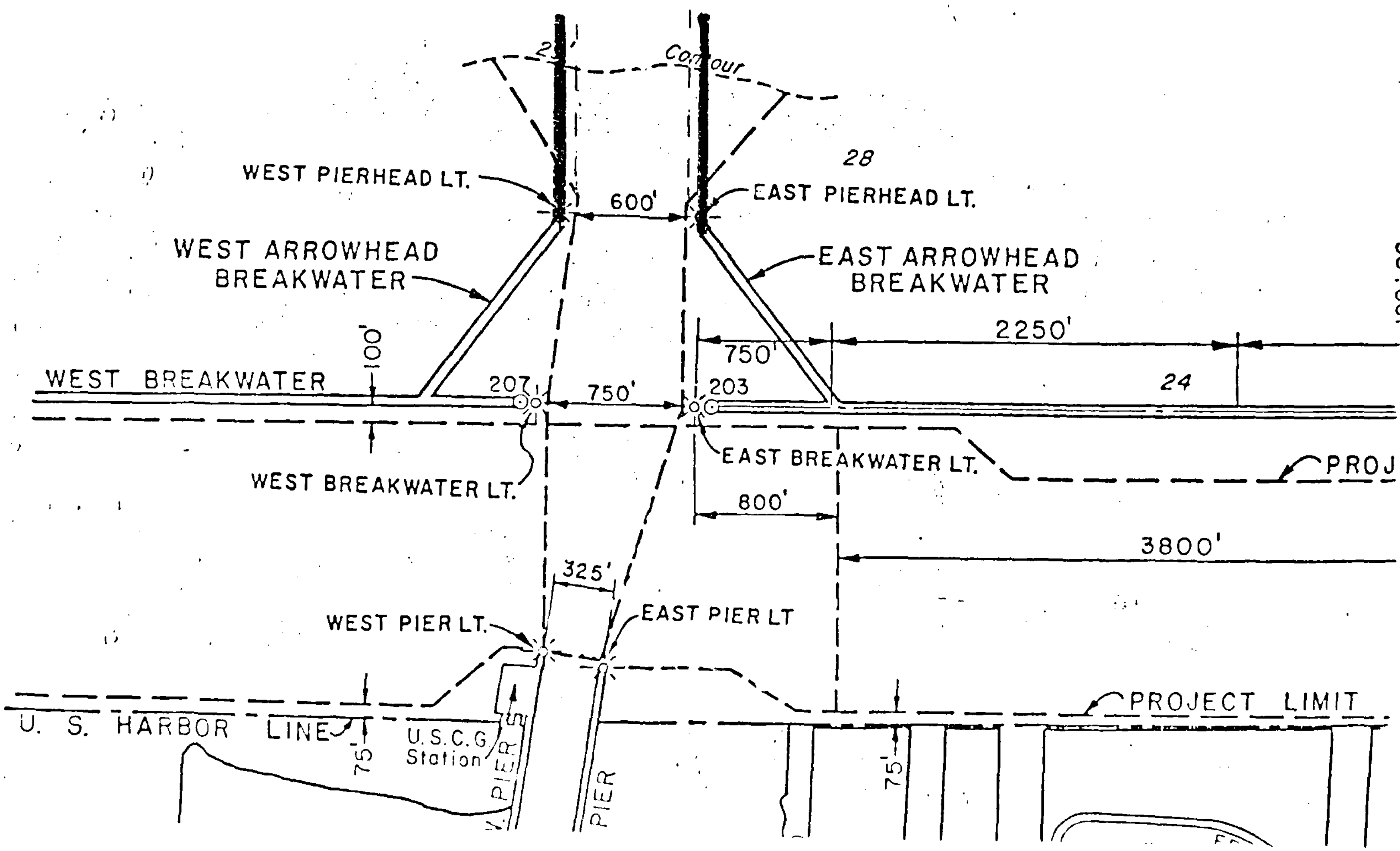
"All-Weather" West Entrance Concept No. 2: Dogleg with Detached Breakw...
(not to scale)



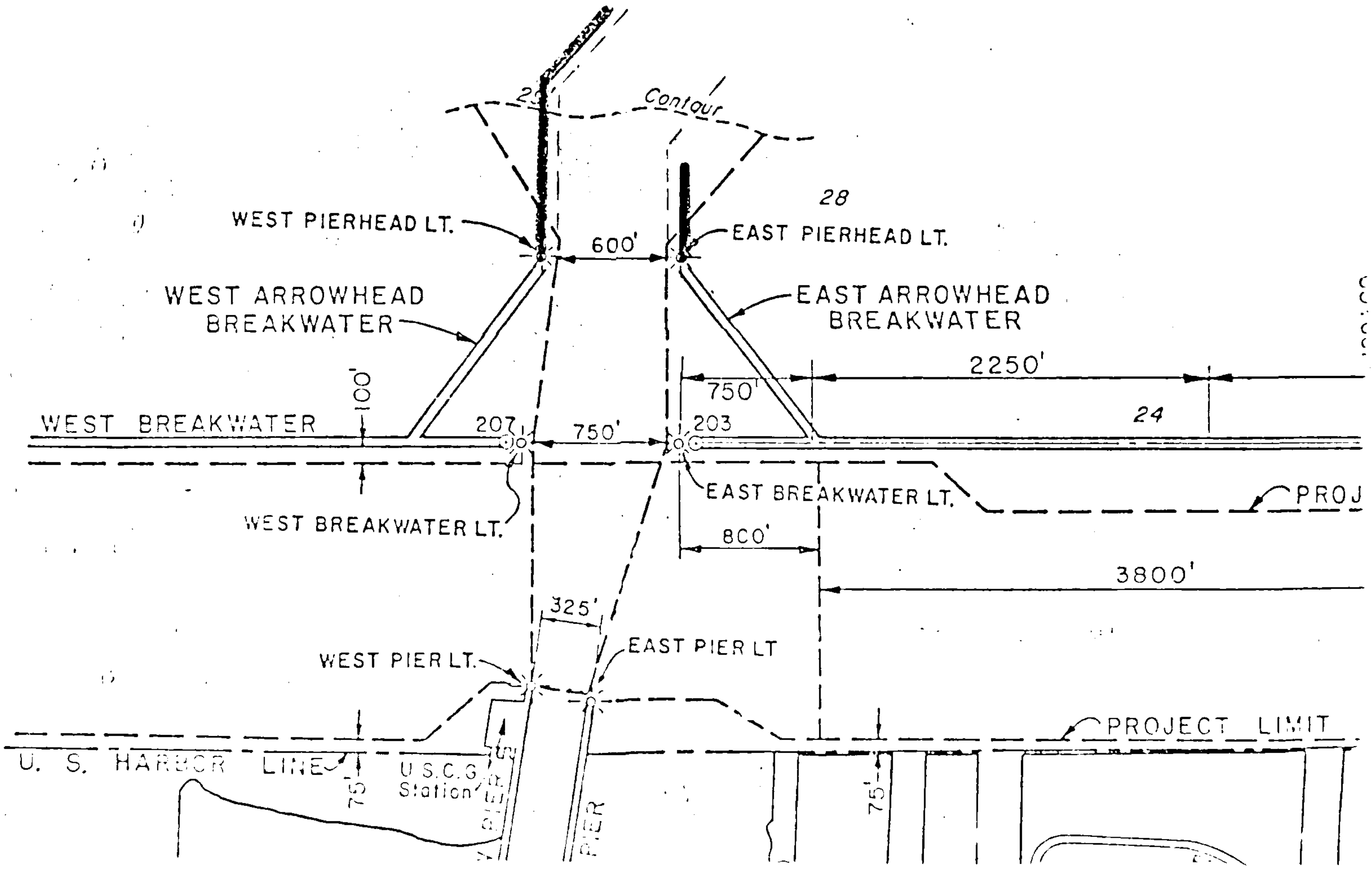
"All-Weather" West Entrance Concept No 3: Parallel Extension

(Not to scale)

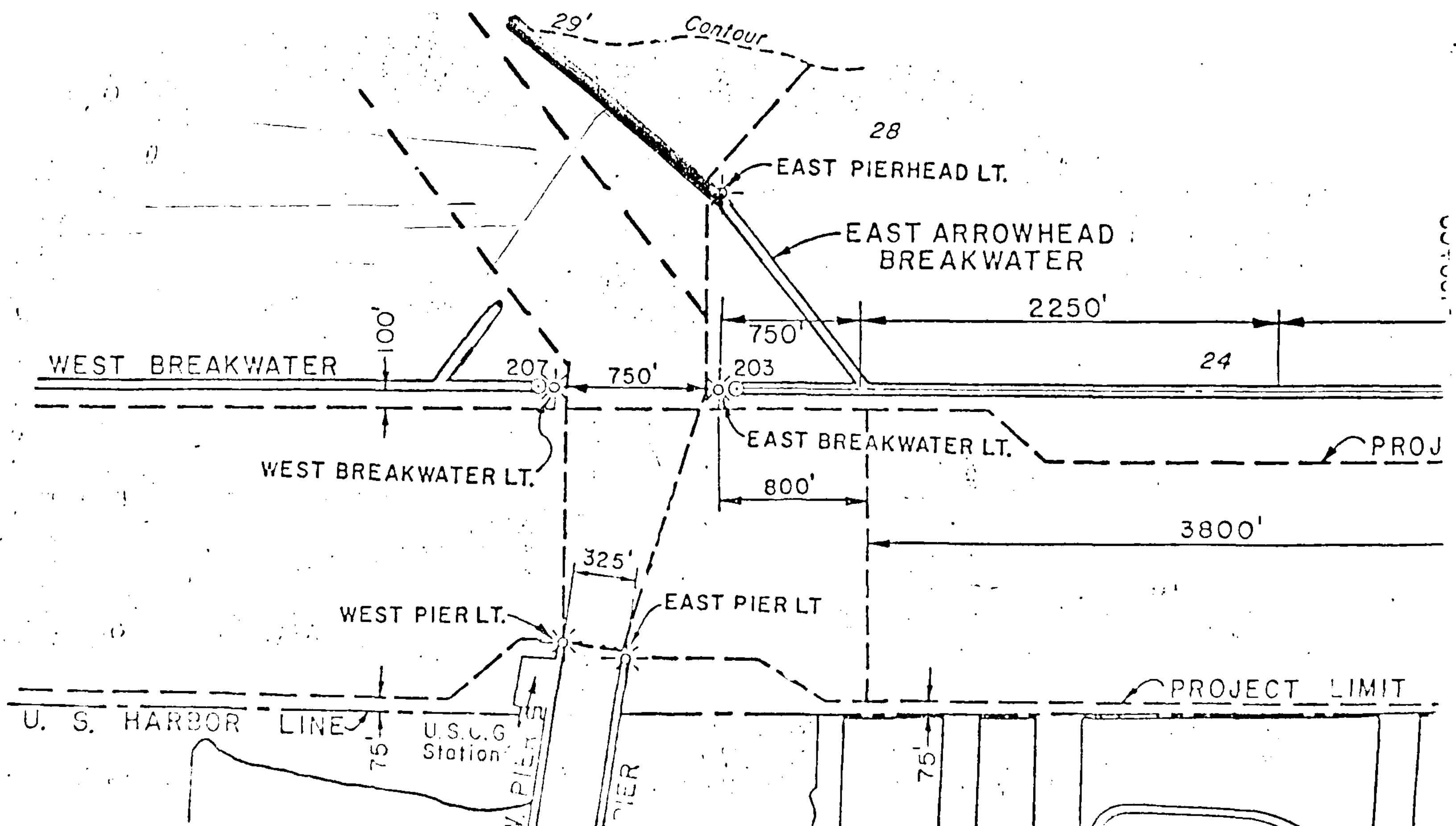
Encl 4



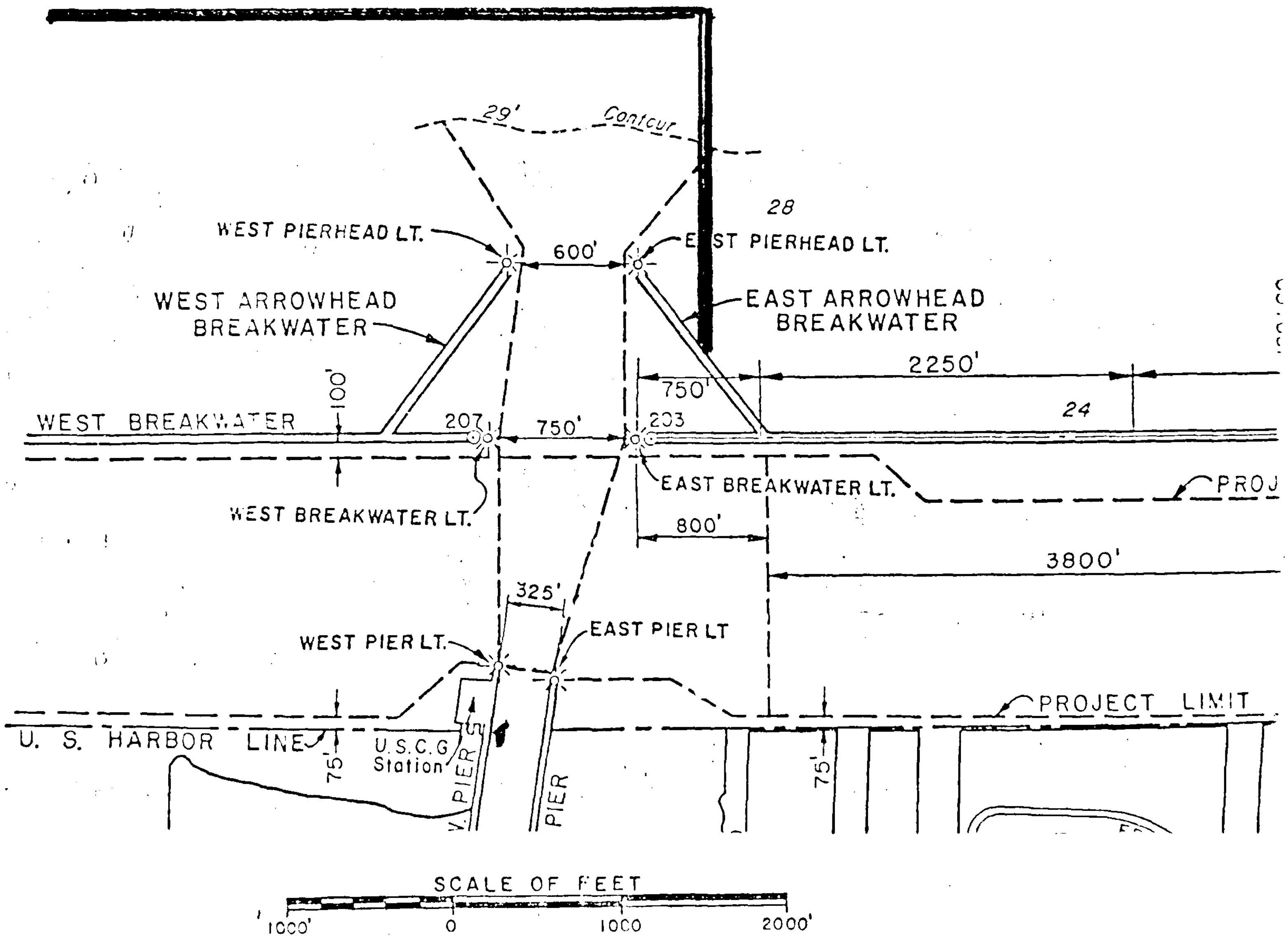
"All-weather" West Entrance Concept No 4 : Dogleg with Parallel Extension
(not to scale)



... West Entrance Concept No. 5: East Arrowhead Breakwater Extension
(not to scale)

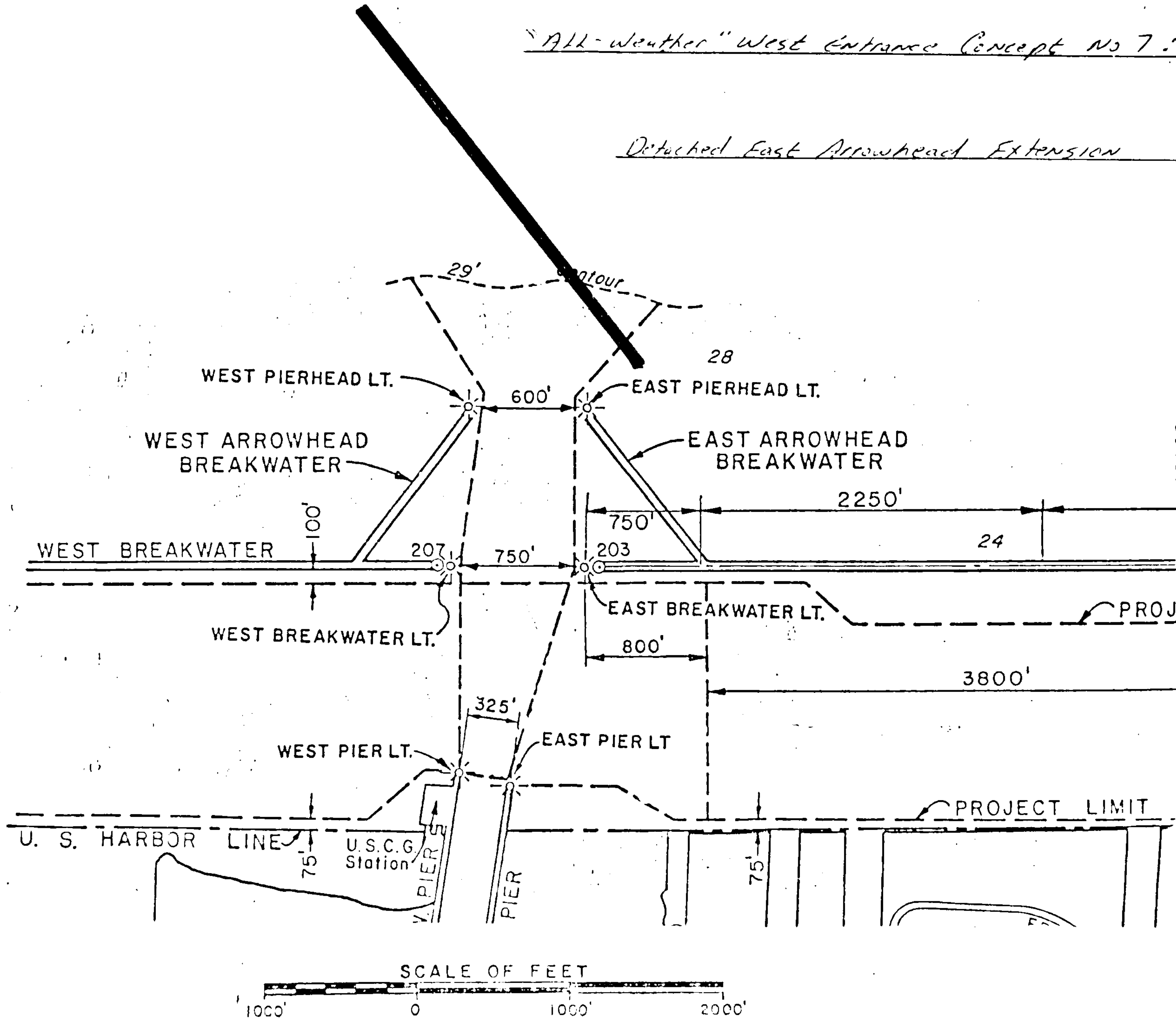


"All-Weather" West Entrance Concept No. 6: "L" Shaped Breakwater



"All-Weather" West Entrance Concept No 7:

Detached East Arrowhead Extension



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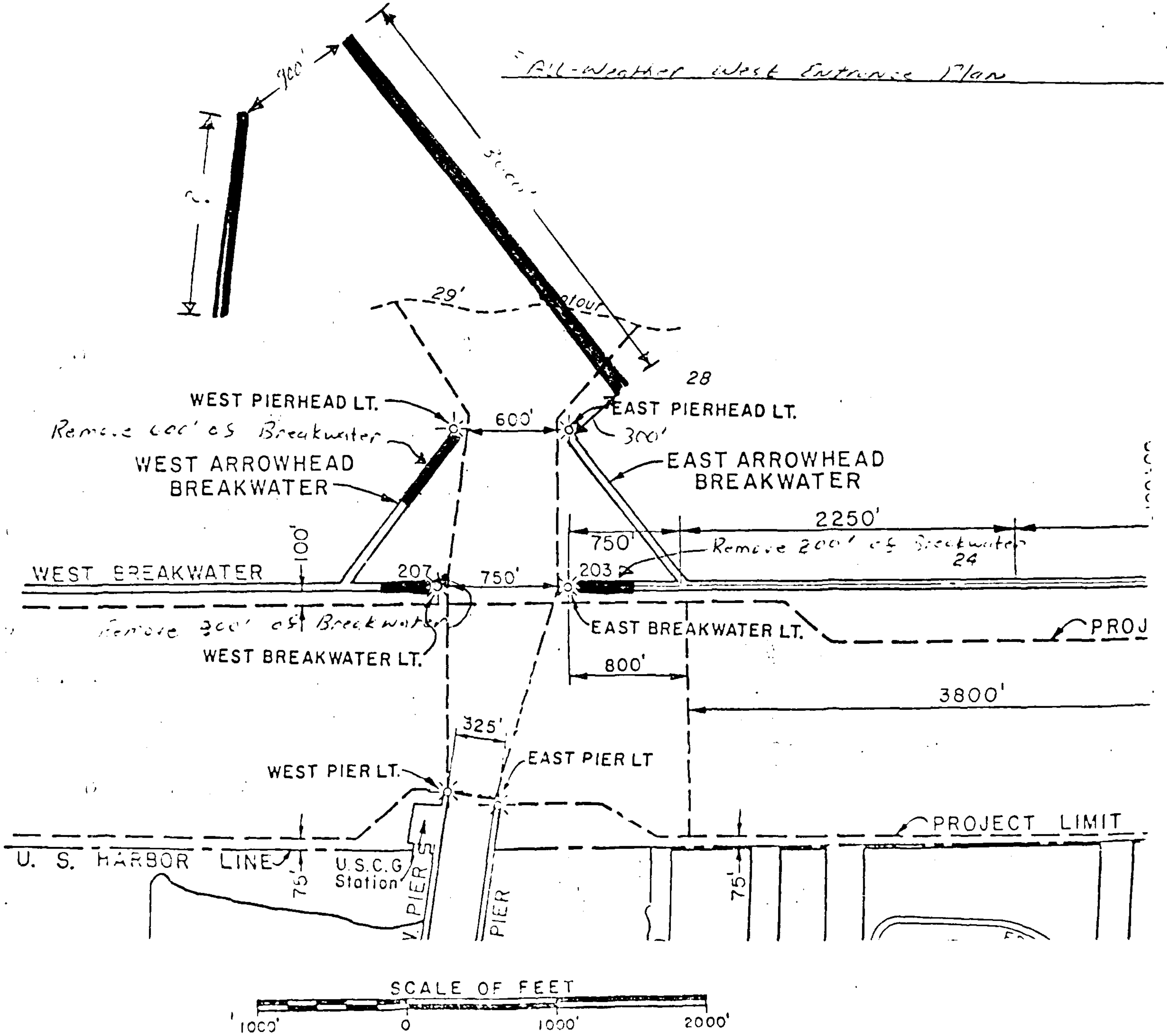
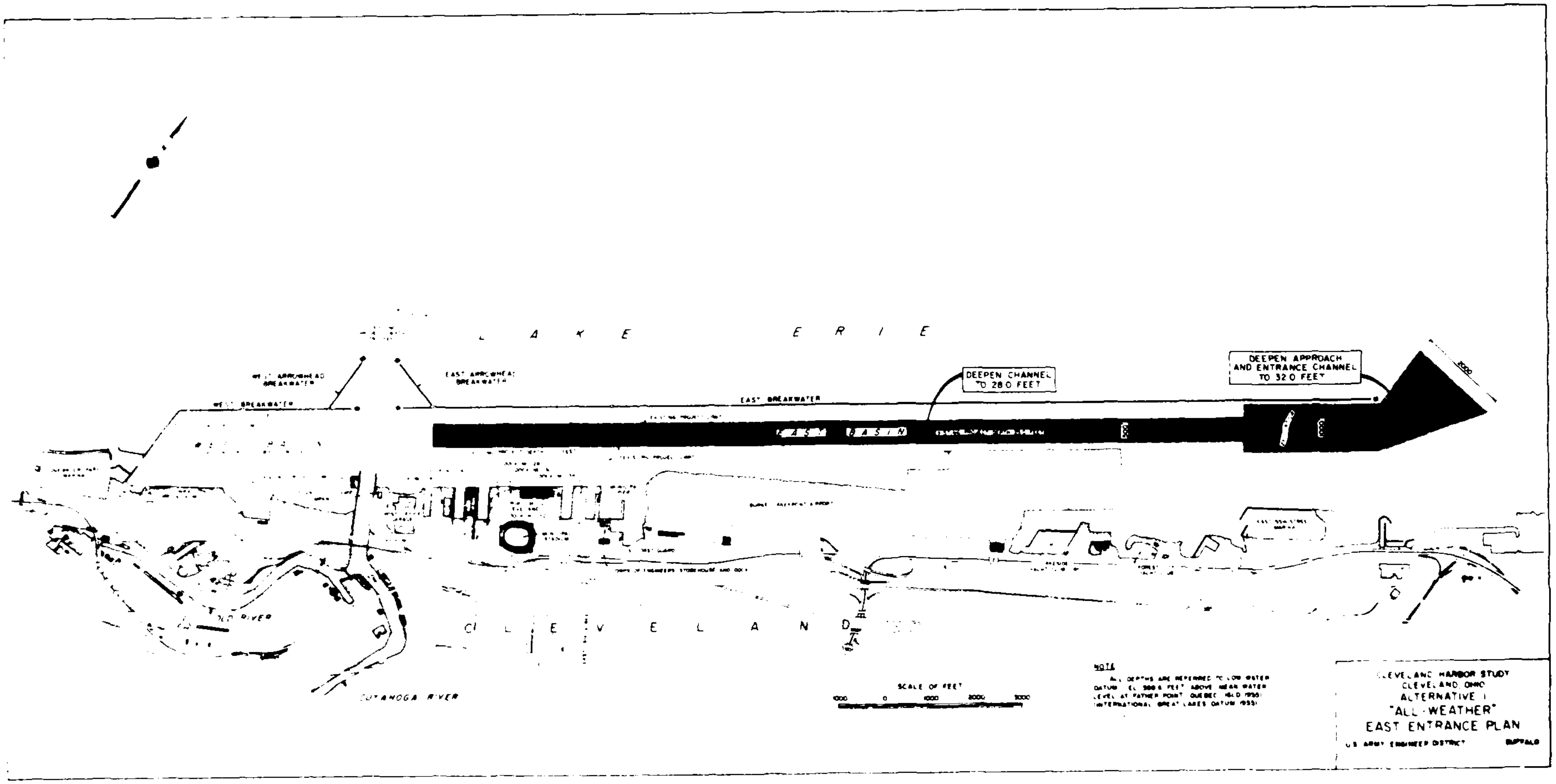
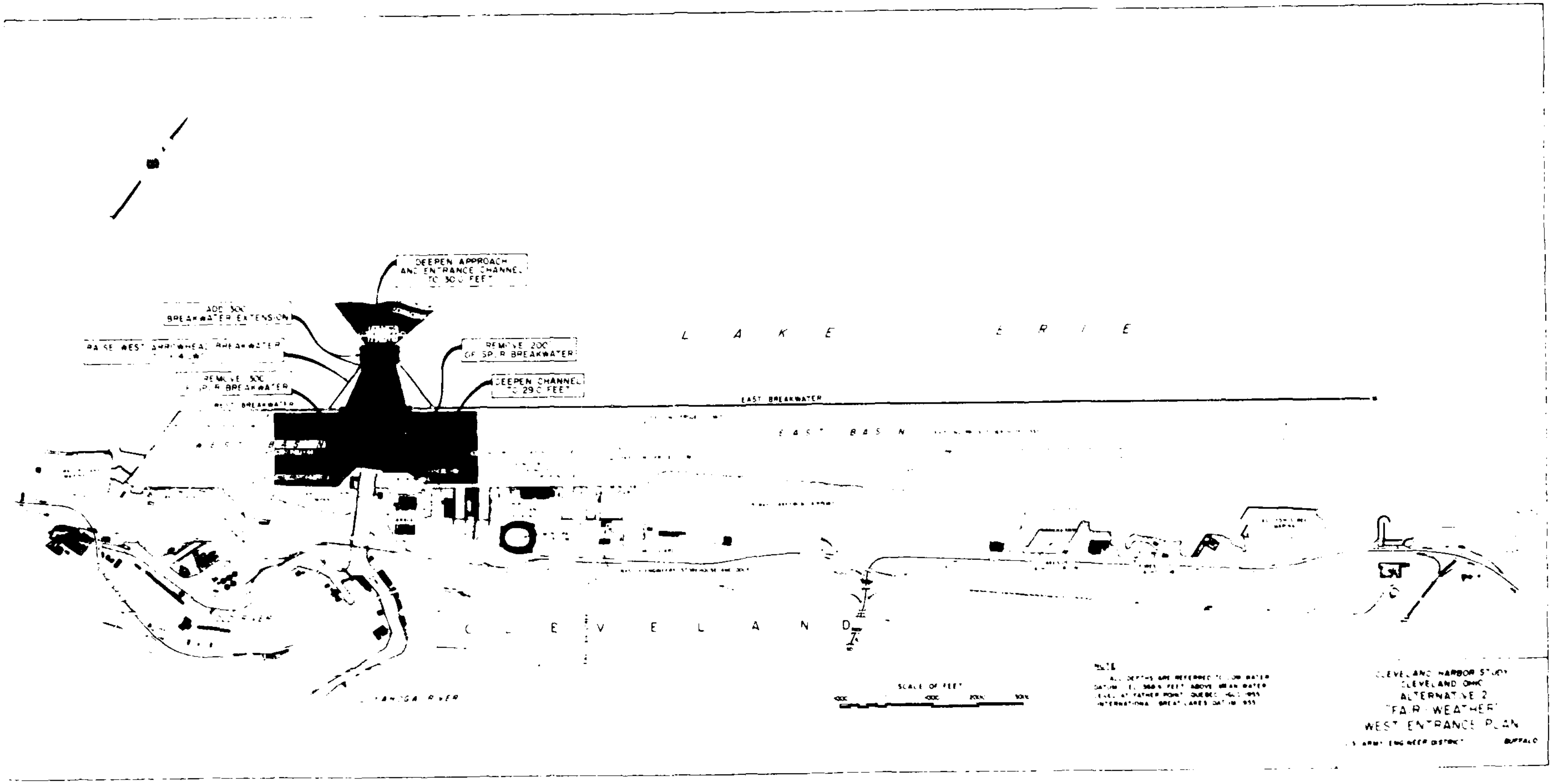
"All-Weather West Entrance Plan"




LAKE ERIE
DEEPEN CHANNEL TO 28.0 FEET
DEEPEN APPROACH AND ENTRANCE CHANNEL TO 32.0 FEET
3000
EAST BREAKWATER
WEST BREAKWATER
EAST ARROWHEAD BREAKWATER
EAST BASIN
CLEVELAND
CUYAHOGA RIVER
OLD RIVER
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE I
"ALL-WEATHER"
EAST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO



DEEPEN APPROACH AND ENTRANCE CHANNEL TO 30.0 FEET
ADD 300' BREAKWATER EXTENSION
REMOVE 200' OF SPUR BREAKWATER
DEEPEN CHANNEL TO 29.0 FEET
EAST BREAKWATER
WEST BREAKWATER
LAKE ERIE
EAST BASIN
CLEVELAND
SCALE OF FEET
CLEVELAND HARBOR STUDY
CLEVELAND OHIO
ALTERNATIVE 2
"FAIR WEATHER"
WEST ENTRANCE PLAN
BUFFALO

NCBPD-WB 5 January 1982

MEMORANDUM FOR RECORD

SUBJECT: Model Study Review Conference - Cleveland Harbor Study

1. On 29 and 30 October 1981 representatives of NCD, NCB, and the Cleveland Port Authority met with masters of 1,000-foot vessels at the Corps Waterways Experiment Station, Vicksburg, MS. The purpose of this meeting was to obtain input from these vessel masters to be used in the development of an "all-weather" West Entrance plan for safe and efficient operation of 1,000-foot vessels at Cleveland Harbor. (NOTE: "All-weather" conditions are defined as a maximum 30-knot wind and 8-foot wave.) The following people were in attendance:

Captain William McSweeney	- NCB	Chuck Gilbert	- NCB
Captain Al Haynes	- American Steamship Company	Denton Clark	- NCB
		John Zorich	- NCB
Captain Vic Chamberlain	- Hanna Mining Co.	Dick Aguglia	- NCB
Gene Chatham	- WES	Larry Hiipakka	- NCD
Ray Bottin	- WES		
Harry Gard	- Cleveland-Cuyahoga County Port Authority		

2. Gene Chatham opened the conference on 29 October by welcoming all participants and stated that the purpose of the conference was to obtain input from the vessel masters to be used in developing an "all-weather" West Entrance plan for safe and efficient operation of 1,000-foot vessels at Cleveland Harbor. Gene then turned the meeting over to Ray Bottin.

3. Ray presented a short movie which illustrated the proposed "fair-weather" West Entrance plan (see Incl 1) that was previously presented at the 8 April 1981 Vessel Masters' Workshop. (NOTE: "Fair-weather" conditions are defined as a maximum 20-knot wind and 4-foot wave). Components of the "fair-weather" West Entrance plan included the following:

a. Removal of 300 feet of the west spur breakwater and 200 feet of the east spur breakwater; and

b. Compensating works to maintain existing wave conditions inside the Lakefront Harbor with the spur breakwaters removed.

4. Ray then presented a slide show illustrating the evolution of the proposed "all-weather" West Entrance plan, from the plan originally developed at the 8 April 1981 Vessel Masters' Workshop (Incl 2), to the plan currently installed in the Cleveland Harbor model (Incl 3). This plan (Incl 3) was the plan the vessel masters had been running navigation tests on with the scale model of a 1,000-foot vessel. Ray also stated that modifications to the

originally proposed plan (Incl 2) were required in order to meet the design criteria previously established (ie., maximum wave height of 3 feet in the entrance channel under "all-weather" design conditions and no increase in wave activity above existing conditions in the Lakefront Harbor).

5. Dick Aguglia then led a general discussion on the "all-weather" West Entrance plan currently installed in the model (Incl 3). Main points of this discussion are as follows:

a. Although navigation tests have not been run with wind and waves from the north, the vessel masters feel that this plan (Incl 3) is about the best that can be accomplished at the West Entrance. They are unanimous, however, in their preference for an "all-weather" East Entrance plan (see Incl 4) for 1,000-foot vessels and feel it is far superior to any West Entrance plan. With an East Entrance plan, masters would be able to enter Cleveland Harbor under adverse weather conditions with sufficient speed to maintain control of their vessel and still have adequate room to reduce their speed once they were in protected water.

b. Captain Haynes stated that he thinks the waves that are acting against the model ship are being amplified more than in real life. It was postulated that this was because the waves being generated in the model are monochromatic and do not have the same dampening effect when they are reflected off the side of the ship as real life waves, which have different periods and wave heights. It was decided to run a few navigation tests with a 6-foot wave, in addition to an 8-foot wave, to see if this produced a force on the ship that would be closer to that generated by an 8-foot wave in real life. However, it was also noted that this difference was not a critical factor in developing an "all-weather" plan.

c. Captain Haynes also stated that the maximum 8-foot wave criteria established for "all-weather" conditions at the 8 April 1981 Vessel Masters' Workshop meeting may have referred to the wave height as it struck the side of the ship and not the incident wave height. However, it was decided to continue to use the 8-foot incident wave criteria for "all-weather" conditions.

6. Following this discussion, Chuck Gilbert asked the vessel masters if there was a need for a harbor-of-refuge on Lake Erie. The concensus of the vessel masters was that a harbor-of-refuge was not needed since vessels could hug Pelee Island or the north shore of Lake Erie during storms and then proceed into harbor when the weather moderated.

7. Dick Aguglia asked the vessel masters if they thought it would be worthwhile to model the proposed "all-weather" East Entrance plan (see Incl 4) and run ship navigation tests. The purpose of these tests would be to refine the dimensions of the fan-shaped approach and entrance channels. The masters agreed that model testing would be worthwhile, especially since it may be a good idea to widen the approach and entrance channels. This additional widening would give the vessel masters more leeway in making their turn into

the East Basin during rough weather. WES will provide the District with a time and cost estimate for conducting model tests on the East Entrance. (NOTE: Estimate received 24 November 1981.) All participants agreed, however, that the present configuration of the "all-weather" East Entrance plan was sufficient for comparison purposes with the West Entrance plan presently under consideration, since the added cost of any changes would be minor in comparison to the total cost of the plan.

8. Harry Gard asked if it would be possible to test modifications to the east breakwater with a view towards reducing wave action along the Port Authority's docks in the Lakefront Harbor. Dick Aguglia replied that this type of testing could be done, however, Federal participation in any improvement to the east breakwater would not be feasible because of lack of economic justification. (NOTE: Past discussions with the Port Authority indicated that, although existing wave activity in the Lakefront Harbor is high, it does not significantly hinder their operations and thus little or no benefit would be gained by improving the east breakwater.) Harry Gard replied that he understood this, but felt it would still be worthwhile for the Port Authority to have plans to improve the east breakwater "on-the-shelf" in the event that funds became available to the Port Authority for this type of work. Harry also stated that he would send a letter to the District requesting that we do this testing for the Port Authority and the design criteria they would like to meet.

9. Following lunch, the meeting reconvened at the Cleveland Harbor model where the vessel masters ran navigation tests with the "all-weather" West Entrance plan installed (see Incl 3). Weather conditions for these tests were 30-knot winds and 8-foot incident waves from the north-northeast initially, with the incident wave being reduced to 6 feet later on in the afternoon. While conducting the navigation tests, it was obvious that the vessel masters were having trouble making the turn into the arrowhead entrance. It appeared that the main problem was the wind acting on the stern cabin which tended to force the stern of the vessel in the opposite direction of the turn they were trying to make (ie., the vessel was being pushed counterclockwise by the wind when the required turn into the arrowhead entrance was clockwise). In order to neutralize the effect of the wind, the vessel would have to carry too much speed to safely make the turn into the arrowhead entrance. In addition, the vessel masters stated that with this type of plan, once they started the initial turn into the entrance, they were totally committed and would have a difficult time backing out if problems arose. It was, therefore, decided to test a different type of "all-weather" plan composed of the following (see Incl 5);

a. two 1,000-foot long parallel piers (crest elevation +8 LWD) 600 feet apart, extending out from the existing east and west arrowhead breakwaters;

b. removal of 300 feet of the west spur breakwater and 200 feet of the east spur breakwater; and

NCBPD-WB
SUBJECT: Model Study Review Conference - Cleveland Harbor Study

c. any additional compensating works required to maintain existing wave conditions inside the Lakefront Harbor with the spur breakwaters removed.

The meeting then adjourned for the remainder of the day while WES personnel installed the new plan (Incl 5) in the model.

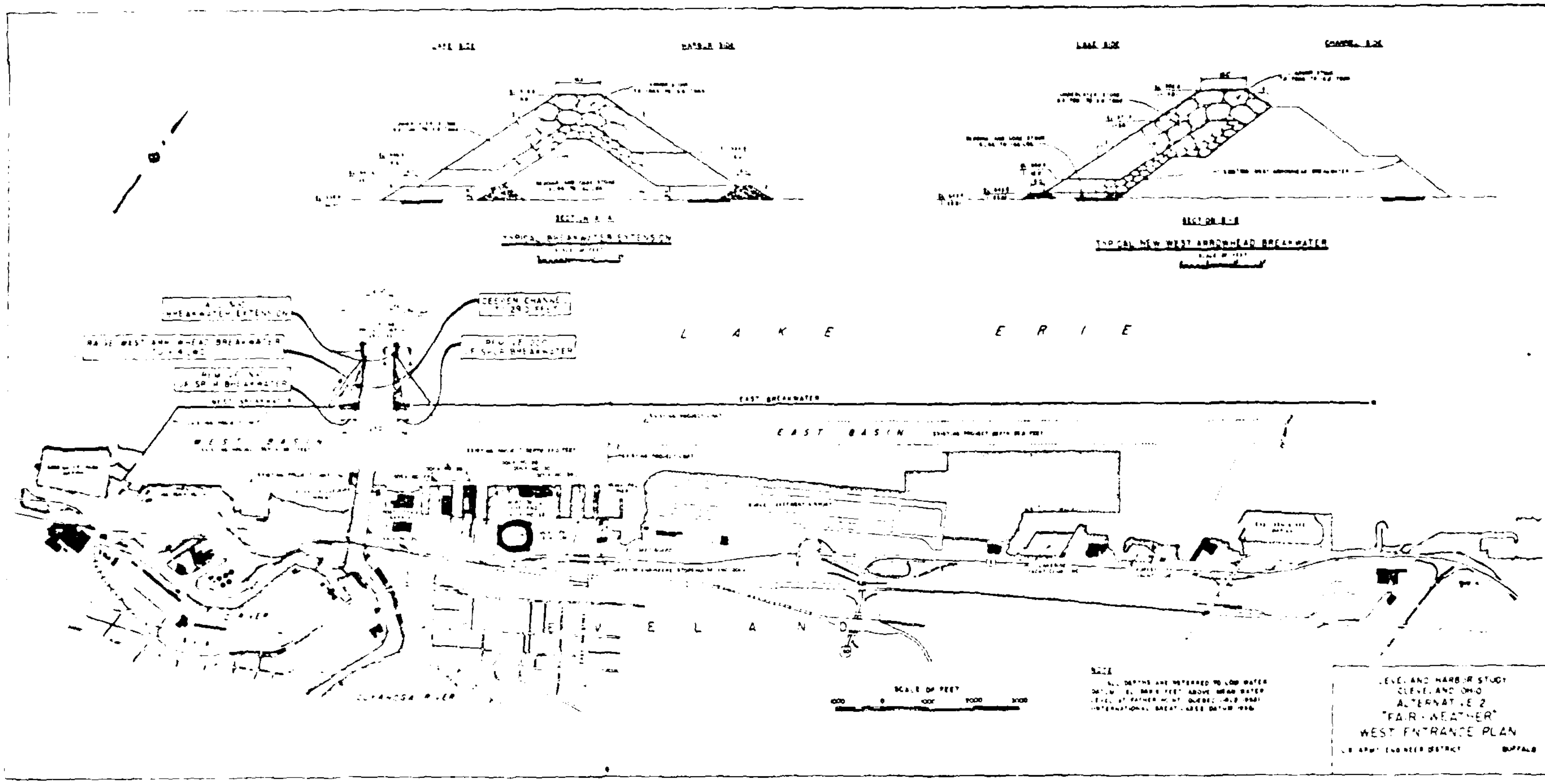
10. The meeting reconvened at the model the following morning (30 Oct) and the vessel masters ran navigation tests with the new parallel pier "all-weather" plan installed (Incl 5). Weather conditions for these tests were 30-knot winds and 8-foot waves from the west, which were considered to be the most difficult conditions for entering the harbor with this type of plan. The vessel masters were unanimous in their preference for this plan over the plan previously installed (Incl 3). Features of this plan that made it preferable were that vessels were not required to make a turn before entering the protected Lakefront Harbor and vessels would have the option of backing out and making a second entrance approach if problems developed during their initial run. In addition, the parallel-pier plan would be considerably cheaper to construct than the previous "all-weather" plan (Incl 3) since the length of new breakwater required would be about 40 percent of the previous plan (2,000 feet of new breakwater required vs 5,000 feet). Therefore, it was decided that the parallel-pier plan would be refined and carried foward as the preferred "all-weather" West Entrance plan. Refinement of this plan would be limited to model tests to determine if there would be an increase in wave activity in the Lakefront Harbor as a result of the spur breakwater removal and, if so, what type of compensating works would be required to reduce it down to existing conditions.

11. Following lunch, the meeting reconvened in the conference room where Gene Chatman summarized the results of the meeting and thanked everyone for their participation. The meeting then adjourned at 1:30 p.m.

(NOTE: Following the meeting, Captain McSweeney stated that 1,000-foot vessels could probably use the existing arrowhead entrance when leaving the harbor if the weather was not too rough. In that case, they could use the existing east entrance with light ballast. Captain McSweeney also stated that he once used the east entrance during rough weather to enter Cleveland Harbor in a 1,000-foot vessel, however, that was only possible because he was light loaded.)

5 Incl
as

RICHARD AGUGLIA
Project Manager


LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
LAKE SIDE
CHANNEL SIDE
SECTION B-B
TYPICAL NEW WEST ARROWHEAD BREAKWATER
L A K E E R I E
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EAST BASIN
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C L E V E L A N D
CUYAHOGA RIVER
SCALE OF FEET
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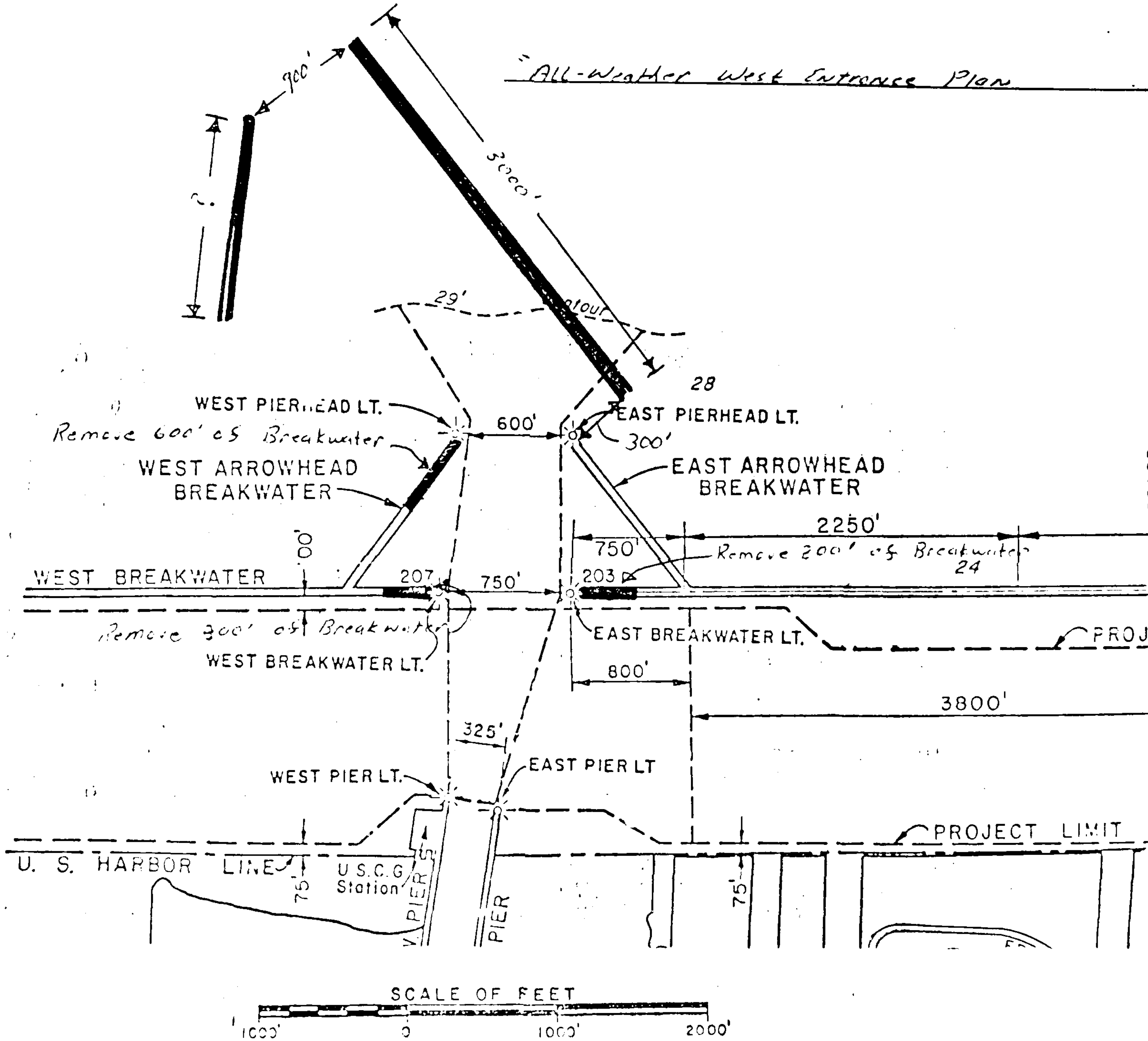
NOTE
CLEVELAND HARBOR STUDY
CLEVELAND OHIO
ALTERNATIVE 2
"FAIR-WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO

Incl 1

"All-Weather West Entrance Plan



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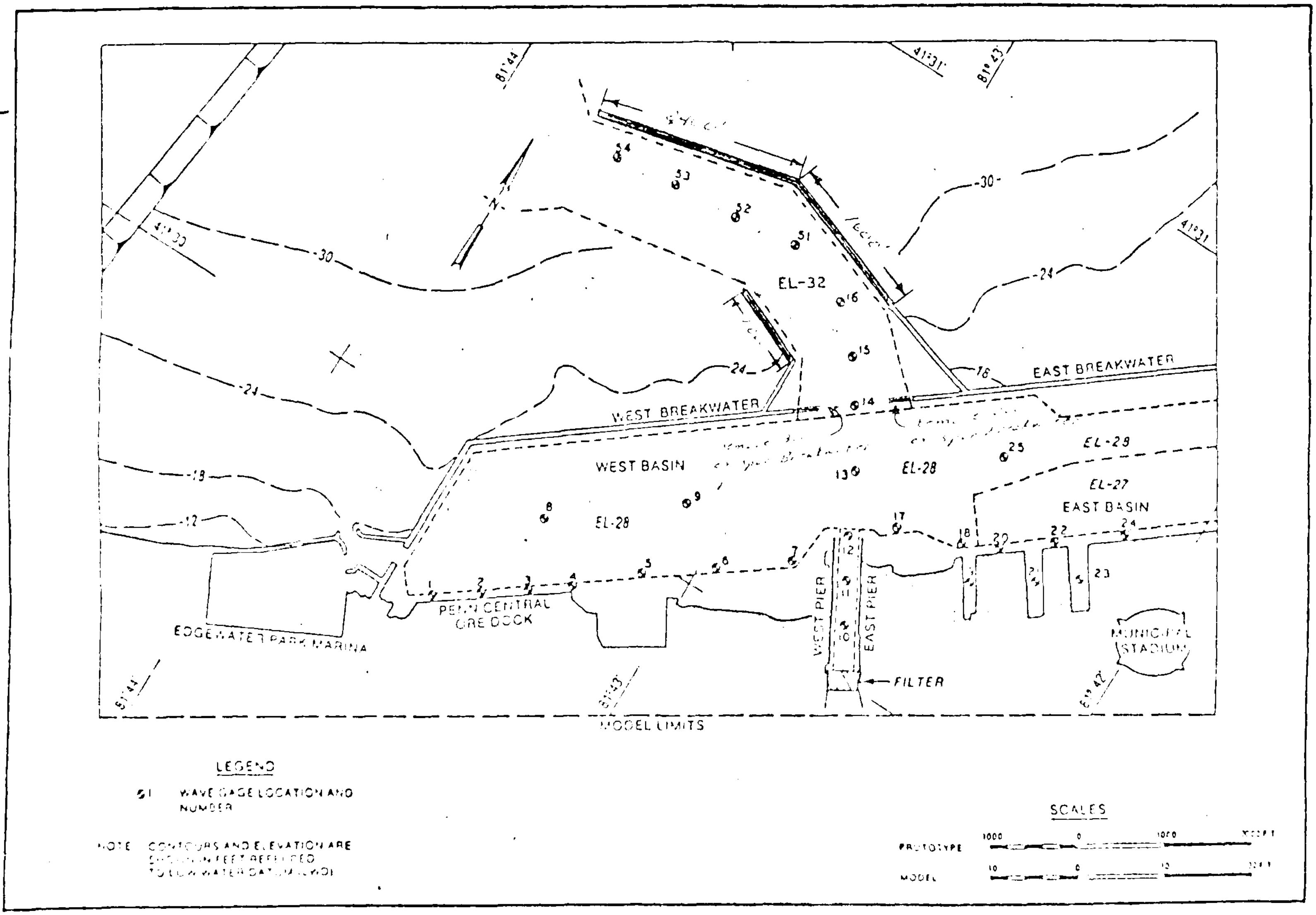
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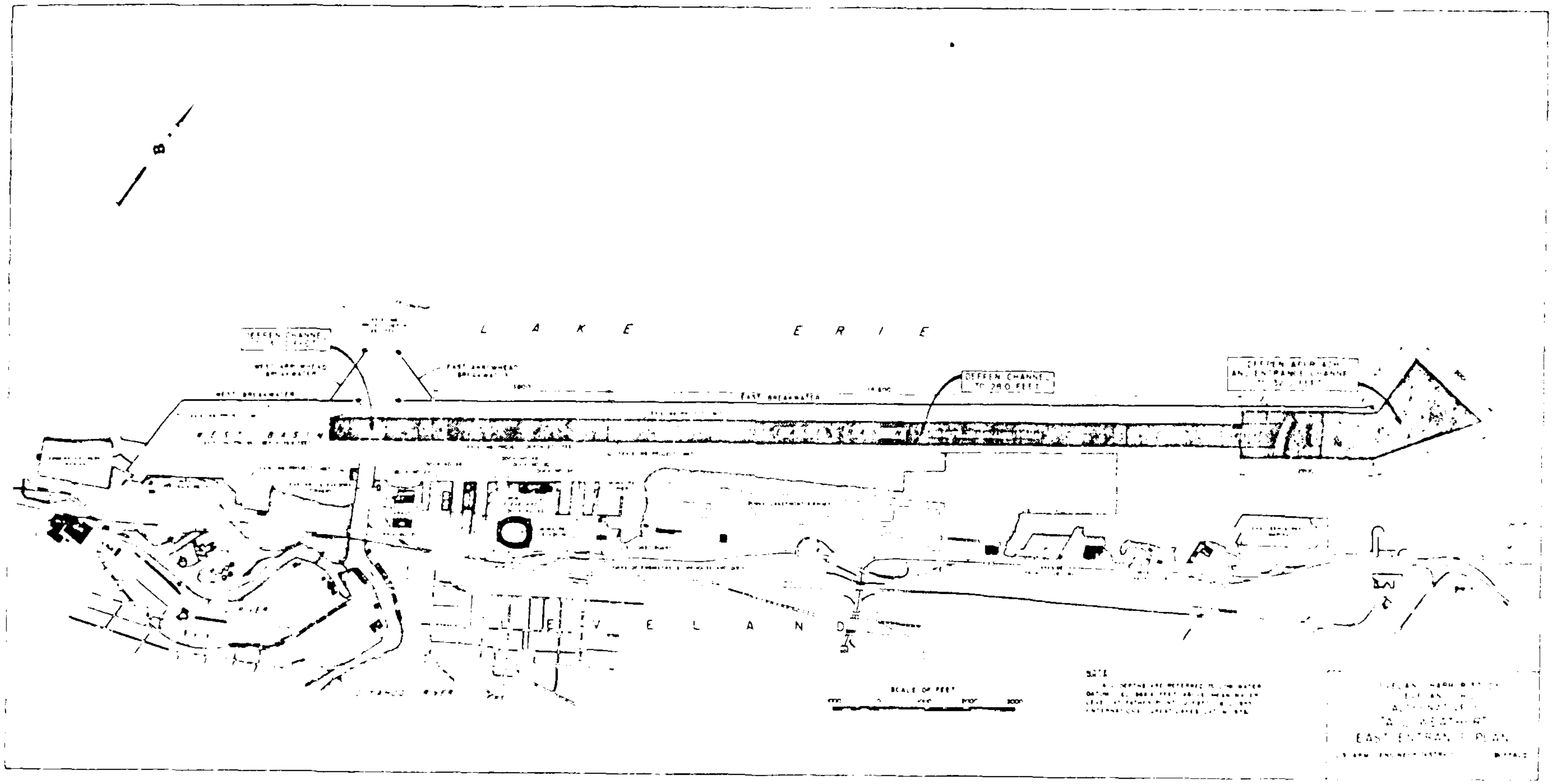
EL-28
EL-29
EL-27
WEST PIER
EAST PIER
FILTER
PENN CENTRAL
ORE DOCK
EDGEWATER PARK MARINA
MUNICIPAL STADIUM
MODEL LIMITS
-30-
-24-
-18
-12
LEGEND
WAVE GAGE LOCATION AND NUMBER
NOTE CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)
SCALES
PROTOTYPE
MODEL



B
LAKE ERIE
DEEPEN CHANNEL
WEST ARROWHEAD BREAKWATER
EAST ARROWHEAD BREAKWATER
WEST BREAKWATER
EAST BREAKWATER
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WEST BASIN
CLEVELAND
SCALE OF FEET
NOTE
EAST ENTRANCE PLAN

AD-A139 380 CLEVELAND HARBOR OHIO DRAFT REFORMULATION PHASE I GENERAL DESIGN MEMORAND..(U) CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT FEB 84 6/8

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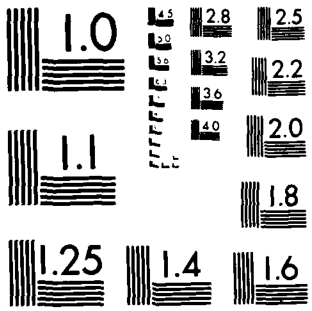


DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBPD-WB	Cleveland Harbor Study - Summary Minutes of 16 Feb. 1982 Meeting with Ontario Stone Corporation

TO PROJECT FILES   FROM R. Aguglia   DATE 18 February 1982 CMT 1

1. On 16 February 1982, Mr. Carl Barcelli, President, Ontario Stone Corporation, visited the Buffalo District Office. The purpose of this visit was to review the authorized, but uncompleted improvements on the Old River. These improvements include: 1.) bank cuts 12 - 15; 2.) replacement of the B&O Railroad Bridge at the mouth of the Old River; and 3.) deepening the navigation channel to 28-feet below LWD. Persons in attendance were as follows:

Bob Johnson - NCBED-DD	Dick Aguglia - NCBPD-WB
Roger Haberly - NCBPD-EC	Carl Borcelli - Ontario Stone Corporation

2. Mr. Aguglia opened the meeting by reviewing the authorized improvements on the Old River. Mr. Aguglia then stated that, because of the recent closing of the Erie Ore Dock, there does not appear to be sufficient potential transportation benefits available to justify these improvements. Since Ontario Stone Corporation recently purchased the Erie Ore Dock, the Buffalo District would like to review Ontario Stone Corp's future plans for this facility. Mr. Barcelli replied with the following:

a.) Ontario Stone will be reopening the dock this year. They presently have commitments to receive 60,000 tons of coal for use in the Cleveland area and to receive 50,000-60,000 tons of steel scrap for local consumption.

b.) Current improvement plans for the dock include: (1) renovating the three brick buildings on the property; (2) installing a truck scale; (3) removing the 3 existing Hulett unloaders; and (4) replacing 450 feet of damaged timber bulkhead with steel sheet pile bulkhead.

c.) Ontario Stone has received an inquiry for exporting approximately 2,000,000 tons of coal from the Erie Ore Dock. Coal would be received at the dock by rail car and loaded out in 650-foot vessels. Since they are in the preliminary stages of discussion, however, no definite commitment for this activity can be made at the present time.

d.) If the authorized improvements on the Old River are completed, Ontario Stone would tranfer their stone receipts (1,000,000 tons per year) from their Cuyahoga River dock to the Old River. In addition, they would increase the size of the vessels used in this traffic from 630-foot vessels (maximum vessel that can transit the Cuyahoga River) to 730 foot vessels. Stone would continue to be delivered to their customers by truck after receipt at the dock. They would also use a 730-foot vessel for the export of coal, if this potential new business becomes a reality.

e.) Mr. Barcelli does not know at the present time whether or not he would build the 40-foot docking area proposed in the authorized improvements. He will make his decision on this aspect just prior to construction of the authorized improvements.

f.) Mr. Barcelli stated that the B&O makes two trips per day over their bridge at the mouth of the Cuyahoga River.

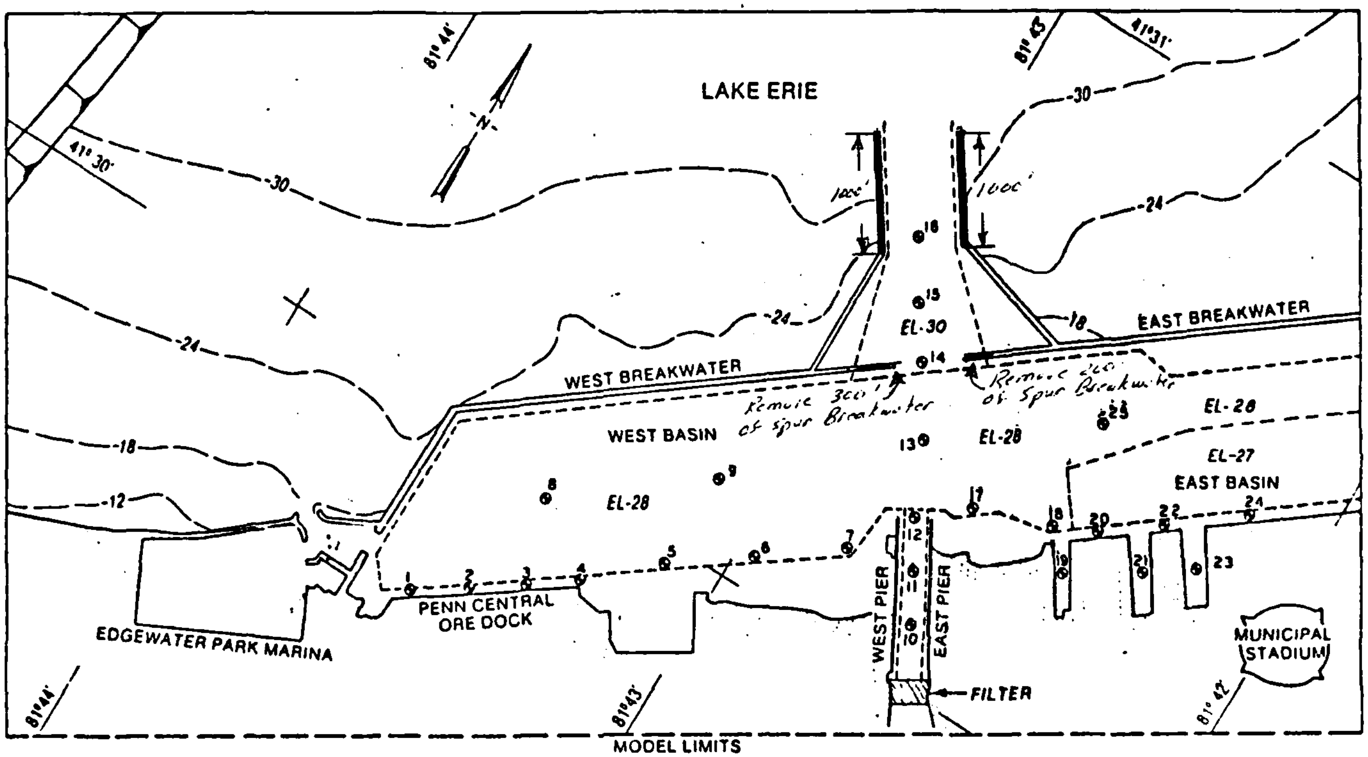
Exhibit G-4

NCBPD-WB
SUBJECT: Cleveland Harbor Study - Summary Minutes of 16 February 1982 Meeting with Ontario Stone Corporation

3. Mr. Barcelli also stated that the Conrail Bridge at the mouth of the Cuyahoga River and the Willow Avenue Bridge on the Old River do not provide adequate vertical clearance for 730-foot vessels when they are in ballast (Note: Both vertical lift bridges provide 98 feet of vertical clearance at LWD when in the up position). The Buffalo District will look into this potential problem further.

4. The meeting then adjourned at 10:00 a.m.

RICHARD AGUGLIA
Project Manager



LEGEND

⊕1 WAVE GAGE LOCATION AND NUMBER

NOTE: CONTOURS AND ELEVATION ARE SHOWN IN FEET REFERRED TO LOW WATER DATUM (LWD)

SCALES

PROTOTYPE 1000 0 1000 2000 FT

MODEL 10 0 10 20 FT

Incl 5

CLEVELAND HARBOR STUDY
SUMMARY MINUTES OF 4 MAY 1982 WORKSHOP MEETING
CLEVELAND-CUYAHOGA COUNTY PORT AUTHORITY OFFICE
CLEVELAND, OHIO

1. A workshop meeting was held on 4 May 1982 at the Cleveland Port Authority's office. The purposes of this meeting were to review the commercial navigation alternatives developed during Stage 2 planning (Development of Preliminary Plans) for the Cleveland Harbor Phase I GDM study and to select the most feasible plans(s) to be carried forward into Stage 3 planning (Development of Detailed Plans). The names of those persons in attendance are shown on Inclosure 1. The meeting agenda is shown on Inclosure 2.

2. Mr. Charles Gilbert opened the meeting at 9:00 a.m. by welcoming all meeting participants and reviewing the purposes of the meeting. Following introduction of the meeting participants, Mr. Gilbert then stated that the current schedule for the Cleveland Harbor study calls for submission of the Stage 2 Report to North Central Division (NCD) in July, 1982 with the report being released to the public in October 1982. The submission of the Final Report to NCD is scheduled for July 1984. NCD will then submit the Final Report to the Board of Engineers for Rivers and Harbors for final review and coordination. Following this final review and coordination, the report will be submitted to Congress for construction authorization. Mr. Gilbert also discussed the President's proposed new cost-sharing legislation for commercial navigation projects currently before Congress. This proposed legislation calls for complete recovery of all costs of the Federal Government for commercial navigation projects authorized for construction after 1 October 1981 and for operation and maintenance costs after 1 October 1982. Mr. Gilbert stressed that this new cost-sharing proposal should be kept in mind when selecting plans to be carried forward into Stage 3 planning. Mr. Gilbert then turned the meeting over to Mr. Richard Aguglia.

3. Mr. Aguglia stated that Buffalo District developed four sets of plans to improve commercial navigation at Cleveland Harbor: (1) plans to improve the Lakefront Harbor for safe and efficient operation of 1,000-foot vessels; (2) a reevaluation of authorized but uncompleted improvements to the Old River navigation channel in light of current conditions; (3) plans to deepen the Cuyahoga River navigation channel; and (4) plans to reduce congestion on the Cuyahoga River navigation channel. Mr. Aguglia then stated that he would be discussing these plans in sets as shown on the agenda. For each set, he would first review each of the plans formulated, including their costs and benefits, followed by the District's tentative recommendation on which plan(s) to carry forward into Stage 3 planning. The meeting would then be opened for general discussion to answer any questions on the plans and to select the final plan(s) to be carried forward into Stage 3 planning.

4. Mr. Aguglia then reviewed the Lakefront Harbor Improvement Plans (Plans 1-4). A description of these plans, including their costs and benefits, is provided in Inclosure 3. Mr. Aguglia also stated that early in the study, a nonstructural tug assistance plan was formulated but was initially eliminated because such a plan would not provide adequate channel depths for 1,000-foot vessels loaded to the system's draft of 25.5 feet, and tugs would not be able

to control the movements of a 1,000-foot vessel during storm conditions while entering the narrow west entrance. Participants were in agreement on the elimination of this plan. Mr. Aguglia also stated that the purpose of Plans 1-4 is to provide for safe and efficient operation of 1,000-foot vessels in the Lakefront Harbor. Several of the plans would also provide adequate entrance channel depths for operation of Class V through Class X vessels loaded to the Great Lakes System draft of 25.5 feet which presently must lighter during low water conditions. Mr. Aguglia also stated that these plans were developed under the following assumptions: (1) that an iron ore transshipment facility, capable of accommodating 1,000-foot vessels, would be constructed in the Lakefront Harbor; and (2) all dredged material would be placed in Dike Site 14. (NOTE: Dikes 12 and 14 were originally authorized to contain 10 years of maintenance dredging. However, due to reduced dredging at Cleveland Harbor over the last several years, these diked areas will have about 2-3/4 million cubic yards of excess capacity after the authorized 10-year period. This excess capacity will be used to contain dredged material from the alternatives developed for this study.) The assumption to use Dike 14 for containment of dredged material may change, however, since the city of Cleveland is interested in using the dredged material in their proposed expansion of Burke Lakefront Airport. The Port Authority is also interested in using the dredged material for possible plans to fill in Whiskey Island. As long as an adequate diked area is provided, the Corps would be willing to give the dredged material to either agency. Following the presentation of two model study movies illustrating Plan 2 and Plans 3A and 3B, Mr. Aguglia stated that the Buffalo District's tentative recommendation is to carry forward Plan 1 into Stage 3 planning and to eliminate Plans 2-4 from further consideration. This tentative recommendation is based on the following considerations: (1) Plan 1 is the NED Plan (i.e., the plan that provides the greatest net benefits); (2) based on input from vessel masters, Plan 1 would provide safer entrance conditions for 1,000-foot vessels than any of the west entrance plans, especially since the 4-mile east basin channel would allow vessels to enter Cleveland Harbor at adequate entrance speeds to counteract the wind and wave forces acting on the vessel during storm conditions; (3) due to the absence at the east entrance of the many obstacles that are present at the west entrance, the potential for vessel accidents would be less for Plan 1 than for any of the west entrance plans; and (4) the cost to construct Plan 1 is significantly less than for any other plan. A general discussion on Plans 1-4 then ensued. The main points of this discussion are as follows:

a. Mr. Layton Washburn asked what credence was given to ODNR's Lakefront State Park development plan which includes shortening the east basin and increasing the usage of the east basin by recreational small boats. Mr. Aguglia replied that ODNR previously stated that they would be modifying their development plan to eliminate this apparent conflict with commercial navigation. However, shortening the east basin, as proposed by ODNR, would not effect the adequacy of the east entrance plan since an adequatly protected channel length would still be available. In regards to impacting on small boats, Plan 1 would result in increased usage by commercial vessels of the east basin. However, since a 1,000-foot vessel loaded to 25.5 feet static draft can carry about three times the tonnage of a 730-foot vessel presently in use at Cleveland Harbor, an overall reduction in the number of commercial ships using the Lakefront Harbor will occur. It is assumed that this positive benefit will counterbalance the negative impact of increased usage by commercial vessels in the east basin. Another potential conflict is ODNR's proposal to develop Whiskey Island as a recreational complex. As previously stated, it is assumed that a new iron ore transshipment facility will be built in the Lakefront Harbor and any recommendation to modify the Lakefront Harbor would be made contingent upon such a facility actually being built. The most logical location for such a facility is Whiskey Island. It will be up to local interests to decide whether to develop Whiskey Island for recreational use or for use as a transshipment facility.

b. Mr. Ed Jacobson asked why develop the east entrance instead of the west entrance for 1,000-foot vessels. He also expressed his concern about the effects of wind forces acting on a vessel as it travels through the east basin. Mr. Aguglia replied that the east entrance plan (Plan 1) is preferred by vessels masters who feel it is superior to any west entrance plan. They have also stated that they anticipate no trouble traveling through the east basin as long as an adequate entrance channel and adequate channel depths are provided. Also, the east entrance has fewer obstacles than the west entrance which reduces the probability of vessel accidents. The east entrance plan was selected because of those reasons and because Plan 1 provided the greatest net benefits of any of the Lakefront Harbor plans. Mr. Aguglia also noted that the east entrance was originally authorized as a storm entrance for Class V vessels (630-foot vessels) who had difficulty entering the west entrance during rough weather. However, the depth of the east entrance became inadequate when the system's draft was increased to 25.5 feet.

c. The Coast Guard expressed concern that wakes from 1,000-foot vessels using the east entrance would cause an increase in shoreline erosion, especially since they would have to travel at speeds sufficient to maintain vessel control in winds up to 30 knots. Also, will a turning basin for 1,000-foot vessels be provided. Mr. Aguglia replied that the expected 2 to 3 mph speed should not produce a wake greater than the waves that are present in the east basin now, when the east breakwater is overtopped. Also, the shoreline in the east basin is protected with stone riprap. Mr. John Manning replied that based on his observations, small boats make more wake than the larger commercial vessels. He also stated that commercial vessel masters would not speed through the east basin. In regards to providing a turning basin, Mr. Aguglia replied that vessel masters previously stated that the 1,500-foot width of the west basin was sufficient to turn a 1,000-foot vessel and, thus, no consideration was given to providing a separate turning basin.

d. Admiral Trimble asked if the savings of 1 to 1-1/2 hours in vessel transit time from using the west entrance in lieu of the east entrance was included in the benefit analysis for the west entrance plans. Mr. Aguglia replied that since this savings was such a small percentage of the total 5 to 6 day round trip, it did not affect the estimated benefits for the west entrance plans. Admiral Trimble also asked if using the dredged material for the expansion of Burke Lakefront Airport or for development of Whiskey Island would decrease the cost of Plan 1. Mr. Aguglia replied that it would not decrease the cost of the plan. (NOTE: Although not mentioned at the meeting, using dredged material for fill material for either proposed plan may result in an added benefit for Plan 1. This aspect will be investigated in Stage 3, as appropriate.)

e. Admiral Trimble also expressed his objection to the term "all-weather" entrance since "all-weather" conditions are defined as a maximum 8-foot wave and 30-knot wind. His concern is that this term could mislead the public who are not completely familiar with the term as used in the context of this study. It was, therefore, decided to change the name in Stage 3 to eliminate this possible confusion.

f. Mr. Robert Lucas asked what the Corps current schedule was for submission of the Final Report to Congress. Mr. Aguglia replied that the Final Report is scheduled to be sent to the Board of Engineers for Rivers and Harbors in August 1984 for final review and coordination. However, once it gets to Washington, it can take anywhere from 6 months to 2 years before it gets to Congress. Mr. Aguglia also stressed that if the project was authorized for construction, Congress would also have to appropriate sufficient funds for construction before the project could be built.

g. Admiral Trimble asked what benefit the Cleveland Port Authority would realize from construction of any of the Lakefront Harbor modification plans. Mr. Tom Burke replied that the Port Authority would not receive any direct benefit to Port facilities, but they are willing to go along with the wishes of the Lake Carriers Association (LCA).

