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MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION--ETC(U)
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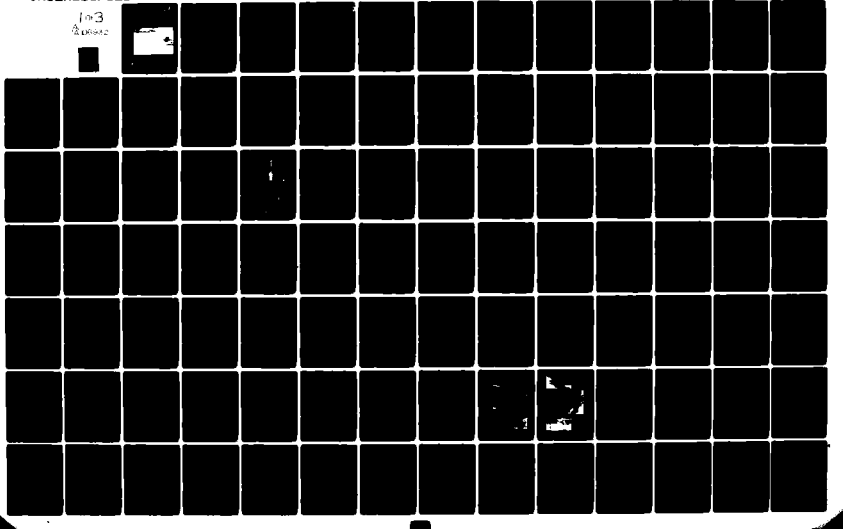

LEVEL II

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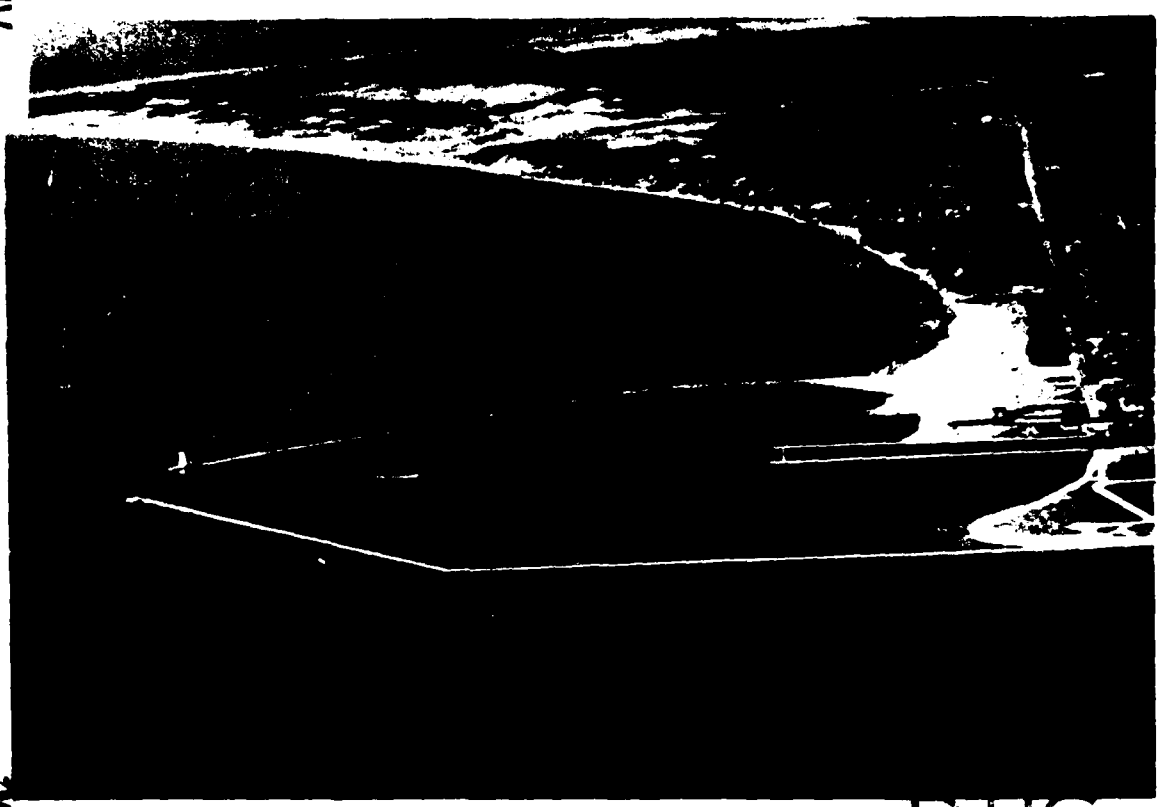
FINAL

ENVIRONMENTAL STATEMENT

MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES AT LUDINGTON HARBOR, MICHIGAN



DECEMBER, 1975
Prepared by
U.S. Army Engineer District
Detroit, Michigan

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SUMMARY
MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES AT LUDINGTON HARBOR, MICHIGAN

( ) DRAFT (X) FINAL ENVIRONMENTAL STATEMENT

RESPONSIBLE OFFICE: U.S. ARMY ENGINEER DISTRICT, DETROIT, MICHIGAN

NAME OF ACTION: (X) ADMINISTRATIVE ( ) LEGISLATIVE

1.1 DESCRIPTION OF ACTION: The Corps of Engineers proposes to mitigate shore erosion in the vicinity of Ludington Harbor, Mason County, Michigan, that is attributable to the Federal navigation structures at the harbor. Studies have determined that the erosion problem is partly attributable to the navigation structures as well as other natural erosion processes. The plan considered most practical for this purpose entails the establishment and maintenance of two beach nourishment supply sites (one north and one south of the harbor structures) to provide immediate and continued relief to damaged shore areas. The unpolluted sediment accululation at or near the harbor mouth will serve as the source of material for the nourishment supply. The establishment and periodic sustenance of these areas will enable those quantities of littoral materials presently interrupted and diverted lakeward by the navigation structures to be restored to the shoredrift system.

1.2 The proposed nourishment sites are to be located at the following nearshore areas:

(1) North Site: Beginning about 9,000 feet north of the breakwater and extending about 3,000 feet to the Lincoln Lake outlet;

(2) South Site: Beginning about 5,500 feet south of the south breakwater and extending about 10,000 feet further south.

An approximate total of 400,000 cubic yards of dredged material will be required for initial establishment. Subsequent site sustenance will require an average of 66,500 cubic yards annually. Shallow-draft, bottom-dumping barges will transport the dredged materials from the harbor mouth (and adjacent shoals) to the nearshore nourishment sites.

1.3 Depending on the type of dredging vessel utilized, initial establishment of these nourishment sites would be accomplished over a one- to four-year interval of 25- to 30-day annual operational periods. Subsequent sustenance activities will require a 10-day period annually. The operations, scheduled for late spring or early summer, will result in minimal interference with fish spawning and migrational activities.

2.1 ENVIRONMENTAL IMPACTS: The establishment of nourishment sites would migrate shore erosion due to the navigation structures. Bluff erosion would decrease, rendering them more suitable for vegetative growth and, hence, more

attractive to wildlife. Shorebird activity would increase due to the general preference of local species for sandy beaches. Newly created beaches would enhance the recreational and aesthetic qualities of the area. The existing turbid condition of Lake waters south of the navigation structures would be considerably reduced. The proposed plan would provide a minimal increase in employment in that a few additional personnel would be required to implement the action. The threat of damage to lakefront property and structures would be reduced, thereby enhancing property values, reducing or obviating the need for additional shore protective works, and providing relief to the state-of-mind of associated property owners.

2.2 On the other hand, implementation of the proposed action would result in some loss of shoreline rubble areas which, since placement for shore protection, have developed into thriving habitats for a few aquatic plants and animals. Benthos at the nourishment sites will be smothered. During operations, small losses of benthic life would also occur at the dredging site. Turbidity would be temporarily increased during annual dredging and beach fill operations, causing fish to temporarily migrate from the area and imparting damage to local drifting plankton; recovery would be rapid following cessation of operations. The presence of men and equipment in the area during the proposed construction and annual maintenance activities will be a temporary imposition on the recreational and aesthetic qualities of the area. Noises and nuisance light (at night) would result primarily from dredging operations and the transport of materials by barge; associated exhaust emissions and small leaks or spills of oil or fuel would be noticeable, insignificant,

and unavoidable. Craft passage may be inconvenienced somewhat by dredge vessel operations at the harbor mouth and possibly in the inner channel entrance.

3.1 ADVERSE ENVIRONMENTAL EFFECTS: The dredging and disposition of sand for the project will temporarily, though unavoidably, cause localized benthos damage and increased turbidity at the operational sites--the latter probably imparting minor damage to local drifting plankton and a temporary displacement of fish. Followup recovery is expected to be rapid, however. Other identified adverse effects include temporary increases in noise, night-time nuisance light, exhaust emission discharge, inconvenience during operations, and an associated detraction in the recreational and aesthetic qualities of the area.

4.1 ALTERNATIVES TO THE PROPOSED ACTION: Alternative solutions considered were:

(A) A "No Action" scheme; this alternative would not satisfy the mandate of Section 111 of P.L. 90-483 since it has been established that a portion of the shore damage is attributable to the Federal navigation project.

(B) Removing the navigation structures at Ludington Harbor; this would cause shoaling at the mouth of the harbor, eliminating commercial traffic and reducing recreational boat traffic; littoral drift would resume southward thus effecting the littoral accretion zones adjacent to the harbor, and altering ecosystem habitats.

(C) Shoreland regulation and management techniques; application of such measures will serve to prevent unwise development in areas subject to erosion but will not offer immediate protection to the eroding shoreline.

(D) Partial removal of navigation structures, reduction of project depth, and shoreline management; a significant reduction in project depth would be necessary to allow littoral materials to bypass the harbor, in which case the effectiveness of the harbor for commercial traffic would be eliminated.

(E) Continuous armor protection with reshaping of the bluffs to a stable angle; this action would deprive the littoral stream of its natural input from bluff erosion so the problem would move downdrift and necessitate additional seawalls; reshaping the bluffs would result in the loss of real estate and recreational beaches.

(F) Installation of groins along the damage area; this alternative is ineffective because littoral drift is insufficient to fill the groins.

(G) Groins artificially filled with littoral materials; could be maintained with annual nourishment by borrow material from the harbor mouth or a land borrow area, but would require quantities in excess of nourishment-site requirements.

(H) Offshore breakwaters; such structures would dissipate wave energy, serve to build up a stable bottom profile and form a protective beach; however, offshore

structures are aesthetically displeasing and a hazard to small craft navigation; they would also alter the character of the littoral zone.

(I) Offshore breakwaters and annual beach nourishment; would accomplish more rapidly the preventive measures listed in (H) above.

(J) Protective beaches or feeder beaches; nearly identical to the recommended approach by serving to restore the littoral drift through the movement of shore currents and wave action; uniform placement of fill material on the beach would be more costly than the method of placement considered for the nearshore nourishment-site proposal.

5.1 COMMENTS REQUESTED: The Draft and Final Environmental Statements have been sent to the following agencies or officials:

Advisory Council on Historic Preservation
Amber Township, Mason County
City of Ludington, Michigan
Federal Power Commission
Great Lakes Area National Park Service
Great Lakes Basin Commission
Hamlin Township, Mason County
Ludington Harbor Commission
Mason County Planning Commission
Michigan Area Council of Governments
Michigan Department of Commerce

Michigan Department of Natural Resources

Michigan Department of Public Health

Michigan Department of State Highways

Michigan Historical Commission
-Office of the Planning Coordinator

National Marine Fisheries

Pere Marquette Township, Mason County

State of Michigan, State Archaeologist

State of Michigan, State Conservationist

State of Michigan, State Historic Preservation Coordinator

State of Michigan, State Historic Preservation Officer

U.S. Department of Agriculture
-Forest Service
-Soil Conservation Service

U.S. Department of Commerce
-National Marine Fisheries Service
-National Oceanic & Atmospheric Administration

U.S. Department of Health, Education & Welfare

U.S. Department of Housing & Urban Development

U.S. Department of the Interior
-Bureau of Outdoor Recreation
-Bureau of Sport Fisheries and Wildlife
-U.S. Geological Survey

U.S. Department of the Interior (National Park Service) for Investigations of Historical, Archaeological and Paleontological Resources

U.S. Department of Transportation
-Federal Highway Administration
-U.S. Coast Guard

U.S. Environmental Protection Agency

Water Resources Council

5.2 COMMENTS REQUESTED: The Draft and Final Environmental Statements have also been sent to the following groups:

Advisory Council for Environmental Quality
Black Creek Watershed Group
Lake Michigan Federation
Ludington Chamber of Commerce
Manistee County Antipollution Organization
Michigan Audubon Society
Michigan Parks Association
Michigan United Conservation Clubs
National Resources Defense Council
Pere Marquette Watershed Council
Sierra Club, Huron Valley Group
Sierra Club, Midwest Representative
West Michigan Environmental Action Council
West Michigan Shoreline Protection Association

6.1 DRAFT STATEMENT TO CEQ ON 9 April 1975.

7.1 FINAL STATEMENT TO CEQ ON 2 March 1977.

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MITIGATION OF SHORE DAMAGE
ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES
AT
LUDINGTON HARBOR, MICHIGAN

1. PROJECT DESCRIPTION

1.01 Section 111 of the River and Harbor Act of 1968 (P.L. 90-483) authorizes the Secretary of the Army, acting through the Chief of Engineers, to investigate, study and construct projects for the prevention or mitigation of shore damages attributable to Federal navigation works. The cost of installing, operating and maintaining such projects shall be borne entirely by the United States. However, no such projects can be constructed without specific authorization by Congress if the estimated first cost exceeds $1,000,000.

1.02 The Section 111 authority provides only for mitigation of erosion in excess of the natural rate. Factors which may not be mitigated under this authority are the effects of wind and wave action, violent storms, high water levels and normal erosion processes. All these factors were investigated and it was determined that erosion attributable to the Ludington Harbor structures is approximately 55% of the total erosion due to all causes. Therefore, the proposed project for shore protection is designed only to mitigate the effects of this portion of erosion on the shoreline.

1.03 Ludington Harbor, Michigan, is located on the east shore of Lake Michigan approximately 153 miles northeasterly of Chicago, Illinois, and 60 miles north of Muskegon, Michigan (see Plate 1 for general location). The configuration of the harbor is shown in Plate 2. The jettied structures serve to protect a navigation channel connecting Lake Michigan with Pere Marquette Lake.

1.04 The coastal region around Ludington Harbor is characterized by accretion and erosion. Studies have shown that the erosion problem is partly attributable to the Federal navigation project at the entrance to Pere Marquette Lake as well as other factors of the normal erosion process. In recent years, high lake levels have greatly extended this problem.

1.05 Disregarding lake level changes, accretion occurs at an average rate of 4.13 ft/yr along the 4400-ft stretch of beach immediately south of the harbor. This is equivalent to an average volumetric gain of 18,000 cu yd/yr of sand. Further south to the Ludington Pump Storage facility (an inclusive distance of approximately 14,600 feet), the shoreline is characterized by erosion, the average rate of which is 3.11 ft/yr; coupled with losses from the 50- to 250-ft high bordering bluffs, an eroded material loss of 20.55 cu yd/yr/ft of beach prevails. This transmutes to an average volumetric loss of 300,000 cu yd/yr of which 41 percent (123,000 cu yd/yr or 8.42 cu yd/yr/ft) is good beach sand and 59 percent (177,000 cu yd/yr or 12.13 cu yd/yr/ft) is finer material (fine sands, silts and clays). The latter fraction is responsible for the creation of highly turbid water conditions (visible in Plate 2) in nearshore areas south of the harbor.

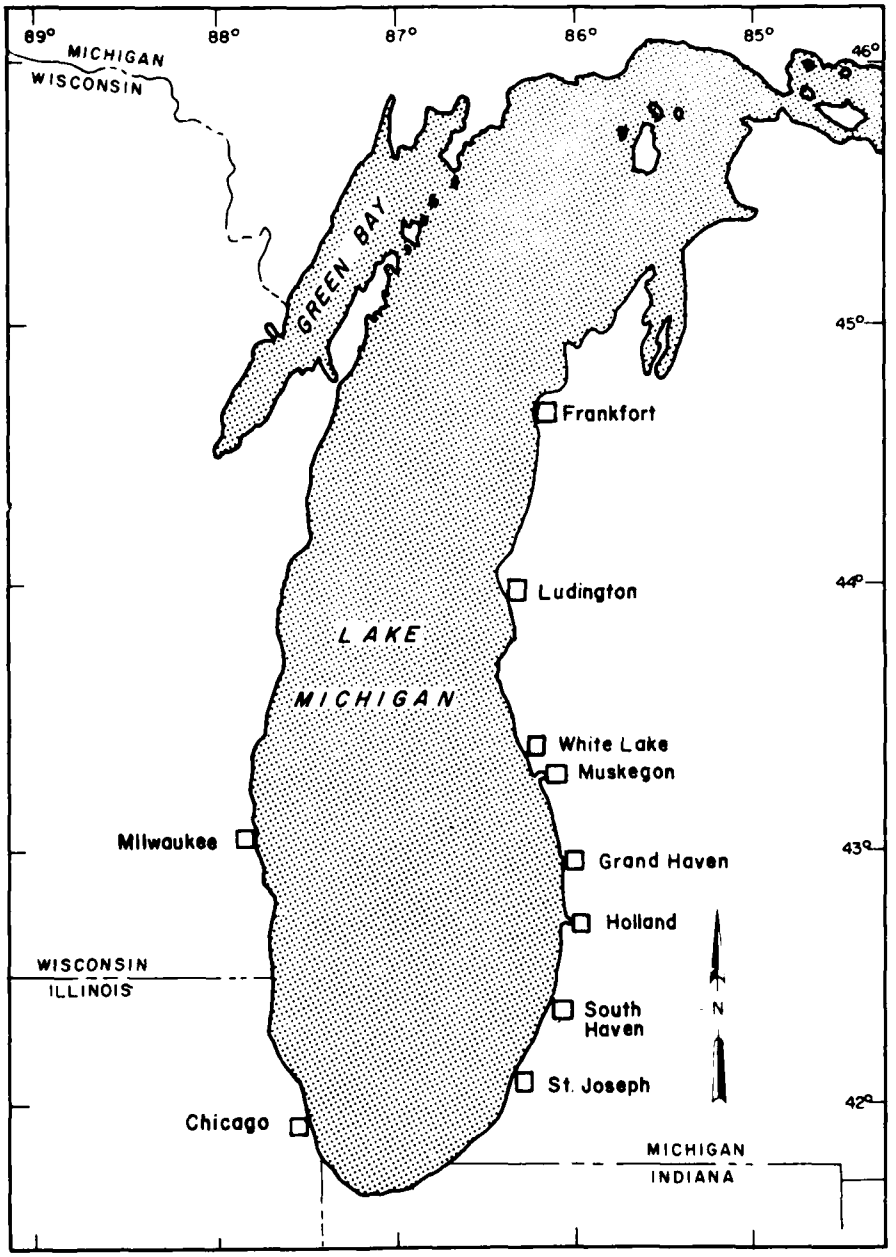


PLATE 1. GENERAL LOCATION MAP

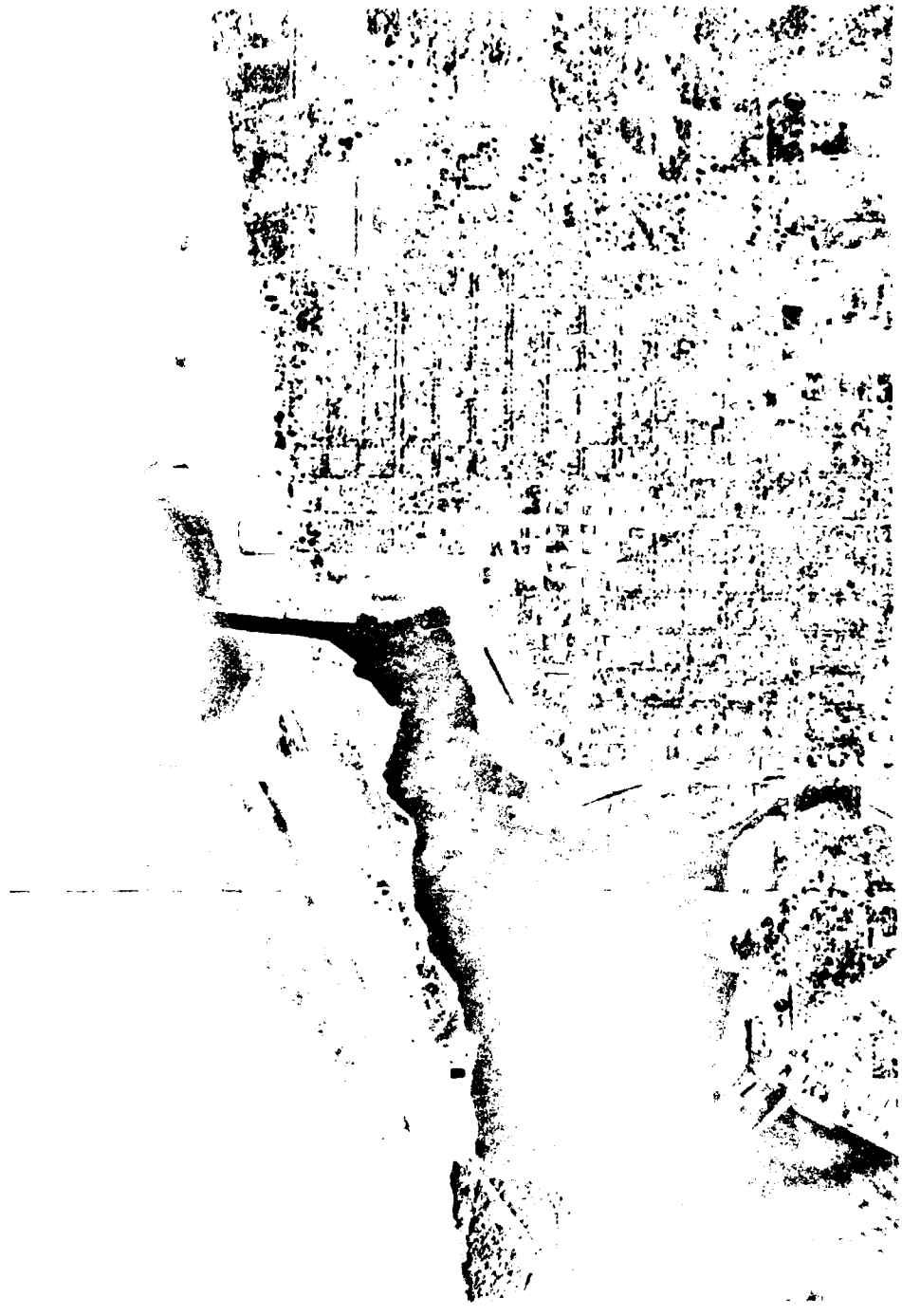


PLATE 2. AERIAL PHOTOGRAPH OF LUDINGTON HARBOR, MICHIGAN (1965)

1.06 Accretion also occurs along the 2000-ft stretch of beach immediately north of the harbor but to a lesser extent than that on the south side. The accretion rate averages about 2.91 ft/yr, equivalent to a volumetric gain of 5800 cu/yd/yr of beach sand. Further north to the confluence of Lincoln Lake and Lake Michigan (an inclusive distance of about 8,900 feet), the shoreline is characterized by man-made accretion. It is due solely to the installation and periodic build-up of shore-protective structures. (Without these works, the shoreline stretch would have suffered erosion to some unknown extent).

1.07 North of the Lincoln Lake outlet, the shoreline (for an undetermined distance) is undergoing erosion at an average rate of 1.52 ft/yr. Coupled with bordering bluff losses, an eroded material loss of 3.77 cu yd/yr/ft of beach prevails. This loss is attributable to natural causes only. It also points to the fact that the 8.42 cu yd/yr/ft of erosion on the south side of the harbor is in excess of the natural rate. The excess--4.65 cu yd/yr/ft of beach--represents an erosion loss attributable solely to the harbor structures and comprises 55% of the total erosion due to all causes.

1.08 Littoral drift trends in the area are both northerly and southerly (depending on the season), with the latter predominating to the net extent of 56,000 cu yd/yr. Of the total southerly drift, 6000 cu yd/yr accumulate in the fillet immediately north of the harbor, and the remainder is interrupted and diverted lakeward to the harbor mouth. A similar phenomenon occurs for the total northerly drift, i.e., 18,000 cu yd/yr accumulate in the fillet immediately south of the harbor. The remaining drift is interrupted and diverted lakeward,

depositing some material at or near the harbor entrance. The remainder presumably moves further offshore to accumulate in deeper parts of the lake. The net result is that the harbor entrance requires maintenance dredging to the extent of 42,500 cu yd/yr. (To date, the practice has been to dispose of this dredged material in deeper parts of Lake Michigan). Moreover, beach areas on the north are being deprived of at least 10,500 cu yd/yr of beach material (i.e., the difference between the fillet plus dredge material accumulations and the net southerly littoral drift) which they would normally receive if the harbor structures were absent.

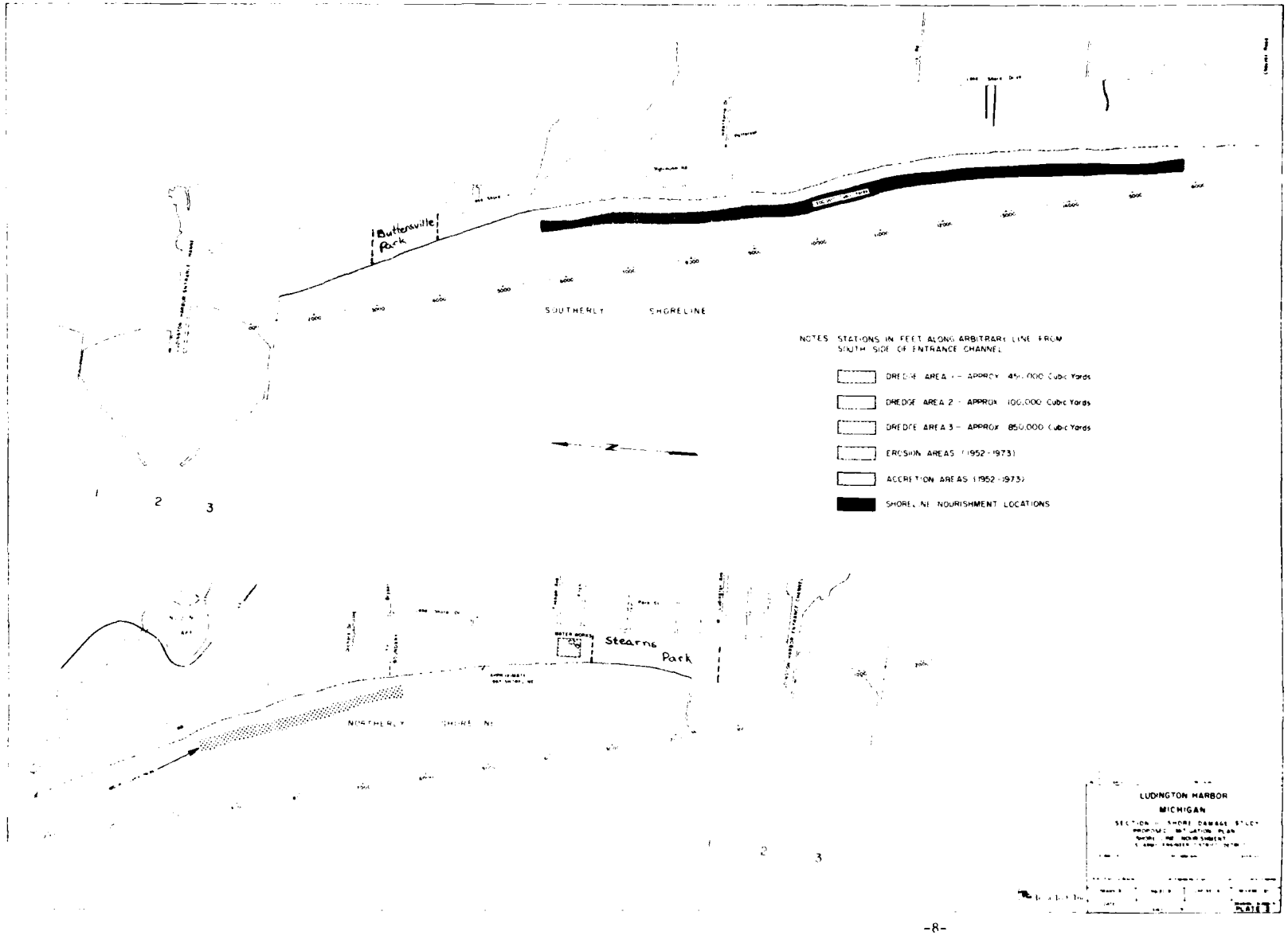
1.09 The proposed mitigation plan is to establish "nourishment sites" at selected nearshore areas fronting deprived and eroded segments of beach. Once established, these sites would be maintained either annually or on an as-needed basis by materials supplied mostly from normal maintenance dredging operations. Establishing nearshore nourishment sites with subsequent maintenance will allow quantities of littoral materials interrupted by the navigation structure to be restored to the system. The result would be an immediate lessening of deprivation and/or erosion at problem coastline areas close to the harbor and subsequent reduction in these problems at areas situated farther away. This latter benefit would be a consequence of periodic nourishment and overall restoration of the mass balance of materials necessary for maintenance of natural littoral drift patterns.

1.10 The initial establishment of nearshore nourishment sources and several years of periodic nourishment of source

supplies would be required before areal stabilization could be expected. The only erosion that would then occur would be that due to natural processes and corresponding natural changes. Expected effects, though, would be highly dependent on localized environmental characteristics. For example, bluff erosion in the immediate project area is partially caused by wave action at its toe and possibly by groundwater seepage through the bluff and sheet erosion. To some extent, the resulting effects of such processes are dependent on the soil characteristics of the bluff itself. Neglecting lake level changes, the proposed beach nourishment plan will reduce bluff erosion due to wave action, but will not alleviate that due to groundwater seepage or sheet erosion.

Improvement Plan and Mode of Implementation

1.11 The proposed plan would establish beach nourishment supply sites at two nearshore locations--one north and one south of the harbor structures (see Plates 3, 5, 6, and 7)--so as to furnish immediate and continued relief to neighboring contiguous shore areas and facilitate distribution of sand fill by shore processes over the entire remaining shore damage area. The southern site would begin approximately 5,500 feet south of the south jetty and would extend southward for a distance of 10,000 feet. That on the north would begin 6,200 feet north of the north jetty and would extend northward for a distance of 3,300 feet. Respective sand volumes of 300,000 and 100,000 cubic yards will be required for their initial establishment. These amounts, respectively, are ten times the average annual demand of the southern location and five times that of the


Butterville Park
SOUTHERLY SHORELINE
NOTES STATIONS IN FEET ALONG ARBITRARY LINE FROM SOUTH SIDE OF ENTRANCE CHANNEL
DREDGE AREA 1 – APPROX 450,000 Cubic Yards
DREDGE AREA 2 – APPROX 100,000 Cubic Yards
DREDGE AREA 3 – APPROX 850,000 Cubic Yards
EROSION AREAS (1952-1973)
ACCRETION AREAS (1952-1973)
SHORELINE NOURISHMENT LOCATIONS
Stearns Park
NORTHERLY SHORELINE
LUDINGTON HARBOR
MICHIGAN

north, and will more than offset any variable increase due to storms, winds and other phenomena of short-term duration.

1.12 The U.S. EPA, utilizing 1974 data (Table 1), classified the sediments as unpolluted and suitable for open water, though lead and zinc exceeded EPA bulk criteria at Station G065. All harbor sediments to be used for both initial and periodic nourishment will be analyzed on a periodic basis to insure a non-polluted character and compliance with the suitability requirements of the Section 404(b) guidelines of PL 92-500 and the EPA criteria including those contained in Appendix A.

1.13 A hopper dredge (possibly the Markham or Hains type) will probably be used to dredge the required sediment deposits for initial site establishment. Material transportation to each nourishment location and subsequent placement will be accomplished with the use of shallow-draft, bottom-dumping barges. These barges will each be approximately 40 feet wide and 100 feet long. Individual barge loadings will be restricted to about 300 cu yd/trip in order to keep draft requirements to a minimum (about 6 feet or less). Actual material placement at each nourishment site would occur between the first and second shoremost sandbars paralleling the coastline (see Plates 5 through 8 for beach profiles and sandbar locations at various coastline stations). In general, this region lies between shore-to-bar distance boundaries of 200 feet and 400 feet, respectively, and provides a natural shallow-draft trough measuring 200 feet wide and a length (paralleling the beach) of any desirable dimension.