Following this discussion, Admiral Trimble stated that the LCA concurs with carrying forward Plan 1 into Stage 3 planning and eliminating Plans 2 through 4 from further consideration. However, their final position on whether to support construction of this plan is dependent upon final Congressional legislation on user fees for commercial navigation projects. Thus, only Plan 1 will be carried forward into Stage 3 planning. Mr. Aguglia then stated that one aspect we will be looking at in Stage 3 is the required depth of water under a vessel's keel. For Stage 2, we have assumed 2 feet of underkeel clearance would be required, however, we would like to verify this aspect. Mr. John Manning stated that the LCA recommended 30 inches of underkeel clearance for the Connecting Channels study.

5. Mr. Aguglia then reviewed the authorized but uncompleted improvements to the Old River navigation channel (Plans 5A and 5B). A description of these plans is provided in Inclosure 3. If implemented, these improvements would allow a 730-foot vessel to navigate the Old River navigation channel loaded to a 25.5-foot static draft. (NOTE: Currently, the Old River navigation channel can accommodate a maximum sized vessel of 649-feet loaded at a 21-foot static draft.) A reevaluation of these authorized but uncompleted improvements at this time is required because of the closure of the old Erie Ore Dock, which was recently sold to Ontario Stone Corporation, and the decision by Forest City Publishing Company not to construct a newspaper complex on their property adjacent to the Old River. Since cargo expected to cross these docks was used, in part, to economically justify the authorized

improvements, their continued economic feasibility is in question. Mr. Aguglia also stated that since the economic reevaluation indicated that the new benefit-cost ratio (BCR) for these plans were below 1.0, the initial reaction of the District was to recommend deauthorizing these authorized improvements. However, recent discussions with a dock owner on the Old River indicated that he was in preliminary discussions with a company interested in exporting approximately 2 million tons of coal from their Old River dock. If this new business was to materialize, it could generate a potential additional benefit of about $1.00 per ton, or $2 million annually. This additional benefit would be sufficient to increase the BCR for Plan 5B to about 1.1, indicating the plan would be economically feasible. Therefore, it is the District's final position that the authorized improvements to the Old River navigation channel remain in the inactive category until such time as a final decision has been reached on whether this new business will materialize. If it does, the improvements would then be placed in the active category and construction would procede under their original authorization. If this business does not materialize, then these improvements would become a candidate for deauthorization. All meeting participants were in agreement with this approach.

6. Mr. Aguglia then reviewed the plans to deepen the Cuyahoga River (Plans 6A and 6B). A description of these plans is provided in Inclosure 3. The purposes of these plans are either to partially or totally eliminate the need to navigate the Cuyahoga River light-loaded. However, because the BCR's for these two plans were significantly below 1.0, it was the District's recommendation to eliminate these plans from further consideration. All meeting participants concurred in this recommendation.

7. The final set of plans to be reviewed were the Cuyahoga River congestion plans (Plans 7A through 7G). A description of these plans is provided in Inclosure 3. The purpose of these plans is to eliminate undue vessel delays at seven locations on the Cuyahoga River identified as delay points by shipping companies transiting the river channel. Mr. Aguglia also stated that it was the District's recommendation to eliminate Plans 7A, 7C, 7D, 7E, and 7G from further consideration due to BCR's being less than 1.0. It is also recommended that construction of Plans 7B and 7F, which are also previously authorized but uncompleted improvements to the Cuyahoga River navigation channel, be pursued under their existing construction authority since they still have BCR's greater than 1.0. All meeting participants were in agreement with these recommendations except as noted below:

a. Because of the significant local costs that would be required for Plan 7B, it was recommended that this authorized improvement plan be kept in deferred status until final legislation on user fees is passed by Congress. In addition, it was stated that the mill adjacent to this improvement site is in a state of disrepair and may be closed down in the future. This action would significantly reduce the local cost for this plan. Thus, it was the final recommendation that Plan 7B be kept in the deferred category.

b. It was also decided to change the status of Plan 7F from deferred to active. The first step in preconstruction planning would then be to investigate the possibility of not bulkheading Bank Cut No. 20, but to cut the bank back on a stable slope. This would significantly reduce the cost of this plan.

c. Although Plan 7G has a BCR less than 1.0, it will still be carried forward into Stage 3 planning since shipping companies indicated that numerous minor accidents occur at this site, but are not of sufficient magnitude to be reported to the Coast Guard. Even though each accident involves only minor damage, in total, they represent a significant amount of damage which may be sufficient to increase the BCR for Plan 7G above 1.0. Shipping companies will supply information on these minor accidents to the Buffalo District for Stage 3 analysis.

8. Mr. Gilbert then reviewed the conclusions reached at this meeting and adjourned the meeting at 12:00 noon.

RICHARD AGUGLIA
Project Manager

CLEVELAND HARBOR STUDY
4 May 1982 Workshop Meeting

Attendance

Name	Organization
Charles Gilbert	Chief, Planning Division, COE
Richard Aguglia	Planning Division, COE
Michael Pelone	Economics Branch, COE
Roger Haberly	Economics Branch, COE
Robert Johnston	Design Section, COE
Robert Lucas	Ohio Department of Natural Resources
Ken Alvey	Ohio Department of Natural Resources
Kent E. Kroonemeyer	U. S. Fish and Wildlife Service
Ken Multerer	U. S. Fish and Wildlife Service
John Baker	International Longshoreman's Association
Joe Hayes	Lake Erie Asphalt Products
Edgar M. Jacobsen	Oglebay Norton
Admiral Paul Trimble	Lake Carriers Association
John Manning	Hanna Mining Company
Carl Barcelli	Ontario Stone Corporation
Michael Neylon	International Salt Company
Layton Washburn	Cleveland City Planning Commission
Roual G. Denning	Cereal Food Processors, Inc.
Captain Davies	Kinsman Lines
Dewey Aston	Pickards Mather
Louis Ervin	American Steamship Company
Ed Guffing	U. S. Coast Guard
Gordon Piche	U. S. Coast Guard
Robert W. Gasior	U. S. Coast Guard
Captain Dave Freeborn	U. S. Coast Guard
Bob Spar	Jones & Laughlin Steel Corporation
P. E. VanCleve	Chessie System
Thomas Burke	Cleveland-Cuyahoga County Port Authority
Anthony Russo	Cleveland-Cuyahoga County Port Authority

Inc. 1

Agenda
for
Workshop Meeting
on
Cleveland Harbor Study

Tuesday, 4 May 1982
Cleveland-Cuyahoga County Port Authority Office
101 Erieside Avenue, Cleveland, Ohio

9:00 a.m.	WELCOME AND OPENING REMARKS . . . . . . .Charles E. Gilbert, Chief, Planning Division, COE
9:15 a.m.	OUTER HARBOR ALTERNATIVES - REVIEW OF PLANS 1-4, INCLUDING MODEL STUDY MOVIES ON PLAN 2 AND PLANS 3A and 3B . . . . . . .Richard Aguglia, COE
10:00 a.m.	OPEN DISCUSSION . . . . . . .All
10:30 a.m.	OLD RIVER ALTERNATIVES - REVIEW OF PLANS 5A, 5B . . . . . . .Richard Aguglia, COE
10:45 a.m.	OPEN DISCUSSION . . . . . . .All
11:00 a.m.	CUYAHOGA RIVER DEEPENING ALTERNATIVES - REVIEW OF PLANS 6A, 6B . . . . . . .Richard Aguglia, COE
11:15 a.m.	OPEN DISCUSSION . . . . . . .All
11:30 a.m.	CUYAHOGA RIVER CONGESTION ALTERNATIVES - REIVEW OF PLANS 7A-7G . . . . . . .Richard Aguglia, COE
11:45 a.m.	OPEN DISCUSSION . . . . . . .All
12:15 p.m.	SUMMARY AND CLOSING REMARKS . . . . . . .Charles E. Gilbert, COE

Inc. 2

Comparison of Commercial Navigation Alternatives (Plans 1-7)(1)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)
1. OUTER HARBOR IMPROVEMENT PLANS (PLANS 1-4): Purpose is to provide for safe and efficient operation of vessels up to 1,000 feet long by 105 feet wide loaded to the Great Lakes System Draft of 25.5-feet in the Lakefront Harbor.									
Alternative Plan No. 1 ("All-weather" East Entrance Plan - See Plate 1). This plan includes dredging a fan shaped entrance channel at the existing east entrance and dredging a 500-foot wide channel through the East Basin to the West Basin. Plan is suitable for vessel operation in "all-weather" conditions (maximum 8-foot wave and 30 knot wind from the west through northeast).	5,060	5,060	0	0	5,060	395.9	17,605	44.5	17,209.1
Alternative Plan No. 2 ("Fair-weather" West Entrance Plan - See Plate 2). This plan includes removal of sections of the spur breakwaters at the west (main) entrance to promote vessel operation during "fair-weather" conditions (maximum 4-foot wave and 20 knot wind from the west through northeast). Also included are breakwater modifications to prevent increased wave activity in the Lakefront Harbor as a result of the spur breakwater removal.	15,100	15,100	0	0	15,100	(4)	(4)	(4)	(4)
Alternative Plan No. 3A (Modified "L" shaped Breakwater "All-weather" West Entrance Plan - See Plate 3). This plan consists of providing a new modified "L" shaped breakwater protected entrance channel, approximately 4,000 feet long, at the existing west (main) entrance and removing portions of the spur breakwaters to promote vessel operation. Plan is suitable for vessel operation during "all-weather" conditions.	33,200	33,200	0	0	33,200	3,160.2	17,605	5.6	14,444.8
Alternative Plan No. 3B (1,000-foot Parallel Breakwater Extension "All-weather" West Entrance Plan - See Plate 4). This plan consists of extending and deepening the existing west (main) entrance channel and removing portions of the spur breakwaters to promote vessel operation. Extended entrance channel would be protected by two new 1,000-foot long parallel breakwaters. Plan is suitable for vessel operation during "all-weather" conditions.	18,900	18,900	0	0	18,900	1,645.2	17,605	10.7	15,959.8

Comparison of Commercial Navigation Alternatives (Plans 1-7)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation Federal ($1,000)	Traditional Cost Allocation Non-Federal ($1,000)	Proposed Cost Allocation Federal ($1,000)	Proposed Cost Allocation Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)
<u>Alternative Plan No. 7B</u> (Site 2 - See Plates 10 and 11). This plan consists of completing the remaining portion of Cut No. 4. In addition, the new bank cut would be bulkheaded and the existing bulkheads immediately downstream of Cut No. 4 would be replaced. A savings in vessel transit time of 20 minutes would result.	3,670	247	3,423	(6)	(6)	287.1	501.2	1.8	214.1
<u>Alternativ Plan No. 7C</u> (Site 3 - See Plates 10 and 11). This plan consists of new bank Cut No. 16 and replacing the existing Cleveland Union Terminal Bridge and Columbus Road Bridge with new bridges spanning the widened channel. In addition, the new bank cut would be bulkheaded. A savings in vessel transit time of 10 minutes would result.	42,500	31,935	10,565	0	42,500	3,703.7	1,251.7	0.3	-2,452
<u>Alternative Plan No. 7D</u> (Site 4 - See Plates 10 and 12). This plan consists of new bank Cuts No. 17 and 18 and replacing the existing NSW Railroad Bridge with a new bridge spanning the widened channel. Again, the new bank cuts would be bulkheaded. A savings in vessel transit time of 10 minutes would result.	39,500	24,912	14,588	0	39,500	3,441.3	708.9	0.2	-2,732.4
<u>Alternative Plan No. 7E</u> (Site 5 - See Plates 10 and 12). This plan consists of new bank Cut No. 19 and bulheading the new bank cut. A savings in vessel transit time of 10 minutes would result.	8,860	1,774	7,086	0	8,860	742.6	436.8	0.6	-305.8
<u>Alternative Plan No. 7F</u> (Site 6 - See Plates 10 and 13). This plan consists of bank Cut No. 20 and bulkheading the new bank cut. A savings in vessel transit time of 15 minutes would result.	2,930	175	2,755	(6)	(6)	229.2	369.1	1.6	139.9
<u>Alternative Plan No. 7G</u> (Site 7 - See Plates 10 and 13). This plan consists of removing the Jefferson Avenue Bridge abutments, new bank Cuts No. 21 and 22, and bulkheading the new bank cuts. A savings in vessel transit time of 10 minutes would result.	4,000	46	3,954	0	4,000	313	225.8	0.7	-87.2

Comparison of Commercial Navigation Alternatives (Plans 1-7)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)
Alternative Plan No. 4 (Combined "All-weather" East Entrance and "Fair-weather" West Entrance Plan - See Plate 5). This plan combines the features of Plans 1 and 2. The "all-weather" east entrance would be used during rough weather, while the "fair-weather" west entrance would be used during relatively calm conditions. Use of the "fair-weather" west entrance in-lieu-of the "all-weather" east entrance would save 1 hour in vessel transit time each time a vessel entered or left the harbor.	19,800	19,800	0	0	19,800	(5)	(5)	(5)	(5)
2. AUTHORIZED BUT UNCOMPLETED IMPROVEMENTS TO THE OLD RIVER NAVIGATION CHANNEL (PLANS 5A AND 5B). Purpose is to determine if authorized but uncompleted improvements to the Old River navigation channel are still economically justified in-light-of current conditions.									
Alternative Plan No. 5A (Replace Bridge No. 23 - See Plates 6 and 7). This plan consists of four bank cuts (Cuts No. 12-15), replacing the existing B&O Railroad Bridge at the mouth of the Old River (Bridge No. 23) with a new vertical lift bridge spanning the new channel width and deepening the navigation channel to 28 feet below Low Water Datum (LWD). In addition, new bank cuts would be bulkheaded and existing bulkheads that become unstable due to the channel deepening would be replaced. Implementation of these improvements would allow a vessel up to 730 feet in length to navigate the Old River navigation channel loaded to the Great Lakes System Draft of 25.5 feet.	66,687	24,001	42,686	(6)	(6)	6,008.5	2,405.4	0.4	-3,603.1
Alternative Plan No. 5B (Interchange System - See Plates 6 and 7). This plan is similar to Plan 5A, except that in-lieu-of replacing the existing B&O Railroad Bridge, the bridge will be removed and a new connection and interchange system to the Conrail trackage on the east side of the Cuyahoga River will be provided. B&O traffic would reach Whiskey Island via this new connection and interchange system and Conrail Bridge No. 1.	54,087	11,263	42,824	(6)	(6)	3,600.5	2,098.5	0.6	-1,502

Comparison of Commercial Navigation Alternatives (Plans 1-7)(1) (Cont'd)

Plan Description	Total Project Cost (2) (June 1982 Price Levels) ($1,000)	Traditional Cost Allocation: Federal ($1,000)	Traditional Cost Allocation: Non-Federal ($1,000)	Proposed Cost Allocation: Federal ($1,000)	Proposed Cost Allocation: Non-Federal ($1,000)	Annual Cost (3) ($1,000)	Annual Benefits (3) ($1,000)	Benefit-Cost Ratio	Average Annual Net Benefits ($1,000)
3. CUYAHOGA RIVER DEEPENING PLANS (PLANS 6A AND 6B). The purpose of these plans is to provide a deeper navigation channel in the Cuyahoga River, partially or totally eliminating the need to traverse the channel light-loaded.									
Alternative Plan No. 6A (Deepen the Cuyahoga River to 25.5 feet - See Plate 8). This plan consists of deepening the Cuyahoga River navigation channel from the existing authorized depth of 23 feet to 25.5 feet below LWD. Even with the proposed deepening, however, vessels would still be required to light-load, although at a reduced level from present practice. In addition, existing bulkheads and bridge fendering systems that become unstable due to the river deepening would be replaced. Also, one utility would be relocated (lowered).	213,000	13,496	199,504	0	213,000	20,165.4	8,915.6	0.4	-11,249.8
Alternative Plan 6B (Deepening Cuyahoga River to 28 feet - See Plate 9). This alternative is similar to Plan 6A, except that the channel would be deepened to 28 feet below LWD instead of 25.5 feet, and four utilities would be relocated. The deepened channel would allow vessels to load to the Great Lakes System Draft of 25.5 feet.	220,000	19,939	200,061	0	220,000	21,154.1	9,745.1	0.5	-11,409
4. PLANS TO REDUCE RIVER CONGESTION ON THE CUYAHOGA RIVER (PLANS 7A THROUGH 7G). The purpose of these plans is to eliminate undue vessel delay at seven locations on the Cuyahoga River identified as delay points by shipping companies transiting the river channel.									
Alternative Plan 7A (Site 1 - See Plate 10). This plan was eliminated from further consideration during the early portion of Stage 2 planning due to the high cost of replacing the existing vertical left Conrail Bridge No. 1 with a new high level bridge and the corresponding approach track modifications required for the new high level bridge. If implemented, a savings of 30 minutes in vessel transit time would have occurred.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

FOOTNOTES:

(1) All costs and benefits stated are preliminary andare subject to change.

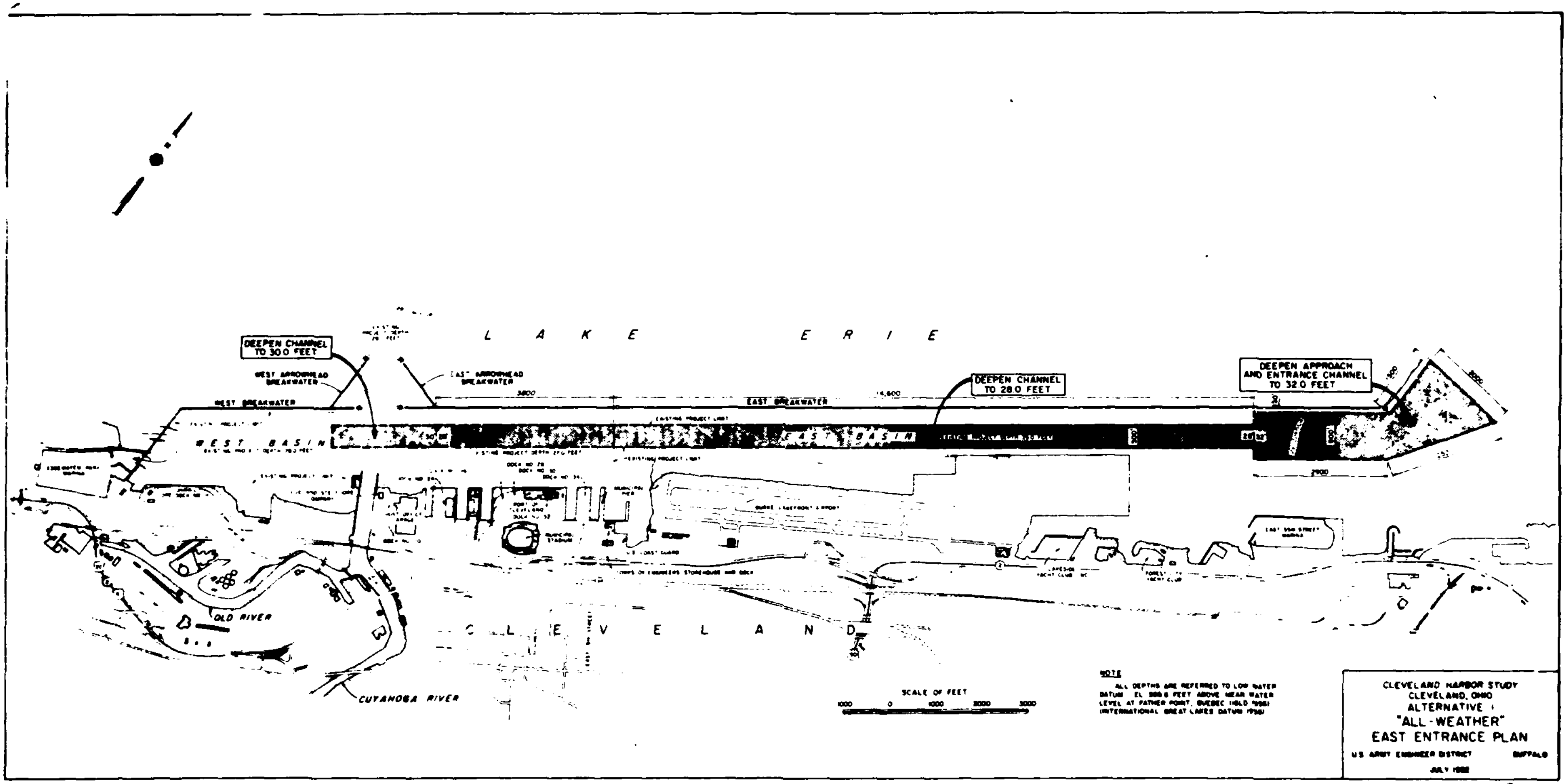
(2) Does not include cost for mitigation of adverse environmental impacts that may be required for each alternative. Mitigation will be evaluated in Stage 3, as appropriate. Also, for all alternatives, it has been assumed that dredged material will be placed in Dike Site 14.

(3) Based on June 1982 price levels, a 50-year economic life, and 7-5/8 percent interest rate.

(4) Economic evaluation was not conducted for Alternative Plan No. 2 because Alternative Plan No. 1 provided greater benefits (i.e., vessel operation during "all-weather" conditions versus vessel operation in "fair-weather" conditions only) for one-third the cost. Thus, Plan No. 1 was obviously more economically efficient than Alternative Plan No. 2.

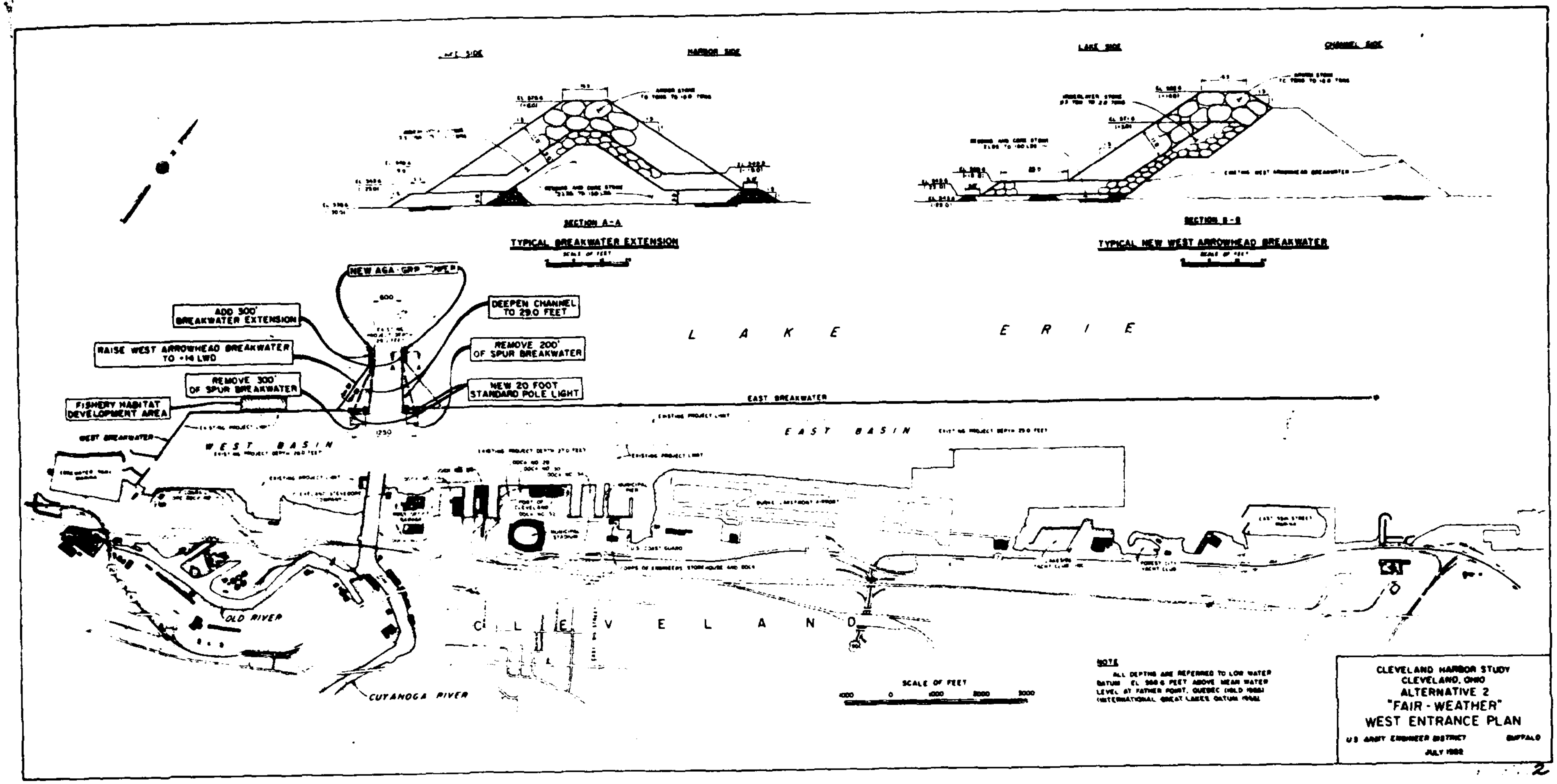
(5) Economic evaluation was not conducted for Atlernative Plan No. 4 since incremental benefits to justify adding the "fair-weather" west entrance component to the "all-weather" east entrance component were obviously insufficient to economically justify the added increment (i.e., the savings in vessel transit time of 1 hour during calm weather conditions would not result in sufficient benefits to justify an expenditure of approximately $15 million).

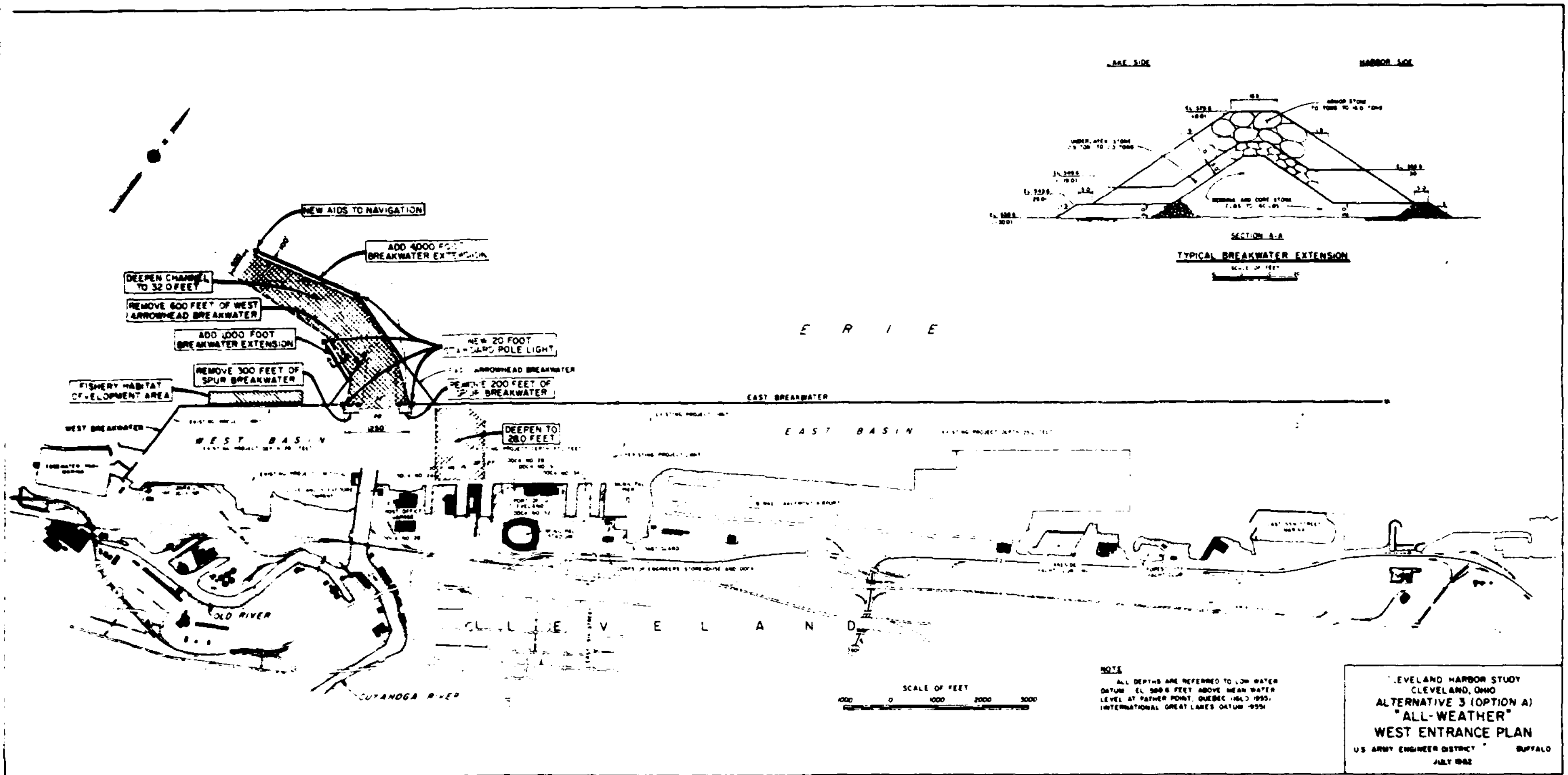
(6) This alternative was funded for construction prior to 1 October 1981 and, therefore, the President's proposed cost allocation is not applicable.



LAKE ERIE
CLEVELAND
DEEPEN CHANNEL TO 30.0 FEET
WEST ARROWHEAD BREAKWATER
EAST ARROWHEAD BREAKWATER
WEST BREAKWATER
EAST BREAKWATER
DEEPEN CHANNEL TO 28.0 FEET
DEEPEN APPROACH AND ENTRANCE CHANNEL TO 32.0 FEET
WEST BASIN
EAST BASIN
3800
14,600
2900
EXISTING PROJECT LIMIT
BURKE LAKEFRONT AIRPORT
U.S. COAST GUARD
CORPS OF ENGINEERS STOREHOUSE AND DOCK
LAKESIDE YACHT CLUB
FOREST CITY YACHT CLUB
EAST 55th STREET MARINA
OLD RIVER
CUYAHOGA RIVER
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL. 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (I.G.L.D. 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 1
"ALL-WEATHER"
EAST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

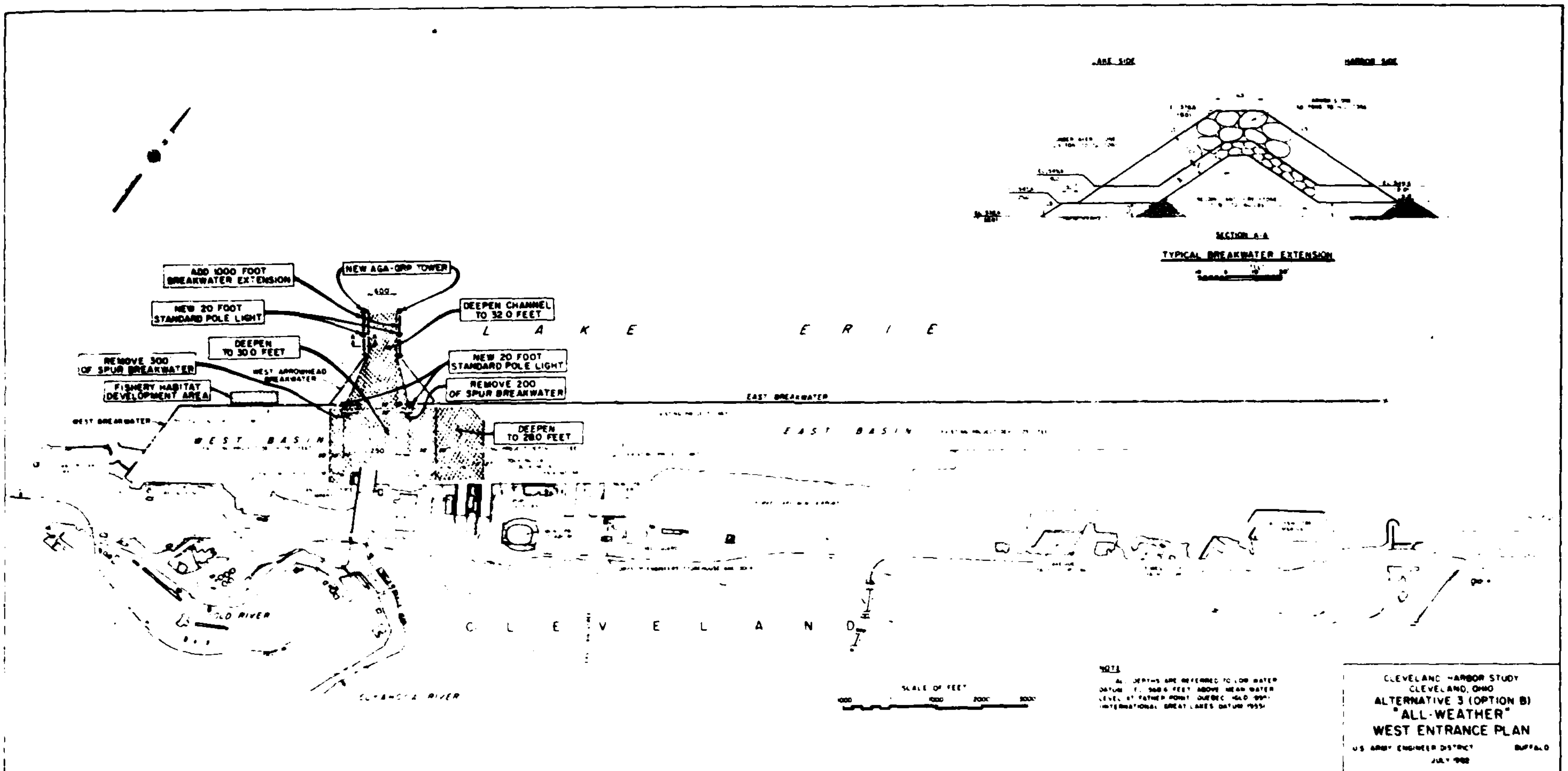
PLAT. 1


HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
SCALE OF FEET
LAKE SIDE
CHANNEL SIDE
SECTION B-B
TYPICAL NEW WEST ARROWHEAD BREAKWATER
SCALE OF FEET
NEW AGA-GRP TOWER
ADD 300' BREAKWATER EXTENSION
DEEPEN CHANNEL TO 29.0 FEET
RAISE WEST ARROWHEAD BREAKWATER TO +14 LWD
REMOVE 200' OF SPUR BREAKWATER
REMOVE 300' OF SPUR BREAKWATER
NEW 20 FOOT STANDARD POLE LIGHT
FISHERY HABITAT DEVELOPMENT AREA
L A K E E R I E
EAST BREAKWATER
WEST BREAKWATER
WEST BASIN
EAST BASIN
1250
600
OLD RIVER
CUYAHOGA RIVER
C L E V E L A N D
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) INTERNATIONAL GREAT LAKES DATUM 1955
SCALE OF FEET
1000 0 1000 2000 3000
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 2
"FAIR-WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982
2



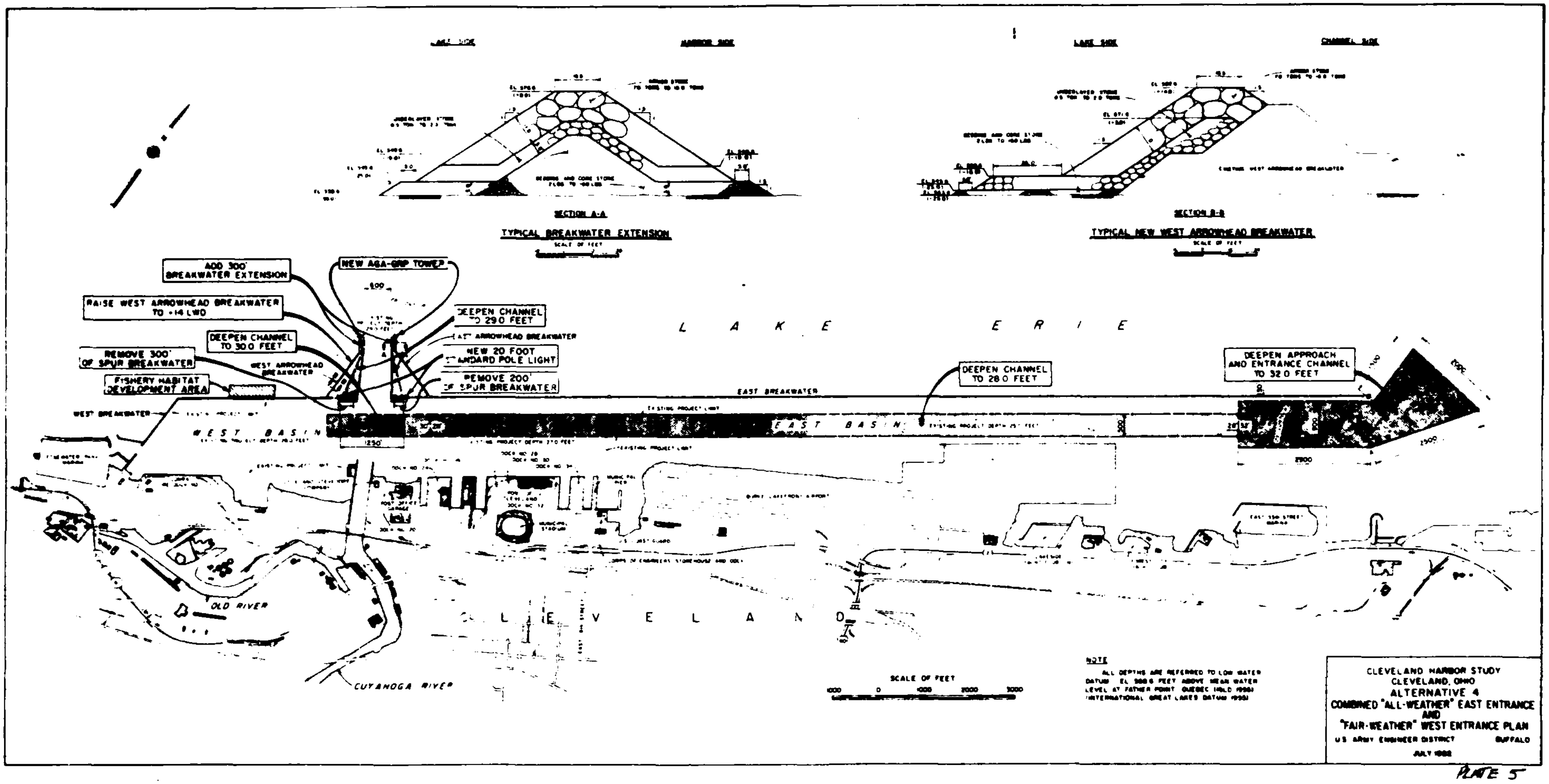
LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
NEW AIDS TO NAVIGATION
ADD 4000 FOOT BREAKWATER EXTENSION
DEEPEN CHANNEL TO 32.0 FEET
REMOVE 600 FEET OF WEST ARROWHEAD BREAKWATER
ADD 1000 FOOT BREAKWATER EXTENSION
NEW 20 FOOT STANDARD POLE LIGHT
ARROWHEAD BREAKWATER
REMOVE 300 FEET OF SPUR BREAKWATER
REMOVE 200 FEET OF SPUR BREAKWATER
FISHERY HABITAT DEVELOPMENT AREA
E R I E
EAST BREAKWATER
WEST BREAKWATER
WEST BASIN
EAST BASIN
DEEPEN TO 28.0 FEET
OLD RIVER
CUYAHOGA RIVER
C L E V E L A N D
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) INTERNATIONAL GREAT LAKES DATUM 1955
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 3 (OPTION A)
"ALL-WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JULY 1982

PLATE 3



CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 3 (OPTION B)
"ALL-WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 4


LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
SCALE OF FEET
LAKE SIDE
CHANNEL SIDE
SECTION B-B
TYPICAL NEW WEST ARROWHEAD BREAKWATER
SCALE OF FEET
ADD 300' BREAKWATER EXTENSION
NEW AGA-GRP TOWER
RAISE WEST ARROWHEAD BREAKWATER TO +14 LWD
DEEPEN CHANNEL TO 29.0 FEET
EAST ARROWHEAD BREAKWATER
DEEPEN CHANNEL TO 30.0 FEET
NEW 20 FOOT STANDARD POLE LIGHT
REMOVE 300' OF SPUR BREAKWATER
WEST ARROWHEAD BREAKWATER
REMOVE 200' OF SPUR BREAKWATER
FISHERY HABITAT DEVELOPMENT AREA
L A K E E R I E
DEEPEN CHANNEL TO 28.0 FEET
DEEPEN APPROACH AND ENTRANCE CHANNEL TO 32.0 FEET
EAST BREAKWATER
WEST BREAKWATER
WEST BASIN
EAST BASIN
EXISTING PROJECT LIMIT
1250'
2900
2500
OLD RIVER
CUYAHOGA RIVER
C L E V E L A N D
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT QUEBEC (IGLD 1955) INTERNATIONAL GREAT LAKES DATUM 1955
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 4
COMBINED "ALL-WEATHER" EAST ENTRANCE
AND
"FAIR-WEATHER" WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982
PLATE 5

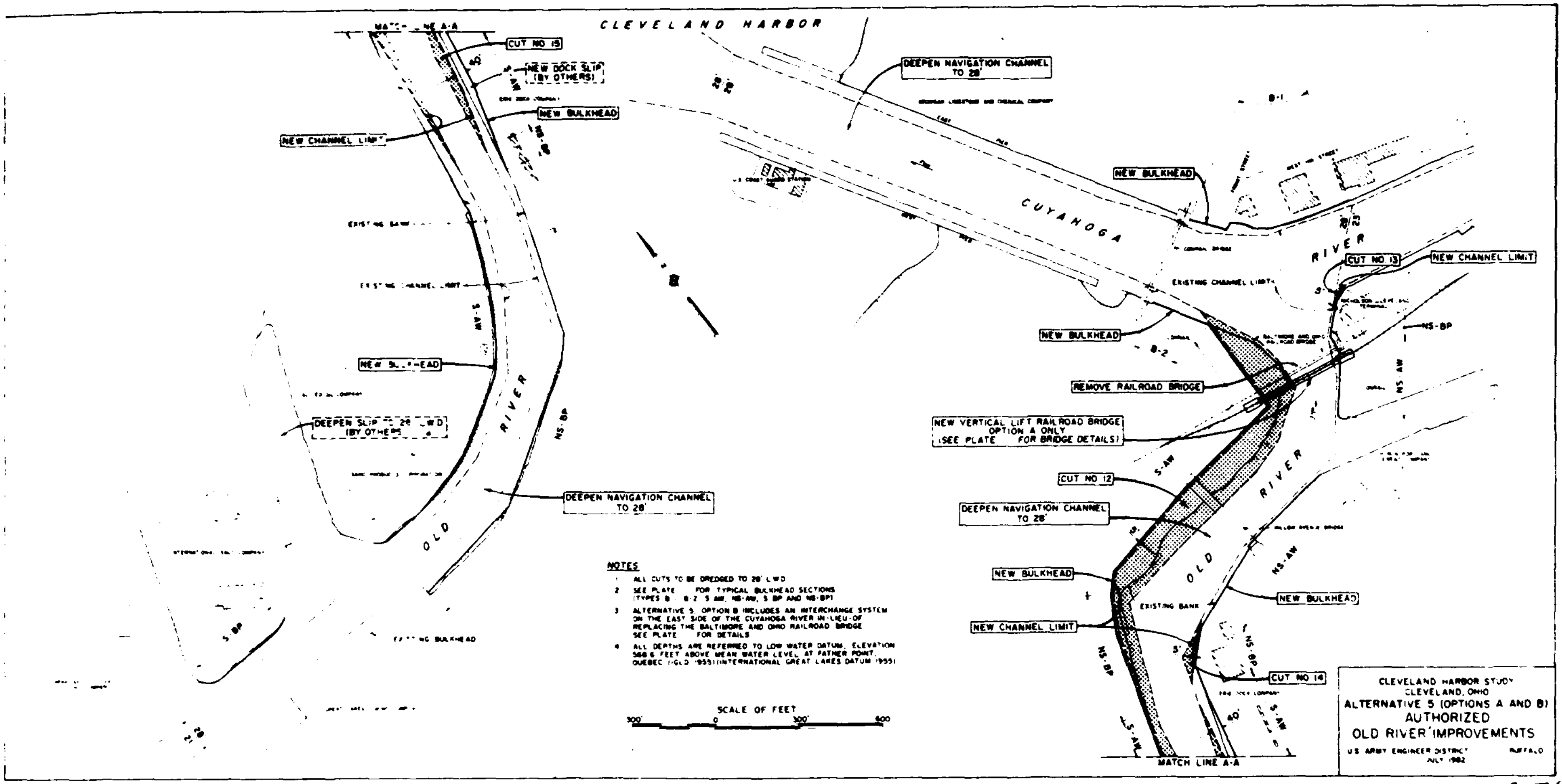
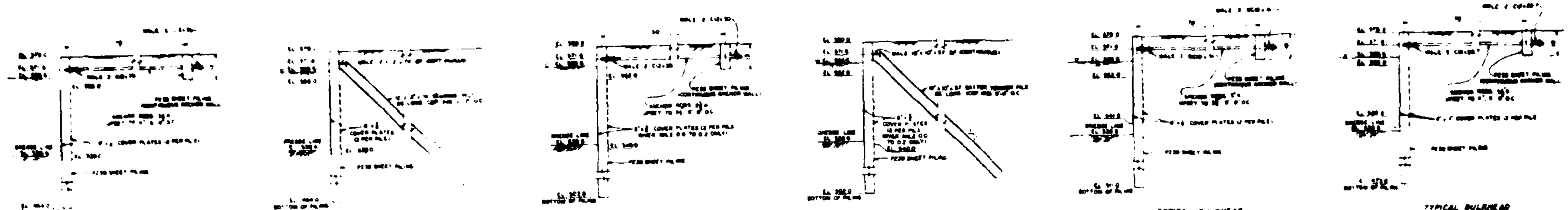

CLEVELAND HARBOR
CUYAHOGA
RIVER
OLD RIVER
MATCH LINE A-A
CUT NO 15
NEW DOCK SLIP (BY OTHERS)
NEW BULKHEAD
NEW CHANNEL LIMIT
EXISTING BANK
EXISTING CHANNEL LIMIT
DEEPEN SLIP TO 28' LWD (BY OTHERS)
DEEPEN NAVIGATION CHANNEL TO 28'
EXISTING BULKHEAD
EXISTING CHANNEL LIMIT
REMOVE RAILROAD BRIDGE
NEW VERTICAL LIFT RAILROAD BRIDGE OPTION A ONLY (SEE PLATE FOR BRIDGE DETAILS)
BALTIMORE AND OHIO RAILROAD BRIDGE
CUT NO 12
CUT NO 13
CUT NO 14
S-AW
NS-BP
NS-AW
S-BP
B-1
B-2
EXISTING BANK
NOTES
1 ALL CUTS TO BE DREDGED TO 28' LWD
2 SEE PLATE FOR TYPICAL BULKHEAD SECTIONS (TYPES B-1, B-2, S-AW, NS-AW, S-BP AND NS-BP)
3 ALTERNATIVE 5, OPTION B INCLUDES AN INTERCHANGE SYSTEM ON THE EAST SIDE OF THE CUYAHOGA RIVER IN-LIEU-OF REPLACING THE BALTIMORE AND OHIO RAILROAD BRIDGE SEE PLATE FOR DETAILS
4 ALL DEPTHS ARE REFERRED TO LOW WATER DATUM, ELEVATION 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955)(INTERNATIONAL GREAT LAKES DATUM 1955)
SCALE OF FEET
300' 0 300' 600
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 5 (OPTIONS A AND B)
AUTHORIZED
OLD RIVER IMPROVEMENTS
US ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 6



TYPICAL BULKHEAD
TYPE S-66

TYPICAL BULKHEAD
TYPE S-BP

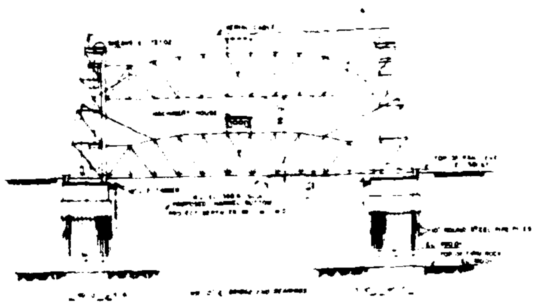
TYPICAL BULKHEAD
TYPE NS-AW

TYPICAL BULKHEAD
TYPE NS-BP

TYPICAL BULKHEAD
TYPE B

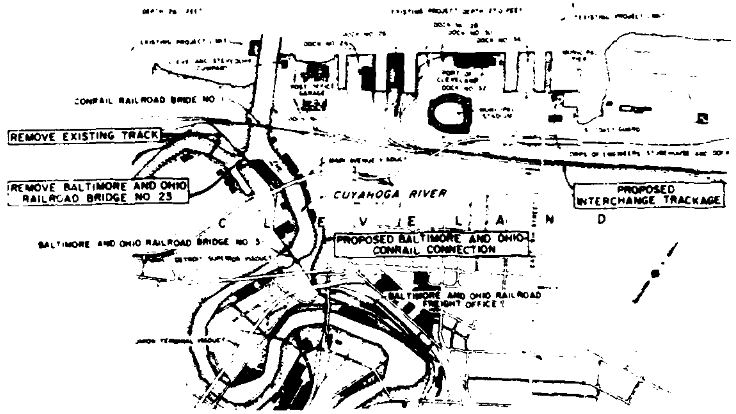
TYPICAL BULKHEAD
TYPE B-T

TYPICAL NEW BULKHEAD SECTIONS



ELEVATION OF PROPOSED VERTICAL LIFT RAILROAD BRIDGE
(ALTERNATIVE 5, OPTION A)

SCALE OF FEET
100 0 100 200



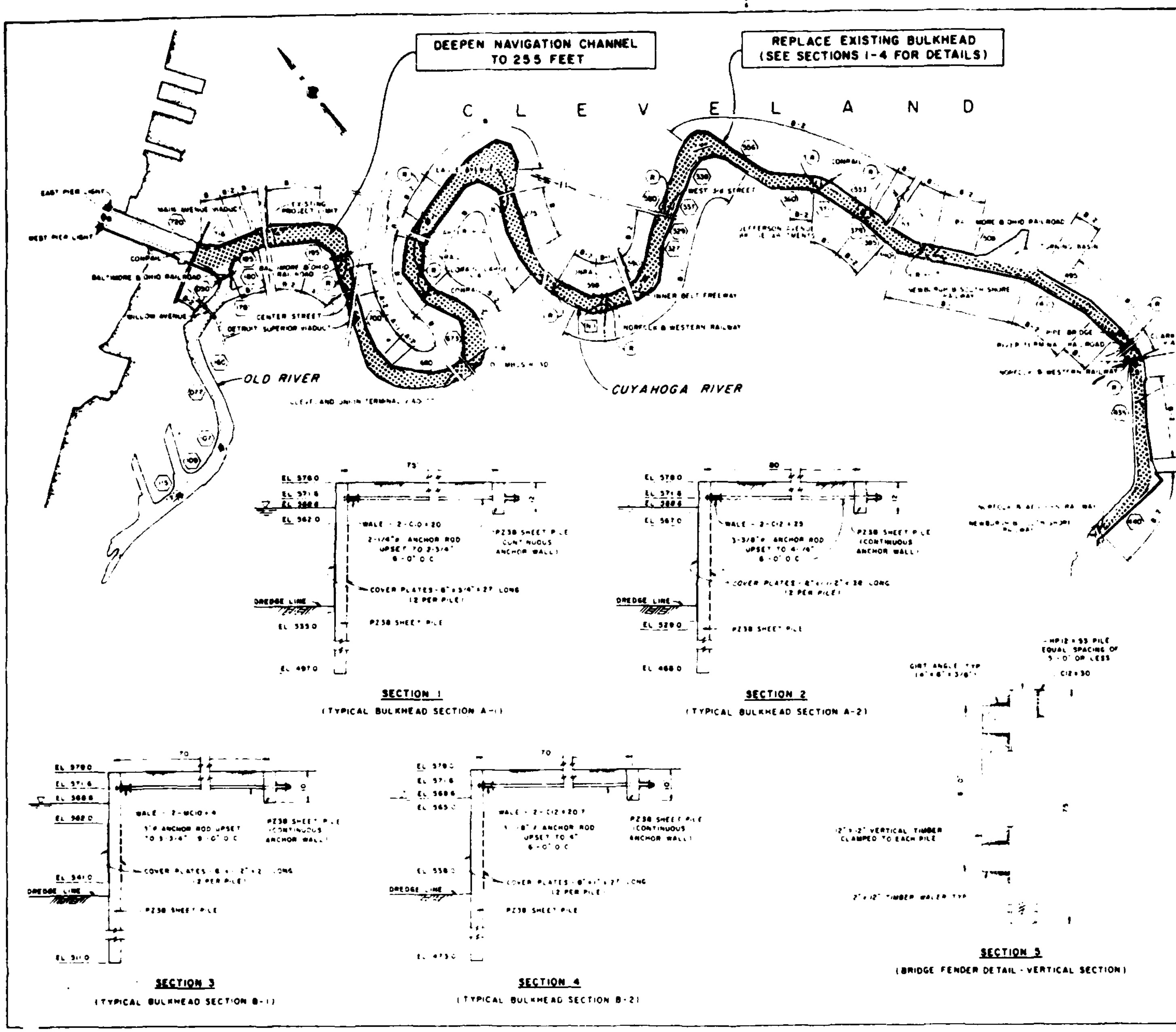
PROPOSED BALTIMORE AND OHIO RAILROAD INTERCHANGE SYSTEM
(ALTERNATIVE 5, OPTION B)

SCALE OF FEET
1000 0 1000 2000 3000

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
TYPICAL SECTIONS
AND INTERCHANGE SYSTEM
FOR ALTERNATIVE 5

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 7



DOCK BY OPERATOR

SHOWN THUS (10)

080 ONTARIO STONE CORPORATION
077 ONTARIO STONE CORPORATION
107 SAND PRODUCTS CORPORATION
109 ASHLAND PETROLEUM CORPORATION
115 INTERNATIONAL SALT COMPANY
16[illegible] ERIE LACKAWANNA ORE
178 HURON CEMENT
180 UNITED STATES STEEL
185 BALTIMORE & OHIO RAILROAD
195 GP SHIPYARD
250 ALPERT BROTHERS
275 MID CONTINENT COAL & COKE
327 CLEVELAND BUILDERS SUPPLY
329 CLEVELAND BUILDERS SUPPLY
337 SHELL OIL
339 TEXACO
360 CLIFTON CONCRETE COMPANY
37[illegible] GULF OIL
378 CLEVELAND BUILDERS SUPPLY
385 EVERLITE HOPPERS
390 C & L CHEMICALS
4[illegible] REPUBLIC STEEL
436 L B L STEEL
440 REPUBLIC STEEL
495 REPUBLIC STEEL
508 DUPONT
530 MARINE FUELING
553 UNITED STATES STEEL
556 UNITED STATES STEEL
580 ONTARIO STONE CORPORATION
590 CLEVELAND BUILDERS SUPPLY
598 FORD MOTOR COMPANY
673 MEDUSA CEMENT
680 CUYAHOGA LIME COMPANY
700 CEREAL FOOD PROCESSORS
716 ALPHA CEMENT
720 LAKE ERIE ASPHALT PRODUCTS DOCK 20

LEGEND

20 MILES ABOVE WEST PIER LIGHT AT OUTER END OF WEST PIER.

(R) BRIDGES REQUIRING FENDER REPLACEMENT DUE TO RIVER DEEPENING (SEE SECTION 5 FOR DETAILS)

UTILITY REQUIRING RELOCATION DUE TO RIVER DEEPENING

[N-1] WESTERN UNION TEL. - 4-4" PIPES

NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 6 (OPTION A)
DEEPEN CUYAHOGA RIVER
TO 25.5 FEET

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 8

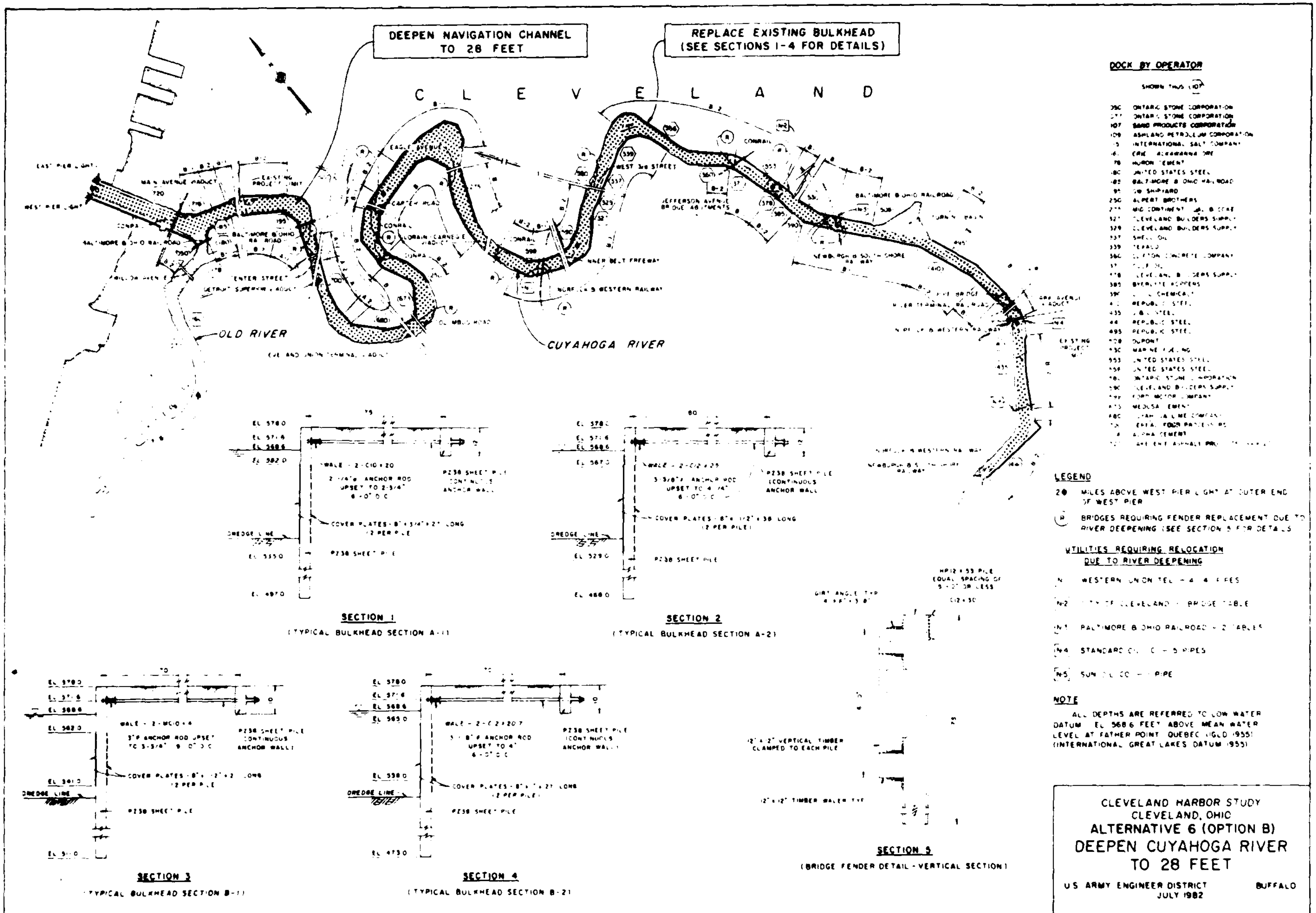
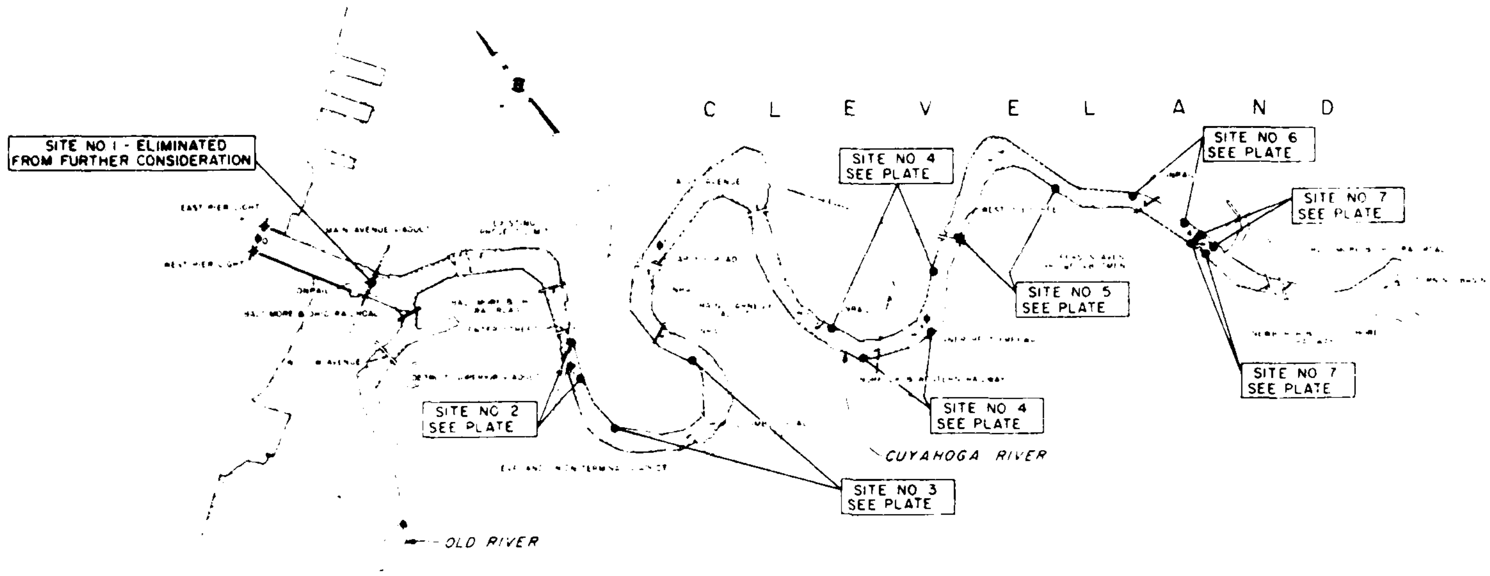
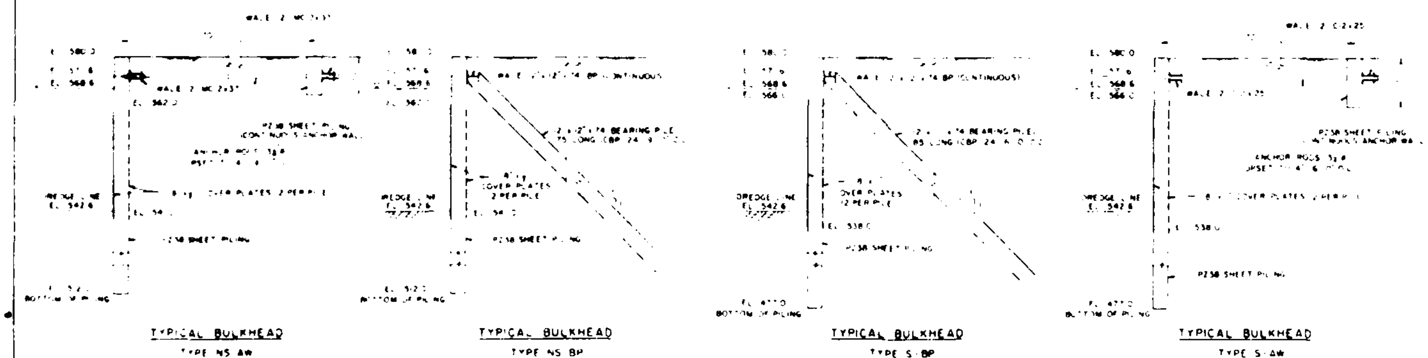

DEEPEN NAVIGATION CHANNEL TO 28 FEET
REPLACE EXISTING BULKHEAD (SEE SECTIONS 1-4 FOR DETAILS)
CLEVELAND
OLD RIVER
CUYAHOGA RIVER
DOCK BY OPERATOR
LEGEND
BRIDGES REQUIRING FENDER REPLACEMENT DUE TO RIVER DEEPENING (SEE SECTION 5 FOR DETAILS)
UTILITIES REQUIRING RELOCATION DUE TO RIVER DEEPENING
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)
SECTION 1
(TYPICAL BULKHEAD SECTION A-1)
SECTION 2
(TYPICAL BULKHEAD SECTION A-2)
SECTION 3
(TYPICAL BULKHEAD SECTION B-1)
SECTION 4
(TYPICAL BULKHEAD SECTION B-2)
SECTION 5
(BRIDGE FENDER DETAIL - VERTICAL SECTION)
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 6 (OPTION B)
DEEPEN CUYAHOGA RIVER
TO 28 FEET
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 9



CONGESTION AREAS UNDER CONSIDERATION



TYPICAL NEW BULKHEAD SECTIONS

LEGEND

MILES ABOVE WEST PIER LIGHT AT OUTER END OF WEST PIER SHOWN THUS 2◆

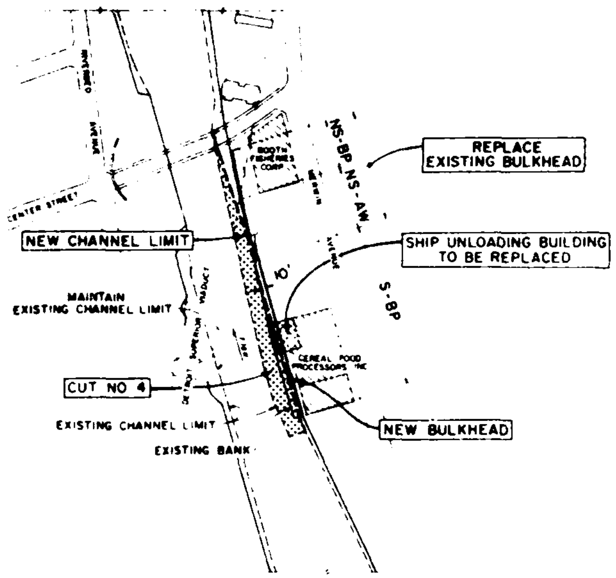
NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT QUEBEC (I.G.L.D. 1955) INTERNATIONAL GREAT LAKES DATUM 1955

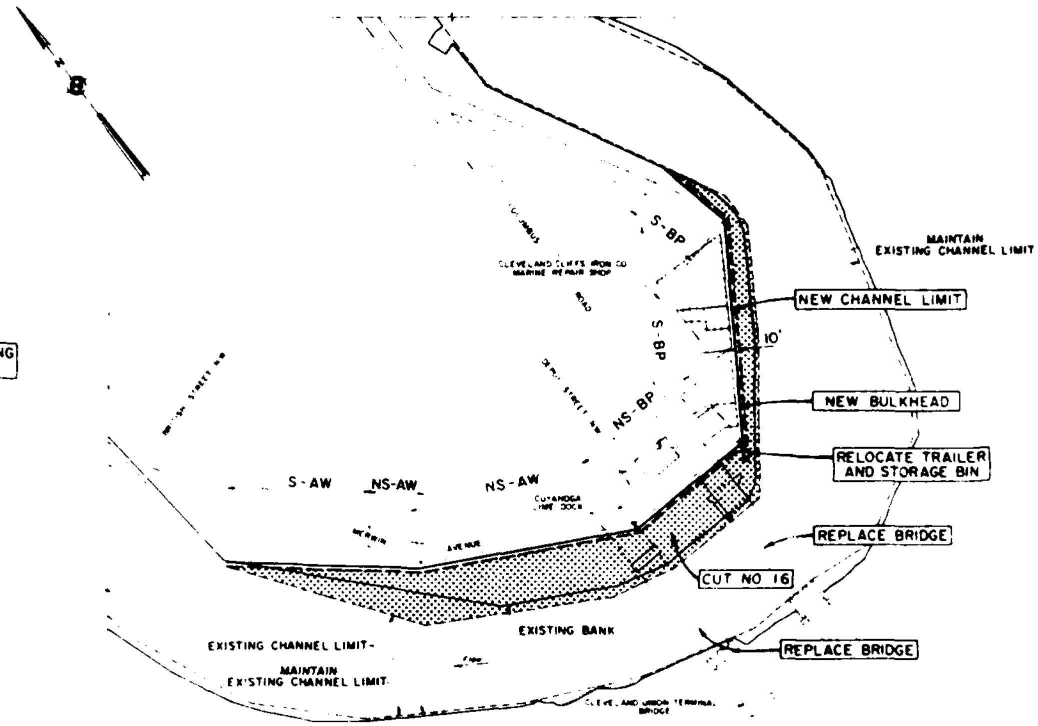
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
INDEX MAP AND
TYPICAL BULKHEAD SECTIONS
FOR ALTERNATIVE 7

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 10



SITE NO. 2
(ALTERNATIVE 7, OPTION B)



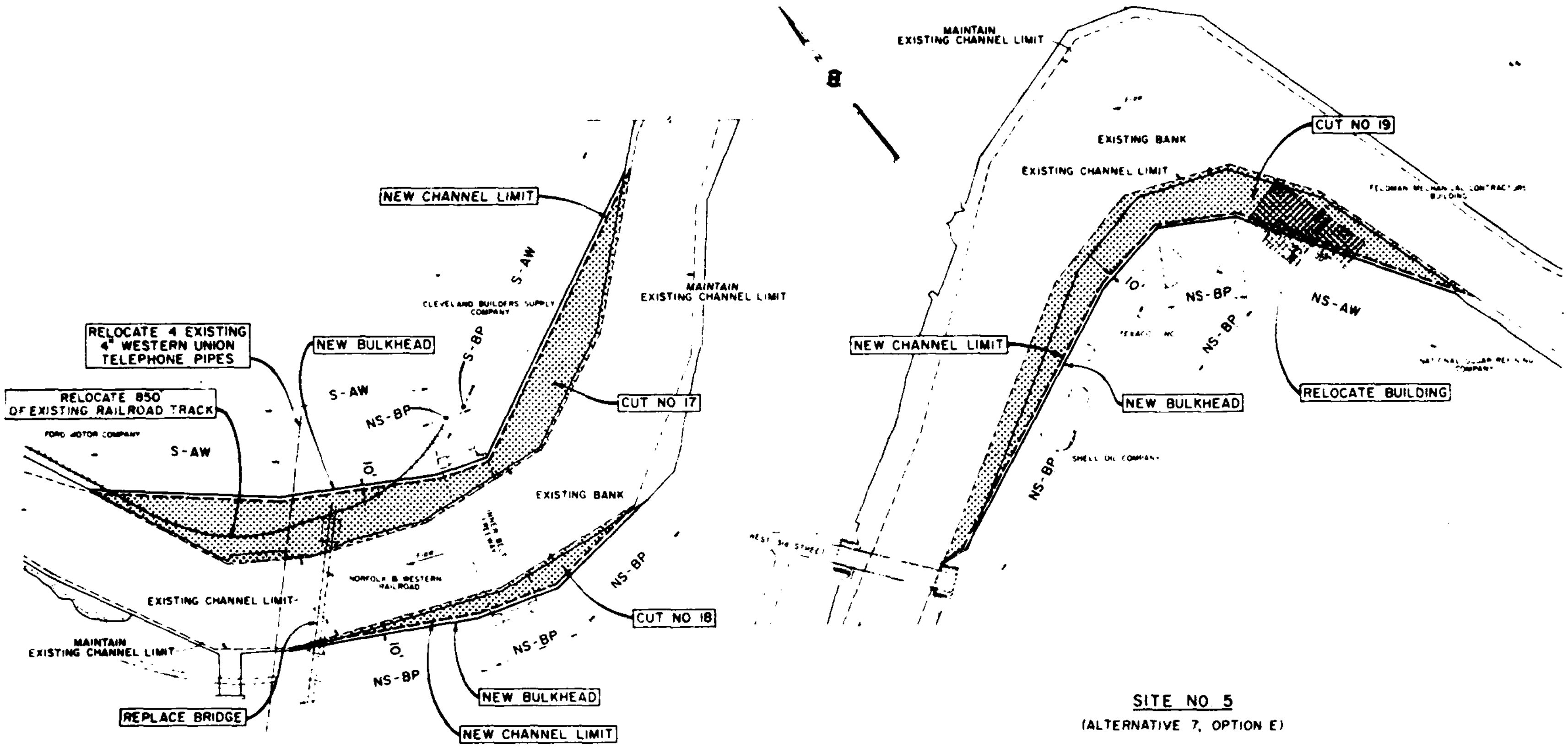
SITE NO. 3
(ALTERNATIVE 7, OPTION C)

NOTES
1. SEE PLATE FOR TYPICAL BULKHEAD SECTIONS (TYPES S-AW, NS-AW, S-BP AND NS-BP)
2. ALL CUTS TO BE DREDGED TO 23 FEET LWD

SCALE OF FEET
300' 0 300' 600'

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 7 (OPTIONS B AND C)
REDUCE RIVER CONGESTION
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 11



SITE NO. 4
(ALTERNATIVE 7, OPTION D)

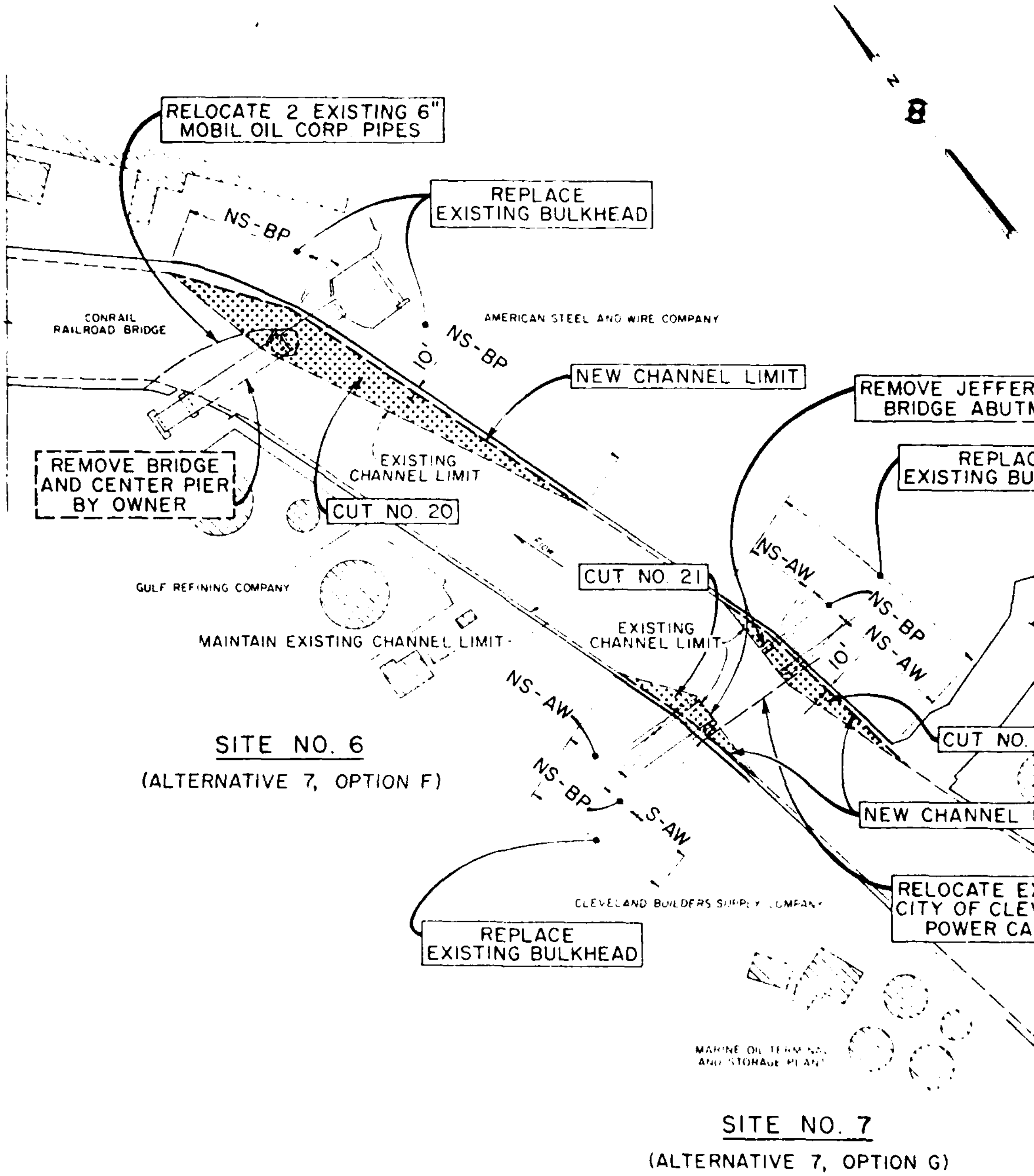
SITE NO 5
(ALTERNATIVE 7, OPTION E)

NOTES
1. SEE PLATE FOR TYPICAL BULKHEAD SECTIONS (TYPES S-AW, NS-AW, S-BP AND NS-BP)
2. ALL CUTS TO BE DREDGED TO 23 FEET LWD

SCALE OF FEET
300' 0 300' 600'

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 7 (OPTIONS D AND E)
REDUCE RIVER CONGESTION
US ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 12



NOTES:

1 SEE PLATE FOR TYPICAL BULKHEAD SECTIONS (TYPES S-AW, NS-AW, S-BP AND NS-BP)

2 ALL CUTS TO BE DREDGED TO 23 FEET LWD

SCALE OF FEET

300' 0 300' 600'

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

ALTERNATIVE 7 (OPTIONS F AND G)

REDUCE RIVER CONGESTION

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 13

Cleveland Harbor Study
Summary Minutes of 24 February 1983
Workshop Meeting
Cleveland-Cuyahoga County Port Authority Office
Cleveland, OH

1. A meeting on Cleveland Harbor was held on 24 February 1983 at the Cleveland Port Authority's office, Cleveland, OH, to develop vessel storm and/or transit delays that would be eliminated if the proposed East Entrance modification plan was implemented. A copy of this plan is attached as Enclosure 1. Storm delays are defined as those delays caused when vessels will not attempt a harbor entry during storm conditions because of the configuration and/or depth of the existing harbor entrances. Transit delays are defined as the additional time required by vessels arriving from or departing to the east that are forced to use the west (main) entrance due to inadequate channel depth in the eastern basin. The names of those persons in attendance are shown on Enclosure 2.

2. Mr. Charles Larsen opened the meeting at 9:00 a.m. by welcoming all meeting participants and reviewing the purposes of the meeting. Following introduction of the meeting participants, Mr. Larsen turned the meeting over to Mr. Richard Aguglia.

3. Before addressing the main purposes of the meeting, Mr. Aguglia gave a brief update on the studies of the two commercial navigation plans on the Cuyahoga River that were carried forward into the detailed study phase: Plan 7G (Remove Jefferson Avenue Bridge Abutments) and Plan 11 (Deepen Turning Basin). Based on a detailed review of as-built drawings for bulkheads in the vicinity of the Jefferson Avenue bridge abutments, it now appears that only a relatively small section of the existing bulkheads would have to be replaced if the navigation channel was widened following removal of the abutments. This will significantly reduce the cost of Plan 7G and it is anticipated that the resultant benefit/cost ratio will be greater than 1. However, the District is still waiting to hear from local shipping companies concerning benefits due to this plan (cumulative wear and tear on vessels caused by striking the abutments that would be eliminated if Plan 7G was implemented). Mr. George Ryan of Lake Carriers Association agreed to assemble the requested information and provide the District with an industry-wide response. In regards to Plan 11, a recently completed analysis of the existing bulkheads lining the turning basin has indicated that, if the turning basin was deepened from its present depth of 18 feet to 23 feet, the bulkheads would become unstable. Thus, replacement of these bulkheads will have to be included as a plan component. Although a cost estimate for this plan has not been completed, it is anticipated that the cost of the bulkhead replacement and deepening would be in the range of $8 to $10 million and the plan would not be economically feasible (ie; benefit-cost ratio less than 1.0). Captain Jacobsen asked about the status of the plan to remove Conrail Bridge No. 14 at river mile 4.0 (the former Erie-Lackawanna Bridge). Mr. Aguglia replied that this authorized but uncompleted improvement project is currently classified as deferred but that Mr. Tom Burke had indicated his intent to request the project be reactivated. When this request is received, the Buffalo District will initiate action requesting reclassification to the

active category and pursue construction under its original authorization. However, construction of the project could not begin until Conrail officially abandons the bridge and removes the superstructure and center pier. Mr. Aguglia also noted that a reevaluation of this authorized plan during the preliminary stage of the Cleveland Harbor study indicated that this project was still economically viable under present-day conditions.

4. Mr. Aguglia then briefly reviewed the East Entrance plan (see Enclosure 1) and stated that two aspects of this plan will be investigated during detailed planning: the required entrance channel depth and the effect of various economic study assumptions on project feasibility. Vessel motion model tests will be conducted at the Corps Waterways Experiment Station during the week of 11 April 1983. These tests will involve subjecting a dynamically balanced 1,000-foot, 1:100 scale model ore carrier to various wave spectra and measuring the degree of roll the vessel experiences in a shallow water environment. We will also attempt to qualitatively measure the effect of various underkeel clearances on vessel maneuverability. In regards to these tests, Mr. Aguglia requested that local shipping companies provide vessel masters to aid in conducting these tests. Both Hanna Mining Company and American Steamship Company agreed to this request. Mr. Aguglia also stated that at various past workshop meetings, local shipping companies and vessel masters stated that a 32-foot entrance channel depth was required for the East Entrance plan. If the shipping industry still feels that a 32-foot entrance channel depth is required, letters from the industry supporting this position would be helpful. These letters, along with the results of the vessel motion tests and other pertinent factors would then be considered in selecting the entrance channel depth to recommend for construction.

5. Mr. Aguglia then stated that the second aspect to be investigated during the detailed study phase for Plan 1 is the effect of various economic study assumptions on project feasibility. During the preliminary study phase, benefits were credited to Plan 1 for allowing 1,000-foot vessels to safely operate in the Lakefront Harbor (i.e; the transportation savings gained by using a 1,000-foot vessel in lieu of a maximum 730-foot vessel) and for deepening (i.e.; transportation savings gained as a result of loading vessels deeper than present conditions safely allow). Since 1,000-foot vessels have recently been operating at Cleveland Harbor on a semi-regular basis and high lake levels have permitted greater vessel drafts, an alternate economic analysis will be conducted during the detailed study phase. This alternate economic analysis will only take into account vessel storm and/or transit delays that would be eliminated if Plan 1 was implemented. It would represent a "worst-case" or most conservative measure of the plan's economic impact. The main purpose of this workshop meeting is to solicit information from the harbor users regarding these storm and/or transit delays for the domestic shipping industry. Similar information was previously provided by the Lakes Pilots Association in regards to foreign flag vessels calling at Cleveland Harbor (see Enclosure 3).

6. Mr. Aguglia then led a general discussion on storm and/or transit delays that would be eliminated for the domestic shipping industry if Plan 1 was implemented. Main points of this discussion are as follows:

a. Plan 1 would not eliminate storm delays for vessels going up the Cuyahoga River due to the difficulty of making the required left hand turn into the river channel. They would, however, gain an intangible safety benefit by being able to enter the harbor and lay behind the east breakwater during storm conditions.

b. Plan 1 would eliminate storm delays for vesels docking in the Lakefront Harbor, primarily the C & P ore dock for the domestic iron-ore trade. Presently, it is estimated that 1,000-foot vessels cannot enter the Lakefront Harbor (west entrance) when winds exceed 20 knots from the west thru east-northeast directions and smaller vessels (Class V through Class VII) canot enter when winds exceed 25 knots from the same directions. If Plan 1 was implemented, these vessels would be able to enter the Lakefront Harbor in winds up to 30 knots, the limiting wind speed for operation of the C & P ore dock. The average delay time that would be eliminated would be 15 hours per storm event.

c. Based on vessel logs, Oglebay Norton Company had two vessels delayed because of weather while attempting to enter Cleveland Harbor during the 1981 navigation season out of a total of 112 vessel trips and no delays in 1982 with 88 vessel trips (see Enclosure 4). American Steamship Company, over the last 4 years (1979-1982), has made about 1,600 trips into Cleveland Harbor. Of these 1,600 trips, 56 trips, or, about 4 percent of the total trips, were delayed due to weather. Total delay time was 876 hours, or, about 16 hours per delay event. However, a portion of these delays were caused by high river current which would not be affected by implementation of Plan 1. Cleveland Cliffs made about 300 trips into Cleveland Harbor in 1979 and experienced a total of 78 hours of delay time due to bad weather conditions. About 10 percent, or 6 hours, was due to use of the east entrance while exiting the harbor since storm conditions made the west (main) entrance unusable. It should be noted that since these companies operate up the Cuyahoga River, implementation of Plan 1 would not eliminate these vessel storm delays. However, they are indicative of the present delays experienced by bulk cargo vessels at Cleveland Harbor.

d. If Plan 1 was implemented, a transit savings of 1 hour would be gained for vessels arriving from or departing to the east in lieu of using the west (main) entrance as is the current practice due to inadequate channel depth in the east basin.

e. Mr. George Ryan of the Lake Carriers Association will provide the District with a letter summarizing these points.

7. Mr. Pat Manley stated that when Republic was investigating the possibility of constructing an iron ore transshipment facility in Cleveland, they had discussions with Captains McSweeney and Alton Allen concerning entering Cleveland Harbor in 1,000-foot vessels. Both captains indicated that the east entrance was the preferable entrance point for all 1,000-footers

entering the harbor. Mr. Manley also stated that Republic would not have placed 1,000-foot vesels into operation at Cleveland Harbor without an East Entrance modification plan in place.

8. Captain Davies asked about the status of the authorized but uncompleted project opposite the Cereal Foods' grain mill adjacent to the Cuyahoga River (Bank Cut No. 4). Mr. Aguglia replied that, based on a reanalysis of this authorized plan during the preliminary study phase, the project was still economically justified under present-day conditions. However, at the request of the Port Authority and the Lake Carriers Association, the project will remain in the inactive category until the ultimate disposition of the grain mill, which local interests claim is in a state of disrepair, is known.

9. Mr. Larsen then thanked all participants for their input and adjourned the meeting at 11:00 a.m.

Richard Aguglia

RICHARD AGUGLIA
Project Manager

4 Enclosures
as stated

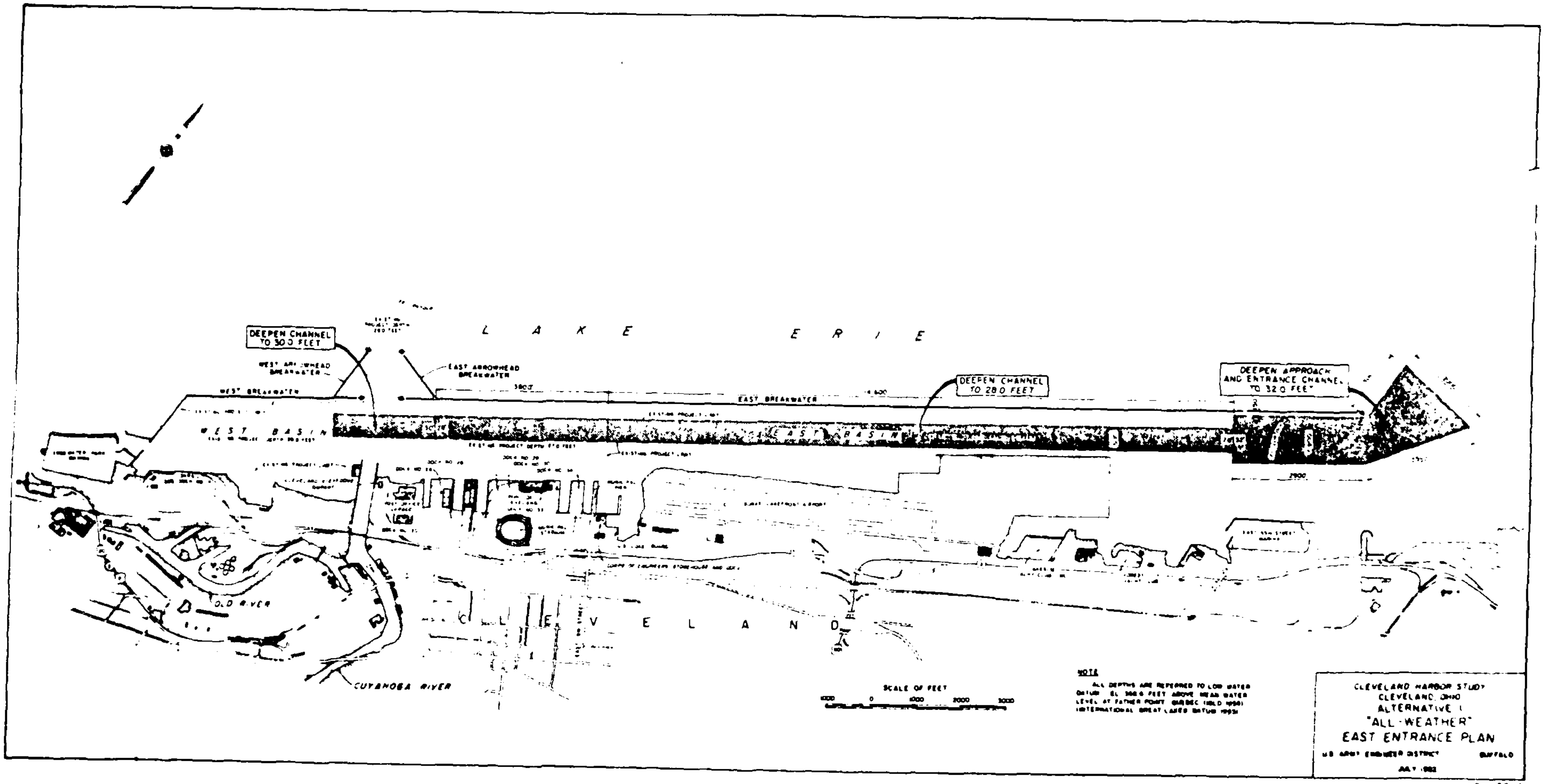


PLATE 6

Incl 1

Cleveland Harbor Study
Summary Minutes of 24 February 1983
Workshop Meeting
Cleveland-Cuyahoga County Port Authority Office
Cleveland, Ohio

Attendance

Name	Organization
Tom Burke	Cleveland-Cuyahoga County Port Authority
George Ryan	Lake Carriers Association
Edgar Jacobsen	Oglebay Norton Co.
W.J. Rohn	Cleveland-Cliffs Iron Co.
Steve Davis	Kinsman Lines, Inc.
Robert Wright	Hanna Mining Co.
G.V. Chamberlain	"
Jim Wager	American Steamship Co.
Ron Hostelley	Republic Steel Corp.
Patrick Manley	" " "
Victor Anderson	Lakes Pilots Association
Bill McTaggort	Congresswomen Mary Rose Oaker's Office
Joseph Kohonoski	Howard Needles Tammen and Bergendoff
Bob St. Aubyn	Maritime Administration
Robert Gasior	9th Coast Guard District
Ralph Bernhagen	Ohio Department of Natural Resources
Charles Larsen	Corps of Engineers
Mike Pelone	"
Richard Gorecki	"
Tom Switala	"
Dick Aguglia	"

t Incl 2

LAKES PILOTS ASSOCIATION, INC.
P. O. Box 902
PORT HURON, MICHIGAN 48060

Phone AREA CODE 313 984-2541

January 7, 1983

Colonel Robert R. Hardiman
U.S. Army Corps of Engineers
Buffalo District
1776 Niagara Street
Buffalo, N.Y. 14207

Dear Colonel Hardiman:

The Great Lakes Pilots Association requests that the following information be considered by the Buffalo District, Corps of Engineers in the development of their recommendations for improvements at Cleveland Harbor, OH. Although a number of improvements have been considered by your agency, we believe that modifications to the existing east entrance would be most beneficial to foreign flag vessels which utilize the public docks in the Outer Harbor. An outline of the expected benefits of a modified east entrance channel follow:

a. Reduction in transit time per trip of one hour when ships are loaded to a draft of 25' or greater when arriving from or departing to the east.

b. Storm-related vessel delays (caused because ships will not attempt a harbor entry when winds are greater than 20 knots from the SSW to NE directions due to restrictive existing harbor entrances) can range from 12 hours duration in the spring months (April and May) to a maximum of 72 hours in the fall months (October, November and December). An overall average vessel delay of 15 hours per occurrence for each vessel affected would be representative of expected annual benefits. Delays would be eliminated when wind speeds vary between 20-40 knots and originate between the south-southwest through northeast compass headings if the east entrance were modified.

c. Another intangible benefit expected is the assurance that, whichever direction the bow of a vessel turns to when leaving a lakefront slip, either harbor exit location (east or west) could be utilized. Reliance upon the existing west arrowhead opening only frequently requires tug-assistance expenses, tug-related delays or additional vessel maneuvering times before proper positioning of the vessel is

Incl 3

LAKES PILOTS ASSOCIATION, INC.

P. O. Box 902

PORT HURON, MICHIGAN 48060

Phone AREA CODE 313 984-2541

accomplished which would be eliminated if the east entrance was modified.

The Association would also like to identify an unmet need of most foreign flag vessels. Dredging of a triangular area east of the port authority docks should be considered by the Corps in order to facilitat safe and obstructed approach/exit to the docks in the Outer Harbor. This area is shown on the attached project map. Increased use of the east entrance channel and the greater need to make a left turn into the lakefront slips is the basis for the additional dredging.

Existing authorized depths in the east entrance channel of 25' at low water datum precludes entry of a Seaway draft vessel despite high water levels for Lake Erie. Vessel charter contract terms commonly specify terms such as "free afloat" and "safe berthing". These contractual restrictions, and a concern for maritime liability on the part of the Pilot's Association, prevent use of available water depths over and above authorized depths. Our Association believes that your recommendation should be a 32' entrance channel depth at LWD to accomodate all possible ship motions (roll,pitch,heave,etc.) when entering during storm conditions and wind speeds between 20 to 40 knots Cleveland Harbor should also be considered unique among Great Lakes Harbors due to its exposed location and because ships would attempt to enter under heavier sea conditions relative to other Lake Erie/ Great Lakes ports with a modified east entrance in place.

Thank you for the opportunity to provide information about our concerns for modifications of Cleveland Harbor.

H.E. MacDermid

H.E.MacDermid, President
Lakes Pilots Association, Inc.

Victor H. Anderson

Victor H. Anderson,Chairman
Navigation Committee

CLEVELAND HARBOR STUDY

Oglebay Norton Company during the 1981 navigation season had 112 vessel arrivals in Cleveland. Entrances were made with the highest wind velocity logged being 24 knots at 290°.

Twice ship's elected not to enter the harbor until the wind subsided. One occasion on May 6, the wind velocity of 28 knots at 025° the vessel anchored at Pigeon Bay for 12 hours. On June 25, the same vessel anchored off Cleveland for 1 hour and 35 minutes. At that time, the velocity was 30 knots and gusting to 38 knots at 223°.

During the 1982 season, we had 88 arrivals, the earliest April 17 and the last November 26. The highest wind recorded by vessels entering the harbor was 26 knots out of the north. No ships were delayed because of weather.

All entrances were made through the main entrance, except two through the east entrance on vessels coming from Buffalo.

Incl 4

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBED-PW	Cleveland Harbor Phase I GDM - Meeting with Cleveland - Cuyahoga County Port Authority

~~TO~~ THRU: Ch, Engr Div
District Engr

FROM Chief, Western Basin DATE 5 Mar 80 CMT 1
Zorich/ml/2261

TO: Project Files

1. Subject meeting was held at the offices of the Port Authority on Tuesday 26 February 1980 at the request of Albert Bernstein. A list of meeting attendees is attached.

2. Mr. Bernstein made introductory remarks welcoming and thanking all for their attendance. He stated his interest in establishing the direction the Corps was going with the Cleveland Harbor study and turned the meeting over to Colonel Johnson to brief the group on past and future activities on the study.

3. Colonel Johnson noted we are on schedule with the study according to the 2 - phase authorization from Section 175 of the 1976 WRDA. The major problem with accomplishing our authorizing directive is the controversy that exists between local interests regarding the East or West entrance to Cleveland Harbor as the "main entrance" for the proposed modified harbor project. At the most recent meeting of 19 December 1979 with locals, there was strong concern that we not sacrifice the possibility of improvements to the West Entrance by indiscriminate concentration on improvements to the East Entrance. Considerable discussion at the 19 December meeting centered on various revisions of legislation now in Congress and changes that might be suggested to preclude total concentration on the East Entrance. Colonel Johnson interjected that maybe the group should separate their short-term goals (apparently improvements to the East Harbor because it provides the shortest time-frame to construction) from their long-term goals. What we need to know from local interests are their long-term objectives and futures for Cleveland.

4. Mr. Bernstein noted that when the previous studies were done (Feasibility Study in 1976-77), it seemed that locals were in unanimous agreement for improvements to the East Entrance. Now we're back to various factions opting for East or West Entrance.

5. Bill Calfee, Authority Counsel, stated that we must identify the particular interests at Cleveland Harbor in order to establish specific needs. These interests are:

a. Shippers

b. Lake Carriers

c. Unions - Don't know their position.

d. Port Authority Board - Interested in developing port for steel industry as much as anything. Are interested in having Dock 20 for bulk commodity transshipments.

e. Conrail - Don't know what they have in mind.

f. National Steel (Hanna) - Also don't know what they propose for C & P Dock.

His impression was that the 19 December meeting was on straightening the river and not concerned about the entrance. The meeting centered on the entrance controversy and feels we are now back to point "zero". He also interprets that Corps wants to go with East Entrance and is concerned that we aren't moving ahead with that project.

EXHIBIT G-7

NCBED-PW
SUBJECT: Cleveland Harbor Phase I GPM - Meeting with Cleveland - Cuyahoga County Port Authority

6. Colonel Johnson stated his surprise that the Port Authority did not state its concern about the entrance question at the 19 December meeting.

7. Jack Hively provided his impression of the 19 December meeting stating that Admiral Trimble noted the changed condition at Dock 20 with Republic's decision to go to Lorain, and with the need for immediate improvements eliminated, we should look at the West Entrance option closer. The Port Authority supported the East Entrance. Mr. Hively stated he didn't know Cleveland Growth Assn. (F. Unger and J. Stanton) position on the entrance.

8. Don Liddell provided his recollection of the 19 December meeting. Corps stated we would probably be oriented toward the plan that provides the greatest net benefits and strongest B/C ratio. The information we have indicates the East Entrance most probably meets these criteria. Corps will look at the most promising West Entrance configurations, but we don't think massive (costly) changes are warranted based on the cost of East Entrance improvements. Colonel Johnson noted that there appeared to be a unanimous preference for the West Entrance option at the 19 December meeting, if there would be no cost constraints. Position seemed to be why move fast for East Entrance when there is no time constraint with Republic opting for Lorain. Jack Hively stated that although there is not a time crunch now, the Port Authority still supports the East Entrance until additional information and considerations changes the situation, and the Port Authority as local cooperator is now involved in coordination with the Corps and industry. Regarding the 19 December meeting, Don Liddell noted that there is a difference of opinion on the preferred entrance among users - apparently the shipper-users and Lake Carriers want the West Entrance because it provides the shortest distance to the docks while the ship masters preferred the East Entrance. The fact four or five 1,000 footers have entered Cleveland Harbor last year can possibly change the "base case" to 1,000 footers, thus reducing the project benefits. Therefore, if we go ahead and construct the East Entrance, it may be that there would be insufficient excess benefits to do much at the West Entrance.

9. Colonel Johnson on Corps Activities. We are proceeding assuming that we don't have authorization to construct the East Basin. This means we're proceeding along the "long route" to construction. If we get construction authorization, the East Basin Entrance could be constructed in 1-1/2 to 2 years, but such action would preclude major modifications to the West. Colonel Johnson further noted that if the construction authorization isn't forthcoming, this would allow the local sponsor (Port Authority) sufficient time to reevaluate the desired Entrance location. Jack Hively said the Port Authority will contact industry and other affected interests with the goal of getting a unified position on Entrance preference from the Port Authority based on input obtained. Colonel Johnson then asked the Port Authority to obtain information from industry on its plans to build transsphipment. This information will be of value on our reevaluation of project benefits. He also stated that if the Port Authority opts for the East Entrance, the Port Authority should provide the rationale for this selection since the development in conjunction with Republic Steel is no longer viable.

10. Sheldon Schecter asked if the Corps prefers the West Entrance at this time. Colonel Johnson responded that we have no preference and we can't decide until we get the Port Authority's position based upon industry input and reevaluate the project economics.

11. Vic Anderson of the Lake Pilots Association stated his concern that the Assn. hadn't been contacted to see if they would be interested in testing the ship model at WES. The

NCBED-PW
SUBJECT: Cleveland Harbor Phase I GDM - Meeting with Cleveland - Cuyahoga County Port Authority

Association would like to be given consideration for assisting with the testing. Don Liddell agreed that this is a worthwhile suggestion and we would be contacting LCA on this matter. The Corps would prefer a Master who has operated 1,000-footers for this work. Don Liddell then briefed the group on the status of the model study at WES.

12. Mr. Bernstein closed the meeting at about noon and thanked all for attending and participating.

John Zorich
JOHN ZORICH
Chief, Western Basin

1 Incl
as

LIST OF ATTENDEES

Jack Saive	Cleveland Builders Supply
Bill McTaggart	Cong. Mary Rose Oakar
Ladd J. Anthony	US Senator Metzenbaum
Barbara J. Perry	US Senator John Glenn
Col. George P. Johnson	U.S. Army Corps of Engineer
Donald M. Liddell	Corps of Engineers, Buffalo
John Zorich	Corps of Engineers, Buffalo
John D. Baker	ILA
Vic H. Anderson	Lake Pilots Assoc.
Robert F. Selgan	ILA
Albert W. Bernstein	CCCPA
Martin J. Hughes	CCCPA
Sheldon D. Schecter	CCCPA
William L. Calfee	CCCPA Legal Counsel (Bakeo & Hastetlec)
John Riley	Charles A. Vanik's Office
Jack R. Hively	CCCPA
Anthony J. Russa	CCCPA
John J. Desmond	CCCPA
Harry D. Gard	CCCPA
Jill J. Hazel	CCCPA
Mary C. Sherman	CCCPA

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NCBED-PW	Summary Minutes of Meeting with Ninth Coast Guard District - Cleveland Harbor Phase I GDM Study

TO Project Files FROM R. Aguglia DATE 24 Sep 81 CMT 1
Aguglia/ds/2263

1. On 16 September 1981 representatives of the Buffalo District and Ninth Coast Guard District met to discuss required aids to navigation for the various Outer Harbor improvement plans under consideration in the subject study. These improvement plans would provide for safe and efficient operation of 1,000-foot bulk cargo vessels at Cleveland Harbor. The following people were in attendance:

Lt. Craig Schnappinger - Ninth Coast Guard District
Robert Gasior - Ninth Coast Guard District
Richard Gorecki - Corps of Engineers
Richard Aguglia - Corps of Engineers

2. Based on discussions at this meeting, it was determined that the following aids to navigation would be required for the various plans under consideration. "Ball-park" estimates (on September 1981 price levels) for the first cost of construction and annual operation and maintenance costs were also developed. These estimates are considered reasonable for the current Stage 2 level of study.

a. Alternative Plan No. 1 ("All-Weather" East Entrance Plan - see Incl 1): No additional aids to navigation would be required and there would be no increase in annual operation and maintenance costs.

b. Alternative Plan No. 2 ("Fair-Weather" West Entrance Plan - see Incl 2): The existing aids to navigation on the end of the east and west arrowhead breakwaters will remain. New AGA - GRP Towers will be placed on the end of each new breakwater extension, at a cost of $50,000 each (including foundation). The existing aids to navigation on the ends of the spur breakwaters will be relocated, if the lights are in good shape. If the lights are not in good shape, new 20-foot standard pole lights will be required at the end of each spur, at a cost of $20,000 each (including foundation). For the Stage 2 estimate, assume new lights will be required. The total increase in maintenance and operation costs will be $500/year.

c. Alternative Plan No. 3 ("All-Weather" West Entrance Plan - see Incl 3): The existing aids to navigation on the ends of the spur breakwaters will be relocated, if the lights are in good shape. If not, new 20-foot standard pole lights will be required at the end of each spur, at a cost of $20,000 each (including foundation). For the Stage 2 estimate, assume new lights will be required. The existing lighthouse on the end of the west arrowhead breakwater will be removed - Corps to estimate removal cost. The lighthouse may be listed on the Federal Register of Historic Places - Corps will research this. A new 20-foot standard pole light will be required at the end of the remaining portion of the west arrowhead breakwater, at a cost of $20,000 (including foundation). A new structure will be required at the west end of the "L-shaped" breakwater. This new structure will house a navigation light, fog signal, radio beacon and electrical generator. The total cost (including structure, foundation, and new equipment) is $350,000. A new 20-foot standard light will also be required at the 90° angle of the "L-shaped" breakwater, at an estimated cost of $20,000 (including foundation). Therefore, the total cost for the aids to navigation for Plan No. 3 is $430,000, plus the cost to remove the existing lighthouse on the end of the west arrowhead breakwater. Additional O and M costs

EXHIBIT G-8

will be $500 per year. It was also stated that if model study tests currently being conducted at the Waterways Experiment Station indicate that the end of the new "L-shaped" breakwater should be offset from the existing east arrowhead breakwater, an additional 20-foot standard pole light will be required at the end of the "L-shaped" breakwater at a cost of $20,000 (including foundation).

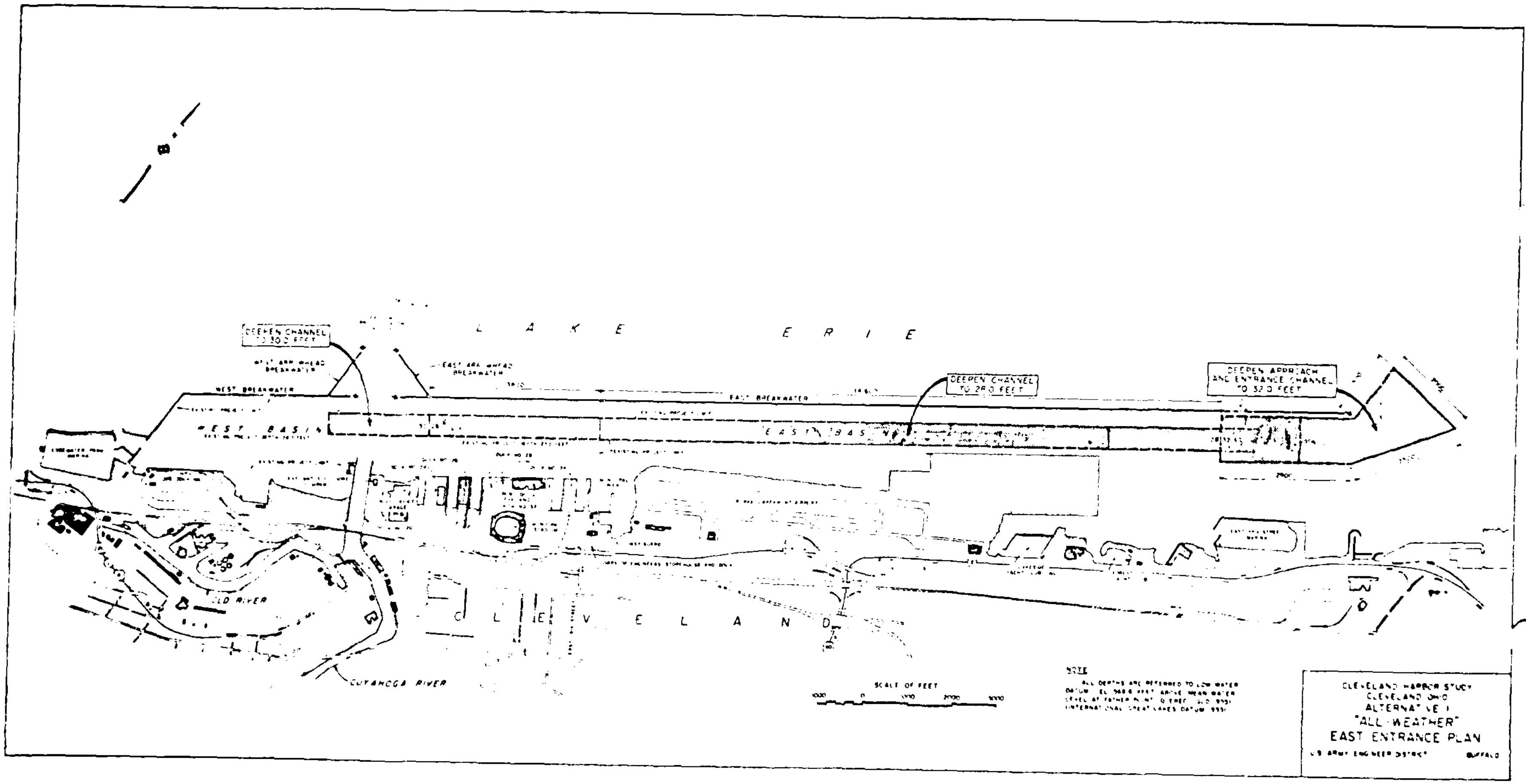
3. Lt. Schnappinger and Mr. Gasior also requested copies of the Buffalo District Project Book (mailed 9/22/81) and to be placed on the mailing list to receive future project books.

4. The meeting then adjourned at 2:30 p.m.

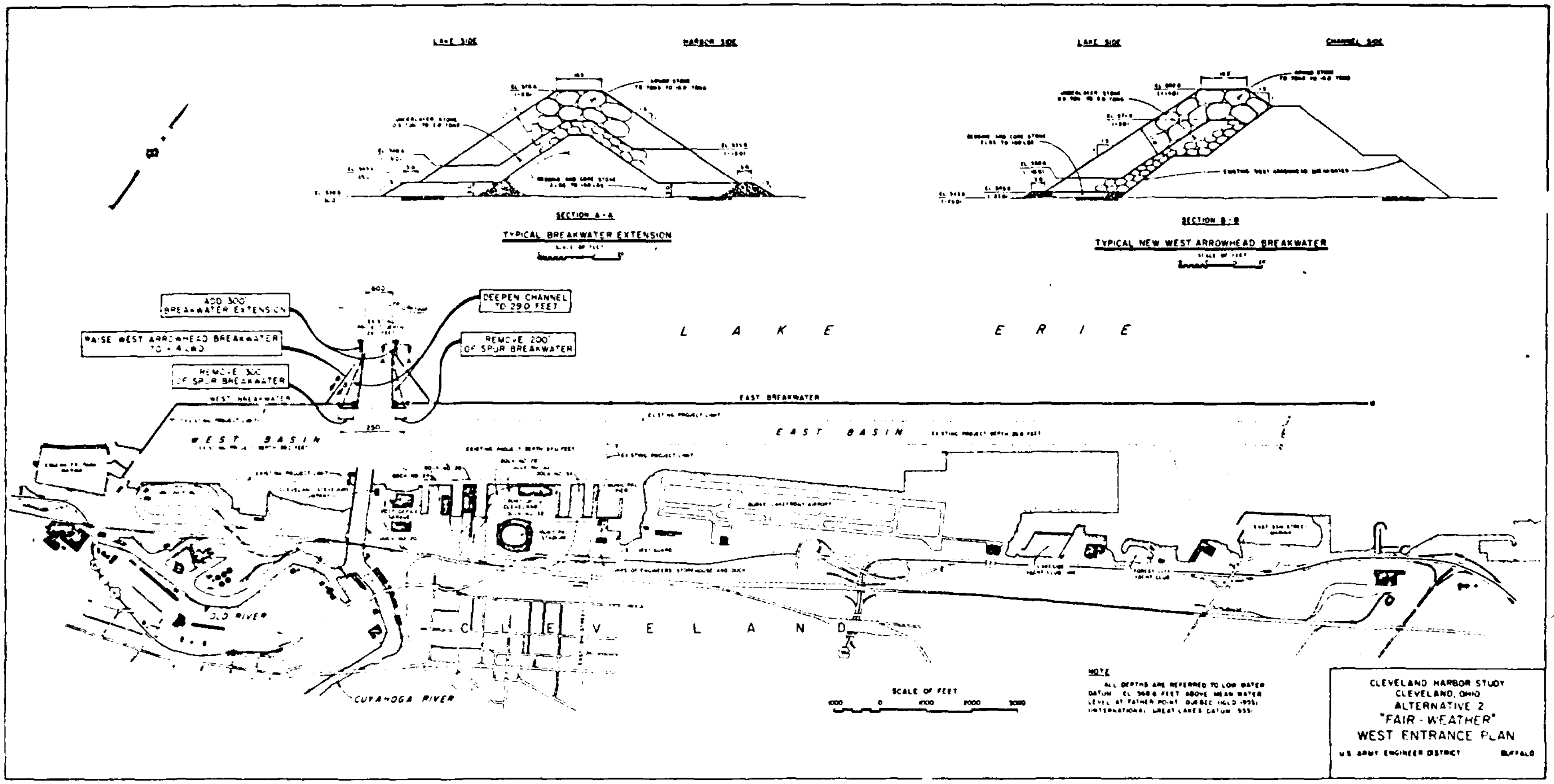
3 Incl
as stated

Richard Aguglia

RICHARD AGUGLIA
Project Manager

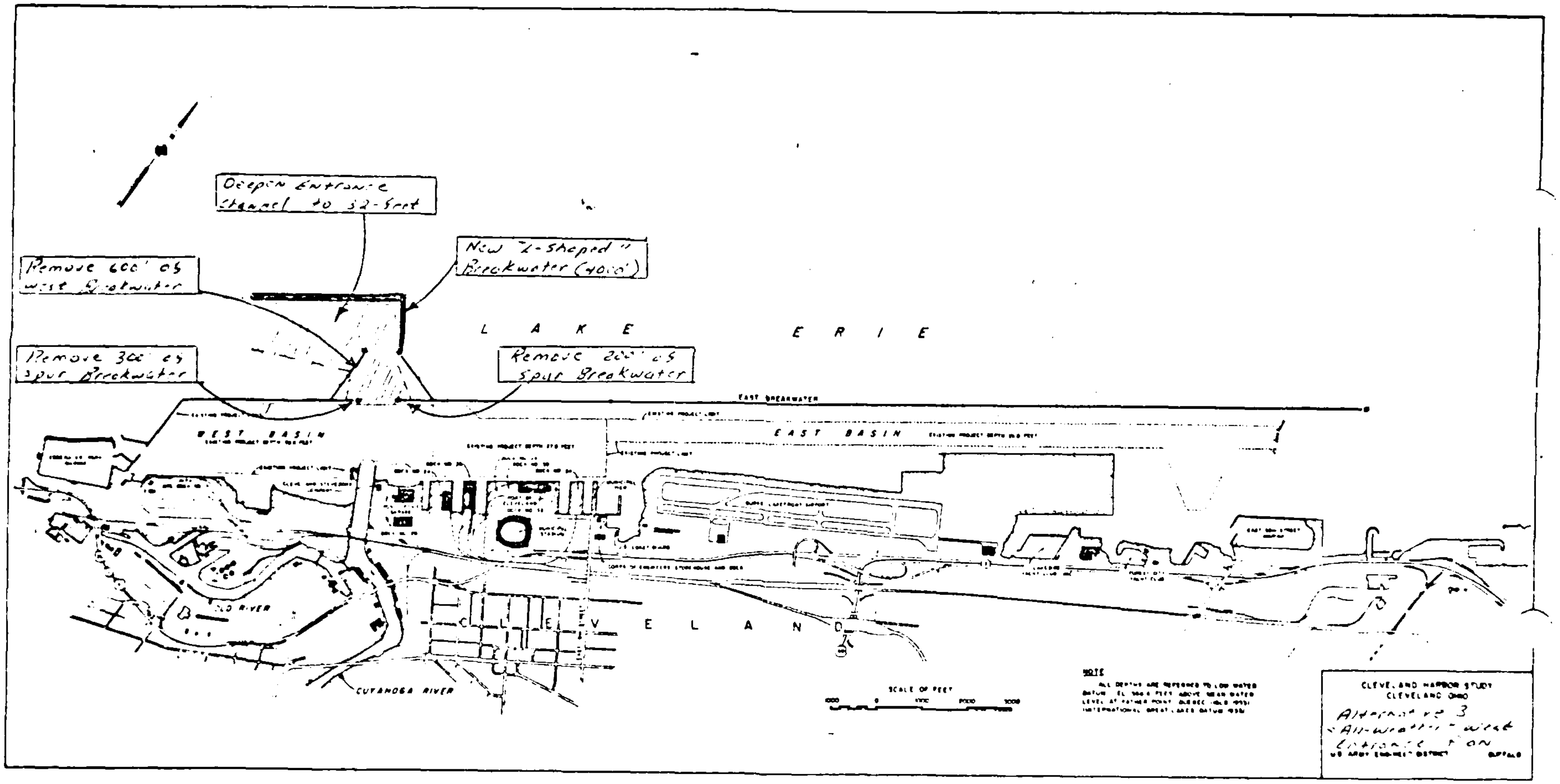

LAKE ERIE
DEEPEN CHANNEL TO 30.0 FEET
WEST ARM WHEAD BREAKWATER
EAST ARM WHEAD BREAKWATER
WEST BREAKWATER
EAST BREAKWATER
WEST BASIN
EAST BASIN
DEEPEN CHANNEL TO 28.0 FEET
DEEPEN APPROACH AND ENTRANCE CHANNEL TO 32.0 FEET
CLEVELAND
OLD RIVER
CUYAHOGA RIVER
SCALE OF FEET
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM
CLEVELAND HARBOR STUDY
CLEVELAND OHIO
ALTERNATIVE 1
"ALL-WEATHER"
EAST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO

incl 1



LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
LAKE SIDE
CHANNEL SIDE
SECTION B-B
TYPICAL NEW WEST ARROWHEAD BREAKWATER
ADD 300' BREAKWATER EXTENSION
RAISE WEST ARROWHEAD BREAKWATER TO +4 LWD
REMOVE 300' OF SPUR BREAKWATER
DEEPEN CHANNEL TO 290 FEET
REMOVE 200' OF SPUR BREAKWATER
LAKE ERIE
WEST BREAKWATER
EAST BREAKWATER
WEST BASIN
EAST BASIN
CLEVELAND
OLD RIVER
CUYAHOGA RIVER
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) INTERNATIONAL GREAT LAKES DATUM 1955)
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 2
"FAIR-WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO

Incl 2


Deepen Entrance Channel to 32-feet
New "L-Shaped" Breakwater (4000')
Remove 600' of west Breakwater
Remove 300' of spur Breakwater
Remove 200' of spur Breakwater
LAKE ERIE
EAST BREAKWATER
WEST BASIN
EAST BASIN
CLEVELAND
OLD RIVER
CUYAHOGA RIVER
SCALE OF FEET
NOTE
CLEVELAND HARBOR STUDY
CLEVELAND OHIO
Alternative 3
US ARMY ENGINEER DISTRICT
BUFFALO

NCBPD-WB 9 April 1982

MEMORANDUM FOR RECORD

SUBJECT: Summary Minutes of 15 March 1982 Workshop Meeting - Cleveland Harbor Phase I GDM Study

1. On 15 March 1982 a workshop meeting was held with the Ohio Department of Natural Resources (ODNR) the US Fish and Wildlife Service (F&WS) and the Buffalo District (NCB) via telephone conference call. The purpose of this meeting was to develop a plan to provide fishermen access to the west breakwater at Cleveland Harbor. The following people were in attendance:

Roger Hubbell - ODNR	Robert Johnson - NCB
Ken Multerer - F&WS	Dave Heicher - NCB
John Zorich - NCB	Dick Aguglia - NCB
Roger Haberly - NCB	

2. John Zorich opened the meeting at 9:30 a.m. by welcoming all participants and reviewing the purpose of the meeting. Mr. Zorich then turned the meeting over to Dick Aguglia.

3. Mr. Aguglia reviewed the fisherman access plan that was developed during the Cleveland Harbor Feasibility Study conducted from 1972 to 1976. This plan (see Incl 1) consisted of: (1) 5,900 feet of pedestrian handrail on the west breakwater at Cleveland Harbor; (2) a pedestrian bridge spanning the gap in the west breakwater; and (3) upgrading the existing crushed stone parking area immediately east of Edgewater Marina. The estimated cost of this plan, on October 1981 price levels, is $2,120,000. Mr. Aguglia then stated that he would like to use this plan as the basis for formulating a fisherman access plan(s) to be evaluated in this Phase I Study.

4. Mr. Roger Hubbell stated that the ultimate fisherman access plan to recommend for construction would be dependent on the results of the Section 107 Study for Edgewater Marina. The purpose of this Section 107 Study is to determine the feasibility of modifying Edgewater Marina for wave reduction in the existing small-boat docking area and for expansion of this small-boat docking area. Two alternatives are presently under consideration. The first alternative assumes, among other things, that the existing entrance to Edgewater Marina from Lake Erie (see Fig 2 of Incl 1) is completely blocked off with construction of a new breakwater extending from the east end of the north breakwater of Edgewater Marina to the west breakwater of Cleveland Harbor. A new gap would then be provided in the west breakwater, approximately 500 feet north of this new breakwater. Small boats would enter the west basin of Cleveland Harbor through this new gap and would continue into Edgewater Marina through the existing gap in the west breakwater. The second plan assumes, among other things, that only minor modifications to the existing entrance are required and it continues to serve as the main entance to Edgewater Marina. However, funds to initiate this Section 107 Study have

not been provided and it is not known when this study will begin. Thus, two fisherman access plans will have to be developed during the Cleveland Harbor Phase I Study. The first plan (designated Plan 8A) will assume the existing entrance to Edgewater Marina is completely closed off and a new gap is provided in the west breakwater of Cleveland Harbor. The second plan (Plan 8B) will assume the existing entrance to Edgewater Marina is only slightly modified and continues to serve as the main entrance to the marina. However, selection of the final fisherman access plan to recommend for construction, if justified, must await the results of the Section 107 Study.

5. A general discussion then ensued on the components of each plan. The main points of this discussion follow:

a. Plan 8A.

(1) Fishermen facilities will be provided on the new breakwater which closes off the existing entrance to Edgewater Marina (approximately 1,000 feet) and on the west breakwater of Cleveland Harbor to the new gap (approximately 500 feet). Fishermen facilities will be similar to those currently being provided by ODNR on the north breakwater of Edgewater Marina. (NOTE: ODNR will provide NCB with copies of these plans.)

(2) There will be no need for a predestrian bridge spanning the gap in the west breakwater. Access to the new breakwater will be from the north breakwater of Edgewater Marina which connects into land to the west of Edgewater. (Note: It was also decided not to provide a pedestrian bridge which would span the new gap in the west breakwater and thus allow fisherman access to the remaining west breakwater at Cleveland Harbor. The reason for this decision was that this bridge would have to be about 85 feet high in order to provide sufficient vertical clearance for sailboats entering Edgewater Marina and it was thought that this high of a bridge would present unacceptable safety risks to fishermen.)

(3) Parking and restroom facilities for fishermen will be provided by expanding parking and restroom facilities currently being constructed by ODNR in conjunction with their fishermen access plan for the north breakwater of Edgewater Marina. ODNR will provide NCB with copies of their construction plans.

b. Plan 8B.

(1) Fishermen facilities (pedistrian handrail) will be provided on the west breakwater of Cleveland Harbor out to the lighthouse on the end of the west arrowhead breakwater (approximately 6,000 linear feet). Even though the demand analysis conducted by NCB indicated that there is sufficient demand to completely fill this length of breakwater on peak days, ODNR questioned

whether this full length would be utilized since fishermen would have to walk over a mile to get out to the west arrowhead breakwater. NCB will look into fishermen utilization at other breakwaters in the District that have fisherman access to see of they are used to capacity. ODNR will also check on the results if their creel survey along Lake Erie which they conducted a few years ago to see if this information would answer their concern. For Stage 2, we will assume that the total length will be utilized on peak days.

(2) A pedestrian bridge will be provided to span the gap in the west breakwater. ODNR will check on the vertical clearance that must be provided by this bridge and will provide this information to NCB. It was also noted that since this plan assumes that the existing entrance to Edgewater Marina is only slightly modified and continues to be the main entrance into the marina, it may be possible to construct this pedestrian bridge level with the west breakwater. ODNR will also check on this possibility. (NOTE: Via telephone call on 6 April 1982, ODNR stated that this pedestrian bridge should be constructed level with the west breakwater.)

(3) Based on NCB's experience at other locations where fisherman access is provided on breakwaters, it was decided that safety platforms on the west breakwater would be required. These safety structures would consist of platforms elevated above the west breakwater and would protect fishermen, trapped on the breakwater during stormy weather, from being washed off the breakwater by over-topping waves. The spacing and size of these platforms will depend on such factors as how quickly waves are generated, the frequency of over-topping waves, the cost of the safety platforms, etc. ODNR also stated that they think these platforms should have a total capacity to accomodate about 50 percent of the number of fishermen expected to fish off the breakwaters on a peak day.

(4) ODNR also stated that the area that was to be developed for parking, as formulated in the feasibility study, is no longer available since ODNR does not anticipate closing the launching ramps located immediately north of this area. ODNR will send NCB a plan of the area outlining possible parking sites.

(5) ODNR also stated that the existing restroom facilities for Edgewater Marina are not sufficient for the marina and will have to be replaced and expanded, although they do not presently have plans developed for this expansion. Since the fisherman access plan developed during the feasibility study assumed that these restroom facilities would be sufficient to accommodate increased usage from fishermen, additional restroom facilities will have to be included in Plan 8B. For Stage 2, we will assume that ODNR has replaced the existing restroom facilities for Edgewater Marina at their present location and that we will have to further expand these facilities to accomodate increased usage from fishermen. The cost of this additional expansion would be changed to the fisherman access plan. NCB will check into design criteria for sizing restroom facilities and will provide ODNR with this information.

NCBPD-WB
SUBJECT: Summary Minutes of 15 March 1982 Workshop Meeting - Cleveland Harbor Phase I GDM Study

c. Handicap Access - ODNR stated that for both plans, consideration must be given to providing facilities for the handicapped. However, it was noted that for Plan 8B, which includes a predestrian bridge, this may not be possible. Irregradless, ODNR is planning on providing fishing facilities for the handicapped on the north breakwater at Edgewater Marina.

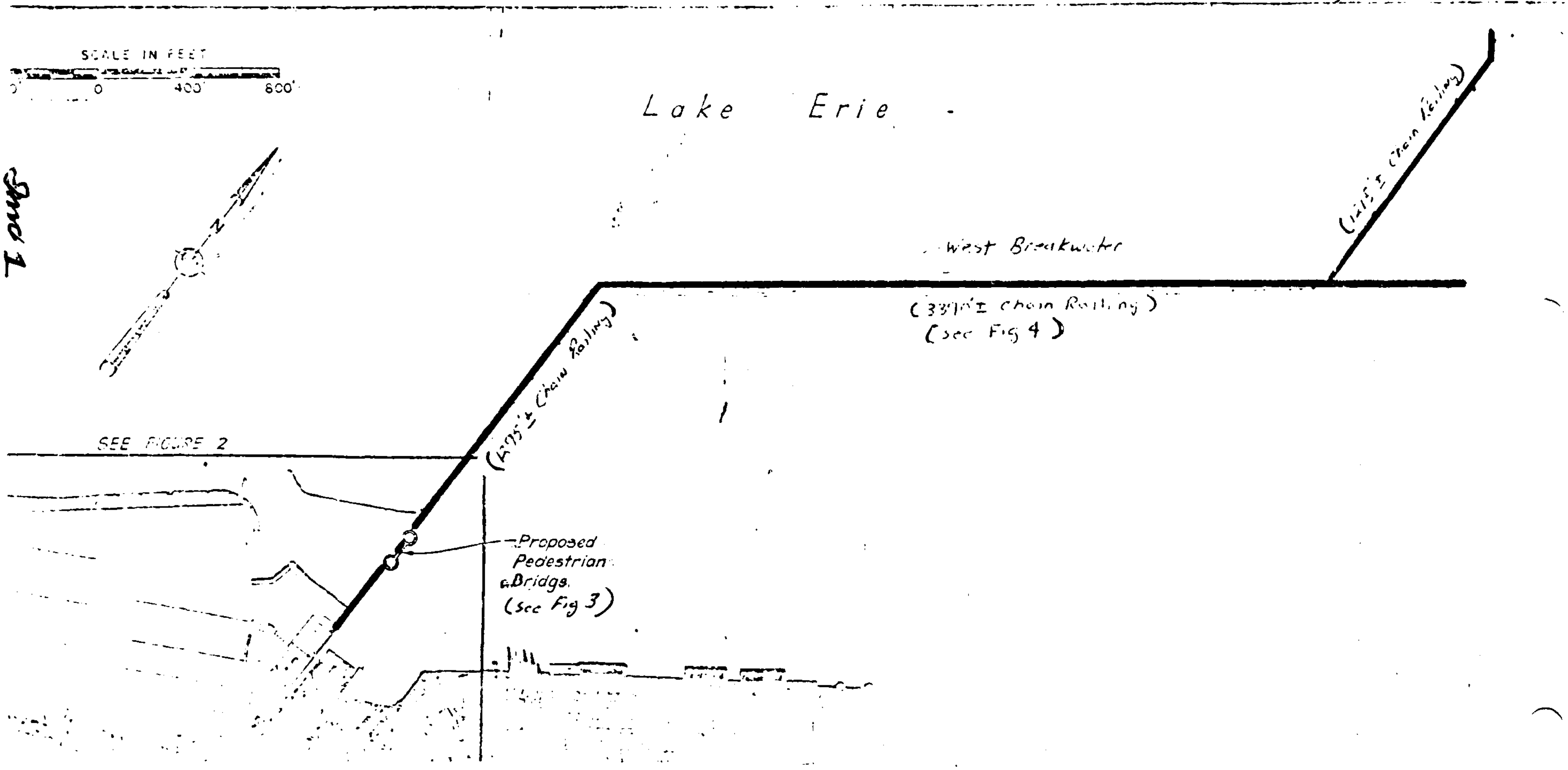
d. Ken Multerer stated that we may have to provide a fish habitat area off the breakwater where fisherman access is provided in order to attract sufficient numbers of desirable sport fish. This habitat area would consist of dumped stone rubble about 2 feet thick and 50 to 100 feet wide along the entire length of the accessable breakwater. For Stage 2, we will assume that this fish habitat area is not required. We will check this assumption by conducting a four seasons survey in Stage 3. Ken also stated that their fisherman space standard is one fisherman every 10 feet and they would expect fishermen to fish off both sides of the breakwater.

6. Following this discussion, John Zorich thanked all participantss for their input and adjourned the meeting at 11:30 a.m.

1 Incl
as

RICHARD AGUGLIA
Project Manager

Figure 1

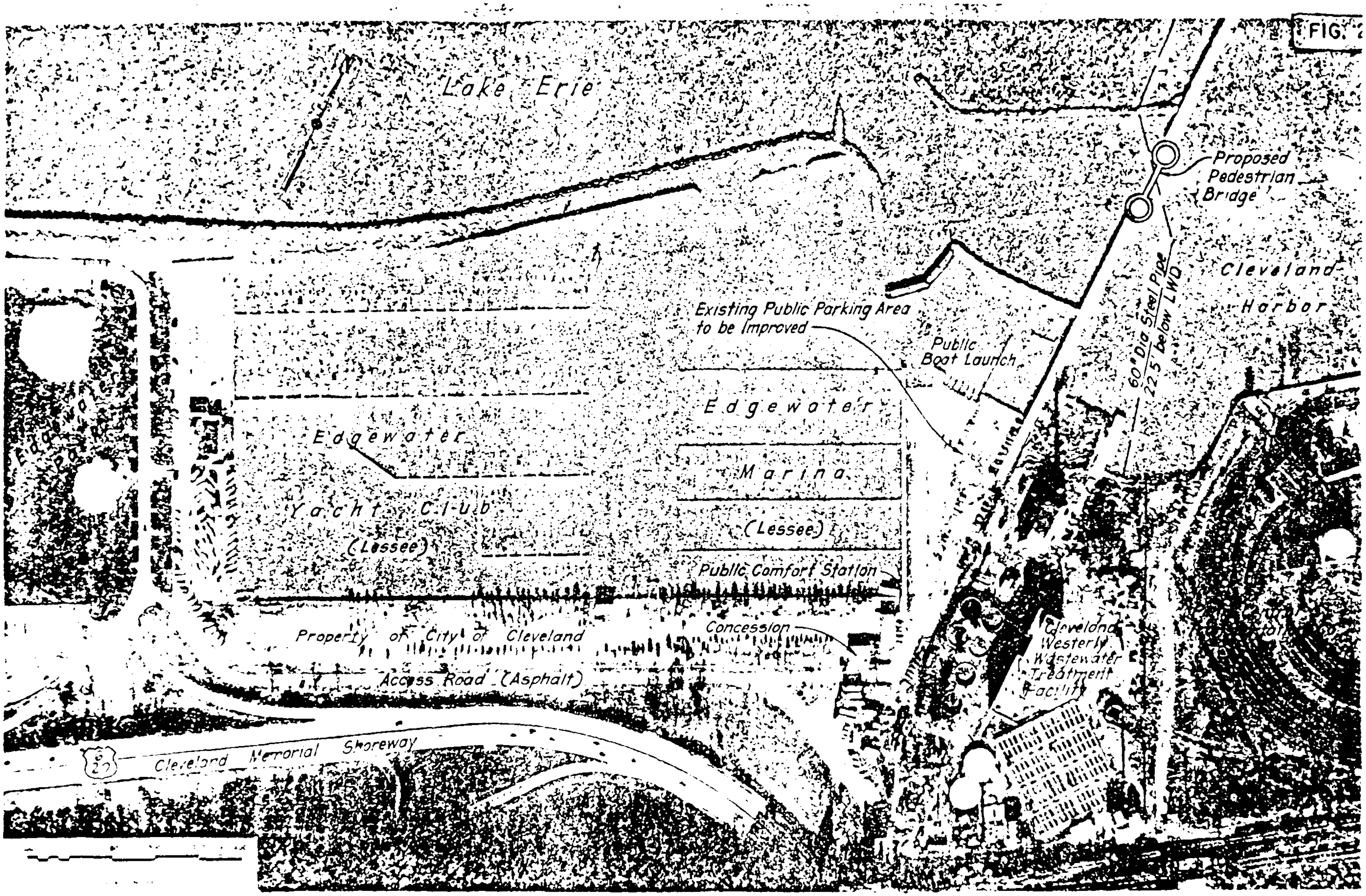


Encl 1

Cleveland Harbor Study

Proposed Breakwater Fishing Plan

FIG. 2


Lake Erie
Proposed Pedestrian Bridge
Cleveland Harbor
60" Dia Steel Pipe
22.5' below LWD
Existing Public Parking Area to be Improved
Public Boat Launch
Edgewater Marina
(Lessee)
Edgewater Yacht Club
(Lessee)
Public Comfort Station
Concession
Property of City of Cleveland
Access Road (Asphalt)
Cleveland Westerly Wastewater Treatment Facility
Cleveland Memorial Shoreway

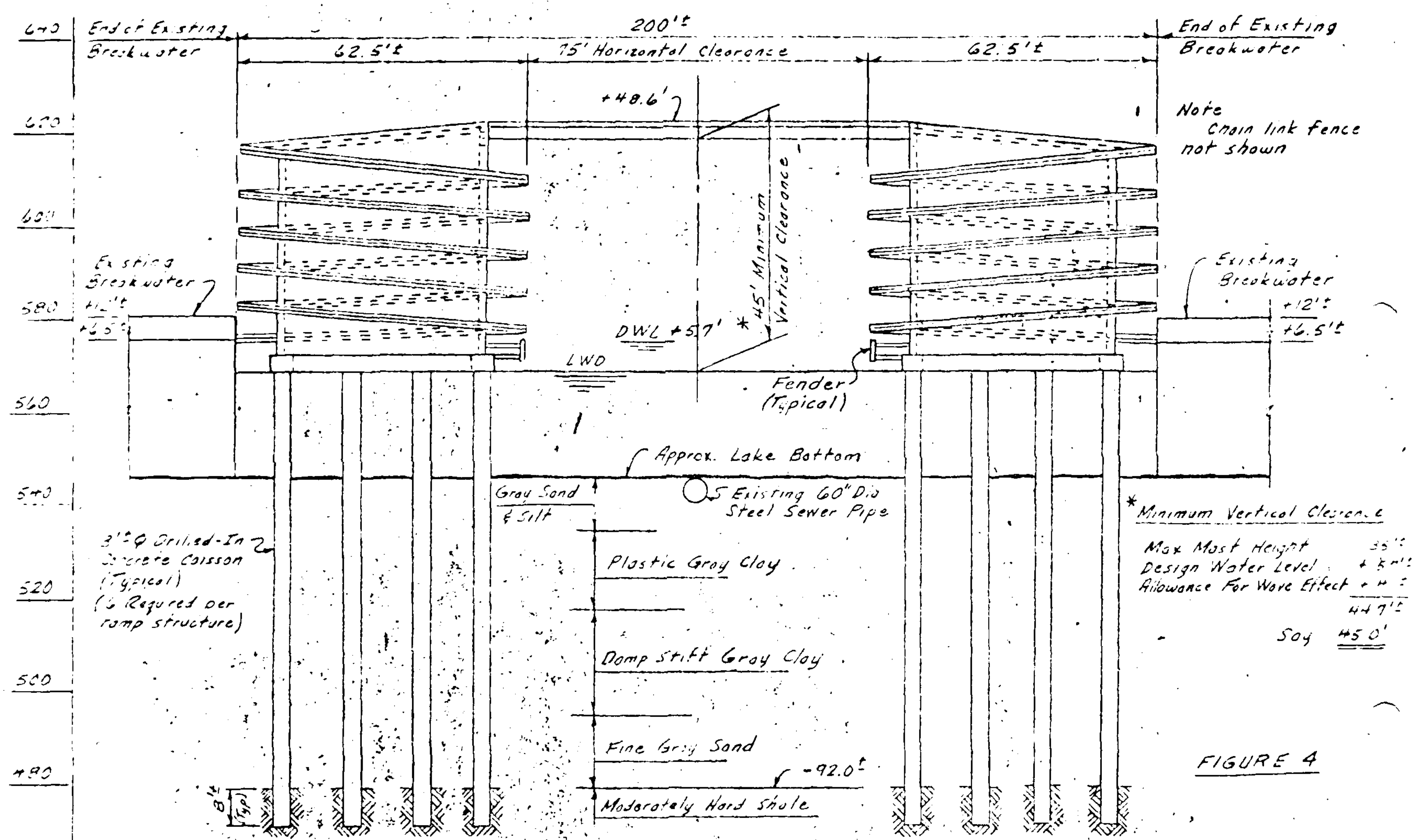
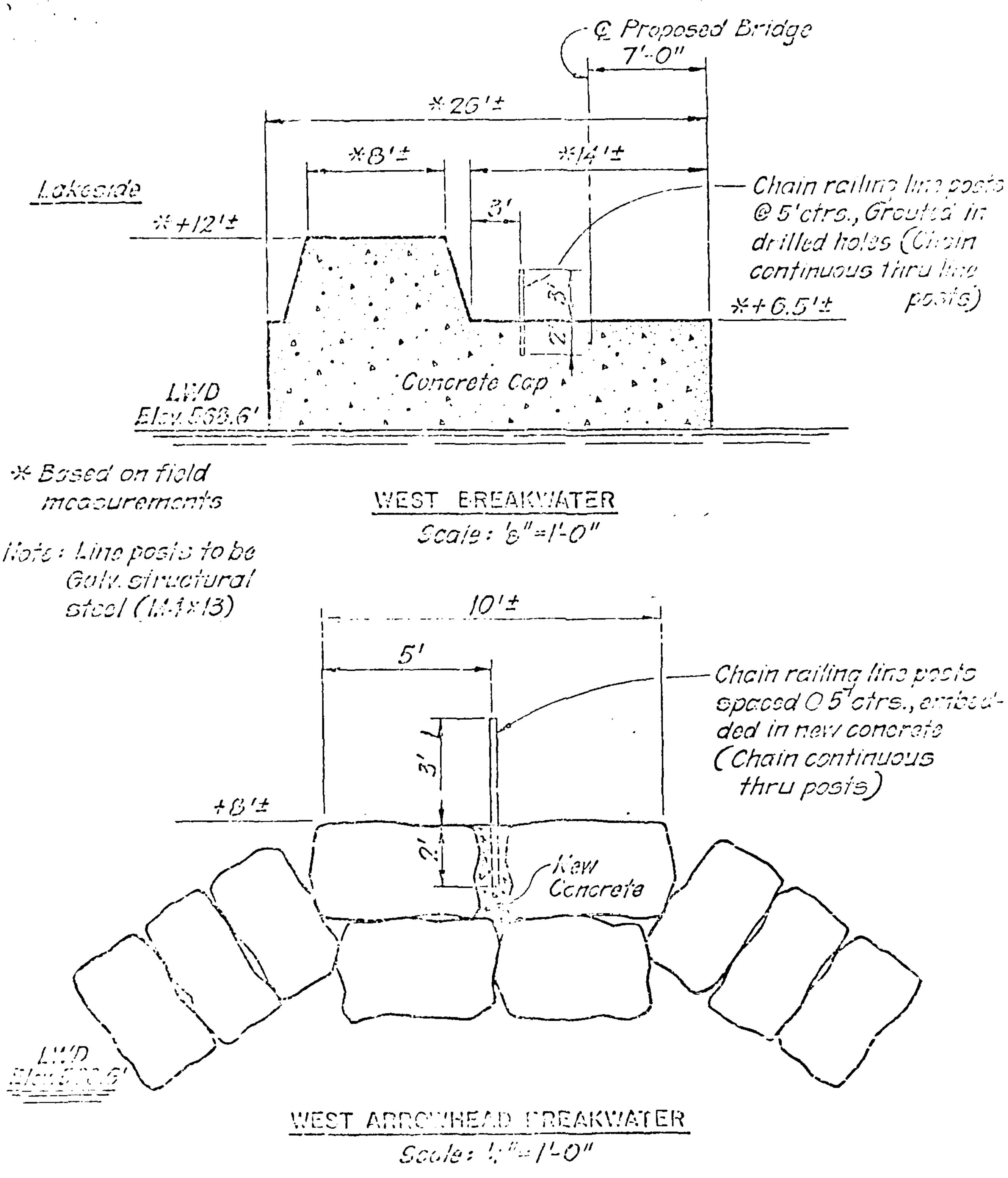


Fig. 3.4 ELEVATION- PROPOSED PEDESTRIAN BRIDGE

Scale: 1" = 20'

FIGURE 4

FIG. 4



TYPICAL SECTIONS - EXISTING BREAKWATERS
(SHOWING PROPOSED CHAIN RAILING)

APPENDIX H
REPORTS OF OTHERS

CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

APPENDIX H
REPORTS OF OTHERS

Exhibit	Description
H-1	Memorandum For Record: Spectral Analysis and Physical Model Tests of Vessel Motion for Cleveland Harbor, Ohio, by Waterways Experiment Station
H-2	Ore Carrier Ballasting Report by David W. Taylor Naval Ship Research and Development Center
H-3	U.S. Fish and Wildlife Service, 24 June 1981 Planning Aid Letter
H-4	U.S. Fish and Wildlife Service, 3 June 1982 Intermediate Report
H-5	U.S. Fish and Wildlife Service, 13 October 1982 Supplemental Planning Aid Letter
H-6	U.S. Fish and Wildlife Service, 15 June 1983 Draft Coordination Act Report

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO:

WESHH 27 April 1983

MEMORANDUM FOR RECORD:

SUBJECT: Spectral Analysis and Physical Model Tests of Vessel Motion for Cleveland Harbor, Ohio

1. Cleveland Harbor is located on the southern shore of Lake Erie at the mouth of the Cuyahoga River adjacent to the city of Cleveland, Ohio (Incl 1). The harbor area comprises approximately 1,300 acres and parallels the shore for a distance of about 25,000 ft. Approaching from the lake, the harbor has two entrances. The West (Main) Entrance is situated lakeward of the Cuyahoga River mouth, and the East Entrance is at the eastern end of the East Breakwater. An aerial photograph of Cleveland Harbor is shown in Incl 2.

2. Access to Cleveland Harbor is currently limited to vessels of 730 ft in length or less in the lakefront area while the Cuyahoga River prohibits passage of vessels larger than 630 ft. Due to the inadequate depths in the eastern portion of the harbor and the breakwater configuration at the West (Main) Entrance, the harbor cannot safely accommodate the larger vessels, up to 1,000 ft in length, that presently ply the Great Lakes. A model study was conducted at the US Army Engineer Waterways Experiment Station (WES) during the period Feb 80 - Dec 81 to determine the modifications required at the West (Main) Entrance that would reduce or eliminate present navigation hazards without increasing wave heights in the harbor. These results are published in WES Technical Report HL-83-6.*

3. The study reported herein was conducted to establish the underkeel allowance required for 1,000-ft-long vessels during storm wind and wave conditions in the interest of vessel safety and vessel operating efficiency.