TABLE 1. BOTTOM SEDIMENT ANALYSIS IN LUDINGTON HARBOR
(Source: U.S. Environmental Protection Agency)

PARAMETER	UNITS	STATION NO.*				ACCEPTABLE LIMITS
		G063	G065	G061	G064	
Volatile Solids	%	1.20	3.86	<1.0	<1.0	6.0
COD	mg/kg	1,000	29,000	2,300	2,800	50,000
Kjeldahl Nitrogen	mg/kg	120	710	73	18	1,000
Oil & Grease	mg/kg	<200	420	310	470	1,500
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	1.0
Lead	mg/kg	32	62**	17	27	50
Zinc	mg/kg	12	65**	11	14	50
Manganese	mg/kg	33	272	39	49	N/A
Nickel	mg/kg	22	43	20	14	N/A
Tot. Phosphrous	mg/kg	48	270	54	49	N/A
Phenols	mg/kg	0.14	0.37	<0.14	0.26	N/A
Arsenic	mg/kg	<1	<1	<1	<1	N/A
Barium	mg/kg	<5	25	15	<5	N/A
Cadmium	mg/kg	3.5	4.9	3.2	0.3	N/A
Chromium	mg/kg	<2	<2	<2	<2	N/A
Cobalt	mg/kg	18	25	16	13	N/A
Copper	mg/kg	3	9	3	3	N/A
Iron	mg/kg	1,800	7,500	1,700	2,100	N/A

*Refer to Plate 4 for station location.

**Exceeds EPA bulk criteria acceptable limits.

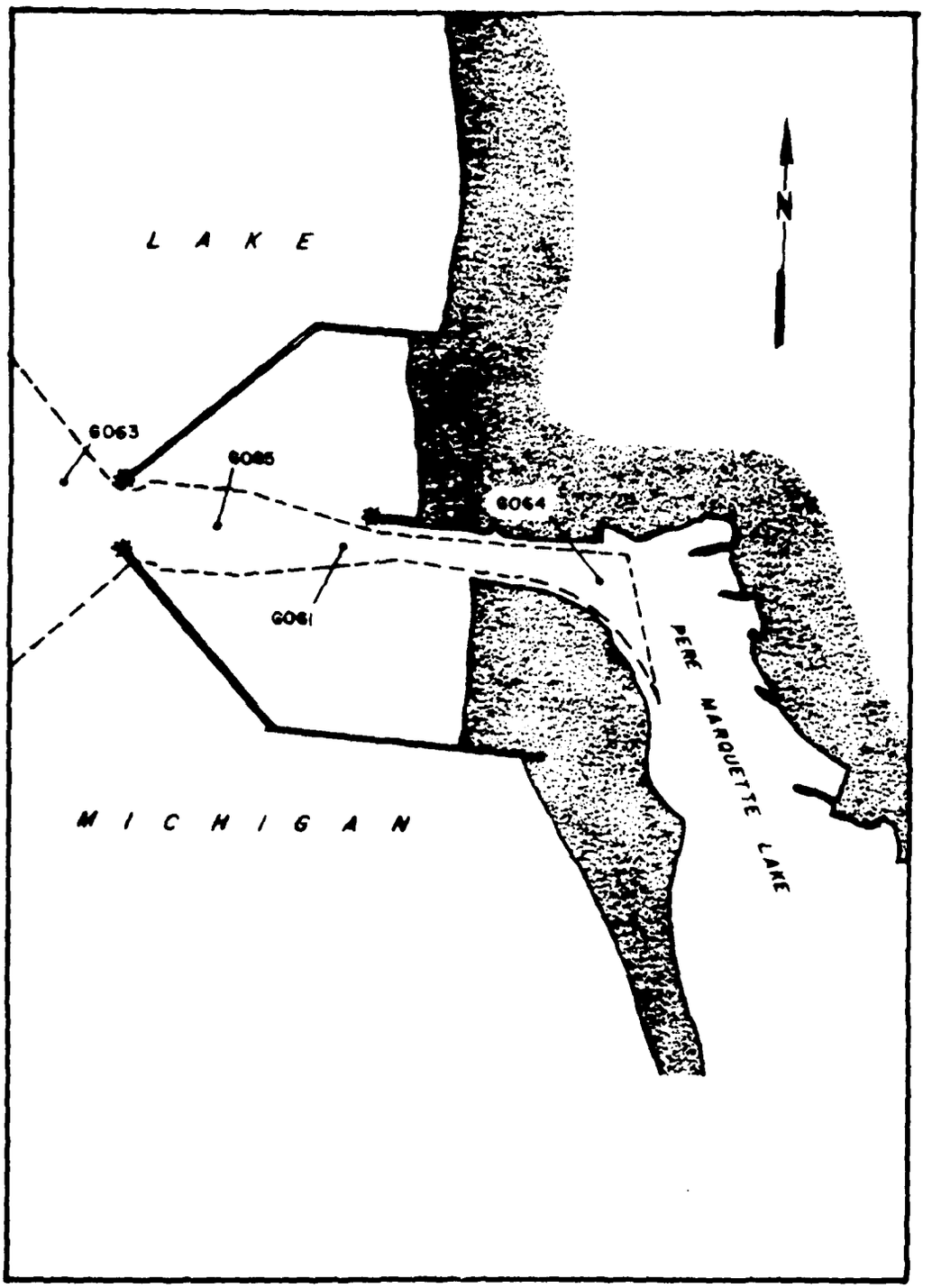
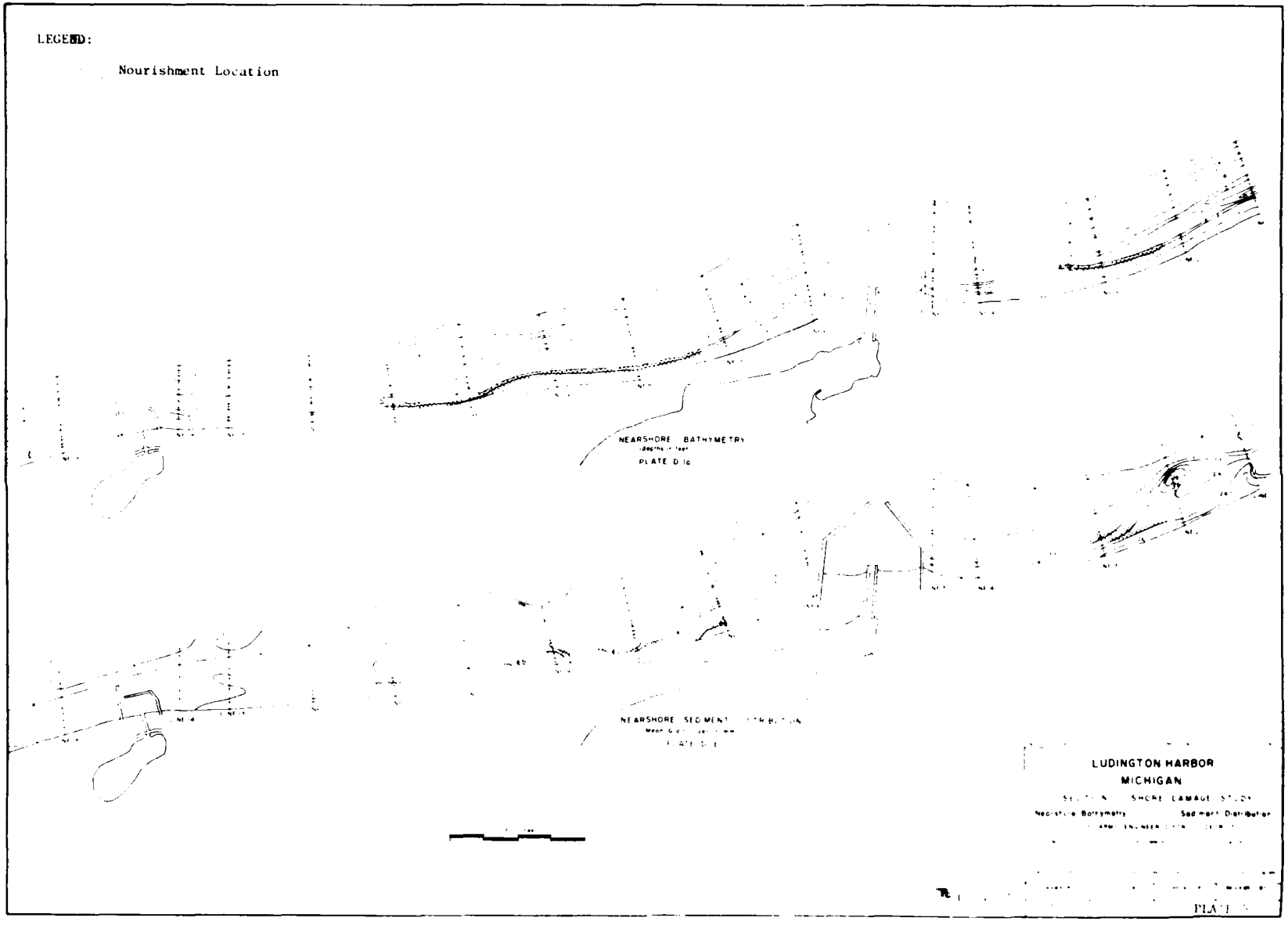
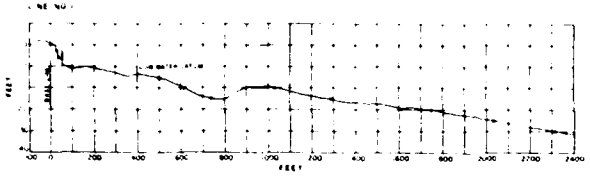
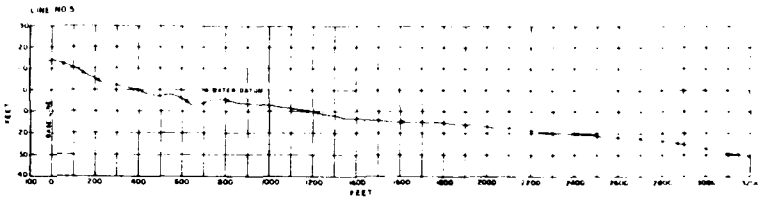
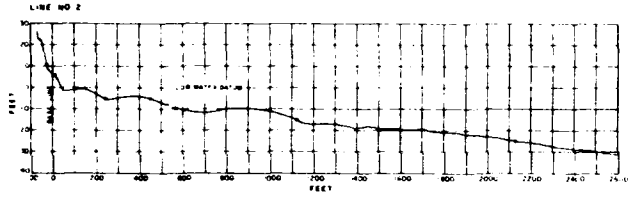


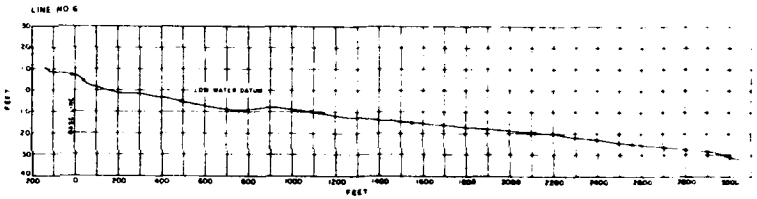
PLATE 4. STATION LOCATION MAP FOR SEDIMENT CHEMICAL DATA OF TABLE 1

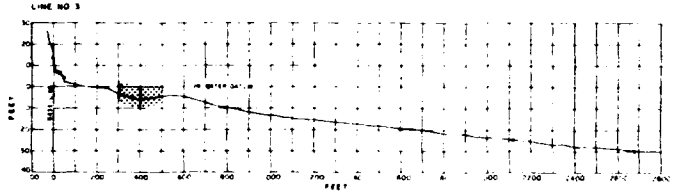

LEGEND:
Nourishment Location
NEARSHORE BATHYMETRY
PLATE D 1c
LUDINGTON HARBOR
MICHIGAN

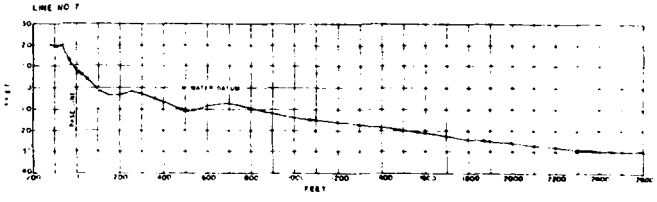


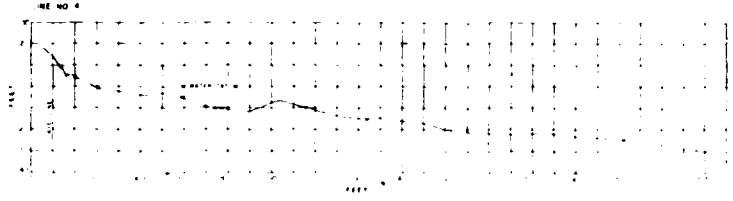










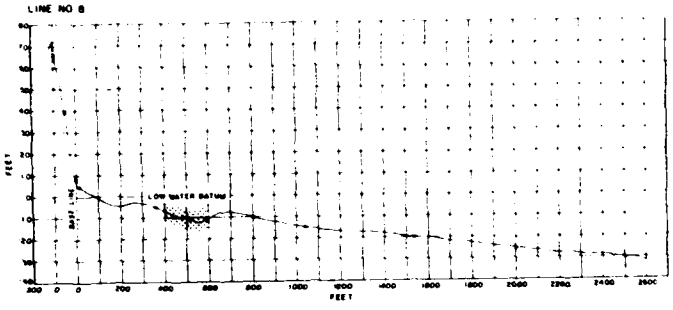


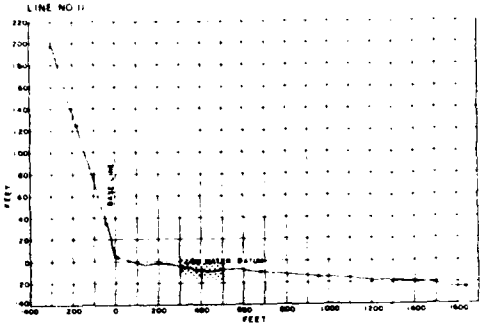
LEGEND:

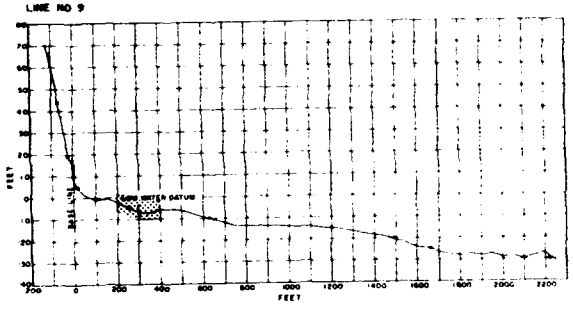
SOIL SAMPLE LOCATION
GROUND ELEVATION
NOURISHMENT SITE

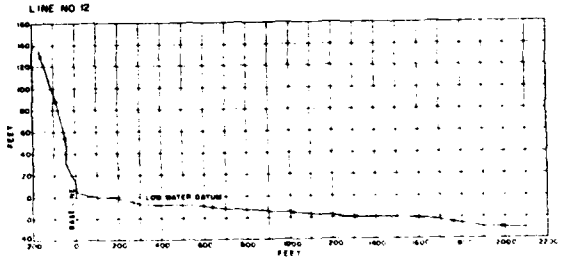
LUDINGTON HARBOR
MICHIGAN

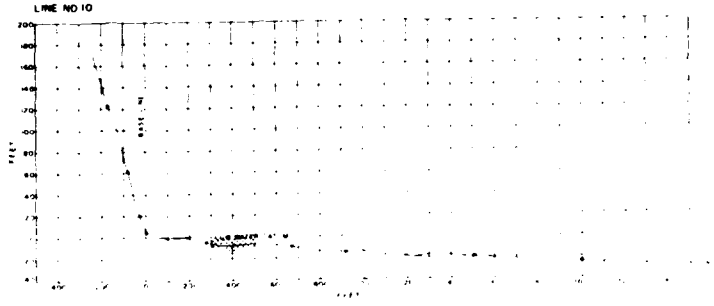
PLATE 6









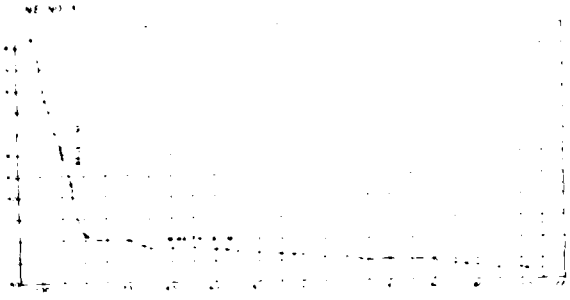


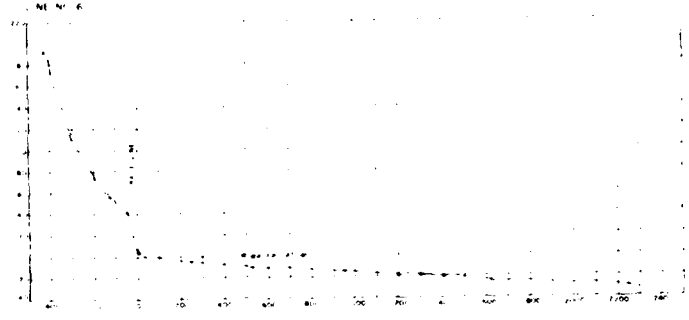
LEGEND:

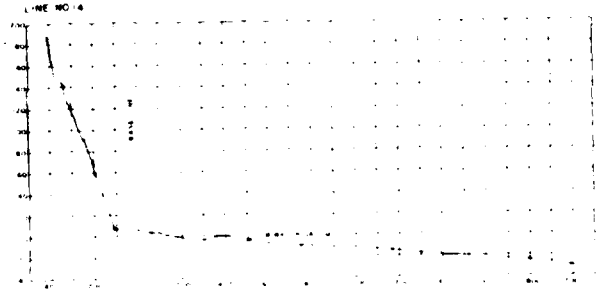
- SOIL SAMPLE LOCATION
- GROUND ELEVATION
- NOURISHMENT SITE

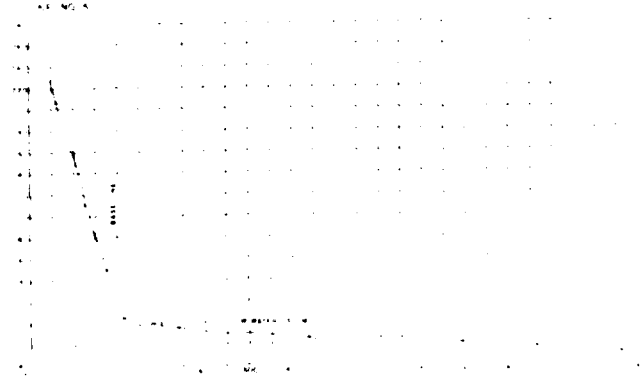
LUDINGTON HARBOR
MICHIGAN

PLATE 7









LEGEND:

- SOIL SAMPLE LOCATION
- GROUND ELEVATION

LEXINGTON HARBOR
MICHIGAN

PLATE 8

-15-

1.14 Material dumping at each designated nourishment site will be controlled to provide an initial material placement distribution of 30 cubic yards per lineal foot of beach. This program would result in the individual site lengths designated in Plate 3. If feasible distribution at isolated shallow spots within a nourishment site is less than that programmed, the resulting length of that site would be extended as necessary to accommodate the total programmed quantity. Compensatory increases in the length of either site would extend southward.

1.15 Use of a hopper dredge for this action will not require the use of additional equipment for discharge support into haul barges. Such barges would normally be hooked up alongside the dredge vessel during its operation and would be loaded continuously while bottom materials were being dredged. Upon completion of each barge loading (about 300 cu yd/load), dredging would cease, and the loaded barge would be released for transport of its contents to a nearshore beach nourishment location. Dredging would resume upon hook-up with a returning empty barge.

1.16 The method of hooking up the barge alongside the hopper dredge and loading continuously while dredging will only be applied when safety is not jeopardized. When sea conditions are less than desirable and/or when maneuverability becomes difficult (such that collisions with neighboring structures pose a threat), then dredging would take place without barge hook-up. In this situation, the hopper dredge would first fill its own hold with dredged material. Then, either it would relocate to a fixed station for transfer of the

material to a haul barge, or it would transfer the material with the barge alongside while underway in more open waters. The most convenient fixed station for temporary mooring during pumpout would be along either of the inner piers. However, minor inner-channel traffic interferences would be likely, thereby suggesting that transfer of dredge material should be accomplished while underway whenever possible. A more costly alternative to the above would be to construct a mooring dolphin at some convenient location within the outer harbor area. However, it is not anticipated that such facilities will be necessary.

1.17 The creation of the two nourishment sites depicted in Plate 3 can be accomplished over a single 25- to 30-day operational period (plus any added downtime) provided that the action is carried out using either the Markham dredging vessel or possibly the services of an outside contractor. A severalfold increase in time would be needed, however, if the Hains vessel were used instead. Considering the maintenance dredging needs of other harbors, it would be impractical to focus a majority of a dredge vessel's seasonal use on one single task. Therefore, if the Hains is used for creation of the nourishment sites, it is anticipated that the task will be accomplished piecewise over an interval of four years under a maximum operational period of 25- to 30-days/year (this also includes the time requirements for incorporation of annual replenishment needs at each site during the latter three years of this interval).

1.18 For the various implementation alternatives discussed above, the 25- to 30-days/year time estimate is based upon

three 8-hour work shifts per day of operation (i.e., 24 hours/day of operation), six days per week, and anticipates the continued use (during that time) of 4 shallow-draft, bottom-dumping barges on a revolving basis. While one barge is being loaded, any other will be in transit to or from a nourishment site or will be unloading its contents at the site itself. In all, an average 80-minute turnaround time is estimated per barge, which includes provision for round-trip transportation (4-5 nautical miles average), loading and unloading, and barge tie-up and disembarkment from a dredging vessel or fixed station.

1.19 The above 25- to 30-day time estimate could fluctuate somewhat depending on any required increase or decrease in the total quantity of dredge material to be handled, possible variations in the operational dredging rate (reflected by differences in dredge vessel type, competence of crews, sea conditions, etc.), and any increase or decrease in the average round-trip transportation distance required of barges. If implemented, the proposed improvement plan would be carried out during late spring or early summer, thereby imparting minimal interference with fish spawning, salmon migrating, and fishery activities.

Periodic Nourishment

1.20 Losses of sediment material from established nourishment sites would be compensated for by providing periodic restoration of quantities interrupted by the navigation works. Collectively, this will average about 66,500 cu yd/yr. North

and south shoreline allocations will be 10,500 cu yd/yr and 56,000 cu yd/yr, respectively. The proposed maintenance plan will be to annually reinstate these quantities to the corresponding deprived nourishment sites so as to maintain a simulated natural pattern of littoral drift.

1.21 The source of material for periodic restoration of the two nourishment sites will also be the harbor mouth and adjacent shoals immediately north and south. Of the anticipated 66,500 cu yd/yr of maintenance material required, 42,500 cu yd/yr would be acquired from normal dredging of the harbor mouth to maintain navigational depths. The remainder--24,000 cu yd/yr--would be obtained from adjacent shoals.

1.22 Shoal reserves are presently estimated to contain over 1.4 million cubic yards of suitable borrow material. Discounting the fact that about 300,000-400,000 cubic yards will be used for the initial establishment of the proposed nourishment sites, the remaining one million or so will support the annual maintenance requirements at each site for a period of approximately 40 years. Moreover, it is expected that the prior and continued removal of borrow material associated with the original creation and periodic maintenance of the two nourishment sites will serve to maintain a subaqueous pit, which will enhance additional sediment recovery (over and above present recoveries) from northerly and southerly moving littoral drift which becomes diverted lakeward by the harbor structures. The extent of this occurrence should eventually render the entire maintenance operation self-sustaining.

1.23 The dredging of sand material from trapped sources at the harbor mouth and adjacent shoal areas will not proceed beyond the 29-foot depth contour (referenced from low water datum, LWD). In the unlikely circumstance that additional supplies are needed, new sediment sources would be sought out to augment proposed supplies. Such sources could be acquired from other nearby submerged shoals or from extension of presently anticipated dredge boundary limits.

1.24 Periodic maintenance of the proposed beach nourishment sites will be carried out in the same manner previously described. Because of the small quantities involved, only two barges will be needed. Each annual maintenance operation will require approximately 10 days to complete (assuming the operation is implemented in accordance with previously stated criteria for initial establishment). This time estimate could vary depending on operating criteria.

Economic Considerations

1.25 Economic consideration was given to the cost for implementing the plan of improvement and subsequent maintenance thereof, and a comparison was made with the anticipated costs of derived benefits. Exact dollar figures calculated for the following economic-consideration data can be found in the attached economic data EXTRACTED FROM THE U.S. ARMY CORPS OF ENGINEERS SECTION 111 DETAILED PROJECT REPORT ON SHORE DAMAGE AT LUDINGTON HARBOR, MICHIGAN.

1.26 Justification for the proposed action was evaluated in accordance with expected benefits to be derived as a result of damage prevention, improvement of property values, reduced need of shore protective structures, and recreational enhancement. Lakefront land values and existing developments were given prime consideration in this evaluation. Present worth costs were amortized at 6-1/8% interest over a projected project life of 50 years. Though a slight decrease in neighboring population is projected over the next 20 years, the anticipated creation of new public beaches is expected to yield some benefit. The primary basis for this assumption is that existing beaches in the areas are presently heavily used.

1.27 The estimated annual cost of the recommended plan and the estimated annual benefit (in dollars) to be realized (if the proposed action is implemented) can be found in the ATTACHED ECONOMIC DATA. Based on these, a benefit/cost ratio (B/C ratio) of approximately 1.26 is derived, thereby providing economic justification for the project. The B/C ratio can be defined as the annual dollar value of expected benefits divided by the projected annual cost of the proposed action leading to these benefits.

1.28 There are various intangible benefits which are difficult to analyze economically. Most significant is the reduction of the hazard of possible human injury and of the insecurity and anguish presently being experienced by lakefront homeowners. Restoring the littoral drift would provide the materials needed to begin natural development of protective beaches, thereby enhancing environmental aesthetics. Such shoreline alteration and resulting

stabilization would provide new habitats for wildlife. These, of course, must be offset by projected losses of shoreline rocky habitats for aquatic life, and corresponding losses of shoreline fishing areas. In weighing these gains and losses, it is expected that the result would be a net benefit of some unknown dollar value which, if incorporated into the benefit/cost formula, would yield a slightly higher benefit cost ratio than stated above.

Other Considerations

1.29 The proposed action involves the initial creation of two nearshore beach nourishment sites or locations for restoration of littoral drift along the shoreline situated both north and south of Ludington Harbor. Periodic nourishment of these sites would be carried out on an annual or as-needed basis. Present Corps practice with respect to the maintenance of the harbor mouth involves the annual dredging of approximately 42,500 cubic yards of material with subsequent deepwater disposal offshore in Lake Michigan 1-1/2 miles west southwest of the South Breakwater Light (course 247°) in approximately 55 feet of water.

1.30 A comparison of sand samples (taken in 1973) from neighboring beaches, bluffs and offshore zones down to the 30-foot depth contour (LWD basis) for different areas lying to the north and south of the harbor revealed the existence of three beach stretches of somewhat differing characteristics. Descriptions of these are as follows:

(a) North of Ludington Harbor. Median particle size diameters at foreshore and shoreline zones average about 0.30 mm (1.75 Ø). Further lakeward, sand sizes become progressively finer, averaging about 0.27 mm (1.90 Ø) at the 5- and 10-ft contour depths, 0.21 mm (2.25 Ø) at the 15- and 20-ft contour depths, and 0.18 mm (2.25 Ø) at the 25- and 30-ft depths. Dune and bluff sands are somewhat finer than the foreshore and shoreline sands, but are coarser than those on the lake bottom. Sorting, on the whole, is good.

(b) South of Ludington Harbor, within 3,000 feet of the Breakwater. Nearer the breakwater, median diameters of foreshore and shoreline sands average 0.55 mm (0.86 Ø); further south in the stretch, they average 0.38 mm (1.40 Ø). Lakeward, sand sizes become progressively finer. Median diameters average about 0.28 mm (1.85 Ø) at the 5- and 10-ft contour depths and progress to a fairly well-sorted uniform average of 0.18 mm (2.50 Ø) at depths between 15 and 30 feet.

(c) Further South of Ludington Harbor. Average median diameters are about 0.31 mm (1.70 Ø) at the foreshore and shoreline, 0.22 mm (2.20 Ø) at the 5- and 10-ft contour depths, 0.19 mm (2.40 Ø) at the 15- and 20-ft depths, and 0.16 mm (2.60 Ø) at the 25- and 30-ft contour depths. Dune and bluff sands are somewhat finer than foreshore and shoreline sands, but are coarser than those on the lake bottom. Sorting in all positions is poor.

Detail calculations for the above can be found in a related report entitled, "U.S. Army Corps of Engineers Section 111 Detailed Project Report on Shore Damage at Ludington Harbor, Michigan," available from Detroit District, P.O. Box 1027, Detroit, Michigan 48231.

1.31 The U.S. Army Corps of Engineers utilizes the Unified Soil Classification System for interpretation of particle size systems. For clarity of above-described sand sizes, reference is made to the grain-size nomenclature values shown in Table 2. On the whole, bottom sands differ only slightly among the three stretches compared. Shore sands south of the harbor are distinctly coarser than those of the north. Also, shore sands near the south breakwater are coarser than those farther south. Moreover, proportions of coarse and sand fractions in shore and lake bottom sands north of the harbor are quite similar; southward of the harbor, the difference increases rather conspicuously from shore to off-shore.

1.32 During any of the aforementioned mitigation activities, the water quality will be monitored to insure minimal degradation. A responsible local agency (Municipal Water Department) will be requested to monitor the quality of lake water, in particular, water supplies entering the Ludington Municipal Water Works facilities. This monitoring will be initiated to protect against possible plant upsets and corresponding deterioration in distributed supplies. The established procedure will include Corps notification to the Michigan Department of Natural Resources of its intent to initiate the proposed mitigation action. Additionally, the Michigan Department of Natural Resources will be requested to coordinate the project at their level, i.e., with other appropriate State Agencies such as the Michigan Department of

TABLE 2. SIZE-NOMENCLATURE CLASSIFICATION OF SEDIMENT MATERIALS

VISUAL DESCRIPTION	DESCRIPTIVE DATA		
	Sieve Size	Diameter (mm)	Phi No. (ϕ)
Boulder	--	Large	--
Cobble	8 in.	203.2	--
Coarse Gravel	3 in.	76.14	-6.25
	1-½ in.	38.57	-5.25
	1 in.	25.38	-4.67
Fine Gravel	3/4 in.	19.03	-4.25
	1/2 in.	12.70	-3.67
	3/8 in.	9.52	-3.25
	#3	6.80	-2.77
Coarse Sand	#4	4.76	-2.25
	#8	2.38	-1.25
Medium Sand	#10	2.00	-1.00
	#20	0.84	0.25
	#30	0.59	0.75
Fine Sand	#40	0.42	1.25
	#50	0.297	1.75
	#70	0.210	2.25
	#100	0.149	2.75
	#200	0.074	3.75
Silt	--	0.05	4.32
	--	0.04	4.64
	--	0.03	5.05
	--	0.02	5.64
	--	0.01	6.64
Clay	--	0.005	7.64
	--	0.004	7.96
	--	0.003	8.38
	--	0.002	8.96
	--	0.0015	9.38

Health. As indicated, the Corps will coordinate its proposed action with the local community. On 11 December 1975, the proposed water quality monitoring program was discussed with Ludington City Manager, Mr. George Vondrak, and approval to initiate same, if and when the proposed mitigation plan is approved and implemented, was given. If any variation in acceptable standards occurs, notification of such will be given to the U.S. Army Corps of Engineers, Detroit District Office and/or the U.S. Coast Guard, at which time Corps mitigation activities will be immediately stopped until corrective action satisfactory to all parties concerned can be initiated.

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

Location and Topography

2.01 The federally maintained harbor at Ludington, Michigan is located along the east coast of Lake Michigan, approximately 153 miles northeast of Chicago, Illinois, and about 60 miles north of Muskegon, Michigan. The harbor channel connects Pere Marquette Lake to Lake Michigan, the former being the natural basin for the Pere Marquette River. The geographic relationship of this harbor to the general area is shown in Plate 1 of the previous section.

2.02 Lake Michigan has a surface area of about 22,300 square miles. It is approximately 307 miles long and 118 miles wide, with its main axis in a north-south direction. Its maximum depth has been recorded at 923 feet. The low water datum--an arbitrary plane to which elevations of the Lake are referred--is 576.8 feet above mean water level at Father Point, Quebec (International Great Lakes Datum, 1955). Lakes Michigan and Huron, connected by the deep and broad straits of Mackinac, act as one hydraulic unit with the same water level.

2.03 The average elevation of the Lake Michigan surface water varies irregularly from year to year. In general, the Lake surface is subject to seasonal fluctuations, with the lowest stages usually prevailing during the winter months and the highest during the summer months. For the 111 years from 1860-1971, the difference between the highest and the lowest monthly mean stages (581.94 feet in June of 1886, and 575.35

feet in March of 1964) was 6.59 feet. The greatest annual fluctuation based on the highest and lowest monthly means for the period of record was 2.23 feet (1943); the smallest annual fluctuation was 0.36 feet (1941). There are also oscillations of irregular amount and duration produced by storms and seiches. Such transient fluctuations may attain a 1.8-foot rise in water level at a frequency of once per year. At the present time, (June, 1975), the Lake water surface elevation is at 579.6 feet.

2.04 Pere Marquette Lake, separated from Lake Michigan by a narrow strip of land called the Buttersville Bar, has its axis in the general north-south direction. It is approximately two miles long and has an average width of about one-half mile. A considerable portion of the Lake is greater than 27 feet in depth with a maximum depth of 44 feet. Approximately 600 acres of marshlands border the southern and southeastern ends of the Lake into which the Pere Marquette River flows.