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* Bottin, Robert R., Jr., "Cleveland Harbor, Ohio, Design for the Safe and Efficient Passage of 1,000-ft-long Vessels at the West (Main) Entrance, Hydraulic Model Investigation", Technical Report HL-83-6, March 1983, US Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Incl 1

Specifically, this information was required to refine entrance channel depth requirements for the proposed east entrance modification plan at Cleveland Harbor. However, it was to be utilized, in some instances, in determining depth requirements at other locations. Although ship roll tests were conducted in October 1982 in the existing Cleveland Harbor model to determine if the vessel would touch bottom for various water depths and monochromatic wave conditions (Incl 3), the tests reported herein were much more elaborate, in that they involved a dynamically-balanced vessel, a spectral analysis of wave conditions at Cleveland, and physical model tests for typical wave spectra and corresponding wind conditions.

4. Five typical wave spectra were developed for Cleveland Harbor from a westerly direction (with significant wave heights of 4, 6, 8, 10, and 12 ft) and three typical wave spectra from a northerly direction (with significant wave heights of 6, 8, and 10 ft). Methods employed to generate these design wave conditions, measured prototype wave data, the numerical shallow water wave model utilized, and verification of test results are presented in Incl 4.

5. The 10-ft-long model ore carrier (representing a 1,000-ft-long prototype vessel, Incl 5) used during testing was remote-controlled and equipped with (a) twin engines that could be operated independently and move the carrier in forward or reverse directions; (b) rudders behind each main engine propeller that were controlled together; and (c) bow and stern thrusters that could be operated independently and move the carrier in the port (left) or starboard (right) directions. For small-scale model ships, scale effects have an influence on maneuvering behavior. Corrections initially required to attain similarity of model to prototype conditions are discussed in WES Technical Report HL-83-6. Prior to this study, the model ore carrier was dynamically balanced at the David Taylor Naval Ship Research and Development Center (the US Navy's principal research, development, test, and evaluation center for naval vehicles).

6. An erratic wind field was reproduced during the conduct of some of the tests. Wind forces against the prototype ship were calculated for various wind velocities (described in WES Technical Report HL-83-6) as shown in the plot presented in Incl 6. The distances the wind generators were placed from the vessel's path governed the force against the model ship. This model force correlated to a calculated prototype force and corresponding wind speed.

7. A 50- by 50-ft flat model test area was constructed prior to conduct of the tests. Depths were simulated by varying the water level in the test basin, and waves were generated by a trapezoidal-shaped, vertical-motion plunger-type wave generator capable of generating the required spectral wave conditions along the entire width of the test area. The angle that the vessel traveled over the test area (in relation to the wave front)

determined the angle of wave approach (i.e., a condition with the model ship moving perpendicular to the direction of wave approach would represent broadside wave attack for waves from the west at Cleveland and a condition with the ship moving in the same direction as wave approach would represent a following sea for waves from the north at Cleveland). Plots depicting the wave spectra generated for 4-, 6-, 8-, 10-, and 12-ft significant waves are shown in Incls 7-11, respectively. The dashed lines represent the desired spectra while the solid lines represent the spectra generated by the wave machine.

8. Captain G. V. Chamberlain, retired vessel master from Hanna Mining Company, Captain A. H. Haynes, vessel master with American Steamship Company, and Captain V. H. Anderson, U.S. registered pilot with Lake Pilots Association, Inc. were present and assisted with model testing. Also present were representatives from the Office, Chief of Engineers, North Central Division, Buffalo District, Detroit District and the Waterways Experiment Station.

9. Tests were conducted with a vessel draft of 25.5 ft and water depths ranging from 27 to 33 ft in 1-ft increments for spectral waves with 4-, 6-, 8-, 10-, and 12-ft significant wave heights. The ship was subjected to both broadside wave attack and following seas. These tests were conducted to determine if vessel roll resulted in the ore carrier striking the bottom of the model floor for various wind and wave conditions. Ship speeds of 4 to 6 mph were simulated during testing conditions. Initial tests indicated that broadside wave attack was more critical than following seas and that wave spectra with significant wave heights of 8 and 10 ft (with corresponding significant wave periods of 7.3 and 8.2 sec, respectively), would best determine design conditions. A plot of significant wave height vs return period at Cleveland is transmitted as Incl 12. Test results for spectral wave conditions are presented in Table 1 (Incl 13). For the 7.3-sec, 8-ft waves the vessel did not strike bottom for water depths of 27-29 ft with no wind. With 22.5-knot winds (those that correspond to 8-ft waves) the vessel did not strike bottom for the 27- and 28-ft depths. With 31-knot winds (those actually associated with 10 ft significant waves but possible with 8-ft waves) the vessel did strike bottom for the 27- and 28-ft depths. For 8.2 sec, 10-ft waves the model ore carrier struck bottom for depths of 29-32 ft with no wind. Each 1-ft increase in depth, however, resulted in less frequent striking of the model floor with less intensity. The vessel did not strike bottom with the 33-ft depth without wind, but did strike with the 31-knot wind imposed. The model ore carrier was then tested on the existing Cleveland Harbor model with monochromatic waves. Test conditions were simulated as described in Incl 3 and the vessel was subjected to 8-sec, 8-ft and 10-sec, 8-ft test waves for 28- and 30-ft water depths. These test results are presented in Table 2 (Incl 14). The model ore carrier did not strike bottom for 8-sec, 8-ft waves for either water depth. For 10-sec, 8-ft waves, however, the vessel struck bottom for both the 28- and 30-ft depths. These test results, for both spectral and monochromatic waves, indicate

that the significant wave period is critical with respect to vessel roll motion. It appears that as the wave period approaches the natural frequency of roll of the vessel (approximately 1.0 second in the model which equates to 10 seconds in the prototype) the roll of the vessel increases, requiring deeper bottom depths.

10. A simplified turning test was conducted in the initial test area for various underkeel clearances for calm water conditions. Test results are shown in Table 3 (Incl 14). The vessel was operated at 6 mph with maximum rudder angles in the port and starboard directions. While not intended to provide quantitative values for the various turning radii, trends indicated that the depth of water under the keel had a definite impact of ship response. These tests indicated that additional water depths under the vessel increases maneuverability.

11. Although the vessel simulates the correct mass and was dynamically balanced, viscous scale effects were not considered and care should be exercised in interpreting test results. Due to viscous scale effects, the model vessel may roll slightly less than that of the prototype ship; therefore, absolute quantitative values of roll angle, etc., may not be accurately reproduced. Relative comparisons, however, should be valid.

Robert R Bottin Jr

14 Incls
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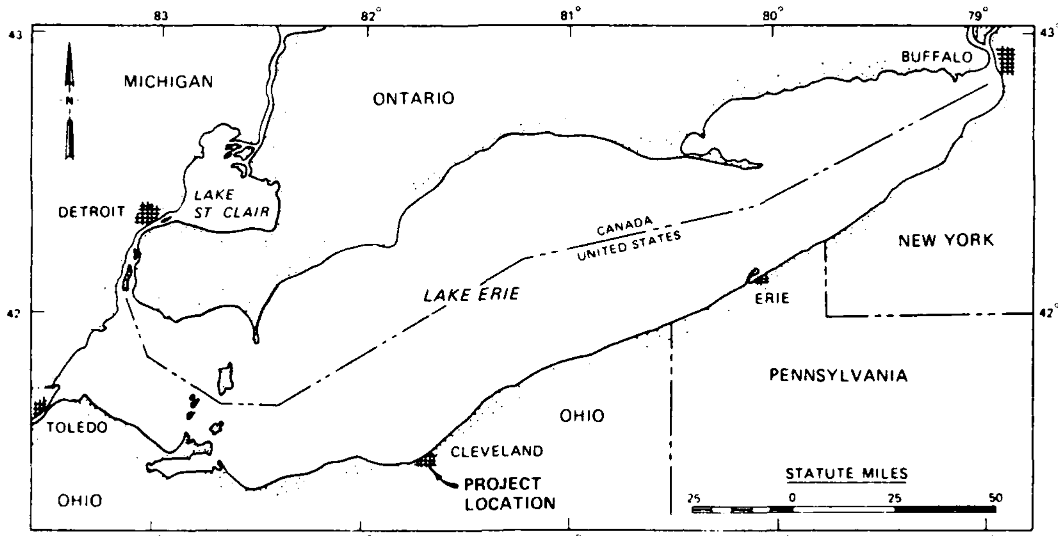
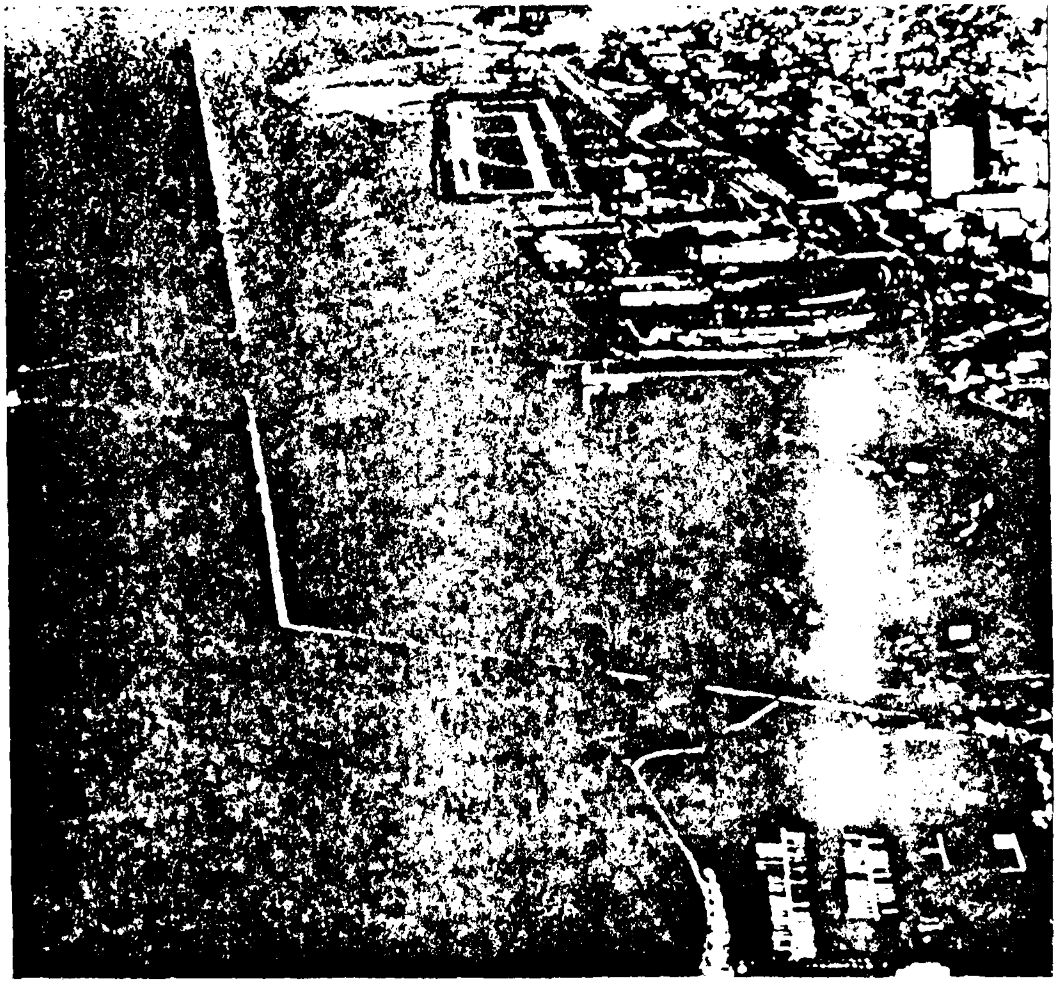
ROBERT R. BOTTIN, JR.
Project Manager
Wave Dynamics



PROJECT LOCATION

Incl 1



Aerial photograph of Cleveland Harbor

Incl 2

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

IN REPLY REFER TO: WESHH

5 October 1982

MEMORANDUM FOR RECORD

SUBJECT: Cleveland Harbor Ship Roll Tests

1. On 27 September 1982 the 10-ft-long model ore carrier (representing a 1,000-ft-long prototype vessel) was navigated through the Cleveland Harbor entrance to determine if ship roll would cause the vessel to touch bottom for various lake levels and wave characteristics. Depths of 27, 28, and 29 ft were simulated in the entrance by varying the water level in the model, and the vessel draft was 25.5 ft. Waves (6 sec, 8 ft and 9 sec, 8 ft) were generated that approached the vessel from 90 degrees (broadside) and 45 degrees (quartering the vessel). Visual observations revealed the following:

a. For the 27-ft depth, the vessel rubbed the bottom and became grounded while under wave attack.

b. For the 28-ft depth, the vessel rubbed and bumped bottom while under wave attack but continued to move slowly through the entrance.

c. For the 29-ft depth, the vessel did not touch bottom while under wave attack when navigating the entrance. Maneuverability was difficult, however, (probably due to the shallow depths under the propellers).

2. Although the vessel simulates the correct mass and an effort was made to equally distribute the weight required for ballast, it was not dynamically balanced and care should be exercised in interpreting these test results. These tests were qualitative and should be used only for guidance (i.e., the 29-ft depth was the best of the depths tested). Absolute quantitative values of roll angle etc., may not be accurately reproduced with this model.

Robert R Bottin Jr

ROBERT R. BOTTIN, JR.
Project Manager
Wave Dynamics Division

CF:
NCB, ATTN: Mr. Rick Gorecki

Incl 3

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
PO BOX 631
VICKSBURG, MISSISSIPPI 39180

REPLY TO
ATTENTION OF
WESHH

11 April 1983

MEMORANDUM FOR RECORD

SUBJECT: Design Significant Height and Energy Density Spectra Estimates for Cleveland Harbor

Introduction

1. This report describes the methods employed to generate design wave conditions for Cleveland Harbor. Wave spectra and significant height (H_s) data were obtained from a recent wave monitoring program at Cleveland Harbor. These data for the period of 30 April-2 December 1981 recorded maximum H_s conditions below what was requested by NCB as design wave conditions. Therefore, the design spectral and H_s estimates were generated from a shallow water wave hindcasting technique. The numerical model results were compared to the measured data. After the verification process was completed, the design wave conditions were generated near the Cleveland Harbor entrance.

Measured Wave Data

2. In the spring of 1981 a wave gaging program was initiated in the area of Cleveland Harbor (Cleveland, Ohio). Two pressure-type wave gages were deployed, one lakeward of the breakwater protecting the harbor and the second landward (Figure 1). The wave gages were self-contained pressure sensing instruments (SEA DATA Model 635). They were mounted on platforms and secured to the lake bottom. The gages were synchronized, thus measuring wave conditions at virtually the same time.

3. The sampling interval for both gages was set at 1.0 Hz, and the total sample record was 1,024 sec, obtained every 3 hours. There were no problems associated with alliasing of the high frequency wave data caused by the sampling interval. The location of the lakeward gage versus depth (35 ft) acted as a high frequency filter and cutoff all energy approximately 1.5 f_m (where f_m is the frequency at the spectral peak).

4. The data tapes were retrieved from the gages and returned to WES for processing. The wave spectra were computed via a discrete Fast Fourier Transform and converted from a dynamic pressure spectrum to a free surface spectrum according to linear wave theory. The spectral energy density of the sea surface was related to the measured pressure spectrum in the following manner,

$$E_s(f) = \left[\frac{\cosh\ (kd)}{\cosh\ (kh)}\right]^2 E_p(f) \qquad (1)$$

Incl 4

where $E_s(f)$ is the free surface energy density spectrum, $E_p(f)$ is the pressure spectrum, k is the wave number defined at each frequency, f at a given local water depth d, and h is defined as the height of the pressure sensor above the bottom. One must note that the computed spectra ($E_s(f)$) are only an approximation to wave conditions that exist at a given period of time, and become dependent on the selection of a particular analysis procedure.

5. The significant height, H_s can then be computed where

$$H_s = 4\sqrt{\int_{1/T}^{1/2\Delta t} E_s(f)df} \qquad (2)$$

and Δt is equal to 1.0 sec, and T is equal to 1,024 sec.

6. During the period of April-December 1981, the maximum H_s recorded results were 7.5 ft occurring on 28 September and also 2 October 1981. Since the design requirements requested by NCB were greater than these maximums (of 8.0, 10.0, and 12.0 ft) it became necessary to supplement the measured data with data obtained using a numerical wave model.

Shallow Water Wave Model (SWWM)

7. The SWWM, developed by Jensen (1983) and summarized in Appendix A, has been employed in two previous studies (Jensen 1983, and Garcia and Jensen 1983) and has been shown to generate accurate results in terms of H_s, T_p (where T_p is the peak period or the inverse of f_m), and finite water depth energy density spectra. The methodology and theory involved in the SWWM remained unchanged in calculating design criteria for Cleveland Harbor.

8. Wind conditions are the driving mechanism of the SWWM. Wind data were obtained at Hopkins International Airport, southeast of Cleveland Harbor. The data, wind speed, and direction were recorded every hour and represent an average 10 minute record. Since the data were recorded overland, a series of adjustments were made to produce "wave-model-ready," over-water winds transformed to a 10 m elevation. The procedure involved in this transformation follows the work conducted by Resio and Vincent (1976) which has been the adopted procedure for most all Corps of Engineers work. Wind conditions were assumed to be uniform over Lake Erie for each wind observation. Isobar patterns associated with a typical storm will verify this assumption. In general, Lake Erie will fall within two isobars, thus wind conditions between these isobars typically remain uniform in speed and direction.

WESHH
SUBJECT: Design Significant Height and Energy Density Spectra Estimates for Cleveland Harbor

9. The SWWM was designed to compute wave conditions at selected locations. All wave conditions generated assume constant water depths over time, therefore neglecting changes in water elevation caused by rises and falls in lake levels and also surge effects. In order to improve computational efficiency, a polar coordinate system is selected where the origin is placed at the wave gage location (Figure 1). After the SWWM was verified to the gage wave results, the hindcast site was moved just seaward of the harbor entrance. Fetch length rays are projected outward from the origin at 10-deg intervals. Because of geographical constraints (the orientation of the breakwater and the location of the hincast site) only certain rays from 0-50 deg and 260-360 deg existed for both the verification and design storm data results, or 16 rays. If the wind direction (θ_w) fell outside the range (or $50 < \theta_w < 260$ deg) the SWWM would identify that the input wind conditions were out of the applicable range to produce wave conditions.

10. Fetch lengths and water depths are discretized into 10 subsections along the total length of every ray. The water depth selected for each subsection is interpolated from available NOAA bathymetric charts. The proper fetch length and subray water depths (h_i) are selected from the input wind direction. With this information, the SWWM is ready to compute wave conditions at the gage site, and once verified, at the entrance to the harbor.

Comparisons

11. Comparisons to actual gage measurements are necessary to determine the validity of the results obtained by the shallow-water wave model. There is only one real control that exists in the SWWM, the amount of energy loss, caused by bottom friction effects. The dimensionless friction factor was set equal to 0.001 (approximately a factor of 10 less than what was used by Reid and Bretschneider (1954), and Bretschneider (1954)), and for all verification tests remained at 0.001.

12. Four storms generating large wave conditions during 1981 were selected for the verification of the SWWM. Hourly wind data were averaged over a 3-hour period of time and are presented in Table 1.

13. Figures 2 and 3 show the time history of measured and computed H_s results for the period of 28 September through 4 October 1981. The computed H_s conditions follow the trends of the measured data with a slight phase difference. The phase differencing is caused by the methodology associated the SWWM where propagation time is omitted. The computed data in general have a tendency to slightly over-predict extreme wave conditions. As the measured H_s results decrease, the computed results diminish but to a lesser degree than what is shown in the gage data. The main reason for this overprediction in the computed data can

be shown in comparisons of the energy density distributions. Figures 4-6 display three sequences found in Storm 2, initial growth, saturation (maximum conditions) and decay. All energy densities are related to each discrete frequency band, and nondimensionalized with respect to f_m. The hindcast data are shifted in time to correspond to the gage results. In general differences between measured and computed peak frequencies were no greater than $2\Delta f$ (where $\Delta f = 0.0079$ Hz). The measured spectra clearly show that the tail of the distributions were truncated caused by the attenuation of high frequency energy at the given depth of the gage, whereas the hindcast spectra remain finite through $f/f_m \approx 3.5$ (although not all data were plotted). If the hindcast spectra were truncated in a similar fashion as the measured data. the total energy would decrease and thus decrease the H_s results inline with the measured results. In light of this the hindcast results demonstrate that it accuratelv describes the foward face and in a generalized form describes the tail of the spectrum.

14. There are two slight limitations associated with hindcasting wave conditions near Cleveland Harbor. The first is that finite (meaning greater than zero) wave conditions are geographically bounded within a very small window of wind directions. By the time the wind direction from a given storm shifts into the "window" the wind speeds are at, or very near, their maximum. Thus, the hindcast H_s results reflect this limitation where in general no wave growth over time is displaved in the time history plots. The second limitation is governed by the assumption that the given wind information is correct. Hindcasted wave conditions can be onlv as accurate as the wind conditions driving the model. For example, the hindcast H_s results found in Figure 3 shows wave growth through 0600 hours on 2 October 1981, then at 0900 hours there is no hindcast H_s results, caused by the wind direction recorded at 230 deg. This wind direction falls outside of the wave generating wind angle bands. There may have been an error in this record or during the sampling time the wind actually shifted for a brief moment. What becomes apparent is that changes in wind speed and direction data will be reflected in the wave data whether the wind information is correct or not.

15. The H_s and spectral results for the period of 6-9 October 1981 are shown in Figures 7-10. The measured and computed H_s over the 3-day period show strong similarities. Again there is a slight phasing difference between the two data sets but when corrected, the maximum errors exist during initial growth and ultimate decay of the storm. The hindcast H_s results tend to overestimate the measured wave conditions but as shown in Figures 8-10 the measured spectra are again truncated. The hindcast spectra remain finite up to approximately $f/f_m \approx 3.5$, thus adding energy to the high frequency wave components, while the recorded

spectra cannot accurately resolve energy higher than approximately $f/f_m = 1.65$. The forward face and the tail of the measured spectra are again accurately represented by the hindcast results, during the maximum, midstorm and decay states in Storm 3. The reason for the extreme difference in maximum wave conditions in the measured (7.0 ft) and hindcast (9.6 ft) data remains unknown, although the wind speed during that period were 25 to 30 percent higher than all data before and after that time.

16. Figure 11 displays measured and hindcast H_s results for the period of 6-8 November 1981. Again the hindcast data corresponds with the trends shown in the measured data with exception to the later stages of the storm where wind conditions remain strong enough to produce moderate wave conditions. The spectral estimates for two periods of time are shown in Figures 12 and 13, and again show strong agreement between the measured and hindcast data sets.

Design Wave Conditions

17. The previous comparisons demonstrated that the SWWM can accurately describe time varying storm wave conditions in terms of H_s (a measure of the total energy) and also spectrally (the distribution of energy as a function of frequency). The subtask of this project is to determine wave spectra for design H_s conditions approaching from the north and from the west in reference to the Cleveland Harbor channel entrance. Prior to the generation of the design specta, 25 years (1948-1973) of wind data from Hopkins International Airport were assembled and analyzed to determine the statistical distribution of wind speeds for winds from the north and also the west. The anemometer level varied over the 25 years, thus, all wind speeds were adjusted to a constant 10 m elevation for comparison purposes. Out of a total of 177,492 observations in the 25-year period 9,234 observations were from the west while 12,607 were from the north. The statistical distributions for wind speeds from the north and west are presented in Figures 14 and 15. The percent occurrence data are based on the total number of observations within the given direction class. Also the maximum wind speeds found in the 25 years are 28.6 knots for winds from the north and 36.1 knots for winds from the west.

18. The design wave and spectral estimates become dependent on wind speed, fetch lengths and water depths and thus, become unique for every site being studied. Therefore, conditions generated for Cleveland Harbor can only be adapted to other areas if the wind conditions, fetch lengths and water depths are nearly identical.

19. One also must be aware that H_s is a measure of the total energy of a population of individual wave heights, each with their own amount of energy at a given frequency. Also, the resulting H_s is based on

dependent parameters and physical processes governing the problem. Those dependent parameters, wind speed, fetch length and water depths, produce the variation in H_s results. Therefore, wind conditions must exist (or have existed) to produce the design wave conditions selected by NCB.

20. Table 2 presents the design wave conditions (namely H_s) sought by NCB for winds blowing from the north and winds blowing from the west. The spectral estimates for these wind conditions are given in Appendix B. As illustrated in Table 2, the maximum wave conditions (H_s = 12 ft from the west and H_s = 10 ft from the north) require wind speeds in excess to what existed in 25 years of wind records. This is not to say that a 43 knot wind blowing from the west and a 30 knot wind blowing from the north ever existed, those conditions were not found in the given data set. Also, refraction effects may have shifted the direction of wave propagation to 0 deg or 270 deg for winds blowing from other angle bands.

Summary

21. The SWWM was shown to produce an accurate description of extreme storm events in terms of significant wave heights, peak spectral frequencies and evergy density spectral distributions when compared to measured results. The design H_s conditions requested by NCB for winds blowing from the north and west were then computed. The winds producing the maximum wave conditions were found to be greater than what was recorded near Cleveland Harbor in 25 years, although the possibility could exist which would produce the maximum conditions. Resio and Vincent (1976) generated extreme wave conditions for a point in close proximity to the Cleveland Harbor entrance (Figure 1). Their data presented in Table 3 shows H_s values from the 100-year return period of 13.8 ft (angle class where 270 deg would exist) and 15.1 ft (angle class where 0 deg would exist), therefore, the likelyhood of the maximum wave conditions sought by NCB for Cleveland Harbor may be pos. ible.

22. These design data have been generated specifically for Cleveland Harbor and can only be adapted to other sites if wind speeds, fetch lengths and water depths are nearly identical. The estimates of H_s and the energy density spectra presented in this report are extremely sensitive to given physical parameters. When those parameters vary so will the wave conditions. Adaptation of these data to other sites cannot be possible if the variation in input parameters falls above 10 percent.

ROBERT E. JENSEN
Wave Dynamics Division

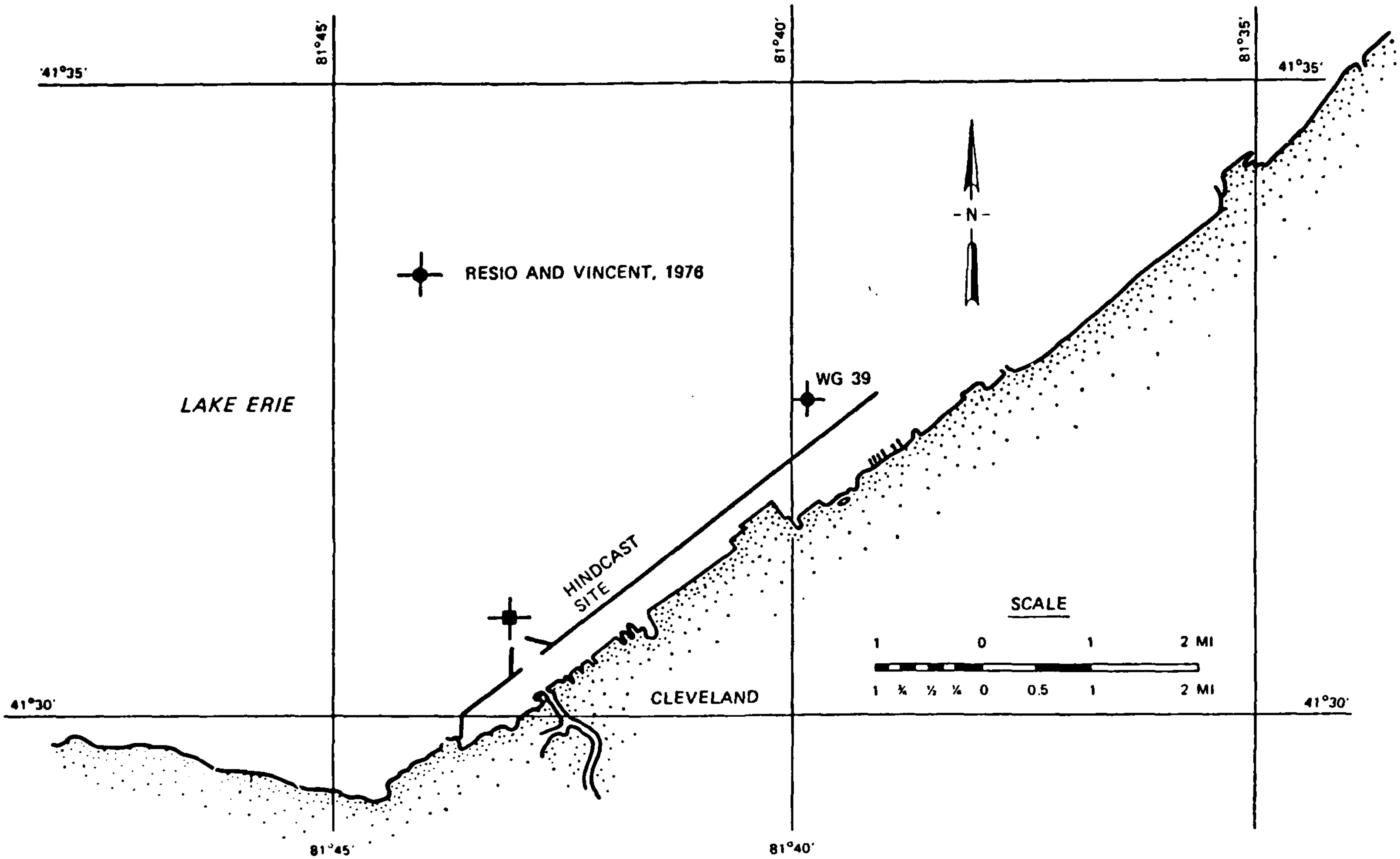


Figure 1. Cleveland Harbor hindcast study area

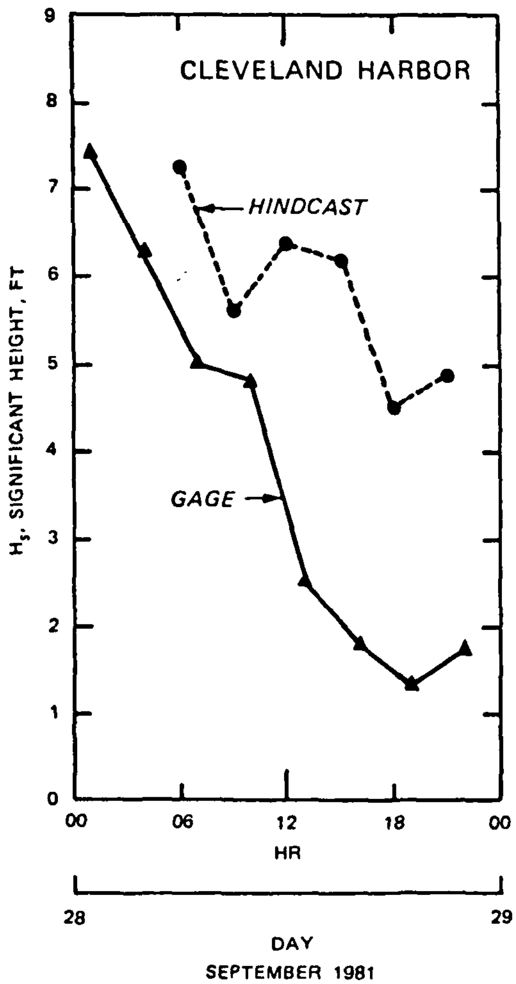


Figure 2. Gage and hindcast H_s results for 28-29 September 1981

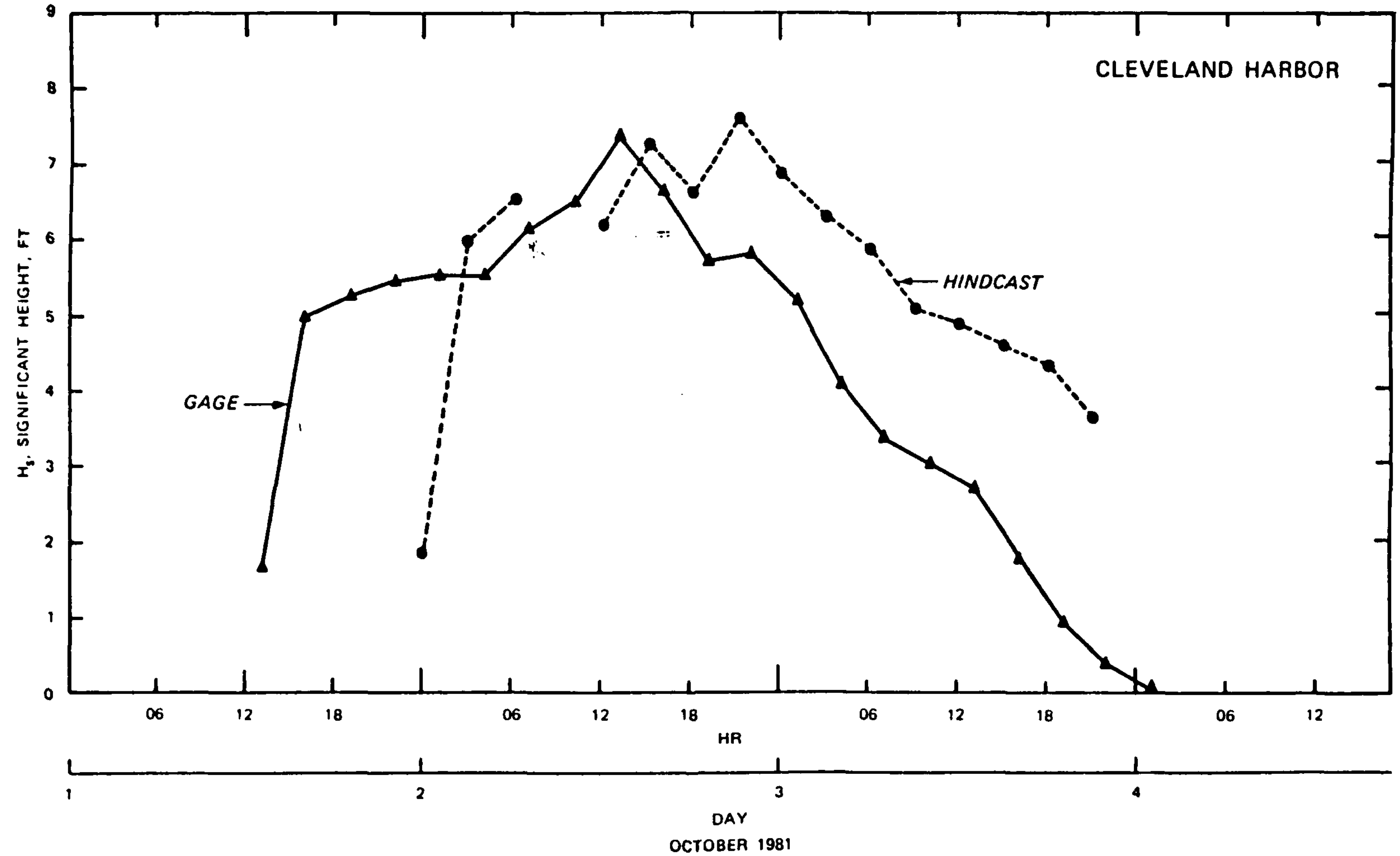


Figure 3. Gage and hindcast H_S results for 1-4 October 1981

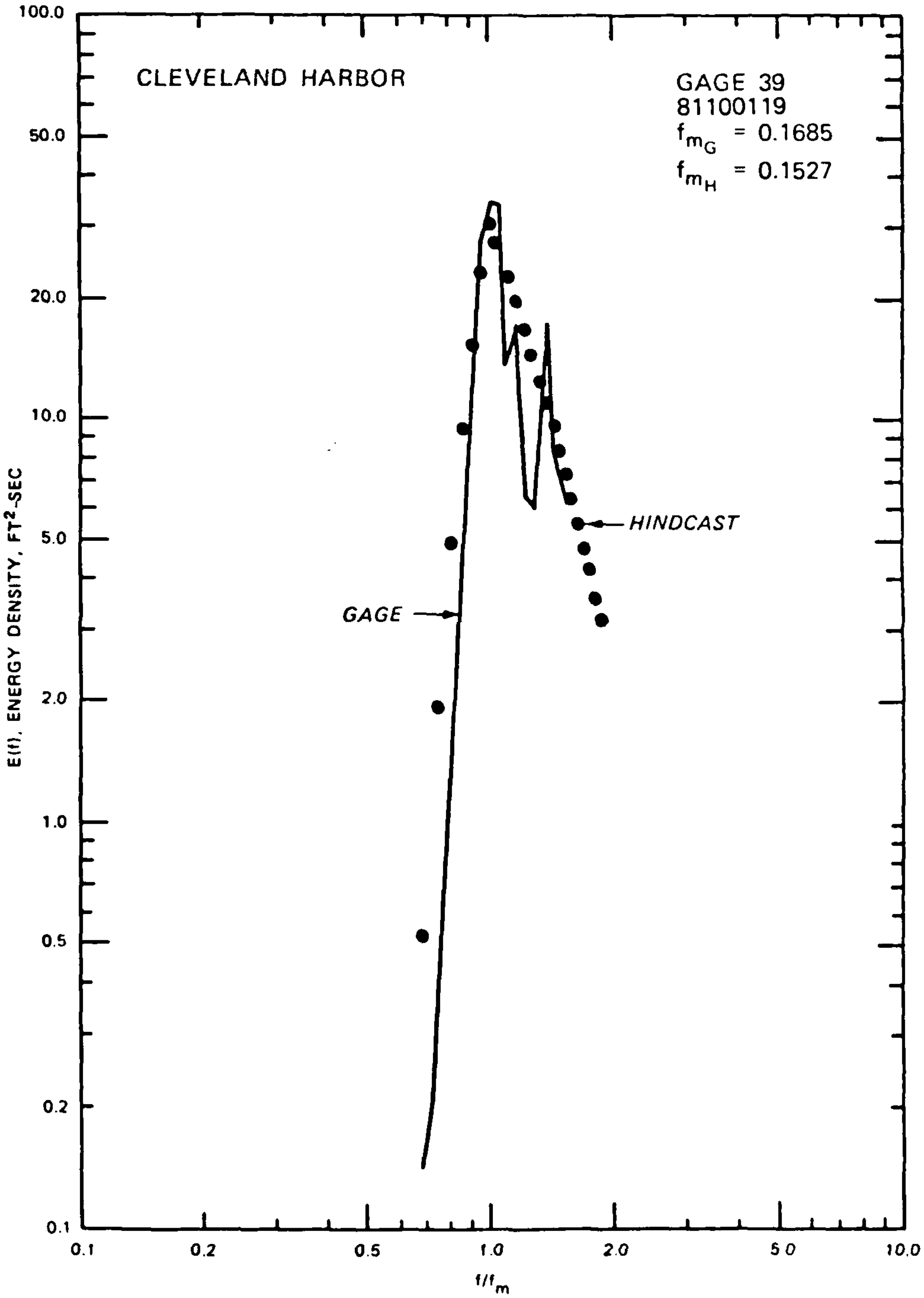


Figure 4. Gage and hindcast energy density spectral results for 1900 hr on 1 October 1981

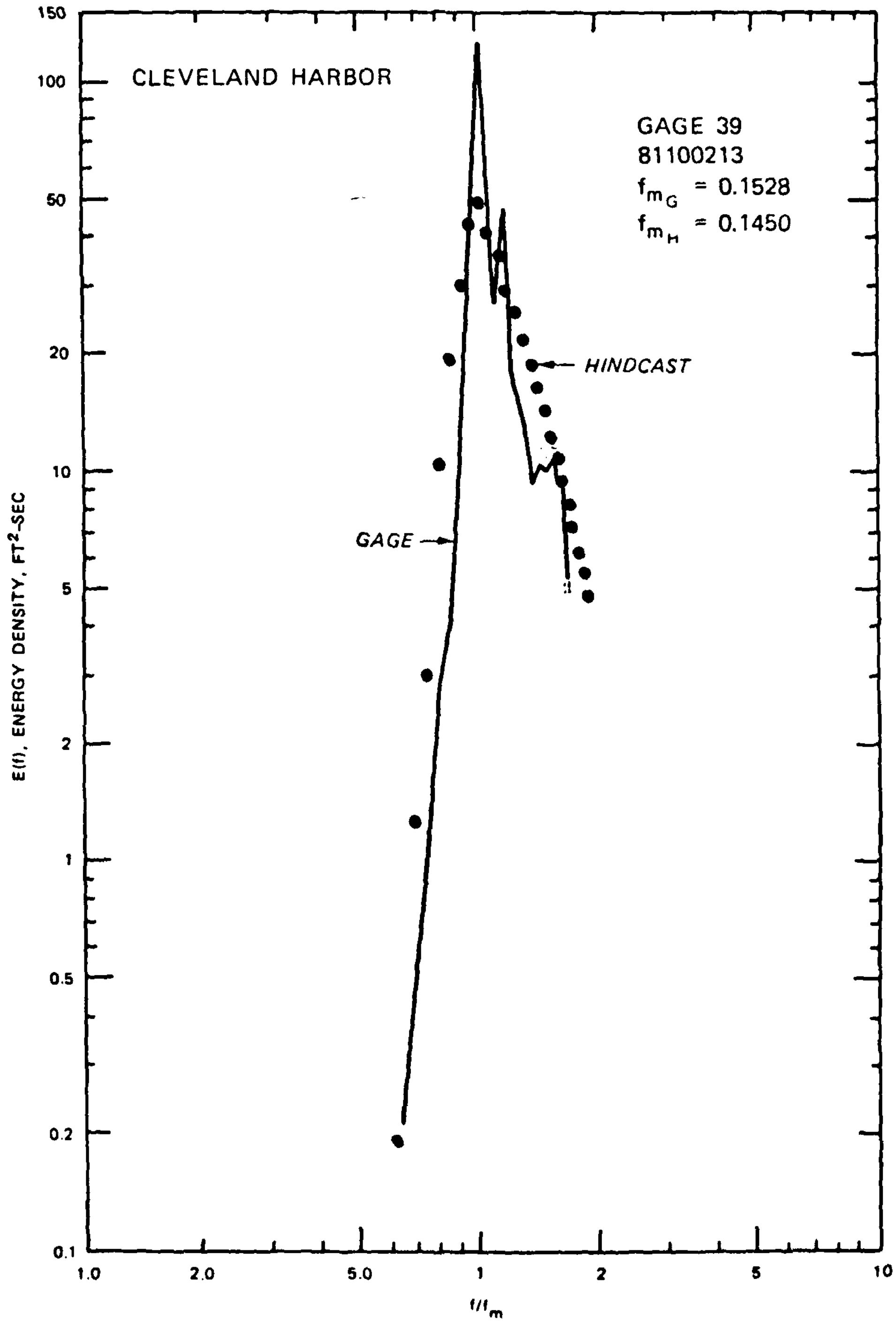


Figure 5. Gage and hindcast energy density spectral results for 1300 hr on 2 October 1981

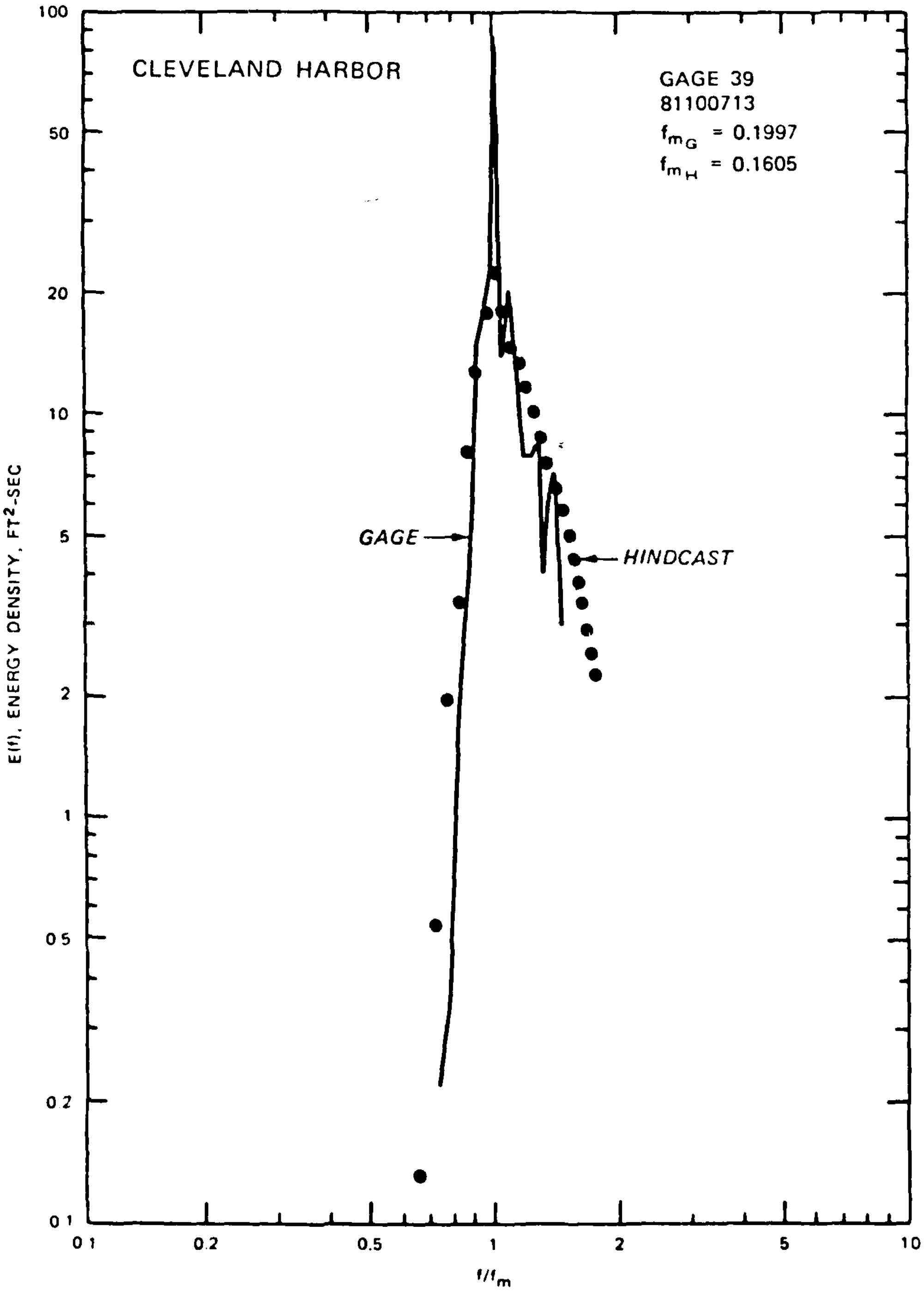


Figure 6. Gage and hindcast energy density spectral results for 0100 hr on 3 October 1981

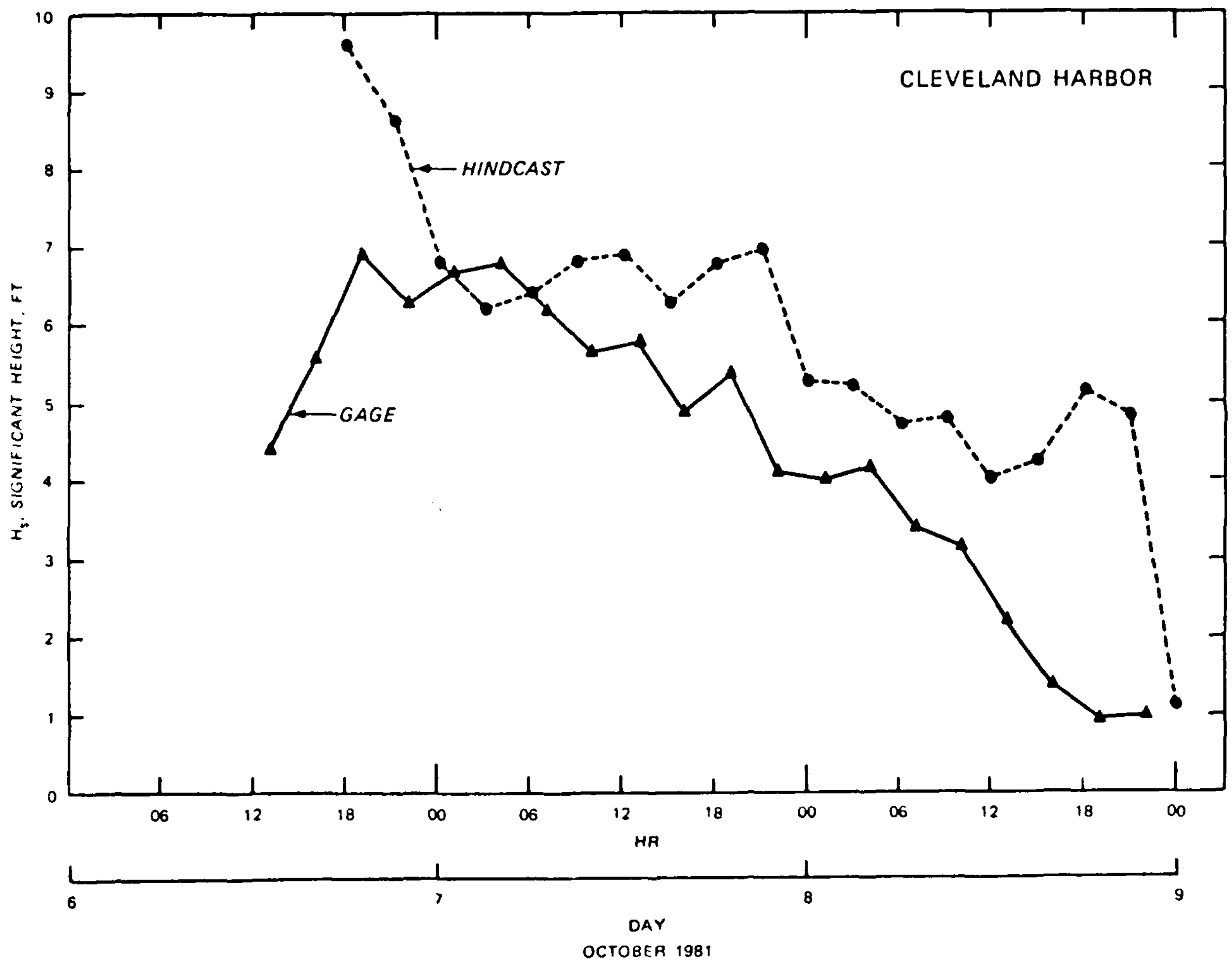


Figure 7. Gage and hindcast H_s results for 6-9 October 1981

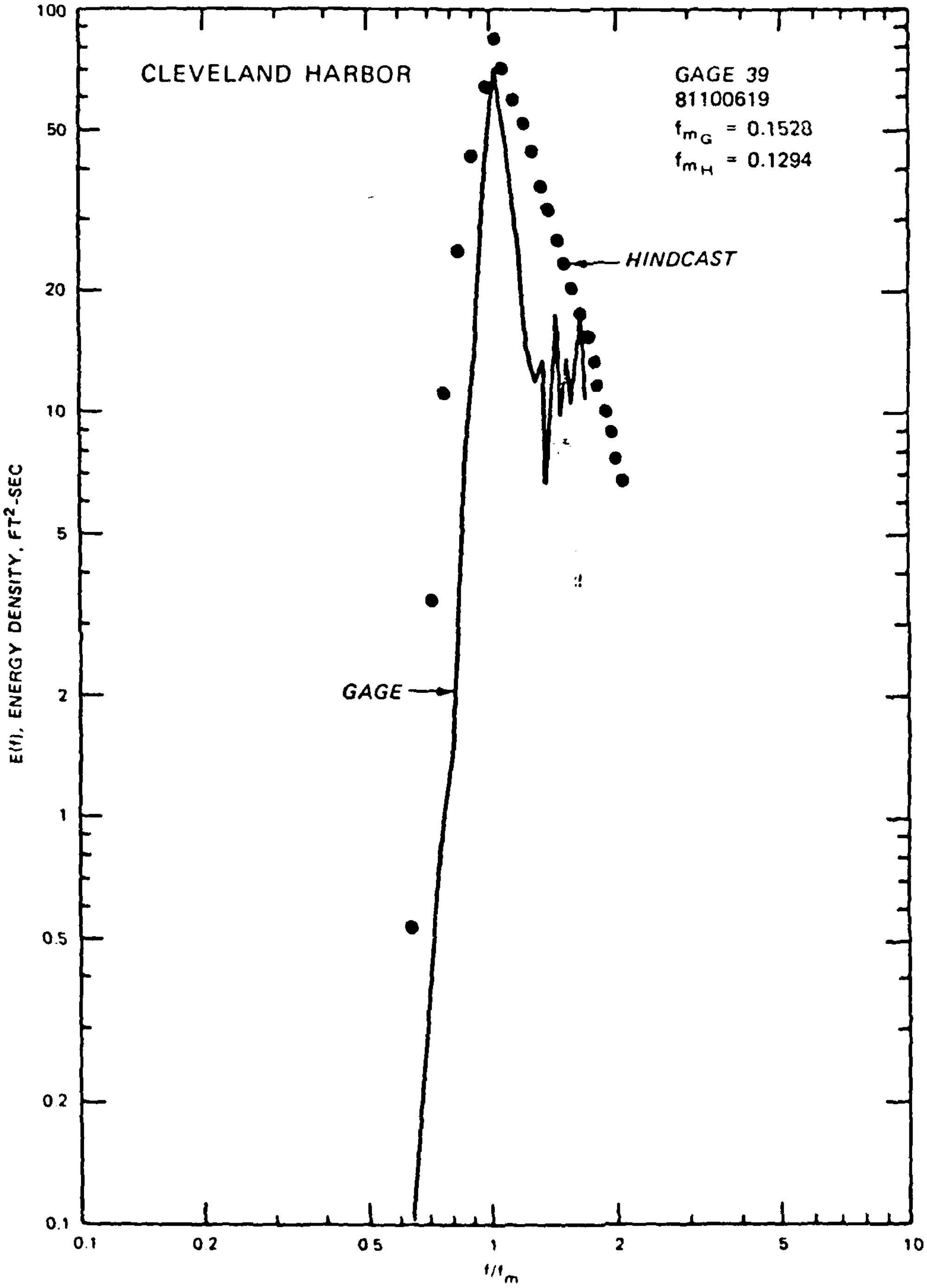


Figure 8. Gage and hindcast energy density spectral results for 1900 hr on 6 October 1981

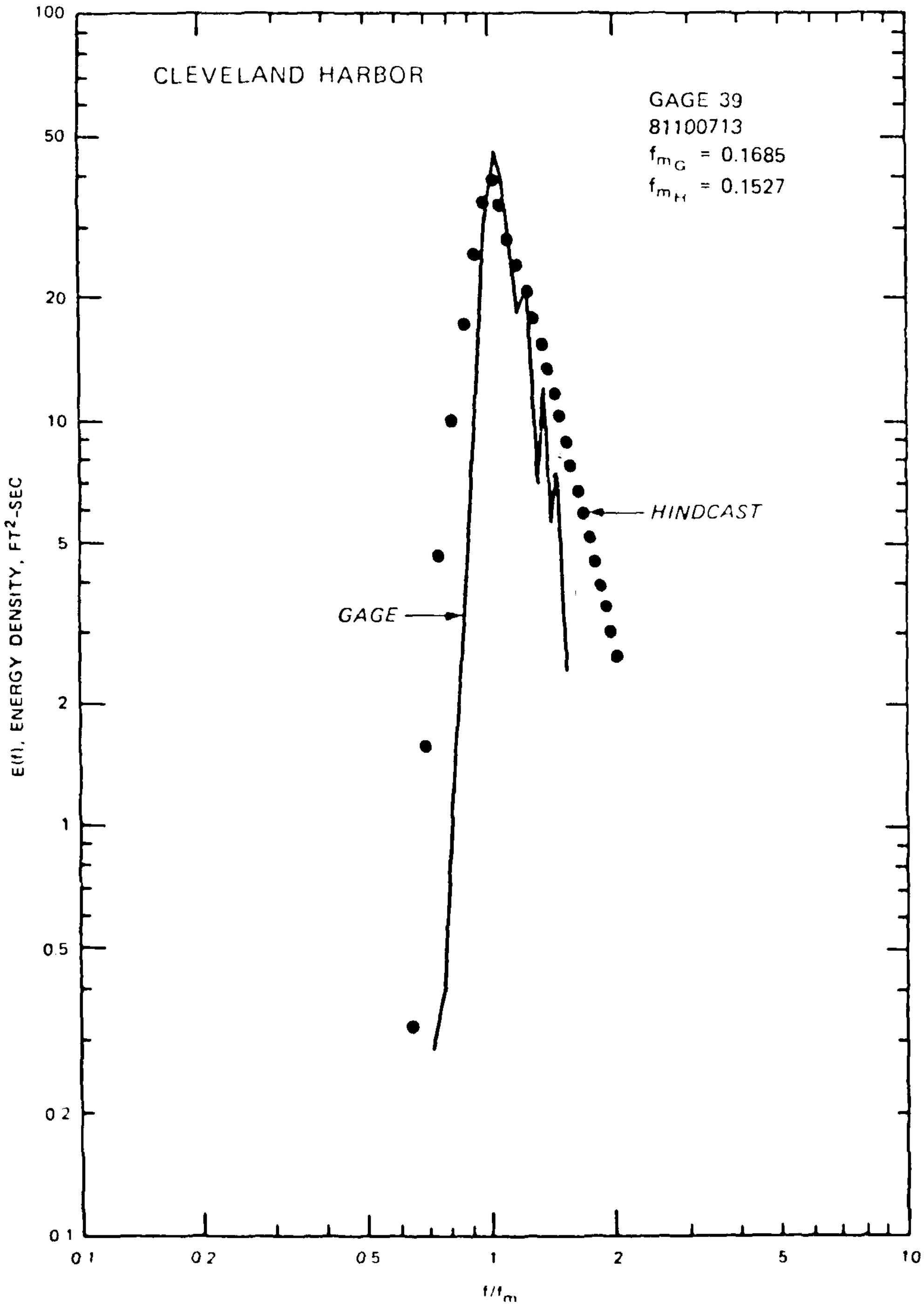


Figure 9. Gage and hindcast energy density spectral results f · 1300 hr on 7 October 1981

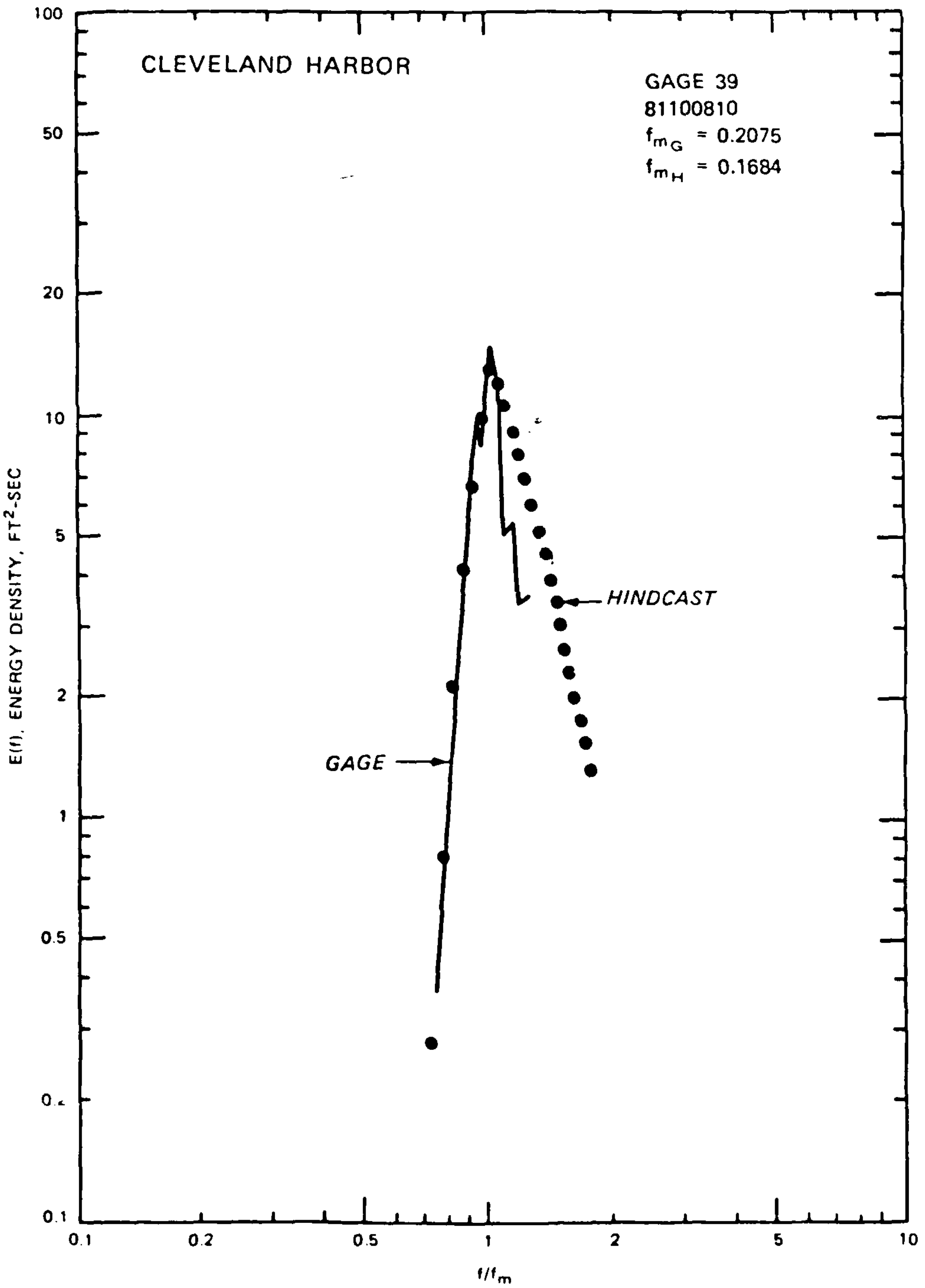


Figure 10. Gage and hindcast energy density spectral results for 1000 hr on 8 October 1981

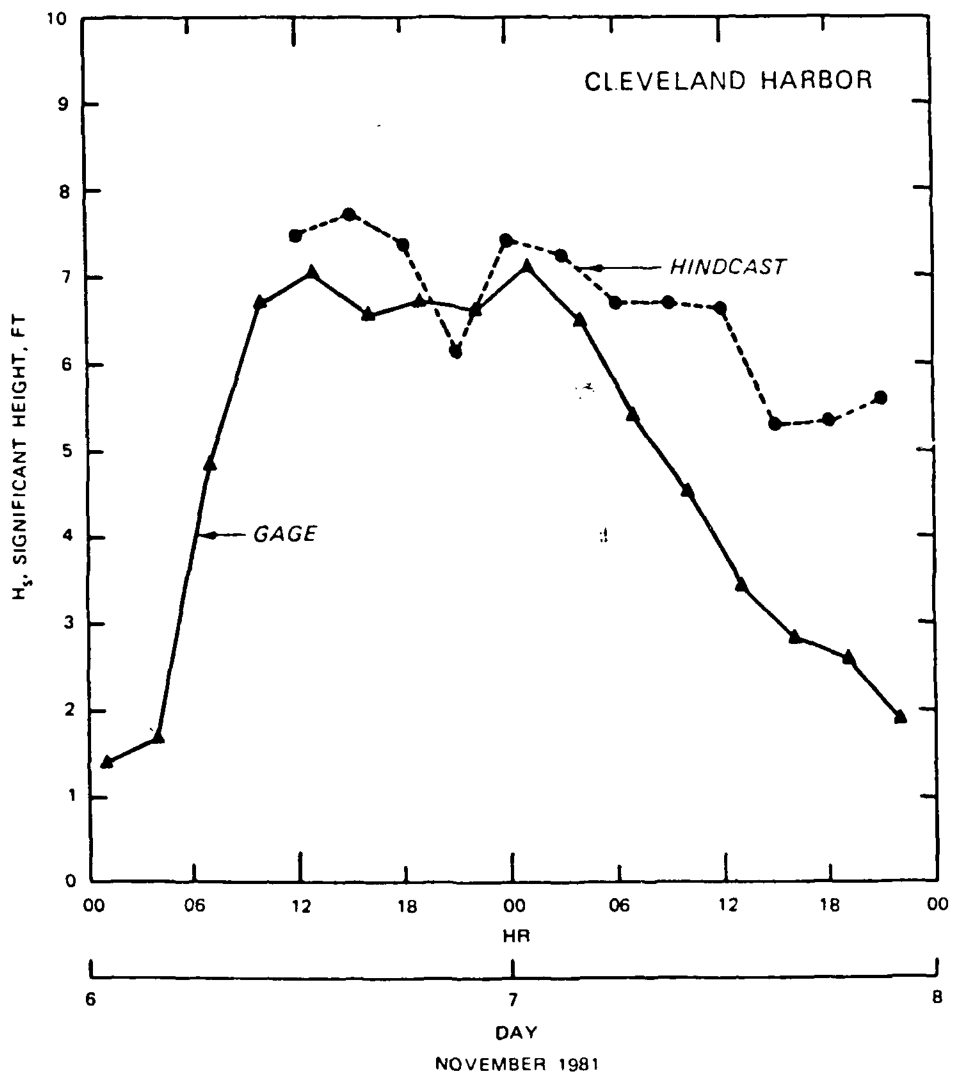


Figure 11. Gage and hindcast H_s results for 6-8 November 1981

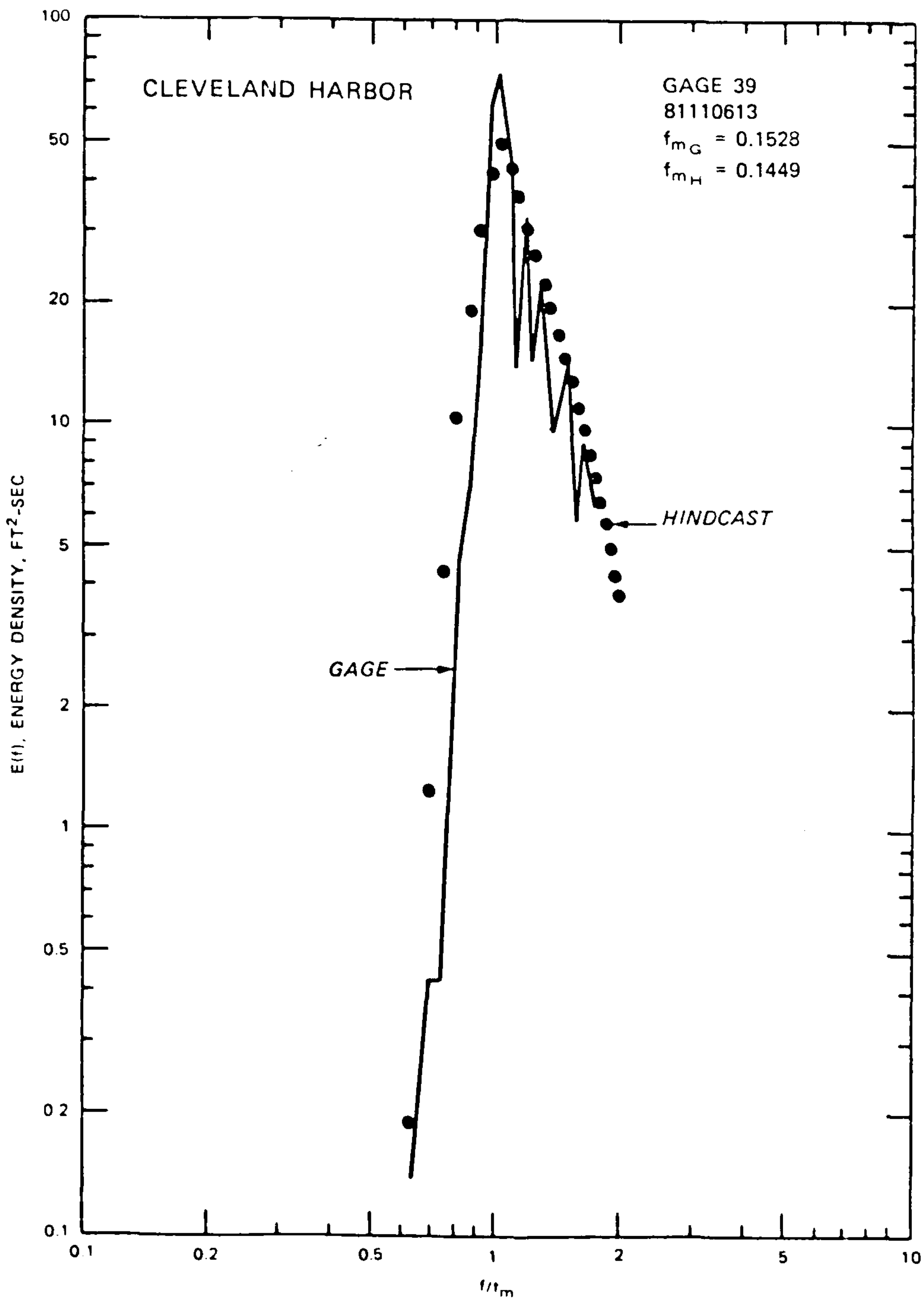


Figure 12. Gage and hindcast energy density spectral results for 1300 hr on 6 November 1981

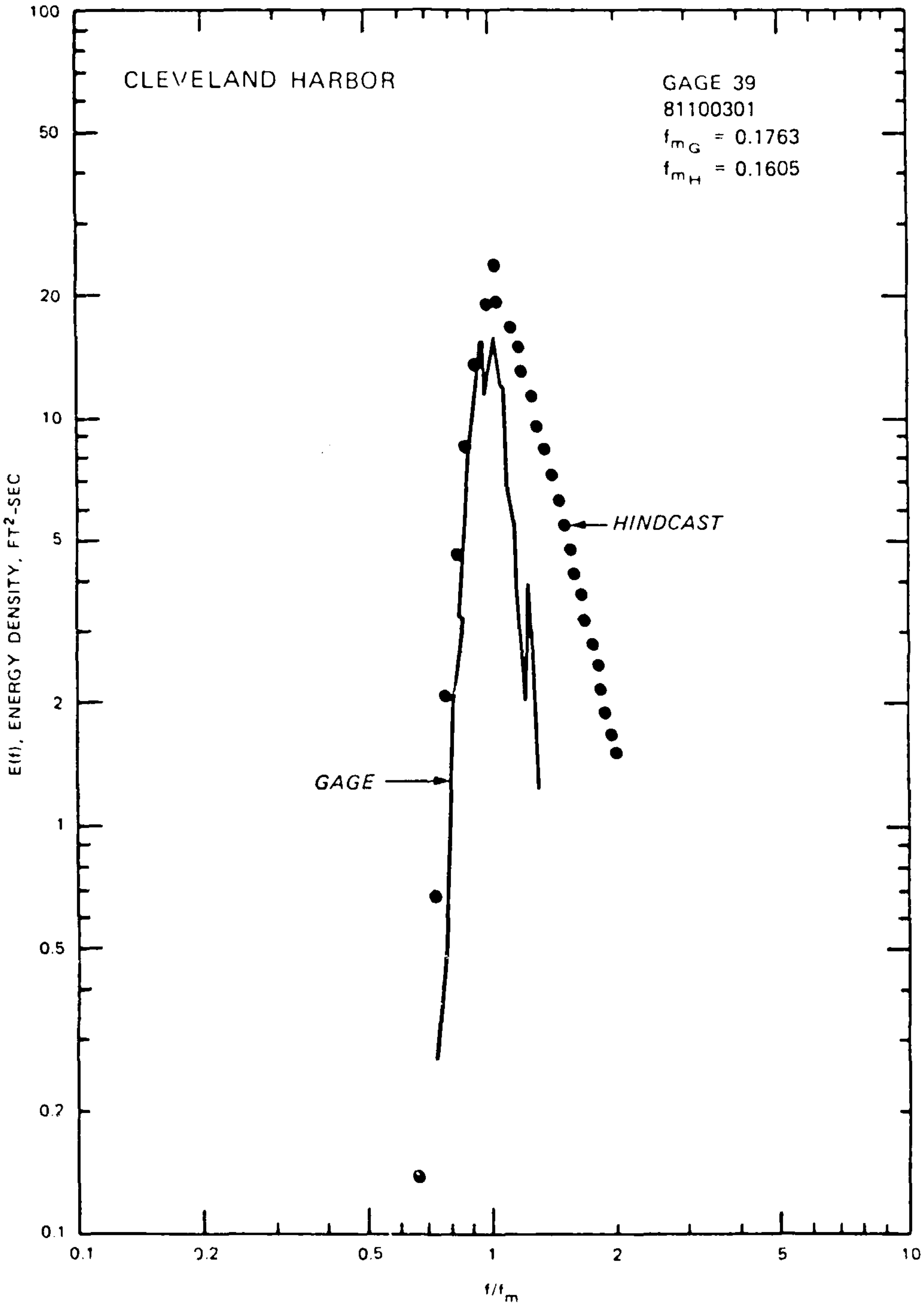


Figure 13. Gage and hindcast energy density spectral results for 1300 hr on 7 November 1981

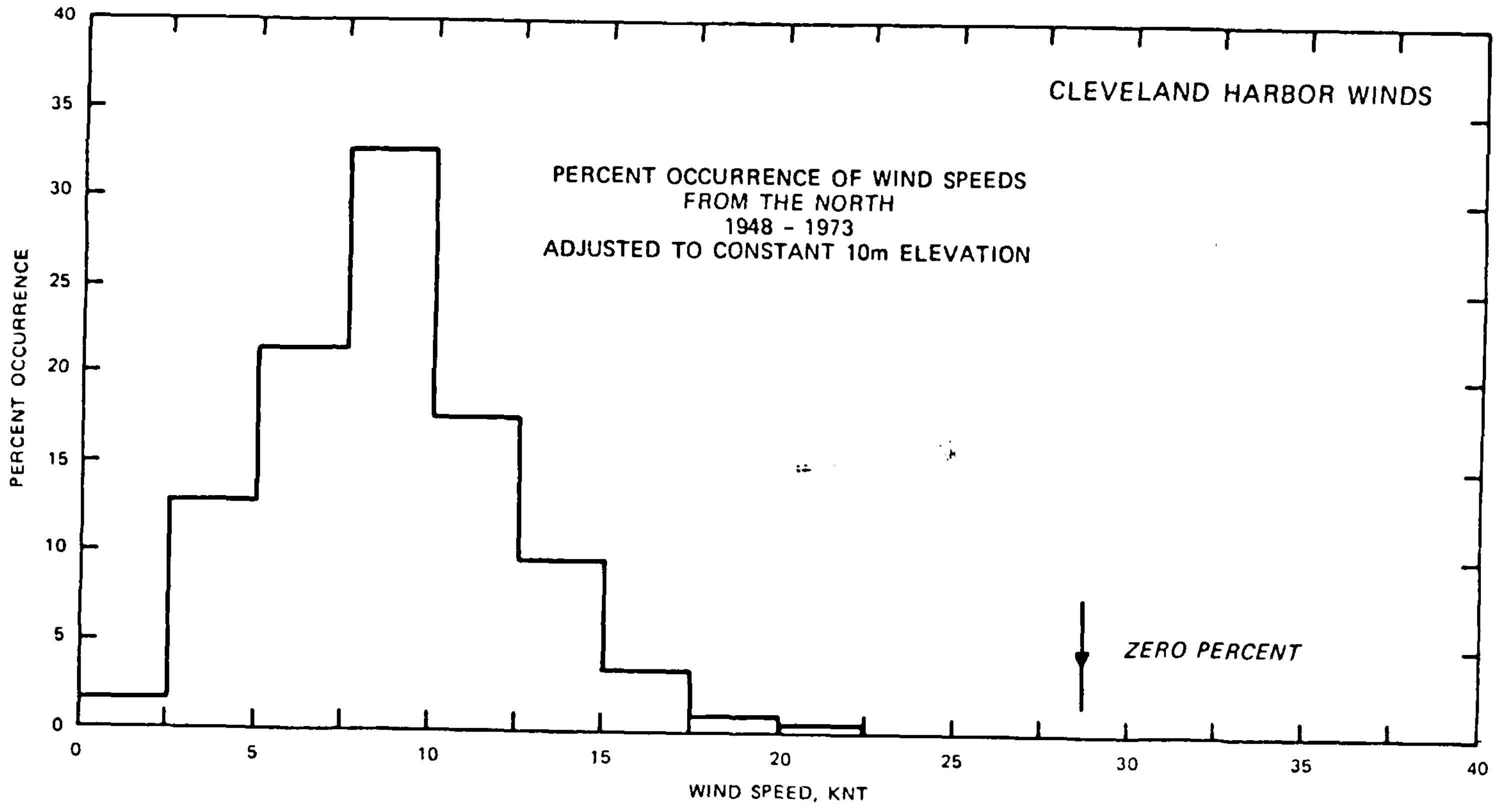


Figure 14. Percent occurrence of wind speeds from the north for the period 1948-1973

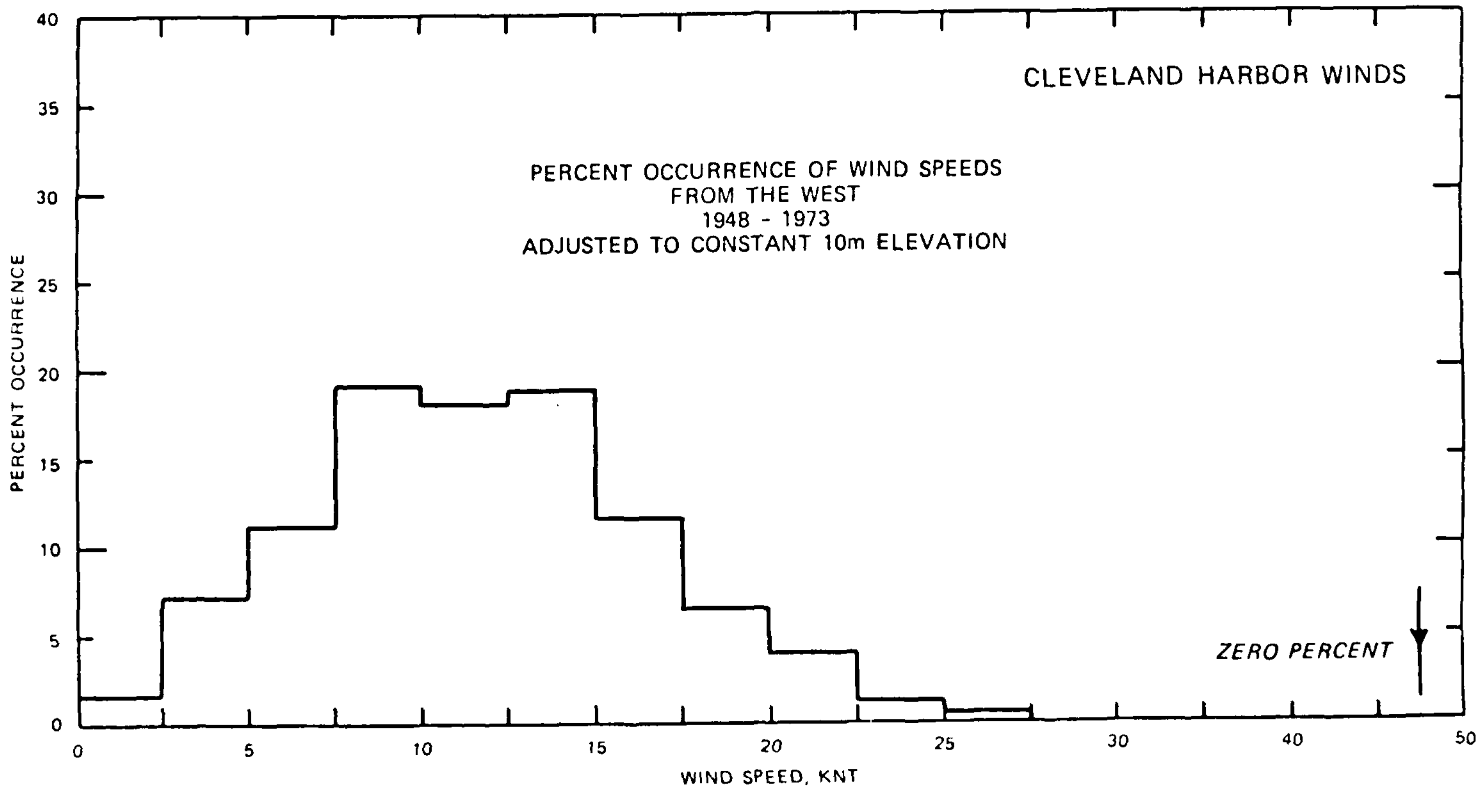


Figure 15. Percent occurrence of wind speeds from the west for the period 1948-1973

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TABLE 1

Wind Data For Storm Wave Comparisons

Storm Number	Date*	Wind Speed (knot)	Wind Direction (deg azimuth)
1	81092800	13.7	240
	81092803	9.7	240
	81092806	17.0	300
	81092809	13.0	300
	81092812	14.7	340
	81092815	14.0	310
	81092818	10.0	300
	81092821	10.3	310
	81092900	7.7	200
2	81100112	11.7	170
	81100115	13.3	230
	81100118	16.7	290
	81100121	16.0	260
	81100200	12.3	260
	81100203	14.0	300
	81100206	14.3	280
	81100209	13.0	230
	81100212	14.7	300
	81100215	17.0	310
	81100218	16.0	300
	81100221	17.7	310
	81100300	15.7	330
	81100303	14.0	320
	81100306	13.0	310
	81100309	10.7	320
	81100312	11.0	300
	81100315	9.5	290
	81100318	9.3	290
	81100321	7.7	300
	81100400	6.0	220

(continued)

TABLE 1 (concluded)

Storm Number	Date*	Wind Speed (knot)	Wind Direction (deg azimuth)
3	81100612	13.0	200
	81100615	14.7	230
	81100618	23.7	280
	81100621	20.3	280
	81100700	16.0	270
	81100703	13.3	280
	81100706	15.0	290
	81100709	16.3	300
	81100712	15.7	320
	81100715	14.0	310
	81100718	15.3	310
	81100721	16.0	310
	81100800	11.3	310
	81100803	11.3	340
	81100806	10.3	350
	81100809	10.3	340
	81100812	8.3	330
	81100815	9.0	320
	81100818	11.0	320
	81100821	10.3	320
	81100900	6.0	280
4	81110600	10.7	220
	81110603	12.3	240
	81110606	11.7	220
	81110609	12.3	240
	81110612	18.3	300
	81110615	17.7	280
	81110618	16.7	280
	81110621	13.7	310
	81110700	17.3	320
	81110703	16.7	320
	81110706	15.0	310
	81110709	15.0	310
	81110712	14.7	320
	81110715	12.0	300
	81110718	13.3	290
	81110721	12.7	290
	81110800	8.0	230

* Date = year, month, day, hour

TABLE 2

Design Wave Conditions for Cleveland Harbor

Wind Direction* (deg Azimuth)	Wind Speed (knot)	H_s (ft)	T_p** (sec)
0	30.0	10.1	8.2
0	28.6	9.2	7.7
0	20.0	8.1	7.3
0	13.0	6.1	6.2
270	43.0	12.1	8.8
270	36.1	10.7	8.2
270	33.7	10.5	8.2
270	22.6	7.9	6.9
270	15.0	6.1	6.2
270	9.0	4.1	5.7

* Wind direction from which they came.

** $T_p = 1./f_m$, peak wave period.

TABLE 3

Table of Extreme H_s Estimates for Cleveland Harbor, Ohio (in ft)
(from Resio and Vincent (1976))

	Winter Angle Classes			
	1	2	3	All
5	8.2 (0.6)*	11.2 (0.4)	10.8 (0.3)	12.3 (0.6)
10	10.2 (0.8)	12.1 (0.6)	11.5 (0.4)	13.3 (0.8)
20	11.5 (1.0)	13.4 (0.7)	12.1 (0.5)	14.3 (1.0)
50	13.8 (1.2)	14.8 (0.9)	13.1 (0.6)	15.7 (1.4)
100	15.1 (1.4)	15.7 (1.0)	13.8 (0.7)	16.8 (1.4)
	Spring Angle Classes			
5	3.9 (0.4)	5.2 (0.5)	6.9 (0.4)	7.6 (0.5)
10	4.9 (0.6)	6.6 (0.6)	7.9 (0.5)	8.6 (0.7)
20	6.2 (0.7)	7.5 (0.8)	8.9 (0.7)	9.6 (0.8)
50	7.5 (0.9)	9.2 (1.0)	10.2 (0.8)	11.1 (1.0)
100	8.5 (1.0)	10.2 (1.1)	11.2 (0.9)	12.0 (1.2)
	Summer Angle Classes			
5	4.9 (1.7)	5.6 (0.8)	6.2 (0.9)	7.3 (1.8)
10	5.9 (2.3)	6.2 (1.1)	7.2 (1.1)	8.4 (2.4)
20	7.5 (2.8)	7.2 (1.4)	8.2 (1.4)	9.7 (3.0)
50	10.2 (3.5)	8.5 (1.7)	9.5 (1.8)	11.4 (3.7)
100	12.1 (4.1)	9.2 (1.9)	10.5 (2.0)	12.9 (4.3)
	Fall Angle Classes			
5	8.9 (0.3)	9.5 (0.4)	9.8 (0.3)	10.9 (0.5)
10	9.8 (0.4)	10.8 (0.6)	10.5 (0.4)	11.7 (0.6)
20	10.5 (0.5)	11.8 (0.7)	11.2 (0.5)	12.6 (0.8)
50	11.5 (0.6)	13.1 (0.9)	12.1 (0.6)	13.9 (0.9)
100	12.1 (0.7)	14.4 (1.0)	12.8 (0.7)	14.9 (1.1)

* Standard deviation of the wave height in feet.

APPENDIX A: THEORY OF THE SHALLOW WATER WAVE MODEL (SWWM)

A1. The prediction of shallow water wave characteristics have become a focal point of research activities across the world. Because construction, shipping, and dredging operation costs have drastically increased over the years, coastal engineers have been faced with more accurately defining the shallow water wave climate. A better understanding of shallow water wave growth and transformation mechanisms is slowly evolving through controlled wave measuring programs such as ARSLOE (Vincent and Lichy 1981). However, not all of the questions have been answered, and it will take some time before all shallow water wave transformation mechanisms are quantified. In light of this, the shallow water wave modeling technique (SWWM) employed in this study adopts "state-of-the-art" mechanisms currently available. The main intent in the development of the SWWM is to describe the physical processes as accurately as possible while simplifying the computational procedures to a degree where shallow water wave hindcasting is economically feasible.

A2. Hasselmann, et al., (1976) introduced a parametric model of wind-wave generation relating the rate of energy growth to non-dimensional characteristics of the wind field. The energy growth (in space or time) is governed by a self-similar process and verified through extensive prototype data (Hasselmann, et al., 1973, 1976). In these studies the dominant energy input to the forward face of the spectrum is related to convergence of energy flux due to nonlinear, resonant wave-wave interactions (Figure A1) of the form described by Hasselmann (1962). Studies by Mitsuyasu (1968, 1969) and Kitaigorodskii (1962) also displayed similar results. Although these formulations were developed for deep-water wave conditions, they are used in the SWWM because the only formulation of the nonlinear transfers are based specifically on JONSWAP type wave spectra.

A3. The rate of wave growth under ideal conditions of fetch limitations or duration limitation and a stationary wind field can be computed (Hasselmann, et al., 1976). For growth along a fetch the solution is

$$E_o = 1.6 \times 10^{-7} U^2 F/g \tag{A1}$$

and, for growth through time, it becomes

$$E_o = 4.3 \times 10^{-10} U^{18/7} g^{-4/7} t^{10/7} \tag{A2}$$

where E_o is the total energy resulting from a wind speed U (assumed to be overwater wind conditions adjusted to 33 ft elevation), blowing over a given fetch length F. The gravitational acceleration is denoted by g ; t is the time since the wind began to blow.

A4. Two additional pieces of information are required to quantify the distribution of E_o given in the form of an energy density spectrum. The nondimensional peak frequency, $\tilde{f}_m$, and α, the Phillips equilibrium constant, (Phillips 1957), are shown in Figures A2 and A3. These parameters are written as

$$\alpha = 0.076\ \tilde{X}^{-.22} \tag{A3}$$

and

$$\tilde{f}_m = 3.5\ \tilde{X}^{-.33} \tag{A4}$$

where $\tilde{X}$ is the nondimensional fetch length

$$\tilde{X} = gF/U^2 \ . \tag{A5}$$

A5. The selection of fetch (Equation A1) or duration limited conditions (Equation A2) is determined from the following:

$$t_{min} = 5.37\ 10^2 \left(\frac{U}{g}\right)\left(\frac{gT_s}{U^2}\right)^{7/3} \tag{A6}$$

where t_{min} is the minimum duration condition and T_s is the significant wave period (U. S. Army CERC, 1981) given by:

$$T_s = 7.54\ \frac{U}{g}\ \tanh\left[0.\ 33\ \frac{g\bar{h}}{U}\right]\ \tanh\left[\frac{0.0379\left\{\frac{gF}{U^2}\right\}^{1/3}}{\tanh\left\{0.833\ \frac{g\bar{h}}{U^2}\ ^{3/8}\right\}}\right] \tag{A7}$$

where $\bar{h}$ is the mean water depth along F.

A6. If t_{min} is less than 3 hours (duration of each input wind condition) then Equation A2 will be used to compute the total energy, otherwise Equation A1 will be employed.

A7. The parameterization of the wave growth is somewhat restricted such that when the non-dimensional peak frequency attains a value of 0.13 or less, a fully developed sea state is achieved and wave growth is halted. Over long fetch lengths and low wind speeds this condition can occur to some degree of regularity. Thus, Equations A1-A5 are then redefined by

$$Q = K \sum_{i=1}^{10} \zeta_i \qquad \text{(A8)}$$

where K is defined as the non-varying parameters (and constants), Q is defined as the dependent parameters and ζ_i is recognized as the independent parameters ($\tilde{F}$ and $\tilde{X}$) found in Equations A1-A5. The parameter i is the increment counter. After each discrete fetch length $\tilde{F}_i$, the non-dimensional peak frequency is evaluated to determine if $\tilde{f}_m \leq 0.13$. If this occurs, wave growth is terminated, and wave decay is initiated for the remainder of the fetch length. Wave decay is parameterized following the work conducted by Bretschneider (1952) and Mitsuyasu and Kimura (1965) for f_m the peak frequency (where $f_m = \tilde{f}_m g/U$) while the total energy decay rate follows that described by Jensen (1983).

A8. Wave conditions generated in a given body of water also must include dispersion effects resulting from finite water depth conditions. When the water depths vary from F_i to F_{i+1}, one must consider the conservative transformation mechanisms of shoaling and refraction. Wave shoaling is determined from the evaluation of group speeds governed by linear theory. Wave refraction is neglected under the assumption that: the bottom topography is assumed to be straight and parallel for every fetch length.

A9. Finite water depth conditions also lead to bottom dissipation effects on the growing seas. Energy losses associated with bottom friction are emperically modeled using the following sets of equations developed by Bretschneider and Reid (1954).

$$E = E_1 \left[\frac{ff \; E_1 \; \phi_f \; \Delta F_i \; f_m^4}{K_s} \right]^{-1} \qquad \text{(A9)}$$

where E is the final total energy at F_i, E_1 is the original total energy at F_{i-1}, ΔF_i is the distance of wave travel within the discrete fetch length, ff is the nondimensional friction factor (set at 0.001),

$$K_s = \tanh\,(k_i h_i) \left[1 + \frac{2k_i h_i}{\sinh\,(2k_i h_i)} \right]^{-1/2} \qquad \text{(A10)}$$

and

$$\phi_f = \frac{64\pi^3}{3g^2} \left[\frac{K_s}{\sinh\,(2k_i h_i)} \right]^3 \qquad \text{(A11)}$$

where k_i is the wave number $(k_i = \frac{2\pi}{L_i})$, L_i is the wavelength evaluated for f_m, and h_i is the water depth at F_i.

A10. The second theoretical aspect of SWWM deals primarily with the distribution of the total energy (E_o) in the form of a one-dimensional discrete frequency spectrum $(E(f_j))$. Through the use of similarity principles, Kitaigordskii, et al., (1975) extended Phillip's deepwater hypothesis (Phillips 1958) of the equilibrium range in the spectrum of wind-generated surface waves to finite depth conditions. The spectral form is defined by

$$E(f_j) = \alpha g^2 (2\pi)^{-4} f_j^{-5} \Phi(\omega_h) \qquad f_j \geq f_m \tag{A12}$$

where $E(f_j)$ is the energy density at each discrete frequency band, f_j, and $\Phi(\omega_h)$ is a non-dimensional function dependent on ω_h given by

$$\omega_h = 2\pi f_j (h/g)^{1/2} \tag{A13}$$

The function $\Phi(\omega_h)$ varies from 1.0 in deep water to 0.0 when $h = 0.0$, as shown by Figure A4.

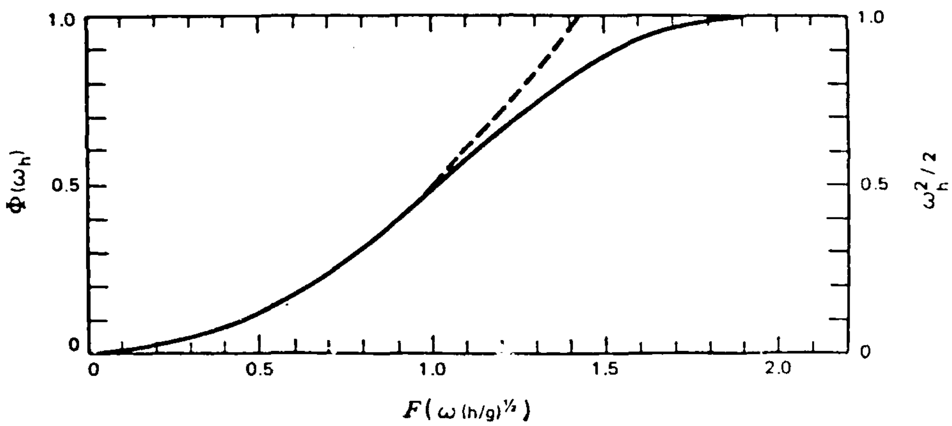

Figure A4. The universal dimensionless function Φ (solid curve) and the function $\omega_h^2/2$ (dashed curve) from Kitaigordskii et al. (1975)

When ω_h is less than 1.0, $\Phi(\omega_h)$ can be approximated by:

$$\Phi(\omega_h) \cong \frac{1}{2}\omega_h^2 \tag{A14}$$

and therefore,

$$E(f_j) = \frac{1}{2}\alpha g h (2\pi)^{-2} f_j^{-3} \qquad f_j \geq f_m \tag{A15}$$

AD-A139 380 CLEVELAND HARBOR OHIO DRAFT REFORMULATION PHASE I GENERAL DESIGN MEMORAND..(U) CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT FEB 84 7/8

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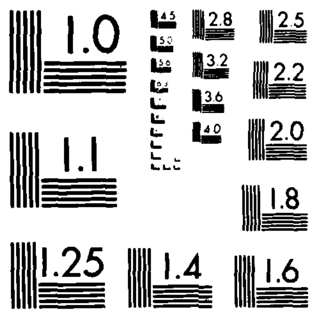


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

or, the spectral shape changes from a f^{-5} to a f^{-3} in the tail of the energy density spectrum, and more importantly, become a function of the water depth

A11. The forward face of the spectrum is assumed to be represented by:

$$E(f_j) = \alpha g^2 (2\pi)^{-4} \exp\left[1 - (f_m/f)^4\right] \Phi'(\omega_h) \qquad f_j < f_m \tag{A16}$$

where $\Phi'(\omega_h)$ is evaluated from the ω_h defined at f_m. Field and laboratory data by Goda (1974), Thornton (1977), Ou (1980), Iwata (1980), and Vincent (1981) support the form given by Equation A12. The verification of Equation A16 can be found in Vincent* (1982a) and is supported in Jensen (1983).

A12. The parametric representation of wave growth assumes a dynamic balance between atmospheric sources and transfers of energy resulting from wave-wave interactions (Figure A1). This parameterization was based on deepwater wave conditions, Hasselmann, et al., (1976). During a recent study it was determined that over moderately short fetch lengths (10-20 nm), this deepwater growth rate expression (Equations A1 and A2) consistently underpredicted the total energy found in the measured data, Garcia and Jensen (1983). The only theoretically consistent location to add the energy would be on the forward face of the spectrum (Figure A5). The function, $E(f,h)_{THEORY}$ is the saturated spectrum based on Equations A12 and A16, and $E(f,h)_{WEIGHTED}$ is the spectrum based on E_o after wave growth. This process also shifts f_m to a lower frequency which has been noticed in field data (Vincent* 1982b). As the fetch length increases, the relative amount of added energy decreases, where eventually, no additional energy is incorporated into the resulting spectrum.

A13. It has been shown that the water depth greatly influences the spectral shape and in so doing will influence the maximum wave condition. The parametric formulation follows the work conducted by Vincent (1981). The depth limiting maximum wave condition is given by,

$$H_m = 4\sqrt{\int_{f_c}^{\infty} E(f)\, df} \tag{A17}$$

* Vincent, C. L. (1982a). Personnel Communication, U. S. Army CERC, Fort Belvoir, Virginia.
Vincent, C. L. (1982b). Personnal Communication, U. S. Army CERC, Fort Belvoir, Virginia.

where H_m is the maximum wave condition, f_c is the lower frequency bounding the total energy, (equal to 0.9 f_m) and $E_m(f)$ is defined from Equation A12. Integrating Equation A17 one obtains the absolute limit on the wave condition at a particular water depth, where

$$H_m = \frac{(\alpha g h)^{1/2}}{\pi f_c} \tag{A18}$$

A14. In summary, the physical process governing wave generation and transformations has been theoretically determined using available, "state-of-the-art" techniques. It must be emphasized that not all shallow water transformation processes have (or can be) measured to determine their relative effect on the total energy, spectral shape and the peak frequency. Therefore, the development of the SWWM as employed in this study attempts to model the physics of the problem in a general sense while maximizing computational efficiency.

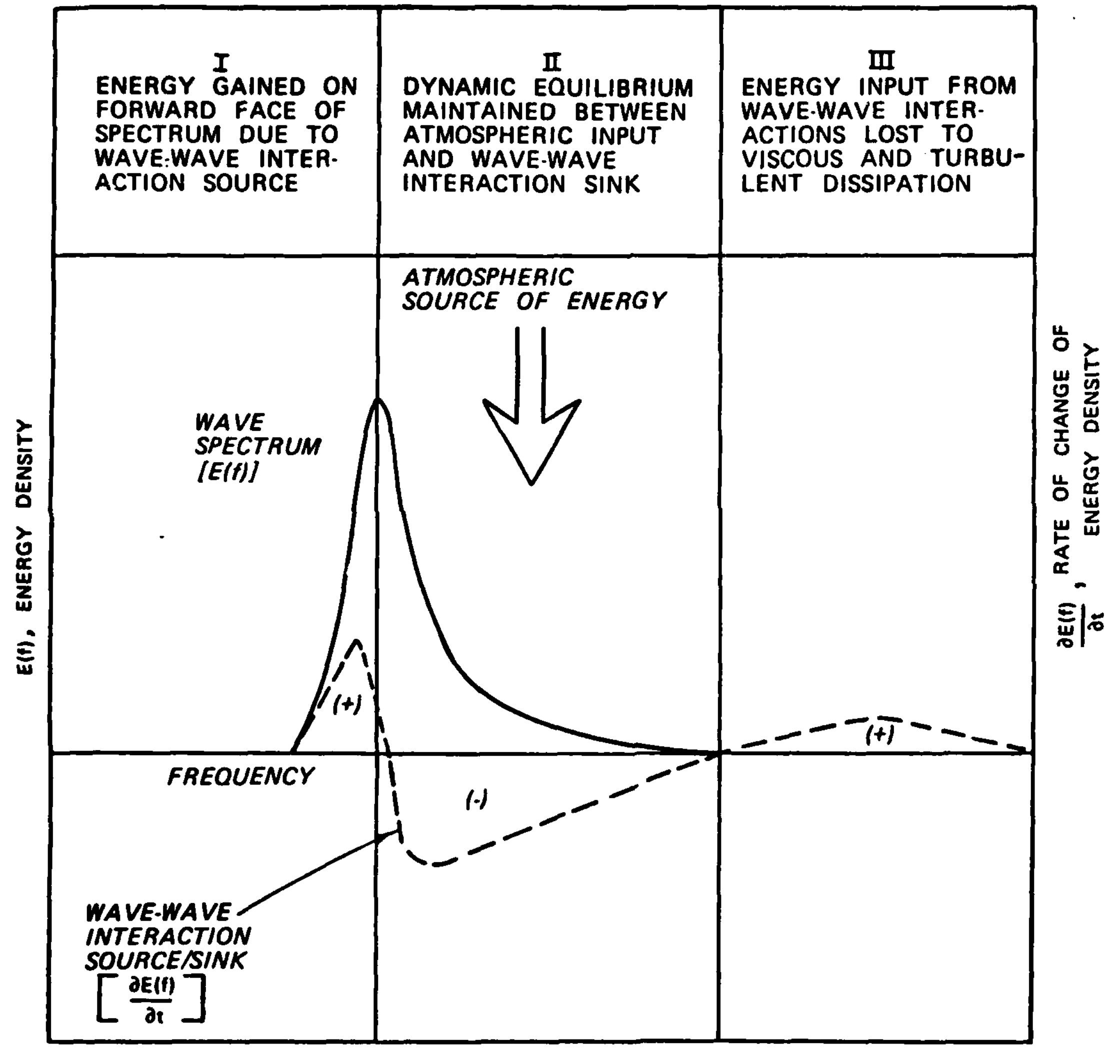


Figure A1. Schematic representation of the nonlinear wave-wave interaction

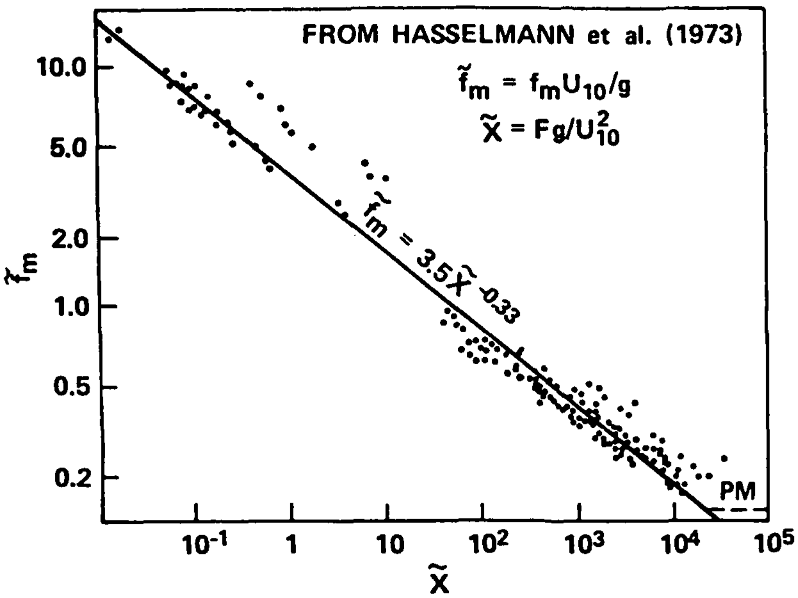
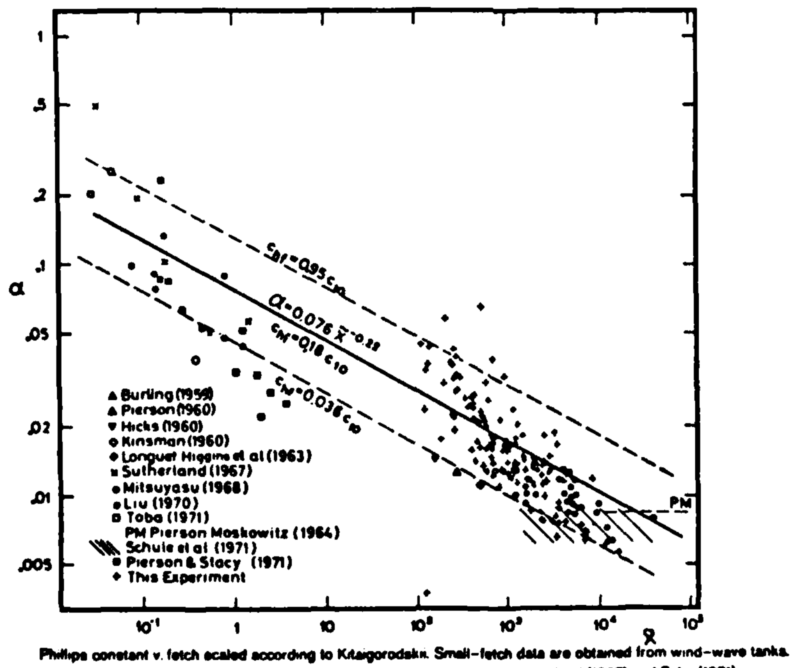


Figure A2. Nondimensional peak frequency $\tilde{f}_m$ as a function of nondimensional fetch length $\tilde{X}$, from Hasselmann et al. (1973)



Phillips constant v. fetch scaled according to Kitaigorodskii. Small-fetch data are obtained from wind-wave tanks. (Capillary-wave data was excluded where possible.) Measurements by Sutherland (1967) and Toba (1971) were taken from W.J. Pierson and R.A. Stacy (1973)

Figure A3. Phillips' equilibuium constant α as a function of nondimensional fetch length $\tilde{X}$, from Hasselmann et al. (1973)

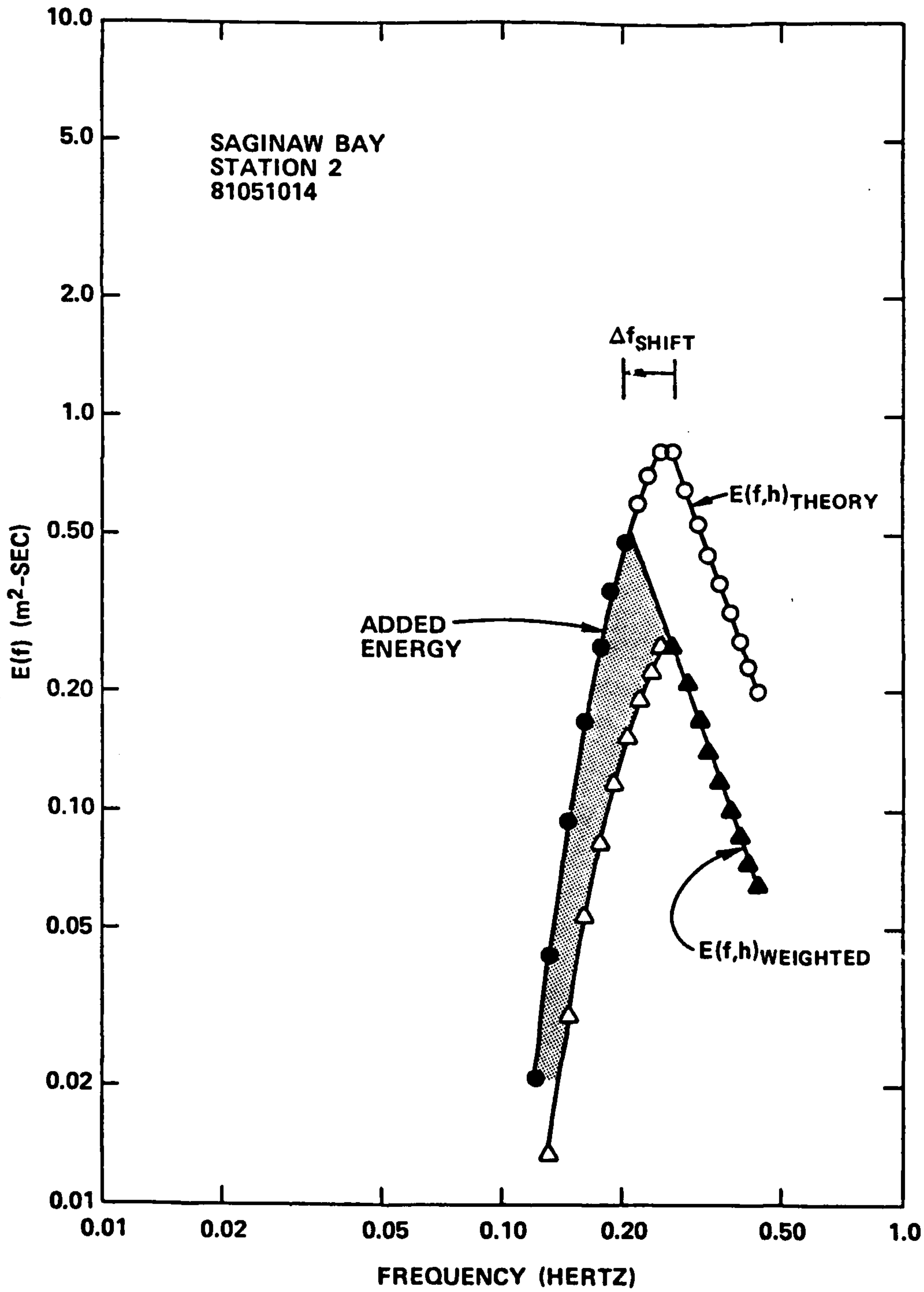


Figure A5. Construction of the final energy density spectrum (solid symbols) caused by shallow water wave generation

APPENDIX B

DESIGN WAVE INFORMATION

I N I T I A L   C O N D I T I O N S

NF = 64 NDIR = 16 NDF = 10 NST = 1
G = 9.81 FFACT = 0.0010

F R E Q U E N C I E S

0.0044	0.0122	0.0200	0.0278	0.0356	0.0434	0.0513	0.0591	0.0669	0.0747
0.0825	0.0903	0.0981	0.1059	0.1137	0.1215	0.1294	0.1372	0.1450	0.1528
0.1606	0.1684	0.1762	0.1840	0.1918	0.1996	0.2075	0.2153	0.2231	0.2309
0.2387	0.2465	0.2543	0.2621	0.2699	0.2777	0.2856	0.2934	0.3012	0.3090
0.3168	0.3246	0.3324	0.3402	0.3480	0.3558	0.3637	0.3715	0.3793	0.3871
0.3949	0.4027	0.4105	0.4183	0.4261	0.4339	0.4418	0.4496	0.4574	0.4652
0.4730	0.4808	0.4886	0.4964						

WATER DEPTHS FOR ALL STATIONS (M) =

9.15

NF - number of frequency bands

NDIR - number of direction bands

NDF - number of disrete fetch lengths

NST - number of stations

FREQUENCIES - are in hertz

DATE = 83030301
WIND SPEED = 43.00 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	43.25	1	47.60	2.52	0.	0.14401E 02	0.32858E 01	0.	142.6683	0.2381	0.0172	12.09	8.79	270.00

DATE = 83030301 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0902	1.7898
10.4583	31.3204	63.7342	102.6372	142.6683	116.8860	96.9465	81.3345	68.8747	58.8436
50.6648	43.9391	38.3566	31.7170	27.6221	24.1179	21.1003	18.4878	16.2155	14.2328
12.4978	10.9777	9.6455	8.4778	7.4556	6.5620	5.7814	5.0995	4.5044	3.9859
3.5332	3.1382	2.7930	2.4910	2.2267	1.9946	1.7905	1.6109	1.4521	1.3117
1.1871	1.0765	0.9780	0.8901	0.8115	0.7411	0.6778	0.6210	0.5697	0.5235
0.4817	0.4438	0.4095	0.3782						

DATE = 83030302
WIND SPEED = 33.70 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	43.25	1	47.60	2.88	0.	0.87376E 01	0.13011E 01	0.	103.3617	0.2719	0.0152	10.53	8.23	270.00

DATE = 83030302 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0051	0.2524
2.5239	10.5535	26.6579	49.6278	76.2402	103.3617	85.7293	71.9237	60.9055	52.0351
44.8026	38.8551	33.9186	28.0472	24.4261	21.3273	18.6589	16.3487	14.3393	12.5860
11.0517	9.7076	8.5295	7.4969	6.5929	5.8027	5.1125	4.5095	3.9832	3.5247
3.1244	2.7751	2.4698	2.2028	1.9691	1.7639	1.5834	1.4245	1.2841	1.1599
1.0498	0.9519	0.8649	0.7871	0.7176	0.6553	0.5994	0.5491	0.5038	0.4629
0.4259	0.3925	0.3621	0.3345						

DATE = 83030303
WIND SPEED = 22.60 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	43.25	1	47.60	3.37	0.	0.45495E 01	0.35891E 00	0.	52.1132	0.3868	0.0130	7.90	6.90	270.00

DATE = 83030303 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
0.0102	0.1847	1.2051	4.2396	10.1096	18.7159	29.2442	40.6696	52.1132	44.5233
38.3349	33.2460	29.0221	23.9983	20.9000	18.2485	15.9653	13.9886	12.2693	10.7691
9.4563	8.3062	7.2982	6.4146	5.6412	4.9650	4.3745	3.8585	3.4082	3.0159
2.6734	2.3745	2.1133	1.8848	1.6848	1.5092	1.3548	1.2188	1.0987	0.9925
0.8982	0.8145	0.7400	0.6735	0.6140	0.5607	0.5129	0.4699	0.4311	0.3961
0.3645	0.3358	0.3098	0.2862						

DATE = 83030304
WIND SPEED = 15.00 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	43.25	1	47.60	3.87	0.	0.22547E 01	0.81960E-01	0.69233E-01	28.7620	0.4746	0.0111	6.10	6.23	270.00

DATE = 83030304 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0001	0.0040	0.0678	0.4506	1.6676	4.2155	8.2548	13.5637	19.7028	26.2018
28.7620	24.9439	21.7748	18.0055	15.6809	13.6915	11.9785	10.4954	9.2054	8.0799
7.0949	6.2320	5.4757	4.8128	4.2325	3.7252	3.2821	2.8950	2.5571	2.2627
2.0058	1.7816	1.5855	1.4141	1.2641	1.1323	1.0165	0.9145	0.8244	0.7446
0.6739	0.6111	0.5552	0.5053	0.4607	0.4207	0.3848	0.3525	0.3234	0.2972
0.2734	0.2519	0.2324	0.2147						

DATE = 83030305
WIND SPEED = 9.00 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TM
1	43.25	1	47.60	4.34	0.	0.90966E 00	0.98157E-02	0.12210E 00	12.7472	0.5715	0.0091	4.06	5.67	270.00

DATE = 83030305 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0002	0.0053	0.0510	0.2525	0.8045	1.8940	3.6055	5.8942
8.6233	11.6201	12.7472	10.5406	9.1798	8.0152	7.0123	6.1441	5.3890	4.7300
4.1534	3.6483	3.2055	2.8175	2.4777	2.1808	1.9214	1.6947	1.4970	1.3246
1.1742	1.0429	0.9282	0.8279	0.7400	0.6629	0.5951	0.5353	0.4826	0.4359
0.3945	0.3578	0.3250	0.2958	0.2697	0.2463	0.2253	0.2064	0.1893	0.1740
0.1601	0.1475	0.1361	0.1257						

DATE = 83030306
WIND SPEED = 36.10 KNOTS OVER LAND
WIND DIRECTION = 270.00 FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TM
1	43.25	1	47.60	2.80	0.	0.96515E 01	0.16220E 01	0.	106.3291	0.2719	0.0156	10.68	8.23	270.00

DATE = 83030306 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0053	0.2597
2.5964	10.8565	27.4233	51.0525	78.4290	106.3291	88.1906	73.9885	62.6541	53.5290
46.0889	39.9706	34.8924	28.8524	25.1274	21.9396	19.1946	16.8180	14.7510	12.9473
11.3690	9.9863	8.7743	7.7121	6.7822	5.9693	5.2593	4.6389	4.0976	3.6259
3.2141	2.8548	2.5407	2.2661	2.0256	1.8145	1.6288	1.4654	1.3210	1.1932
1.0799	0.9793	0.8897	0.8097	0.7382	0.6741	0.6166	0.5649	0.5183	0.4762
0.4382	0.4037	0.3725	0.3441						

DATE = 83030310
WIND SPEED = 30.00 KNOTS OVER LAND
WIND DIRECTION = 0. FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TM
1	66.00	1	56.45	3.42	0.	0.10135E 02	0.86324E 00	0.	95.1390	0.2719	0.0140	10.11	8.23	0.

DATE = 83030310 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0047	0.2323
2.3231	9.7139	24.5372	45.6797	70.1751	95.1390	78.9093	66.2019	56.0603	47.8956
41.2384	35.7641	31.2203	25.8160	22.4829	19.6307	17.1745	15.0481	13.1986	11.5848
10.1725	8.9353	7.8509	6.9005	6.0685	5.3411	4.7058	4.1507	3.6664	3.2443
2.8758	2.5544	2.2733	2.0276	1.8124	1.6235	1.4574	1.3112	1.1820	1.0677
0.9663	0.8762	0.7961	0.7245	0.6605	0.6032	0.5517	0.5054	0.4637	0.4261
0.3921	0.3612	0.3333	0.3079						

DATE = 83030311
WIND SPEED = 20.00 KNOTS OVER LAND
WIND DIRECTION = 0. FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TM
1	66.00	1	56.45	3.97	0.	0.50122E 01	0.21513E 00	0.	56.5144	0.3463	0.0119	8.09	7.29	0.

DATE = 83030311 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0018
0.0736	0.7496	3.3691	9.2313	18.5217	30.3398	43.3840	56.5144	47.8568	40.8868
35.2039	30.5306	26.6517	22.0382	19.1929	16.7581	14.6613	12.8460	11.2672	9.8895
8.6839	7.6278	6.7021	5.8907	5.1804	4.5595	4.0172	3.5433	3.1298	2.7695
2.4550	2.1806	1.9407	1.7309	1.5472	1.3860	1.2441	1.1193	1.0090	0.9114
0.8249	0.7480	0.6796	0.6185	0.5639	0.5149	0.4710	0.4315	0.3959	0.3637
0.3347	0.3084	0.2845	0.2628						

DATE = 83030312
WIND SPEED = 13.00 KNOTS OVER LAND
WIND DIRECTION = 0. FROM WHICH THEY CAME

IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	66.00	1	56.45	4.49	0.	0.22812E 01	0.41096E-01	0.11637E-01	29.1003	0.4746	0.0101	6.06	6.23	0.

DATE = 83030312 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0037	0.0618	0.4105	1.5190	3.8398	7.5191	12.3548	17.9467	23.8665
29.1003	25.2373	22.0309	18.2173	15.8653	13.8526	12.1194	10.6188	9.3137	8.1749
7.1783	6.3053	5.5401	4.8694	4.2823	3.7690	3.3207	2.9290	2.5872	2.2894
2.0294	1.8025	1.6042	1.4308	1.2790	1.1457	1.0284	0.9252	0.8341	0.7534
0.6819	0.6183	0.5617	0.5112	0.4661	0.4257	0.3893	0.3567	0.3272	0.3007
0.2767	0.2549	0.2352	0.2173						

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WIND DIRECTION = 0. FROM WHICH THEY CAME

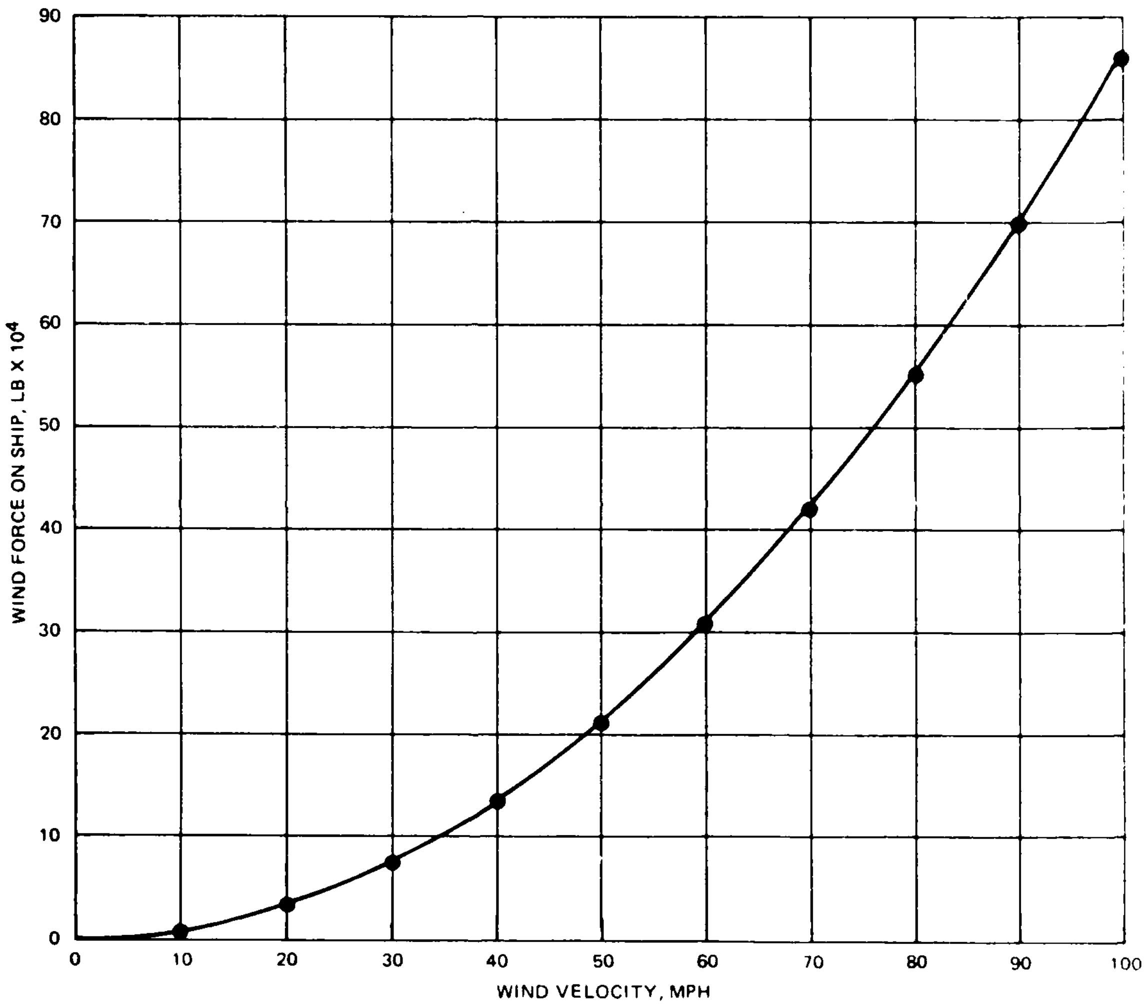
IG DURATION LIMITED = ZERO FETCH LIMITED = ONE
ALL ENERGIES IN (FT2-SEC) SYSTEM
ALL DEPTHS AND HEIGHTS IN (FT)
ALL FETCH LENGTHS (TOTX DECLIN) IN (NMI)
TDUR DURATION IN HOURS
ALL WAVE ANGLES IN DEG AZIMUTH FROM WHICH THEY CAME

ST	DBAR	IG	TOTX	TDUR	DECLN	EGROWTH	ELOSS	EATM	EMAX	PHIFM	ALPHA	HS	TP	TH
1	66.00	1	56.45	3.57	0.	0.81483E 01	0.57390E 00	0.	75.5116	0.3079	0.0134	9.19	7.73	0.

DATE = 83030313 STATION = 1
FREQUENCY SPECTRA (FT2-SEC)

0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0254
0.4863	3.0477	10.0057	22.2071	38.5210	56.9150	75.5116	63.3513	53.6464	45.8332
39.4628	34.2241	29.8760	24.7044	21.5149	18.7854	16.4350	14.4001	12.6302	11.0859
9.7345	8.5506	7.5129	6.6034	5.8072	5.1111	4.5032	3.9720	3.5085	3.1046
2.7520	2.4444	2.1754	1.9403	1.7344	1.5536	1.3946	1.2547	1.1311	1.0217
0.9247	0.8385	0.7618	0.6933	0.6321	0.5772	0.5280	0.4837	0.4438	0.4077
0.3752	0.3457	0.3189	0.2946						

View of model ore carrier



Wind force versus wind velocity

Incl 6

CLEVELAND

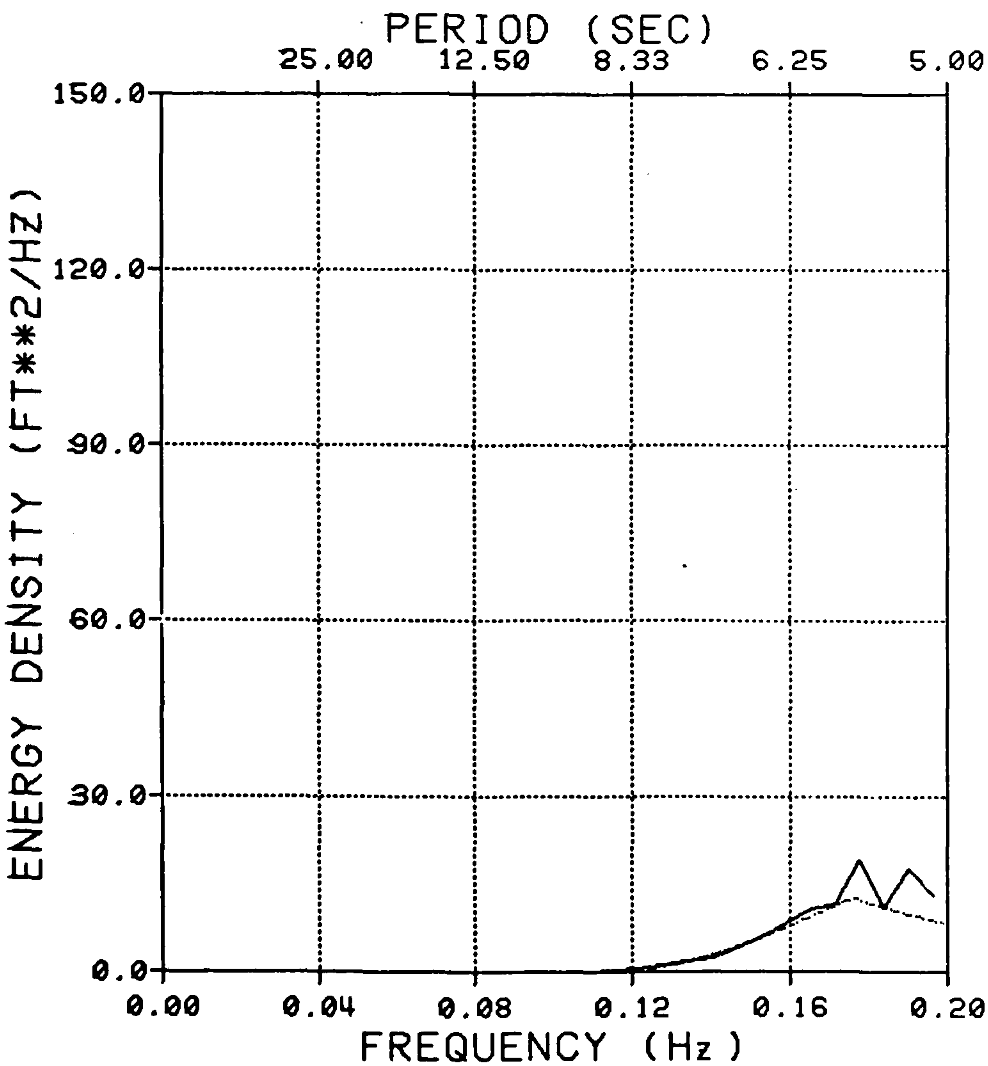
WAVE STATISTICS AND SPECTRAL PLOT

RUN 26 PLAN CAL ARRANGEMENT 1

SIGNIFICANT HEIGHT = 4 FT,SIGNIFICANT PEROID = 5.7 SEC

GAGE RD02 SPECTRAL PEAK 0.223 AT 5.541 SECONDS

REFERENCE ENERGY 0.55



Incl 7

CLEVELAND

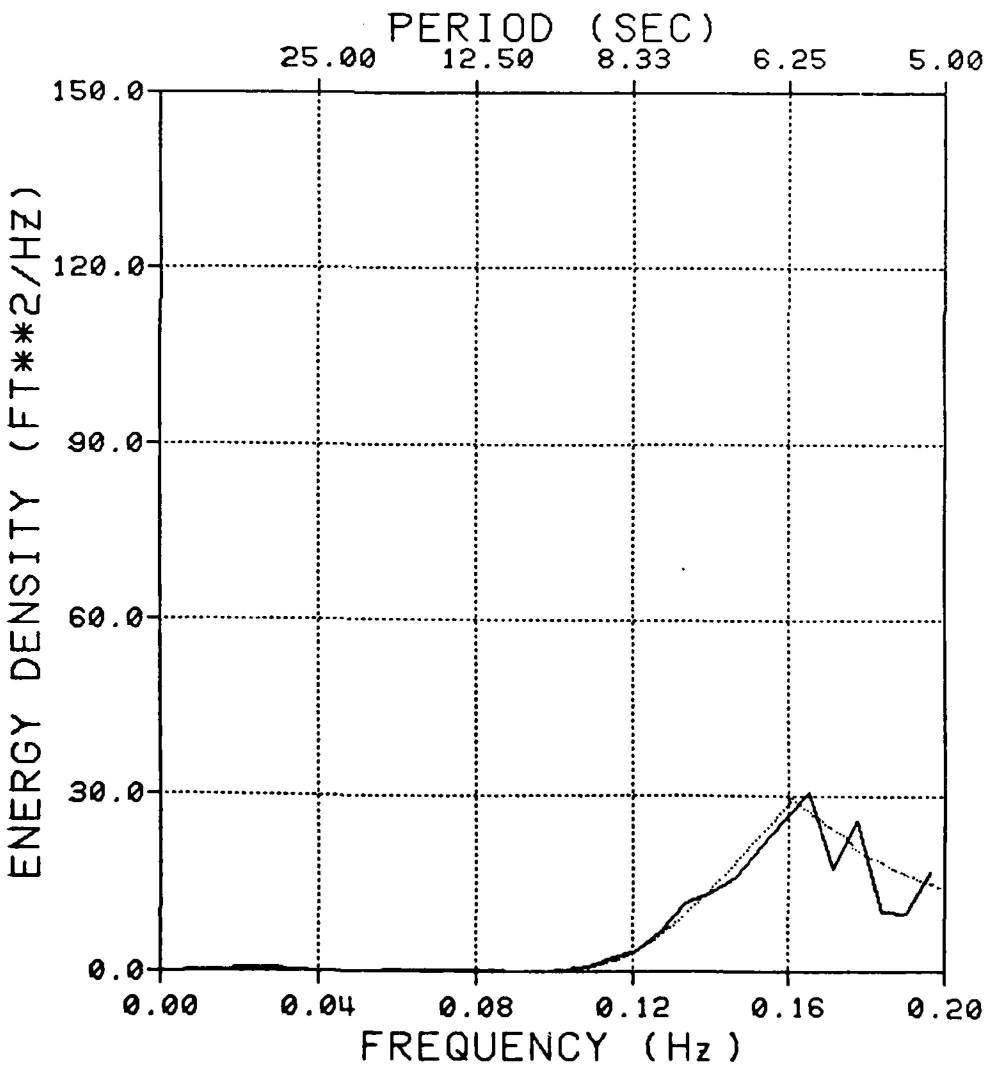
WAVE STATISTICS AND SPECTRAL PLOT

RUN 29 PLAN CAL ARRANGEMENT 1

SIGNIFICANT HEIGHT = 6 FT,SIGNIFICANT PEROID = 6.2 SEC

GAGE RD02 SPECTRAL PEAK 0.300 AT 6.038 SECONDS

REFERENCE ENERGY 1.45



Incl 8

CLEVELAND

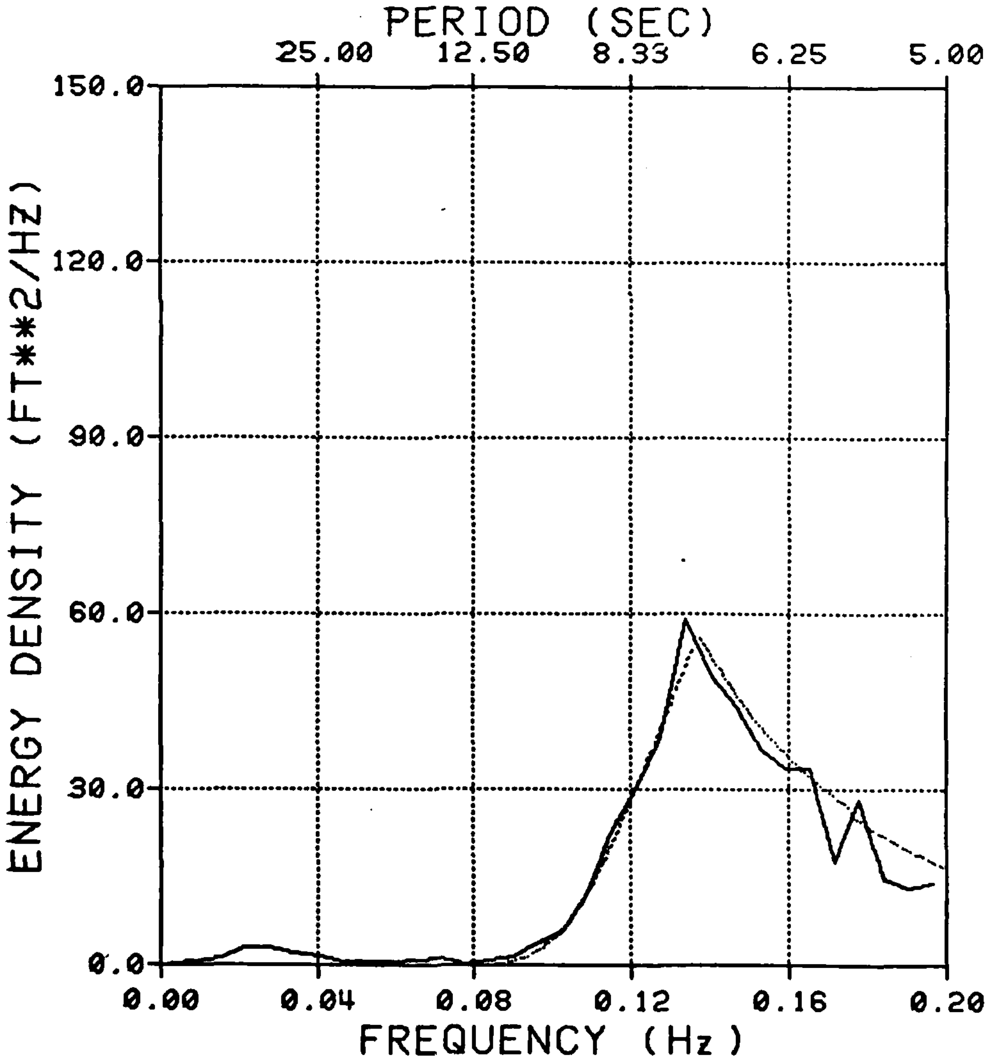
WAVE STATISTICS AND SPECTRAL PLOT

RUN 28 PLAN CAL ARRANGEMENT 1

SIGNIFICANT HEIGHT = 8 FT,SIGNIFICANT PEROID = 7.3 SEC

GAGE RD02 SPECTRAL PEAK 0.365 AT 7.314 SECONDS

REFERENCE ENERGY 3.06



Incl 9

CLEVELAND

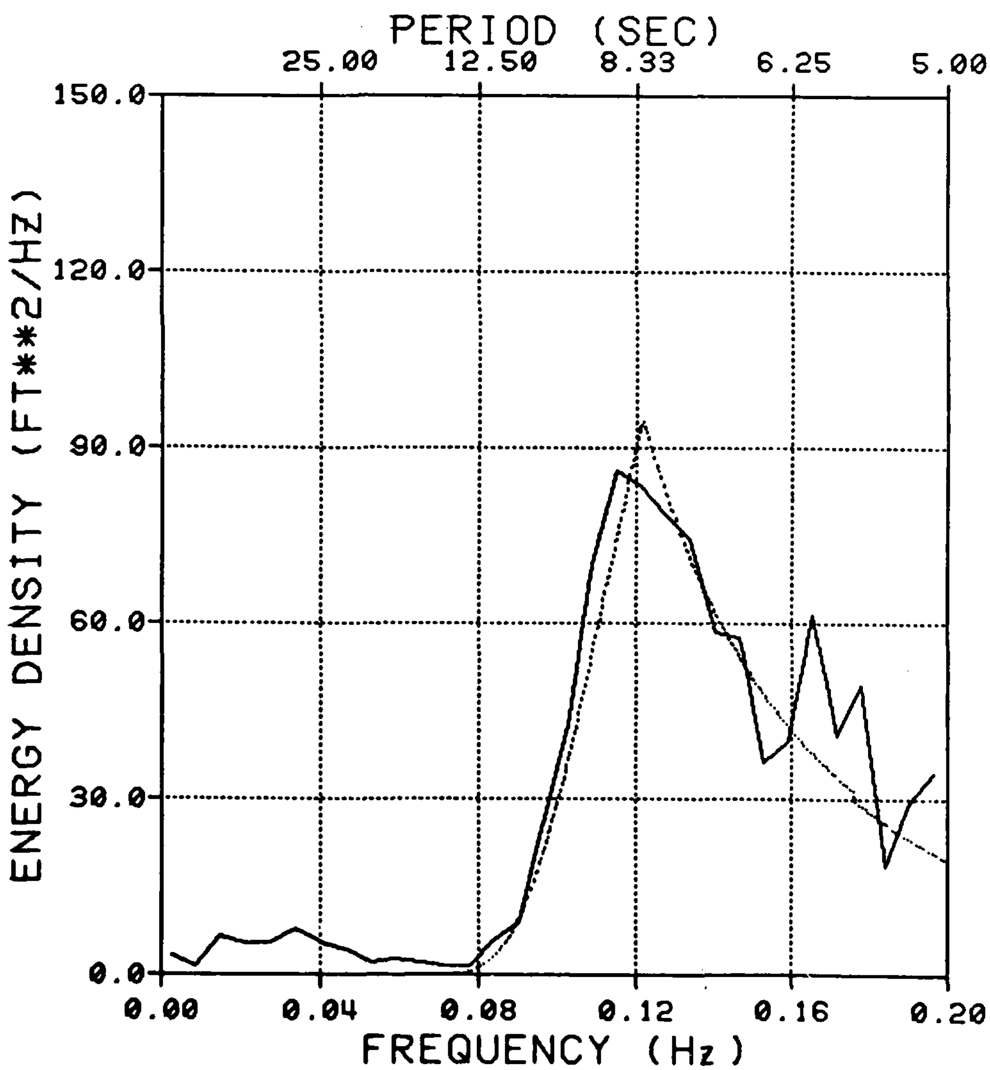
WAVE STATISTICS AND SPECTRAL PLOT

RUN 27   PLAN CAL   ARRANGEMENT 1

SIGNIFICANT HEIGHT = 10 FT,SIGNIFICANT PEROID = 8.2 SEC

GAGE RD02   SPECTRAL PEAK 0.446 AT 7.805 SECONDS

REFERENCE ENERGY 5.17



Incl 10

CLEVELAND

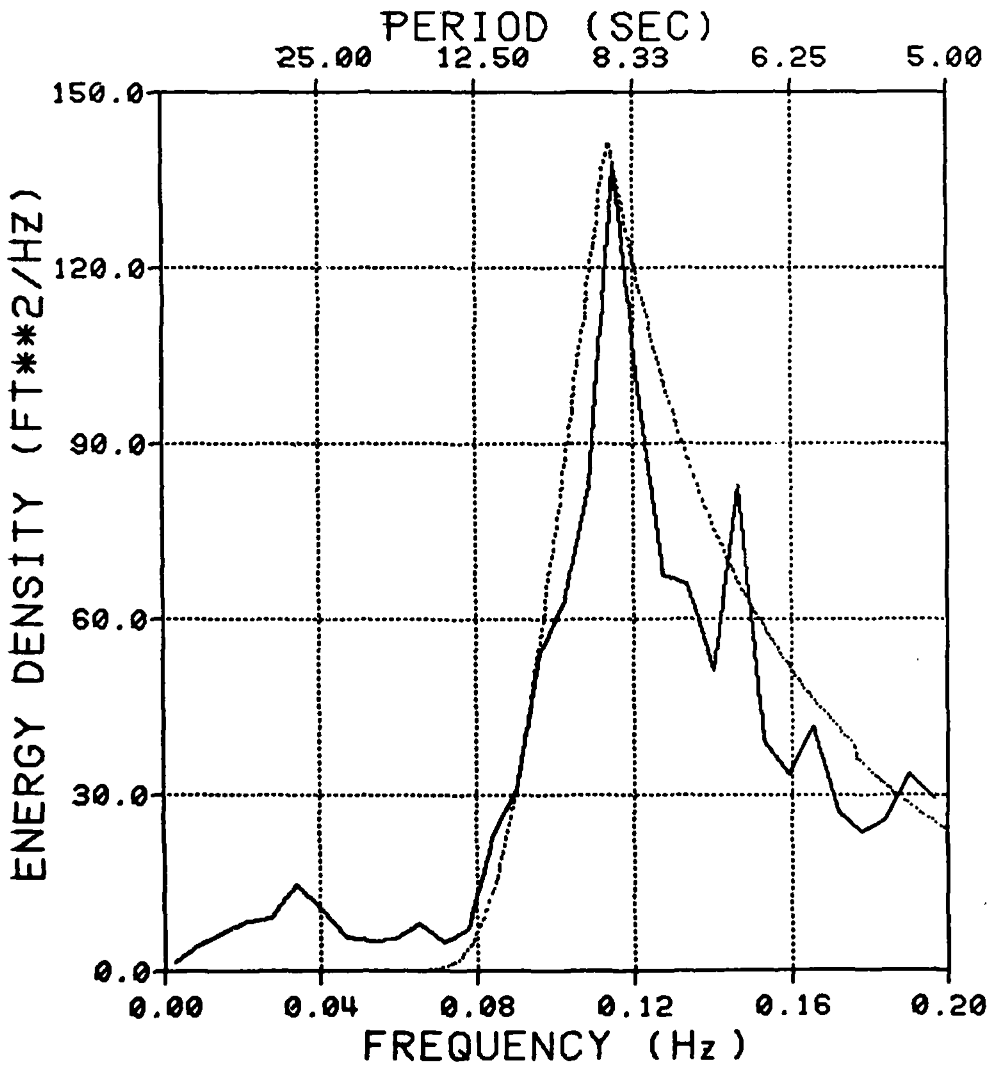
WAVE STATISTICS AND SPECTRAL PLOT

RUN 30 PLAN CAL ARRANGEMENT 1

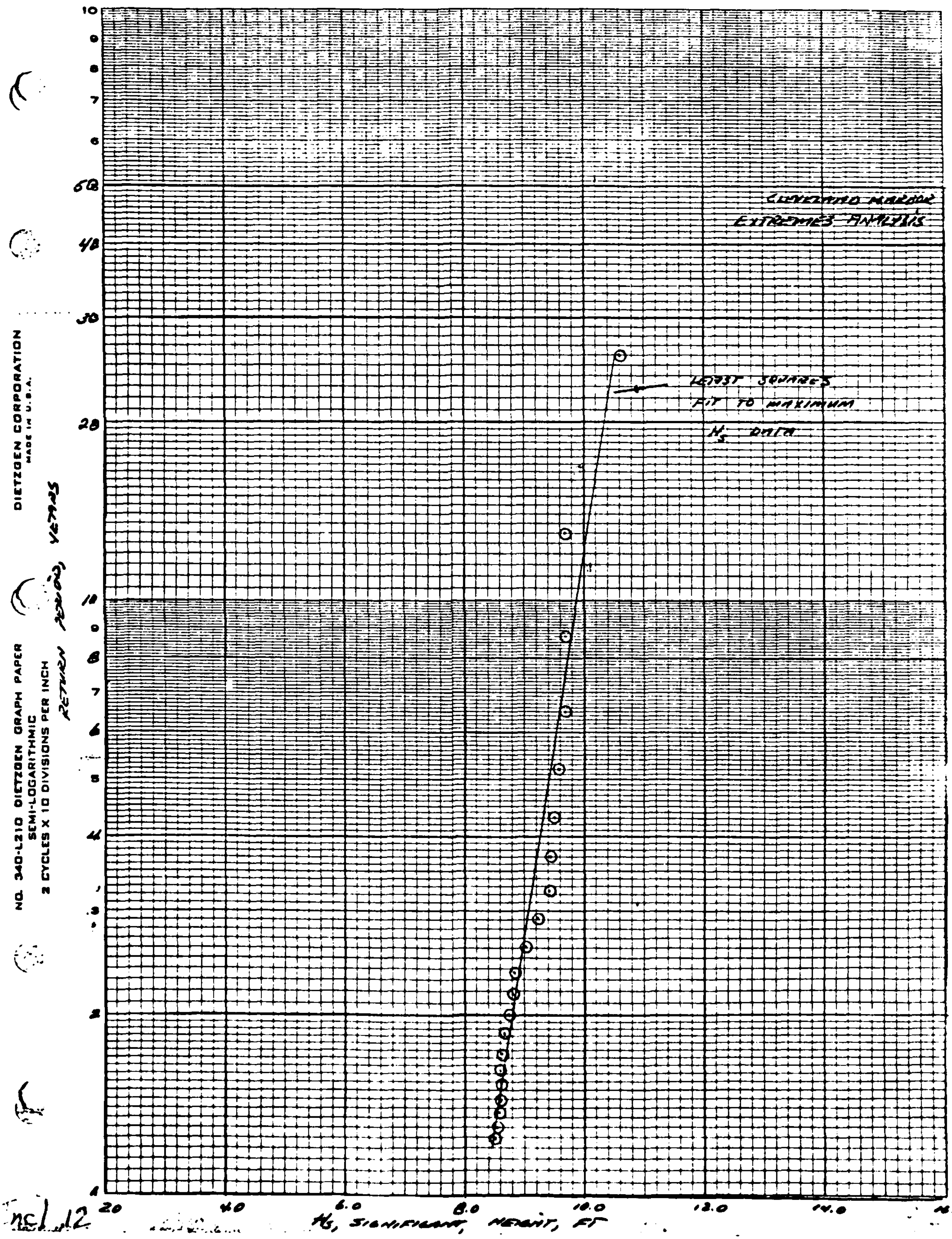
SIGNIFICANT HEIGHT = 12 FT,SIGNIFICANT PEROID = 8.8 SEC

GAGE RD02 SPECTRAL PEAK 0.672 AT 8.767 SECONDS

REFFRENCE ENERGY 7.63



Incl 11


CLEVELAND HARBOR
EXTREMES ANALYSIS
LEAST SQUARES FIT TO MAXIMUM H_s DATA
RETURN PERIOD, YEARS
H_s, SIGNIFICANT HEIGHT, FT
NO. 340-L210 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
2 CYCLES X 10 DIVISIONS PER INCH
DIETZGEN CORPORATION
MADE IN U.S.A.