2.05 Coastal lands in the vicinity of Ludington are primarily residential. Numerous residential dwellings and summer cottages are clustered in a few areas such as Epworth Heights on the north and scattered locales on the south. On the whole, however, the area is not highly developed. Coastal parks in the vicinity include Ludington State Park and Stearns Park on the north, and Buttersville Park on the south. The Ludington Water Works facility is located about 2000 feet north of the harbor. Most of the shoreline is characterized either by erosional or accretional changes. The presence of groins, seawalls and rubble barriers are evidence of man's attempts to forestall these changes.

2.06 Big Sable Point is located about eight miles north of Ludington. Little Sable Point is situated about 27 miles to the south. Between the two lies the curved locus of the Lake Michigan shoreline. Eight miles south of the harbor the shoreline is oriented N5°W. North of this the shoreline curves westward. Directional shoreline orientations at the harbor and seven miles to the north are N13°W and N30°W, respectively.

Geomorphology

2.07 The geologic history of the Ludington area includes events common to other regions on the western shore of Lake Michigan. These events were marine transgressions, periodic uplift and erosion, evaporate formulation, and glaciation.

2.08 The Ice Ages, especially the latest one (which terminated 9500 years ago in Michigan), combined with post-glacial events of 2000-3000 years ago, were primarily responsible for the current topographical features and the extent of surface water in this region. About 4000 years ago, the combined effects of ice retreat and followup water level risings resulted in the flooding of the Pere Marquette River Valley and, hence, the complete submergence of the area now known as Ludington. During the next several hundred years, water levels fell and the shoreline of Lake Michigan receded. The result was the exposition of the Ludington area and the formation of the Buttersville Bar separating Pere Marquette Lake from Lake Michigan.

2.09 The bedrock underlying the northeastern part of Lake Michigan consists of a series of gently inclined sedimentary

rock formations. These rock formations are composed of limestone, gypsum, sandstone and shale. Overlying the bedrock is a mantle of unconsolidated sands, gravels and clays. In the immediate Ludington area contiguous to the shoreline, sandy lake bottom deposits are characteristic.

2.10 Soils in the Ludington area differ in accordance with slope, depth, texture, drainage and other characteristics. In general, the soil types can be classified as well drained, gently sloping to steep, moderately coarse and medium textured south of the Ludington Harbor and well drained, nearly level to steep north of the harbor. Soil borings have been taken in the inner harbor and channel areas, and the results indicate that the inner harbor turning area consists of predominantly fine sands of very loose to dense consistency. Soils in the inner channel are composed primarily of fine to coarse sands with subordinate and mixed gravel. Offshore soils, north of the harbor, consist of medium to fine sand underlain with blue, sandy clay.

2.11 Up to four lines of nearshore sandbars parallel the coast along shoreline stretches north and south of the harbor. The first three bars occur within about 900 feet of the shoreline and are situated at various depths down to about minus 15 feet (LWD basis). The fourth occurs about 2000 feet from shore at a depth of about 20 feet. Minor beaches exist along the Buttersville Bar and at the accreted fillets adjacent to the harbor; otherwise, they are nearly non-existent. The existing low dunal bluff north of the harbor is in direct contact with the waters of Lake Michigan. South of Buttersville Park, high (up to 250 feet) bluffs having a significant clay till composition plunge precipitously into the Lake.

2.12 Extensive shoals have developed off the offshore sections of both the north and south breakwaters. These shoals run parallel to the breakwaters. They are gently sloped across their 800- to 1000-foot widths and are more steeply sloped in front of and off the harbor entrance. The average depth of these formations is 17 feet.

Climate

2.13 The climate of Ludington is greatly influenced by Lake Michigan which acts as a vast reservoir for the storage and subsequent exchange of heat energy with the atmosphere. As the prevailing westerlies pass over Lake Michigan into Ludington, they are moderated in temperature. As a result, Ludington experiences slightly warmer winters and cooler summers compared to inland areas. The annual temperature for Ludington averages about 46.5°F. February is usually the coldest month (mean temperature 24.6°F), and July is generally the warmest (mean temperature 69.2°F). Extremely hot days are rare for this latitude, and temperatures above 90°F occur infrequently (usually 2-3 days per year on an average). Severely cold days (i.e., days of 0°F or less) occur at about the same average frequency. The highest temperature ever recorded at Ludington was 97°F on August 19, 1947. The lowest was -21°F on February 9, 1934.

2.14 Precipitation for the area averages 29.2 inches per year, with 55% of the total occurring from April through September. Heaviest amounts of rainfall occur in June and September, with averages of 3.10 and 3.00 inches, respectively. Local thunderstorms occur frequently in the summer months and account for the heaviest intensity of rainfall.

2.15 Although snowfall averages about 71.9 inches per year, there is wide variation from season to season. Measurable amounts are common from September through May, with the heaviest amounts occurring during December through February. A climatological summary for Ludington, Michigan is presented in Table 3.

Areal History

2.16 The first white explorer to visit the Ludington area was a French missionary named Pere Jacques Marquette. On May 18, 1675, he and his companions landed on the narrow peninsula (the Buttersville Bar) that divided Pere Marquette Lake from Lake Michigan. An historic shrine now stands there in his memory.

2.17 Despite Pere Marquette's early landing, the first white settlement did not come about until the late 1840's under the efforts of Burr Caswell. Sawmills were quickly set up, as the area was rich in timber. In 1873, Ludington was incorporated as a city. It was named after James Ludington--one of the most prominent men in the area--who, in addition to being the first large mill operator, owned all of the land incorporated into the original city plot. For 10 years he had planned the town, laying out streets and naming them after himself and his family. Upon his retirement in 1869, a group of prominent men purchased his interests and continued the development of the city.

2.18 Over the years, the abundant timber supplies were exploited to the point of critical depletion. By then, however,

TABLE 3 . SUMMARY OF CLIMATIC AVERAGES FOR LUDINGTON, MICHIGAN (1929-1958)

MONTH	MEAN TEMPERATURE (°F)	PRECIPITATION (inches)	SNOW, SLEET (inches)
January	24.7	2.20	17.5
February	24.6	1.74	12.8
March	32.0	1.78	7.7
April	43.5	2.51	2.1
May	53.4	2.57	0.1
June	63.5	3.10	0.0
July	69.2	2.25	0.0
August	68.2	2.71	0.0
September	60.9	3.00	T
October	51.1	2.58	7.5
November	38.5	2.76	7.1
December	28.4	2.01	12.9
Annual Average	46.5	29.21	71.9

its numerous natural attractions had earned it the reputation of being a coastal resort city. Today, Ludington is still somewhat of a summer resort. It also supports a substantial shipping industry, fruit production, certain manufacturing activities and, more recently, a pump storage facility for the production of hydroelectric power.

Harbor History and Description

2.19 Prior to 1867, a channel, seven feet in depth, connected Pere Marquette to Lake Michigan. The adoption of the River and Harbor Act of 1867 provided Federal assistance for improving the harbor and channel. Revetments and channel piers were constructed under this Act. The piers were later lengthened, and the connecting channel was dredged to a depth of 12 feet. Further improvements such as the construction of breakwaters, shore connections, and basin dredging were authorized by the River and Harbor Act of 1907. Completed by 1918, these changes provided the harbor with an 18-foot deep, outer exterior basin enclosed by breakwater arms 1800 feet in length, and attached to the shore by jettied connections measuring 1103 feet and 2004 feet on the north and south sides, respectively. Later (1927), the inner channel piers were shortened. Still later (1939), 100 feet of the south breakwater was removed. In August of 1965, private interest groups deepened the central 80 feet of the inner harbor channel to a 24-foot depth. Subsequent dredging modifications have since followed. Plate 9 depicts the harbor facility in its present state.

2.20 Incoming vessels enter the harbor through the 475-ft opening between the breakwaters and pass into the inner channel

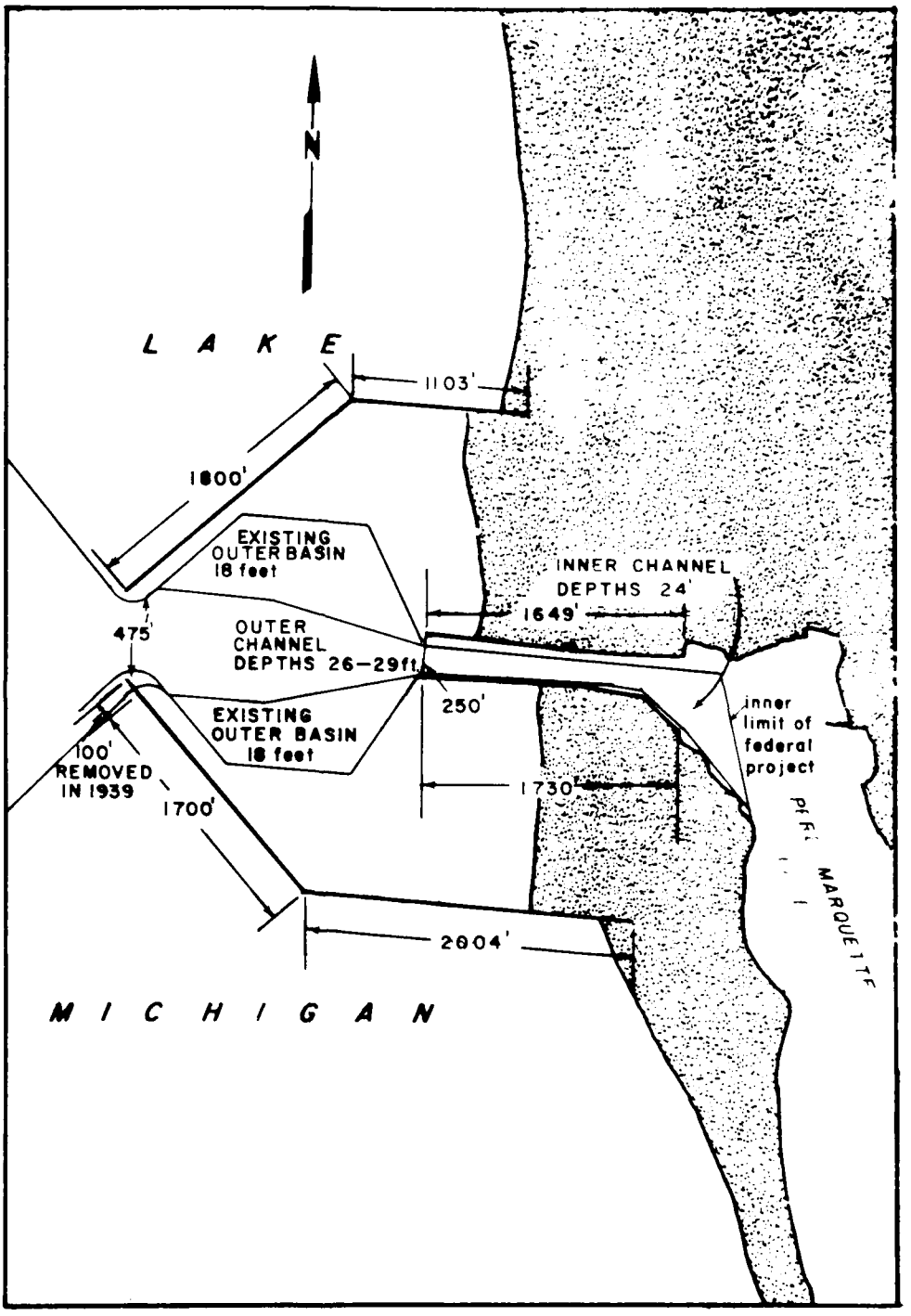


PLATE 9. LUDINGTON HARBOR STRUCTURES AND CHANNEL DIMENSIONS

1900 feet beyond. Entering the north end of Pere Marquette Lake, the vessels must maneuver a near right-angle turn to reach the harbor's docking facilities. The harbor entrance is maintained at a 29-ft depth inside the breakwater opening, a 25-ft depth at inner piers, and an average 24-ft depth within the inner channel.

Natural Resources

2.21 Petroleum, natural gas, limestone, shale, salt and brines are important natural resources which are extracted from bedrock formations in Mason County. Some of these, along with sands and gravels from glacial drifts, are obtained from areas in the immediate vicinity of Ludington. Also available are large supplies of groundwater. Typical wells are 8 inches or more in diameter and deliver water at flowrates of 100-500 gpm (gallons per minute).

2.22 Although agriculture is important to the economy of the Ludington area, its role in recent years has been declining. In 1959, farm products for Mason County were valued at $4.3 million. However, the value yielded by manufacturing in 1958 was four times as much. Dairy products, fruits, nuts and livestock were the principle farm commodities produced.

2.23 The nationwide trend in agriculture has been toward fewer but larger, more mechanized farms. The result has been a decline in farm employment. Census information for the State of Michigan indicates that:

(a) Marginal farm lands are being removed from production;

(b) Small farms are consolidating into larger farms;

(c) Average value per farm, including lands and buildings, is increasing;

(d) More and more farmers are working off their farms.

There are also indications that many farmers have given up the practice and have moved to Ludington and other small towns in the area to take up new trades.

Socio-Economic Resources

2.24 Demography. Mason County is one of the more sparsely populated regions in the State of Michigan. Among the 83 counties which comprise the state, Mason ranks fiftieth in size of population. While the state grew at a rate of 22.8 percent from 1950 to 1960, Mason County grew only 7.1 percent. The 1960-1970 decade produced smaller growth rates for both the state and county at 13.4 and 3.1 percent, respectively.

2.25 Between 1950 and 1970 the population growth in Mason County resulted from a natural increase (excess of births over deaths) rather than net migration (see Table 4). In fact, for both the 1950-1960 and 1960-1970 decades, Mason County experienced a net migration loss, i.e., more people have left

TABLE 4. COMPONENTS OF POPULATION GROWTH (1950-1970)

AREAL UNIT	TOTAL GROWTH	NATURAL INCREASE*	NET MIGRATION ABSOLUTE RATE
1950-1960			
Mason County	1,455	2,382	-927 (-4.5%)
Michigan	1,451,428	1,295,257	+156,171 (+2.5%)
1960-1970			
Mason County	683	1,225	-542 (-2.5%)
Michigan	1,051,889	1,041,697	+27,236 (+0.3%)

*Births minus deaths

Source: U.S. Bureau of the Census, Current Population Reports, Series P-23, No. 7, November, 1962.
U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 461, June, 1971

the county than have entered. The facts suggest that Mason County is losing population due to its inability to support its local inhabitants. Consequently, the population is migrating elsewhere to find employment.

2.26 The bulk of the population growth within Mason County has taken place outside the political boundaries of the city of Ludington (the largest incorporated city in the county). Ludington has experienced a decline in population for the periods 1950-1960 and 1960-1970. The former period witnessed a loss of 0.9 percent for the city while the remainder of the county grew at 14 percent. The succeeding decade produced a larger loss for the city (4.2 percent) and a smaller growth for the remainder of the county (8.7 percent). While the population of the city has declined, the adjacent townships have been growing. From the figures in Table 5, it can be seen that the increases in the population of townships exceed the decreases in the city population. It could therefore be concluded that the Ludington vicinity has not in fact lost population; the growth has simply shifted to the adjacent suburbs. Yet, even with the apparent shifts in settlement patterns, Ludington remains the source of employment, shopping, cultural events, recreational and educational facilities, and all other amenities that make an area attractive.

2.27 Industrial Activity. Today, Ludington is primarily an industrial city. The 1970 Census reported that nearly 35 percent of the resident labor force was involved in manufacturing. While the city experienced only a modest employment growth of 6.1 percent during the period 1960-1970 (see Table 6), the manufacturing sector increased by 20.3 percent for the

TABLE 5 . POPULATION TRENDS (1950-1970)

AREA	YEAR			PERCENT CHANGE	
	1950	1960	1970	1950-1960	1960-1970
State of Michigan	6,371,766	7,823,194	8,875,083	22.8	13.4
Mason County	20,474	21,929	22,612	7.1	3.1
Ludington	9,506	9,421	9,021	-0.9	-4.2
Amber Township	887	1,060	1,278	19.5	20.6
Hamlin Township	930	1,468	1,778	57.8	21.1
Pere Marquette Township	1,032	1,513	1,846	46.6	22.0

TABLE 6. INDUSTRIAL EMPLOYMENT
LUDINGTON, MICHIGAN (1960-1970)

INDUSTRY	NUMBER OF EMPLOYEES AGE 16 YRS. AND OVER		PERCENT CHANGE
	1960	1970	1960-1970
Construction	108	153	41.7
Durable Goods	619	857	38.4
Manufacturing	1021	1228	20.3
T.C.U.S.S.[a]	496	404	-18.5
Wholesale and Retail Trade	750	607	-19.1
F.I.B.R.S.[b]	371	111	-70.1
Professional and Related Services	361	627	73.7
Public Administration	85	177	108.2
Other Industries[c]	112	199	77.7
TOTAL	3304	3506	6.1

(a) Transportation, Communication, Utilities and Sanitation
(b) Finance, Insurance, Business, & Repair Services (includes
(c) Entertainment, personal and recreational services)
Includes those industries "not reported"

Source: U.S. Bureau of Census, 1960 and 1970 Census of Population

same period. Durable goods increased by 38.4 percent while non-durable goods (total manufacturing minus durable goods) actually decreased during this period.

2.28 At present, Ludington has 36 manufacturers of diversified products. Some of the larger manufacturing firms (85 or more employees) in Ludington include:

- Dow Chemical Company (chemicals)
- Atkinson Manufacturing Company (tool & security boxes)
- Great Lakes Casting Corporation (gray iron castings)
- Handy Things Manufacturing Company (housewares)
- Harbison-Walker Refractories Company (refractory magnesite)
- Jackson Vibrators, Inc. (concrete machinery)
- Howell Wire Products, Inc. (welded wire products)
- Star Watch Case Company (watchcases, stamping)

2.29 Large increases of industrial employment for the same period have taken place in the public administration sector (108.2%), professional and related services (73.7%), and the construction industry (41.7%) (see Table 6). On the other hand, the finance, insurance, business and repair services' sector decreased by 260 employees, representing a loss of 70.1%.

2.30 The future appears promising for industrial development, especially in the chemical field. Ludington is in the heart of

the rapidly developing chemical industry, with unlimited salt brine natural resources. Additional growth is presently underway with the existing chemical companies and new industries expanding in order to take advantage of local chemical products. This potential development is further enhanced by the city's excellent rail, bus, truck, air, and ship facilities which allow readily accessible means of product transportation.

2.31 Waterborne Commerce. The Ludington Harbor, which is among the finest and safest on Lake Michigan, is vital to the industrial, commercial, and recreational activities of the area. The volume of waterborne commerce for the period 1955-1972 was close to four million tons annually (see Table 7). Approximately 75 percent of this amount consisted of various commodities and raw materials which were traffic by auto/train ferry traffic. The balance, consisting mostly of coal and limestone receipts, was transported by deep-draft vessels. The total commerce and tonnages carried by auto/train ferry and vessel traffic during the period 1955-1972 are presented in Table 7.

2.32 The primary commodities transported through the harbor by deep-draft vessels for the period 1955-1972 were limestone and coal (see Table 8). The miscellaneous commodities included sand and ground rock, steel mill products, and slag. Fresh fish was not included after 1956.

2.33 Vessel transport of goods will likely increase in future years, resulting in an increase in the harbor's commercial value. However, auto/train ferry traffic will continue to transport a greater percentage of the total tonnage. The prospective increase in vessel commerce is expected to be associated mainly with the

TABLE 7 . WATERBORNE COMMERCE AT LUDINGTON HARBOR
1955 THROUGH 1972 (Short Tons)

YEAR	TOTAL LAKE[3] COMMERCE	AUTO/TRAIN FERRY[2] TRAFFIC	VESSEL TRAFFIC
1955	3,602,919	3,219,710	383,209
1956	3,860,395	3,294,551	565,844
1957	3,541,359	3,103,827	437,532
1958	3,504,549	2,965,624	538,925
1959	3,838,473	3,146,170	692,303
1960	3,892,300	3,105,714	786,594
1961	3,588,858	2,867,587	721,271
1962	3,686,435	2,846,015	840,420
1963	3,843,407	2,964,761	878,646
1964	3,904,089	2,997,600	906,489
1965	3,978,708	3,093,026	885,682
1966	3,969,311	3,120,001	849,310
1967	3,836,254	2,904,195	932,059
1968	3,639,093	2,744,747	884,346
1969	3,664,748	2,699,231	965,517
1970	4,643,609[1]	2,698,951	1,944,658
1971	4,258,442	1,910,507	2,347,935
1972	3,368,015	1,761,376	1,606,639
10-Yr. Average 1963-1972	3,910,568	2,689,440	1,220,128

1) Plus approximately 681,140 tons received by Consumers Power Company for a large construction project which was completed in 1973.
2) Source: Chesapeake & Ohio Railway Company, 1965-1972.
3) U.S. Department of the Army, Corps of Engineers, "Waterborne Commerce of the United States, Part 3, Waterways and Harbors, Great Lakes, 1965."

TABLE 8 . LAKE VESSEL COMMERCE AT LUDINGTON HARBOR (1955-1972)
(Short Tons)

YEAR	TOT. LAKE COMMERCE	COAL	LIMESTONE	MISC.	SHIPMENTS CHEMICALS (b)
1955	383,209	98,629	247,299	37,281	--
1956	565,844	230,548	315,626	19,670	--
1957	437,532	118,703	288,684	30,145	--
1958	538,925	144,654	382,288	11,983	--
1959	692,303	205,067	461,950	25,286	--
1960	786,594	192,067	551,036	28,891	14,600
1961	721,271	139,681	555,007	12,333	14,250
1962	840,420	220,387	584,787	6,298	28,948
1963	878,646	178,064	658,618	21,726	20,238
1964	906,488	199,400	664,609	4,565	37,914
1965	886,000	NA	410,000	NA	70,000
1966	849,000	NA	560,000	NA	70,000
1967	932,000	NA	650,000	NA	40,000
1968	884,000	NA	590,000	NA	80,000
1969	966,000	NA	722,000	NA	110,000
1970	1,945,000	NA	1,551,757	NA	130,000
1971	2,348,000	NA	2,149,444	NA	120,000
1972	1,607,000	(a)	1,465,381	NA	140,000
10-Year Avg. 1963-1972	1,220,213		942,181		

(a) Shipments discontinued in 1972

(b) Source: Dow Chemical Company

transporting of coal, limestone and industrial chemicals. In view of the amount of land and number of dock sites available along the shores of Pere Marquette Lake, as well as the area's excellent rail connections, more new industry and waterborne commerce may be attracted to Ludington than is currently expected.

2.34 Prospective increases of fuel oil and limestone receipts through 1990 are indicated by the Dow Chemical Company. Also, total vessel shipments are expected to increase during this period. Slightly more than one-third of this outbound commerce will continue to be moved by bulk carriers, with the remaining tonnage being handled by tankers. It is expected that by 1990 annual inbound vessel traffic associated with Dow Chemical alone will be about 284,000 tons of fuel oil and 1,128,000 tons of limestone. It is also expected that outbound self-unloading vessel traffic will include 228,000 tons of industrial chemicals. Table 9 indicates the projected tonnages in five-year increments for the Dow Chemical Company.

2.35 Recreation. The coastal environment of Ludington supports considerable recreation activity. The harbor provides a haven for recreational boating, including both powered boats and sailboats. A launching facility north of the inner channel, owned jointly by the City of Ludington and Michigan Department of Natural Resources, is used both by pleasure boaters and fishermen. Canoeing and rowboating are popular in the Pere Marquette River; however, neither the harbor nor Lake Michigan beyond offer suitable conditions for these activities. The City of Ludington plans to build an ice-free marina on the northwest

TABLE 9. PROSPECTIVE LAKE VESSEL COMMERCE *
LUDINGTON, MICHIGAN (1975-1990)
(Short Tons)

YEAR	RECEIPTS			SHIPMENTS		
	Tanker (Fuel Oil)	Limestone	Total	Bulk Carrier	Tanker	Total
1975	194,000	768,000	962,000	100,000	200,000	300,000
1980	224,000	888,000	1,112,000	185,000	370,000	555,000
1985	254,000	1,008,000	1,262,000	228,000	457,000	685,000
1990	284,000	1,128,000	1,412,000	228,000	457,000	685,000

*For Dow Chemical Co. at Ludington, Michigan
Source: Dow Chemical Company

side of Pere Marquette Lake. Subsequently, recreational use of the harbor is expected to increase.

2.36 Recreational fishing is very popular, especially since the recent introduction of Coho Salmon into Lake Michigan. Between April first and mid-November, both the north and south breakwaters are extensively used by fishermen and sightseers. In August of 1972, the City of Ludington sponsored a Coho derby which was well received and has become an annual event. Anglers used the area between Big and Little Sable Points extensively, as well as the breakwaters.

2.37 In addition to the recreational appeal of the harbor, a famous summer resort--Epworth Heights Assembly--overlooks Lake Michigan from bluffs and dunes about two miles north of Ludington. This Methodist retreat includes 225 cottages, several recreational and service facilities, and offers excellent outdoor activities such as boating, swimming, golf and tennis.

Shore Description

2.38 To facilitate discussion, the coastal environment in the vicinity of Ludington has been divided into six reaches (see Plate 10). From north to south, they are:

(1) Reach #1: Hamlin Lake Outlet to Lincoln Lake Outlet
(2) Reach #2: Lincoln Lake Outlet to Orchard Drive
(3) Reach #3: Orchard Drive to Fitch Street
(4) Reach #4: Fitch Street to Ludington North Pier

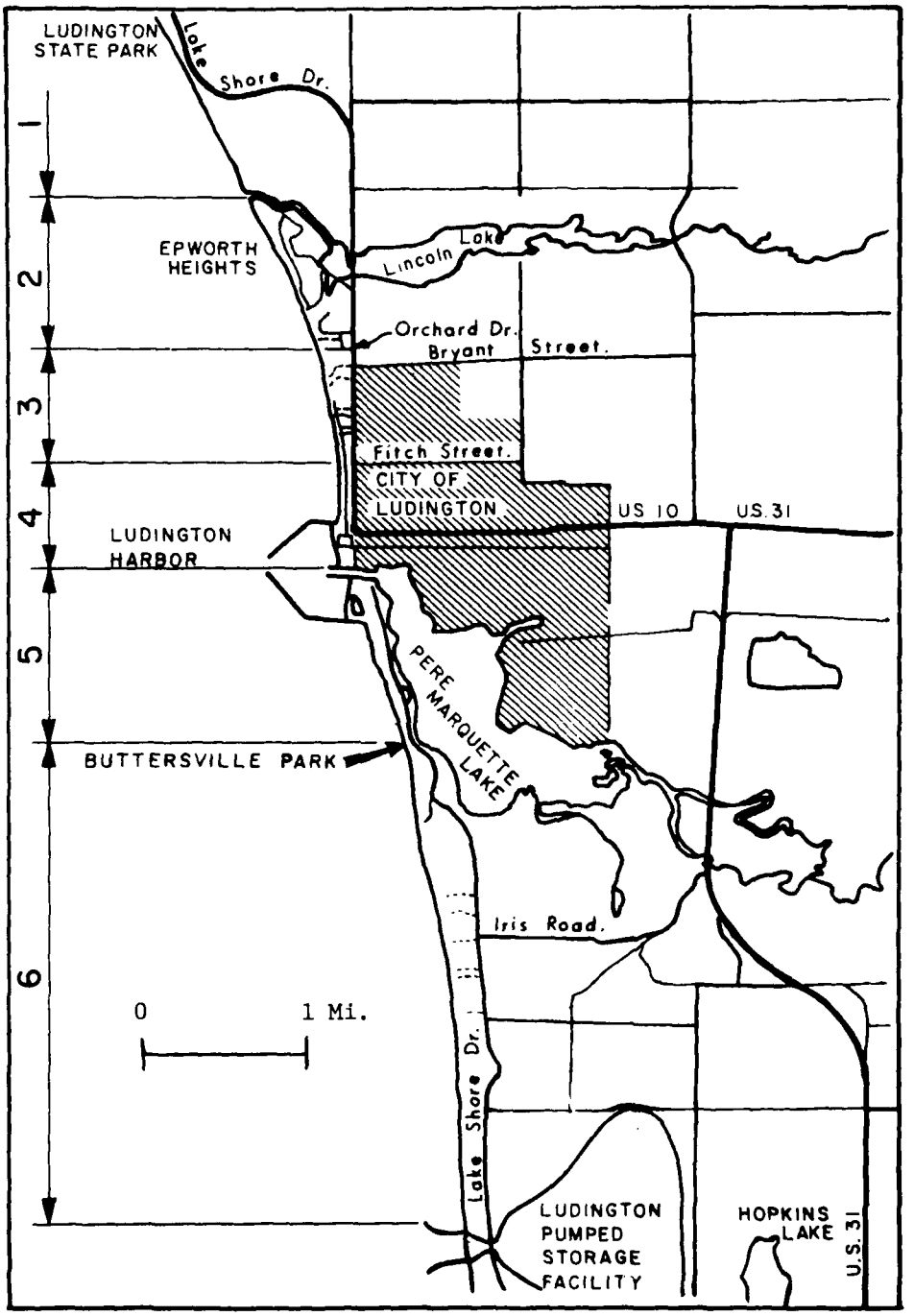


PLATE 10. **Definition of Shoreline Reaches near Ludington Harbor**

(5) Reach #5: Ludington South Pier to Buttersville Park

(6) Reach #6: Buttersville Park to the Ludington Pumped Storage Facility

2.39 The first reach, approximately 3.5 miles long, is characterized by a low bluff which descends in height from about 20 feet in the north to only 6 feet in the south. The existing beaches in this reach are very narrow. The bluff and the beaches are composed of fine to medium sand. Aside from Highway M-116, which runs parallel and close to the crest of the bluff, there is very little development in this coastal stretch. The large number of groins (some as long as 100 feet) in this reach is an indication of a human attempt to mitigate the erosion problem. Yet, for the past 20 years, the annual rate of erosion in this area has been from one to two feet. The sparse vegetative cover has aggravated the condition by allowing the development of numerous blowouts.

2.40 The second reach, covering a distance of 1.1 miles, contains the residential area known as Epworth Heights. There are no beaches in this area; however, the low bluff adjacent to the shoreline is the setting for a large number of residential and recreational structures. An old wooden seawall, which once protected these structures, was replaced in 1972 by a steel sheet pile wall. This seawall, which has been effective in preventing further retreat of the shoreline, has safeguarded this area from severe damage. Observations made from aerial photographs reveal that shoreline accretion has prevailed in this reach over the past 20 years. However, this is largely the result of human actions (i.e., lakeward additions of protective works) rather than natural causes.

2.41 The coastal environment of the third reach encompasses only 0.7 miles of shoreline and is similar to the area immediately north. The low lakeward bluff (up to 20 feet high), which is in direct contact with the lake, is a fully developed residential area. An old seawall-groin system (which is in poor condition) is located just south of Orchard Drive. Observations reveal that this reach has been accreting, but this is largely the result of artificial filling.

2.42 Approximately one-half mile in length, the fourth reach includes the Ludington Water Works at Fitch Street; a public park between the Water Works and the north breakwater; and a boat launching facility, a park, and a public parking area between the breakwater and the north pier. Being void of vegetation, this reach requires reshaping annually to redistribute the sand which is constantly drifting. The beaches range from none at all at the north end to about 70 feet at the breakwater. The park area has also been mechanically reshaped to provide a fairly uniform slope from the park road to the beach. The paved parking lot area and the boat launching facility have been subject to wave and ice damage. Over the past decade, rising lake levels have been responsible for an apparent landward retreat of the shoreline. In actuality, this area has shown a steady pattern of accretion since the construction of the navigation structures. Moreover, this trend is presently continuing.

2.43 The Buttersville Bar (Reach #5) extends from Buttersville Park into the southern portion of the outer harbor. This coastal reach, about one mile in length, is characterized by low bluff formation which varies in height from three to four

feet near the south pier to about 20 feet one mile southward. While a fairly good vegetative layer covers the bluff, its near-vertical slope is essentially barren. The top of this low bluff has become the setting for a moderately dense residential development. A narrow beach, about 20 feet wide, spans this entire reach. The bluffs and the beach are composed of fine to medium sand, with some gravel along the bermline. There is minor evidence of erosion along this reach, primarily at the southward end whereat several short Z-groin barriers have been placed. In general, the rate of bluff retreat does not appear to be severe. The beach between the south pier and south breakwater is only about 10-20 feet wide and undergoes minor change due to wave action. As in the previous reach, this area is showing signs of ever-continuing accretion, even though the apparent shoreline is retreating due to the rising lake level trend. Except for Government-owned land along the south pier and revetment, this area has been leveled and plotted, and lots have been offered for sale. No construction has taken place as of the present time (June, 1975).

2.44 The sixth reach (from Buttersville Park to the Ludington Pump Storage Plant) is about 2.7 miles in length and is characterized by sand and clay till bluff ranging from 50 to 250 feet in height. This shoretype extends for some distance beyond the southern limit of the reach and is cut by deep "V" shaped ravines where runoff streams enter the lake. The low lakeward bluff found to the north is no longer present, and there is little or no beach. Existing high bluffs are presently being undermined at the toe, and extensive sloughing of the slope is in progress. While vegetation in quite abundant on the crest of the bluffs, the slopes are generally bare. However,

there are short reaches where the slope supports a floral community; these appear to be stable. At the southern end of this reach the rubble mound jetties of the pump storage facility extend about 1500 feet out from the shore, ending in about 22 feet of water. A rubble mound breakwater, about 2200 feet offshore in 32 feet of water, is located across the opening between the jetties. Observations from aerial photographs indicate that erosion rates have averaged 3-5 feet per year over the past 20 years. Recently, there has been considerable accretion of sediments in the fillets on the north and south sides of the pumped-storage facility structures.

Shoreline Processes

2.45 The predominate characteristic of the Lake Michigan coastal environment in the vicinity of Ludington Harbor is its ever-changing nature due to the forces of wind and wave action, changing water elevations, ice abrasion, and littoral drift. Wave action is variably dependent on local and seasonal climatic changes. Although the lake has no tide, the water level fluctuates in response to long-term rainfall, seasonal snowmelt and short-term meteorological effects.

2.46 The formation of ice in Lake Michigan begins about the last week of January and continues until mid-March. Depending on the severity of the winter, the ice coverage will range from consolidated ice packs to open and closed packs. Variations are in rapid response to current and changing wind conditions. Acting as a wave absorber, the ice dissipates wave energy before it reaches the beach. Shifting ice abrades the beach and has

been known to cause damage to shore protective structures. In Ludington Harbor, winter conditions usually produce only minor ice problems. Although the harbor between the breakwater entrance and the inner channel piers is usually free of ice, westerly winds occasionally cause ice to drift into the outer harbor and eventually between the inner channel piers. Even with this situation, disturbance to vessel traffic is not major. Car ferries, which are the only vessels to make use of the harbor in winter, can usually break through the ice masses and push them aside. As winter progresses, however, this becomes increasingly more difficult to accomplish, primarily because of the counterforces exerted by floe piles which have gradually built up along the channel margins.

2.47 Littoral transport in this area is predominantly southward during the winter and northward during the summer. These are variable on a per-time basis as is shown by the monthly fluctuations depicted in Plate 11. Large waves produce the southern drift and more sand is transported south. In the absence of obstructions, the normal to-and-from beach supply equilibrium would prevail along all segments of the shoreline. On the average, the annual southward drift exceeds the northward drift by 56,000 cubic yards of material.

Influence of the Navigation Structure on the Shoreline

2.48 Since the construction of the outer structures of Ludington Harbor, northerly and southerly drift movements have been impeded. Studies have revealed that variable quantities of drift material from both sides of the harbor are being diverted lakeward each year. Approximately 42,500 cubic yards

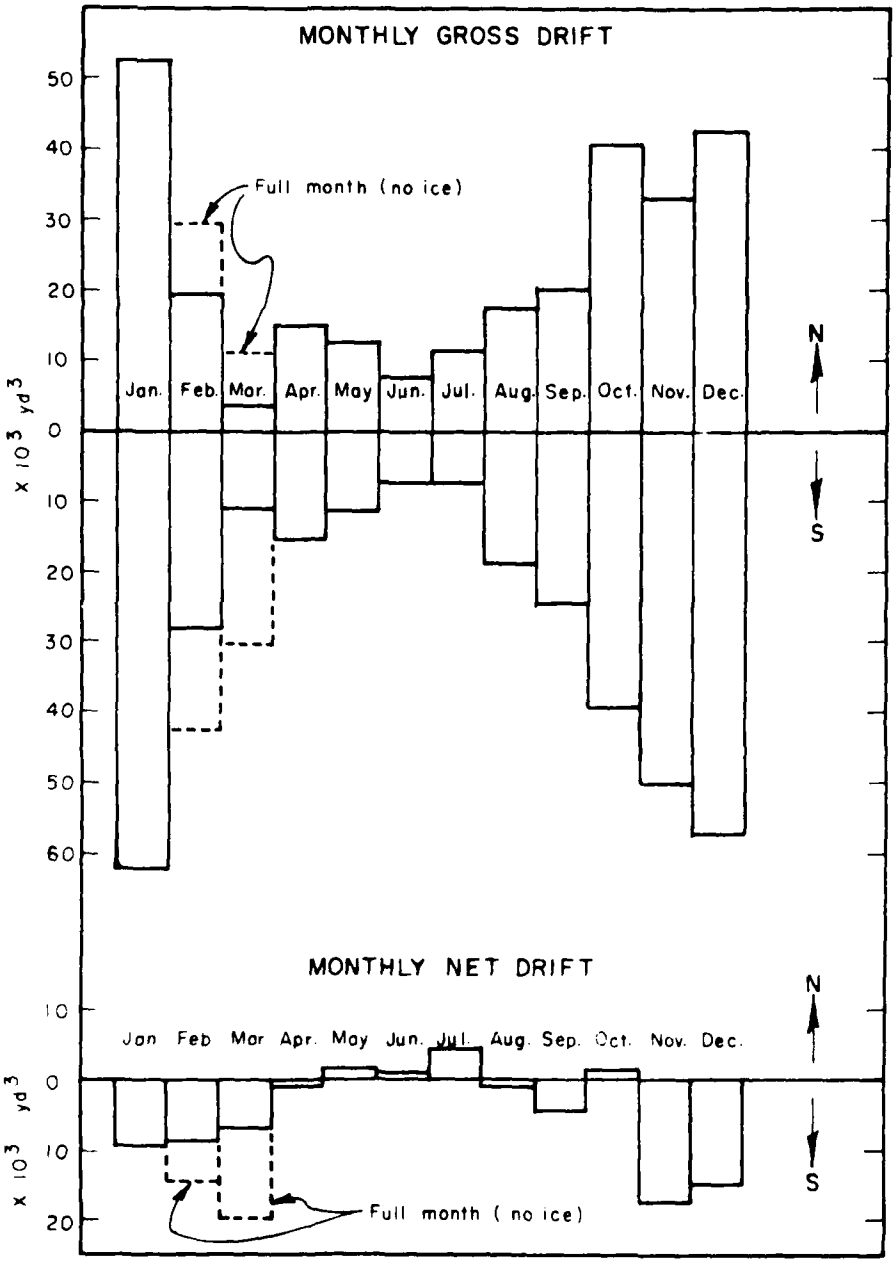


PLATE 11. MONTHLY VARIATION OF COMPUTED GROSS AND NET LITTORAL DRIFT AT LUDINGTON, MICHIGAN

of this diverted material are trapped annually by the harbor. Until now, these accumulations have been dredged on an annual basis and transported to deeper parts of the lake for dumping. Consequently, most, if not all, of this material is permanently removed from the littoral supply.

2.49 As a result of the harbor structures' interruption of the littoral drift pattern and the subsequent lakeward diversion of these materials, various segments of the shoreline in the vicinity of Ludington are deprived of normal supplies. Over the years, this has resulted in extensive erosion of beaches and bluffs located south of Buttersville Park. Beach segments north of the harbor are similarly deprived, but to a lesser extent than those on the south. Associated erosive conditions have been halted, however, as a direct result of man's intervention. Examples of eroded and accreted areas and past efforts to counter erosion are shown in Plates 12 and 13.

Shoreline Ecology

2.50 In compliance with the Federal Water Pollution Control Amendment of 1972 (P.L. 92-500, Section 316), the Michigan Water Resources Committee of the Michigan Department of Natural Resources has developed a series of geographic zones for the State based on biotic community associations. Ludington and contiguous areas are in zone #2, which extends from the Oceana and Mason County line northward to the confluence of Lake Michigan and Lake Huron. This zone is classified as a northern

View Looking North from a Point Located about 5,300 feet North of the Outer Breakwater

View Looking North from a Point Located about 6,200 feet North of the Outer Breakwater

View Looking South from a Point Located about 7,300 feet North of the Outer Breakwater

View Looking North from a Point Located about 7,300 feet North of the Outer Breakwater

PLATE 12. View Showing Shoreline Conditions to the North of Ludington, Michigan, taken in November 1974.

View to the South
from Buttersville Park

Bluff Erosion
Near Rohrmoser Road

View to the North
from Buttersville Park

PLATE 13. Views Showing Shoreline Condition to the South of Ludington, October 1974

hardwoods-conifer ecotone consisting of maple (*Acer nigrum*), beech (*Fagus grandifolia*), and hemlock (*Tsuga canadensis*). Both the quacking aspen (*Populus fremuloides*) and the bigtooth aspen (*Populus grandidentata*) are also present.

2.51 The sediment environment of the shoreline of Lake Michigan in the vicinity of Ludington consists of fine sand. That of Pere Marquette Lake consists primarily of mud. The faunal assemblage of the benthos consists of a number of species of oligochaete worms (families Lumbriculidae and Tubificidae) and insect larvae of the dipteran family Chironomidae (midges). Data on diversity and productivity of benthic organisms appear to be lacking. Benthic algal productivity is apparently very low and consists of a few species of benthic diatoms associated with stable environs such as boulder substrates. Freshwater clams, snails, and mayfly larvae are also representative members of the benthic community in this area.

2.52 Data on the biomass or productivity in the aquatic environment around Ludington also appear to be lacking. However, it is known that most of the primary producers are pelagic and benthic diatoms, flagellated protozoans, and green algae. The zooplankton population consists of cladocerans, cyclopoid and calanoid copepods, amphipods (scuds) and numerous insect larvae.

2.53 The Ludington Harbor area is a popular place for fishing. A variety of fish species populate both Lake Michigan and Pere Marquette Lake in the Ludington vicinity. Some are permanent residents, while others are seasonal or migratory (see Table 10). Steelhead trout (*Salmo gairdneri gairdneri*) populate the

TABLE 10. FISHES OF LAKE MICHIGAN IN THE VICINITY OF LUDINGTON (From "Representative Important Species," Michigan Water Resources Commission, July 25, 1974)

SCIENTIFIC NAME	COMMON NAME	STATUS
Acipenser fulvescens	Lake sturgeon	TE
Catostomus commersoni	White sucker	C
Catostomus catostomus	Longnose sucker	C
Alosa pseudoharengus	Alewife	C
Coregonus artedii	Lake herring	TE
Coregonus reighardi	Shortnose cisco	TE
Coregonus zenithicus	Shortjaw cisco	TE
Coregonus kiyi	Kiyi cisco	TE
Coregonus clupeaformis	Lake whitefish	C
Coregonus hoyi	Bloater	TE
Cottus cognatus	Slimy sculpin	C
Cottus bairdi	Mottled sculpin	C
Cyprinus carpio	Carp	C
Notropis hudsonius	Spottail shiner	C
Notropis atherinoides	Emerald shiner	C
Lota lota	Burbot	C
Pungitius pungitius	Ninespine stickleback	C
Osmerus esperlanus	Rainbow smelt	C
Perca flavescens	Yellow perch	C
Percina caprodes	Logperch	C
Percopsis omiscomaycus	Troutperch	C
Salvelinus namaycush	Lake trout	C
Salmo gairdneri	Rainbow smelt	C
Salmo trutta	Brown trout	C
Oncoryhnchus kisutch	Coho salmon	C
Oncoryhnchus tschawytscha	Chinook salmon	C
Salmo salar	Atlantic salmon	C
Micropterus dolomieui	Smallmouth bass	C
Prosopium cylindraceum	Round whitefish	C
Stizostedion vitreum	Walleye	C
Esox lucius	Northern pike	C

C= Common

TE= Threatened or endangered

Pere Marquette River and Lake as do brown trout (*Salmo trutta*). Two recently introduced species, coho and chinook salmon (*Oncorhynchus kisutch* and *O. tschawytscha*), enter Pere Marquette Lake from Lake Michigan. Walleye (*Stizostedion vitreum*) and northern pike (*Esox lucius*) also populate both lakes. Of those species listed for the area, six have been recorded as threatened or endangered, two of which are of commercial value (lake herring and bloater).

2.54 The beach area in the vicinity of Ludington consists of littoral sand dunes classified as Big Sable Dune Shoretype. These dunes are composed of vast expanses of shifting sand. Consequently, few organisms are permanent residents in this shoreline environment, although various species of birds forage for food and/or nest in the area.

2.55 The terrestrial region contiguous to the beach consists of heavily vegetated and forested areas composed predominantly of those trees listed under Section 2.53 and a variety of shrubs such as beach grass (*Ammophilia breviligulata*) and sand cherry (*Prunus pumila*). Numerous other plant species occur in the area and may constitute dominant influences in certain localized regions. The immediate project area is relatively open and affords little food and cover for wildlife. No coastal marshlands exist in this area to provide cover and nesting accommodations for ducks. Inland marshes do exist along the southern boundary of Pere Marquette Lake. These support waterfowl and numerous other bird species.

2.56 The birds of the Ludington area comprise two groups--those which are permanent residents (Table 11) and those which migrate and/or form temporary breeding colonies in the area

TABLE 11. LIST OF BIRDS THAT STAY THE YEAR ROUND IN THE LUDINGTON AREA

SCIENTIFIC NAME	COMMON NAME
Colinus virginianus	Bobwhite quail
Bonasa umbellus	Ruffed grouse
Phasianus torquatus	Long-necked pheasant
Philohela minor	Woodcock
Larus argentatus	Herring gull
Larus delawarensis	Ring-billed gull
Strix varia	Barred owl
Bubo virginianus	Great horned owl
Otus asio	Screech owl
Aegolius acadicus	Saw-whet owl
Melanerpes erythrocephalus	Red-headed woodpecker
Dendrocopos pubescens	Downy woodpecker
Dendrocopos villosus	Hairy woodpecker
Cyanocitta cristata	Blue jay
Corvus brachyrhynchos	Crow
Parus atricapillus	Black-capped chickadee
Parus bicolor	Tufted titmouse
Sitta carolinensis	White-breasted nuthatch
Sitta canadensis	Red-breasted nuthatch
Certhia familiaris	Brown creeper
Troglodytes troglodytes	Winter wren
Regulus satrapa	Golden-crowned kinglet
Bombycilla cedrorum	Cedar waxwing
Lanius excubitor	Northern shrike
Sturnus vulgaris	Starling
Passer domesticus	House sparrow
Pheucticus ludovicianus	Rose-breasted grosbeak
Hesperiphona vespertina	Evening grosbeak
Carpodacus purpureus	Purple finch
Spinus tristis	Goldfinch
Acanthis flammea	Common redpoll
Spinus pinus	Pine siskin
Junco hyemalis	Slate-colored junco

(Table 12). Both tables list only birds which are associated with the sand dune regions and marshlands around Ludington. A total of 95 of the more common representative species are listed in Tables 11 and 12.

2.57 A total of 35 species of mammals (exclusive of the bats) are recorded for the Ludington area. These are listed in Table 13. Of these, eight are listed as endangered forms, many of which may no longer be found in the Ludington vicinity (Long, C.A., 1974).

2.58 The Fisheries Division of the State of Michigan Department of Natural Resources (MDNR) has recently indicated that any proposed dredging action should be scheduled so as not to conflict with perch spawning, salmon migrating, and various fishing activities. In this regard, projects implemented prior to late May or early June would have the least impact. It is anticipated that both the initial establishment phase and subsequent periodic nourishment operations will be carried out in late spring or early summer and <u>will not</u> affect or impact any threatened, rare, or endangered species of fish and wildlife within or near the project boundaries.

<u>Water Quality</u>

2.59 The water quality in the vicinity of Ludington is affected by the nutrients and organic material loadings from several sources including the Pere Marquette River watershed, the City of Ludington Sewage Treatment Plant, and industrial waste discharges. In spite of these factors, the waters of Lake

TABLE 12. LIST OF BIRDS THAT ARE SEASONAL RESIDENTS OF THE LUDINGTON AREA (Nesting or Migratory)

SCIENTIFIC NAME	COMMON NAME
Dryocopus pileatus	Pileated woodpecker
Tyrannus tyrannus	Eastern kingbird
Myiarchus crinitus	Great crested flycatcher
Riparia riparia	Bank swallow
Progne subis	Purple martin
Troglodytes aedon	House wren
Dumetella carolinensis	Catbird
Toxostoma rufum	Brown thrasher
Turdus migratorius	Robin
Hylocichla mustelina	Wood thrush
Hylocichla guttata	Hermit thrush
Hylocichla minima	Gray-checked thrush
Hylocichla fuscescens	Veery
Sialia sialis	Bluebird
Mniotilta varia	Black-and-white warbler
Dendroica petechia	Yellow warbler
Dendroica caerulescens	Black-throated blue warbler
Dendroica fusca	Blackburnian warbler
Seiurus aurocapillus	Ovenbird
Sturnella magna	Meadowlark
Agelaius phoeniceus	Redwinged blackbird
Icterus spurius	Orchard oriole
Icterus galbula	Baltimore oriole
Cyphagus cyanocephalus	Brewer's blackbird
Molothrus ater	Brownheaded cowbird
Quiscalus quiscula	Grackle
Piranga olivacea	Scarlet tanager
Passerina cyanea	Indigo bunting
Spizella arborea	Tree sparrow
Spizella passerina	Chipping sparrow
Zonotrichia leucophrys	White-crowned sparrow
Zonotrichia albicollis	White-throated sparrow
Passerella iliaca	Fox sparrow
Plectrophenax nivalis	Snow bunting
Sterna hirundo	Common tern
Coccyzus americanus	Yellow-billed cuckoo
Coccyzus erythropthalmus	Black-billed cuckoo
Nyctea scandiaca	Snowy owl
Caprimulgus vociferus	Whip-poor-will

Continued Next Page

TABLE 12 (Cont'd) LIST OF BIRDS THAT ARE SEASONAL RESIDENTS OF THE LUDINGTON AREA (Nesting or Migratory)

SCIENTIFIC NAME	COMMON NAME
Chordeiles minor	Common nighthawk
Archilochus colubris	Ruby-throated hummingbird
Megaceryle alcyon	Belted kingfisher
Colaptes auratus	Yellow-shafted flicker
Aix sponsa	Wood duck
Aythya collaris	Ring-necked duck
Aythya americana	Redhead
Aythya valisineria	Canvasback
Ardea herodias	Great blue heron
Casmerodius albus	Common egret
Chen hyperborea	Snow goose
Chen caerulescens	Blue goose
Branta canadensis	Canada goose
Olor columbianus	Whisling swan
Ixobrychus exilis	Least bittern
Botaurus lentiginosus	American bittern
Nycticorax nycticorax	Black-crowned night heron
Anas platyrhynchos	Mallard
Anas rubripes	Black duck
Anas strepera	Gadwall
Mareca americana	American widgeon
Anas acuta	Pintail
Spatula clypeata	Shoveler

TABLE 13. MAMMALS OF THE LUDINGTON AREA (Exclusive of the bats) (Some may no longer be in the area)

SCIENTIFIC NAME	COMMON NAME	STATUS
Didelphis marsupialis	Opossum	C
Scalopus aquaticus	Prairie mole	C
Condylura cristata	Starnosed mole	UC
Sorex cinereus	Masked shrew	C
Blarina brevicauda	Short-tailed shrew	C
Castor canadensis	Beaver	TE
Lepus americanus	Snowshoe rabbit	C
Tamias striatus	Eastern chipmunk	C
Marmota monax	Woodchuck	C
Spermophilus tridecemlineatus	Thirteen-lined ground squirrel	C
Peromyscus lencopus	White-footed mouse	C
Microtus pennsylvanicus	Meadow vole	C
Ondatra zibethicus	Muskrat	C
Rattus norvegicus	Norway rat	C
Mus musculus	House mouse	C
Zapus hudsonius	Meadow jumping mouse	C
Erethizon dorsatum	Porcupine	TE
Canis lupus	Timber wolf	TE
Urocyon cinereoargenteus	Gray fox	C
Ursus americanus	Black bear	TE
Procyon lotor	Raccoon	C
Mustela frenata	Long-tailed weasel	C
Mustela vison	Mink	TE
Taxidea taxus	North American Badger	TE
Lutra canadensis	River otter	TE
Mephitis mephitis	Striped skunk	C
Lynx rufus	Bobcat	TE
Odocoileus virginianus	White-tailed deer	C
Sylvilagus floridanus	Eastern cottontail rabbit	C
Glaucomys sabrinus	Northern flying squirrel	C
Peromyscus maniculatus	Deer mouse	C
Tamiasciurus hudsonicus	Red squirrel	C
Sciurus niger	Fox squirrel	C
Sciurus carolinensis	Gray squirrel	C
Glaucomys volans	Southern flying squirrel	C

C= Common

UC= Uncommon

TE= Threatened or endangered

Michigan in this area are low in hardness and good in quality. Recent data comparing the chemical quality of intake waters of the Ludington Water Treatment Plant with Public Health Service (PHS) Drinking Water Standards are presented in Table 14.

2.60 The State Water Resources Commission has been testing the waters of Lake Michigan around Ludington for bacteriolocial conditions. The results, as shown in Table 15, indicate that the Ludington Harbor area is safe for water contact sports such as swimming, boating, etc. The criteria for safety are standards issued by the State of Michigan. According to the State, the fecal coliform count must not be greater than 200 per milliliter for swimming purposes, and less than 1,000 per milliliter for other waterborne activities.

2.61 The annual water temperature cycle for Lake Michigan is characterized by a five-month warming period from mid-March to mid-August, followed by a seven-month cooling period. Surface water temperatures reaching 70°F can be expected in late July through early August. These temperatures drop into the 30-35° range in the winter months. While a large portion of Lake Michigan remains ice-free in winter, large accumulations of ice may exist at the shore zone.

Historical and Archaeological Sites

2.62 The National Register of Historic Places and its latest supplements have been consulted. While there are several listed places of historic value within the city, none will be

TABLE 14. WATER QUALITY FOR INTAKE AT LUDINGTON SEWAGE TREATMENT PLANT

CHEMICAL TESTS (mg/1)	INTAKE 5-2-74	1962 PHS DRINKING WATER STANDARDS
Arsenic	<0.005	0.05
Barium	<0.05	1.0
Cadmium	<0.001	0.01
Chloride	12.0	250
Chromium	0.00	0.05
Copper	0.017	1
Cyanide	0.00	.02
Fluoride	1.3	--
Iron	0.09	0.3
Lead	0.00	0.05
Manganese	0.01	0.05
Mercury	0.00	--
Nitrate (NO_3)	1.4	45
Selenium	0.003	0.01
Silver	0.004	0.05
Sodium	6.0	--
Sulfate	42.0	250
Zinc	0.012	5
Alkalinity ($CaCO_3$)	0.00	--
Hardness ($CaCO_3$)	145.0	--
pH	7.9	--
Total Dissolved Solids	191.0	500

TABLE 15. BACTERIOLOGICAL CONDITIONS AT LUDINGTON HARBOR

(NUMBER/100 ml)

DATE	PERE MARQUETTE RIVER, MOUTH		LAKE MICHIGAN OFF LUDINGTON STATE PARKS*					
			South Limits		Opposite Concession		North Limits	
	Total Coliform	Fecal Coliform	Total Coliform	Fecal Coliform	Total Coliform	Fecal Coliform	Total Coliform	Fecal Coliform
6-70	400	<10	100	<10	<100	10	200	<10
7-70	6,100	390	1,100	<10	400	<10	300	<10
8-70	2,000	40	500	10	1,700	<10	<100	<10
6-71	4,600	40	<100	<10	<100	<10	<100	<10
7-71	1,400	10	<100	<10	<100	<10	100	<10
8-71	1,400	<10	400	<10	1,200	<10	300	20
6-72	2,100	<10	200	>10	100	>10	200	>10
7-72	83,000	130	5,100	50	25,000	<10	5,800	20
8-72	7,700	30	6,500	<10	5,100	<10	3,700	20

* Samples taken at 30-foot depth

< less than amount shown

> more than amount shown

affected by this project. Not listed are two historic sites--the Father Marquette Shrine and the Caswell House--located on the Buttersville Bar; both are registered with the Michigan Historical Commission. Also, the old lighthouse structures situated on the breakwaters are of potential significance to the area. None of these are expected to be directly impacted by the proposed action. Special care will be taken to assure their protection.

2.63 Ongoing erosion, which has greatly assisted in the creation of new bottomlands, precludes finding old shipwrecks located on older bottomlands. Since most of the project would only affect presently submerged lands, no terrestrially situated Indian sites would be disturbed.

2.64 During the preparation of this statement, various authorities were contacted for information regarding the specific locations of known archeological sites in the Ludington vicinity. Specific information was withheld because it was felt that such knowledge in a publicly available document might be tantamount to an invitation for site tampering by unskilled individuals. During August and September 1973, a reconnaissance of the proposed project area was conducted for the purpose of determining the need for an archaeological survey to identify potential historical, geological, and paleontological sites. Investigation included a bluff, dune, backshore, foreshore and nearshore sediment sampling program. Investigations were conducted by Corps staff including a professional geologist-paleontologist familiar with present and historical processes which identify the physical characteristics and potential of the proposed project site for prehistoric or historic cultural material. The reconnaissance of the proposed mitigation plan site,

located in a dynamic shoreline zone characterized by critical ongoing erosion, identified no historical structures or surface traces of prehistoric or historic cultural material noting the presence of archaeological sites that would be directly impacted by the project. It should be noted, however, that in response to the Corps mandate for Recording and Preserving Historical and Archeological Finds within its project areas, all items having any apparent historical or archeological interest which are discovered in the course of any construction activities shall be carefully preserved. The archeological find shall be left undisturbed and the proper authorities shall be notified.

3. RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

Existing Use of the Shore Area

3.01 In recent years, the population growth and a higher standard of living for the Lake Michigan area have resulted in an increase in lakeside living and water-based activities. While providing an excellent environment for relaxation in today's fast-paced world, the Lake Michigan shorelines are being threatened by severe erosion. The natural forces of wind and wave action, violent storms and high water levels, combined with man-made changes have resulted in property damage as well as human misery. Due to these conditions, local interest groups requested that a study be made to determine whether or not the erosion damage is caused or aggravated to any degree by the Federal navigation structures located at Ludington Harbor.

3.02 The gravity of the situation can be illustrated by the data presented in the document entitled, "Preliminary Examination Report on Property Damage on the Great Lakes Resulting from Changes in Lake Levels," dated June, 1952, and the "Great Lakes Region Inventory Report--National Shoreline Study," dated August, 1971. Erosion damage recorded for the counties of Muskegon, Oceana, Mason, Manistee, Benzie, Grand Traverse, Leelanau, Emmit, Charlevoix and Antrim, adjusted to 1970 dollars and presented in the Great Lakes Inventory Report, is estimated at over $6.1 million dollars for the one-year period from spring, 1951 to spring, 1952. Many critical erosion problems exist in this reach of shoreline, particularly from Manistee

southward to Muskegon. Critical erosion areas as defined in the Inventory Report are those where land loss, economic loss and other considerations appear to justify protective measures.

3.03 The proposal of the Corps of Engineers (to mitigate shore erosion in the vicinity of Ludington Harbor, Michigan, which is attributable to the Federal navigation structures at the harbor), conforms with the objectives and specific terms of existing or proposed federal, state and local land use plans, policies and controls for the area affected.

3.04 Currently, the zoning regulations for the City of Ludington and the townships of Pere Marquette and Hamlin do not set forth standards for the development of high-risk erosion areas. Much of the coastal environment is zoned for residential use. A small portion of the study area is devoted to municipal works and park lands. The Department of Natural Resources of the State of Michigan has recently designated a major portion of the Ludington coastal environment as a high-risk erosion area. In conjunction with this designation, the city and coastal townships will be rezoning these coastal lands.

3.05 The State of Michigan, under the Shoreland Protection and Management Act of 1970, has no control over shoreland already plotted and developed. Consequently, the mandate would not eliminate unwise development in those areas subject to erosion. The act would, however, regulate future use of any undeveloped property that remains.

3.06 Local shoreland regulation and management techniques which might be applied include zoning, subdivision regulation, building codes, ordinances, permits, acquisition taxes, condemnation and evacuation. It should be noted that evacuation and moving of structures would not be warranted even if the cost thereof would be less than the cost of shore protection by other means. Evacuation is rarely acceptable to the interests concerned.

Prior Reports and Meetings

3.07 "A Preliminary Report on Property Damages on the Great Lakes" was prepared in June, 1952. Appendix B of the report, "Basic Physical and Damage Data on Lake Michigan," presents estimates of property damage during the one-year period from the spring of 1951 to the spring of 1952 for shore areas showing serious erosion and inundation along Lake Michigan. A joint study is presently being compiled by the International Joint Commission of Canada and the United States with assistance from various Government agencies and departments. The purpose of this study, among other things, is to investigate the feasibility of further regulation of the Great Lakes water levels to reduce property damage of unprotected shore reaches. Data collected for the 1952 Preliminary Examination Report is being incorporated into the current study.

3.08 A Great Lakes Basin Framework Report is being prepared by the Great Lakes Basin Commission and will serve as the foundation for a comprehensive, coordinated, joint plan for

the development of water and related resources. Appendix 12 of the report, "Shore Use and Erosion," analyzes the nature and extent of shoreline erosion and flooding damages, and presents data on shoreline use and development alternatives. The Framework Study Appendix was prepared concurrently with the Great Lakes Region Inventory Report.

3.09 Two public workshops to discuss ongoing and scheduled Section 111 studies along Lake Michigan were held on 13 November 1974 in the City of Muskegon Municipal Building Council Chambers, Muskegon, Michigan. The purpose of the workshops was to present a clarification of policy concerning Section 111 so as to provide the public and all interested parties with an opportunity to express their viewpoints, ask questions and raise issues bearing on the erosion problem to the District Engineer, Detroit District. Approximately 50 persons attended the workshops and a great deal of information was exchanged. Also, a presentation was made by the Lake Michigan Federation seeking to promote public participation in policy decisions pertaining to Lake Michigan. The overall opinion was that the Corps' new advocacy of beach nourishment was a viable means of mitigating erosion damage attributable to Federal navigation structures.

Prior Corrective Action and Existing Structures

3.10 Numerous shore protective structures such as seawalls, groins, and piled rubble have been erected by state and local organizations and private individuals at various locations (mostly north of the harbor) along the damaged shoreline. In

spite of these works, severe erosion continues to plague many areas. Continued erosion has necessitated increased maintenance and augmented expansion of the protective structures. Moreover, the provided protection has only been adequate to limit recession of the beaches and/or bluffs which they protect. Adjoining unprotected properties continue to erode to such an extent that the protective works eventually become flanked and lose their effectiveness.

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MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION--ETC(U)
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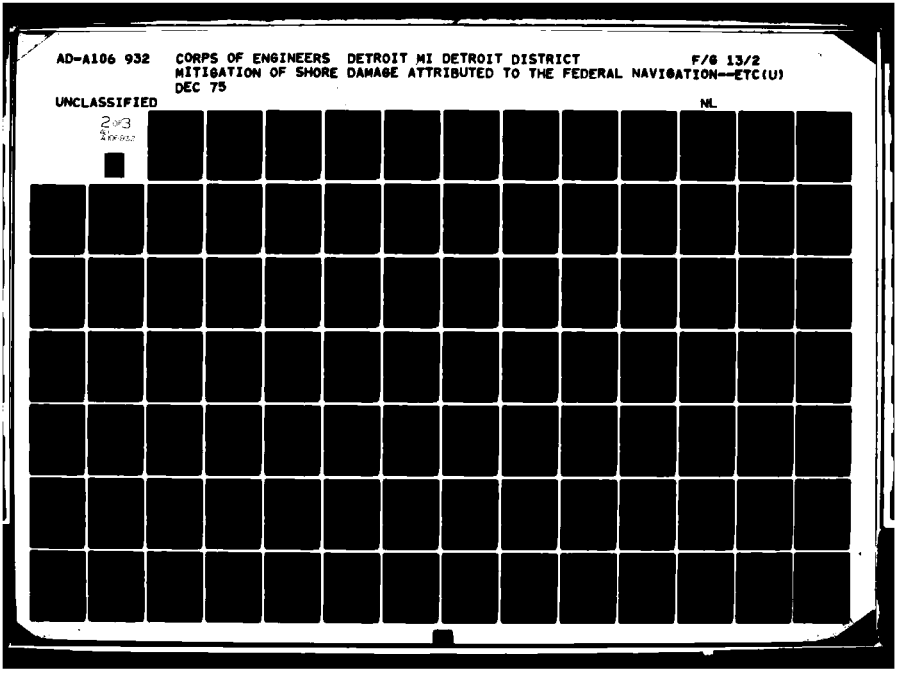

4. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

4.01 The effect (impact) of the proposed action on the existing environment has been thoroughly analyzed. In this section both beneficial and detrimental environmental changes that may result with the development and maintenance of shoreline nourishment sites are discussed. A qualitative, and if possible, quantitative approach is used to identify the direct and indirect effects along with the intangible factors. Special attention is given to protective measures which will be taken to either mitigate or avert adverse environmental consequences.