Incl 12

Table 1

Test Results, Spectral Waves

	$^*H_s$ = 8 ft, T_s = 7.3 sec			$^*H_s$ = 10 ft, T_s = 8.2 sec		$^*H_s$ = 12 ft, T_s = 8.8 sec
	Wind (Knots)			Wind (Knots)		Wind (Knots)
Depth	None	22.5	31	None	31	None
27	-	-	X			
28	-	-	X			
29	-			X		
30				X		
31				X		
32				X		
33				-	X	X

X indicates vessel struck bottom.

\- indicates vessel did not strike bottom.

Nothing in blank indicates no test conducted.

$^*H_s$ = significant wave height

T_s = Significant wave period

Incl 13

Table 2

Test Results, Monochromatic Waves

Depth (lwd)	$*H_s$ = 8 ft T_s = 8 sec	$*H_s$ = 8 ft T_s = 10 sec
28	-	X
30	-	X

X indicates vessel struck bottom.

- indicates vessel did not strike bottom.

$*H_s$ = Significant wave height.

T_s = Significant wave period.

Table 3

Test Results, Model Vessel Radius Test

Depth (lwd)	Radius (Model ft) Starboard Turn	Port Turn
27	38.6	34.9
28	28.7	27.6
30	25.2	23.4

Incl 14

DEPARTMENT OF THE NAVY
DAVID W TAYLOR NAVAL SHIP RESEARCH
AND DEVELOPMENT CENTER
HEADQUARTERS
BETHESDA, MARYLAND 20084

ANNAPOLIS LABORATORY
ANNAPOLIS, MD 21402
CARDEROCK LABORATORY
BETHESDA, MD 20084

IN REPLY REFER TO:
1561:LEM
3900
4612
12 APR 1983

From: Commander, David W. Taylor Naval Ship R&D Center
To: Director, U.S. Army Corps of Engineers, Buffalo District

Subj: Ore Carrier Ballasting

Ref: (a) Support Agreement NCB-SA-83-04RW
(b) FONECON btwn D. Aguglia, USAE and L. Motter, DTNSRDC of 22 Mar 1983

Encl: (1) Loading and Ballasting Criteria

1. I have enclosed herewith the loading and ballasting criteria for the ore carrier MV McSweeney. The loading values were determined from the "Guidance Manual for Loading, M/V Belle River," as prepared by R. A. Stearn, Inc. and supplied to DTNSRDC by the American Steamship Company. The ballasting criteria was derived from information found on the "Capacity Plan", drawing number 38024 of the Bay Shipbuilding Company.

2. The model has been shipped to the USAE Experimental Waterways Station, Vicksburg, Mississippi, via commercial air freight, collect. If you have any questions or if I may be of further service, please feel free to call me, Mr. L. Motter on (202) 227-1692.

D. S. Cieslowski

D. S. CIESLOWSKI
By direction

Copy to:
USAE Waterways Experiment Station (R. Bottin)

18 APR 83 12 53
OFC. MGMT. OAS

EXHIBIT H-2

LOADING/BALLASTING FOR
MV McSWEENEY (ORE CARRIER)

SHIP PARTICULARS

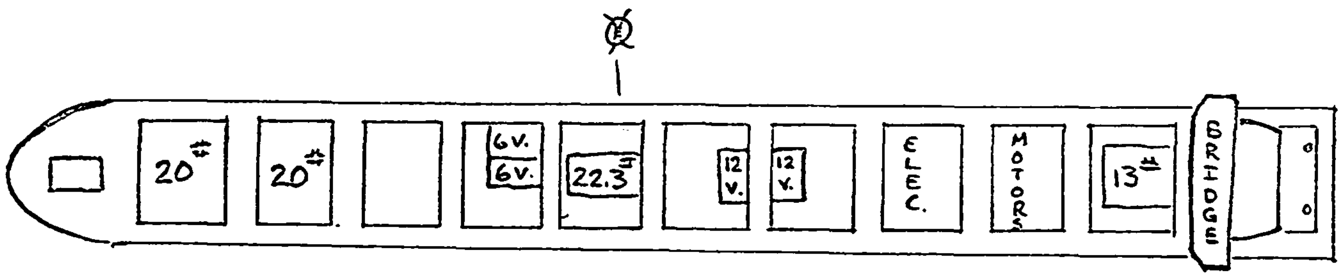
	Full scale	Model scale
Draft (T)	25.5 ft	3.1 in
Trim	0.0 ft	0.0 in
Beam (B)	105.5 ft	12.6 in
Transverse KM (KMT)	49.8 ft	6.0 in
Roll Period (T)		0.86 sec
Vertical Center of Buoyancy (VCB)	13.0 ft	1.6 in
Longitudinal Center of Buoyancy (LCB)	498.3 ft	4.98 ft
Displacement, Fresh Water	69,900.0 LT	153.6 lb
Length Between Perpendiculars (LBP)	990.0 ft	9.9 ft
Length Over All (LOA)	1000.0 ft	10.0 ft
Vertical Center of Gravity (VCG)	26.3 ft	3.2 in
Transverse Metacentric Height (GMT)	23.5 ft	2.8 in
Yaw Radius of Gyration (k)	266.9 ft	2.7 ft

(all vertical distances measured from the baseline)
(all longitudinal distances measured from the forward perpendicular)

LOADING ASSUMPTIONS

TACONITE PELLETS (0 degrees repose)

	WEIGHT	VCG
Hold #1	8160 LT	25.7 ft
Hold #2	6960 LT	24.8 ft
Hold #3	8780 LT	25.2 ft
Hold #4	8290 LT	24.7 ft
Hold #5	8390 LT	24.8 ft
Hold #6	6770 LT	24.5 ft
Hold #7	5560 LT	32.1 ft



20#
20#
6V.
6V.
22.3#
12 V.
12 V.
ELEC.
MOTORS
13#
BRIDGE

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

East Lansing Area Office
Manly Miles Building, Room 202
1405 South Harrison Road
East Lansing, Michigan 48823

JUN 24 1981

Colonel George P. Johnson
District Engineer
U. S. Army Engineer District
Buffalo
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Johnson:

This planning aid letter on proposed Cleveland Harbor modifications is provided in accordance with obligations of the U. S. Fish and Wildlife Service per the FY-1981 Fish and Wildlife Coordination Act Agreement with the Buffalo District, Corps of Engineers. Section 175 of the Water Resources Development Act of 1976 (PL 587, 94th Congress) authorized the phase I design memorandum stage of advanced engineering and design for harbor modifications at Cleveland, Ohio, in accordance with the District Engineers' June 1976 feasibility report.

This letter has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), in compliance with the intent of the National Environmental Policy Act of 1969, and the Endangered Species Act of 1973, as amended.

I. Project Proposal

The proposed Cleveland Harbor modifications recommended in the June 1976 feasibility report as stated in the Classification Report and Plan of Study for Cleveland Harbor (Corps of Engineers, revised October 1979) consist of: (1) extending and deepening lake approach channels at both entrances; (2) deepening the east basin channel and west entrance; (3) removing portions of the west entrance breakwaters; (4) constructing a breakwater extension on the east end of the existing east breakwater; (5) constructing a diked disposal area, if required; and (6) installation of recreational fishing facilities on the west breakwater.

Additional activities under the phase I reformulation investigation will consider: (1) 1,000-foot vessel operation and refuge in the lakefront harbor; (2) deepening the navigation channel to 27 feet in the Old River channel; (3) authorized but incompleted bridge replacements and associated bank cuts on the Cuyahoga River and Old River channel; (4) deepening the lower 5.8 miles of the Cuyahoga River from 23 feet to 27 feet; (5) recreational fishing from harbor structures; and (6) vessel congestion on the Cuyahoga River.

II. Description of Area

The Cleveland Harbor area, protected by the breakwaters, is five miles long and 1,600 to 2,400 feet wide for a total area of approximately 1,300 acres. Improved and dredged channels are maintained in the lower 5.8 miles of the Cuyahoga River and the lower mile of Old River. The lake approach channel is maintained at a depth of 29 feet. The outer harbor is 28 feet deep up to the mouth of the Cuyahoga River. The lower Cuyahoga River channel is 27 feet deep up to the junction of Old River and 23 feet deep upstream to mile 5.8. The maximum flow of the Cuyahoga River is 24,800 cfs and minimum flow is 14.0 cfs.

A. Water Quality

In general, water quality deteriorates from west to east across the harbor area and improves with distance from the shore. The localized areas of water quality degradation are associated with sources of waste discharge near the mouth of the river and near wastewater treatment plants. Another area of depressed water quality is along the lake side of the east breakwater where dredge spoils were dumped until several years ago. During the summer months and other low flow periods, the dissolved oxygen content of the Cuyahoga River in the lower reaches and pooled areas is zero. At that time, over eighty percent of the river's flow is inadequately treated domestic sewage (U.S. Environmental Protection Agency 1976, U. S. Army Corps of Engineers 1978). The pollution in this area is complicated by decreased water velocity which results from the dredging of the channel (Bently et al. 1975).

B. Benthos

Approximately 50 species of benthic macroinvertebrates have been reported in the Cleveland nearshore zone (Table 1). These organisms serve as a food source for many species of fish in the harbor. The majority of the benthic fauna are composed of aquatic oligochaetes (Pliodzinkas 1979). The Army Corps of Engineers (1978) also found abundant populations of mobile macrobenthic invertebrates, including crayfish, amphipods, and isopods in the river channel and harbor. These mobile benthic fauna prefer, and may be restricted to, rocky substrate including breakwalls where abundant growth of the plant, Cladophora, occur. During summer 1975, 1,076 amphipods/M^2 were sampled from the breakwall area (U. S. Army Corps of Engineers 1978).

Phytoplankton crops in Lake Erie have greatly increased in the last 50 years, indicating increased eutrophication. Pronounced spring and fall pulses of phytoplankton occur in the Cleveland Harbor. The dominant species are diatoms, including Asterionella spp., Melosira spp., and Fragilaria spp. Green and blue-green algae also contribute to phytoplankton blooms in the harbor (Hartley and VanVooren 1977, U. S. Army Corps of Engineers 1978).

Zooplankton populations appear to peak with high concentrations in the fall. The most abundant zooplankton in Cleveland Harbor include Rhizopoda, Rotifera, Cladocera, and Copepoda (U. S. Army Corps of Engineers 1978).

C. Terrestrial Vegetation

Upland vegetation in the Cleveland Harbor area is severely limited. There are some trees, vines, and shrubs along the west side of Irishtown Bend on the lower Cuyahoga River, between bridges 5 and 8. The eastern end of Whiskey Island and the filled diked disposal areas are also partially vegetated with grasses, shrubs, and small trees (U. S. Army Corps of Engineers 1978).

D. Fish

Fish populations of the Cleveland area are under great stress from degradation of the ecosystem. Pollution, siltation, and loss of aquatic vegetation are factors that have affected Cleveland fish fauna (White et al. 1978). Table 2 lists those species of fish collected in Cleveland Harbor and adjacent marinas, 1972-1974. Common emerald shiner, eastern gizzard shad, and yellow perch are the most abundant species in the harbor. The yellow perch is the most important species in terms of contribution to the commercial and sport harvest. Both coho and chinook salmon, which occur in the harbor, are stocked in the Chagrin River (White et al. 1975).

White et al. described the following as principal fish nursery zones in the Cleveland area: the mouth, lower one mile, and adjacent shoreline of the Rocky River; the mouth and adjacent shoreline of the Chagrin River; and the Cleveland Harbor and adjacent marinas. Table 3 indicates those species collected as fry or young-of-the-year in Cleveland Harbor. Most of the harbor nursery areas are dominated by a few abundant species.

It is probable that a list of species spawning in the harbor would be similar to Table 3 (White et al. 1975). During 1972-74, goldfish, pumpkinseed sunfish, largemouth blackbass, and yellow perch were observed spawning within Cleveland Harbor (White et al. 1975).

Recreational fishing from harbor structures is an important activity for thousands of residents of the Cleveland area. For the years 1975 to 1977, Baker et al. 1979, reported an average annual harvest of 99,979 fish by shore anglers in the west Cleveland area which includes Cleveland Harbor. The commercial fishery in the Harbor itself has virtually disappeared, resulting in the loss of millions of dollars to the Cleveland economy. The diverse fish fauna and commercial fishery of Cleveland Harbor are restorable if appropriate measures to reduce pollution and restore the environment are implemented (White et al. 1975).

E. Birds

Approximately 260 species of birds have been observed in the Cleveland area (U. S. Army Corps of Engineers 1978). Cleveland Harbor is situated on a migration corridor, located on both Mississippi and Atlantic flyways, which contains a population of over three million ducks and geese (Bellrose 1976).

Migrating waterfowl cross the Cleveland area of Lake Erie on both north-south and east-west routes between breeding and wintering grounds. Birds which occur in the Harbor area include: Bonaparte's gull (Larus philadelphia), ring-billed gull (L. delawarensis), herring gull (L. argentatus), common loon (Gavia immer), horned grebe (Podiceps auritis), great blue heron (Ardea herodias), mallard (Anas platyrhyhchos), black duck (Anas rubripes), canvasback (Aythya valisineria), goldeneye (Bucephola clangula), bufflehead (Bucephala akeola), oldsquaw (Claugula hyemalis),and common merganser (Megus merganser) (U. S. Army Corps of Engineers 1978). Waterfowl are often attracted to the warm, open water areas of the power plant effluents in Cleveland Harbor.

Table 4 shows results of Christmas bird counts for the years 1968-1978 in the Cleveland area.

F. Mammals

At one time, the harbor area supported a diverse fauna of terrestrial and wetland mammals (Burt 1972). Habitat loss has probably eliminated most mammals from the area.

G. Reptiles and Amphibians

The following reptiles have been reported in the Cleveland Harbor area: northern ring-necked snake (Diadophis punctatus edwardsii), racers (Coluber constrictor spp.), eastern milk snake (Lampropeltis doliata triangulum), DeKay's snake (Storeria dekayi), and eastern garter snake (Thamnophis sirtalis sirtalis) (Conant 1951). Other reptiles and amphibians that have been recorded in the area are listed in Table 5.

III. Discussion

The major impacts to fish and wildlife resources will result from the extensive dredging that will be required to increase and maintain navigational channel and harbor depths. Deepening the navigational channel in the Old River channel and lower Cuyahoga River has the potential of resuspending significant quantities of toxic material. This resuspension of toxic material could affect all aquatic organisms in the Cleveland Harbor area. Thus, all sediments to be dredged should be sampled prior to dredging commencement in order to identify the qualitative and quantitative properties of any toxic material. Also, the sampling program should identify any "hot spots" of toxic material which would require special dredging and disposal procedures.

Since the breakwaters provide an excellent benthic substrate, removal of the arrow head spurs of the west channel entrance would reduce benthos production and thus a reduction of fish food organisms. However, proposed breakwater construction at the east and west channel entrances should provide suitable replacement substrate. Since more breakwater is proposed for construction than will be removed, a net loss of available lake-bottom benthic habitat will result. However, the breakwater substrate should compensate for this additional loss of benthic habitat.

The bank cuts on the Cuyahoga River and Old River channel create an additional disposal problem. We assume that most of this material will be of an unpolluted nature and thus, should have a useful purpose. Due to negative aquatic impacts, we would object to placement of the material in any wetland area. If the bank cuts under study are deemed necessary, the exact locations and volume of material to be removed should be discussed in the phase I General Design Memorandum.

Cleveland Harbor and adjacent areas provide local residents an excellent opportunity for recreational fishing. The harbor structures (especially breakwaters) would provide access to varying water depths for shore fishing. The existing City of Cleveland breakwater at Edgewater Park, with its pedestrian walkway, provides public fishing access to both Lake Erie and the marina basin. Access to the west breakwater would greatly expand public fishing access in the Cleveland area.

The proposed recreational fishing access consists primarily of: (1) a pedestrian bridge spanning the 200-foot opening in the shore arm of the existing west breakwater, (2) a pedestrian handrail along the top of the west breakwater, and (3) upgrading of the existing public parking area located east of the Edgewater Marina.

The Cleveland Harbor area and lower Cuyahoga River have undergone major modifications over the years. The fish and wildlife resources and their habitats have been gradually diminished to the point that many species of plants and animals have been extricated from the area and only remnant populations of other species exist. Thus the opportunity to mitigate (replace in kind, restore) project caused loss of habitat is precluded. As stated earlier, the construction of rubble mound breakwaters would create benthic habitat to replace benthic habitat lost due to additional breakwater construction. However, no mitigation is planned for other project caused losses (benthic community destruction, water quality degradation, and loss of fish spawning and nursery areas) due to enlarging and deepening the navigational channels. The recreational fishing access will provide a greater opportunity for the public to utilize the remaining aquatic resources. Some mitigation could be provided by developing artificial spawning areas for specific species which can be enticed to use artificial substrates.

Other than the work conducted by White on the Old River channel and near the mouth of the Cuyahoga River, little is known of the fish and wildlife values of the lower 5.8 miles of the Cuyahoga River. Historic records indicate that this reach of the river has been severely degraded and that aquatic life has been greatly diminished. The Ohio Division of Wildlife has not conducted a fishery survey on the lower Cuyahoga River for at least seven years (LaConte, personal communication). Therefore, if engineering studies indicate that additional dredging and bank cuts are necessary on the lower 5.8 miles of the Cuyahoga River, fishery and benthic surveys should be conducted in the area affected. Also, a survey of riparian habitat and wildlife use of the habitat should be conducted along the lower 5.8 miles of the Cuyahoga River.

IV. Endangered Species

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973 as amended, Federal agencies are required to obtain from the Fish and Widllife Service information concerning any endangered or threatened species, listed or proposed to be listed, which may be present in the area of a proposed action. Therefore, we are providing you with the following list of species which may be present in the concerned area.

Common Name	Scientific Name	Classification	Habitat
Indiana bat	Myotis sodalis	Endangered	Caves and riparian
Peregrine falcon	Falco peregrinus	Endangered	Migratory
Kirtland's warbler	Dendroica kirtlandii	Endangered	Migratory
Bald eagle	Haliaeetus leucocephalus	Endangered	Breeds in Lucas, Ottawa, Sandusky. and Erie Counties, Ohio
Blue pike	Stizostedion vitreum glaucum	Endangered	Lake Erie

Also, Section 7(c) requires that the Federal agency responsible for actions authorized, funded or carried out in furtherance of the project to conduct a biological assessment for the purpose of identifying endangered, threatened or proposed species likely to be affected by the action. If the biological assessment indicates the presence of such a species, the formal consultation process should be initiated. This can be done by writing to the Area Manager, U. S. Fish and Wildlife Service, Room 202, Manly Miles Building, 1405 S. Harrison Road, East Lansing, Michigan 48823.

V. Recommendations

Based on the above information and discussion, we recommend that:

1. The recreational fishing access (pedestrian bridge, breakwater handrail, and upgraded parking area) be completed at the same time as other project measures.

2. If engineering and economic studies indicate that additional dredging and bank cuts are necessary on the lower 5.8 miles of the Cuyahoga River, benthic and fishery surveys of the area be conducted along with a survey of riparian habitat and wildlife use of this habitat.

3. The use of artificial spawning substrate (placement of tires, gravel, drain tiles, etc.) for selected fish species be investigated as potential mitigation measures.

4. Useful purposes (i.e. road construction, building sites) be investigated for spoiling of excess unpolluted dredged material and bank cut material.

5. Upland disposal sites be investigated to receive unpolluted dredged material and bank cut material.

6. All sediments to be dredged be sampled, prior to dredging commencement, to determine their "polluted" status.

We would appreciate notification of any major alterations in project plans in order that related revisions may be made in our future Fish and Wildlife Coordination Act report. Please advise us of your proposed actions regarding our recommendations.

Sincerely yours,

David Wildhausen

Acting Area Manager

Table 1. Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, Ohio*

Phylum Coelenterata	Class	Hydrozoa
		Hydra sp.
Phylum Aschelminthes	Class	Nematoda
		Alaimus sp.
		Dorylaimus sp.
		Mesodorylaimus sp.
Phylum Annelida	Class	Polychaeta
		Manayunkia speciosa
	Class	Oligochaeta
		Aulodrilus piqueti
		A. pluriseta
		Branchiura sowerbyi
		Ilyodrilus templetoni
		Limnodrilus angustipenis
		L. cervix
		L. claperedeianus
		L. hoffmeisteri
		L. profundicola
		L. udekemianus
		Peloscolex ferox
		P. multisetosus
		Potamothrix moldaviensis
		P. vejdovskyi
		Tubifex tubifex
		Dero digitata
		Nais communis
		N. pseudobtusa
		N. variabilis
		Ophidonais serpentina
		Stylria fossularis
	Class	Hirudinea
		Illinobdella sp.
		Helobdella stagnalis
Phylum Mollusca	Class	Pelecypoda
		Pisidium sp.
		P. casertanum
		P. henslowanum
		P. lilljeborgi
		Sphaerium sp.
	Class	Gastropoda
		Amnicola sp.
		Physa sp.
		Valvata sincera

Table 1. (continued) Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, Ohio*

Phylum Arthropoda	Class Crustacea
	Lirceus sp.
	Cypricercus sp.
	Asellus intermedius
	Gammarus fasciatus
	Pontoporeia affinis
	Class Insecta
	Order Diptera
	Chironomus sp.
	C. plumosus
	C. riparius
	Tanytarsini (Tribe)
	Procladius sp.
	P. adumbratus
	P. attenuatus
	P. euliciformes
	P. riparius

Source: Rolan, 1973
Nacht, 1977

*From Pliodzinkas 1979

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Table 2. The Relative Abundance of Fishes Collected in the Cleveland Harbor and Adjacent Marinas (Revised July 1974)*

Species	No. Collected	% of Total
Longnose gar	1	0.01 %
Alewife	92	0.85
Eastern gizzard shad	2,525	23.43
Chinook salmon	9	0.08
Coho salmon	42	0.39
Rainbow trout	2	0.02
Rainbow smelt	323	3.00
Northern pike	15	0.14
Carp	64	0.59
Goldfish	97	0.90
Golden shiner	393	3.65
Longnose dace	1	0.01
Creek chub	1	0.01
Western blacknose dace	1	0.01
Common emerald shiner	4,092	37.97
Striped shiner	1	0.01
Spottail shiner	903	8.38
Spotfin shiner	6	0.06
Northern sand shiner	33	0.31
Northern mimic shiner	6	0.06
Northern fathead minnow	1	0.01
Bluntnose minnow	74	0.69
Stoneroller minnow	2	0.02
Eastern quillback	1	0.01
Black redhorse	1	0.01
Golden redhorse	2	0.02
Northern shorthead redhorse	1	0.01
Common white sucker	89	0.83
Channel catfish	2	0.02
Brown bullhead	23	0.21
Black bullhead	14	0.13

Table 2. (continued) The Relative Abundance of Fishes Collected in the Cleveland Harbor and Adjacent Marinas (Revised July 1974)*

Species	No. Collected	% of Total
Stonecat madtom	13	0.12 %
Trout-perch	153	1.42
Brook silverside	3	0.03
White bass	223	2.07
White crappie	80	0.74
Black crappie	11	0.10
Northern rockbass	5	0.05
Northern largemouth blackbass	3	0.03
Warmouth sunfish	1	0.01
Green sunfish	3	0.03
Bluegill sunfish	4	0.04
Pumpkinseed sunfish	34	0.32
Yellow walleye	2	0.02
Yellow perch	1,254	11.64
Northern logperch darter	1	0.01
Freshwater drum (sheepshead)	170	1.58
TOTALS	10,777	100.05 %

47 Species

* from White et al. 1975

Table 3. Species of Fishes Collected as Fry or Young-of-the-Year in the Cleveland Harbor, 1972-1974*

Species	Abundance**
Alewife	Abundant
Eastern gizzard shad	Abundant
Rainbow smelt	Abundant
Eastern quillback	Rare
Common white sucker	Uncommon
Carp	Common
Goldfish	Common
Golden shiner	Abundant
Longnose dace	Rare
Common emerald shiner	Abundant
Spottail shiner	Uncommon
Fathead minnow	Rare
Bluntnose minnow	Common
Trout-perch	Rare
Brook silverside	Rare
White bass	Uncommon
Rockbass	Uncommon
Largemouth blackbass	Rare
Green sunfish	Uncommon
Bluegill sunfish	Common
Pumpkinseed sunfish	Abundant
Yellow perch	Common
Northern logperch darter	Rare
White crappie	Uncommon

* From White et al. 1975

** Abundance of each species is depicted as a relative term

Table 4. Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Ring-billed gull*	10	14,104
Bonaparte's gull*	10	5,480
Herring gull*	10	4,212
Starling	10	1,302
House sparrow	10	872
Mallard*	10	703
Common crow	10	363
Black-capped chickadee	10	347
Black duck*	10	307
Dark-eyed junco	10	294
Cardinal	10	278
Tree sparrow	10	262
Common goldeneye*	10	212
Tufted titmouse	10	183
Blue jay	10	181
American goldfinch	10	121
Red-breasted merganser*	10	117
Downy woodpecker	10	98
Cedar waxwing	10	98
Mourning dove	10	92
White-breasted nuthatch	10	80
Song sparrow	10	56
Lesser scaup*	10	39
American robin	10	38
Hairy woodpecker	10	32
Redhead*	10	17
Red-bellied woodpecker	10	17
Bufflehead*	10	16
White-throated sparrow	10	15
Eastern bluebird	10	12
Red-tailed hawk	10	6
Belted kingfisher	10	5
Pileated woodpecker	10	5
Brown creeper	10	5
Golden-crowned kinglet	10	5
American kestrel	10	4
Canada goose*	9	719
Snow bunting	9	48
Red-breasted nuthatch	9	22
Ruddy duck*	9	21
Ring-necked pheasant	9	10
Common flicker	9	7
Rufous-sided towhee	9	6
Wood duck	9	5
American wigeon*	9	4

Table 4. (continued) Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Barred owl	9	2
Carolina wren	9	2
Greater scaup*	8	144
Common merganser*	8	85
Field sparrow	8	5
Winter wren	8	2
Pine siskin	7	20
American coot*	7	8
Great black-backed gull*	7	7
Horned grebe*	7	3
Swamp sparrow	7	3
Hooded merganser*	7	2
Yellow-bellied sapsucker	7	2
Evening grosbeak	6	9
Horned lark	6	5
Purple finch	6	4
Pied-billed grebe*	6	3
Red-shouldered hawk	6	2
Mockingbird	6	2
Brown-headed cowbird	6	2
Common grackle	6	1
Great horned owl	6	1
Canvasback*	5	36
Red-winged blackbird	5	3
Pintail*	5	2
Rough-legged hawk	5	2
Common redpoll	4	65
Killdeer	4	6
Gadwall*	4	3
Ruby-crowned kinglet	4	3
Great blue heron	4	2
Green-winged teal*	4	2
Cooper's hawk	4	2
Red-headed woodpecker	4	2
Common snipe	4	1
Bobwhite	3	24
Yellow-rumped warbler	3	7
White-winged scoter*	3	3
Ruffed grouse	3	3
Hermit thrush	3	3
Surf scoter*	3	2
White-crowned sparrow	3	2
Brown thrasher	3	1
White-winged crossbill	2	32
Red crossbill	2	7
Whistling swan*	2	3

Table 4. (continued) Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Oldsquaw*	2	2
Marsh hawk	2	2
Northern shrike	2	2
Eastern meadowlark	2	2
Lapland longspur	2	2
Double-crested cormorant*	2	1
Sharp-shinned hawk	2	1
American woodcock	2	1
Glaucous gull*	2	1
Gray catbird	2	1
White-fronted goose*	1	5
Common loon*	1	1
Snow goose (Blue morph)*	1	1
Shoveler*	1	1
Ring-necked duck*	1	1
King eider*	1	1
Common scoter*	1	1
Franklin's gull*	1	1
Screech owl	1	1
Eastern phoebe	1	1
Boreal chickadee	1	1
Swainson's thrush	1	1
Northern oriole	1	1

Average number of species recorded per census = 72

Average number of individuals recorded per census = 30,569

* Species of birds likely to utilize the waters off the Municipal Light Plant for feeding or resting.

** From U. S. Army Corps of Engineers 1978

Table 5. Published Records of Reptiles and Amphibians with Wetland Affinities from Ohio Counties Bordering Lake Erie*

	County							
Species	Ashtabula	Lake	Cuyahoga	Lorain	Erie	Sandusky	Ottawa	Lucas
Mudpuppy					X			X
Jefferson salamander				X				
Red-backed salamander				X				
Red-spotted newt				X				
American toad					X			
Northern spring peeper				X				
Green frog					X			
Bullfrog	X	X	X	X	X	X	X	X
Northern ringneck snake	X	X	X	X	X		X	X
Eastern fox snake					X	X	X	X
Eastern milk snake	X	X	X	X	X		X	X
Kirtland's water snake					X	X		X
Queen snake	X	X	X	X	X	X	X	X
Northern water snake	X	X	X	X	X	X	X	X
Northern brown snake	X	X	X	X	X		X	X
Northern red-bellied snake	X	X						
Butler's garter snake			X		X		X	X
Northern ribbon snake	X	X	X	X	X			X
Eastern garter snake	X	X	X	X	X	X	X	X
Stinkpot					X		X	X
Snapping turtle	X	X	X	X	X		X	X
Spotted turtle	X	X		X	X			X
Blanding's turtle	X	X		X	X	X	X	X
Map turtle	X			X	X	X	X	X
Midland painted turtle	X	X	X	X	X	X	X	X
Eastern spiny softshell		X		X	X		X	X

* Conant 1951, Morse 1904, from CLEAR 1979

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United States Department of the Interior
FISH AND WILDLIFE SERVICE
Columbus Field Office
3990 East Broad Street
Columbus, Ohio 43215

IN REPLY REFER TO:

June 3, 1982

Colonel George P. Johnson
District Engineer
U. S. Army Engineer District
Buffalo
1776 Niagara Street
Buffalo, New York 14207

Dear Colonel Johnson:

This planning aid letter on proposed Cleveland Harbor modifications is provided for inclusion in your Stage 2 Report in accordance with obligations of the U. S. Fish and Wildlife Service per the FY-1982 Fish and Wildlife Coordination Act Agreement with the Buffalo District, Corps of Engineers. This letter has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and in compliance with the intent of the National Environmental Policy Act of 1969.

The Cleveland Harbor area, protected by breakwaters, is five miles long and 1,600 to 2,400 feet wide for a total area of approximately 1,300 acres. The lake approach channel is maintained at a depth of 29 feet. The outer harbor area up to the mouth of the Cuyahoga River is maintained at various depths, ranging from 25 to 28 feet. A description of fish and wildlife resources of the Cleveland Harbor area is contained in our June 24, 1981 Planning Aid Letter.

Proposed commercial navigation improvements were considered under four broad areas: (1) outer Harbor Improvements; plans 1, 2, 3A, 3b, and 4; (2) Authorized But Uncompleted Improvements to Old River Navigation Channel: plans 5A and 5B; (3) Cuyahoga River Deepening: plans 6A and 6B; and (4) Plans to Reduce River Congestion on the Cuyahoga River, plan 7A, 7B, 7C, 7D, 7E, 7F, and 7G. Since many of the plans did not have a positive B/C ratio or other plans had a higher B/C ratio, only plans 1 and 7G will be carried into stage three for further evaluation. Alternatives 5A and 5B were placed in an inactive status for the time being. All other plans have been eliminated from further consideration during the stage three planning or will be pursued under their existing construction authority.

We are in agreement that alternative plan No. 1 ("All-weather" East Entrance Plan) should be carried into stage 3 planning since it has the same benefits as the other outer harbor alternatives, but at less cost. This plan includes the dredging of a 32-foot deep fan-shaped entrance channel at the existing east entrance and dredging of a 500-foot wide, 27 feet deep channel through the East Basin to the West Basin. This plan would allow 1,000-foot vessels to operate in "all-weather" conditions (maximum 8-foot waves and 30 knot winds from the west through northeast). It is currently proposed to place all of the dredged material in contained Disposal Area 14. Also, analysis of samples from the project area will be conducted during the summer of 1982. We also concur that plans 7F and 7B should be pursued under their existing construction authority.

We understand that mitigation measures, primarily in-water fishery habitat development in the vicinity of the west breakwater, and increased fishermen access will be developed further in stage 3. We further understand that the ultimate fisherman access plan to recommend for construction will be dependent on the results of the Section 107 Study for Edgewater Marina. The purpose of the Section 107 Study is to determine the feasibility of modifying the entrance to Edgewater Marina for wave reduction and expansion of the small boat docking area.

We appreciate this opportunity to comment on the proposed Cleveland Harbor improvements and request that we be notified of alterations in project plans and kept informed of planning activities.

Sincerely yours,

Kent E. Kroonemeyer

Kent E. Kroonemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Serv, M. Colvin, Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL
Ohio EPA, Attn: J. Albrecht, Columbus, OH

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Columbus Field Office
3990 East Broad Street
Columbus, Ohio 43215

IN REPLY REFER TO:

October 13, 1982

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

Attention: Dave Heicher

Dear Colonel Hardiman:

This letter supplements our June 24, 1981 planning aid letter on proposed Cleveland Harbor modifications at Cleveland, Cuyahoga County, Ohio.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and in compliance with the intent of the National Environmental Policy Act of 1969.

In our June 24, 1981 letter, we recommended that benthic, fishery, and riparian habitat surveys be conducted on the lower 5.8 miles of the Cuyahoga River if dredging and bank cuts appear feasible.

Due to the constricting nature of the instream Jefferson Avenue bridge abutments, their removal is being considered (Alternative 7G). An onsite inspection of the project area (Jefferson Avenue bridge abutments) was conducted on September 22 and 23, 1982. Also, two variable mesh gill nets were set in the vicinity of the abutments and left overnight. Fish species in one net consisted of four small (7 - 9 inch) white bass and one 16-inch carp. The second net contained no fish and was located about 2,000 feet downstream of where it was set. We assume that a ship or tug may have accidently pulled the net downstream.

Based on this cursory fish survey, the habitat in the area, and the limited work area required to remove the bridge abutments, we do not believe it is necessary to conduct further benthic, fishery, or riparian habitat surveys in the area. However, standard construction procedures to control erosion should be implemented and all abutment material removed to an upland disposal site.

If you have any questions, please contact me or Ken Multerer at 943-6923 (FTS).

Sincerely yours,

Kent E. Kroonemeyer

Kent E. Kroonemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Service, Attn: M. Colvin, Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL
Ohio EPA, Attn: J. Albrecht, Columbus, OH

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Columbus Field Office
3990 East Broad Street
Columbus, Ohio 43215

IN REPLY REFER TO

June 15, 1983

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

Attention: Richard Aguglia

Dear Colonel Hardiman:

This is our revised Draft Fish and Wildlife Coordination Act Report, which supersedes our report issued on May 18, 1983, on Cleveland Harbor Modification Plans at Cleveland, Cuyahoga County, Ohio. Section 175 of the Water Resources Development Act of 1976 (PL587, 94th Congress) authorized the Phase I design memorandum stage of advanced engineering and design of the harbor modifications at Cleveland Harbor, Ohio in accordance with the report of the District Engineer, dated June 1976. Our report is based, in part, on the July 1982 Stage 2 Report (revised February 1983) for Reformulation Phase I General Design Memorandum for Cleveland Harbor, Ohio.

This report has been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and in compliance with the intent of the National Environmental Policy Act of 1969.

Planning Aid Letters on the project were submitted to the Buffalo District, Corps of Engineers on June 24, 1981 and June 3, 1982. On October 13, 1982, we provided a supplement to our June 24, 1981 letter. This report has been reviewed by the Ohio Division of Wildlife and a copy of their May 12, 1983 letter of concurrence is attached.

PROJECT DESCRIPTION

Cleveland Harbor is located on the south shore of Lake Erie at the mouth of the Cuyahoga River. The harbor includes the Lakefront Harbor protected by approximately five miles of breakwater and an Inner Harbor of navigation channels on the Cuyahoga River and Old River (the former outlet of the Cuyahoga River). A navigation channel is maintained on about one mile of Old River and 5.8 miles of the lower Cuyahoga River. Immediately to the west of Cleveland Harbor area is Edgewater Park, Marina and Yacht Club while Gordon Park is located just east of the east channel entrance. Several other yacht basins, boat clubs or marinas are located within the harbor area near the eastern end. Public boating access to the harbor area and Lake Erie is provided at Edgewater Park and Gordon Park and at several other areas within the Lakefront Harbor. Both Edgewater Park and Gordon Park along with other recreational areas are included in the Cleveland Lakefront State Park.

The Stage 2 Reformulation Report recommends that Alternative Plans Numbers 1, 7G, 8A, 8B, and 11, in addition to the "No Action" alternative, Plan 10, be carried forward into Stage 3 planning (development of detailed plans). Subsequent to release of the Stage 2 Report, plans have been selected for improvements of Edgewater Marina which make alternatives 8A and 8B infeasible. A description of alternative plans currently under consideration is as follows:

Plan 1 "Severe Weather" East Entrance

This plan would provide a "severe weather" entrance into the Lakefront Harbor for 1,000-foot vessels at the existing east entrance. "Severe Weather" conditions are defined as a maximum 8-foot wave and 30-knot wind from the west through northeast.

Components of Plan 1 include a fan-shaped entrance channel (2,000 feet wide at the lakeward end) at the existing east entrance and an interior channel through the east basin to the west basin. The width of the channel narrows to 900 feet at the end of the east breakwater. The 900-foot channel extends approximately 2,900 feet into the east basin where it narrows to 500 feet. The 500-foot wide channel is maintained through the remainder of the east basin. The depth of the entrance channel would be 32 feet while the 500-foot wide interior channel would be at a depth of 28 feet. In the vicinity of the west entrance, the depth would be 30 feet. The principal construction item for Plan 1 would be the removal of approximately 1.3 million cubic yards of bottom material. Since most of the material is assumed to be of a polluted nature, the dredge material would be placed in Diked Disposal Facility Site No. 14.

Plan 7G - Reduce River Congestion (Site 7)

This plan would eliminate a potential accident site and eliminate undue vessel delay at river mile 4.3. Components of Plan 7G include relocating an existing utility, removing the portion of the former Jefferson Avenue Bridge abutments which protrude into the navigation channel and related bank cuts (No. 21 and 22) adjacent to the bridge abutments. Removing a portion of the bridge abutments and bank cuts No. 21 and 22 will increase the width of the navigation channel from 130 feet to 190 feet. New bulkheads would be installed where the abutments are removed.

Plan 11 - Deepening Turning Basin

Plan 11 would deepen the turning basin from 18 feet to 23 feet at mile 4.7 on the Cuyahoga River. In addition to the required dredging, the existing turning basin bulkheads would be replaced.

Plan 10 - No Action

The "No Action" plan will be considered if detailed studies show that structural and/or non-structural plans cannot be implemented. Under the "No Action" plan, the Cleveland Harbor and Cuyahoga River would be maintained at existing conditions.

DESCRIPTION OF RESOURCES

Aquatic Resources

Approximately 50 species of benthic macroinvertebrates have been reported in the Cleveland nearshore zone (Table 1). These organisms serve as a food source for many species of fish in the harbor. The majority of benthic fauna are composed of aquatic oligochaetes (Pliodzinkas 1979). The Army Corps of Engineers (1978) also found abundant populations of mobile macrobenthic invertebrates, including crayfish, amphipods, and isopods in the river channel and harbor. These mobile benthic fauna prefer, and may be restricted to, rocky substrate including breakwalls where abundant growth of the plant Cladophora, occur. During summer 1975, 1,076 amphipods/M^2 were sampled from the breakwall area (U. S. Army Corps of Engineers 1978).

Phytoplankton crops in Lake Erie have greatly increased in the last 50 years, indicating increased eutrophication. Pronounced spring and fall pulses of phytoplankton occur in the Cleveland Harbor. The dominant species are diatoms, including Asterionella spp., Melosira spp., and Fragilaria spp. Green and blue-green algae also contribute to phytoplankton blooms in the harbor (Hartley and VanVooren 1977, U. S. Army Corps of Engineers 1978).

Zooplankton populations appear to peak with high concentrations in the fall. The most abundant zooplankton in Cleveland Harbor include Rhizopoda, Rotifera, Cladocera, and Copepoda (U. S. Army Corps of Engineers 1978).

Fish populations of the Cleveland area are under great stress from degradation of the ecosystem. Pollution, siltation, and loss of aquatic vegetation are factors that have adversely affected Cleveland fish fauna. Table 2 lists those species of fish collected in Cleveland Harbor and adjacent marinas, 1972-1974. Common emerald shiner, eastern gizzard shad, and yellow perch are the most abundant species in the harbor. The yellow perch is the most important species in terms of contribution to the commercial and sport harvest. Both coho and chinook salmon, which occur in the harbor, are stocked in the Chagrin River (White et al. 1975). A limited fishery survey in the harbor area was conducted by U. S. Fish and Wildlife Service personnel in 1982. On two occasions (August 10-11 and October 5-6), two 150-foot by 6-foot gill nets were set adjacent to and shoreward of the west breakwater of Cleveland Harbor. Each gill net used on August 10-11 contained six panels, with one panel each of mesh size 1/2", 3/4", 1", 1 1/2", 2", and 2 1/2". The gill nets used on October 5-6 contained six panels with three 1 1/2" mesh panels and three 2" mesh panels. On each occasion, the nets were set between 11:00 AM and 2:00 PM of the first day and lifted between 9:00 AM and 11:00 AM of the second day. As could be expected, the most common species collected were freshwater drum, yellow perch, white bass, and spottail shiner. Only one specimen each of coho salmon, rock bass, and stonecat madtom was collected. A complete list of species collected is provided in Table 3.

Two 150-foot variable mesh gill nets were also set in the vicinity of the Jefferson Avenue bridge abutments on the Cuyahoga River on September 22, 1982. The overnight sets yielded a total of four small white bass and one carp.

White et al. described the following as principal fish nursery zones in the Cleveland area: the mouth, lower one mile, and adjacent shoreline of the Rocky River; the mouth and adjacent shoreline of the Chagrin River; and the Cleveland Harbor and adjacent marinas. Table 4 indicates those species collected as fry or young-of-the-year in Cleveland Harbor. Most of the harbor nursery areas are dominated by a few abundant species.

It is probable that a list of species spawning in the harbor would be similar to Table 4 (White et al. 1975). During 1972-74, goldfish, pumpkinseed sunfish, largemouth black bass, and yellow perch were observed spawning in Cleveland Harbor (White et al. 1975).

Recreational fishing from harbor structures is an important activity for thousands of residents of the Cleveland area. From May to October 1982, personnel from U. S. Fish and Wildlife Service, Columbus Field Office made seven counts of persons fishing from breakwaters in the Edgewater Park area. A total of 307 fishermen were counted with a high of 76 fishermen on May 3 and a low of 15 on September 22.

A check of the fisherman's catch revealed that most were landing white bass, perch, and freshwater drum. For the years 1975 to 1977, Baker et al. 1979, reported an average annual harvest of 99,979 fish by shore anglers in the west Cleveland area which includes Cleveland Harbor. Table 5 presents data on shore angler fishery pressure and harvest for the years 1980-82 at both the west harbor area (Edgewater) as well as the east harbor area (Niki Pier and 72nd Street Pier). Table 5 also indicates that the three most important species are yellow perch, white bass and drum. The commercial fishery in the harbor itself has virtually disappeared, resulting in the loss of millions of dollars to the Cleveland economy. The diverse fish fauna and commercial fishery of Cleveland Harbor are restorable if appropriate measures to reduce pollution and restore the environment are implemented (White et al. 1975).

Upland Resources

At one time, the harbor area and riparian habitat along the Cuyahoga River supported a variety of upland wildlife species. Habitat loss has eliminated most mammals from the harbor area, although cottontail rabbits and small mammals may be abundant in localized areas. Also, some reverting or early successional areas along the Cuyahoga River support good populations of cottontail rabbits and pheasants.

Approximately 260 species of birds have been observed in the Cleveland area (U. S. Army Corps of Engineers 1978). Table 6 shows results of Christmas bird counts for the years 1968-1978 in the Cleveland area. Cleveland Harbor is situated on a migration corridor, located on both Mississippi and Atlantic flyways, which contains a population of over three million ducks and geese (Bellrose 1976).

Migrating waterfowl cross the Cleveland area of Lake Erie on both north-south and east-west routes between breeding and wintering grounds. Birds which occur in the Harbor area include: Bonaparte's gull (Larus philadelphia), ring-billed gull (L. delawarensis), herring gull (L. argentatus), common loon (Gavia immer), horned grebe (Podiceps auritis), great blue heron (Ardea herodias), mallard (Anas platyrhyhchos), black duck (Anas rubripes), canvasback (Aythya valisineria), goldeneye (Bucephola akeola), oldsquaw (Claugula hyemalis), and common merganser (Megus merganser) (U. S. Army Corps of Engineers 1978). Waterfowl are often attracted to the warm, open water areas of the power plant effluents in Cleveland Harbor.

To facilitate compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain from the Fish and Wildlife Service information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action. Therefore, we are providing you the following list of endangered (E) or threatened (T) species which may be present in the concerned area:

Name/Status	Habitat	Distribution
Indiana bat (E) Myotis sodalis	Caves and riparian	Statewide, except Athens, Belmont, Carroll, Coshocton, Gallia, Guernsey, Harrison, Jackson, Jefferson, Lawrence, Meigs, Monroe, Morgan, Muskingum, Noble, Tuscarawas, Vinton, and Washington Counties.

Section 7(d) of the 1978 Amendment to the Endangered Species Act underscores the requirement that the Federal agency and the permit or license applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which in effect would deny the formulation or implementation of reasonable alternatives regarding their actions on any endangered or threatened species.

The project area was inspected by a biologist of the U. S. Fish and Wildlife Service. Since proposed project measures are primarily water oriented in an industrialized urban area, the likelihood of project induced impacts on the Indiana bat are remote. This precludes the need for further consultation on this project as required under Section 7 of the Endangered Species Act as amended. Should this project be modified or new information indicates that endangered species may be affected, consultation should be initiated.

DISCUSSION

The major impacts associated with the modification of Cleveland Harbor will result from the proposed dredging and associated disposal of material. Since the proposed dredging will deepen the entrance and interior channels of Cleveland Harbor as well as the turning basin on the Cuyahoga River, previously undisturbed material (between 25 and 32 feet) should be analyzed to determine its polluted/non-polluted nature. If the material is polluted, it should be confined in Diked Disposal Facility Number 14. If the material is not polluted, instead of open lake disposal, a useful purpose for the material should be sought.

The actual dredging process would destroy existing benthic populations and may destroy larval fish if dredging occurs during this phase of the life cycle. Adult or juvenile fish species would disburse from the dredging area and thus losses should be few. The dredging would impact adult fish species due to suspension of material and the release of pollutants. Dredging effects on fish populations should be temporary and fish species should reoccupy the dredged area once dredging operations cease. The annual maintenance dredging required under Plan 1 and 11 should not be much greater than that presently required to maintain existing channel depths. Therefore, the long term impacts on fish and wildlife resources should not be significantly increased over existing harbor conditions.

The removal of the Jefferson Avenue Bridge abutments should only have minor impacts on fish and wildlife resources since the aquatic resources are at depressed levels in this section of the Cuyahoga River. The proposed bank cuts adjacent to these abutments should have no significant adverse impacts on fish and wildlife resources. A useful purpose for the removed material (broken concrete, unpolluted material) should be investigated during Stage 3 planning.

Recommendations

Based on the above information and discussion, we recommend that:

1. All proposed dredge material be sampled prior to dredging to determine its "polluted" status.

2. All polluted dredged material be confined in Diked Disposal facility number 14.

3. Useful purposes, such as beach nourishment, instead of open lake disposal be considered for unpolluted dredged material.

4. If suitable, the concrete abutment material removed under Alternative 7G be placed lakeward of the Edgewater Park breakwater to provide fish habitat.

Sincerely yours,

for Ken Multerer
Kent E. Kroonemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
ODNR, Outdoor Recreation Service, Attn: M. Colvin, Columbus, OH
Ohio EPA, Attn: A. Lynch, Columbus, OH
U.S.EPA, Office of Environmental Review, Chicago, IL

Table 1. Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, Ohio*

Phylum Coelenterata	Class	Hydrozoa
		Hydra sp.
Phylum Aschelminthes	Class	Nematoda
		Alaimus sp.
		Dorylaimus sp.
		Mesodorylaimus sp.
Phylum Annelida	Class	Polychaeta
		Manayunkia speciosa
	Class	Oligochaeta
		Aulodrilus piqueti
		A. pluriseta
		Branchiura sowerbyi
		Ilyodrilus templetoni
		Limnodrilus augustipenis
		L. cervix
		L. claperedeianus
		L. hoffmeisteri
		L. profundicola
		L. udekemianus
		Peloscolex ferox
		P. multisetosus
		Potamothrix moldaviensis
		P. vejdovskyi
		Tubifex tubifex
		Dero digitata
		Nais communis
		N. pseudobtusa
		N. variabilis
		Ophidonais serpentina
		Stylria fossularis
	Class	Hirudinea
		Illinobdella sp.
		Helobdella stagnalis
Phylum Mollusca	Class	Pelecypoda
		Pisidium sp.
		P. casertanum
		P. henslowanum
		P. lilljeborgi
		Sphaerium sp.
	Class	Gastropoda
		Amnicola sp.
		Physa sp.
		Valvata sincera

((

Table 1. (continued) Benthic Macroinvertebrate Taxa Reported in the Lake Erie Nearshore Zone in the Vicinity of Cleveland, Ohio*

Phylum Arthropoda	Class	Crustacea
		Lirceus sp.
		Asellus intermedius
		Gammarus fasciatus
		Pontoporeia affinis
	Class	Insecta
	Order	Diptera
		Chironomus sp.
		C. plumosus
		C. riparius
		Tanytarsini (Tribe)
		Procladius sp.
		P. adumbratus
		P. attenuatus
		P. euliciformes
		P. riparius

Source: Rolan, 1973
Nacht, 1977

*from Pliodzinkas 1979

Table 2. Relative Abundance of Fishes Collected in Cleveland Harbor and Adjacent Marinas (revised July 1974)*

Species	No. Collected	% of Total
Longnose gar	1	0.01 %
Alewife	92	0.85
Gizzard shad	2,525	23.43
Chinook salmon	9	0.08
Coho salmon	42	0.39
Rainbow trout	2	0.02
Rainbow smelt	323	3.00
Northern pike	15	0.14
Carp	64	0.59
Goldfish	97	0.90
Golden shiner	393	3.65
Longnose dace	1	0.01
Creek chub	1	0.01
Blacknose dace	1	0.01
Emerald shiner	4,092	37.97
Striped shiner	1	0.01
Spottail shiner	903	8.38
Spotfin shiner	6	0.06
Sand shiner	33	0.31
Mimic shiner	6	0.06
Fathead minnow	1	0.01
Bluntnose minnow	74	0.69
Stoneroller	2	0.02
Quillback	1	0.01
Black redhorse	1	0.01

Table 2. (continued) Relative Abundance of Fishes Collected in Cleveland Harbor and Adjacent Marinas (revised July 197[illegible])*

Species	No. Collected	% of Total
Golden redhorse	2	0.02
Shorthead shiner	1	0.01
White sucker	89	0.83
Channel catfish	2	0.02
Brown bullhead	23	0.21
Black bullhead	14	0.13
Stonecat	13	0.12
Trout-perch	153	1.42
Brook silverside	3	0.03
White bass	223	2.07
White crappie	80	0.74
Black crappie	11	0.10
Rock bass	5	0.05
Largemouth bass	3	00.3
Warmouth	1	0.01
Green sunfish	3	0.03
Bluegill	4	0.04
Pumpkinseed	34	0.32
Walleye	2	0.02
Yellow perch	1,254	11.64
Logperch	1	0.01
Freshwater drum	170	1.58
TOTALS	10,777	100.05 %
47 Species		

* from White, et al., 1975; names updated

((

Table 3. Fish Species Collected Inside West Breakwater of Cleveland Harbor, 1982

Species	Date Aug. 10-11*	Oct. 5-6**
Common carp	X	X
Freshwater drum	X	X
Brown bullhead		X
White sucker		X
Gizzard shad	X	X
Sauger		X
White bass	X	
Yellow perch	X	
Coho salmon		X
Rock bass	X	
Spottail shiner	X	
Walleye	X	
Trout-perch	X	
Emerald shiner	X	
Stonecat madtom	X	

* Gill net mesh size 1/2" to 2 1/2"

** Gill net mesh size 1 1/2" to 2"

Table 4. Species of Fishes Collected as Fry or Young-of-the-Year in Cleveland Harbor, 1972-1974*

Species	Abundance**
Alewife	Abundant
Gizzard shad	Abundant
Rainbow smelt	Abundant
Quillback	Rare
White sucker	Uncommon
Common carp	Common
Goldfish	Common
Golden shiner	Abundant
Longnose dace	Rare
Emerald shiner	Abundant
Spottail shiner	Uncommon
Fathead minnow	Rare
Bluntnose minnow	Common
Trout-perch	Rare
Brook silverside	Rare
White bass	Uncommon
Rock bass	Uncommon
Largemouth bass	Rare
Green sunfish	Uncommon
Bluegill	Common
Pumpkinseed	Abundant
Yellow perch	Common
Logperch	Rare
White crappie	Uncommon

* from White et al. 1975
** Abundance of each species depicted as a relative term

((

Table 5. Shore Angler Harvest and Pressure in the Cleveland Harbor area, Cleveland, Ohio*

1. Edgewater Park (West Cleveland Harbor)

	1980	1981	1982
Angler Hours	120,409	146,063	135,819
Yellow perch	24,669	12,312	36,755
White bass	10,106	17,931	31,812
Freshwater drum	17,955	56,194	22,325
Channel catfish	1,433	767	417
Other species	4,925	4,814	187

2. Niki Site Pier & East 72nd Street Pier (Eest Cleveland Harbor)

	1980	1981	1982
Angler Hours	138,075	140,096	249,692
Yellow perch	40,201	17,542	61,426
White bass	33,274	102,604	150,360
Freshwater drum	14,671	21,646	31,625
Channel catfish	496	274	917
Other species	9,798	6,544	2,919

* from Johnson, ODNR, Sandusky, Ohio 1983

Table 6. Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Ring-billed gull*	10	14,104
Bonaparte's gull*	10	5,480
Herring gull*	10	4,212
Starling	10	1,302
House sparrow	10	872
Mallard*	10	703
Common crow	10	363
Black-capped chickadee	10	347
Black duck*	10	307
Dark-eyed junco	10	294
Cardinal	10	278
Tree sparrow	10	262
Common goldeneye*	10	212
Tufted titmouse	10	183
Blue jay	10	181
American goldfinch	10	121
Red-breasted merganser*	10	117
Downy woodpecker	10	98
Cedar waxwing	10	98
Mourning dove	10	92
White-breasted nuthatch	10	80
Song sparrow	10	56
Lesser scaup*	10	39
American robin	10	38
Hairy woodpecker	10	32
Redhead*	10	17
Red-bellied woodpecker	10	17
Bufflehead*	10	16
White-throated sparrow	10	15
Eastern bluebird	10	12
Red-tailed hawk	10	6
Belted kingfisher	10	5
Pileated woodpecker	10	5
Brown creeper	10	5
Golden-crowned kinglet	10	5
American kestrel	10	4
Canada goose*	9	719
Snow bunting	9	48
Red-breasted nuthatch	9	22
Ruddy duck*	9	21
Ring-necked pheasant	9	10
Common flicker	9	7
Rufous-sided towhee	9	6
Wood duck	9	5
American wigeon*	9	4
Barred owl	9	2
Carolina wren	9	2
Greater scaup*	8	144
Common merganser*	8	85
Field sparrow	8	5

Table 6. (continued) Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Winter wren	8	2
Pine siskin	7	20
American coot*	7	8
Great black-backed gull*	7	7
Horned grebe*	7	3
Swamp sparrow	7	3
Hooded merganser*	7	2
Yellow-bellied sapsucker	7	2
Evening grosbeak	6	9
Horned lark	6	5
Purple finch	6	4
Pied-billed grebe*	6	3
Red-shouldered hawk	6	2
Mockingbird	6	2
Brown-headed cowbird	6	2
Common grackle	6	1
Great horned owl	6	1
Canvasback*	5	36
Red-winged blackbird	5	3
Pintail*	5	2
Rough-legged hawk	5	2
Common redpoll	4	65
Killdeer	4	6
Gadwall*	4	3
Ruby-crowned kinglet	4	3
Great blue heron	4	2
Green-winged teal*	4	2
Cooper's hawk	4	2
Red-headed woodpecker	4	2
Common snipe	4	1
Bobwhite	3	24
Yellow-rumped warbler	3	7
White-winged scoter*	3	3
Ruffed grouse	3	3
Hermit thrush	3	3
Surf scoter*	3	2
White-crowned sparrow	3	2
Brown thrasher	3	1
White-winged crossbill	2	32
Red crossbill	2	7
Whistling swan*	2	3
Oldsquaw*	2	2
Marsh hawk	2	2
Northern shrike	2	2
Eastern meadowlark	2	2
Lapland longspur	2	2
Double-crested cormorant*	2	1
Sharp-shinned hawk	2	1
American woodcock	2	1
Glaucous gull*	2	1

Table 6. (continued) Summary of Data from Christmas Bird Counts at Cleveland, Ohio, 1968-1978**

Species	No. Years Recorded Out of 10 Years	Average Per Year in Years Recorded
Gray catbird	2	1
White-fronted goose*	1	5
Common loon*	1	1
Snow goose (Blue morph)*	1	1
Shoveler*	1	1
Ring-necked duck*	1	1
King eider*	1	1
Common scoter*	1	1
Franklin's gull*	1	1
Screech owl	1	1
Eastern phoebe	1	1
Boreal chickadee	1	1
Swainson's thrush	1	1
Northern oriole	1	1

Average number of species recorded per census = 72

Average number of individuals recorded per census +30,569

* Species of birds likely to utilize the waters off the Municipal Light Plant for feeding or resting

** from U. S. Army Corps of Engineers 1978

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APPENDIX I
PLATES

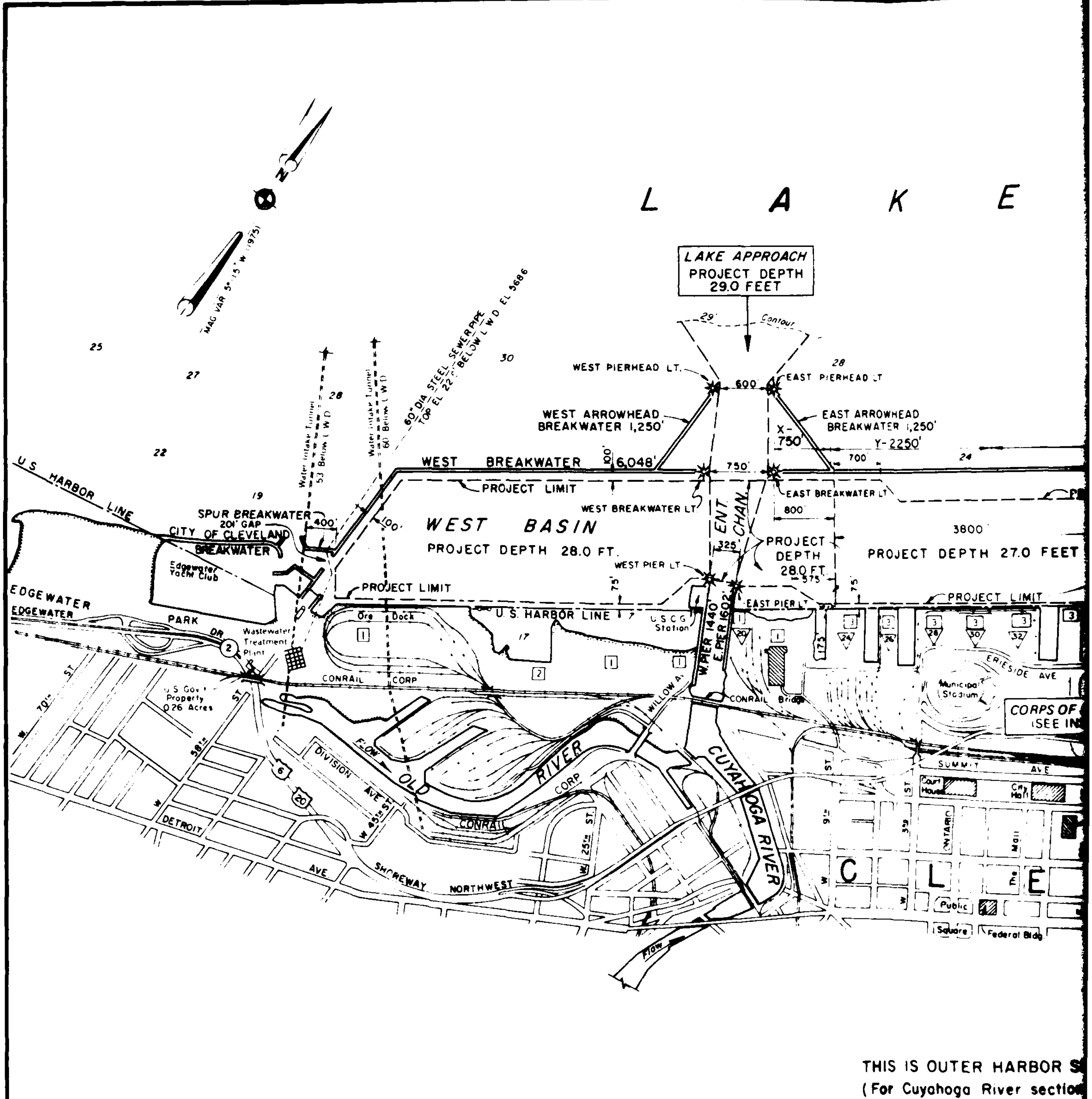
CLEVELAND HARBOR, OHIO

DRAFT REFORMULATION PHASE I
GENERAL DESIGN MEMORANDUM

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

APPENDIX I
PLATES

APPENDIX 1 (Cont'd)
PLATES (Cont'd)

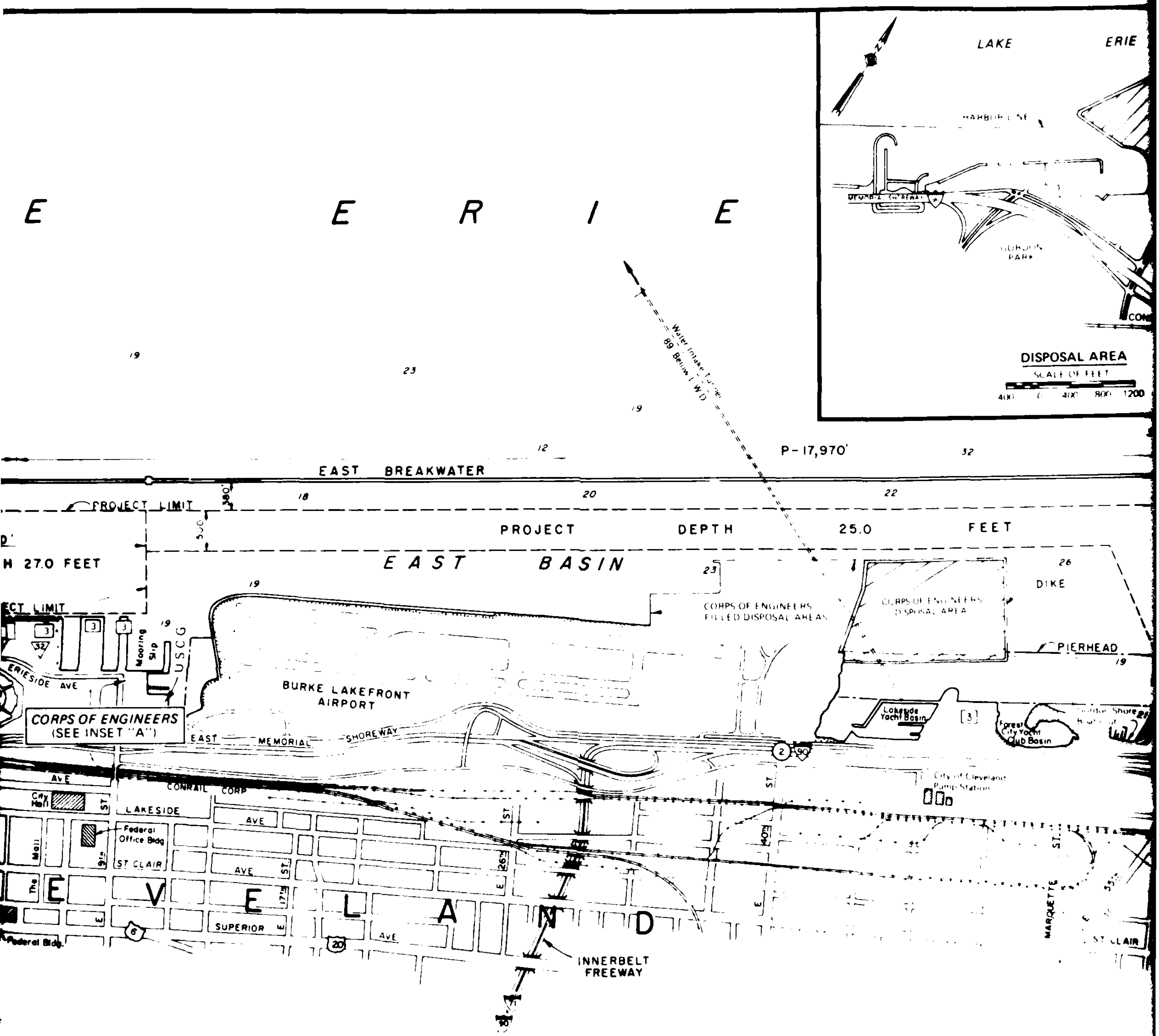


WATERFRONT OWNERSHIP

SHOWN THUS [2]

1 CONRAIL
2 GREAT LAKES DREDGE AND DOCK CO (L) CONRAIL (O)
3 CITY OF CLEVELAND (O)
4 NICHOLSON CLEVELAND TERMINAL CO (O)
5 EAST 55th ST. MARINA, CITY OF CLEVELAND (O)
6 CLEVELAND ELECTRIC ILLUMINATING CO (O)

(O) INDICATES OWNER (L) INDICATES LESSEE



HARBOR SECTION
(River section, see Map 6 A)

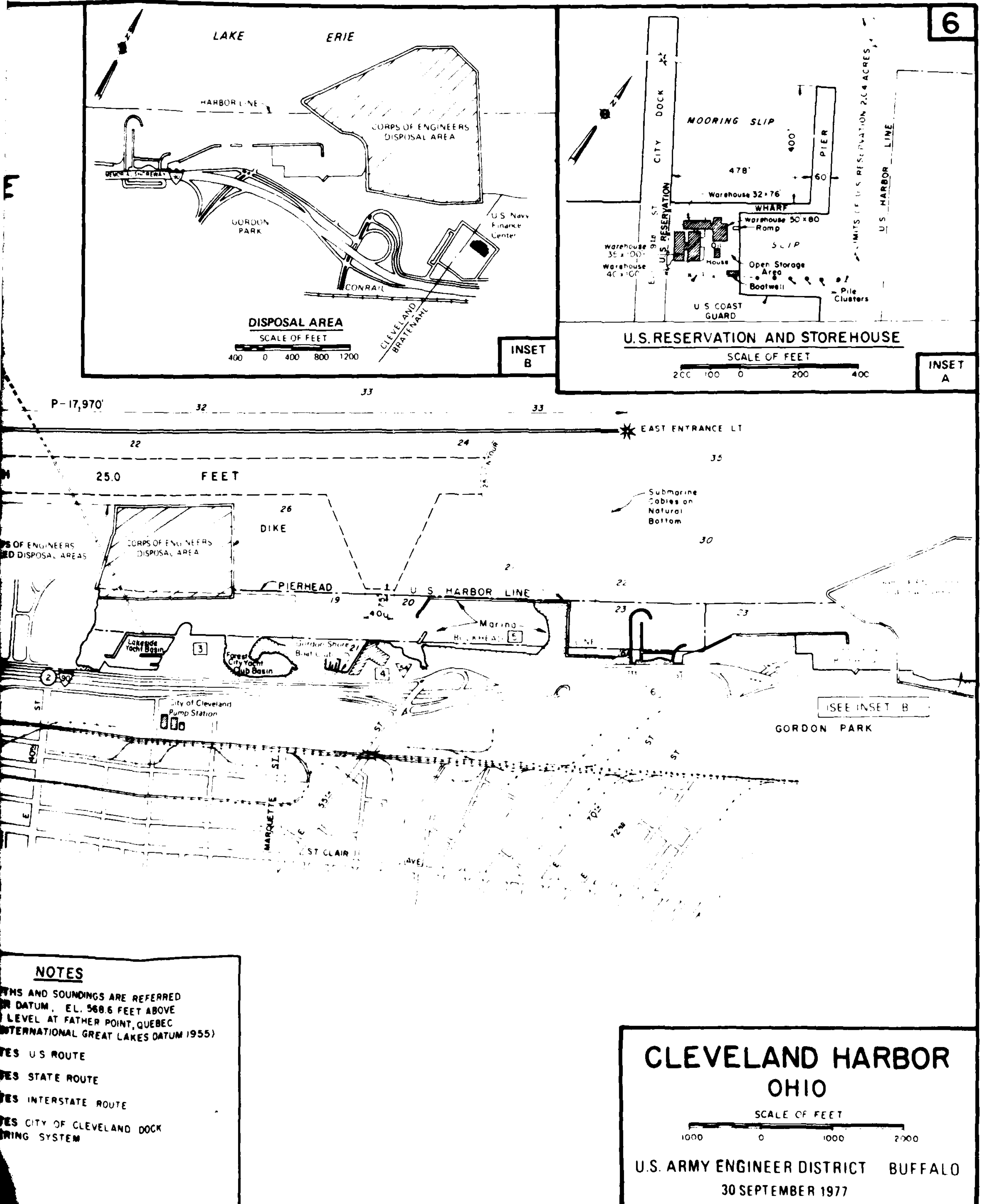
NOTES

PROJECT DEPTHS AND SOUNDINGS ARE REFERRED TO LOW WATER DATUM, EL. 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

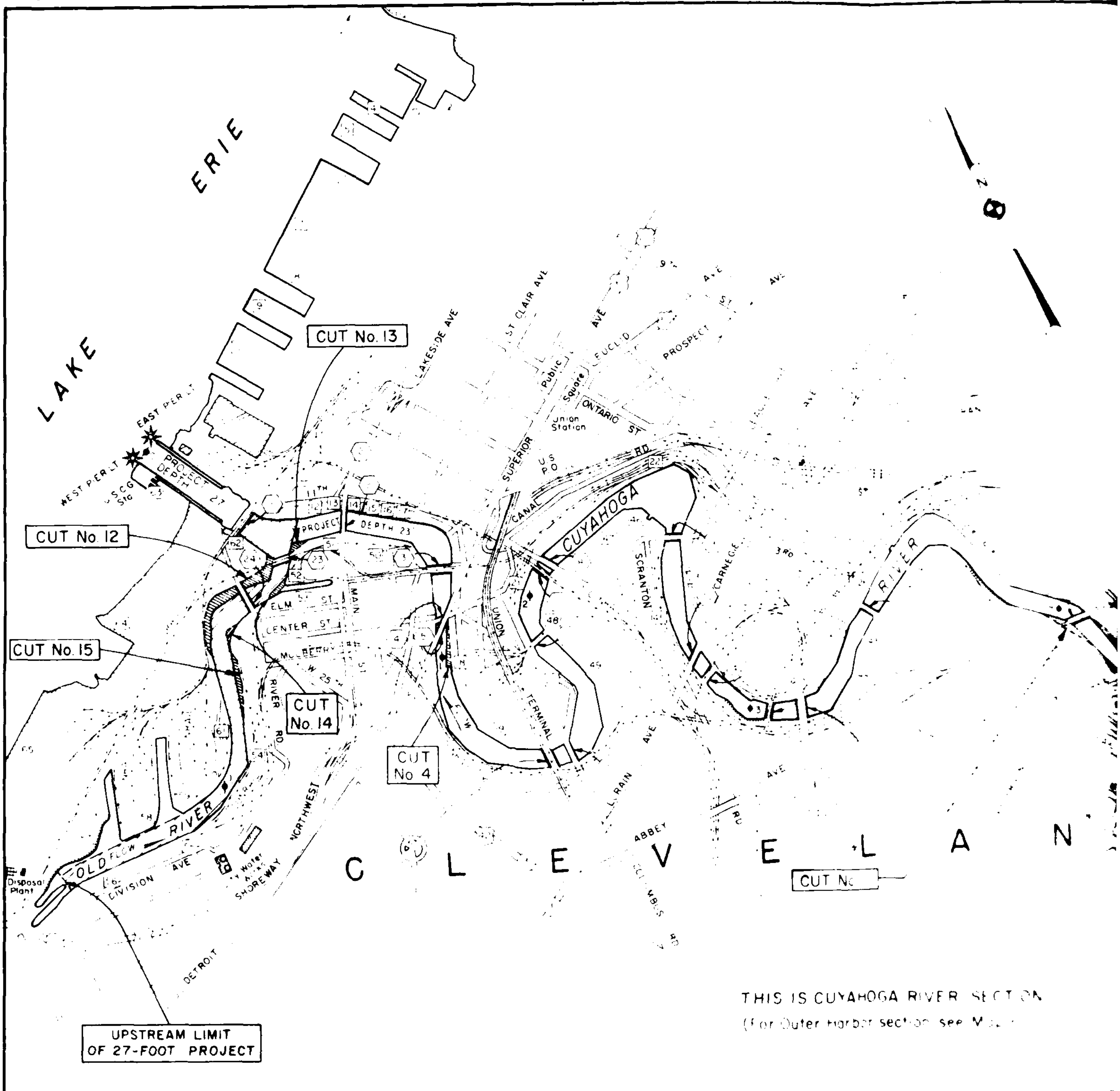
- (6) INDICATES U.S. ROUTE
- (2) INDICATES STATE ROUTE
- INDICATES INTERSTATE ROUTE
- INDICATES CITY OF CLEVELAND DOCK NUMBERING SYSTEM

2

U S ARMY



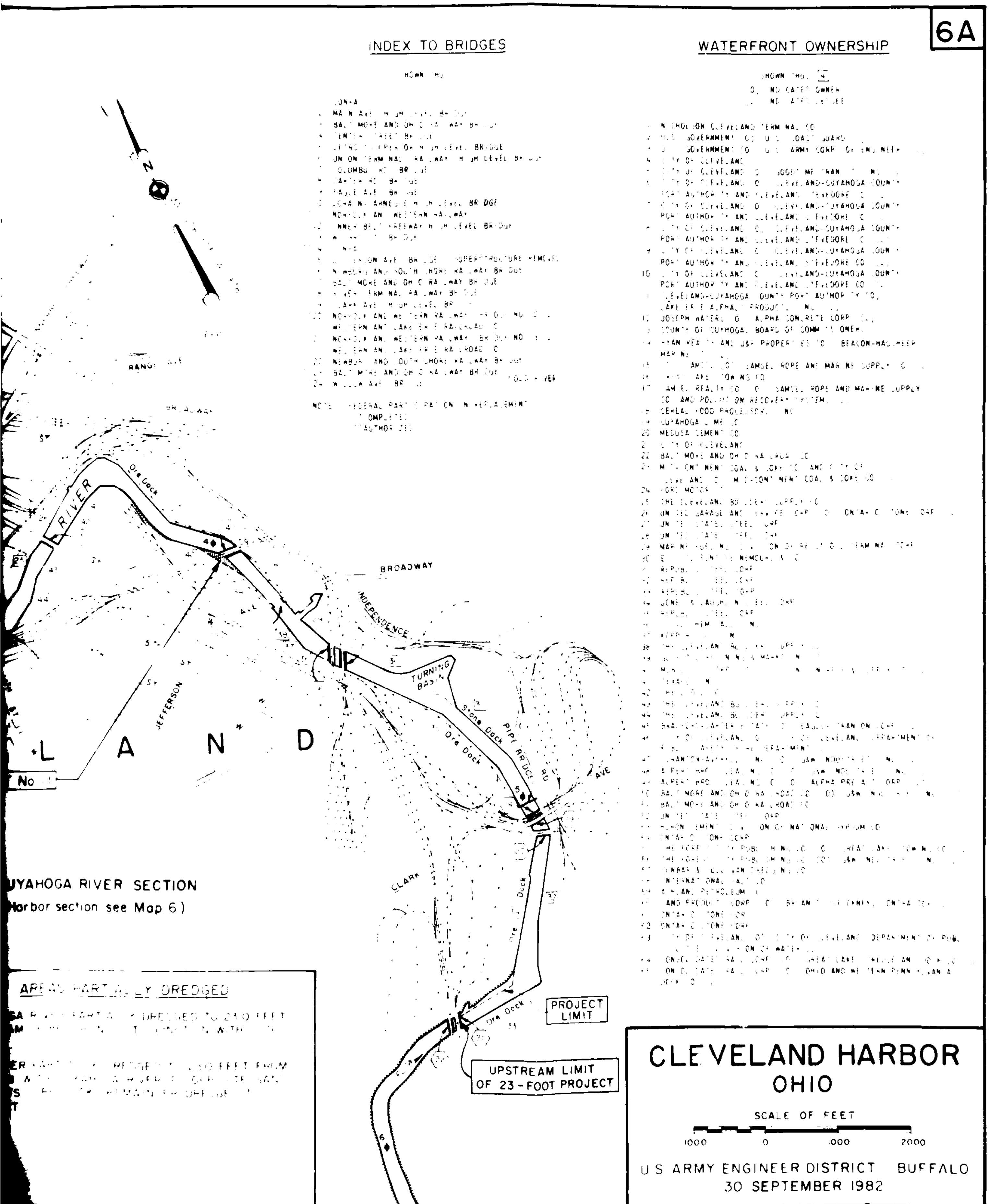
PLATE

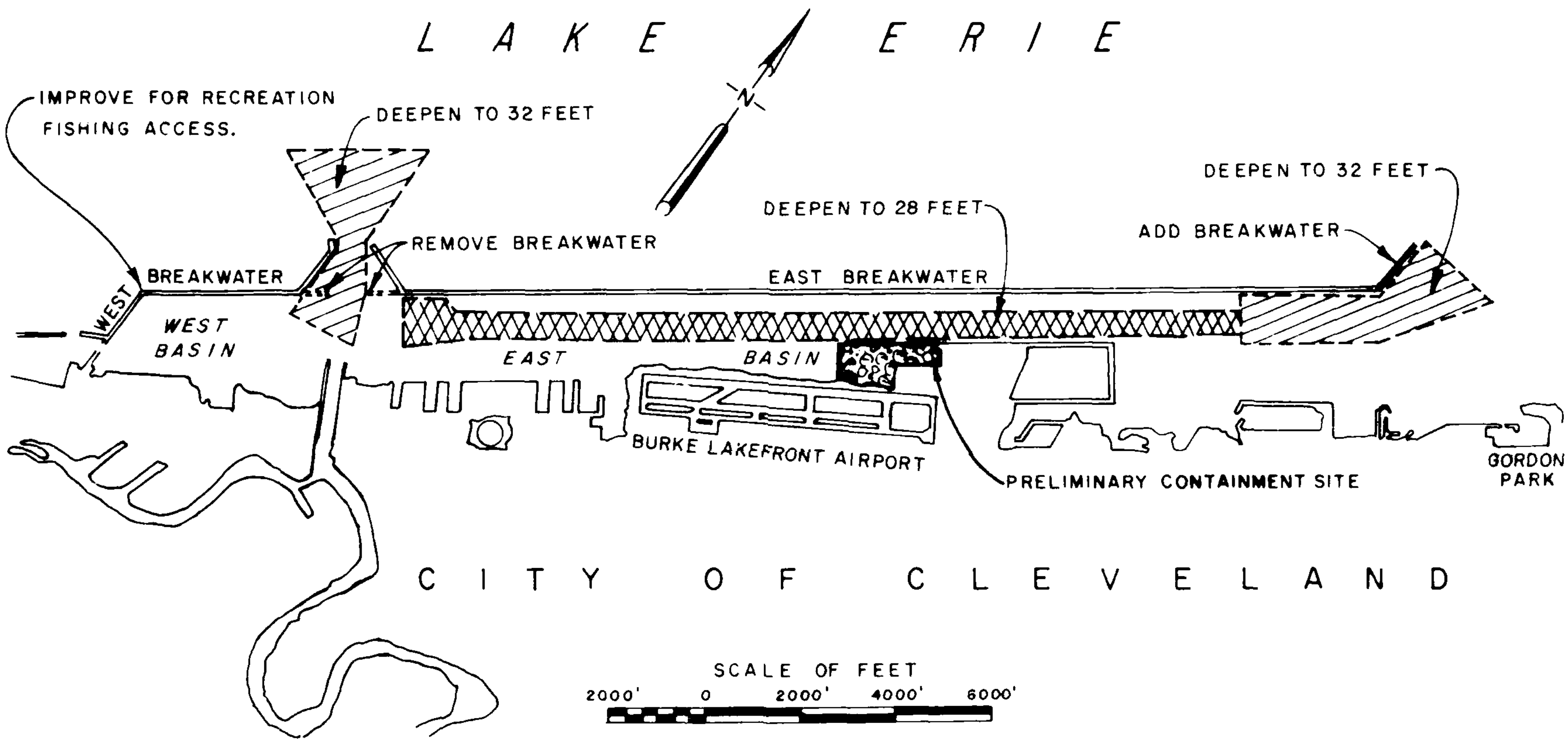


NOTES

23 FEET IN REMAINDER OF ... YAHOGA RIVER
18 FEET IN TURNING BASIN AT MILE 4.8 ON CUYAHOGA RIVER
27 FEET IN OLD RIVER

PROJECT DEPTHS AND SOUNDINGS ARE REFERRED TO LOW WATER DATUM, ...


6A
INDEX TO BRIDGES
WATERFRONT OWNERSHIP
JOSEPH WATERS
COUNTY OF CUYAHOGA, BOARD OF COMM
MEDUSA CEMENT CO
THE CLEVELAND BUILDERS SUPPLY CO
RIVER
Ore Dock
BROADWAY
INDEPENDENCE
TURNING BASIN
Stone Dock
PIPE BRIDGE
Ore Dock
JEFFERSON
CLARK
AVE
L A N D
No
UYAHOGA RIVER SECTION
Harbor section see Map 6)
AREAS PARTIALLY DREDGED
PROJECT LIMIT
UPSTREAM LIMIT OF 23-FOOT PROJECT
CLEVELAND HARBOR
OHIO
SCALE OF FEET
1000
0
1000
2000
U S ARMY ENGINEER DISTRICT BUFFALO
30 SEPTEMBER 1982



NOTES:

1. THE SELECTED PLAN ALSO INCLUDES TRANSSHIPMENT FACILITIES, WHICH ARE A NON-FEDERAL RESPONSIBILITY.

2. DEPTHS REFERRED TO LOW WATER DATUM, WHICH IS 568.6 FEET ABOVE MEAN SEA LEVEL AT FATHER POINT, QUEBEC ON INTERNATIONAL GREAT LAKES DATUM - 1955.

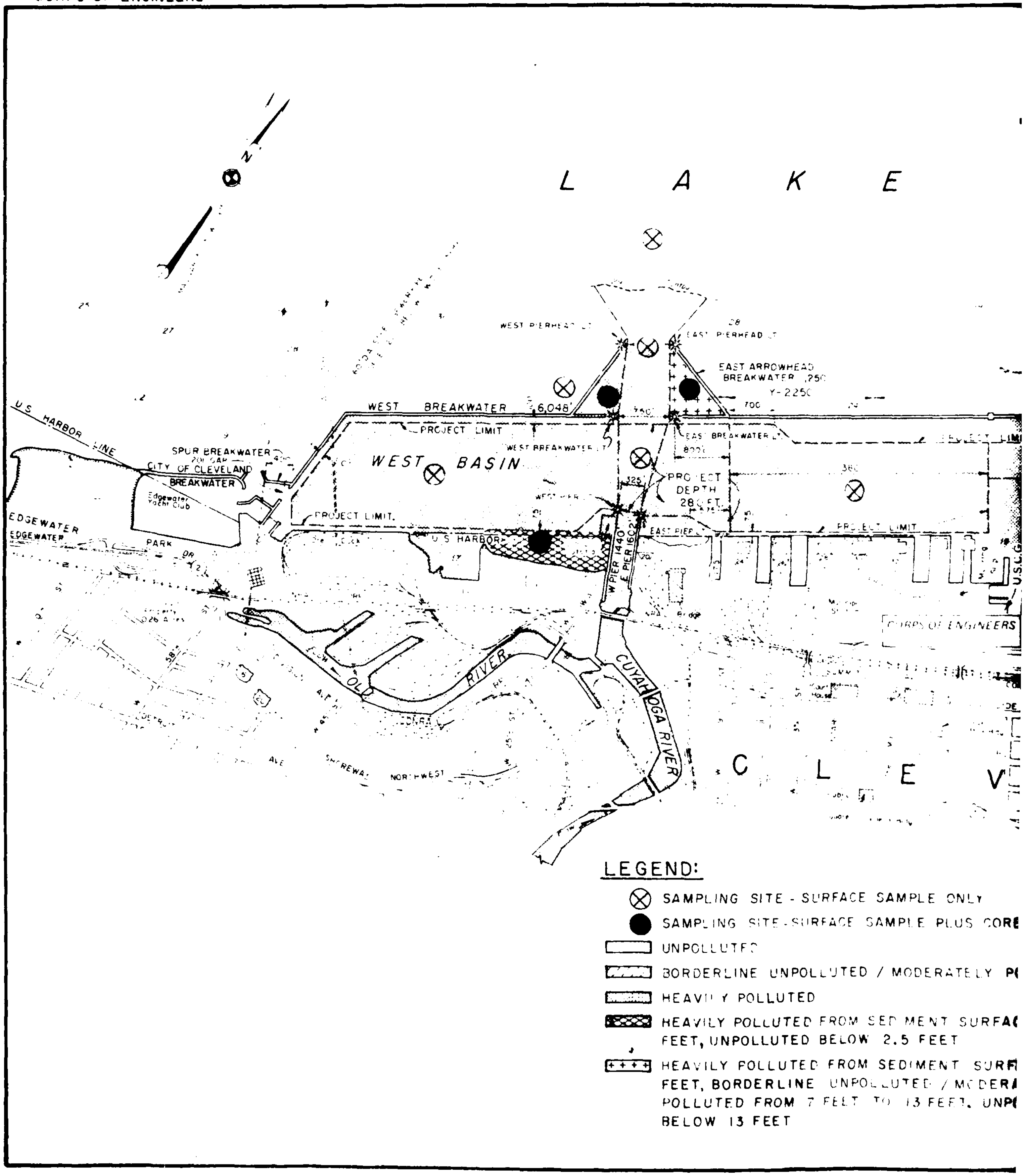
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

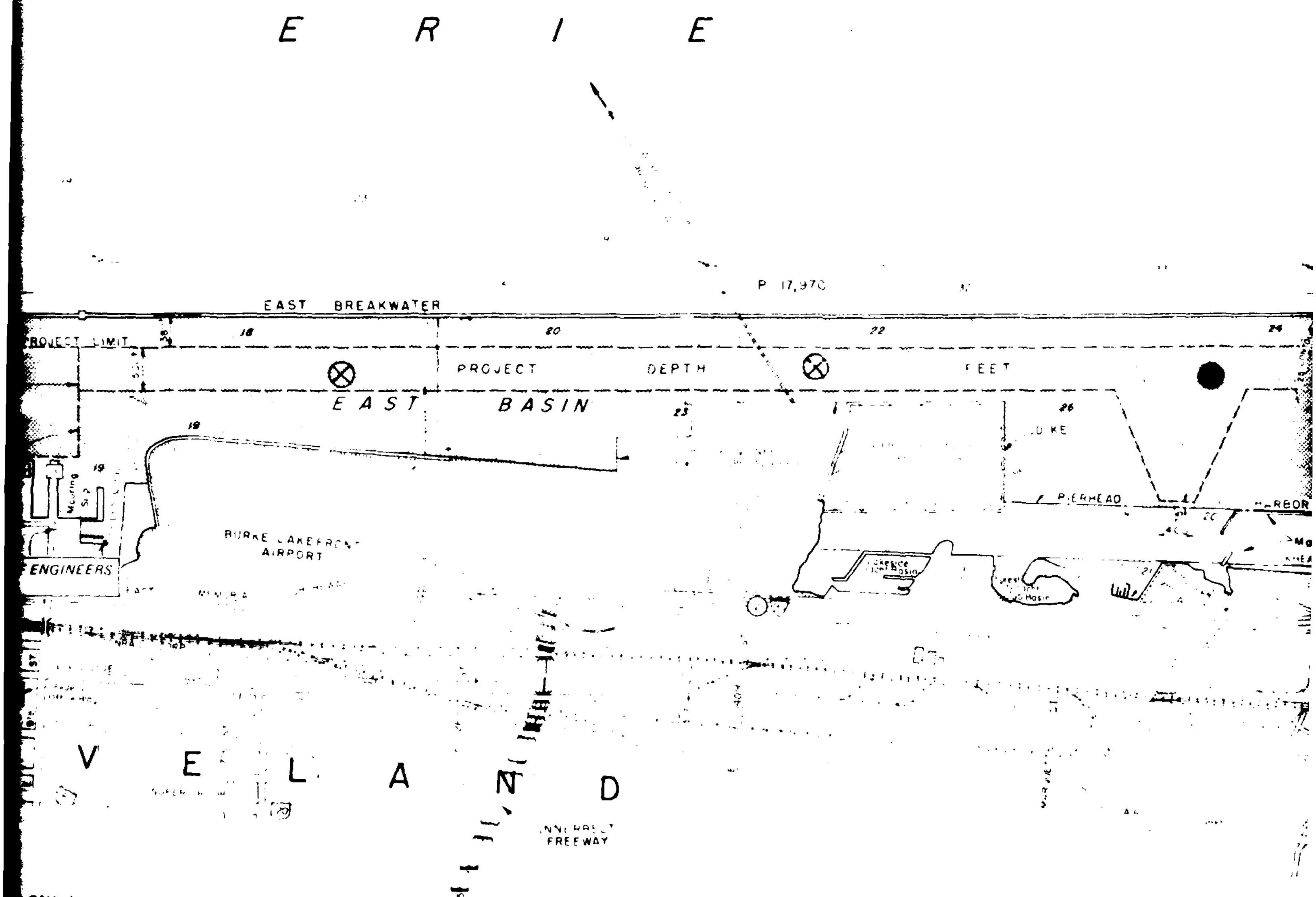
THE SELECTED PLAN

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

PLATE 3

CORPS OF ENGINEERS





ONLY
LUS CORE SAMPLES

ATELY POLLUTED

T SURFACE TO 2.5
ET

NT SURFACE TO 7
/ MODERATELY
ET. UNPOLLUTED

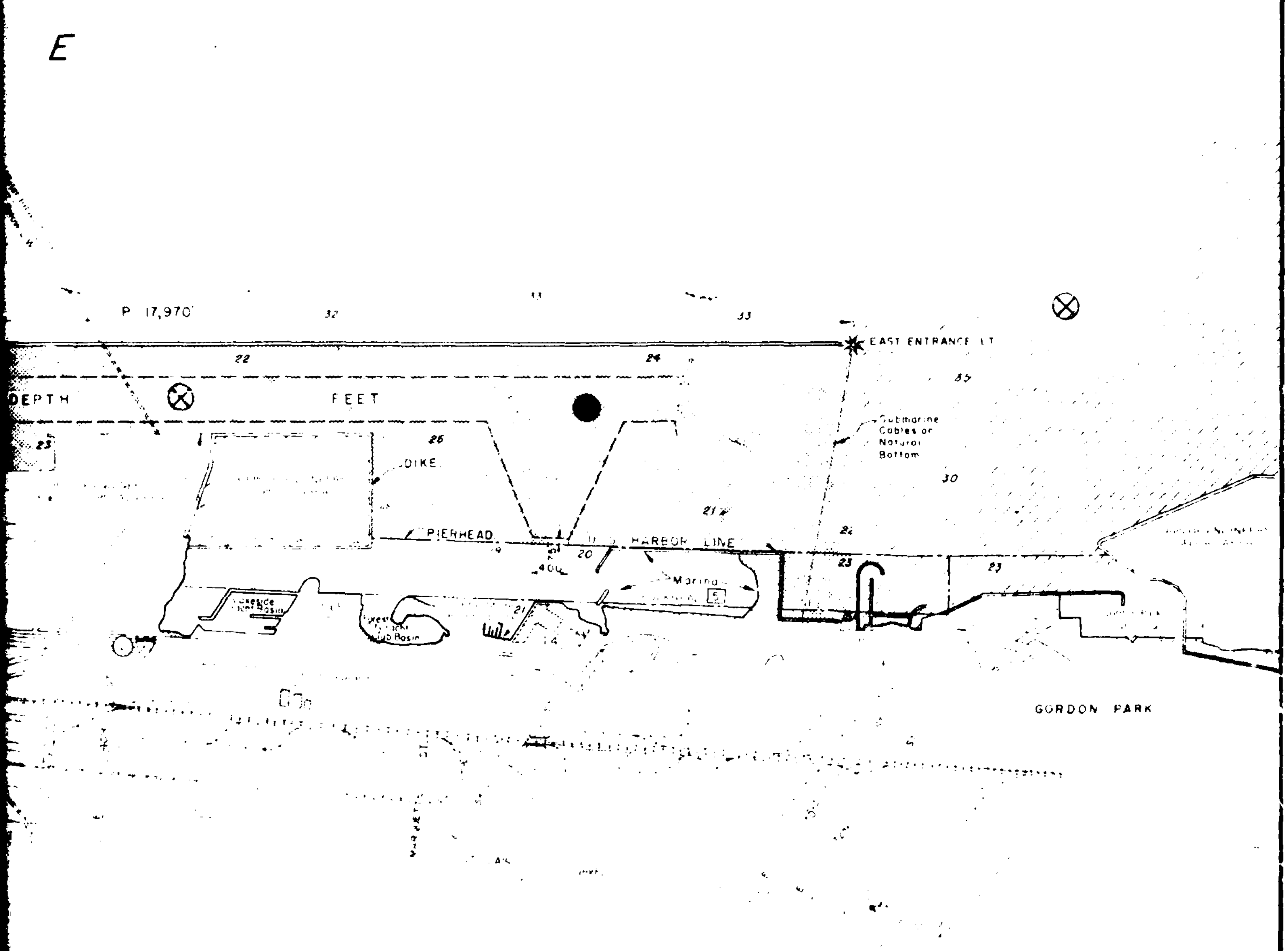
NOTE:

ADDITIONAL SAM[illegible] SITES WERE LOCATED ON THE CUYAHOGA AND OLD RIVERS.

SOURCE:

U.S. EN[illegible] PROTECTION AGENCY [illegible]

U S ARMY



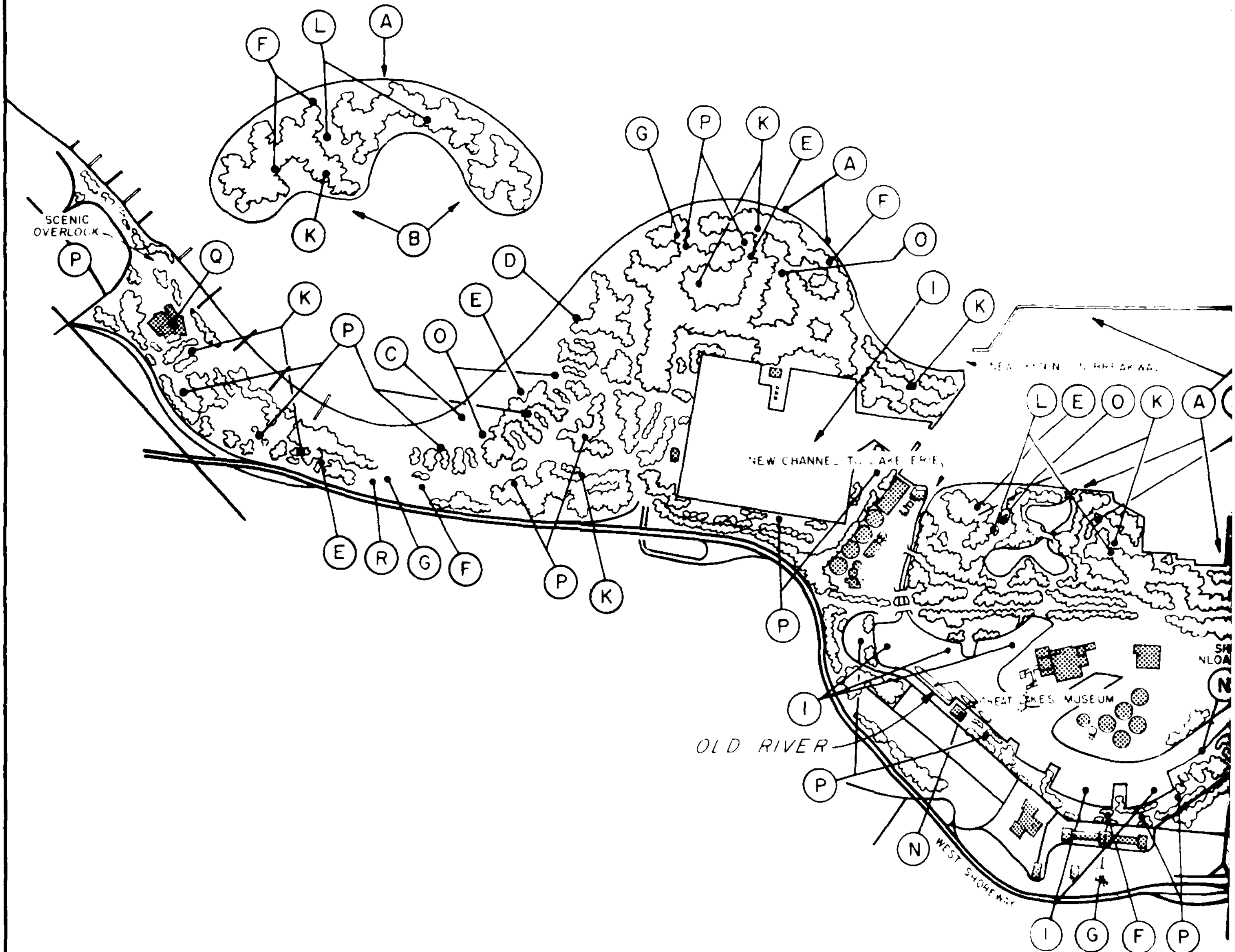
TIONAL SAMPLE SITES WERE LOCATED
HE CUYAHOGA AND OLD RIVERS.

CE:
ENVIRONMENTAL PROTECTION
NCY

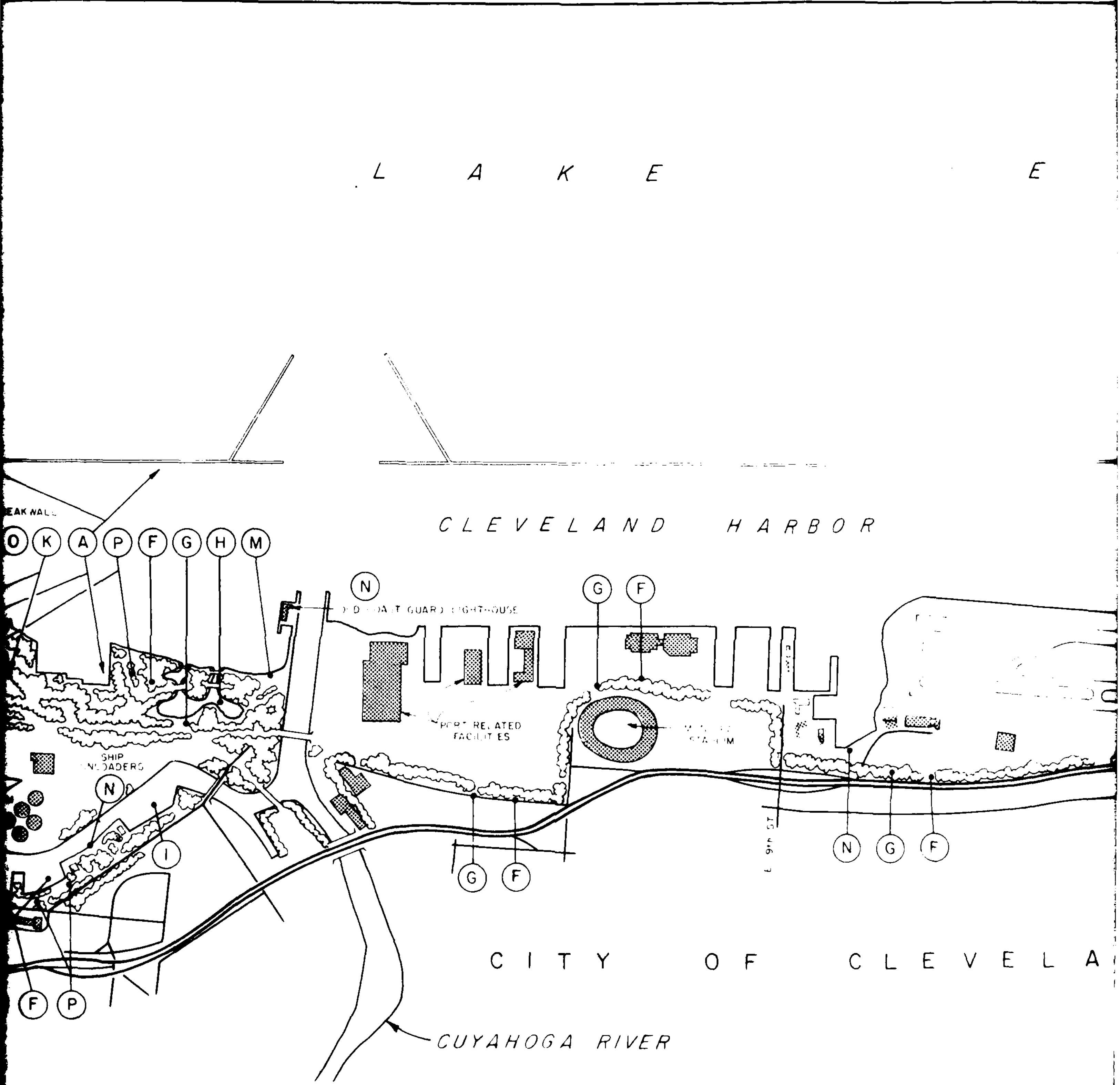
RESULTS OF 1977
SEDIMENT SAMPLING

1 3

PLATE 4

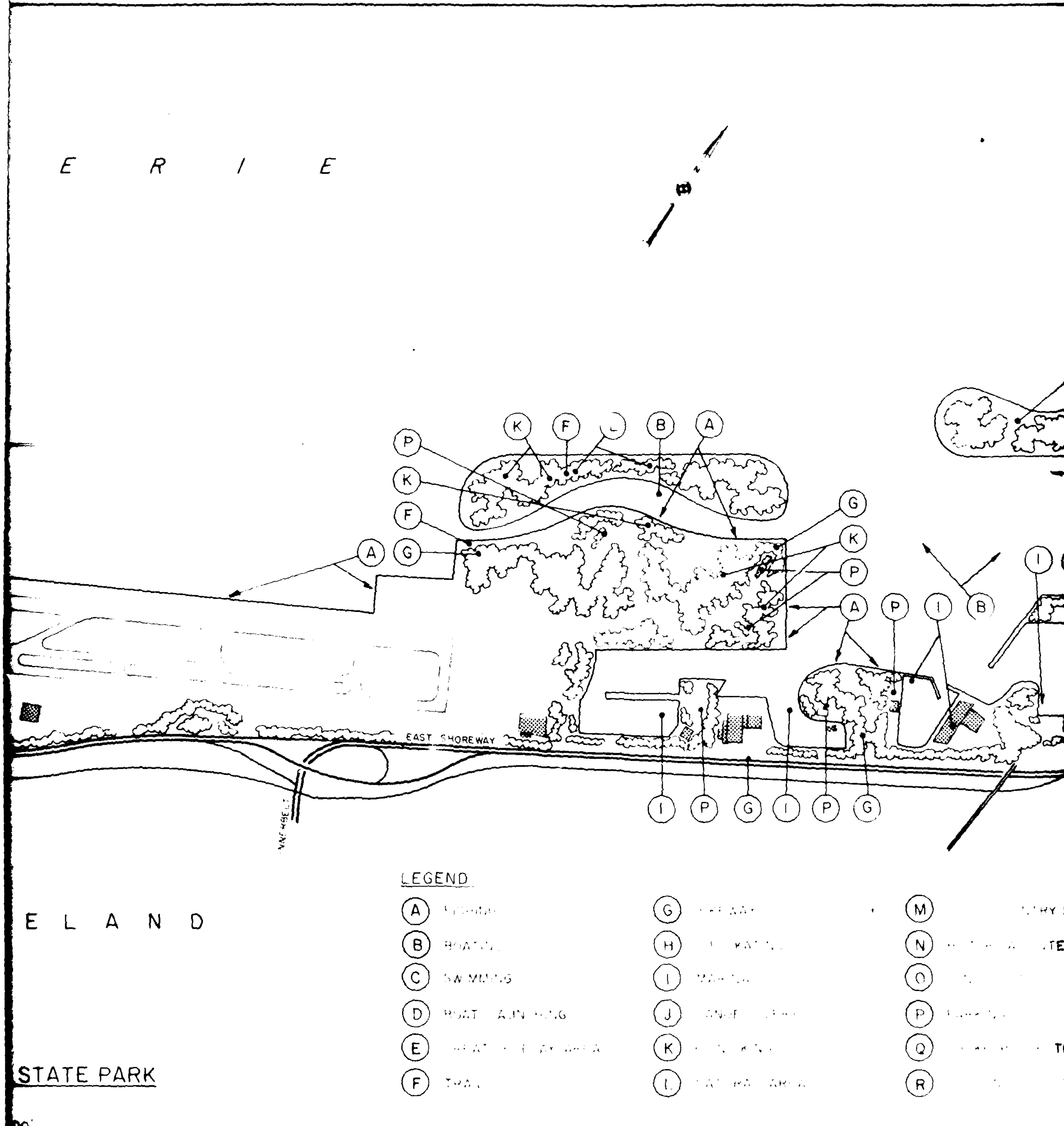


SOURCE: CLEVELAND LAKEFRONT STATE PARK (1979)



PLAN OF CLEVELAND LAKEFRONT STATE PA

SCALE IN FEET


E R I E
E L A N D
EAST SHOREWAY
STATE PARK
LEGEND
A
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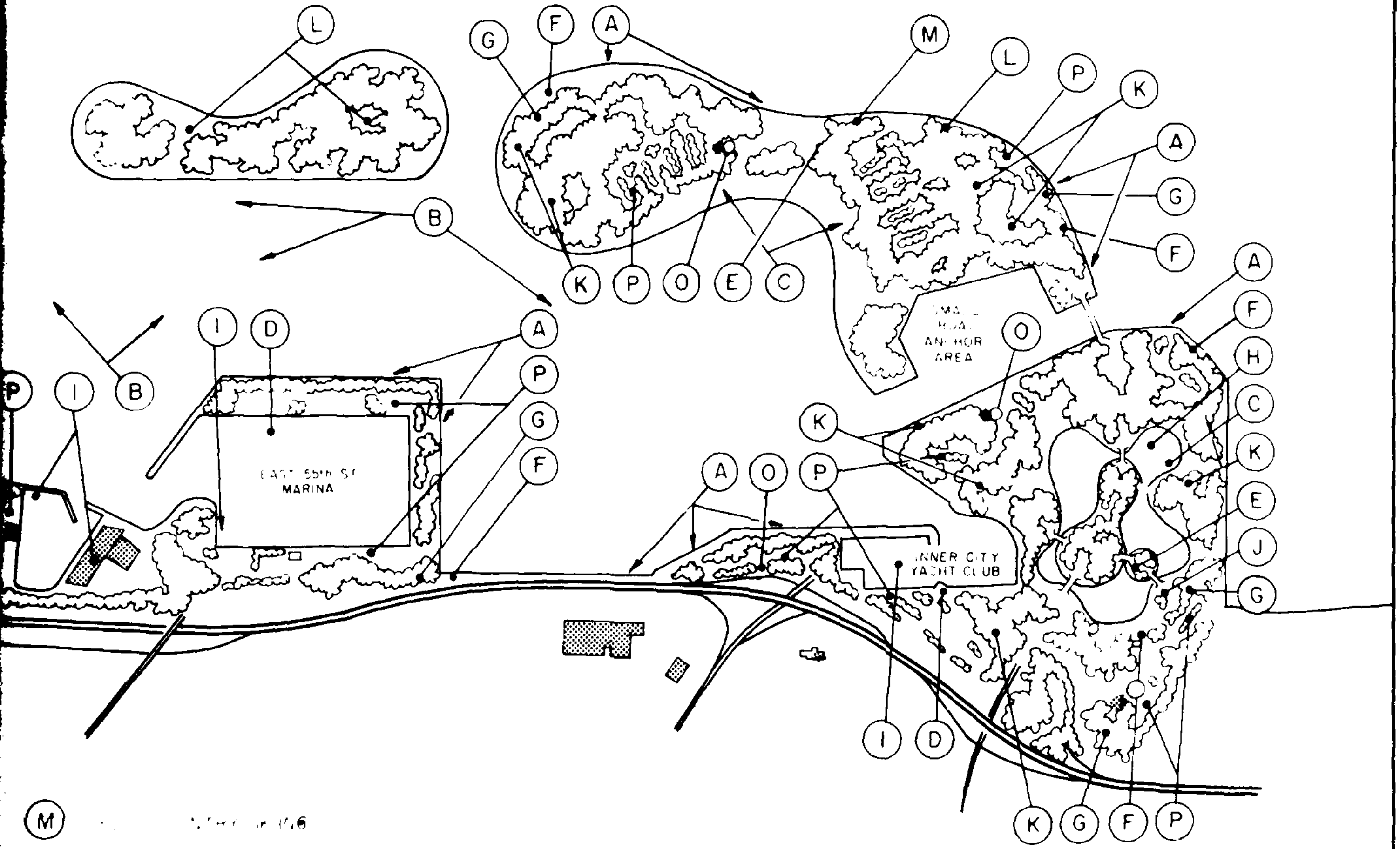


(M)

(N) ... EREST

(O)

(P)

(Q)

(R)

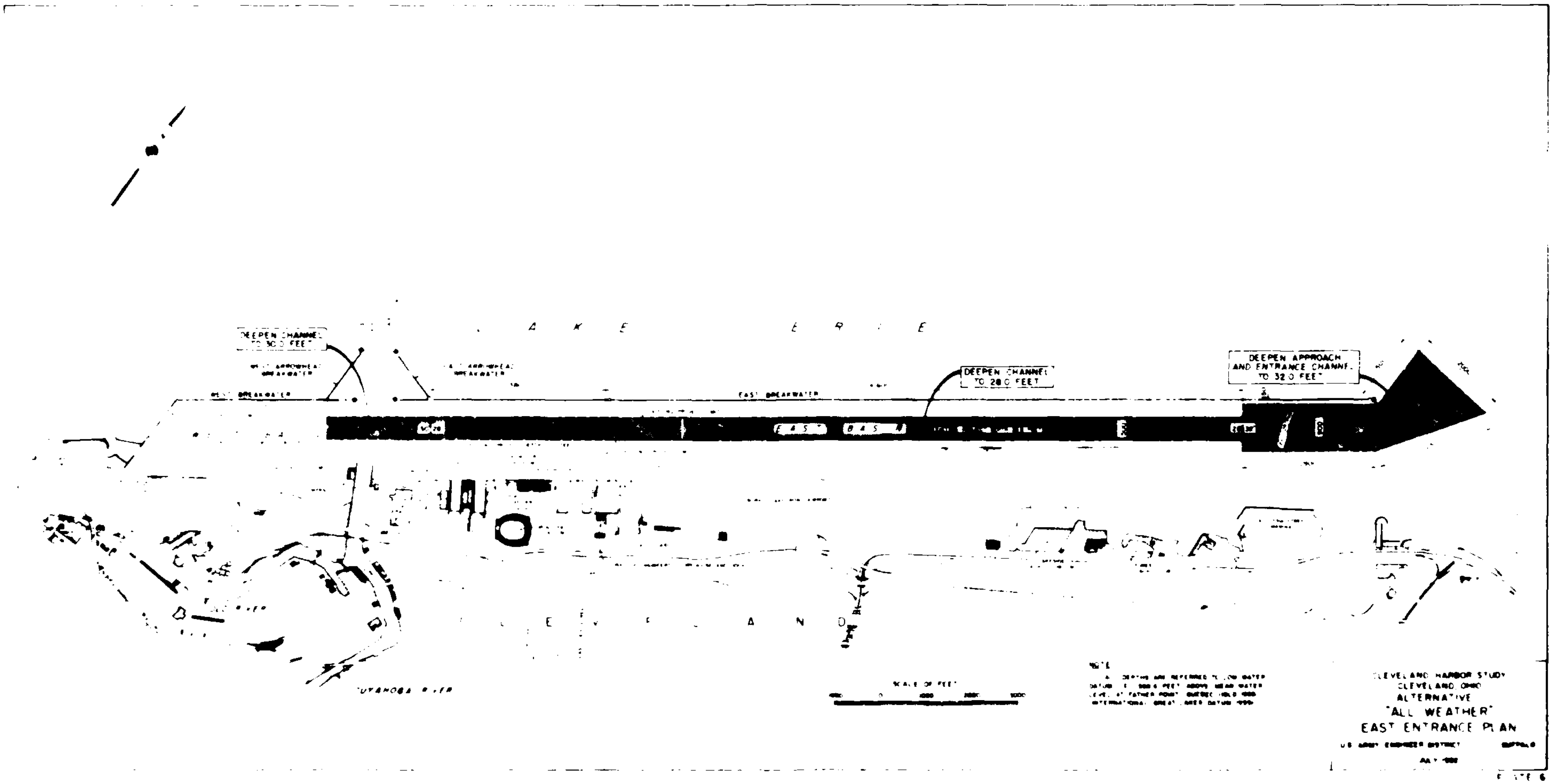
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

PROPOSED CLEVELAND LAKEFRONT STATE PARK

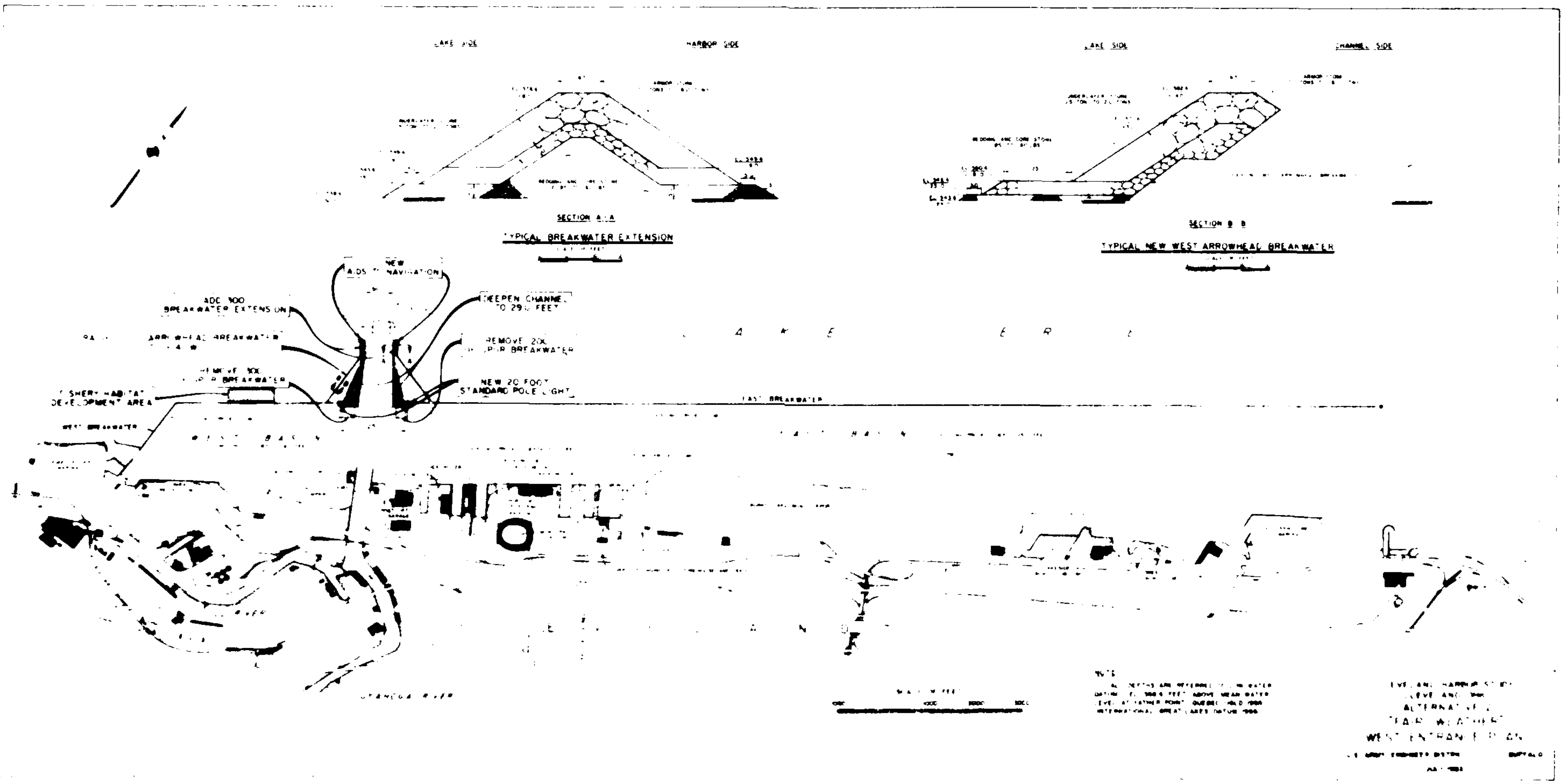
NOVEMBER 983

4

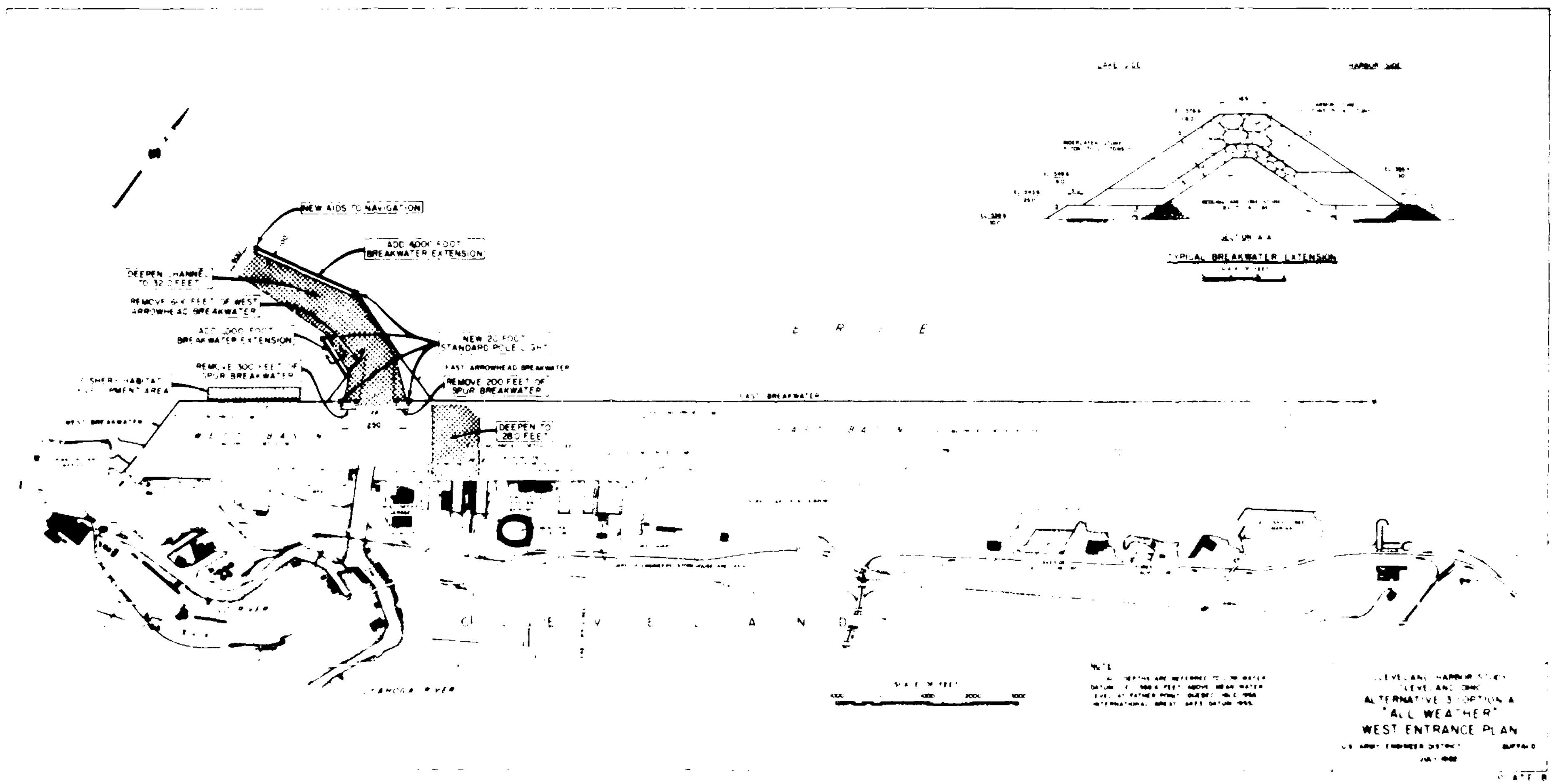
PLATE



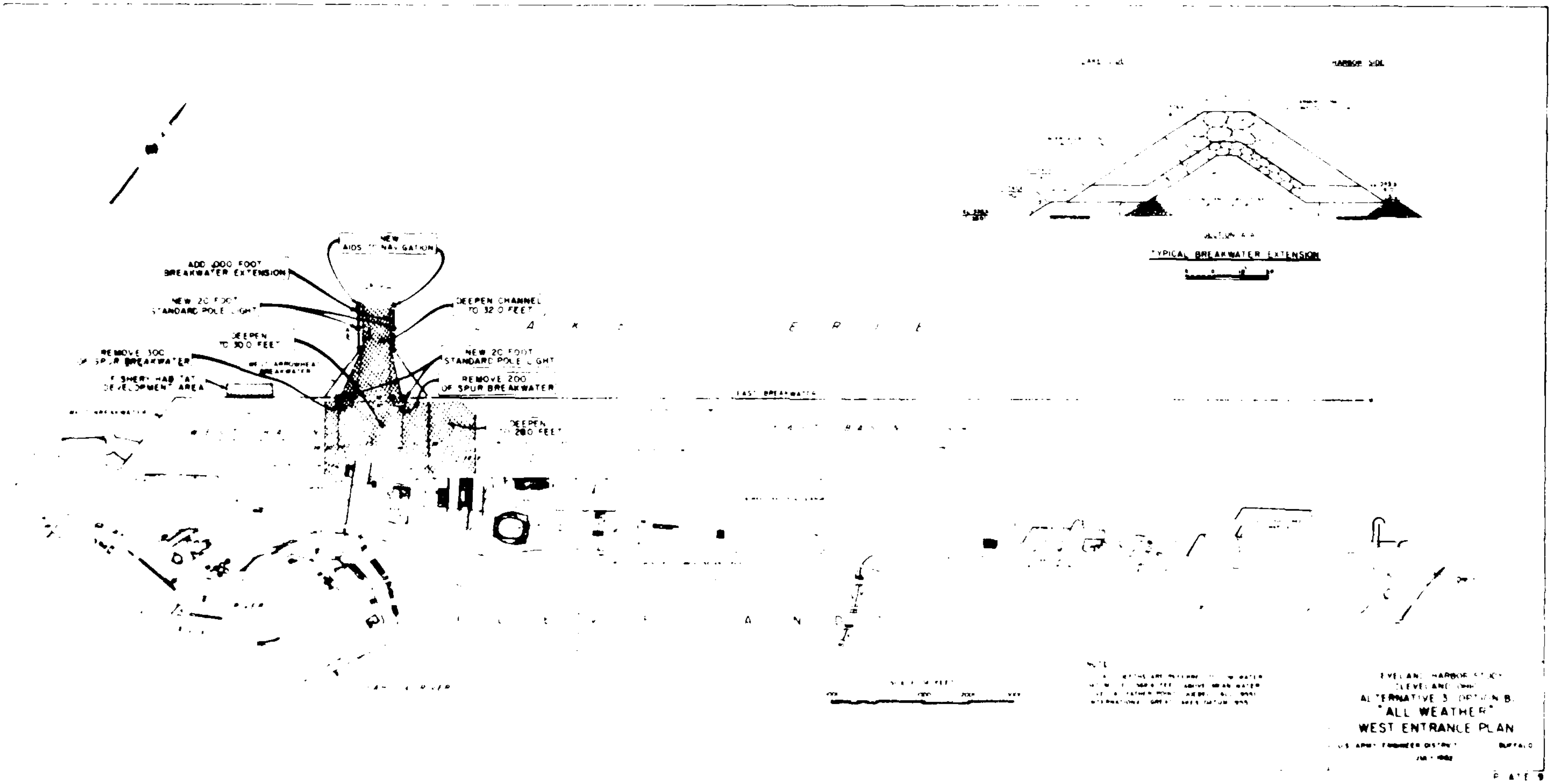
LAKE ERIE
DEEPEN CHANNEL TO 30.0 FEET
WEST BREAKWATER
EAST BREAKWATER
EAST BASIN
DEEPEN CHANNEL TO 28.0 FEET
DEEPEN APPROACH AND ENTRANCE CHANNEL TO 32.0 FEET
CLEVELAND
CUYAHOGA RIVER
SCALE OF FEET
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE
"ALL WEATHER"
EAST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO



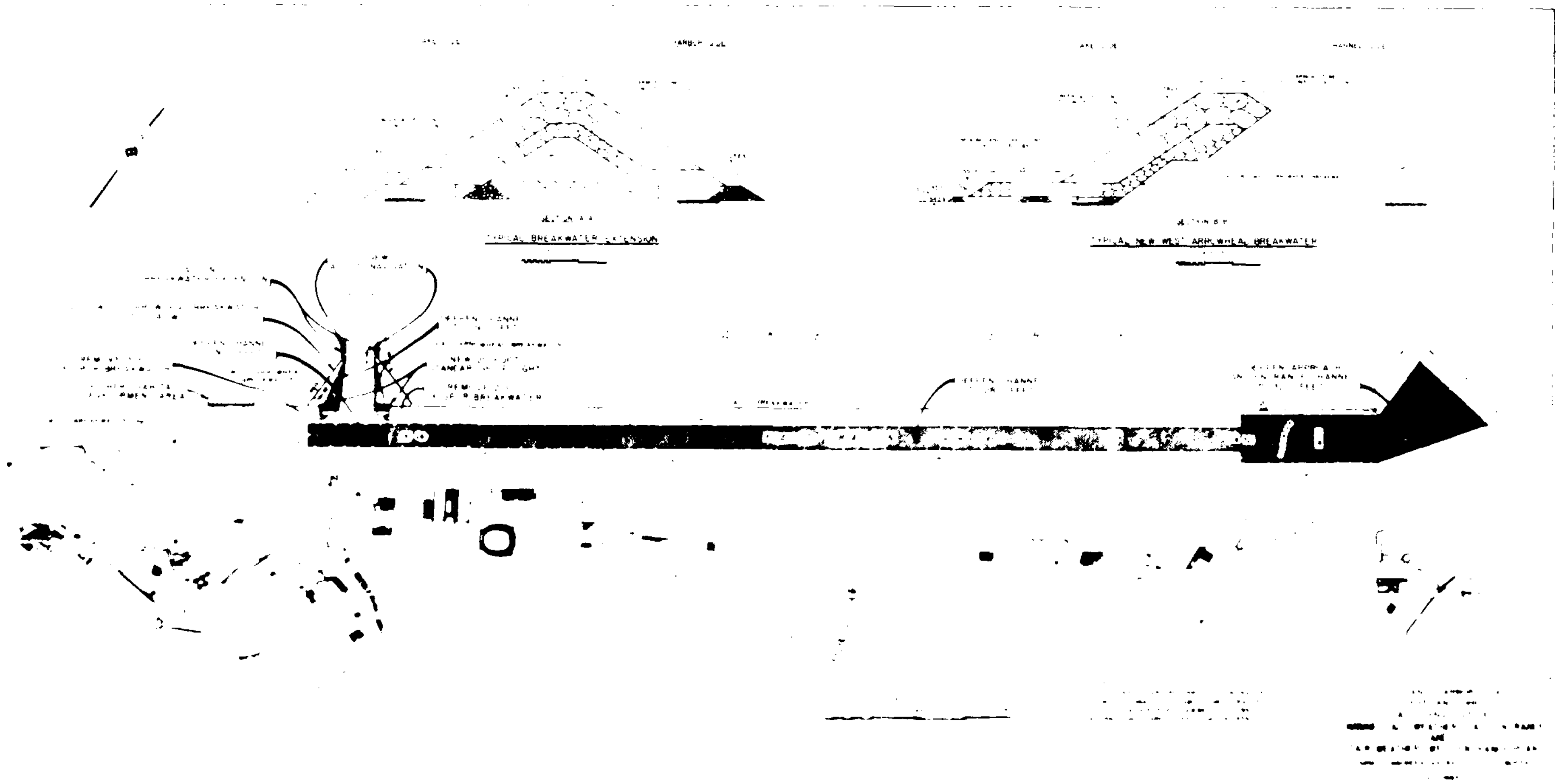
LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
LAKE SIDE
CHANNEL SIDE
SECTION B-B
TYPICAL NEW WEST ARROWHEAD BREAKWATER
NEW AIDS TO NAVIGATION
ADD 900' BREAKWATER EXTENSION
DEEPEN CHANNEL TO 29.0 FEET
NEW 20 FOOT STANDARD POLE LIGHT
FISHERY HABITAT DEVELOPMENT AREA
WEST BREAKWATER
EAST BREAKWATER
WEST BASIN
EAST BASIN
CUYAHOGA RIVER
NOTE
WEST ENTRANCE PLAN

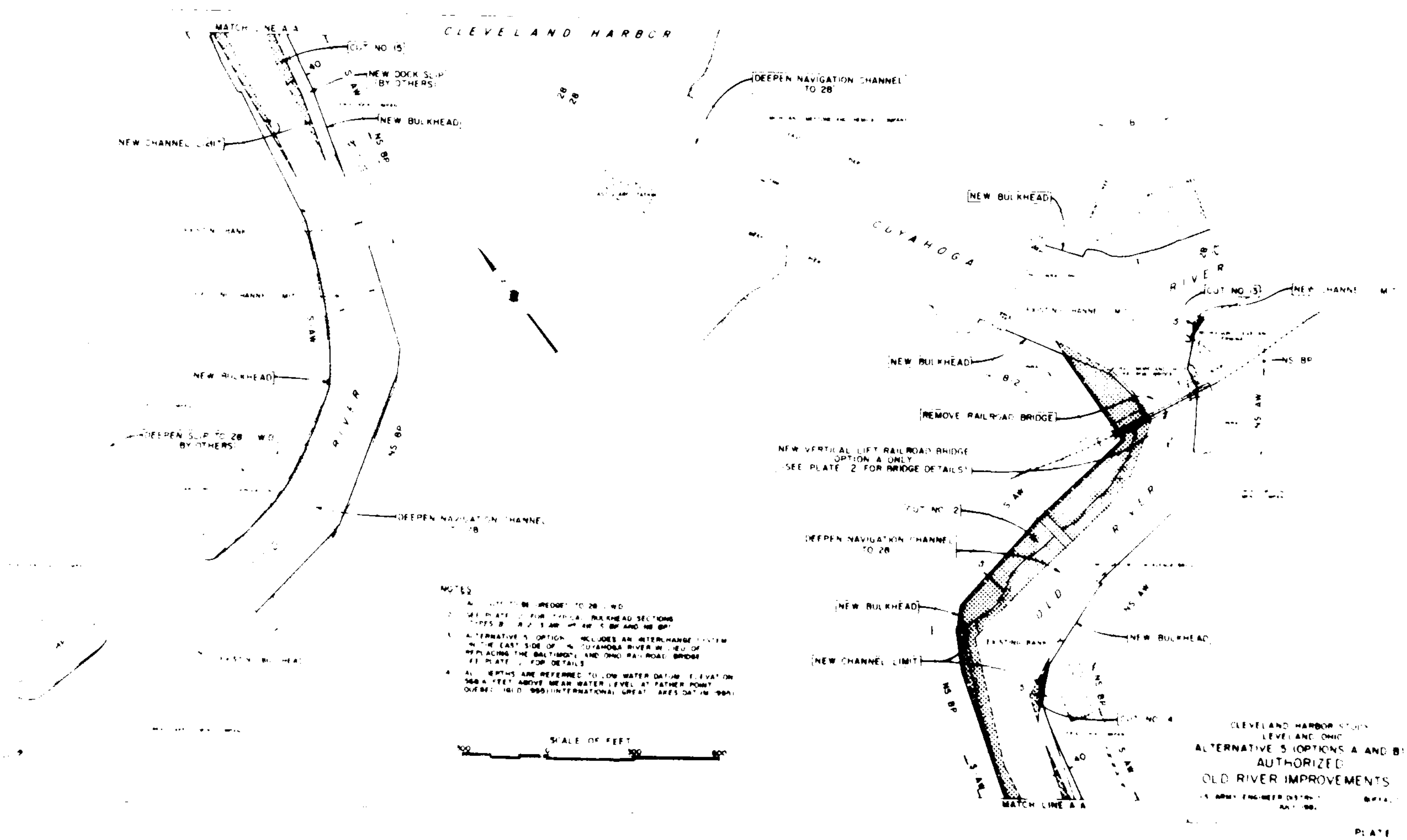


NEW AIDS TO NAVIGATION
ADD 4000 FOOT BREAKWATER EXTENSION
DEEPEN CHANNEL TO 32.0 FEET
REMOVE 600 FEET OF WEST ARROWHEAD BREAKWATER
ADD 1000 FOOT BREAKWATER EXTENSION
REMOVE 300 FEET OF SPUR BREAKWATER
FISHERY HABITAT ENHANCEMENT AREA
NEW 20 FOOT STANDARD POLE LIGHT
EAST ARROWHEAD BREAKWATER
REMOVE 200 FEET OF SPUR BREAKWATER
DEEPEN TO 28.0 FEET
WEST BREAKWATER
EAST BREAKWATER
E R I E
C L E V E L A N D
LAKE SIDE
HARBOR SIDE
SECTION A-A
TYPICAL BREAKWATER EXTENSION
SCALE IN FEET
NOTE
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 3 OPTION A
"ALL WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT BUFFALO

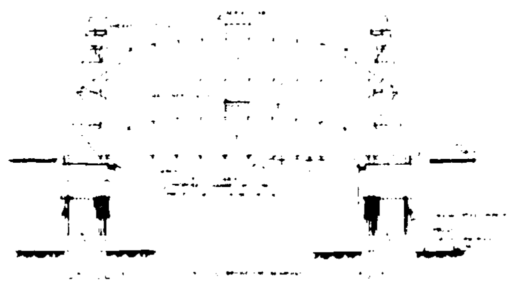


NEW AIDS TO NAVIGATION
ADD 1000 FOOT BREAKWATER EXTENSION
NEW 20 FOOT STANDARD POLE LIGHT
DEEPEN TO 30.0 FEET
REMOVE 300' OF SPUR BREAKWATER
FISHERY HABITAT DEVELOPMENT AREA
DEEPEN CHANNEL TO 32.0 FEET
NEW 20 FOOT STANDARD POLE LIGHT
REMOVE 200' OF SPUR BREAKWATER
DEEPEN TO 28.0 FEET
EAST BREAKWATER
HARBOR SIDE
TYPICAL BREAKWATER EXTENSION
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 3, OPTION B
"ALL WEATHER"
WEST ENTRANCE PLAN
U.S. ARMY ENGINEER DISTRICT, BUFFALO
PLATE 9

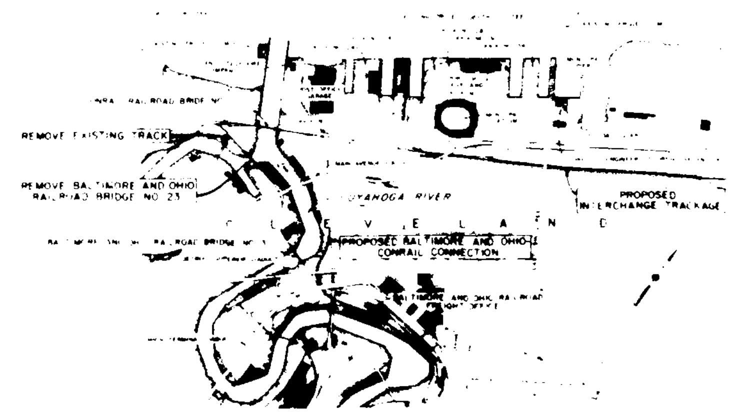

TYPICAL BREAKWATER EXTENSION
TYPICAL NEW WEST ARROWHEAD BREAKWATER


CLEVELAND HARBOR
CUYAHOGA
RIVER
OLD RIVER
MATCH LINE A-A
CUT NO. 15
NEW DOCK SLIP (BY OTHERS)
NEW BULKHEAD
NEW CHANNEL LIMIT
DEEPEN SLIP TO 28' W.D. BY OTHERS
DEEPEN NAVIGATION CHANNEL TO 28'
CUT NO. 3
CUT NO. 2
CUT NO. 4
REMOVE RAILROAD BRIDGE
NEW VERTICAL LIFT RAILROAD BRIDGE OPTION A ONLY (SEE PLATE 2 FOR BRIDGE DETAILS)
NOTES
SCALE OF FEET
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 5 (OPTIONS A AND B)
AUTHORIZED
OLD RIVER IMPROVEMENTS
PLATE

TYPICAL NEW BULKHEAD SECTIONS



ELEVATION OF PROPOSED VERTICAL LIFT RAILROAD BRIDGE
ALTERNATIVE 5 OPTION A



PROPOSED BALTIMORE AND OHIO RAILROAD INTERCHANGE SYSTEM
ALTERNATIVE 5 OPTION B

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
TYPICAL SECTIONS
AND INTERCHANGE SYSTEM
FOR ALTERNATIVE 5
U.S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE 3

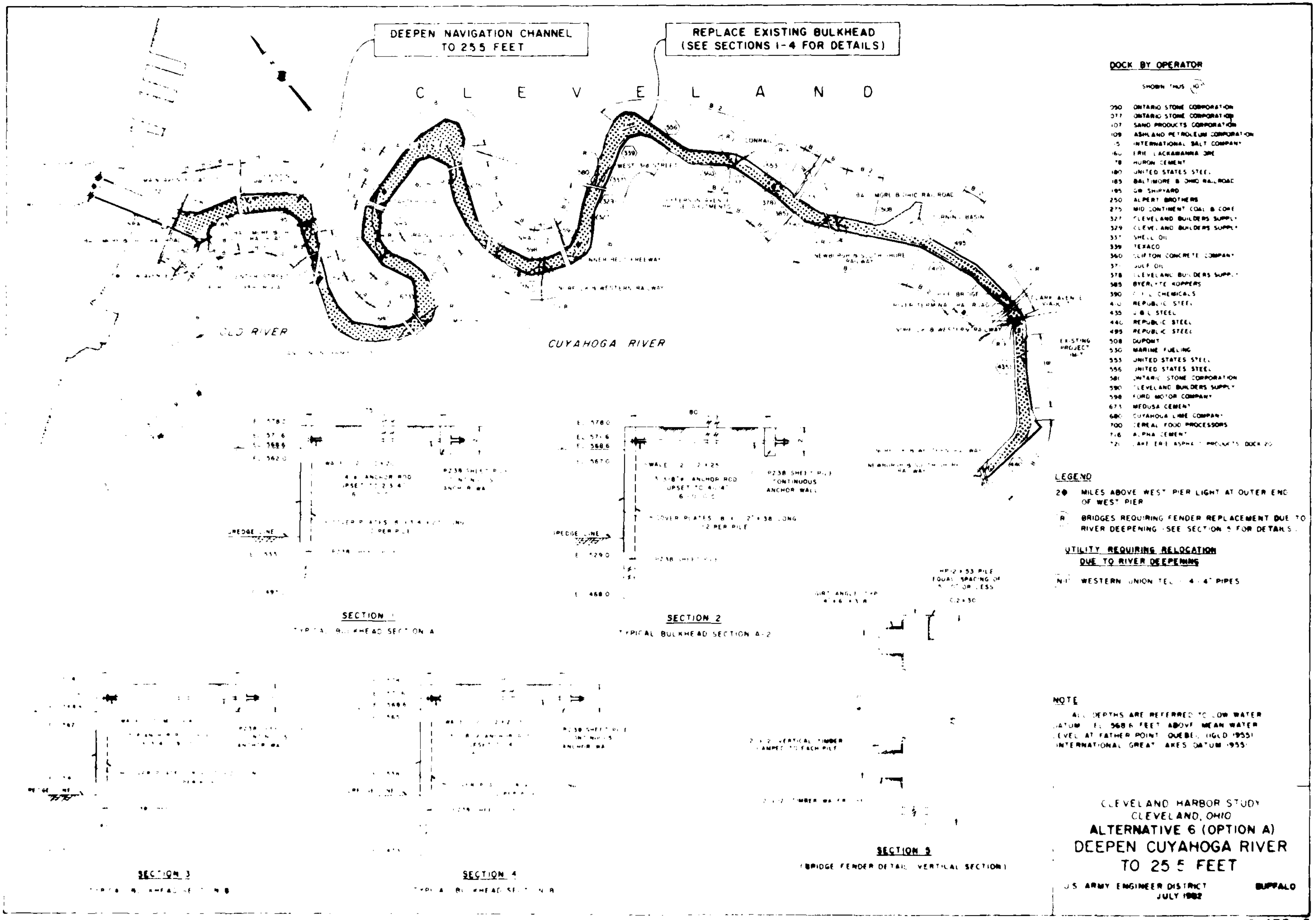
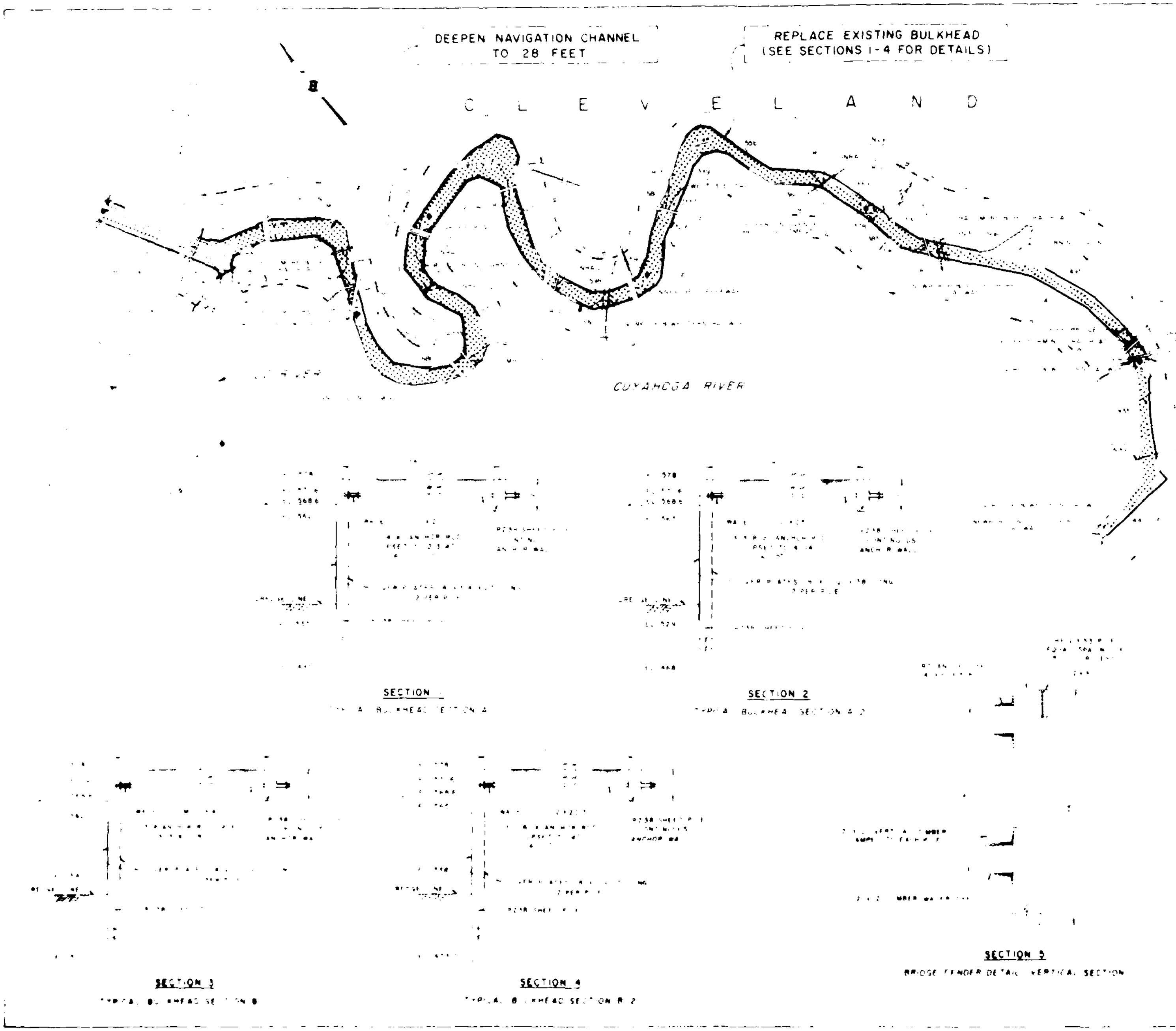