4.02 For this statement, evaluation of the environmental impact of the proposed action is accomplished with the aid of an impact matrix as shown in Plate 14. This matrix was designed to assign a rating to the impact of specific aspects of the action on certain environmental factors. As noted, there are five particular aspects of the action which will have some impact on one or more of 17 identifiable environmental factors. Each impact is quantifiably defined in terms of a set of two numbers placed in the appropriate matrix box element coinciding with the action aspect and the impacted environmental factor. The two numbers are separated by a diagonal line. The upper lefthand number defines the magnitude (i.e., degree, extensiveness, scale, probability of occurrence) of the impact upon that particular sector of the environment. The lower righthand number weights the importance (i.e., significance) of the impact as it relates

LEGEND Magnitude Rating Matrix Element Box Importance Rating		ACTION ASPECTS CAUSING IMPACT					IMPACTS/FACTOR		
		Alteration of Shoreline	Noise / Lights	Dredging	Traffic	Spills and Leaks	Positive (+)	Negative (-)	TOTALS
IMPACTED ENVIRONMENTAL FACTORS	Shoreline Stability	+8 / +8					1		1
	Water Turbidity	3 / 4		1 / 5			1	1	2
	Water Quality					1 / 6		1	1
	Air Quality				1 / 1			1	1
	Erosion	+6 / +8					1		1
	Aquatic Plants	2 / 2		1 / 3		1 / 3		3	3
	Plankton	2 / 2		1 / 3		1 / 5		3	3
	Fishes	1 / 3		1 / 2		1 / 5		3	3
	Benthic Organisms	4 / 2		1 / 3		1 / 5		3	3
	Terrestrial Vegetation	+3 / +7					1		1
	Terrestrial Animals	+2 / +2	1 / 2				1	1	2
	Birds	+5 / +6	1 / 2		1 / 1	1 / 7	1	3	4
	Recreation	+5 / +6	1 / 4	1 / 4	1 / 4	1 / 7	1	4	5
	Shoreline Serenity/Aesthetics	+5 / +7	1 / 5	1 / 2	3 / 4	1 / 6	1	4	5
	Health	+1 / +4	1 / 4		1 / 1	1 / 1	1	3	4
	Employment	+1 / +1		+1 / +1	+1 / +1	+1 / +1	4		4
	Structures	+2 / +3					1		1
IMPACTS/ACTION	Positive (+)	11		1	1	1	14[a]		
	Negative (-)	4	5	7	5	9		30[b]	
	TOTALS	15	5	8	6	10			44[c]

[a] Represents the total number of potential positive (+) impacts, i.e., the number of filled element boxes with plus signs.

[b] Represents the total number of potential negative (-) impacts, i.e., the number of filled element boxes without plus signs.

[c] Represents the total number of potential impacts, i.e., the number of filled element boxes.

PLATE 14. IMPACT MATRIX FOR PROPOSED ACTION

to the specifics of the action and of the existing environment as a whole. Both numerical ratings are on a scale of 1 to 10 in accordance with the following word weights:

Rating Numbers	Magnitude or Importance
1	Insignificant
2	Minimal
3	Minor
4	Discernible
5	Moderate
6	Significant
7	Substantial
8	Great
9	Major
10	Extreme

A plus (+) sign preceding a rating indicates that the impact is positive or beneficial. If no plus sign is assigned, then the corresponding impact is negative (i.e., a minus sign is implied). Only those matrix box elements containing a diagonal line and two numbers represent an impacting situation. Box elements which are blank or empty represent no impact.

4.03 To illustrate the difference between a magnitude rating and an importance rating, the following examples are given.

Example 1: A particular action may cause substantial erosion and be given a magnitude rating of 7; however, if erosion is quite common in the area, then the added erosion caused by the action is probably insignificant

in terms of the normal total and could be given an importance rating of 1.

Example 2: A proposed jetty might be of such design as to have little or no effect on the normal passage of littoral drift. Hence, the possible occurrence of neighboring accretion and erosion problems (as a result of the structure) would be insignificantly remote, i.e., magnitude 1. If, however, the design were to fail for some unknown reason, the resulting effect might be major, i.e., its importance rating might be 9.

4.04 With respect to the proposed mitigation plan, the impact matrix (Plate 14) displays 44 potential impacts (many of which are beneficial) as well as the magnitude and importance ratings of each. As noted, no rating is larger than 8. Moreover, 15 of these impacts can be attributed solely to the shoreline alteration aspect of the proposed action. Further, the environmental factors most affected (i.e., impacted by all aspects of the proposed action) are recreation and the aesthetics and serenity of the shoreline. All other factors are impacted by 4 "action aspects" or less.

Alteration of Shoreline

4.05 This aspect of the proposed action includes the actual dumping of the dredged material into the shallow (less than 10 feet) offshore waters as well as the resulting change in

coastline that is expected to occur. The primary effect of this action would be the strenthening and stabilization of the coastal environment, thereby mitigating erosion in problem areas and diminishing turbid water conditions south of the harbor. Bluff denudation would lessen, thus promoting recovery of vegetative cover. This recovery would further stabilize these bluffs, rendering them more suitable habitats for certain fauna. A more aesthetically pleasing terrain would be expected overall. With periodic nourishment, new beaches may be generated, adding to the existing recreational benefits of the area. Over the years, the strenthened coastline would become more aesthetically pleasing. Damage reduction to private and municipal lakefront property will provide relief to the present mental discomfort of local homeowners and municipal officials, and will mitigate future expenses for shore protective works. Also, property values are expected to occur as a result of this aspect of the proposed action. Adverse impacts due to shoreline alteration would include temporarily increased turbidity to the north and south of the harbor, loss of habitats from rubble and shore protection structures and, on a temporary basis, loss of benthic organisms at the dumping sites.

4.06 Sport and commercial fisheries may be affected on a short-term basis due to the dredging and subsequent deposition of material from the harbor area; however, the timing of deposition has been arranged so that these effects are minimized. Recovery should occur rather quickly, benthic and aquatic organisms should return within a short period of time (3-4 wks), and fishery activities are expected to return to normal.

4.07 The natural processes of winds, wave action and littoral drift would help disperse newly deposited material along the damage affected shoreline. With periodic nourishment of the shoreline, the associated beaches and bluffs (especially on the southern shoreline) would become stronger and more stable. This impact upon the coastal stability of the area is of great importance because the action attacks the erosion problem itself. Also, a large portion of the shoreline will be affected in this regard. By returning lakeward diverted littoral sediments to the shoreline, further harbor-induced erosion of shoreline beaches and bluffs will be eliminated. That accomplishment alone represents an impact of great importance to the present outlook of the area.

4.08 Shoreline alteration would help promote modification of the existing habitat. With periodic nourishment, the beach would be strengthened and neighboring bluffs would become more suitable for plant growth. Although the magnitude of this occurrence would only be minor, its importance would rate as substantial, since a vegetative cover would provide further protection against slides and slumps.

4.09 A secondary impact would be the increased attractiveness of these vegetated bluffs to land animals. However, it is not expected that this area would experience a phenomenal growth in animal population. Thus, both ratings for this impact would be minimal. The impact upon birds would also be important. A larger beach would attract birds that prefer

sand, and renewed vegetated bluffs would attract those preferring hillsides. While the overall magnitude of this impact might have a moderate effect, its importance would at least rate as significant.

4.10 Certain aquatic organisms existing at the proposed nearshore dumping locations would surely be destroyed during initial and periodic nourishment operations. This effect, however, would be restricted to those having slow locomotive capabilities. For example, benthic life at the actual nourishment sites will likely be smothered, and temporarily increased turbidity may be detrimental to local drifting plankton; such impacts would be temporary since recovery would be rapid soon after operations have ceased. Also, neighboring groin and rubble areas, which--since placement as shore protective works--have become thriving habitats for a few aquatic plants and animals, may slowly be buried as periodically placed nourishment materials spread laterally by natural forces. In terms of the total sphere of Lake Michigan's ecology, the associated local impacts on aquatic plants, plankton and the benthos will be minimal in magnitude and importance.

4.11 Alteration of the shoreline has a potential impact of minor importance to certain groups of fish such as spawning perch, sturgeon, lake trout, the whitefish family, and migrating salmon. However, these activities will not likely be affected since implementation of the proposed action is scheduled to avoid them. In the event of equipment unavailability or similar constructional limitation at the designated time, implementation of the mitigation plan will be rescheduled within the new engineering constraints so as to minimize possible adverse effects.

Moreover, other fish residing in the area during operations will move away temporarily and return later when operations have ceased. Hence, the overall magnitude of any shoreline alteration impact on this factor should be insignificant.

4.12 Turbid waters would result at both of the shoreline nourishment sites during initial and periodic implementation of the proposed action. Slight turbidity might also result during periods of heavy weather as sand is eroded from newly developed beaches. During initial establishment of the southern nourishment site, the added turbidity will be negligible compared to that which already exists. Besides, an overall reduction in turbidity is expected in adjacent southerly waters. Any turbidity created during initial establishment of the northern site and subsequent maintenance of both sites will likely be of discernible importance to the overall area. The magnitude of the impact would be minor, since the occurrence would only be temporary. Any resuspension of deposited materials during storms will likely be minor.

4.13 Recreational activity which is popular along the coastline will also be affected by an alteration of shoreline. Newly developed beaches would provide additional locations for swimming, sunbathing, and beach strolling activities. These impacts would be moderate in magnitude. Their importance to the general public, however, would be significant since existing beaches are already being used to a great extent and added capacity is needed.

4.14 Further impacts associated with the shoreline alteration aspect of the proposed action include a probable increase in shoreline aesthetics and serenity, and a reduction in the

threat of damage to lakefront property. As natural forces distribute the nourished material along the shoreline, the newly created beaches of increased stability might serve as an encouragement to lakefront property owners to remove unburied rubble litter and groins. Coupled with prospects for new bluff vegetation and increased shorebird activity, a moderate enhancement of serenity, which is of substantial importance to the area, would prevail. The proposed action would likely relieve some of the mental discomfort of threatened property owners. This, in turn, would reflect a discernible benefit to their general health and well-being. The magnitude of this impact would rate insignificant since only a few individuals will be affected.

4.15 Alteration of the shoreline would have a positive impact of minimal magnitude on the preservation of lakeshore buildings and enhancement of property values. The importance of this impact would only be minor since the ratio of lakeshore structures and property to that of the greater Ludington area is small.

4.16 Finally, the activities associated with shoreline alteration would require the efforts of additional manpower for site locationing and staking, and barge operation. The magnitude and importance of this impact would be insignificant, however, when considering the overall general employment situation of the Ludington area.

Noise/Lights

4.17 Noises and nocturnal lights, resulting primarily from dredging operations and barge transport, would only be temporary, lasting about 25-30 days/year during the initial establishment phase and an average 10 days/year for subsequent periodic maintenance phases. On the whole, additional dredging time over that of recent maintenance operations would be required, particularly with regard to the initial establishment phase. However, it is expected that the effects of the additional noise or lights associated with the mitigation plan would be minor. The distant location of the dredging activity (about ½ mile offshore) would provide a dampening effect with respect to noise audibility at the shoreline. Similarly, the offshore light intensity would be attenuated. The bulk of the noise and nuisance light would be caused by the barges transiting between the dredge site and the shoreline nourishment sites. The level of intensity, however, is expected to be low.

4.18 Noises associated with barge activity could possibly prevent the migration into, or habitation of, terrestrial animals and birds in the immediate vicinity of the shoreline nourishment sites. This impact, however, should be insignificant due to the short period of time involved and the low level intensity, and of minimal importance.

4.19 Recreational activities, as well as the peace of mind of individuals, might be negatively affected by any noise generated. Many individuals vacation to this area during the summer, and participation in shoreline recreational activities

is generally high. Moreover, distracting noises generated concomitant with these activities would be of discernible importance to the quality of associated enjoyment. However, expected dredging and barging noises will be of low intensity and short duration. Therefore, the magnitude of the resulting impact should be insignificant.

4.20 Finally, the project noise and associated night-lights would have an adverse impact on the serenity of the shoreline. Although these disturbances are considered to be of moderate importance to the general atmosphere of the area, their temporary presence and low level intensity would result in and impact of insignificant magnitude.

Dredging

4.21 This activity includes the physical removal of accumulated bottom sediments near the harbor mouth and the dredging vessel maneuvers in and around the harbor. Previous annual maintenance dredging operations produced several negative environmental impacts, including: temporary increases in water turbidity at the dredging sites, local destruction of benthic organisms and drifting plankton, temporary local displacement of fish populations, inconveniences to the recreation and commercial boat traffic, and disturbances of shoreline serenity and aesthetics. Under the proposed action, dredging procedures will be similar to those of the recent past. Only the duration of dredging will differ, primarily as a result of the increased quantities to be dredged. This is especially true regarding the initial establishment phase.

Moreover, difficulties experienced during nearshore dumping operations may also prolong the expected operation schedule of subsequent annual maintenance phases, though this increase would likely be small (one or two days at most). Hence, the environmental factors affected by the proposed dredging activities will be the same as those impacted by past dredging activities. The magnitude of the impact associated with prolonging these affects (due to increased dredging time) would be insignificant, if dredging is conducted prior to June, as proposed.

4.22 Dredging activities will be concentrated at the harbor mouth, where the waters are generally low in turbidity. Hence, any prolonged increase in this factor would be of moderate importance. Although the material to be dredged is unpolluted, the area will be monitored continually during operations to insure against possible chemical pollution.

4.23 Concerning the ecological segment of the environment, the aquatic plants, benthic organisms, and plankton in the dredging area will temporarily be disturbed. It is probable that some of these organisms, especially those with little or no locomotive ability, will perish as a consequence of the dredging activity and/or the increased water turbidity. Those organisms possessing greater locomotive abilities, such as fish, will simply evacuate the area until stability occurs. Considering the temporary nature of these effects, as well as their localization, the importance of this impact would be minimal with respect to the fish populace and minor with respect to other aquatic biota types. Perch spawning and salmon migration activities would not be affected if dredging is conducted prior to June, as proposed.

4.24 The presence of a hopper-dredge operating at or near the mouth of the harbor may curtail some recreational fishing and other sport-associated activities, resulting in an impact of discernible importance. The aesthetics and shoreline serenity of the area may also be disturbed by such operations. These impacts can only be considered to be of minimal importance in view of the many other aesthetic areas that would remain unaffected by this aspect of the proposed action.

4.25 Although manpower will be required to carry out the dredging operation, little employment increase is expected over and above that which would normally be required for annual maintenance dredging operations. Hence, the overall importance of this impact would be rated as insignificant.

Traffic

4.26 This aspect of the proposed action is concerned primarily with the increased dredging and barging operations. While current dredging operations involve the barging of material lakeward, the proposed plan would employ several smaller barges to transport this material to the shoreline nourishment sites. Environmental factors which would be negatively affected by traffic include air quality, recreation, bird life, human well-being, and shoreline serenity. Employment is the only environmental factor which is positively impacted by this action aspect.

4.27 Increased barge traffic will have a slightly adverse effect on air quality. The increase in exhaust emissions would be quite small in relation to the total emission level

in the Ludington area. Coastal winds would greatly assist in dispersing these emissions. Thus, the overall impact is rated insignificant in both magnitude and importance.

4.28 The presence of landward-moving barges might be unpleasant to local bathers, fishermen, and recreational boaters, and cause some disturbance to the shorebirds in the area. The magnitude of the impact, however, would be expected to vary directly with the number of barges used. Four barges are expected to be employed in the initial establishment phase of the proposed action, and two will be used in subsequent maintenance phases. Because of the small number of barges involved and the temporary nature of each operational phase, the above-mentioned impacts are expected to be insignificant in magnitude. The potential of the impact, however, is of discernible importance, since the proposed operations are scheduled for a period when recreational activities are usually near their highest levels.

4.29 The incorporation of a larger number of barges and/or increased operating time beyond that required during recent dredging activities would necessitate additional manpower. Any increase, however, would be small. Hence, the resulting impact upon employment will be insignificant in both magnitude and importance, since any additional manpower needed for this operation would be negligible in terms of the total labor of Ludington.

4.30 Of discernible importance is the impact on the serenity of the area. The presence of landward moving barges might be aesthetically displeasing to the local population. Conse-

quently, during periods of shoreline nourishment, an aesthetic impact of minor magnitude will be felt.

Spills and Leaks

4.31 This aspect of the proposed action is concerned with the accidental, and/or unavoidable spills and leaks of gas and oil from vessels associated with dredging and barging operations. Factors of potential impact include water quality, aquatic plants, plankton, fish, benthic organisms, birds, shoreline serenity, recreation, human well-being, and employment.

4.32 Increased dredging and barging activities would further increase the possibility of oil spills and/or leaks, therefore directly impacting water quality. Depending on the extent of occurrence, secondary impacts on the aquatic biota could result. Aquatic plants and plankton could suffer damage, resulting in secondary impacts to fish and benthic organisms. Serious spills from dredge vessels or barges would constitute a threat to bird life, certain aspects of recreational activity, and the visual aesthetics of the area. In all, they would impact some discomfort to those deriving pleasure from usage of the area.

4.33 All of the spills and leaks that will occur will likely be minor and unavoidable. Typical among these would be the oil and gas leaks through vessel exhaust systems, and undetected minor leaks in hydraulic and fuel systems. Overall, the associated impacts are expected to be insignificant in magnitude. The occurrence of larger spills, i.e., those constituting a more serious hazard, would be extremely remote.

4.34 The most probable source of a more serious oil or gas spill would be the refueling operations necessary to operate the dredge vessel and barges. In all likelihood, these would be quickly detected and ceased. More remote would be the possibility of a collision or sinking of either the dredge vessel or barges, resulting in the release of whatever fuel or oil was on board. Because on-board quantities are generally very small, any impact would be highly localized and probably insignificant.

4.35 Extremely remote would be the collision with, and rupturing or sinking of a fuel tanker vessel. Fuel tankers operate in and out of Ludington Harbor on a year-round basis. In any one month, however, the total number of arrivals and departures is small. Because of the ever persistent risk of operating these large vessels in restricted waters, the piloting in and out of a harbor is given maximum attention to avoid collisions or grounding. The presence of a dredge vessel or barges for certain periods of time each year will necessitate that some additional measure of care be taken to avoid adverse consequences. Past activities have already demonstrated an accident-free record. Future activities in this regard should result in insignificant additional risk.

5. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSED PLAN BE IMPLEMENTED

5.01 Since the proposed overall plan only deviates slightly from past maintenance dredging activities, its implementation would result in few additional adverse environmental effects. One of the most noticeable impacts would be the presence of landward moving barges, which would unavoidably detract from the aesthetics of the area and possibly interfere with certain recreational activities. These effects would be minimal, since the operations would last only 25-30 days/year during the first year(s) (up to 4 years, depending on the dredging vessel or contracting mode used) of initial site establishment and about 10 days/year for each subsequent year thereafter.

5.02 The scheduled increase in the quantities of material to be dredged (particularly those for initial establishment of the beach nourishment sites) will require additional dredging time. Compared to previous activities, this will unavoidably result in prolonged turbidity conditions at the dredge site. Moreover, when these materials are placed at the northern nourishment site, unavoidable turbidity and associated impairment of light penetration will result. Consequential turbidities generated at the southern site will be negligible compated to present conditions. In any case, the materials which would cause these turbidities are known to be unpolluted. Also, created turbidities would rapidly diminish following suspension of dredging and shoreline disposal operations.

5.03 The aquatic ecosystem at the harbor mouth and adjacent vicinity will be unavoidably impacted during dredging operations. Local destruction of benthic forms and drifting plankton will occur, and fishes will temporarily evacuate the dredge area. Moreover, the duration of these impacts will be necessarily greater during the initial establishment phase as compared to subsequent replenishment phases. Such impacts will be temporary (as they were during previous maintenance dredging operations), however, and followup rapid recovery to predredging conditions will ensue.

5.04 The dumping of dredged sediments at the proposed shoreline nourishment sites would adversely affect the nearly non-locomotor forms of benthic and pelagic organisms. At the wave-washed beach sites south of the harbor, the effect should be minimal due to the sparseness of these organisms. This is not the case at shore-protected beach sites north of the harbor, where various structural materials (brick, stone, concrete rubble, groin pilings, etc.) have become suitable substrates for active ecosystems. Shoreline nourishment operations will result in the burial of any such habitats at the proposed nourishment sites. Also, periodic nourishment will sustain this condition indefinitely. Further, littoral transport of shoreline-placed sands will slowly fill in other such habitats adjacent to the programmed nourishment sites. In time, the newly developing sand areas would repopulate with organisms preferring sediment habitats, though at a somewhat reduced population density. During dumping, fish will simply migrate to an adjacent, more suitable locale. The time schedule for the annual phases of the proposed action will not interfere with perch spawning and salmon migrating activities. Local fishing activities will be minimally impacted.

5.05 Implementation of the initial establishment phase and periodic replenishment phases of the proposed actions will unavoidably create temporary turbid conditions in waters adjacent to the northern shoreline nourishment site. Rapid recovery is expected, however, following cessation of operations due to the rapid settling velocities of the large grain sized particles of sand composing the dredged material. Similarly created turbidities in waters adjacent to the proposed southern shoreline nourishment site would be negligble compared to that which already exists from eroding dry bluffs, whose fine silty particles tend to remand in suspension for a longer period of time. In the long run, the eventual formation of a sandy beach will reverse these conditions.

5.06 Any increase in dredging or barging activity over that of past maintenance dredging and deepwater dumping operations would result in added vessel movement in and around the harbor. Such additional movements will occasionally impede the flow of commercial or recreational vessel traffic. Expected inconveniences, however, would only be minor.

5.07 Other unavoidable impacts include the discharge of exhaust emissions into the atmosphere, the production of noise, and the illumination of activity areas at night. Odorous fuel fumes, noise, and lights may prove bothersome to local residents, boaters, and other users of the area. It is expected that these would be minimal due to the project location.

5.08 Finally, there will be unavoidable occurrences of oil and/or gas spills and leaks which will result from the operation of a dredging vessel and transport barges. Any

of these (i.e., engine oil and gear box drippings, etc.) are expected to be small. Although a major spillage would be highly remote, contingency oil spill procedures have been established in accordance with EPA guidelines and U.S. Coast Guard Regulations to institute clean-up operations. In the event of a large spill the nearest Coast Guard installation would be notified of the fact, and oil absorbent material would beutilized. One of several commercial firms on the Great Lakes set up to handle oil spills on a 24 hour basis would be notified to begin emergency operations to contain and pick up the oil.

6. ALTERNATIVES TO THE PROPOSED ACTION

6.01 In reviewing this statement and reflecting upon the proposed action, certain alternatives are apparent for the mitigation of shore damage in the Ludington Harbor vicinity. Alternatives were given due consideration while formulating the engineering plan for this project. These are individually identified below with appropriate comment. In reviewing and assessing these, it is important that the following facts be kept in mind.

6.02 The primary objective of developing a Section 111 Project at Ludington Harbor is the restoration of that part of the littoral drift being interrupted by the navigation project. The authority is not intended to provide mitigation measures which would insure the same degree of protection usually associated with regular beach erosion control projects. The Section 111 authority states that the government will mitigate damages attributable to Federal navigation works when equitable and in the public interest, fully considering the preproject condition and intangible benefits. Moreover, the entire cost for the mitigation effort will be borne by the Federal government.

6.03 Alternative 1: No Action. It has been determined that erosion attributable to the Ludington Harbor structure is approximately 55% of the total erosion due to all causes. A "No Action" scheme would perpetuate the past practice of dumping the dredged sand in deep water, thus depriving the

shoreline forever of the trapped sand. Erosion would continue, and the coastal environment would undergo further damage. The turbidity along the shore area south of the southern breakwater would continue unabated. Trees and brush would give way as bluffs were eroded. Existing homes and shoreline municipal works would come under increased threat. Property values would plummet. Eventually, coastal dwellings would be lost to the elements. Those fronted by protective works might possibly withstand these effects; however, the problem would likely be transferred downdrift, and protected dwellings would become flanked. The end result would therefore be the same. Hence, a "No Action" alternative would be detrimental to the existing shoreline habitat, private and municipal property, and the aesthetics of the area. Furthermore, the alternative would not satisfy Section 111 of Public Law 90-483, the intent of which is to provide a procedure for mitigation of damage due to the Federal harbor works. Since substantial benefits are possible from a minimum action (such as returning maintenance dredge materials to the beach), the law (as specified in Section 111) authorizes a plan for mitigation.

6.04 Alternative 2: Removal of the Navigation Structure. Removing the navigation structures at Ludington Harbor would result in a significant local loss and minor regional and national loss of economic development, as well as a loss of social well-being in the Western Michigan area. The economic benefits received from the navigation project are principally the savings in transportation costs of importing and exporting bulk commodities such as limestone and coal. Average annual tonnage through the harbor for the years

1955-1972 was 3-4 million tons. Without the navigation works, commerce would be forced to use other routes of entry and exit, such as neighboring harbors and/or land routes. The alternative would also curtail certain recreational activities. Small craft passage through the harbor would be reduced somewhat. Sportsfishing and sightseeing activities associated with the navigation structure would be minimized. Local concerns whose livelihood depends heavily on this recreational activity would suffer income losses.

6.05 Removing the navigation structures would allow a resumption of littoral drift and would result in a significant adjustment in the littoral zone adjacent to the harbor. Accreted shores would move landward a considerable distance and the associated nearshore zone would deepen as littoral materials moved downdrift to establish equilibrium bottom profiles. The entrance to Pere Marquette Lake would shoal, thus eliminating all commercial traffic and significantly reducing recreational boat traffic. Maintenance of an opening would be economically unjustifiable.

6.06 Finally, removal of the harbor structures would result in a significant alteration of ecosystem habitats. Adjacent perch spawning areas would be lost. Local residents and visitors would be deprived of recreational fishing from the breakwaters.

6.07 Alternative 3: Shoreland Regulation and Management. This alternative includes the employment of such techniques as zoning, subdivision regulation, building codes, ordinances,

permits, acquisition, taxes, condemnation, and evacuation. The State of Michigan Shorelands Management and Protection Act of 1970 states that:

> (a) Within three years after the effective date of the Act, all local units of government (cities, villages, counties, and townships) which are situated along the shores of the Great Lakes may zone those high-risk erosion and environmental areas as determined from those studies described in (c) below. If local units of government fail to zone those areas within the three-year period, the Water Resources Commission is authorized to set regulations for the zoning of these properties.
>
> (b) Within eighteen months after the effective date of the Act, the Water Resources Commission is required to prepare a comprehensive plan for overall management of Michigan's Great Lakes Shorelands. It is expected that recommendations emanating therefrom will guide future shoreland use and development.
>
> (c) Within one year after the effective date of the Act, the Michigan Water Resources Commission shall make an engineering study of the shorelands to determine the high-risk erosion areas and to develop alternatives for the best means to prevent such erosion. Similarly, the Department of Natural Resources will make an environmental study of the shorelands

to locate all valuable natural resources and fish and wildlife habitat areas which should be protected from further encroachment or damage.

The zoning regulations for the coastal region around Ludington Harbor do not currently contain rules for the development of high-risk erosion areas. However, the city of Ludington and the adjacent coastal townships plan to rezone their contiguous shoreline properties. The intent is in response to the Department of Natural Resources' designation that most of the related shoreline is a high-risk erosion area. Aside from the municipal works and park areas, zoning of the remaining shore damage area is residential. However, development to date has only been partial. Under the Shoreland Protection and Management Act, the State of Michigan has no control over developed shorelands, and its effect would not eliminate unwise development in those areas subject to erosion. The act would, however, regulate a mandatory building set-back distance on any undeveloped property that remains.

6.07b The zone of adverse harbor influence is subject to regulation under the Flood Insurance Program administered by the Federal Insurance Administration of the Department of Housing and Urban Development (HUD). Community eligibility for participation depends upon the establishment (by the local government) of ordinances restricting building practices in high-risk areas. Although such a program normally considers flooding problems, storm-induced bluff erosion is also included.

6.08 Evacuation and moving of structures would not be warranted even if a cost savings could be realized over the expense of shore protection by other means. Evacuation is rarely acceptable to the interests concerned. At best, it is a temporary measure to be used only in emergency situations where destruction is imminent. Erosion would continue, and the evacuated area would still require direct protection and/or additional evacuation.

6.09 The essence of this third alternative is to provide regulatory protection to humans and property resources. It does not provide for any mitigation of shore erosion. As such it does not satisfy Section 111 of PL 90-483. Erosion and the accompanying damage to the existing shoreline property, both private and public, would continue. It would only prevent an increase in erosion connected damages by limiting the types of property in this area.

6.10 Alternative 4: Partial Removal of the Navigation Structures, Reduction of Project Depth, and Shoreline Management. This alternative would seriously restrict waterborne commerce and be detrimental to local, national and regional development and social well-being. A significant reduction in project depth would be required to allow littoral transport materials to bypass the harbor. Such a depth reduction would restrict the passage of vessels having larger draft requirements. Reduced draft requirements would force reductions in loading capacity. This would make shipping to and from Ludington uneconomical. Ultimately, much of the harbor commerce would shift elsewhere, and related transportation costs would rise. Maintenance of the limited project depths would then become economically unjustifiable.

6.11 Partial removal of the navigation structures would result in a loss of habitat to certain aquatic organisms. Important in this respect is the perch spawning grounds in the riprap adjacent to the breakwater structures. Moreover, breakwater fishing activities would suffer a partial loss. South of the harbor, the high turbidity of associated waters would progressively decrease.

6.12 Alternative 5: Continuous Armor Protection With Bluff Reshapement to a Stable Angle. This alternative would prevent all future damage caused by both the navigation structures and natural processes. However, seawall armor protection has a tendency to cause scour along their bases. This deepening of the lake bottom would result in a loss of recreational potential at the waterfront. Alterations resulting from the emplacement of seawall armor would produce changes in the benthic biotic communities along the shoreline. Foraging by birds and fish would likely be impacted. Reshaping of the bluff would result in loss of real estate and would no doubt necessitate the moving or razing of structures. Alterations in vegetation patterns would occur, possibly inducing changes in the terrestrial animal populations and/or distributions within the area. A continuous belt of armor protection would deprive the littoral stream of its natural input from bluff erosion. Although that deprivation would eliminate existing adverse turbidity conditions in contiguous waters, the erosion problem would move downdrift and eventually necessitate the emplacement of more seawalls. Moreover, such continuous shore protection would be aesthetically displeasing.

6.13 Alternative 6: Groins at the Shore Damage Area. The installation of groins along the shoreline damage area would be an ineffective means of mitigating shore damage because the

prevailing littoral drift is insufficient to fill the groins. Interruption of the existing littoral drift would cause the erosion problem to move downdrift. Eventually, additional protection would be required. Structural property damage would continue with resulting continued economic decline.

6.14 The major littoral movement of sediment is along the shoreline with some losses to the offshore regions. The presence of groins would cause localized rip currents to occur, thereby effecting increases in the rate of sediment loss. Bluff erosion would be accelerated along with corresponding losses of shoreline vegetation. Moreover, contiguous waters would become increasingly more turbid.

6.15 Alternative 7: Artificially Filled Groins. Groins, artificially filled upon initial construction, would reduce shore damage. Annual nourishment would maintain them in a filled condition. Borrow material for initial construction and annual nourishment would be taken from either the harbor entrance channel or a land borrow area. Structural property damage would cease and artificially created beaches within the groin field would serve as recreational bathing beaches. However, the increased rip current concentration would cause increased sediment losses to the offshore. Hence, annual groin maintenance nourishment would exceed that required by the nourishment sites of the proposed action. Moreover, such groins would limit the feeding of downdrift shoreline areas.

6.16 Alternative 8: Offshore Breakwaters. These structures would dissipate wave energy prior to its incidence on the beach. Erosion would continue until the area between the

breakwaters and the water's edge built up to a stable bottom profile, and a protective beach formed. Eventually, damage would be prevented and physical loss of land would cease. However, offshore structures placed parallel to the shoreline would be a hazard to small craft navigation. Also, the erosion problem would not be eliminated, but would move downdrift.

6.17 Alternative 9: Offshore Breakwaters and Annual Beach Nourishment. This alternative would accomplish all of that stated in alternative 8, but more rapidly. Nourishment would establish a stable bottom profile and a protective beach sooner than if equilibrium were developed from materials derived from bluff erosion. Also, the nourishment would serve to alleviate erosion downdrift of the structures. This particular solution appears to offer an attractive scheme to reduce or prevent shoreline erosion.

6.18 Alternatives 10 and 11: Protective Beaches and Feeder Beaches. The two alternatives are discussed together because they are nearly identical and accomplish the same end. Protective beaches and feeder beaches both would serve to restore the littoral drift partially interrupted by the navigation project. Artificial beaches may be constructed by direct placement of material or by stockpiling along the shore with the material distributed by shore currents. Wave action would sort, adjust slopes, and distribute fill material. The initial overall slope of the beach fill would be unavoidably steeper than that of the natural shore area.

6.19 Regardless of the method of placement, the same end result would occur. Annual nourishment would be required to balance the diverted littoral drift trapped by the navigation project. After periods of annual nourishment, a protective beach would develop along the shore damage area. This would mitigate damage attributable to the Federal harbor structures. Artificial beaches would be aesthetically pleasing and would provide recreational opportunities. Existing turbid water conditions would no longer prevail.

6.20 As was discussed, the Section 111 authority is not intended to provide mitigation measures which would insure the extent of protection usually associated with regular beach erosion control projects. Both natural and man-made factors prevent the restoration of the affected shoreline to its condition prior to the harbor's construction. The climatic effects of wind and wave actions, violent storms and recent high lake levels, combined with the natural erosion process, have contributed significantly to the deterioration of the shoreline. In addition, adverse effects have ironically resulted from human attempts to protect the shoreline. These factors have been evaluated and given proper weight and consideration in the analysis.

7. RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

7.01 Long-term productivity will be enhanced by the project. Beach nourishment will stabilize the shore area and reduction of erosion will help safeguard the bluffs from much future damage. Presently, larger trees and other types of vegetation are falling into the Lake; property, private homes and municipal works are being threatened; municipalities and many shoreline residents are being caused discomfort and undue financial burdens; and property values are decreasing in affected shore areas. The present condition should be rectified as a result of the project. Returning the drift material to the littoral area will involve minor short-term expenditures of money, manpower, and resources, with resultant long-term gains in preventing shore damage.

8. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

8.01 The irretrievable use of resources for the proposed action include the commitment of manpower, money, petroleum-based fuels and vessels. The petroleum-based fuels to be utilized in the dredging and barging phases of the proposed action constitute an irreversible commitment of limited hydrocarbon resources. Likewise, the manpower, money and use of vessels for the project will be irretrievable. Due to minimum action of the proposed project, the irreversible and irretrievable commitments will be minor. The dredged material for shoreline nourishment represents a gain in a resource, which in the past has been dumped offshore and permanently lost as a source for beach supply.

9. COORDINATION, COMMENTS AND RESPONSE

Coordination with the Public and Other Agencies

9.01 Public Participation. There have been no formal public meetings for the purpose of reviewing or discussing the proposals contained in the Section 111 Detailed Project Report on Shore Damage at Ludington Harbor, Michigan. However, two public workshops were held on 13 November 1974 at the City of Muskegon Municipal Building Council Chambers, Muskegon, Michigan, to discuss ongoing and scheduled Section 111 studies along Lake Michigan. The purpose of these workshops was to provide information and clarification of policy concerning Section 111 studies and to provide the public and all interested parties with an opportunity to express their viewpoints, ask questions and raise issues bearing on the erosion problem to the District Engineer, Detroit District. Approximately 50 persons attended the workshops, and a great deal of information was exchanged. The overall opinion was that the Corps' new advocacy of beach nourishment was a viable means of mitigating erosion damage attributable to Federal navigation structures.

9.02 Government Assistance. On 17 March 1971, the Director of the Michigan Department of Natural Resources requested the Detroit District to take those steps necessary to implement an engineering review dealing with the problem of beach erosion at Ludington, Michigan, along the Lake Michigan frontage. On 15 March 1972, the Chief of Engineers directed that such a study at Ludington be undertaken. Study efforts have concentrated on maximizing expected benefits through the coordination of proposed actions with current operations. Implementation of the proposed

project would take place in spring, in conjunction with ongoing project maintenance dredging. This would be compatible with Michigan DNR Fisheries Division recommendations that implementation of the proposed project, as well as annual activities, occur in the spring, specifically late May to early June or before. Other pertinent information and data were also requested from the Bureau of Sport Fisheries and Wildlife, U.S. Department of Interior; History Division, Michigan Department of State; and others. Copies of related correspondence are presented in Appendix C. Various agencies were also visited in the cities of Ludington, Lansing, and Detroit, Michigan, from whom a great deal of information was acquired for incorporation into this statement. Consultations were also held with representatives of the Coastal Engineering Research Center, Corps of Engineers, concerning erosion problems of the area.

Statement Deliveries

9.03 Agencies and Officials. Copies of the Draft Environmental Impact Statement were sent to the United States Senators and Representatives, the State Governor, concerned Federal and State Agencies, local governments, interested private organizations and concerned citizens. The draft statement was also mailed in response to all requests. The addresses of the requesting citizens or agencies were noted and these interested parties will also receive a copy of the Final Environmental Statement.

9.04 The Draft and Final Environmental Statements have been sent to the following agencies and officials:

Advisory Council on Historic Preservation
Amber Township, Mason County
City of Ludington, Michigan
Federal Power Commission
Great Lakes Area National Park Service
Great Lakes Basin Commission
Hamlin Township, Mason County
Ludington Harbor Commission

Mason County Planning Commission

Michigan Area Council of Governments

Michigan Department of Agriculture/Weather Service

Michigan Department of Commerce

Michigan Department of Natural Resources

Michigan Department of Public Health

Michigan Department of State Highways

Michigan Historical Commission
-Office of the Planning Coordinator

National Marine Fisheries

Pere Marquette Township, Mason County

State of Michigan, State Archaeologist

State of Michigan, State Conservationist

State of Michigan, State Historic Preservation Coordinator

State of Michigan, State Historic Preservation Officer

U.S. Department of Agriculture
-Forest Service
-Soil Conservation Service

U.S. Department of Commerce
-National Marine Fisheries Service
-National Oceanic & Atmospheric Administration

U.S. Department of Health, Education & Welfare

U.S. Department of Housing & Urban Development

U.S. Department of the Interior
-Bureau of Outdoor Recreation
-Bureau of Sport Fisheries and Wildlife
-U.S. Geological Survey

U.S. Department of the Interior (National Park Service) for Investigations of Historical, Archaeological and Paleontological Resources

U.S. Department of Transportation
-Federal Highway Administration
-U.S. Coast Guard

U.S. Environmental Protection Agency

Water Resources Council

9.05 Citizen Groups: The Draft and Final Environmental Statements have also been sent to the following groups:

Advisory Council for Environmental Quality
Black Creek Watershed Group
Federated Garden Club of Michigan
Lake Michigan Federation
Ludington Chamber of Commerce
Manistee County Antipollution Organization
Michigan Audubon Society
Michigan Parks Association
Michigan United Conservation Clubs
National Resources Defense Council
Pere Marquette Watershed Council
Sierra Club, Huron Valley Group
Sierra Club, Midwest Representative
West Michigan Environmental Action Council
West Michigan Shoreline Protection Association

Comments and Response

9.06 The following comment/response section addresses pertinent comments and suggestions submitted by interested agencies, groups, and citizens. In total, 15 replies to the Draft Environmental Statement were received.

FEDERAL AGENCIES

U.S. Department of Agriculture - Soil Conservation Service

1. Comment: We have reviewed the draft environmental impact statment and do not have any comments.

Federal Power Commission - Regional Office

1. Comment: Comments of this office are made in accordance with the National Environmental Act of 1969 and the August 1, 1973 Guidelines of the Council on Environmental Quality. Our principal concern with developments affecting land and water resources is the possible effect of such developments on bulk and electric power facilities including potential hydroelectric developments and on natural gas *pipeline facilities.*

2. Comment: Since the above noted proposed project apparently would pose no major obstacle to the construction and operation of such facilities, we have no comments on the Draft EIS.

U.S. Department of Transportation - Federal Highway Administration, Region 5

1. Comment: As requested, we have reviewed the draft environmental statement for the mitigation of shore damage attributed to Federal Navigation Structures, Ludington, Michigan. We have no comments since the proposed work will not affect any highways.

U.S. Department of Agriculture - Forest Service, Eastern Region

1. Comment: We view the establishment and maintenance of beach nourishment supply areas as an acceptable alternative. The work should be done at periods of the year when conflict with users in the area will be minimized.

Response: Correspondence has been made with Ned E. Frogle, Michigan Department of Natural Resources, Fisheries Division so as to establish the optimum time schedule for such activities in the Ludington area. It was agreed that if the proposed work took place during late May to early June, if not before, no conflict with area anadromous fish species would occur. Work should be completed before the busiest portion of the summer season.

2. Comment: Since the erosion problem is partly attributable to the navigation structure, the atabilization of the bluffs should be accelerated by timely planting of trees and shrubs.

Response: The proposed mitigation plan will stabilize the coastal environment, thereby mitigating erosion of the beaches and bluffs to the extent attributable to the navigation structure, in accordance with the Section 111 authority. A certain portion of bluff instability is due to naturally occurring erosion (e.g. wind, wave, storm, etc.) and mitigation measures to prevent such erosion conditions do not fall under this jurisdiction. However, private land holders desiring to establish vegetation on their beach property to help control erosion should contact the following local Soil Conservation Districts for information as to where to go to obtain dune or beach grass cloves for transplanting:

1. Alle-van Soil and Water Conservation District
   212 E. Main St.
   Fennville, Michigan 49408

2. Ottawa Soil and Water Conservation District
   Federal Building
   Grand Haven, Michigan 49417

3. Manistee Soil Conservation District
   Box 275
   Onekama, Michigan 49675

4. Mason Lake Soil Conservation District
   102 East 5th St.
   Scottville, Michigan 49454

5. Muskegon Soil Conservation District
   Federal Building
   Muskegon, Michigan

3. Comment: We recommend the beaches created by this action be open to the public for shore fishing, swimming and other uses and not used exclusively by adjacent property owners. We feel that is an important concept to be built into projects of this type and would provide for increased public benefit over and above the erosion stabilization. When known, the secondary impact of the future use of the beach areas should be evaluated. The impacts caused by this use, either public or private, may be greater than the initial disturbance caused by enrichment.

Response: Section 111 authority provides for the mitigation of shore damages attributable to Federal navigation works; this includes both public and private properties. Those areas

of beach now open for public recreational use that might benefit from the mitigation plan would remain public trust and promote similar use. Likewise, those frontage lots now privately owned that might benefit from the mitigation plan, including any new lands, would remain privately owned. The Great Lakes Submerged Lands Act (Act 247, P.A. 1955) states that one who owns a frontage lot as a "riparian" under riparian law has ownership control to the water's edge.

U.S. Department of Interior

1. Comment: The effect of continual enlargement of the subaqueous pit by removal of 1.4 million cubic yards of shoal is not properly addressed.

Response: Annual dredging provides a means for removing deposited sediments within a specific waterway. This sediment removal and deposition of new material becomes cyclic; the 1.4 million cubic yards of shoal will be removed over a period of years just as its deposition occurs.

2. Comment: The statement could also be further improved by presenting the various alternatives and their probable impacts or benefits in some form of table.

Response: Information requested can be found in Appendix B, pages B-1 through B-7.

3. Comment: Onshore nourishment would impact upon the environment considerably less than the chosen alternative.

Response: Careful consideration was given to all alternatives involved, including the possibility of placing the nourishment material on the beach versus placement in the waterway. Results would be the same as would the primary environmental impacts. However, for shore placement there would be greater secondary and tertiary effects such as increased economics for additional handling as well as increased social impacts relating to the access through private property and influences at a regional level.

Therefore, the alternative for onshore nourishment was considered not feasible for this study and proposed plan.

4. Comment: Page iv, sentence 1. This paragraph should indicate that damage to the benthos likely will span the life of the project. Total recovery of the benthic community cannot be expected during the period between disruptions should desposition at the same site be repeated for a number of years.

Response: The time required for recolonization of benthic communities is dependent on the development rate and fecundity of those species involved. The freshwater benthic communities expected in the project area are dominated by oligochaetes, primarily members of the families Lumbriculidae and Tubificidae, and chironomid larvae (Diptera chironomidae). Most oligochaetes reach maturity within eight days to 10 weeks. Chironomid larvae generally develop more quickly. Based on these data, it is expected that viable recolonized benthic environment should occur within three to four weeks after the dredging of the borrow sites. Thus, it is reasonable to predict an impact of minor importance and magnitude on the benthic communities.

5. Comment: While the information presented on pages 2 to 5, paragraphs 1.05 to 1.08 appears adequate, clarification would be helpful. In particular, the amount of materials available annually at the harbor entrance, the amount needed for annual nourishment and the amount diverted by the navigation structures should be stated.

Response: Information referencing the amount of material available annually at the harbor entrance (42,500 cu yds), the amount needed for annual nourishment (66,500 cu yds) and the amount diverted by the navigation structures (24,000 cu yds) may be found in paragraph 1.21 on page 19 of section 1.

6. Comment: As described on page 7, paragraph 1.11, the two beach nourishment supply sites should be delineated on Plates 5, 6, 7, and 8.

Response: The suggested changes have been made. Plate 8 remains unchanged due to its cross-sections being located south of the proposed nourishment site.

7. Comment: We suggest Plate 3 (page 8) be revised so that, when it appears in the final EIS, it will indicate the name and boundaries of public recreation areas along the northerly and southerly shoreline. In this way, the reader may compare the location of the proposed shoreline nourishment areas to the location of the public recreation areas.

Response: Plate 3 has been revised to more clearly show public recreational boundaries along the shoreline.

8. Comment: Paragraph 1.21 indicates that 66,500 cubic yards of material will be required for annual nourishment after the first year. However, by deriving the average annual requirement from the sand volumes given on page 7 only 50,000 cubic yards would be needed. This discrepancy should be explained.

Response: An error was found in the aforementioned paragraph. The amount of supplemental material to be used will consist of 24,000 cubic yards/year of sediment taken from adjacent shoal areas and not the stated 14,000 cubic yards. The anticipated 66,500 cu yd/yr. of maintenance material is correct. Please refer to page 19, section 1, paragraph 1.21.

9. Comment: Comments in paragraph 2.62 indicate that the project might have an effect on historic properties. These comments should be expanded to indicate whether or not the project may be expected to have an effect on historic properties which are eligible for addition to the National Register of Historic Places. It is the responsibility of the Federal project sponsor to consult with the State Historic Preservation Officer in making such a determination.

Response: The aforementioned has been addressed in section 2, paragraphs 2.62 through 2.64, pages 67 to 71. Please refer to responses to comments received from the U.S. Department of the Interior and James E. Fitting, State Archaeologist, Michigan History Division, for further clarification.

10. Comment: Paragraphs 2.64 states that an archeological survey was conducted during August and September, 1973, and that no historical or archeological sites were located. However, the scope and extent of this survey is unclear. The statement should provide documentation in the form of a letter from the archeologist conducting the survey.

Response: Mr. Jordon Tannenbaum of the Advisory Council on Historic Preservation; Dr. William Lovis, Jr., for the Conference on Michigan Archaeology; and Dr. James E. Fitting, State Archaeologist, Michigan History Division, Michigan Department of State, were contacted by telephone by J. J. Doline, Physical Scientist, Corps of Engineers, Detroit District, Environmental Resources Branch, to provide a verbal description of the survey referred to in the D.E.I.S. The contents of the telephone conversations are addressed in this revised text under Section 2, paragraph 2.64 as well as in the Comment and Response Section addressing Comments from the aforementioned agencies and/or individuals.

Further, a letter from Dr. Martha M. Bigelow, Director, Michigan History Division and State Historic Preservation Officer (see Appendix C, page C-9) was received, addressing the D.E.I.S.: Mitigation of Shore Damage Attributed to Federal Navigation Structures at Grand Haven Harbor, Michigan, as well as other similar projects including the proposed Ludington Harbor, Section 111 project.

As indicated in the letter received in response to the D.E.I.S. from Dr. William Lovis, for the Conference on Michigan Archaeology (please see Comment and Response Section), "Given that the proposed project will not include construction activities on the shoreline, but will involve submerged lands, I foresee minimal impact on shoreline cultural resources." Further, Dr. James E. Fitting, State Archaeologist, Michigan History Division, corroborated the aforementioned in his letter in response to the D.E.I.S. (please see Comment and Response Section), when he indicated, ". . . and will have little, if any, negative impact on upland or submerged archaeological resources."

11. Comment: It would be desirable in paragraph 3.05 on page 73 to stipulate the amount of land in the area which will be covered by the Michigan Shoreland Protection Management Act.

Response: In view of the facts presented in paragraph 3.04 that the city and coastal townships will be rezoning these coastal lands, it would not be possible at the present time to provide an accurate accounting of these shore areas.

12. Comment: As the project is expected to make the beaches more attractive to recreational use, stabilize the bluffs, and improve the project area's aesthetics, it may engender a significant level of vacation and retirement home construction in the project area. We urge this secondary environmental impact be addressed in the final EIS.

Response: This could be a secondary impact in undeveloped areas. However, only the public recreational beaches now remain undeveloped.

13. Comment: The last sentence in paragraph 4.05 on page 81 indicates that turbidity due to dumping will be an adverse impact north of the harbor, but it does not indicate that turbidity also will accompany dumping south of the harbor.

Response: The aforementioned has been corrected in this revised text.

14. Comment: Paragraph 4.23, page 88. While some of the plankton will only be temporarily disturbed, the balance of the plankton, in addition to the benthic organisms and aquatic plants, likely will be destroyed. The paragraph should indicate that damage to the benthos probably will span the life of the project. Total recovery of the benthic community cannot be expected during the period between disruptions should deposition at the same site be repeated for a number of years.

Response: The time required for recolonization of benthic communities is dependent on the development rate and fecundity of the species involved. The freshwater benthic communities expected in the project area are dominated by oligochaetes, primarily members of the families Lumbriculidae and Tubificidae and chironomid larvae (Diptera chironomidae). Most oligochaetes reach maturity within eight days to ten weeks. Chironomid larvae generally develop more quickly. Based on these data, it is expected that

viable recolonized benthic environment should occur within three to four weeks after dredging and nearshore nourishment have taken place. Those organisms that do perish simply return their constituents to the food chain, resulting in little or no loss of nutrients. Thus, an irreversible or irretrievable commitment of resources of the benthic communities is not expected from this project.

15. Comment: With turbidity occurring for 25 to 30 days of each year, significant impairment of light penetration may be expected and should be addressed on page 93, paragraph 5.02.

Response: Please refer to revised paragraph 5.02 where the aforementioned has been addressed.

U.S. Department of Commerce

1. Comment: Of the two proposed beach nourishment sites, the one on the south side of Ludington Harbor will require three times more initial feeding than that on the north side and over five times more annual nourishment. Determination of the nourishment requirements was based on restoration of natural drift quantities interrupted by the navigation works. In a shoreline reach where Federally built harbors are located on both ends of the reach, the exact determination is not essential of the quantities of drift interrupted by the structures of harbors. However, the littoral drift on shoreline reach south of Ludington Harbor is intercepted on the north by the works of Ludington Harbor and on the south by the structures of privately owned Ludington Pump Storage. The structures of the Pump Storage consist of the rubble mound jetties extending about 1500 feet out from the shore in about 22-foot water depth and of a rubble mound breakwater about 2200 feet offshore in 32 feet of water located across the opening between the jetties (paragraph 2.44). It appears that these structures completely intercept the littoral drift both from the north and from the south. This causes accumulation of drift at the structures and shoreline erosion further away from the structures. The combined effect of the two shoreline structures, Ludington Harbor and Ludington Pump Storage, is a severe erosion which, as stated above, will require annual nourishment five times larger than for the shoreline on the north side of Ludington Harbor.

Since the Corps may not use Federal funds to mitigate shore damages caused by privately owned shoreline structures, an analysis of littoral drift and amounts intercepted by the structures is essential to assess properly the shore damages by Ludington Harbor. Discussion of littoral processes presented in the statement is both incomplete and incorrect. It does not include discussion of the littoral drift past the site of Ludington Pump Storage, and the drift rates past the Ludington Harbor appear to be excessive.

Response: The purpose of this project is to mitigate the effect of the Federal navigation structures at Ludington Harbor on the shoreline. The determination of the area of influence is based mainly on data available before the construction of the Ludington Pump Storage Plant (1971). Therefore, this project will mitigate damage attributed to the harbor and not any damage which might be attributed to Plant. The study also showed that the effect of the harbor did not extend beyond the Pump Storage Plant, which forms a barrier to the littoral movement of material past the structures. The annual nourishment quantities were determined by examining the effects of the Federal harbor structures only. The analysis showed that the harbor intercepted an average of 66,500 cubic yards annually. This average is made up of 42,500 cubic yards annual dredging, 6,000 cubic yards accreting north and 18,000 cubic yards south of the harbor. The net littoral drift, north to south, was determined to be 56,000 cubic yards, and this quantity should be placed south of the harbor. The remainder, 10,500 cubic yards would be placed north of the harbor.

2. Comment: Harbor breakwaters and the 29-foot deep entrance channel completely intercept the drift both from the north and from the south. The drift is deposited essentially in four locations: in front of the breakwaters, in the entrance channel, in deep lake by breakwater-deflected currents, and in the outer harbor by oscillating currents. Only the drift deposited in front of the breakwaters is eroded by shifting waves and currents. The deposits in the other three locations cannot enter the littoral stream due to insufficient forces to pick them up from deposition. Surveys of the hydrography in the vicinity of the harbor, records of dredging, and estimate of erosion provide information on the rate of littoral drift at the harbor site from both directions. Empirical equations based on longshore wave energy, current speed, and effective length

of the shoreline provide a reasonable estimate of individual drift rates from north and from south. The statement estimates the quantities interrupted by the navigation works to average about 66,500 cubic yards per year (paragraph 1.20). On Plate 11, the annual north-to-south drift is shown as being 330,000 cubic yards and from south-to-north, 270,000 cubic yards. This would indicate that about 90 percent of the drift bypasses the harbor, which is obviously incorrect.

Response: The littoral drift quantities shown on Plate 11 are theoretical maximum potential rates based on the formula given in Technical Report 4 (Beach Erosion Board). The Shore Protection Manual by the U.S. Army Coastal Engineering Research Center replaced TR-4 and also provides a formula. However, this formula provides estimates higher yet. Bajorunas (1961, 1970) provides emperical formulas based on Great Lakes data. Estimates based on Bajorunas' formulas are lower than TR-4. None of these formulas provide for consideration of the local geology. The actual rates are dependent on source material availability. The use of the TR-4 formula was preferred because it provides for more conservative results.

3. Comment: Similar analysis of littoral drift past the Ludington Pump Storage is needed to determine the Federal and private shares of costs for mitigation of shore damage. As mentioned above, such split is not essential for a shoreline with Federal structures at both ends of it.

Response: The Corps of Engineers does not have the authority to study and recommend possible mitigation measures for the Ludington Pump Storage Facility. Our study is authorized by Section 111 of the River and Harbor Act of 1968 to study and construct projects for the prevention or mitigation of shore

damages attributed to Federal navigation works.

4. Comment: Plate 13 indicates extensive shore erosion at the Buttersville Park and it appears that in this area, the north-to-south current, deflected by the harbor structures, reaches again the shoreline causing excessive removal of shore material. It is suggested that the nourishment area, as shown on page 8, be extended by about 1,000 feet in the northerly direction.

Response: The proposed nourishment site was designed so that material placed there will move both north and south supplying nourishment for the above-mentioned area.

5. Comment: A few typing errors were noted. In paragraph 1.21, the 24,000 cubic yards per year appears to be correct instead of 14,000. In paragraph 2.02, water area should replace the shore area.

Response: These corrections have been incorporated into the F.E.I.S.

6. Comment: A water level gage is located in Ludington Harbor. There are geodetic control survey monuments located within the project area. If there is any planned activity which will disturb or destroy these monuments, the National Ocean Survey (NOS) requires not less than 90 days notification in advance of such activity in order to plan for their relocation. NOS recommends that funding for this project includes the cost of any relocation required for NOS monuments.

Response: The proposed project should in no way affect existing NOS monuments or water level gages within the harbor or project area. If the proposed activity does conflict with any of these structures, the proper authorities will be notified.

U.S. Environmental Protection Agency - Region V

1. Comment: We have no major environmental objections regarding the project and believe the EIS provided sufficient information to assess the environmental impacts of the proposed action.

2. Comment: It is stated on page 10 of the EIS that no sampling station exceeds EPA's acceptable limits for chemical pollution. The table on the same page shows that lead and zinc exceeded the limits at Station G065; thus, the statement should be revised to reflect this marginal exception. Harbor sediments to be used for initial beach nourishment as well as any augmentative material should be analyzed on a periodic basis to insure a non-polluted character and compliance with the suitability requirements of the Section 404(b) guidelines (Federal Register, May 6, 1975, Vol. 40, No. 88).

Response: Marginal contamination of the sediments at Station G065 is correct. Change has been made in Table 1. See Comment 2 MDNR, page 114.

3. Comment: Detailed water quality monitoring plans should be explained in the Final EIS. Specifically, the responsible local agency, the parameters to be tested, and the frequency and location of sampling should be determined.

Response: During all phases of construction, water quality will be monitored to insure that no degradation occurs in the vicinity of the municipal water intake located approximately 3500 feet north of the harbor structures and approximately 3000 feet west of the shoreline, in approximately 35 feet of

water. The continuing established procedure will include notification of the Michigan Department of Natural Resources by the Corps of its intent to initiate the proposed mitigation procedures. In addition, the Michigan Department of Natural Resources will be required to coordinate the enforcement at their level (e.g., other appropriate State agencies such as the Michigan Department of Health). The Corps will coordinate its proposed action with the local community. Following past procedures, the Ludington Water Department will be asked to monitor the quality of the water to insure that no degradation occurs in the vicinity of that city's municipal water intake. If any variation in acceptable standards (e.g., turbidity, pH, alkalinity, phenols, chlorides, total solids, sulphates, fluorides, total iron, nitrates, magnesium, total coliform, fecal streptococci, fecal coli, color index or dissolved oxygen) is noted during monitoring operations, the City will notify the U.S. Army Corps of Engineers, Detroit District, Grand Haven Area Office and/or the U.S. Coast Guard and/or the Corps Detroit District Office; at which time the Corps mitigation activities will be immediately stopped until corrective action satisfactory to all parties concerned can be initiated.

4. Comment: The shoal areas that will be used to augment harbor dredged material for beach nourishment should be delineated on a map and their biological productivity discussed.

Response: Please see Plate 3, page 8, for locations of the shoals that will be used to augment harbor dredged material for beach nourishment. These areas have been designated as the accretion areas to either side of the harbor. It is generally accepted that shifting unstable bottom sediments, caused by wave and current action, do not produce optimum conditions for a productive biological community.

5. Comment: Finally, we suggest that the Corps of Engineers' Dredged Material Research Program conduct an analysis on the success of the proposed project as well as its effects on the open water and beach ecosystems involved.

Response: Your comment has been forwarded to the Corps of Engineers Waterways Experimental Station in Vicksburg, Mississippi, which is responsible for the Corps' Dredged Material Research Program.

6. Comment: As indicated in the above discussion and in accordance with EPA procedures, we have classified our comments as LO, lack of objection, and have rated the Draft EIS as Category 1, sufficient information. In accordance with our responsibility under Section 309 of the Clean Air Act, the classification and date of our comments will be published in the Federal Register. If you or your staff have any questions concerning our comments, please contact Mr. Gary A. Williams at 312-353-5756. We appreciate the opportunity to review this Draft EIS; please send us two copies of the Final EIS when it is filed with the Council on Environmental Quality.

U.S. Department of Transportation - U.S. Coast Guard

1. Comment: The Draft Environmental Impact Statement referenced above has been reviewed by this office, and at this time we have no comment to offer.

U.S. Department of Agriculture - Forest Service, Northeastern Area

1. Comment: We see no immediate effect of the above project on forested land and have no specific comments.

We appreciate your sending us the statement for review.

STATE AGENCIES

Department of Natural Resources, Director

1. Comment: The material contained in the statement is presented in an orderly, readable manner and is for the most part adequate to determine the environmental impacts that are likely to occur. The presentation of graphic information is also well done.

2. Comment: We are concerned that a sediment sample taken just inside the harbor (STA G065) showed concentrations of lead and zinc in excess of acceptable limits set by EPA for non-contained disposal. We would urge that more than one sample be taken in the area to be dredged in order to confirm more adequately the unpolluted classification of these sediments.

Response: There is some question regarding the concentrations of lead and zinc in bottom sediments just inside the harbor. This question will be resolved prior to project implementation by way of sediment analysis in accordance with P.L. 92-500 and EPA regulations. During the mitigation activities, the water quality will also be monitored to insure minimal degradation (see paragraph 1.32).

3. Comment: We do not agree with either the importance rating or the magnitude rating in the matrix on page 78, regarding the effect of dredging and disposal upon recreation. During this activity there would very likely be a substantial loss of pier and shore fishing due to the high turbidity levels. This activity would span about 30 days per year over

the first four years and 10 days a year thereafter. We would suggest that the associated impacts on recreation would accordingly be significant, and that it should be so stated in the final environmental statement.

Response: Impacts associated with proposed dredging and dumping activities have been re-evaluated; a brief discussion follows:

Previous annual maintenance dredging operations produced several negative environmental impacts, including: temporary increases in water turbidity at the dredging site, local destruction of benthic organisms and drifting plankton, temporary local displacement of fish populations, inconveniences to the recreation and commercial boat traffic, and disturbances of shoreline serenity and aesthetics. Under the proposed action, dredging procedures will be similar to those of the recent past. Only the duration of dredging will differ, primarily as a result of the increased quantities to be dredged. Scheduled for prior to early June, the project would have the least impact upon fish and fishing activities at the dredge site. It is anticipated that both the initial establishment phase and subsequent periodic nourishment operations will be carried out in late spring or early summer, and thus will avoid interference with recreational fishing of the summer. The environmental factors affected by the proposed project will be the same as those impacted by past dredging activities; and the project scheduling is such as to minimize impacts to recreational fishing. Hence, the magnitude of the impact associated with prolonging these effects (due to increased dredging time) would be insignificant.

Due to the seasonal popularity of recreational fishing around the harbor structures, an impact of discernible importance would result should these activities be disturbed.

Alteration of the shoreline including the actual dumping of the dredged material into the shallow offshore waters, will result in a mixture of positive and negative impacts. Recreational activity which is popular along the coastline will be affected by this action aspect. Newly developed beaches would provide additional locations for swimming, sunbathing, and beach-strolling activities. On the other hand, recreational fishing from the shoreline may be affected on a short-term basis due to the deposition of material at selected nourishment locations. However, the timing of material deposition has been so arranged that these effects are to be minimized. Fishery activities are expected to return to normal within a short period of time. Thus, the major impact considered here is that of beach development, resulting in a positive net impact of moderate magnitude. The importance of this impact to the general area would be significant since alteration of the shoreline would result in beaches of additional capacity and aesthetic value.

4. Comment: The species lists in tables 10-13 (pages 60, 62, 64-66) contain many errors and should be corrected in the final statement and in future similar draft statements, by consulting publications of the Fisheries and Wildlife Societies. As an example, the following corrections should be made in the fishes listed in table 10 (page 60):

FROM	TO
Coregonas artedii	Coregonus artedii
Coregonas reighardi	Coregonus reighardi
Coregonas zenithicus	Coregonus zenithicus
Leucichthys kiyi	Coregonus kiyi
Coregonas clupeaformis	Coregonus clupeaformis
Coregonas hoyi	Coregonus hoyi
Cottus bairdii	Cottus bairdi
Burbat	Burbot
Osmerus esperlanus	Osmerus mordax
Perca caprodes	Percina caprodes
Percopsis omiscomaycas	Percopsis omiscomaycus
Oncoryhnchus tschawystsche	Oncoryhchus tschawytscha
Salmo solar	Salmo salar
Exos lucias	Esox lucius

Response: Corrections have been made. Scientific and common names are from Fishes of the Great Lakes Region, Hubbs and Lagler, 1958 (Preface, 1964).

5. Comment: In the same table, the emerald shiner is a threatened species in Lake Michigan while the yellow perch and atlantic salmon are neither threatened or endangered species. The status indicated should be revised accordingly.

Response: Table 10 has been revised in compliance with information from "Representative Important Species," Michigan Water Resources Commission, Michigan Department of Natural Resources, July 25, 1974. Accordingly, the emerald shiner (*Notropis atherinoides*) is listed as a common forage species, not threatened or endangered, for the zone including Ludington Harbor.

6. Comment: Page 8, Plate 3 - The area that is indicated for shoreline nourishment north of the harbor extends to the

Lincoln River and whether this could interfere with boating.

Response: In view of the aggravated shoaling problem at the Lincoln River which the proposed project may create, the project has been re-designed to include a more southernly deposition site. For further clarification, please refer to comments 3 and 4, Epworth Assembly, and Plate 3, page 8 for revised site location.

7. Comment: Page 48, Section 2.36 - This paragraph should be expanded to include chinook salmon as an important introduced species. Chinook migrate up the Pere Marquette River making them important to local fishing in Lake Michigan, Pere Marquette Lake, and in the river itself.

Response: Coho and chinook salmon are addressed in revised paragraph 2.53.

8. Comment: Page 63, Section 2.58 - We suggest changing the second and third sentences to read as follows: "In this regard, projects scheduled PRIOR TO late May and early June would have the least impact. It is anticipated that both the initial establishment phase and subsequent periodic nourishment operations will be carried out in late spring or EARLY summer....

Response: Paragraph 2.58 has been revised accordingly. In the event of equipment unavailability or similar constructional limitation at the designated time, the project will be rescheduled within the new engineering constraints so as to minimize possible adverse effects.

9. Comment: Page 81, Section 4.06 - It is our opinion that various organisms will not recover "rather quickly" as indicated in this section. We suggest that these two words be deleted from the text.

Response: The time required for recolonization of benthic communities is dependent on the development rate and fecundity of those species involved. The freshwater benthic communities expected in the project area are dominated by oligochaetes, primarily members of the families Lumbriculidae and Tubificidae, and chironomid larvae (Diptera chironomidae). Most oligochaetes reach maturity within eight days to 10 weeks. Chironomid larvae generally develop more quickly. Based on these data, it is expected that a viable recolonized benthic environment should recur within three to four weeks after the cessation of material deposition.

10. Comment: Page 83, Section 4.4 [sic] - We suggest that various forage species would be disturbed more extensively than perch or salmon in the area to be nourished.

Response: Reference to perch in this paragraph (4.11) is by way of example; certainly other fish would also be affected. Generally, these fish would include sturgeon, lake trout, and those of the whitefish family. The aforementioned paragraph has been revised for clarity.

11. Comment: Page 88, section 4.23 - We suggest the last sentence be expanded to read, "Perch spawning and salmon migration activities will not be affected WHEN DREDGING IS CONDUCTED PRIOR TO JUNE."

Response: Comment has been incorporated in revised paragraph 4.23.