DEEPEN NAVIGATION CHANNEL TO 25.5 FEET
REPLACE EXISTING BULKHEAD (SEE SECTIONS 1-4 FOR DETAILS)
CLEVELAND
OLD RIVER
CUYAHOGA RIVER
DOCK BY OPERATOR
250 ONTARIO STONE CORPORATION
277 ONTARIO STONE CORPORATION
107 SAND PRODUCTS CORPORATION
109 ASHLAND PETROLEUM CORPORATION
INTERNATIONAL SALT COMPANY
ERIE LACKAWANNA ORE
HURON CEMENT
180 UNITED STATES STEEL
185 BALTIMORE & OHIO RAILROAD
195 GB SHIPYARD
250 ALPERT BROTHERS
275 MID CONTINENT COAL & COKE
327 CLEVELAND BUILDERS SUPPLY
329 CLEVELAND BUILDERS SUPPLY
SHELL OIL
339 TEXACO
360 CLIFTON CONCRETE COMPANY
GULF OIL
378 CLEVELAND BUILDERS SUPPLY
385 BYERLYTE KOPPERS
390 CHEMICALS
REPUBLIC STEEL
435 LTV STEEL
440 REPUBLIC STEEL
495 REPUBLIC STEEL
508 DUPONT
530 MARINE FUELING
553 UNITED STATES STEEL
556 UNITED STATES STEEL
581 ONTARIO STONE CORPORATION
590 CLEVELAND BUILDERS SUPPLY
598 FORD MOTOR COMPANY
671 MEDUSA CEMENT
680 CUYAHOGA LIME COMPANY
700 CEREAL FOOD PROCESSORS
ALPHA CEMENT
LAKE ERIE ASPHALT PRODUCTS DOCK
LEGEND
20 MILES ABOVE WEST PIER LIGHT AT OUTER END OF WEST PIER
BRIDGES REQUIRING FENDER REPLACEMENT DUE TO RIVER DEEPENING (SEE SECTION 5 FOR DETAILS)
UTILITY REQUIRING RELOCATION DUE TO RIVER DEEPENING
WESTERN UNION TEL. 4-4" PIPES
NOTE
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL. 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) INTERNATIONAL GREAT LAKES DATUM 1955
SECTION 1
TYPICAL BULKHEAD SECTION A
SECTION 2
TYPICAL BULKHEAD SECTION A-2
SECTION 3
SECTION 4
SECTION 5
(BRIDGE FENDER DETAIL VERTICAL SECTION)
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 6 (OPTION A)
DEEPEN CUYAHOGA RIVER
TO 25.5 FEET
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 13



DOCK BY OPERATOR

LEGEND

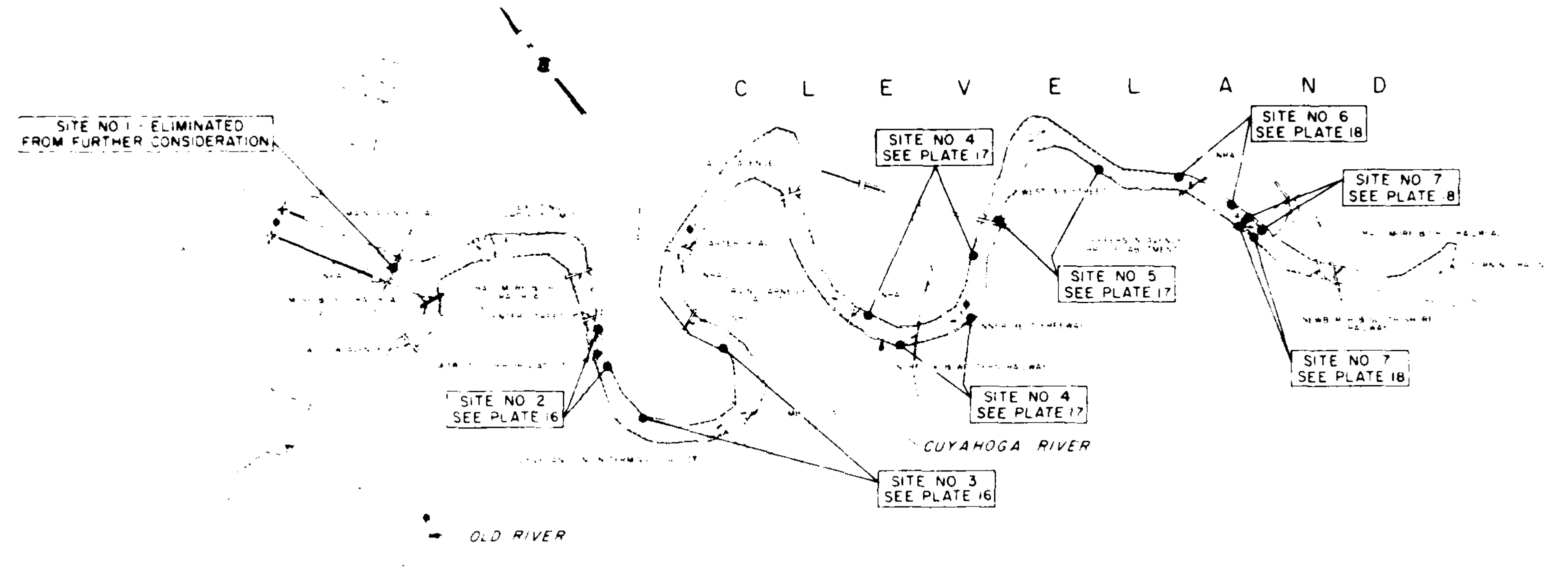
UTILITIES REQUIRING RELOCATION DUE TO RIVER DEEPENING

NOTE

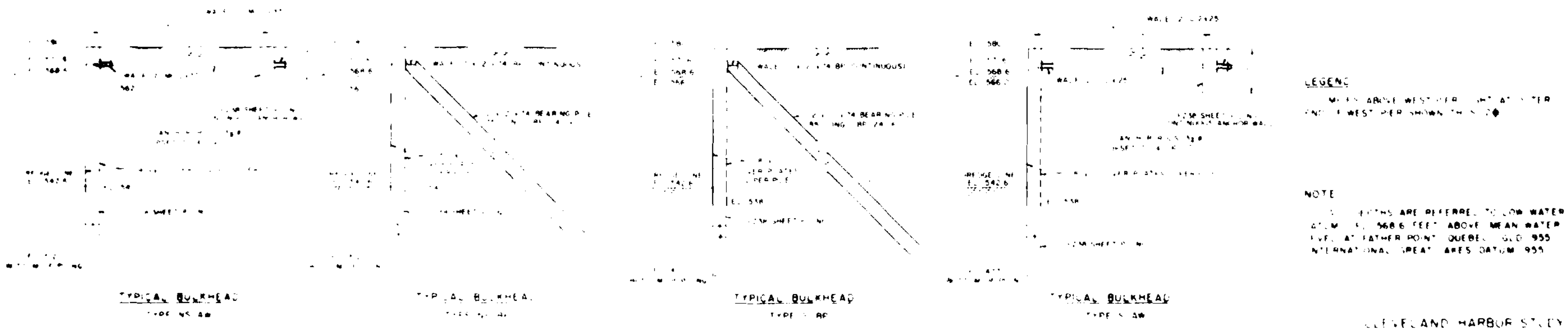
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 6 (OPTION B)
DEEPEN CUYAHOGA RIVER
TO 28 FEET

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 14



CONGESTION AREAS UNDER CONSIDERATION

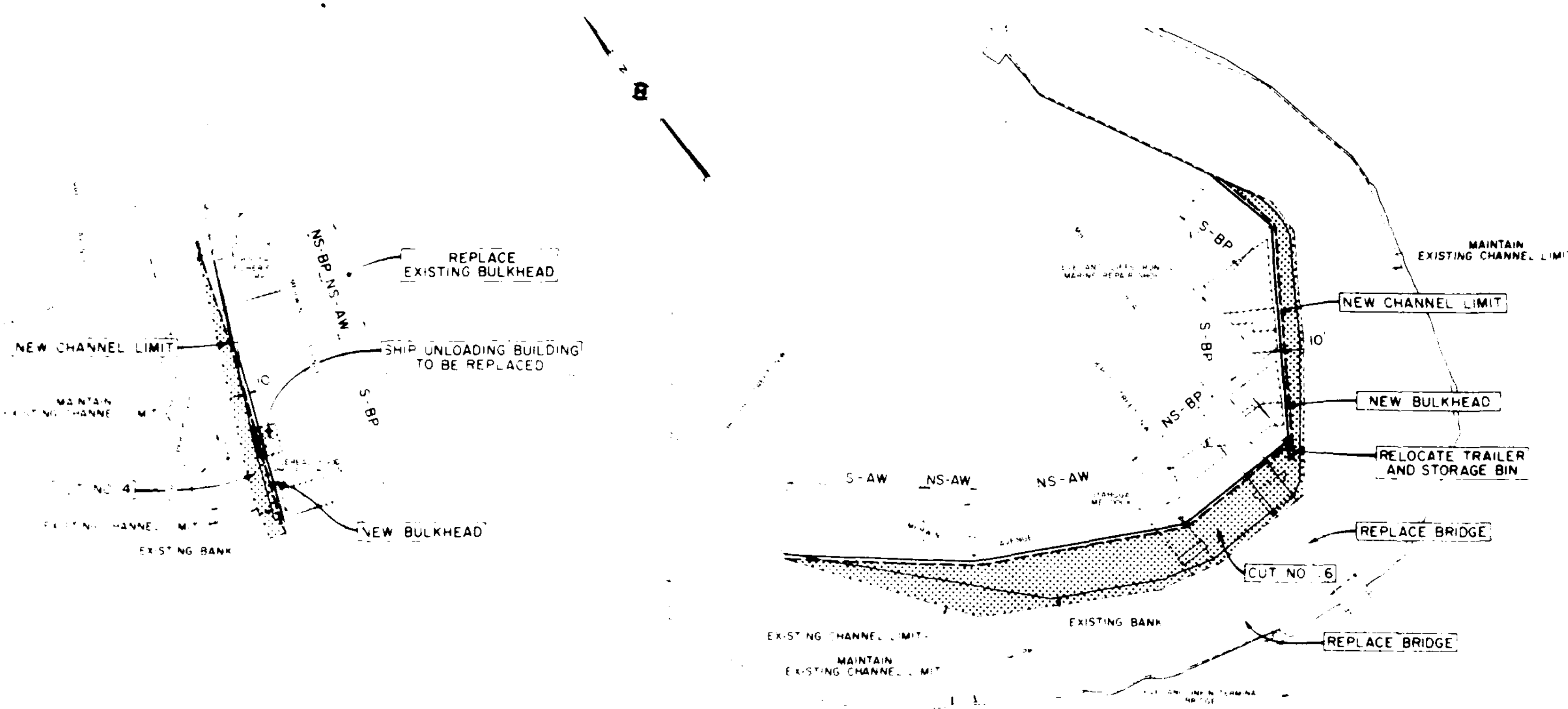


TYPICAL NEW BULKHEAD SECTIONS

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
INDEX MAP AND
TYPICAL BULKHEAD SECTIONS
FOR ALTERNATIVE 7

U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1987

PLATE 15



SITE NO 2

ALTERNATIVE 7 OPTION B

SITE NO 3

ALTERNATIVE 7 OPTION C

NOTES

SCALE OF FEET

300 0 300 600

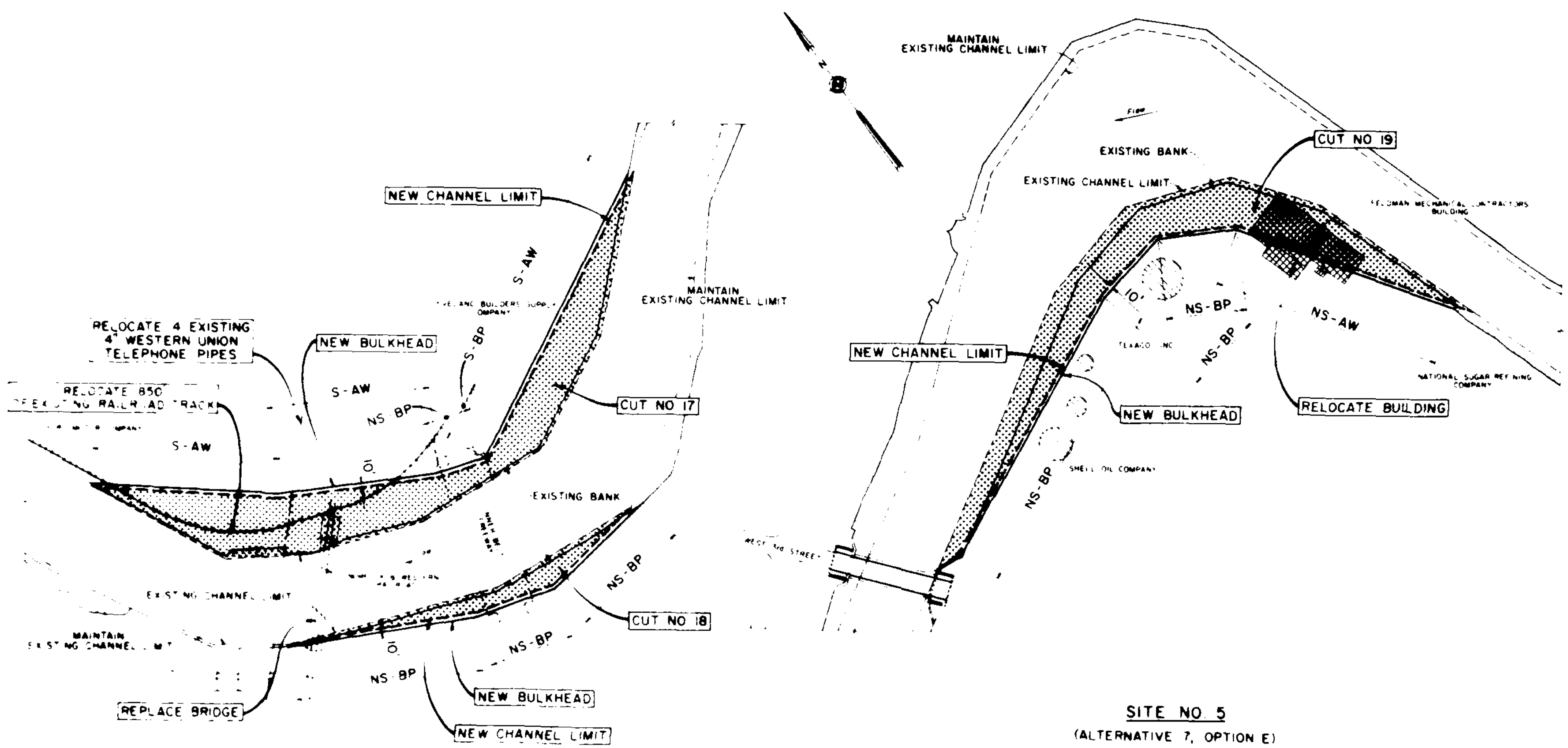
CLEVELAND HARBOR STUDY
CLEVELAND OHIO

ALTERNATIVE 7 (OPTIONS B AND C)

REDUCE RIVER CONGESTION

ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 16



SITE NO 5
(ALTERNATIVE 7, OPTION E)

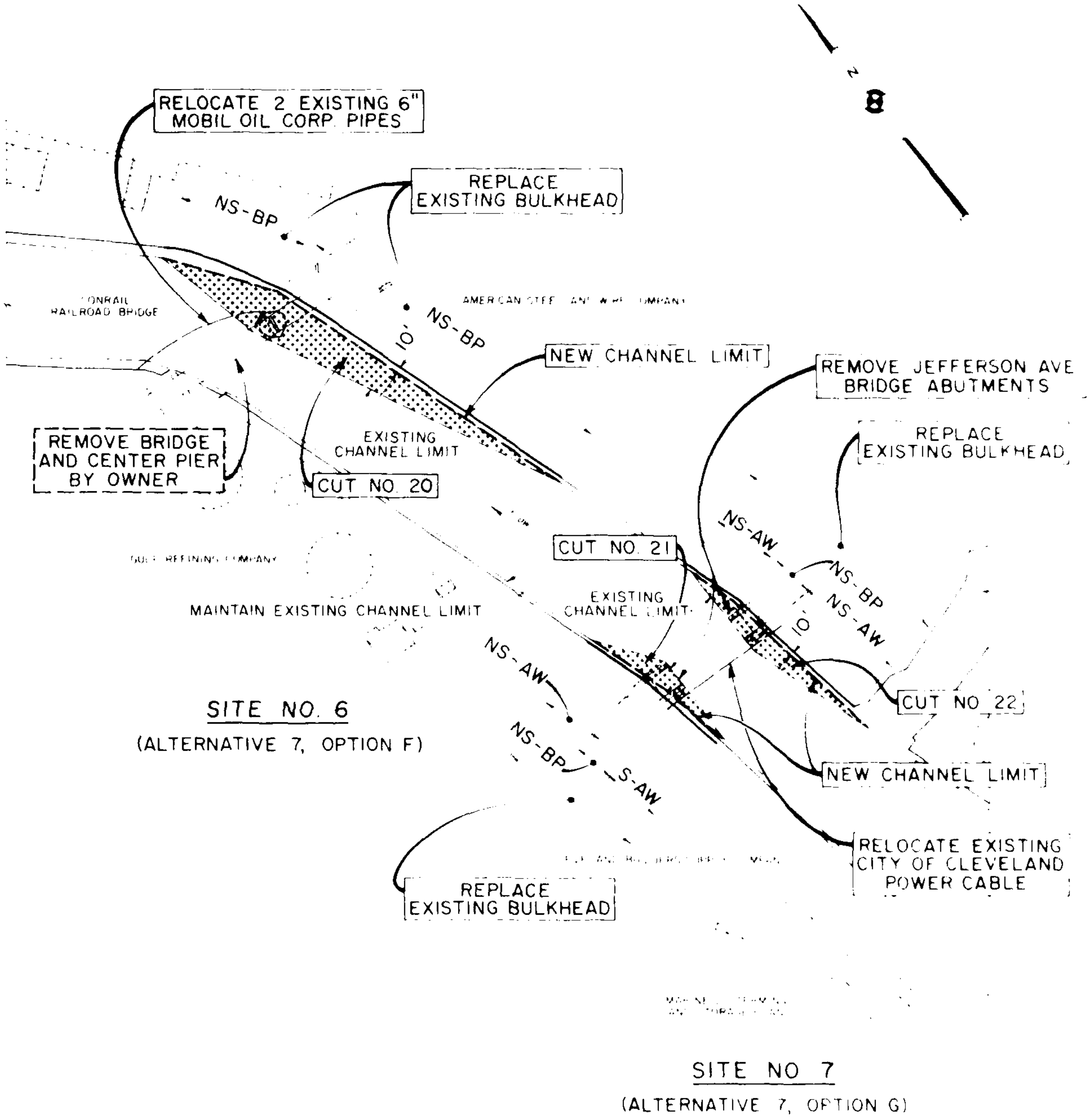
SITE NO 4
(ALTERNATIVE 7, OPTION D)

NOTES
1. SEE PLATE 6 FOR TYPICAL BULKHEAD SECTIONS TYPES S-AW, NS-AW, S-BP AND NS-BP
2. ALL CUTS TO BE DREDGED TO 23 FEET LWD

SCALE OF FEET
300 0 300 600

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 7 (OPTIONS D AND E)
REDUCE RIVER CONGESTION
U.S. ARMY ENGINEER DISTRICT BUFFALO
JULY 1982

PLATE 17



NOTES:

1. SEE PLATE 15 FOR TYPICAL BULKHEAD SECTIONS (TYPES S-AW, NS-AW, S-BP AND NS-BP)
2. ALL CUTS TO BE DREDGED TO 23 FEET LWD

SCALE OF FEET

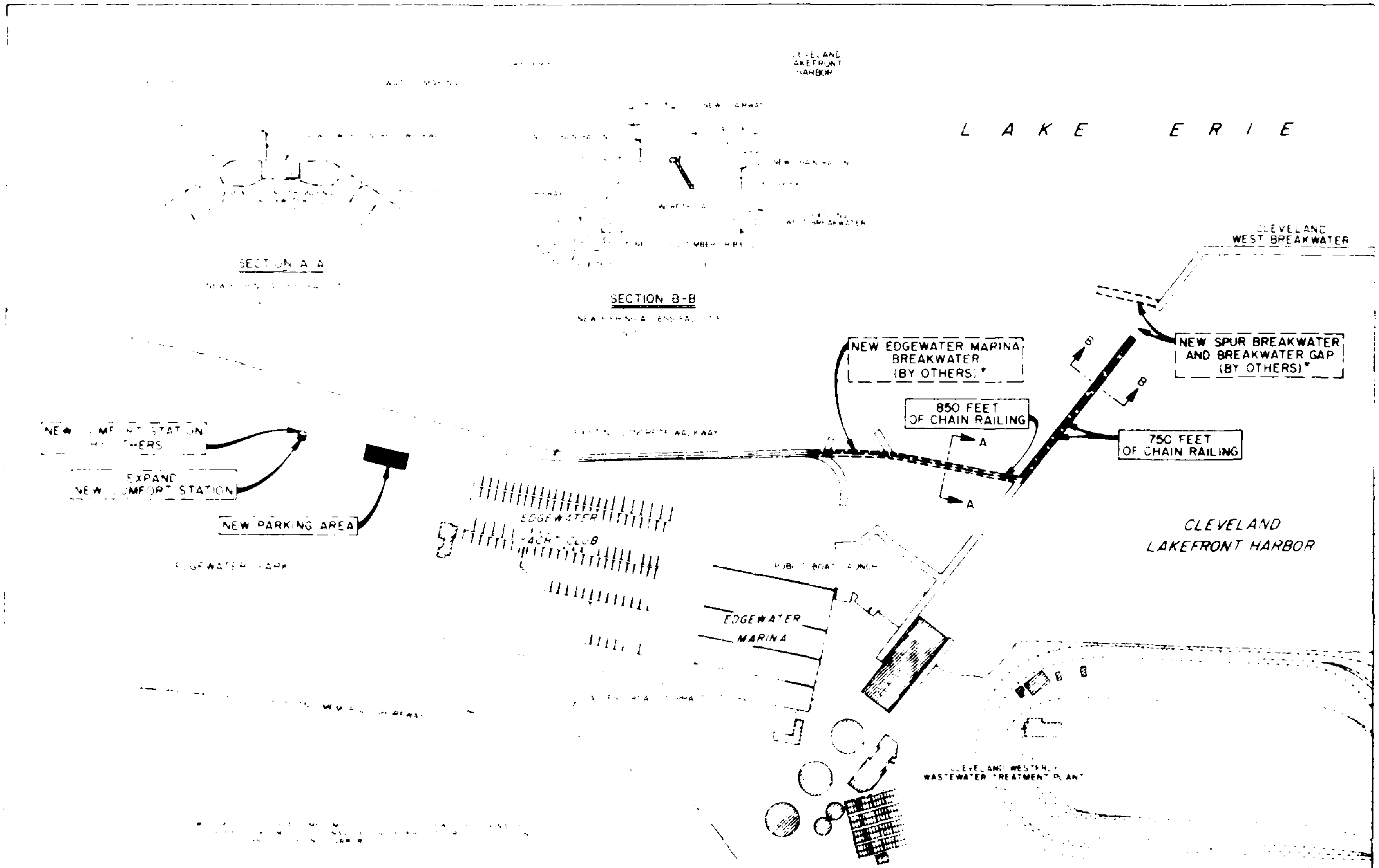
300 0 300 600

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

ALTERNATIVE 7 (OPTIONS F AND G)

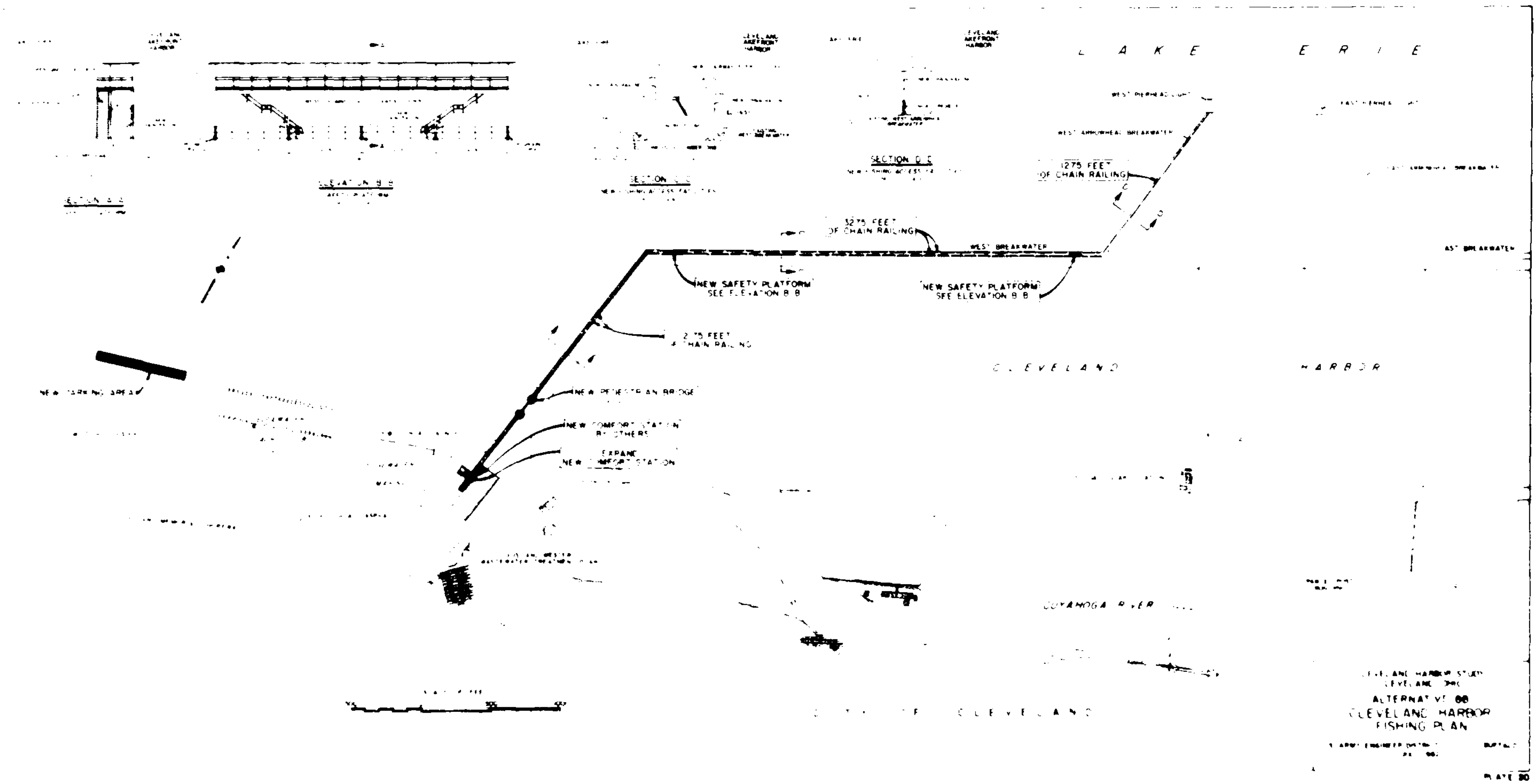
REDUCE RIVER CONGESTION

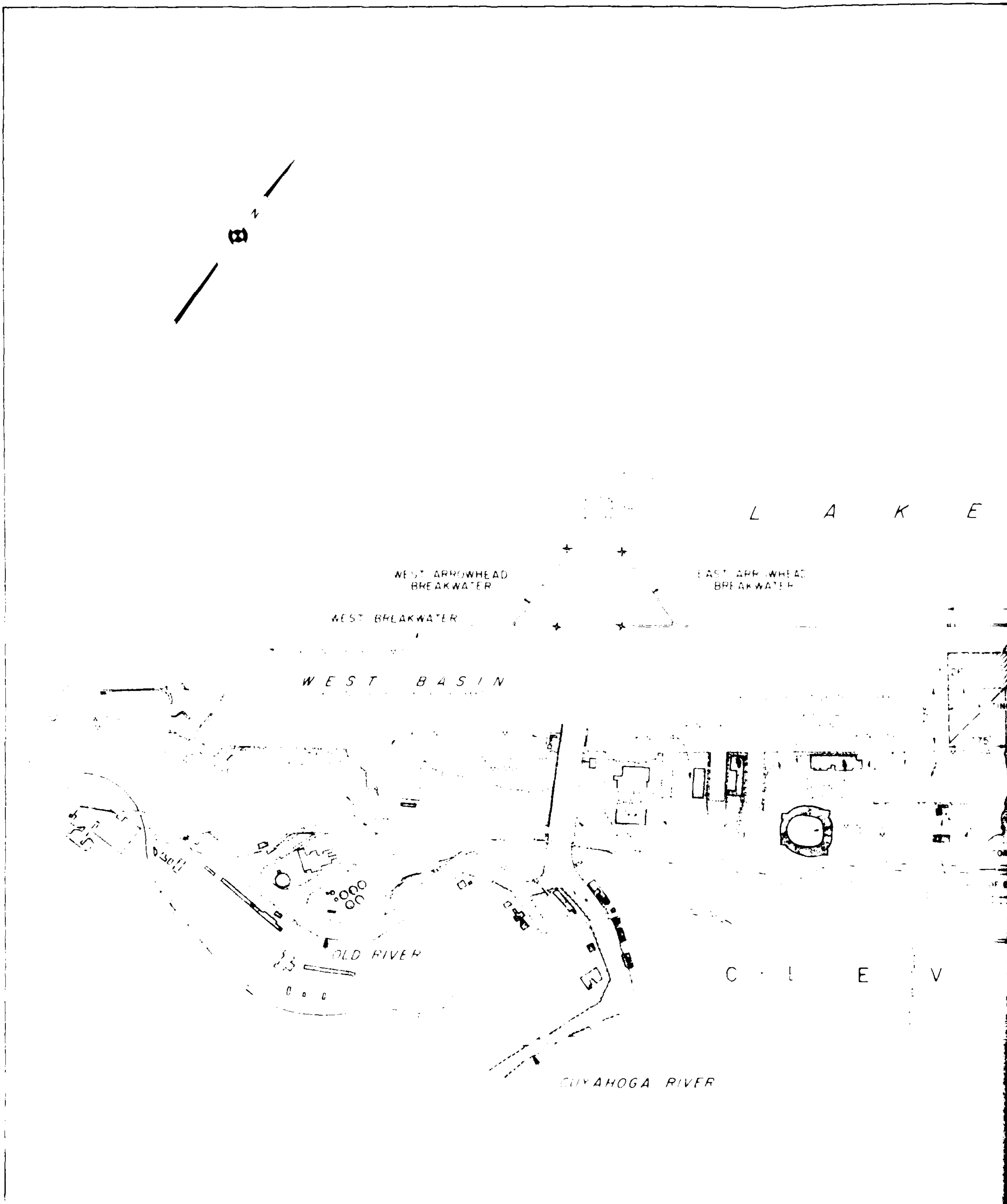
PLATE



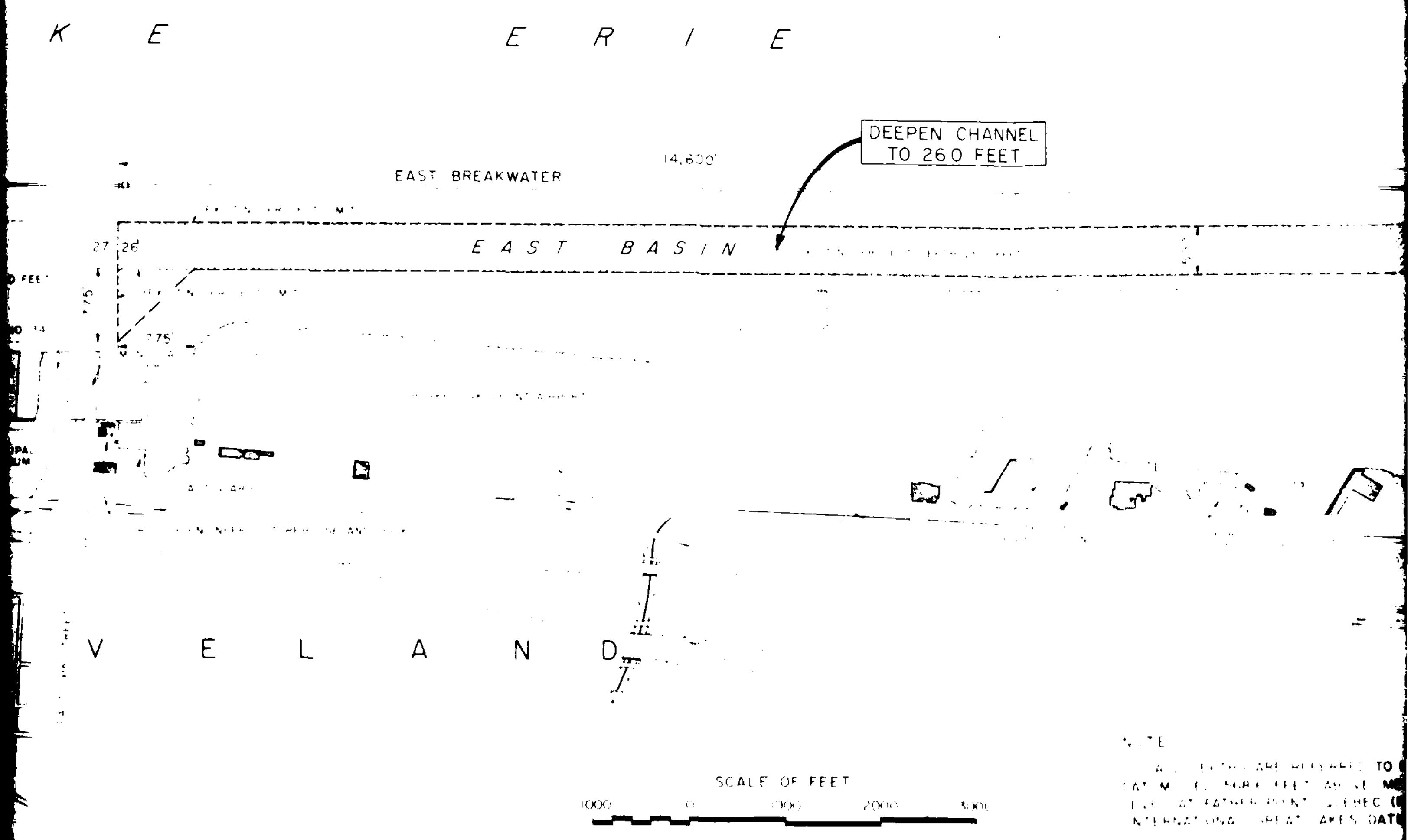
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE 8A
EDGEWATER MARINA FISHING PLAN
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JULY 1982

PLATE 19


LAKE ERIE
WEST PIERHEAD LIGHT
WEST ARROWHEAD BREAKWATER
1275 FEET OF CHAIN RAILING
3275 FEET OF CHAIN RAILING
WEST BREAKWATER
NEW SAFETY PLATFORM SEE ELEVATION B-B
NEW SAFETY PLATFORM SEE ELEVATION B-B
SECTION D-D
SECTION C-C
ELEVATION B-B
SECTION A-A
CLEVELAND HARBOR
NEW PEDESTRIAN BRIDGE
NEW COMFORT STATION BY OTHERS
EXPAND NEW COMFORT STATION
NEW PARKING AREA
CUYAHOGA RIVER
CITY OF CLEVELAND
ALTERNATIVE 8B
CLEVELAND HARBOR
FISHING PLAN
PLATE 80

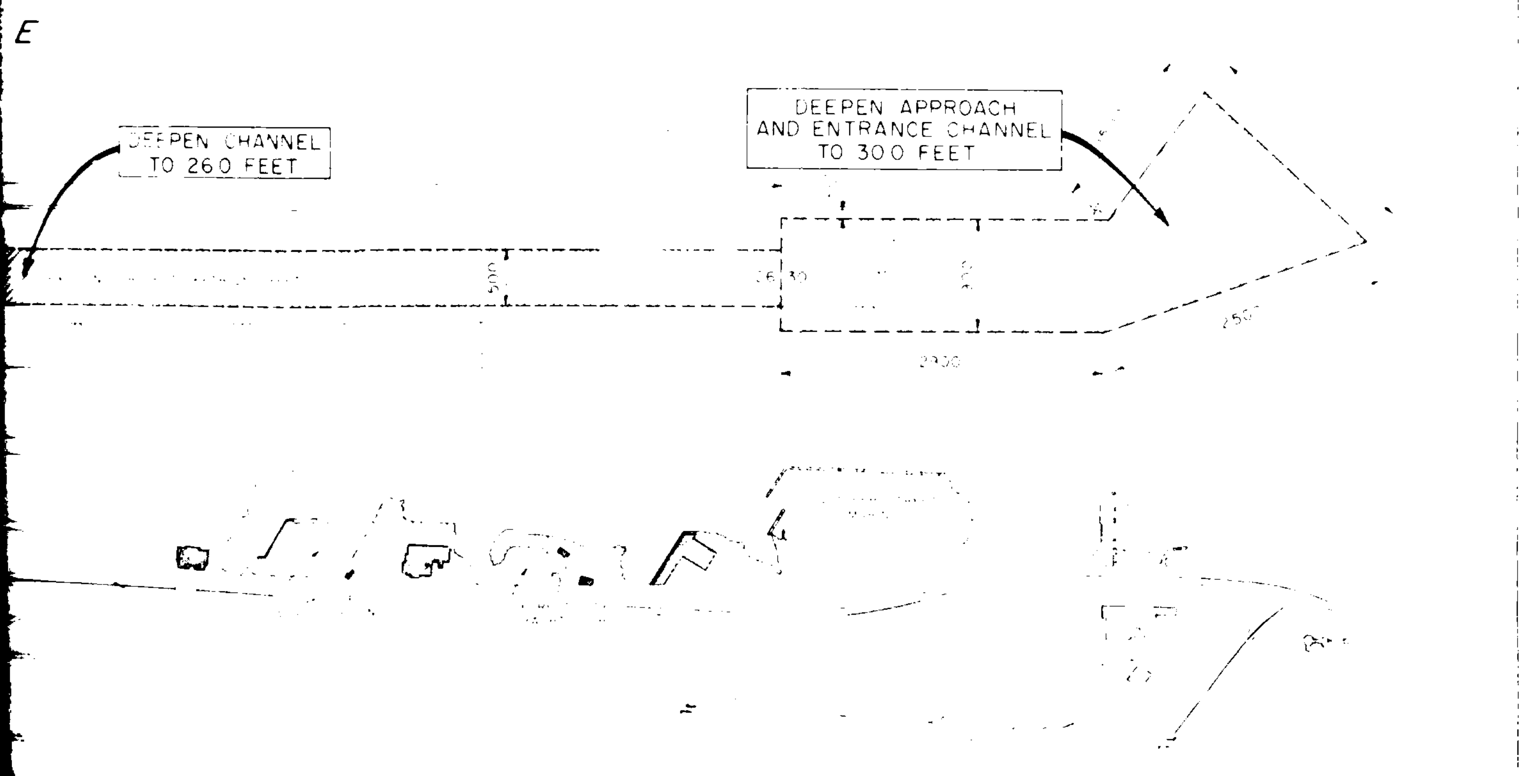


N
L A K E
WEST ARROWHEAD
BREAKWATER
WEST BREAKWATER
WEST BASIN
OLD RIVER
C L E V
CUYAHOGA RIVER



K E
E R I E
DEEPEN CHANNEL TO 260 FEET
14,600'
EAST BREAKWATER
EAST BASIN
27
28
775'
775'
V E L A N D
SCALE OF FEET
1000 0 1000 2000 3000

2



NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL. 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC ... INTERNATIONAL GREAT LAKES DATUM 1955

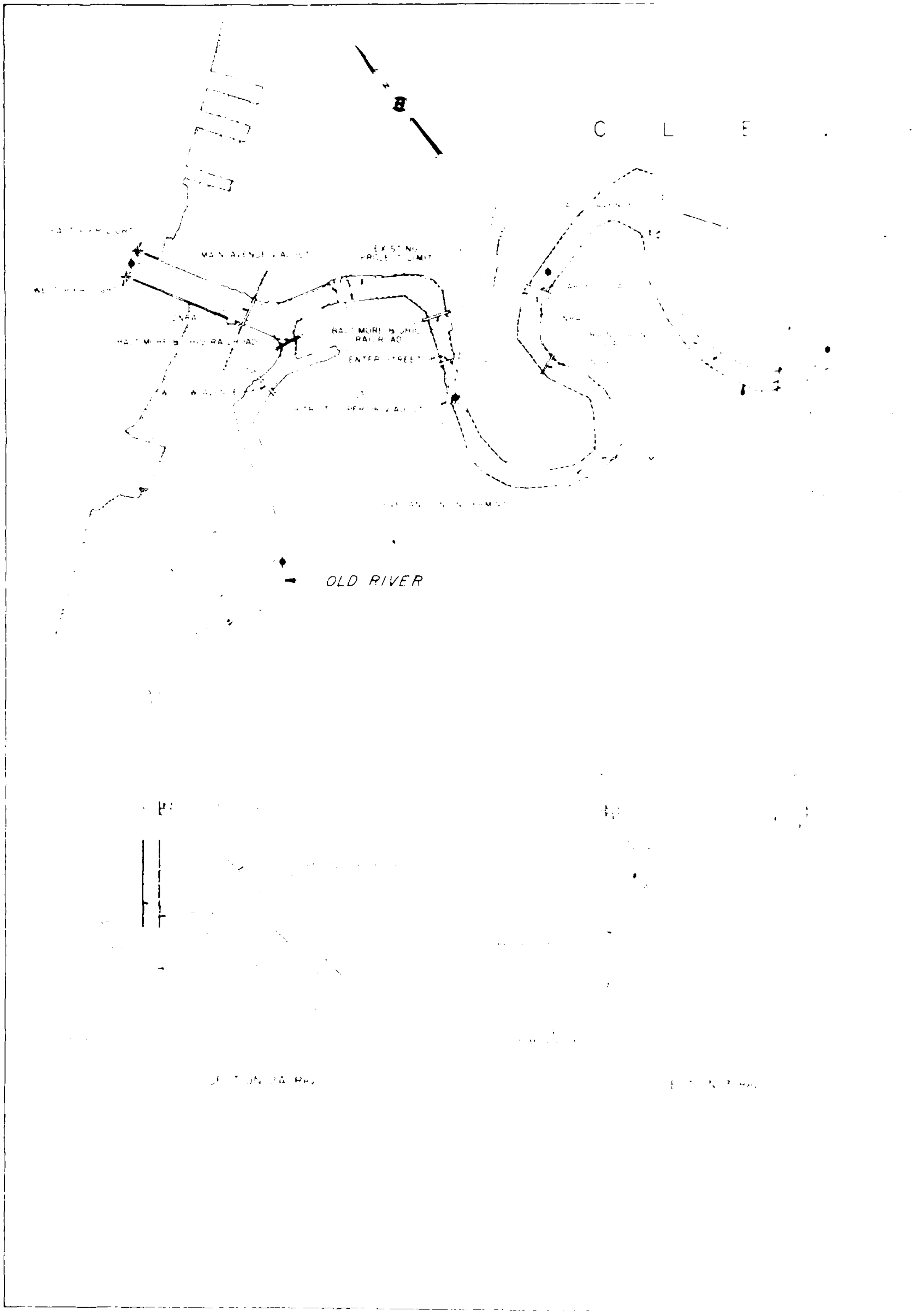
OF FEET
1000

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE I
"SEVERE-WEATHER"
EAST ENTRANCE PLAN

U.S. ARMY ENGINEER DISTRICT ... BUFFALO

3

PLATE

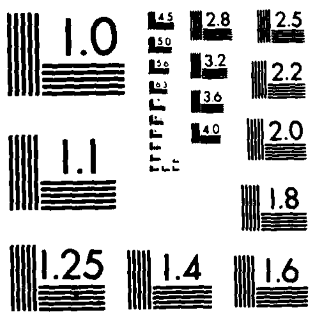

OLD RIVER

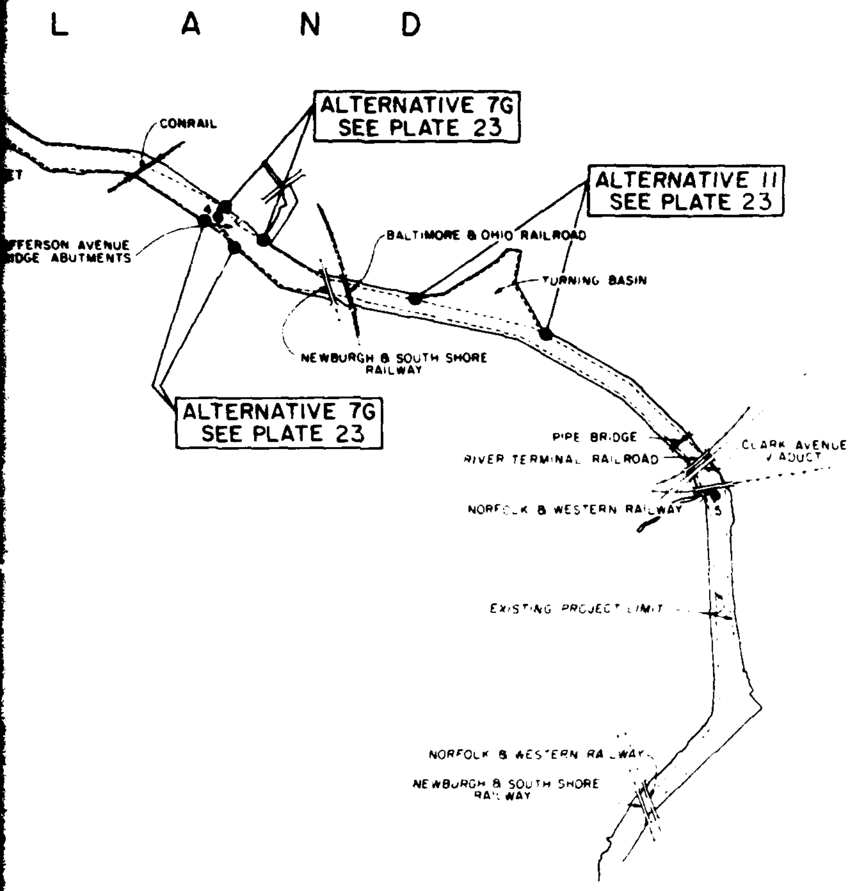
AD-A139 380 CLEVELAND HARBOR OHIO DRAFT REFORMULATION PHASE I GENERAL DESIGN MEMORAND..(U) CORPS OF ENGINEERS BUFFALO NY BUFFALO DISTRICT FEB 84

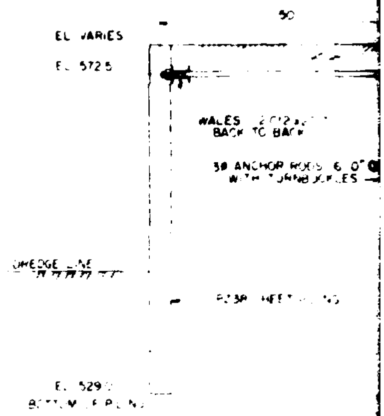
8/8

UNCLASSIFIED F/G 13/2 NL

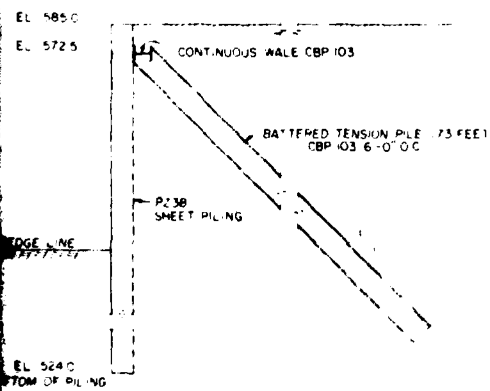
END
DATE
FILMED
5 84
DTIC


1.0
4.5
5.0
5.6
6.3
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

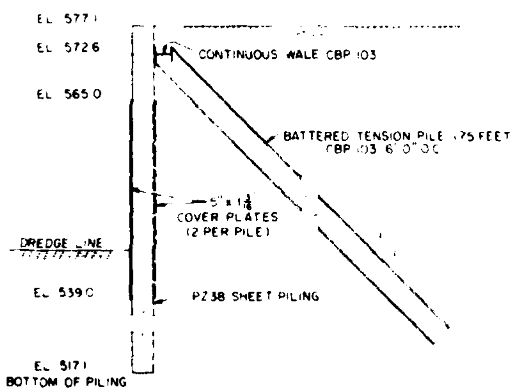




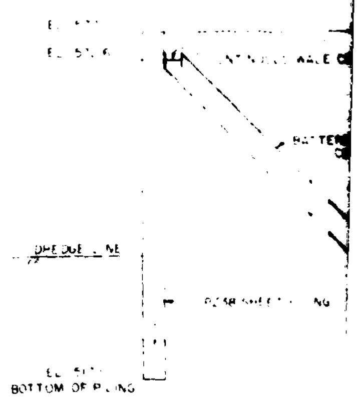
SECTION 1 Rev



SECTION 3A



SECTION 4 Rev



SECTION 5

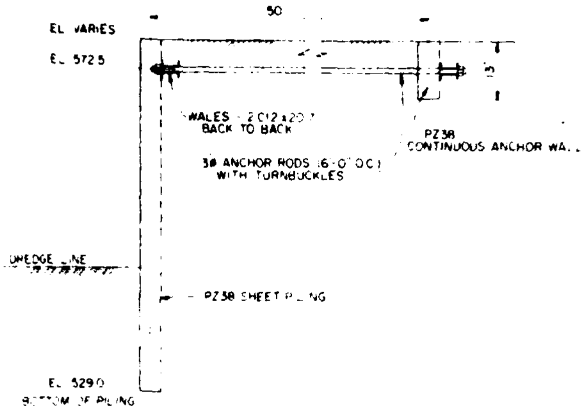
SCALE OF FEET

LEGEND

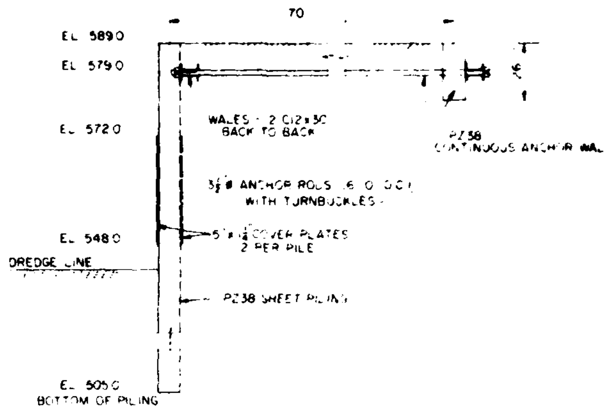
MILES ABOVE WEST PIER LIGHT AT OUTER END OF WEST PIER SHOWN THUS 2●

NOTE

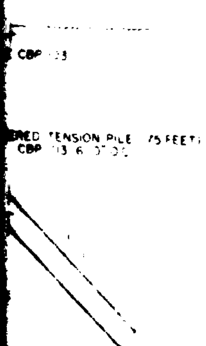
ALL DEPT
DATUM EL
LEVEL AT FA
(INTERNATION

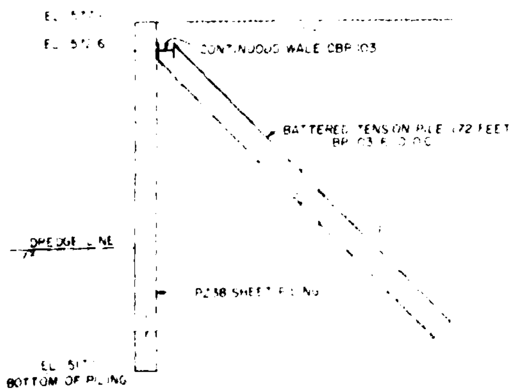


SECTION 1 Rev

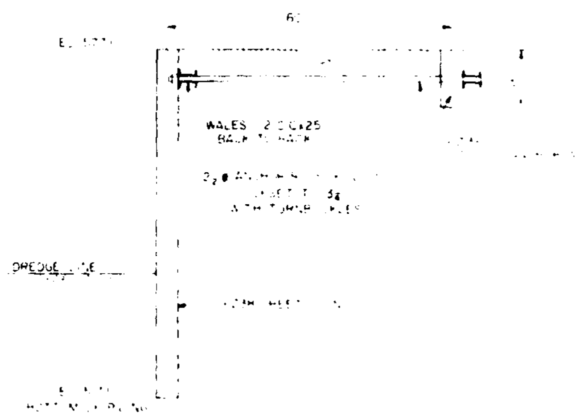


SECTION 2 Rev





SECTION 5



SECTION 6

Rev

END

MILES ABOVE WEST PIER LIGHT AT OUTER
OF WEST PIER SHOWN THUS 2●

NOTE

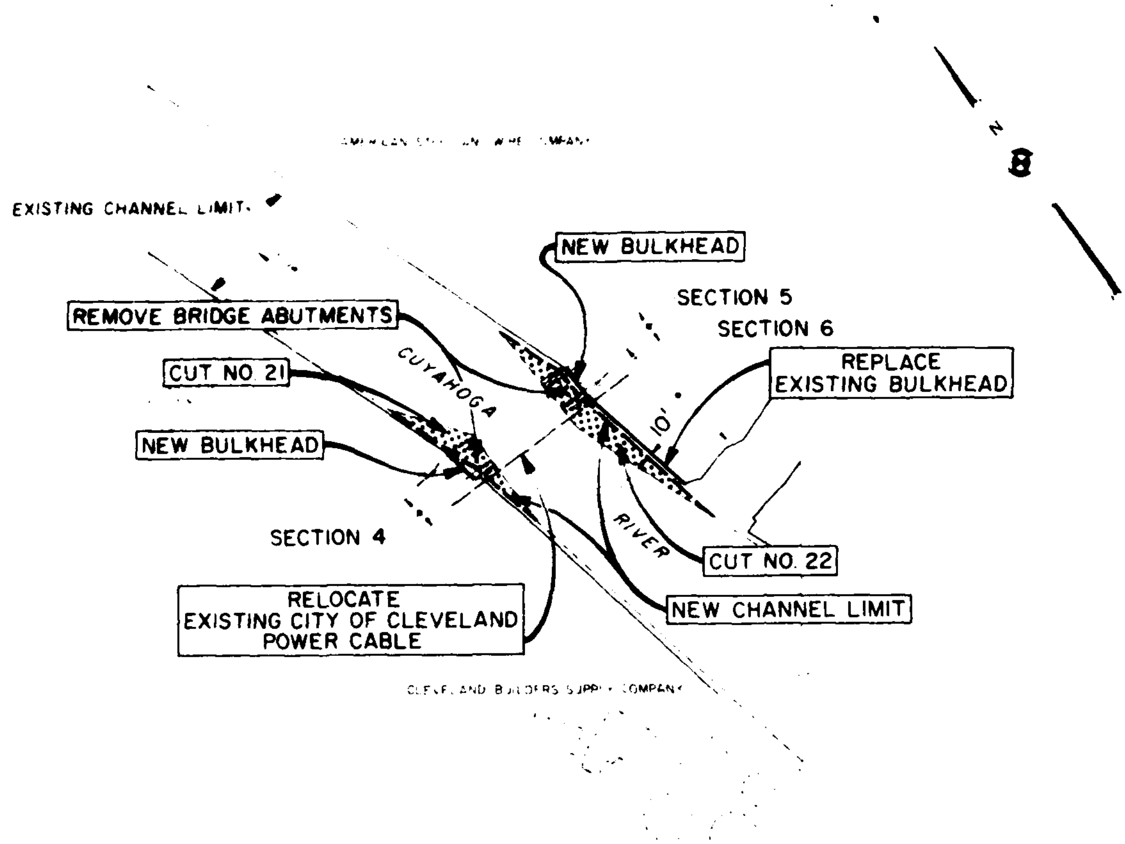
ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

INDEX MAP
AND TYPICAL BULKHEAD SECTIONS
FOR ALTERNATIVES 7G AND 11

U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

3



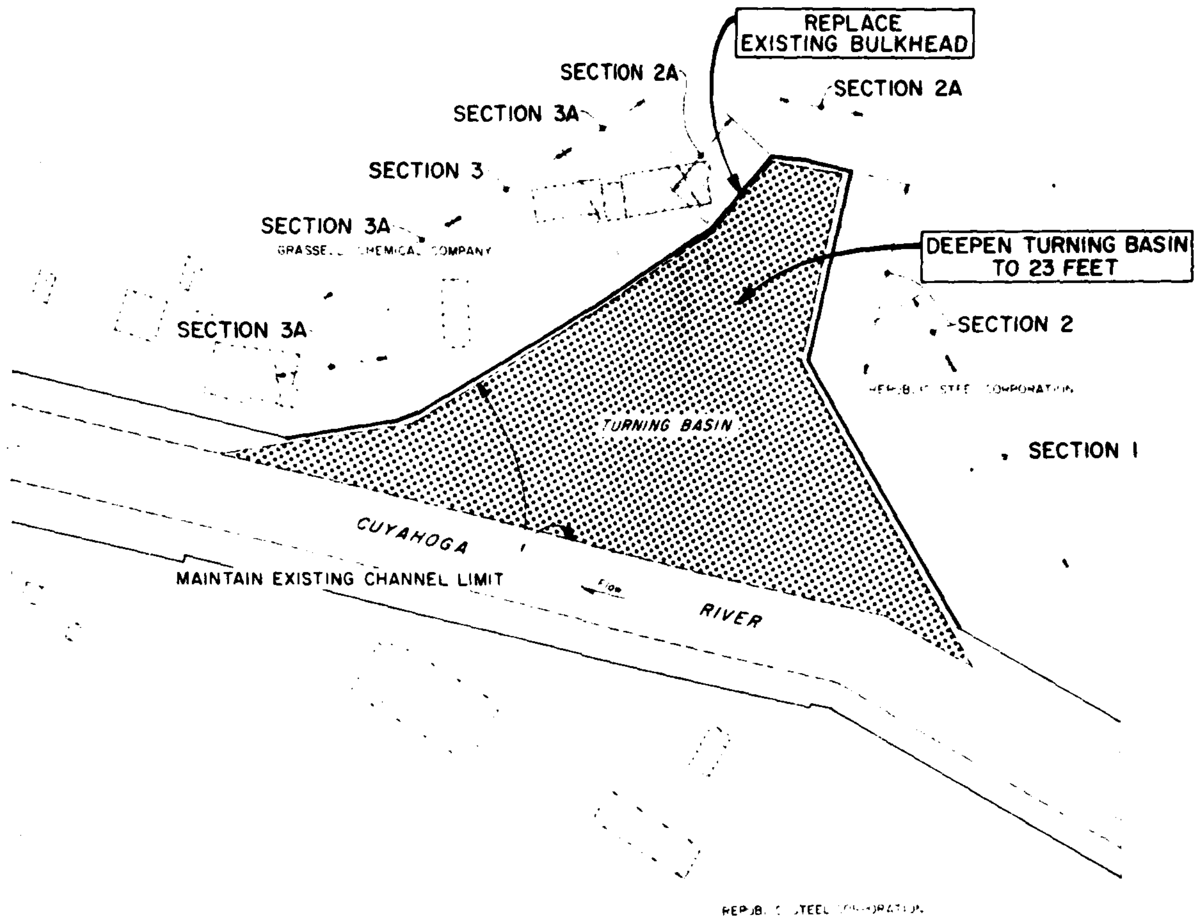
ALTERNATIVE 7G

(REMOVE JEFFERSON AVENUE BRIDGE ABUTMENTS)

NOTES:

1. SEE PLATE 22 FOR TYPICAL BULKHEAD SECTIONS (SECTIONS 1, 2, 2A, 3, 3A, 4, 5 AND 6)
2. ALL CUTS TO BE DREDGED TO 23 FEET LWD

300'



ALTERNATIVE II
(DEEPEN TURNING BASIN)

SCALE OF FEET
300' 0 300' 600'

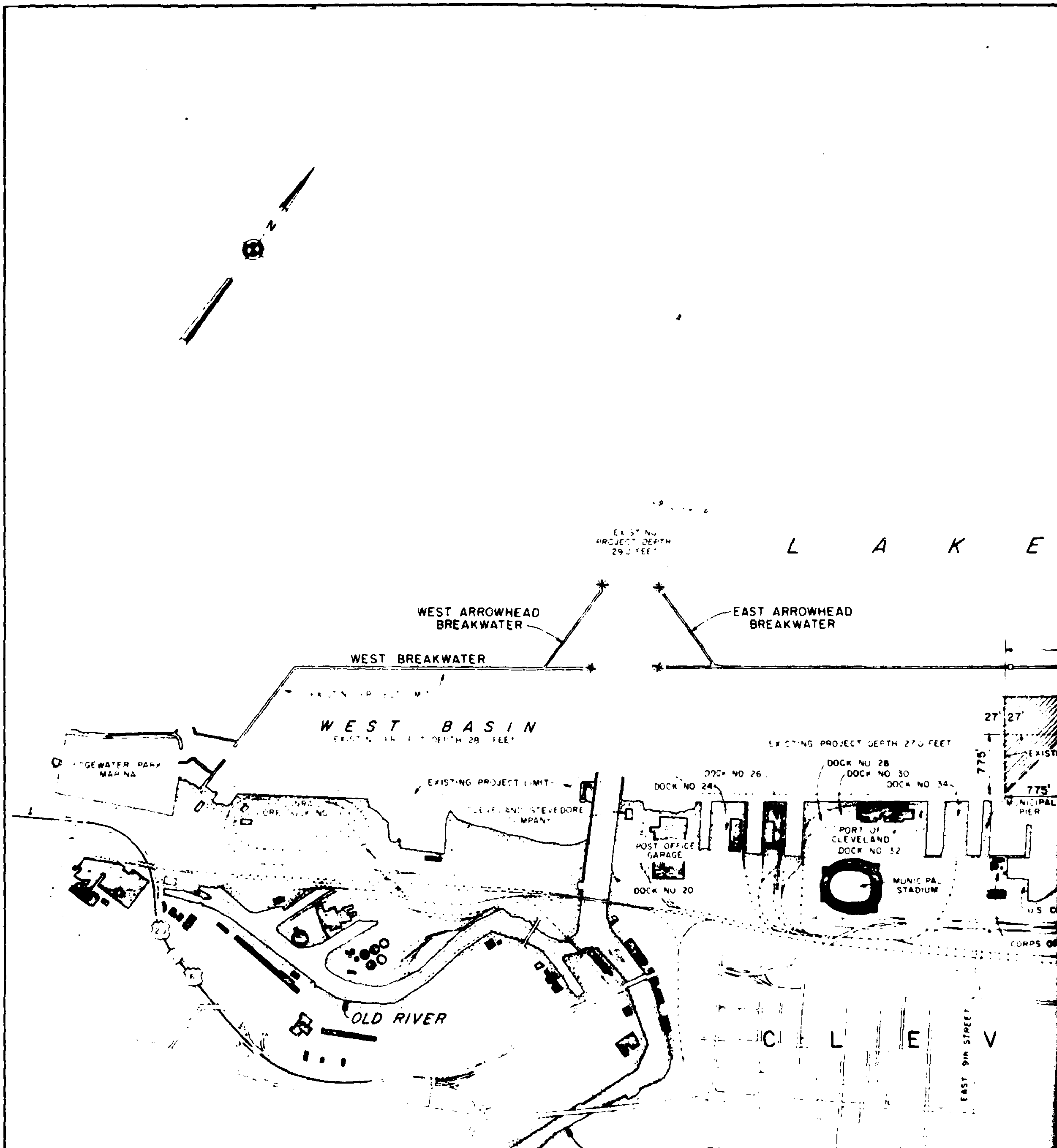
CLEVELAND HARBOR STUDY
CLEVELAND, OHIO

GENERAL FEATURES:
ALTERNATIVES 7G AND II

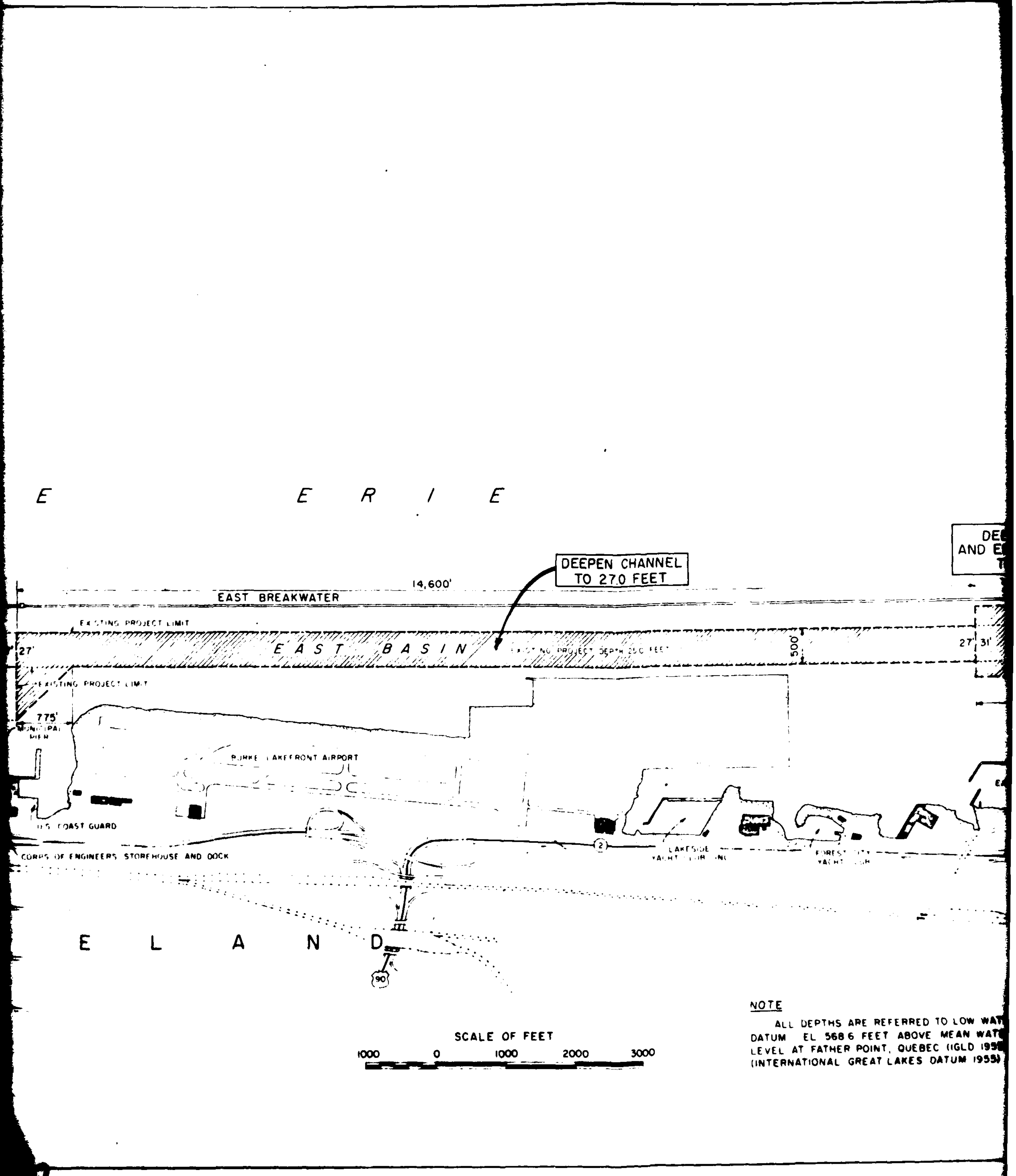
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

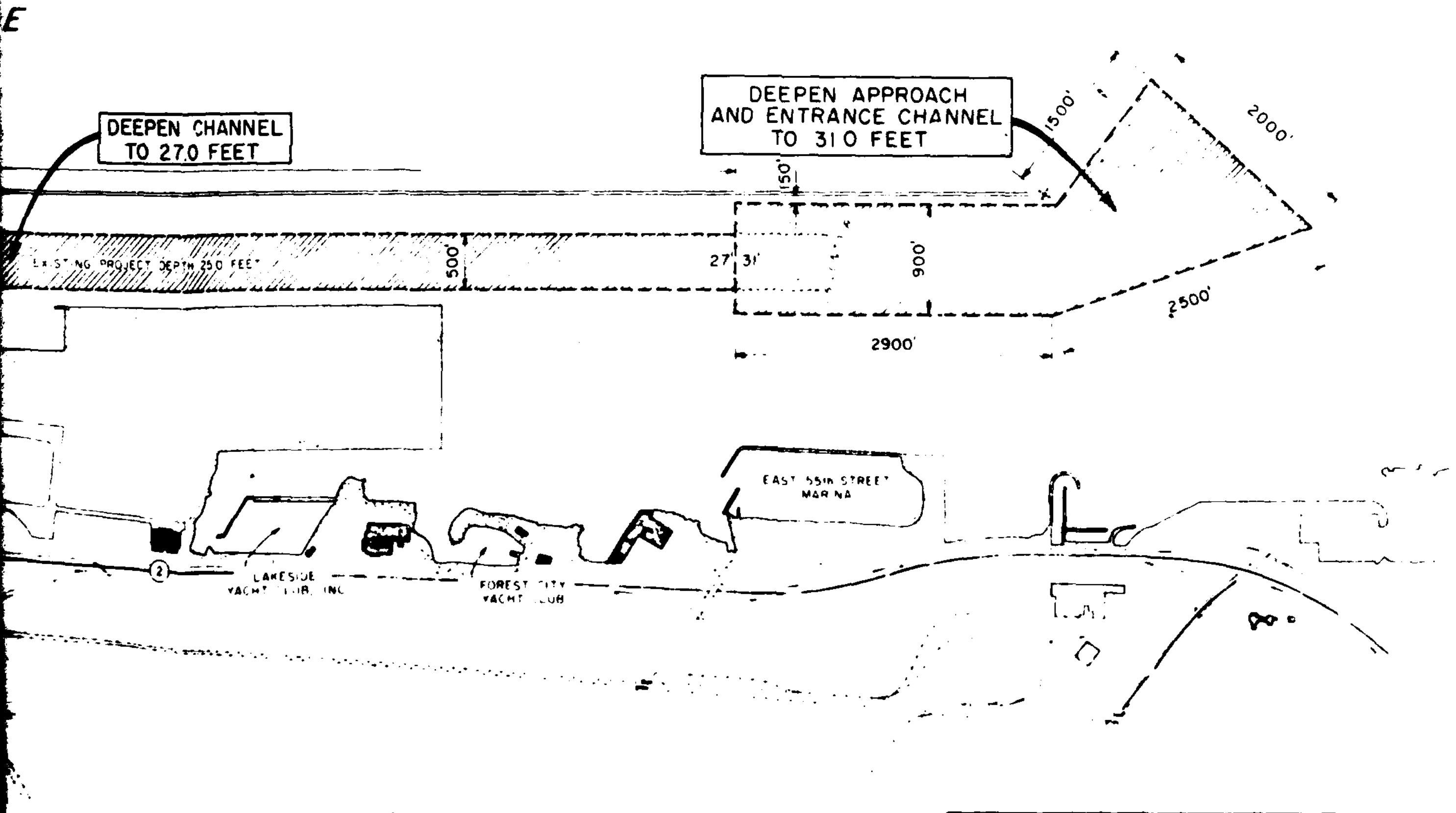
2

PLATE 23



N
L A K E
EXISTING PROJECT DEPTH 29.0 FEET
WEST ARROWHEAD BREAKWATER
EAST ARROWHEAD BREAKWATER
WEST BREAKWATER
WEST BASIN
EXISTING PROJECT DEPTH 27.0 FEET
EDGEWATER PARK MARINA
EXISTING PROJECT LIMIT
CLEVELAND STEVEDORE COMPANY
DOCK NO 24
DOCK NO 26
DOCK NO 28
DOCK NO 30
DOCK NO 34
POST OFFICE GARAGE
PORT OF CLEVELAND DOCK NO 32
DOCK NO 20
MUNICIPAL STADIUM
MUNICIPAL PIER
27'
27'
775'
775'
CORPS OF
OLD RIVER
CUYAHOGA RIVER
C L E V
EAST 9th STREET


E
E R I E
DEEPEN CHANNEL
TO 27.0 FEET
14,600'
EAST BREAKWATER
EXISTING PROJECT LIMIT
EAST BASIN
27'
500'
27' 31'
EXISTING PROJECT LIMIT
775'
BURKE LAKEFRONT AIRPORT
U.S. COAST GUARD
CORPS OF ENGINEERS STOREHOUSE AND DOCK
2
E L A N D
90
SCALE OF FEET
1000 0 1000 2000 3000
NOTE
ALL DEPTHS ARE REFERRED TO LOW WAT
DATUM EL 568.6 FEET ABOVE MEAN WAT
LEVEL AT FATHER POINT, QUEBEC (IGLD 195
(INTERNATIONAL GREAT LAKES DATUM 1955)



OF FEET
2000 3000

NOTE

ALL DEPTHS ARE REFERRED TO LOW WATER DATUM EL 568.6 FEET ABOVE MEAN WATER LEVEL AT FATHER POINT, QUEBEC (IGLD 1955) (INTERNATIONAL GREAT LAKES DATUM 1955)

CLEVELAND HARBOR STUDY
CLEVELAND, OHIO
ALTERNATIVE IB
MODIFIED "SEVERE-WEATHER"
EAST ENTRANCE PLAN
(RECOMMENDED PLAN)
U.S. ARMY ENGINEER DISTRICT BUFFALO
NOVEMBER 1983

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PLATE 24