12. Comment: Page 89, Section 4.24 - We suggest that the degree of impact on sporting activities depends on the time frame of dredging as it relates to peak fishing activity. This impact can be of minimal importance, as stated, only when dredging is scheduled to occur before the peak fishing activity begins. This qualification should be so written in the statement.

Response: The environmental factors affected by the proposed dredging activities, including sport-fishing, will be the same as those impacted by past dredging activities. Due to an expected increase in dredging time, these affects will be prolonged. However, the magnitude of the associated impact would be insignificant if dredging is conducted prior to June, as proposed. Due to the popularity of fishing in the harbor area, the presence of a hopper-dredge and associated turbidities would result in an impact of discernible importance. Refer to revised paragraphs 4.21 and 4.24, and the revised impact matrix for clarity.

13. Comment: Page 94, Section 5.04 - It is stated that the nourished beaches will, in time, repopulate with organisms that prefer sediment habitats. It should also be noted that this would not compare favorably to the density of organisms that would be sacrificed by covering the rubble and pilings with sand.

Response: Comment has been incorporated in revised paragraph 5.04.

14. Comment: Page 103, Section 6.12 - It is stated in the third sentence that deepening of the lake bottom due to scouring along a seawall base would result in a loss of recreation. This is not necessarily so. In the past, deepening of inshore areas has attracted fish and resulted in a significant sport fishing.

Response: The presence of sea-wall armor protection reduces beach and shallow water accessibility. Furthermore, a deepening of the lake bottom, due to scouring along the bases of the armor plates, eliminates potential shallow-water wading and beach use at these sites. Alterations resulting from the emplacement of seawall armor would produce changes in the benthic biotic communities along the shoreline, which may impact fish and birds, as stated in paragraph 6.12.

Michigan Department of State - Michigan History Division, Director

1. Comment: Dr. Lawrence Finfer, Historic Preservation Coordinator, and Dr. James Fitting, State Archaeologist, have

reviewed the Draft Environmental Statement for the project at Ludington Harbor, Ludington, Michigan. There is only one historic site in the project area: Marquette's Death Site, State Site No. 278, Buttersville Point. It is unlikely that the project will have a negative impact on this site.

2. Comment: The project's minimal impact on historic and archaeological resources notwithstanding, Dr. Fitting is quite concerned about the report of an archaeological survey that may not have been carried out by an archaeologist. He feels that an acceptable statement on archaeological survey must identify the archaeologist and contain, in full or summary, a copy of this person's report or a written, signed statement on the absence of archaeological sites.

Response: No archaeologist was named, nor was any report incorporated into the EIS, because during August and September 1973, a reconnaissance of the proposed project area was conducted for the purpose of determining the need for an archaeological survey to identify potential historical, geological and paleontological sites. Investigations were conducted by Corps staff including a professional geologist-paleontologist familiar with present and historical processes which identify the physical characteristics and potential of the proposed project site for prehistoric or historic cultural material. The reconnaissance of the proposed mitigation plan site, located in a dynamic shoreline zone characterized by critical ongoing erosion, identified no historical structures or surface traces of prehistoric or historic cultural material noting the presence of archaeological sites that would be directly impacted by the project; therefore, no archaeological survey was deemed necessary. Further clarification can be found in paragraph 2.64 of the revised text.

It should be noted that in response to the Corps Mandate for Recording and Preserving Historical and Archaeological Finds within affected project areas, all items of apparent historical or archaeological interest which are discovered in the course of construction activities shall be carefully preserved. The contractor (if any) shall leave the archaeological find undisturbed, and shall immediately report the find to the Contracting Officer so that the proper authorities may be notified.

Michigan Department of State - Michigan History Division, State Archaeologist

1. Comment: I have reviewed the draft Environmental Impact Statement "Mitigation of Shore Damage Attributed to Federal Navigation Structures at Ludington Harbor, Michigan" and agree with the conclusion that this project is largely beneficial and will have little, if any, negative impact on upland or submerged archaeological resources. I also welcome your statement on the importance of confidentiality on site location, particularly for sites not immediately endangered by the project.

2. Comment: The statements or archaeological survey on pages 70 and 71, however, are unsatisfactory. An archaeological survey can be conducted only by a trained professional archaeologist who is familiar with the area or who has worked in similar areas. Since no archaeologist is named and no report is enclosed, I suspect that the "survey" reported in this statement was not carried out by a professional archaeologist and, therefore, has no validity. If the statement contains one such unverified assertion, how many more might be present in the document? In this instance, your conclusions may be correct but the method used to reach these conclusions may be untenable.

Response: Please refer to the response to comment No. 2 from the Michigan History Division, Michigan Department of State, and in revised paragraph 2.64.

Department of State Highways and Transportation - Environmental and Community Factors Division

1. Comment: The proposed use of dredged materials for shoreline restoration would seem to be a preferable alternative to the current practice of dumping in deep water lake areas.

2. Comment: Although the Draft Environmental Statement is generally of excellent quality, there are numerous errors in identification and nomenclature for those wildlife species shown in Tables 10, 11, 12 and 13 in the section Shoreline Ecology. These errors should be corrected in the Final Environmental Statement.

Response: The tables have been revised to agree with: "Representative Important Species," *Water Resources Commission*, Michigan Department of Natural Resources, July 25, 1974; Checklist of North American Birds, American Ornithologist's Union, 1957; and Fishes of the Great Lakes Region, Hubbs and Lagler, 1958.

Michigan State University, Curator of Great Lakes Archaeology

1. Comment: Given that the proposed project will not include construction activities on the shoreline, but will

involve submerged lands, I foresee minimal impact on shoreline cultural resources.

2. Comment: However, I must again question whether the archaeological survey conducted concurrent with the geological investigation (p. 70, Sec. 264) was performed by a professional archaeologist. Due to the specialized nature of such reconnaissance it is necessary that these actions be performed by qualified individuals. Although the present project will have minimal impact on shoreline cultural resources, future projects with more intense impact that have had survey performed by non-professionals may well need re-survey.

Response: Please refer to the response to comment No. 2 from the Michigan History Division, Michigan Department of State, and in revised paragraph 2.64.

INTERESTED ORGANIZATIONS

Epworth Assembly

1. Comment: The above-mentioned project of Deep Draft Harbor Modification at Ludington affects our Assembly directly since it becomes the northerly shoreline nourishment location for the Harbor deposits (ref: drawing #3, page 8). The 100,000 cubic yards is a monumental quantity of material, and we are concerned about how it will be placed. Under no circumstances will we allow these deposits to alter our natural beach available to us in periods of normal water levels. Any artificial formation of high sand bars will not be acceptable to us; however, we would accept deposits on our shoreline adjacent to our sea walls if it meets the quality of sand which now is in this location.

Response: Placement of the nourishment material will be between the first and second offshore bars. Elevation of the feeder site will be such that it will have a greater depth than the second bar area.

2. Comment: Your proposal of deposit sites between 200 feet and 400 feet offshore is not acceptable since many shallow draft boats and also swimming take place in this vicinity.

Response: As described in Comment 1, the feeder beach will provide adequate depth for boating and other offshore activities that are not impeded by the normal contours of the second bar area.

3. Comment: Referring to your drawings, the 12000-11000 proximity is in the general vicinity of the Lincoln River where it enters Lake Michigan and is now kept open for small pleasure craft entering and departing from Lincoln Lake and the Epworth Assembly Marina. We have been using this river entrance successfully at a considerable expense to the Assembly since we have

made many important improvements. Therefore, we do not under any circumstances wish to see this entrance deteriorate but rather improve it as the high water levels recede. There is a possibility that a request will be made from the Corps of Engineers and the State of Michigan to extend the opening of the Lincoln River into Lake Michigan at some future time, and we are presently watching the build up of sand in front of the opening.

Response: David Roellig and Charles Kureth of the Detroit District Corps of Engineers met with Kai H. Hansen and Norman A. Peterson of the Epworth Assembly on 21 November 1975. At the conclusion of the meeting, it was agreed, by both concerned parties, that the feeder beach site would be moved 2500 feet to the south of the original proposed project site. Please see Plate 3, page 8, for revised site location.

4. Comment: The point I am referring to is that the offshore deposits will drift sand in a northerly direction under certain current conditions and make it impossible to use the Lincoln River as a natural waterway. This river also is a great water entrance for all kinds of fish migration, brown trout, steel heads, salmon, etc. This sport fishing is enjoyed by all people in this vicinity; if the entrance is blocked this will also cease to exist.

Response: The aforementioned Comment was addressed at the meeting of 21 November 1975. The agreed relocation of the north feeder beach will be sufficient to eliminate the concern for shoaling at the mouth of the Lincoln River as a product of the proposed project.

5. Comment: The work on this Federal funded project must not take place during the summer months when all activity in the area is at its highest.

Response: Refer to U.S. Department of Agriculture Comment 1.

6. Comment: We would like to further share our opinions with you so as to come to a mutual agreement on this project without resorting to legal means, which we are prepared to do. We are looking forward to your immediate reply so that it can be discussed at our Annual Board Meeting held in early December.

Response: Hopefully this information was transmitted during the meeting of 21 November 1975.

GLOSSARY

accretion - natural accretion is the gradual build-up of land over a long period of time solely by the action of the forces of nature, on a BEACH by deposition of water- or air-borne material. Artificial accretion is a similar build-up of land by reason of an act of man, such as the accretion formed by a groin, breakwater, or beach fill deposited by mechanical means.

agriculture and undeveloped lands - this type of shoreland use includes croplands, pasturelands, and all vacant and undeveloped lands except forests and wooded areas.

algae - primitive aquatic plants, either one- or multi-celled, capable of photosynthesis. These plants are a source of food for the higher forms of life and, like all plants, put oxygen into the water.

alluvial deposit - sediment (sand, silt or detrital material) deposited in place by the action of streams.

artificial nourishment - the process of rebuilding a beach by the replenishment of beach materials by artificial means such as the deposition of dredge spoil.

artificial beach - an area of the shoreland that has been artificially modified by man through the placement of structures, by filling, or by dredging so that the original natural shoreline no longer exists.

backshore - that zone of the shore or beach that lies landward of the foreshore which is usually dry and only affected by wave action generated by severe storms.

beach - a shoreland zone of unconsolidated material that extends landward from the shoreline to the place where there is a marked change in material or physiographic form or to the line of permanent vegetation. The lakeward limit of a beach includes the foreshore and backshore.

beach erosion - the carrying away of beach materials by wave action, tidal currents, or littoral currents, or by winds.

beach width - the horizontal dimension of the beach as measured normal to the shoreline.

benthos - the group of organisms which comprise the aquatic bottom community.

biota - animal and plant life of a stream or other water body.

bluff - a high, steep bank of cliff, especially beside a body of water.

BOD - an abbreviation for biochemical oxygen demand which is the quantity of oxygen consumed in the biochemical oxidation of organic matter in a specific time, at a specified temperature.

breakwater - a structure for breaking the force of waves to protect craft anchored in a harbor or to protect a beach from erosion. An offshore barrier may be either an artificial structure or a natural formation. Sometimes it is connected at one, or both, ends with the shore.

coastal area - the land and sea area bordering the shoreline.

coast line - (1) technically, the line that forms the boundary between the coast and the shore; (2) commonly, the line that forms the boundary between the land and the water.

COD - an abbreviation for chemical oxygen demand. This term is a measure of oxygen consuming capacity of organic and inorganic matter present in water or wastewater.

coliform - a group of bacteria which includes all aerobic and facultative anaerobic gram-negative bacilli that ferment lactose with the production of gas.

commercial - this type of shoreland use generally includes buildings, parking areas and other lands directly related to retail and wholesale trade and business and professional services. Examples of commercial land uses are stores, gas stations, motels, marinas, professional buildings, and restaurants.

contour - (1) a line connecting the points, on a land or submarine surface, that have the same elevation; (2) in topographic or hydrographic work, a line connecting all points of equal elevation above or below a datum plane.

conventional pollutants - phenols, phosphorous, nitrogen, iron, oil and grease, solids and heavy metals other than mercury.

current, coastal - one of the offshore currents ›wing generally parallel to the shore line with a relatively uniform velocity (as compared to the littoral currents). They are not related genetically to distribution of mass in lake waters (or local eddies), and wind-driven currents.

current, littoral - the nearshore currents primarily due to wave action, e.g., Longshore currents and Rip currents.

downdrift - the predominant direction of movement of littoral materials.

dredge spoil - material removed from the bottom of a lake or river by a process known as dredging.

drift - (1) the speed at which a current runs; (2) also, floating material deposited on a beach (driftwood); (3) a deposit of a continental ice sheet, as a drumlin; (4) sometimes used as an abbreviation of littoral drift.

dunes - ridges, mounds or hills of loose, windblown material, usually sand. Stable dunes are those which are covered with vegetation and generally not readily susceptible to erosion by wind or water runoff. Unstable dunes are those which are bare of vegetation and subject to movement or erosion by both wind and water.

ecology - the study of organisms in relation to their environment.

environmental areas - areas of the shorelands both upland and offshore, which provide habitat for fish, wildlife and other aquatic life, contain unique populations of flora and fauna, or are otherwise ecologically significant.

environmental impact - a word used to express the extent or severity of an environmental effect.

erosion - the wearing away of the land by the action of wind, water, gravity or a combination thereof. Shoreland erosion on the Great Lakes is most often a result of a combination of (a) wind driving waves beating upon the shore and forming littoral currents, and (b) high water levels.

fecal coliform - portion of the coliform group present in the feces of warm-blooded animals, which produces gas from lactose at 44.5^{o}C.

feeder beach - an artificial beach formed by the deposition of imported sediments on the shoreline for the purpose of supplying materials into the littoral stream.

foreshore - that zone of the shore or beach lying landward of the shoreline which is usually wet and directly affected by all wave action.

forest - this land use consists of all public and private and forested areas or woodlands which are not designated as recreational lands.

freeboard - the additional height of a structure above design high water level to prevent overflow. Also, at a given time the vertical distance between the water level and the top of the structure. On a ship, the distance from the water line to main deck or gunwale.

gabion - a specifically designed basket or box of corrosion resistant wire used to hold rock and other coarse aggregate. Gabions may be locked together to form groins, seawalls, revetments, deflectors, breakwaters and other protective structures for erosion control. Their flexible construction permits minor adjustments of alignment resulting from undercutting, filling and settling.

geomorphology - that branch of both physiography and geology which deals with the form of the earth, the general configuration of its surface, and the changes that take place in the evolution of land forms.

Great Lakes Region - the boundary of the Great Lakes Basin defined by selected county lines for statistical data availability and economic analysis.

groin - a shore protective structure (built usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore. It is narrow in width and its length may vary from less than one hundred to several hundred feet (extending from a point landward of the shoreline out into the water). Groins may be classified permeable or impermeable and may be manufactured of wood,

concrete or steel. Impermeable groins have a solid or nearly solid structure. Permeable groins contain openings of sufficient size to permit passage of large quantitites of littoral drift.

groundwater - water in the pores and crevices of the earth's mantle rock which has entered it as rain percolating down from the ground surface.

harbor - an area of water along the shoreline which affords shelter to commercial and recreational water craft. It may have been formed naturally or artificially, or by the artificial improvement of a natural shore feature. Harbors may be classified as commercial harbors or harbors-of-refuge. Commercial harbors are deep-draft harbors designed primarily for overseas or domestic vessels engaged in waterborne commerce. Harbors-of-refuge are small harbors along the shores of the Great Lakes located between commercial harbors and designed mainly to be a place of refuge for small recreational craft during storms.

high water line - in strictness, the intersection of the plane of mean high water with the shore. The shoreline delineated on the nautical charts of the National Ocean Survey is an approximation of the Low Water Datum.

hopper dredge - a vessel equipped with two drag and suction pipes to "vacuum" the water floor and with hopper bins to store the dredged material which will finally be pumped into a disposal area.

impact matrix - an array of numerical values in prescribed form which quantify the impact of the action aspects (columns) upon certain environmental factors (rows).

industrial - this type of land use includes all industrial buildings, parking areas, adjacent yards and landscaped grounds. Included are warehousing, mining and other extractive industries, manufacturing industries, steel mills, private utilities and railroad facilities.

jetty - this term is used synonymously with groins on ocean sea coasts and are designed to prevent shoaling by littoral materials in channels. They are often constructed at the mouth of a river or tidal inlet to help deepen and stabilize the channel.

levee - a dike or embankment for the protection of land from inundation.

littoral - pertains to the shore, either or both the shoreland and shore waters and nearshore bottom of a lake.

littoral deposits - deposits of littoral drift.

littoral drift - the bottom materials moved in the littoral zone under the influence of waves and current. Direction of movement or "transport" of littoral materials depends upon wind, wave, and current direction.

littoral transport - the movement of material along the shore in the littoral zone by waves and currents.

low water datum - an approximation to the plane of mean low water that has been adopted as a standard reference plane.

marsh - a tract of soft, wet or periodically inundated land, generally treeless and usually characterized by grasses and other low growth.

monitoring program - an investigation before, during and after a project to study effects.

mooring facility - a place where a ship is fastened.

nodal-zone - an area at which the predominant direction of the littoral transport changes.

non-structural measures - the management, utilization or control of water and related shorelands without structural development to achieve a desired goal or objective. Recommendations for non-structural measures for the shorelands of the Great Lakes in this study will often apply most reasonably to undeveloped portions of the shorelands.

offshore - in beach terminology, the comparatively flat zone of variable width, extending from the breaker zone lakeward.

pier - a structure extending out into the water from the shore to serve as a landing place, a recreational facility or to form a channel rather than afford shoreland protection.

pile - a long, slender piece of wood, concrete, or metal to be driven or jetted into the earth or sea bed to serve as a support or protection.

pile, sheet - a pile with a generally flat cross-section to be driven into the ground or sea bed and meshed or interlocked with like members to form a diaphragm, wall, or bulkhead.

plain - a low-lying, relatively flat shoreland which extends several hundred feet landward from the shoreline.

plankton - drifting organisms, usually microscopic, floating or weakly swimming in a body of water.

pollutant - matter in the environment that exceeds established levels of tolerance set by man for his health, comfort and well-being.

profile, beach - the intersection of the ground surface with a vertical plane; may extend from the top of the dune line to the seaward limit of sand movement.

public buildings and related lands - this shoreland use includes all buildings and related grounds belonging to public or quasipublic agencies, governments, or organizations. This would encompass medical facilities, educational facilities, religious institutions, governmental administration and service buildings, military installations, water and sewage treatment plants, and airports.

pumpout station - a temporary dock where a connection is made between land and dredge pipes; a booster pump may be used.

recreation and other urban public use space - this shoreland use contains all designated public outdoor recreation lands and associated facilities. Privately owned outdoor recreation lands, such as golf courses, tennis clubs, amusement parks, and race tracks are included. Cemetaries have been placed in this category as well.

residential - residential shoreland use has been defined to include four or more single or multi-family dwelling units adjacent to each other. Also included within this category are churches, elementary schools, small neighborhood parks, and small isolated commercial buildings, such as a neighborhood grocery store, within the boundaries of the residential area.

revetment - a facing of stone, concrete, etc., built to protect a scarp, embankment, or shore structure against erosion by the wave action or currents.

riparian - one who owns land on the bank of a natural watercourse or body of water.

riparian right - the right of an owner of land bordering on a stream or lake to have access to, and use of, the shore and water. The use of this water is restricted to riparian landowners, and the right is automatic, not created by use nor forfeited through disuse.

riprap - a layer, facing, or protective mound of stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment; also the stone so used.

rubble-mound structure - a mound of random-shaped and random-placed stones protected with a cover layer of selected stones or specially shaped concrete armor units. (Armor units in primary cover layer may be placed in orderly manner or dumped at random).

run-up - the rush of water up a structure on the breaking of a wave. The amount of run-up is the vertical height above still water level that the rush of water reaches.

scientific nomenclature - scientific nomenclature of animals requires (1) that each species and genus found in the world shall have a name that is independent of change, such as pertains to common names used in many languages; (2) that each species and genus shall have separate names duplicated by none which refer to some other species or genus; and (3) that different names shall not be applicable to any one species or genus. The following is a breakdown of Categories of Higher Rank than Species and Genus:

Kingdom
Phylum
Class
Order
Family
Tribe
Genus
Species

Referencing the above, a glossary of fish families follows:

Family Acipenseridae - the sturgeon family, consisting of temperate water fishes in the northern hemisphere. Members of this family are of great commercial and sportfishing value.

Family Catostomidae - a family which is composed of small fish commonly called suckers. Members of this family are bottom feeders and are important food sources for larger fish.

Family Clupeidae - the herring family. Members of this family live in large lakes and sluggish areas of large rivers. Most feed on plankton. Fresh water species have little commercial value but play an important role in the diet of many gamefishes. The gizzard shad and the alewife are prominent Great Lakes species.

Family Cottidae - a family of fish consisting of sculpins and related forms. Most of the species of this family are marine, however, a few freshwater species exist, all of which are relatively small.

Family Cyprinidae - the minnow family. Certain members of this family have adapated to living in diverse environmental conditions. Some minnows require water with a high dissolved oxygen content; others, such as the carp, can live almost anywhere. The cyprinids are omnivorous feeders. Smaller members of this family are important as food fish for larger fish.

Family Gadidae - the codfish family which includes some of the most valuable food fishes, such as burbot of Lake Mighican.

Family Osmeridae - the family of the true smelt. These are small inshore cold-water fishes in the northern hemisphere.

Family Percidae - the perch family. This family includes the yellow perch and the walleye, both important economically in commercial and recreational fisheries.

Family Percopsidae - the troutperch. The troutperch live in shoal water of the Great Lakes and some larger inland lakes. They are important as food for gamefish.

Family Salmonidae - the salmon family. The Salmon, trout, and whitefish make up this family of fish. The salmonids live in streams and cold-water lakes and require higher concentrations of oxygen and lower water temperatures than most families. They are very important economically both in commercial and recreational fisheries.

seawall - a structure separating land and water areas primarily designed to prevent erosion and other damage due to wave action.

seiche - a periodic, rapid, and often violent fluctuation or oscillation of the water level of a lake most often caused by winds and barometric pressure. A seiche often occurs after a prolonged period of strong winds from the same direction which causes the water of a lake to pile up on

its windswept side. Seiches can cause fluctuations in water levels of up to eight feet which may result in serious flooding of, or damage to, the adjacent shorelands.

shoal - a place where water is shallow, sometimes created by a sandbar, in the shipping channels, created by deposition of eroded material.

shore - a strip of land bordering any body of water. A shore of unconsolidated materials is usually called a beach.

shorelands - those lands, waters, and lands beneath the waters in close proximity to the shoreline of the Great Lakes. Included, for the purposes of the study, are uplands extending one-half mile landward of the shoreline and bottomlands and waters extending two miles lakeward of the shoreline.

shorelines - the line forming the intersection of the water with the shore. This line, of course, will vary depending upon the water levels of the Great Lakes.

shoreline protection - structural measures designed for placement along the shore to relieve erosion and flooding damages. Examples of structural measures are protective beaches, seawalls, groins and revetments.

shore type - the character of the shoreland immediately adjacent to the shoreline based upon the physical features of height, composition and erodibility. Shoretypes used in this study are low plain, high bluff, low bluff, high dune, wetlands, and artificial.

slope - the degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating 1 unit rise in 25 units of horizontal distance; or in a decimal fraction (0.04); degrees (2^{o} 18'); or percent (4%). It is sometimes described by such adjectives as: steep, moderate, gentle, mild or flat.

still water level - the elevation of the surface of the water if all wave action were to cease.

substrate - any substance used as nutrient by a microorganism.

tide - the periodic rising and falling of the water that results from the gravitational attraction of the moon and sun acting on the rotating earth.

topography - the configuration of a surface including its relief, the position of its streams, roads, buildings, etc.

turbidity - condition of water caused by the presence of suspended matter, resulting in the scattering and absorption of light rays.

water quality - the chemical, physical, and biological characteristics of water with respect to its suitability for a particular purpose.

wave - a ridge, deformation, or undulation of the surface of a liquid.

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APPENDIX A

CRITERIA FOR DETERMINING ACCEPTABILITY OF DREDGED SPOIL TO THE NATIONS WATERS

OCTOBER 1972

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region V
Michigan District Office
Grosse Ile, Michigan

APPENDIX A

CRITERIA FOR DETERMINING ACCEPTABILITY OF
DREDGED SPOIL DISPOSAL TO THE NATION'S WATERS

Use of Criteria

These criteria were developed as guidelines for EPA, WQO evaluation of proposals and applications to dredge sediments from fresh and saline waters.

Criteria

The decision whether to oppose plans for disposal of dredged spoil in U.S. waters must be made on a case-by-case basis after considering all appropriate factors; including the following:

(a) Volume of dredged material.
(b) Existing and potential quality and use of the water in the disposal area.
(c) Other conditions at the disposal site such as depth and currents.
(d) Time of year of disposal (in relation to fish migration and spawning, etc.).
(e) Method disposal and alternatives.
(f) Physical, chemical, and biological characteristics of the dredged material.
(g) Likely recurrence and total number of disposal requests in a receiving water area.
(h) Predicted long and short term effects on receiving water quality.

AD-A106 932 CORPS OF ENGINEERS DETROIT MI DETROIT DISTRICT F/G 13/2
MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION--ETC(U)
DEC 75

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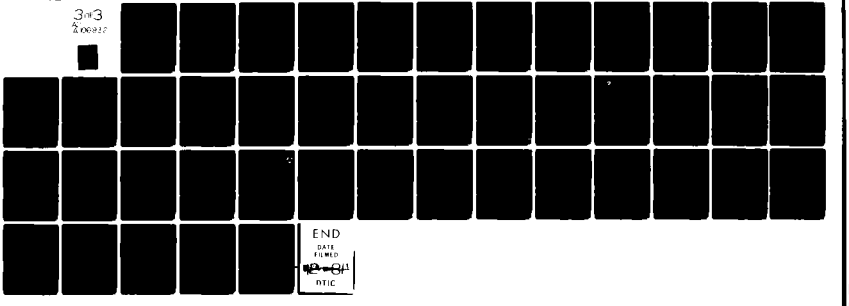

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When concentrations, in sediments of one or more of the following pollution parameters exceed the limits expressed below, the sediment will be considered polluted in all cases and, therefore unacceptable for open water disposal.

Sediments in Fresh and Marine Waters	Conc. Percent (dry wt. basis)	Mg/Kg
Volatile Solids	6.0	-
Chemical Oxygen Demand (COD)	5.0	50,000
Total Kjeldahl Nitrogen	0.10	1,000
Oil-Grease	0.15	1,500
Mercury	0.0001	1
Lead	0.005	50
Zinc	0.005	50

The volatile solids and COD analyses should be made first. If the maximum limits are exceeded, the sample can be characterized as polluted and the additional parameters would not have to be investigated.

Dredged sediment having concentrations of constituents less than the limits stated above will not be automatically considered acceptable for disposal. A judgment must be made on a case-by-case basis after considering the facts listed in (b) through (h) on the preceding page.

In addition to the analyses required to determine compliance with the stated numerical criteria, the following additional tests are recommended where appropriate and pertinent:

Total Phosphorus

Total Organic Carbon (TOC)

Immediate Oxygen Demand (IOD)

Setteability

Sulfides

Trace Metals (iron, cadmium, copper, chromium, arsenic, and nickel)

Pesticides

Bioassay

The first four analyses would be considered desireable in almost all instances. They may be added to mandatory list when sufficient experience with their interpretation is gained. For example, as experience is gained, the TOC test may prove to be a valid substitute for the volatile solids and COD analyses. Tests for trace metals and pesticides should be made where significant concentrations of these materials are expected from known waste discharges.

All analyses and techniques for sample collection, preservation, and preparation shall be in accord with a current EPA, WQO analytical manual on sediments.

SECTION 111

ENVIRONMENTAL STATEMENT

MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES AT LUDINGTON HARBOR, MICHIGAN

APPENDIX B

IMPACT OF ALTERNATIVE SOLUTIONS

TABLE B-1

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
1. No Action (Erosion caused by navigation structures continues)	Continued Economic Decline	a. Physical loss of land b. Unstable littoral envir. c. Detrimental to aesthetics d. Perch spawning area adjacent to north and south breakwaters would remain e. Turbid water condition south of navigation structures would continue	a. Recreational fishery off breakwaters would remain b. Structural property damage c. Loss of land d. Loss of access to the lake e. Loss of buildings which cannot be economically moved	Continued economic decline
2. Remove navigation structures	Negative impact on national development	a. Restore littoral drift and improve environmental quality of shore damage area b. Reduce loss of land c. Improve littoral environment d. Eliminate turbid condition of lake waters south of navigation structures e. Decrease in maintenance costs of existing shore protective structures and obviate the need for installation of new structures f. Improve wildlife habitat in general g. Eliminate perch spawning areas known to exist adjacent to north and south breakwaters	a. Negative impact on community development b. Increased unemployment c. General decline in economic well-being d. Loss of recreation afforded pleasure craft using harbor e. Loss of accreted beaches adjacent to harbor f. Loss of recreation afforded by harbor structures	a. Negative impact on regional development - Alternative means of transporting goods resulting in increased costs for goods and services b. Curtailment of trade, industry c. Loss of industrial capital investment in harbor facilities and industry dependent upon them d. Loss of employment e. Loss of possible future industrial development dependent on port expansion

TABLE B-1 (Cont'd)

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

	Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
3.	*Shoreland regulation* (Limiting unwise development in high-risk erosion areas through zoning, building codes, subdivision regulation, etc.). Evacuation (Moving homes in jeopardy).	*Prevents losses to potential* future development	a. *Preserve ecologically* unique areas from encroachment b. Shoreline erosion would continue c. Denudation of bluff vegetation would continue d. Turbid water condition south of navigation structures would continue	a. *Restricts individual* freedom of land use b. Reduces potential suffering and hazard	*Prevents losses to* potential future shoreline development
4.	Partial removal of navigation structures, reduction of project depth, and shoreline management	a. Negative impact on national development b. Limited project depth would make shipping uneconomical and eliminate commerce c. Increased dredging cost might make harbor maintenance uneconomical d. Prevention of losses to potential future development	a. Partially restore littoral drift and improve environmental quality b. Reduce loss of land c. Partially improve littoral environment d. Partially eliminate turbid condition south of harbor e. Somewhat improve wildlife habitat f. Preserve ecologically unique areas from encroachment g. *Partial loss of perch* spawning areas adjacent to north and south breakwaters h. Decrease in maintenance cost of existing shore protective structures and reduction in need for installation of new structures	a. Negative impact on community development b. Increased unemployment c. General decline in economic well-being d. Restricts individual freedom of land use e. Reduces potential suffering and hazard f. Reduction in recreation afforded by pier fishing g. Increased wave action within harbor would reduce recreational boating (Partial loss *of afforded pleasure* craft using harbor)	a. Negative impact on regional development *Alternative means of* transporting goods resulting in increased costs for food and services b. Curtailment of trade, industry c. Loss of industrial capital investment in harbor facilities and industry d. *Loss of* employment e. Loss of possible *future industrial* development dependent on port expansion f. Prevents losses to potential future shoreline developments

TABLE B-1 (Cont'd)

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
5. Continuous armor protection (Bulkheads, seawalls, revetments) with reshaping of bluff to stable angle of repose. Seed and sod	Prevent future damage	a. Eliminate loss of land b. Reduce turbid condition south of harbor c. Cause scour and loss of material from in front of walls d. Cause erosion problem to move downdrift so eventually a continuous belt of armor protection would be required e. Aesthetically displeasing f. Decrease in maintenance costs of existing shore protective structures and obviate the need for installation of new structures	a. Some homes would be moved and property lost with bluff shaping b. Loss of recreation beaches c. Loss of access to the lakes d. Structural property damage would cease	Prevent future damage
6. Groins	Continued economic decline because littoral supply insufficient to fill groins and eliminate future damage	a. Physical loss of land b. Unstable littoral environment c. Turbid condition south of harbor would continue d. Cause erosion problem to move downdrift so that eventually additional protection would be required e. Detrimental to aesthetics f. Decrease in maintenance costs of existing shore protective structures	a. Reduce structural property damage b. Loss of recreation beaches c. Loss of buildings which cannot be economically moved	Continued economic decline

TABLE B-1 (Cont'd)

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
7. Groins artifically filled (annual nourishment)	Prevent future damage	a. Eliminate loss of land b. Eliminate turbid condition of lake waters south of navigation structures c. Aesthetically displeasing d. If lake borrow is used for initial construction and/or annual nourishment, a temporarily turbid condition in lake borrow area and area of placement would be created e. Land borrow would create a temporary turbid condition in area of placement f. Decrease in maintenance costs of existing shore protective structures and obviate the need for installation of new structures	a. Structural property damage would cease b. Artificial creation of bathing beaches c. Loss of land would cease	Prevent future damage

TABLE B-1 (Cont'd)

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
8. Offshore breakwaters	Eventual prevention of damage	a. Physical loss of land would continue at a decreased rate b. Unstable littoral environment c. Turbid condition of lake waters south of harbor would diminish d. Aesthetically displeasing e. Decrease in maintenance costs of existing shore protective structures and obviate the need for installation of new structures f. Potentially act as fish attractors g. Could result in loss of lake bottom	a. Structural property damage would slowly decrease b. Eventual creation of artificial bathing beaches c. Loss of land would slowly decrease d. Hazard to navigation	Economic decline would continue but at a slower rate until eventually eliminated
9. Offshore breakwaters and annual beach nourishment	(All of 8, but would eliminate damage and negative impacts quicker).			

TABLE B-1 (Cont'd)

IMPACT OF ALTERNATIVE SOLUTIONS

FOR

LUDINGTON MICHIGAN SECTION 111 PROJECT

Description	National Economic Development	Environmental Quality	Social Well-Being	Regional Development
10 & 11. Protective and feeder beaches (Restore littoral drift) and annual replenishment	Mitigate future shore damage caused by harbor without eliminating natural erosion	a. Future loss of land attributable to the navigation project would be mitigated b. Littoral environment would be stabilized c. Reduction of turbid condition south of navigation structures d. Aesthetically pleasing e. If lake borrow is used for initial construction and/or annual nourishment, would create a temporarily turbid condition in lake borrow area and area of placement f. If land borrow is used, would create a temporary turbid condition in area of placement g. Decrease in maintenance costs of existing shore structures and obviate the need for installation of new structures h. Will not disturb perch spawning area known to exist adjacent to the north and south piers i. Area under eroding bluffs will become more accessible to shore fishermen	a. Damage and loss of land attributable to navigation project would be mitigated b. Eventual creation of artificial bathing beaches	Economic decline attributable to Federal navigation project would be mitigated

SECTION 111

ENVIRONMENTAL STATEMENT

MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES AT LUDINGTON HARBOR, MICHIGAN

APPENDIX C

PERTINENT CORRESPONDENCE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Great Lakes Fishery Laboratory
1451 Green Road
P.O. Box 640
Ann Arbor, Michigan 48107

IN REPLY REFER TO

September 26, 1974

Mr. John Lane
Tetra Tech, Incorporated
630 N. Rosemead Boulevard
Pasadena, California 91107

Dear Mr. Lane:

Enclosed are the articles you requested in our telephone conversation of September 24.

If you need anything further, let me know.

Yours sincerely,

LaRue Wells

LaRue Wells
Project Leader, Lake Michigan
Fish Population Assessment

Enclosures

TETRA TECH, INC.
630 NORTH ROSEMEAD BLVD.
PASADENA, CALIFORNIA 91107
TELEPHONE (213) 449-6400

19 September 1974

Mr. Michael Washo
Michigan History Division
Michigan Department of State
208 North Capitol Avenue
Lansing, Michigan

Dear Mr. Washo:

In our telephone conversation of 18 September 1974, I explained that Tetra Tech is doing several Environmental Impact Statements for the U.S. Army Corps of Engineers. The five areas involved are all in the State of Michigan: Holland, Muskegon, Ludington, Grand Haven, and White Lake Harbors. Enclosed are two maps of Michigan which depict these areas.

In our Environmental Impact Statements there is a section which is concerned with the existing environmental conditions. In this area, I would appreciate any information that you can provide me regarding the historical and archeological aspects.

If you have any questions, please contact me at (213) 449-6400, Ext. 241.

Sincerely,

Frank Gerard

Frank Gerard
Environmental & Marine Engrg. Division

FG:ds

Encls: Two Maps-Lake Michigan

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48918

MICHIGAN HISTORY DIVISION
ADMINISTRATION, PUBLICATIONS, RESEARCH, AND HISTORIC SITES
208 N. Capitol Avenue
STATE ARCHIVES
3405 N. Logan Street
STATE MUSEUM
505 N. Washington Avenue

October 2, 1974

Mr. Frank Gerard, Environmental Division
Tetra Tech Incorporated
630 N. Rosemead Boulevard
Pasadena, California 91107

Dear Mr. Gerard:

Michael Washo of our staff has asked me to comment on the archaeological questions of your letter of September 19. From the maps provided, I can state that these projects will be taking place in the richest archaeological areas in Western Michiga. Archaeological sites are known from all five areas and two already have sites of first order National Register quality, the Quick-site on the Pere Marquette and the Spring Creek site on the Muskegon.

It is not our policy to publish specific locations for archaeological sites or to make such information from our files available to anyone other than professional archaeologists. We also no longer prepare archaeological evaluations for Environmental Impact statements since, on the state level, we are the agency that must review these same statements. You are working in five rich and sensitive archaeological areas and I would be most happy to furnish you with a list of firms, individuals and institutions in the State of Michigan who would be qualified to prepare survey evaluations for these five areas.

Sincerely,

James E. Fitting, State Archaeologist
Michigan History Division

JEF:tj

cc: Michael Washo

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, LANSING, MICHIGAN 48926

RALPH A. MAC MULLAN, Director

March 17, 1971

Myron Snoke, Colonel
U. S. Army Corps of Engineers
Detroit District
P. O. Box 1027
Detroit, Michigan

Dear Colonel Snoke:

Reference is made to earlier correspondence from the State of Michigan requesting beach erosion studies at St. Joseph and South Haven on Lake Michigan and Hammond Bay on Lake Huron under the provisions of Section 111 of the Rivers and Harbors Act of 1968.

We have recently been advised by the Lake Survey that Lake Michigan-Huron water level will probably crest in excess of nine inches over last summer's levels. If these estimates represent the conditions for this summer, we forecast that beach erosion damages will be most severe on both lakes and will cause substantial damages to developments that exist along the shore.

In view of the numerous complaints we are receiving from property owners along the shoreline, we at this time find it necessary to request Section 111 studies at the following additional areas where government navigational facilities exist:

1) Grand Haven
2) Muskegon
3) White Lake (Whitehall)
4) Pentwater
5) Ludington
6) Manistee
7) Portage Lake
8) Frankfort
9) Leland
10) Harbor Beach
11) Harrisville
12) Monroe (lake currents)
13) Whitefish Point
14) Grand Marais

Your acknowledgement of this request for these necessary services would be appreciated. We recognize that this represents considerable

additional staff effort and finances to carry on this work, and wish to be advised if this request will create an unmanageable burden on your district at this time.

Sincerely,

Ralph A. MacMullan
Director

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, LANSING, MICHIGAN 48926
A. GENE GAZLAY, Director

Refer to
File 5501.1

November 15, 1974

Colonel
U. S. Department of Army
Detroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Attention: Mr. Jerome J. Doline, Environments Resource Branch

Dear Sir:

I just recently ran across a note to myself regarding my sending you some information on preferred dredging times for Lake Michigan harbors. If I have not previously sent this material, I most humbly apologize.

The following dates are the times which we would propose as being best suitable for maintenance dredging so as not to conflict with various fishery activities.

St. Joseph Harbor	- Late March
South Haven Harbor	- Late March
Saugatuck Harbor	- Early April
Holland Harbor	- Mid April
Grand Haven Harbor	- Mid to late April
Muskegon Harbor	- Early May
White Lake Harbor	- Mid to late May
Ludington Harbor	- Late May to early June
Manistee Harbor	- Late June
Frankfort Harbor	- Early July
Leland Harbor	- Early July

If you have any further questions, please feel free to contact me.

Sincerely,

Ned E. Fogle
Great Lakes Management Specialist
FISHERIES DIVISION

NEF:ea
cc: D. Jenkins
H. Miller

CHIGAN
4/74

SCS-CONS-5
2-70
FILE CODE CONS-14-5

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

INVENTORY & EVALUATION

* INDIVIDUAL / GROUP / UNIT OF GOVERNMENT

REQUESTED BY Norman Shields, Tetra-Tech. Corp. LOCATION Pasadena, California

ASSISTED BY R. J. Amsterburg, Jr., District Conservationist DATE 01-10-75

SITUATION: Information requested on minerals, groundnd water and soils in Mason County area near Ludington, MI.

SUGGESTED SOLUTION(S): 1. Enclosed is copy of the Northwest Michigan Resource Conservation and Development Project Plan with the above requested information. This handbook is your own personal copy and need not be returned. Please credit handbook and whatever agency work is used.

R. J. Amsterburg, Jr.
District Conservationist
Scottville, Michigan 49454

* Circle appropriate category.

MANISTEE-MASON DISTRICT HEALTH DEPARTMENT

Mason Division
401 E. Ludington Ave.
Ludington, Michigan
Telephone 843-3994

Manistee Division
COURT HOUSE
Manistee, Michigan
Telephone 723-2168

January 16, 1975

Please Address Reply to:

Tetra-Tech
630 N Rosemead
Pasadena, California 91107

Attn: Frank Gerard

It is my understanding that you have requested information regarding groundwater for Ludington and Mason County, Michigan. This office does not have such information in any documented form which would be useful for an impact statement. I would suggest that you contact the engineering firm which has done most of the engineering field work for the City of Ludington and a considerable amount in the townships surrounding Ludington. I am sure that they can provide you with the information you seek. Please contact:

Williams and Works, Consulting Engineers
611 Cascade West Parkway, S.E.
Grand Rapids, Michigan 49500

Phone A/C 616 942-9600

Very Truly,

Robert L. Dixon, R.S.
Mason County Division

RLD/rc

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48918
(517) 373-0510
MICHIGAN HISTORY DIVIS
ADMINISTRATION, PUBLICATION
RESEARCH, AND HISTORIC SITI
208 N. Capitol Avenue
STATE ARCHIVES
3405 N. Logan Street
STATE MUSEUM
505 N. Washington Avenue

April 25, 1975

U.S. Army Engineer District, Detroit
Attn: Environmental Resources Branch
P.O. Box 1027
Detroit, Michigan 48231

Dear Sir:

The comments below relate to the Draft Environmental Statement: Mitigation of Shore Damage Attributed to Federal Navigation Structures at Grand Haven Harbor, Michigan.

Dr. James E. Fitting, State Archaeologist, has reviewed this proposal and feels that the project is unlikely to have a negative impact on any archaeological sites which might be in the area. In fact, the establishment of feeder beaches could lead to the preservation of sites by halting erosion. He has expressed concern that the archaeological survey reported on page 68 was not carried out by a trained archaeologist and wishes to emphasize that this procedure will not be acceptable on other projects where damage to archaeological sites is possible. He has informed me that he has had extensive conversations with Mr. Jerome Doline about this situation and that the particular terminology used in this, and several other recent statements, will be altered in the future to reflect actual Corps procedure and threshold criteria.

We thank you for giving us the opportunity to comment on this project.

Sincerely yours,

Martha M. Bigelow

Martha M. Bigelow
Director, Michigan History Division
and
State Historic Preservation Officer

MMB/cw

FINAL ENVIRONMENTAL STATEMENT

MITIGATION OF SHORE DAMAGE ATTRIBUTED TO THE FEDERAL NAVIGATION STRUCTURES AT LUDINGTON HARBOR, MICHIGAN

APPENDIX D

RESPONSE TO
DRAFT ENVIRONMENTAL
IMPACT STATEMENT

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE Room 101, 1405 South Harrison Road
East Lansing, Michigan 48823

April 15, 1975

U.S. Army Engineer District, Detroit
ATTN: Environmental Resources Branch
P.O. Box 1027
Detroit, Michigan 48231

Gentlemen:

The draft environmental impact statement for the proposed use of two nearshore nourishment sites in the vicinity of Ludington Harbor, Mason County, Michigan, was received by this office for review and comment.

We have reviewed the draft environmental impact statement and do not have any comments.

We appreciate the opportunity to review and comment on this proposed project.

Sincerely yours,

D. F. Cratty

Arthur H. Cratty
State Conservationist

FEDERAL POWER COMMISSION
REGIONAL OFFICE
31st Floor, Federal Building
230 South Dearborn Street
Chicago, Illinois 60604

April 16, 1975

Colonel James E. Hays
District Engineer
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Attention: Environmental Resources Branch

Dear Colonel Hays:

We have reviewed a Draft Environmental Statement transmitted with a memorandum(April 9)from Mr. P. McCallister, Chief, Engineering Division, covering the proposed use of two nearshore nourishment sites in the vicinity of Ludington Harbor, Mason County, Michigan, to mitigate shore erosion that is attributable to the Federal navigation structures at the harbor. Our comments are requested.

Comments of this office are made in accordance with the National Environmental Act of 1969 and the August 1, 1973 Guidelines of the Council on Environmental Quality. Our principal concern with developments affecting land and water resources is the possible effect of such developments on bulk and electric power facilities including potential hydroelectric developments and on natural gas pipeline facilities.

Since the above noted proposed project apparently would pose no major obstacle to the construction and operation of such facilities, we have no comments on the Draft EIS.

The foregoing statements are of this office and therefore do not necessarily represent the views of the Federal Power Commission.

Thank you for the opportunity to comment on the Draft Environmental Statement.

Sincerely yours,

Lenard B. Young
Regional Engineer

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD, ILLINOIS 60430

April 22, 1975

IN REPLY REFER TO
05-00.5

U.S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Attention: Environmental Resources Branch

Gentlemen:

As requested, we have reviewed the draft environmental statement for the mitigation of shore damage attributed to Federal Navigation Structures, Ludington, Michigan. We have no comments since the proposed work will not affect any highways.

The opportunity to review and comment on the draft environmental statement for the proposed improvement is appreciated.

Sincerely yours,

H. L. Anderson
Regional Administrator

By:

W. G. Emrich, Director
Office of Environment and Design

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Eastern Region
633 West Wisconsin Avenue, Milwaukee, Wisconsin 53203

8420

May 6, 1975

Mr. P. McCallister
ATTENTION: Environmental Resources Branch
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

We have reviewed the Draft Environmental Statement concerning the Mitigation of Shore Damage Attributed to the Federal Navigation Structure at Ludington Harbor, Michigan.

We view the establishment and maintenance of beach nourishment supply areas as an acceptable alternative. The work should be done at periods of the year when conflict with users in the area will be minimized.

Since the erosion problem is partly attributable to the navigation structure, the stabilization of the bluffs should be accelerated by timely planting of trees and shrubs.

We recommend the beaches created by this action be open to the public for shore fishing, swimming and other uses and not used exclusively by adjacent property owners. We feel that is an important concept to be built into projects of this type and would provide for increased public benefit over and above the erosion stabilization. When known, the secondary impact of the future use of the beach areas should be evaluated. The impacts caused by this use, either public or private, may be greater than the initial disturbance caused by enrichment.

We appreciate the opportunity to review this draft and will look forward to receiving the final Statement.

Sincerely,

JAY H. CRAVENS
Regional Forester

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

May 28, 1975

Mr. P. McCallister
Chief, Engineering Division
Corps of Engineers
Department of the Army
P. O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

The draft environmental impact statement "Mitigation of Shore Damage Attributed to the Federal Navigation Structures at Ludington Harbor, Michigan," which accompanied your letter of April 9, 1975, has been received by the Department of Commerce for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

Of the two proposed beach nourishment sites, the one on the south side of Ludington Harbor will require three times more of initial feeding than that on the north side and over five times more of the annual nourishment. Determination of the nourishment requirements was based on restoration of natural drift quantities interrupted by the navigation works. In a shoreline reach where federally-built harbors are located on both ends of the reach, the exact determination is not essential of the quantities of drift interrupted by the structures of harbors. However, the littoral drift on shoreline reach south of Ludington Harbor is intercepted on the north by the works of Ludington Harbor and on the south by the structures of privately owned Ludington Pump Storage. The structures of the Pump Storage consist of the rubble mound jetties extending about 1500 feet out from the shore in about 22-foot water depth and of a rubble mound breakwater about 2200 feet offshore in 32 feet of water located across the opening between the jetties (paragraph 2.44). It appears that these structures completely intercept the littoral drift both from the north and from the south. This causes accumulation of drift at the structures and shoreline erosion further away from the structures. The combined effect of the two shoreline structures, Ludington Harbor and Ludington Pump Storage, is a severe erosion which, as stated above, will require annual nourishment five times larger than for the shoreline on the north side of Ludington Harbor.

Since the Corps may not use Federal funds to mitigate shore damages caused by privately owned shoreline structures, an analysis of littoral drift and amounts intercepted by the structures is essential to assess properly the shore damages by Ludington Harbor. Discussion of littoral drift processes presented in the statement is both incomplete and incorrect. It does not include discussion of the littoral drift past the site of Ludington Pump Storage and the drift rates past the Ludington Harbor appear to be excessive.

Harbor breakwaters and the 29-foot deep entrance channel completely intercept the drift both from the north and from the south. The drift is deposited essentially in four locations: in front of the breakwaters, in the entrance channel, in deep lake by breakwater-deflected currents, and in the outer harbor by oscillating currents. Only the drift deposited in front of the breakwaters is eroded by shifting waves and currents. The deposits in the other three locations cannot enter the littoral stream due to insufficient forces to pick them up from deposition. Surveys of the hydrography in the vicinity of the harbor, records of dredging, and estimate of erosion provide information on the rate of littoral drift at the harbor site from both directions. Empirical equations based on longshore wave energy, current speed, and effective length of the shoreline provide a reasonable estimate of individual drift rates from north and from south. The statement estimates the quantities interrupted by the navigation works to average about 66,500 cubic yards per year (paragraph L.20). On Plate 11, the annual north-to-south drift is shown as being 330,000 cubic yards and from south-to-north, 270,000 cubic yards. This would indicate that about 90 percent of the drift bypasses the harbor, which is obviously incorrect.

Similar analysis of littoral drift past the Ludington Pump Storage is needed to determine the Federal and private shares of costs for mitigation of shore damage. As mentioned above, such split is not essential for a shoreline with Federal structures at both ends of it.

Plate 13 indicates extensive shore erosion at the Buttersville Park and it appears that in this area, the north-to-south current, deflected by the harbor structures, reaches again the shoreline causing excessive removal of shore material. It is suggested that the nourishment area, as shown on page 8, be extended by about 1,000 feet in the northerly direction.

A few typing errors were noted. In paragraph 1.21, the 24,000 cubic yards per year appears to be correct instead of 14,000. In paragraph 2.02, water area should replace the shore area.

A water level gage is located in Ludington Harbor. There are geodetic control survey monuments located within the project area. If there is any planned activity which will disturb or destroy these monuments, the National Ocean Survey (NOS) requires not less than 90 days notification in advance of such activity in order to plan for their relocation. NOS recommends that funding for this project includes the cost of any relocation required for NOS monuments.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN STREET
CHICAGO, ILLINOIS 60604

Mr. P. McCallister
Chief, Engineering Division
U. S. Army Engineer District, Detroit
P. O. Box 1027
Detroit, Michigan 48231

JUN 4 1975

Attention: Environmental Resources Branch

Dear Mr. McCallister:

As requested in your letter dated April 9, 1975, we have completed our review of the Draft Environmental Impact Statement (EIS) for Mitigation of Shore Damage Attributed to the Federal Navigation Structures at Ludington Harbor, Michigan. We have no major environmental objections regarding the project and believe the EIS provided sufficient information to assess the environmental impacts of the proposed action. We offer the following comments for your use in preparing the Final EIS.

It is stated on page 10 of the EIS that no sampling station exceeds EPA's acceptable limits for chemical pollution. The table on the same page shows that lead and zinc exceeded the limits at station G06; thus, the statement should be revised to reflect this marginal exception. Harbor sediments to be used for initial beach nourishment as well as any augmentative material should be analyzed on a periodic basis to insure a non-polluted character and compliance with the suitability requirements of the Section 404(b) guidelines (Federal Register, May 6, 1975, Vol. 40, No. 88).

Detailed water quality monitoring plans should be explained in the Final EIS. Specifically, the responsible local agency, the parameters to be tested, and the frequency and location of sampling should be determined.

The shoal areas that will be used to augment harbor dredged material for beach nourishment should be delineated on a map and their biological productivity discussed.

Finally, we suggest that the Corps of Engineers' Dredged Material Research Program conduct an analysis on the success of the proposed project as well as its effects on the open water and beach ecosystems involved.

As indicated in the above discussion and in accordance with EPA procedures, we have classified our comments as LO, lack of objection, and have rated the Draft EIS as Category 1, sufficient information. In accordance with our

responsibility under Section 309 of the Clean Air Act, the classification and date of our comments will be published in the Federal Register. If you or your staff have any questions concerning our comments, please contact Mr. Gary A. Williams at 312-353-5756. We appreciate the opportunity to review this Draft EIS; please send us two copies of the Final EIS when it is filed with the Council on Environmental Quality.

Sincerely yours,

Donald A. Wallgren
Chief,
Federal Activities Branch

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER (mep)
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199
Phone: 216-522-3918

5922/9
5 May 1975

Department of the Army
Detroit District, Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Re: NCEED-ER; Draft Environmental Impact Statement, Ludington Harbor, Mason County, Michigan

Dear Sir:

The Draft Environmental Impact Statement referenced above has been reviewed by this office and at this time we have no comment to offer.

Sincerely,

W. C. OCHMAN
Captain, U. S. Coast Guard
Chief, Marine Safety Division
By direction of the Commander,
Ninth Coast Guard District

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA 19082
215--597--3770

3400
May 28, 1975

P. McCallister, Chief
Engineering Division
Dept. of the Army
Detroit District, Corps of Engineers
PO Box 1027
Detroit, Michigan 48231

Refer to: NCEED-ER; Draft Environmental Statement, Mitigation of Shore Damage, Ludington Harbor, MI

Dear Mr. McCallister:

We see no immediate effect of the above project on forested land and have no specific comments.

We appreciate your sending us the statement for review.

Sincerely,

DALE O. VANDENBURG
Group Leader
Environmental Improvement

FROM (Name)	OFFICE SYMBOL	TELEPHONE NO.	RELEASER'S SIGNATURE
D. Kelly	NCEED-ER	313-226-2256	
TO (Name)	**OFFICE (Agency)**	**TELEPHONE NO.**	**PAGES** / **REFERENCE** / **DATE**
I. Collins	Tetra Tech, Inc	213-449-6400 x 223	5/21/75

NATURAL RESOURCES COMMISSION

EARL T. JOHNSON
E. M. LAITALA
DEAN PRATHER
HENRY F. SPEED
RAYMOND W. WESTERLY
JOHN E. MOSS
CHARLES G. YOUNGLOVE

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING, LANSING, MICHIGAN 48926

HOWARD A. TANNER, Director

May 19, 1975

U.S. Army Engineer District
Attn: Environmental Resources Branch
P.O. Box 1027
Detroit, Michigan 48231

Re: NCEED-ER

Dear Mr. McCallister:

We have reviewed the draft environmental statement entitled "Mitigation of Shore Damage Attributed to the Federal Navigation Structures at Ludington Harbor, Michigan."

The material contained in the statement is presented in an orderly, readable manner and is for the most part adequate to determine the environmental impacts that are likely to occur. The presentation of graphic information is also well done.

We are concerned that a sediment sample taken just inside the harbor (STA CO65) showed concentrations of lead and zinc in excess of acceptable limits set by EPA for non-contained disposal. We would urge that more than one sample be taken in the area to be dredged in order to confirm more adequately the unpolluted classification of these sediments.

We do not agree with either the importance rating or the magnitude rating in the matrix on page 78, regarding the effect of dredging and disposal upon recreation. During this activity there would very likely be a substantial loss of pier and shore fishing due to the high turbidity levels. This activity would span about 30 days per year over the first four years and 10 days a year thereafter. We would suggest that the associated impacts on recreation would accordingly be significant, and that it should be so stated in the final environmental statement.

The species lists in tables 10-13 (pages 60, 62, 64-66) contain many errors and should be corrected in the final statement and in future similar draft statements, by consulting publications of the Fisheries

and Wildlife Societies. As an example, the following corrections should be made in the fishes listed in table 10 (page 60):

FROM	TO
Coregonus artedii	Coregonus artedii
Coregonus reighardi	Coregonus reighardi
Coregonus zenithicus	Coregonus zenithicus
Leucichthys kiyi	Coregonus kiyi
Coregonus clupeaformis	Coregonus clupeaformis
Coregonus hoyi	Coregonus hoyi
Cottus bairdii	Cottus bairdi
Burbat	Burbot
Osmerus esperlanus	Osmerus mordax
Perca caprodes	Percina caprodes
Percopsis omiscomaycas	Percopsis omiscomaycus
Oncorhynchus tschawytsche	Oncorhynchus tschawytscha
Salmo solar	Salmo salar
Exos lucius	Esox lucius

In the same table, the emerald shiver is a threatened species in Lake Michigan while the yellow perch and atlantic salmon are neither threatened or endangered species. The status indicated should be revised accordingly.

The remainder of our comments will be addressed to page and paragraph in the text.

Page 8, Plate 3
The area that is indicated for shoreline nourishment north of the harbor extends to the Lincoln River. It should be mentioned whether this could cause shoaling at the mouth of Lincoln River and whether this could interfere with boating.

Page 48, Section 2.36
This paragraph should be expanded to include chinook salmon as an important introduced species. Chinook migrate up the Pere Marquette River making them important to local fishing in Lake Michigan, Pere Marquette Lake, and in the river itself.

Page 63, Section 2.56
We suggest changing the second and third sentences to read as follows: "In this regard, projects scheduled ~~for~~ PRIOR TO late May and early

June would have the least impact. It is anticipated that both the initial establishment phase and subsequent periodic nourishment operations will be carried out in late spring or EARLY summer.....

Page 81, Section 4.06
It is our opinion that various organisms will not recover "rather quickly" as indicated in this section. We suggest that these two words be deleted from the text.

Page 83, Section 4.4
We suggest that various forage species would be disturbed more extensively than perch or salmon in the area to be nourished.

Page 88, section 4.23
We suggest the last sentence be expanded to read, "Perch spawning and salmon migration activities will not be affected WHEN DREDGING IS CONDUCTED PRIOR TO JUNE."

Page 89, Section 4.24
We suggest that the degree of impact on sporting activities depends on the time frame of dredging as it relates to peak fishing activity. This impact can be of minimal importance, as stated, only when dredging is scheduled to occur before the peak fishing activity begins. This qualification should be so written in the statement.

Page 94, Section 5.04
It is stated that the nourished beaches will, in time, repopulate with organisms that prefer sediment habitats. It should also be noted that this would not compare favorably to the density of organisms that would be sacrificed by covering the rubble and pilings with sand.

Page 103, Section 6.12
It is stated in the third sentence that deepening of the lake bottom due to scouring along a seawall base would result in a loss of recreation. This is not necessarily so. In the past, deepening of inshore areas has attracted fish and resulted in a significant sport fishing.

We are sure that these comments will be helpful in the preparation of the final statement, as well as in the preparation of future draft statements.

Sincerely,

H. A. Tanner

Howard Tanner
Director

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN 48913
(517) 373-0510
MICHIGAN HISTORY DIVISION
ADMINISTRATION PUBLICATIONS
RESEARCH, AND HISTORIC SITES
208 N. Capitol Avenue
STATE ARCHIVES
240 N. Logan Street
STATE MUSEUM
505 N. Washington Avenue

April 14, 1975

U.S. Army Engineer District, Detroit
Attn: Environmental Resources Branch
P.O. Box 1027
Detroit, Michigan 48231

Dear Sir:

Dr. Lawrence Finfer, Historic Preservation Coordinator, and Dr. James Fitting, State Archaeologist, have reviewed the Draft Environmental Statement for the project at Ludington Harbor, Ludington, Michigan. There is only one historic site in the project area: Marquette's Death Site, State Site No. 278, Buttersville Point. It is unlikely that the project will have a negative impact on this site.

The project's minimal impact on historic and archaeological resources notwithstanding, Dr. Fitting is quite concerned about the report of an archaeological survey that may not have been carried out by an archaeologist. He feels that an acceptable statement on archaeological survey must identify the archaeologist and contain, in full or summary, a copy of this person's report or a written, signed statement on the absence of archaeological sites.

We thank you for providing us with the materials necessary to the formation of this appraisal.

Sincerely,

Martha M. Bigelow

Martha M. Bigelow
Director, Michigan History Division
and
State Historic Preservation Officer

MMB/cw

MICHIGAN DEPARTMENT OF STATE
RICHARD H. AUSTIN SECRETARY OF STATE

LANSING
MICHIGAN
(517) 373-
MICHIGAN HISTORICAL
ADMINISTRATION
RESEARCH, ANNU
STATE ARCHIVES
STATE MUSEUM

April 14, 1975

Mr. P. McCallister
U.S. Army Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

I have reviewed the draft Environmental Impact Statement "Mitigation of Shore Damage Attributed to Federal Navigation Structures at Ludington Harbor, Michigan" and agree with the conclusion that this project is largely beneficial and will have little, if any, negative impact on upland or submerged archaeological resources. I also welcome your statement on the importance of confidentiality on site location, particularly for sites not immediately endangered by the project.

The statements on archaeological survey on pages 70 and 71, however, are unsatisfactory. An archaeological survey can be conducted only by a trained professional archaeologist who is familiar with the area or who has worked in similar areas. Since no archaeologist is named and no report is enclosed, I suspect that the "survey" reported in this statement was not carried out by a professional archaeologist and, therefore, has no validity. If the statement contains one such unverified assertion, how many more might be present in the document? In this instance, your conclusions may be correct but the method used to reach these conclusions may be untenable.

Sincerely,

James E. Fitting
State Archaeologist
Michigan History Division

JEF/cw

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

STATE HIGHWAYS BUILDING [illegible] LANSING, MICHIGAN 48914

JOHN P. WOODFORD, DIRECTOR

April 2[illegible], 1975

Mr. P. McCallister, Chief
Engineering Division
U. S. Army Engineer District, Detroit
Environmental Resources Branch
P. O. Box 1027
Detroit, Michigan 48231

Dear Mr. McCallister:

The Department of State Highways and Transportation has reviewed the Draft Environmental Statement for "Mitigation of Shore Damage Attributed to the Federal Navigation Structures at Ludington Harbor, Michigan."

The proposed use of dredged materials for shoreline restoration would seem to be a preferable alternative to the current practice of dumping in deep water lake areas. Although the Draft Environmental Statement is generally of excellent quality, there are numerous errors in identification and nomenclature for those wildlife species shown in Tables 10, 11, 12 and 13 in the section Shoreline Ecology. These errors should be corrected in the final Environmental Statement.

Sincerely,

G. Robert Adams, Administrator
Environmental and Community
Factors Division

MICHIGAN
THE GREAT LAKE STATE

MICHIGAN STATE UNIVERSITY

THE MUSEUM EAST LANSING • MICHIGAN

April [illegible], 1975

U.S. Army Engineer District, Detroit
ATTN: Environmental Resources Branch
P.O. Box 1027
Detroit, MI 48231

Dear Sirs:

This is in response to a Draft Environmental Statement titled Mitigation of Shore Damage Attributed to the Federal Navigation Structures at Ludington Harbor, Michigan.

Given that the proposed project will not include construction activities on the shoreline, but will involve submerged lands, I foresee minimal impact on shoreline cultural resources. However, I must again question whether the archaeological survey conducted concurrent with the geological investigation (p. 70, Sec. 2.64) was performed by a professional archaeologist. Due to the specialized nature of such reconnaissance it is necessary that these actions be performed by qualified individuals. Although the present project will have minimal impact on shoreline cultural resources, future projects with more intense impact that have had survey performed by non-professionals may well need re-survey.

Thank you for the opportunity to comment on this statement.

Sincerely,

William Lovis
Curator of Great Lakes Archaeology
(for)
Committee on Michigan Archaeology

mlw

3465 Bradway
Birmingham, Michigan 48010

October 15, 1975

District Engineer
U.S. Army Engineers District, Detroit
Att: Environmental Resources Branch
P.O. Box 1027
Detroit, Michigan 48231

Re: Ludington Harbor, Ludington, Michigan (Epworth Assembly).

Dear Sir:

I have recently completed a review of the Federal Deep Draft Harbor Modification at Ludington, Michigan. After discussing this project briefly with the Project Manager, I would like to give you our comments as it has a direct effect on the Epworth Assembly frontage on Lake Michigan.

To give you some background of the work which has been done at this location, we have over the last five years successfully stopped the erosion of our frontage (ref: Draft 50-2.40) at a considerable sum of money. This was done at the expense of all our residents at the Assembly. The work done to our sea walls was successfully tested in the January 10-11 storm this year, which caused so much damage to other areas on Lake Michigan. We did have some secondary damage behind our sea wall from this storm which we are correcting at this time. We now consider ourselves in excellent shape to withstand further storms.

The above mentioned project of Deep Draft Harbor Modification at Ludington affects our Assembly directly since it becomes the northerly shoreline nourishment location for the Harbor deposits (ref: drawing #3, page 8). The 100,000 cubic yards is a monumental quantity of material and we are concerned about how it will be placed. Under no circumstances will we allow these deposits to alter our natural beach available to us in periods of normal water levels. Any artificial formation of high sand bars will not be acceptable to us, however, we would accept deposits on our shoreline adjacent to our sea walls if it meets the quality of sand which now is in this location.

Your proposal of deposit sites between 200 feet and 400 feet off-shore is not acceptable since many shallow draft boats and also swimming takes place in this vicinity. Referring to your drawings, the 12000-11000 proximity is in the general vicinity of the Lincoln River where it enters Lake Michigan and is now kept open for small pleasure craft entering and departing from Lincoln Lake and the Epworth Assembly Marina. We have been using this river entrance successfully at a considerable expense to the Assembly since we have made many important improvements. Therefore, we do not under any circumstances wish to see this entrance deteriorate but rather improve it as the high water levels recede. There is a possibility that a request will be made from the Corps of Engineers and the State of Michigan to extend the opening of the Lincoln River into Lake Michigan at some future time and we are presently watching the build up of sand in front of the opening.

The point I am referring to is that the off-shore deposits will drift sand in a northerly direction under certain current conditions and make it impossible to use the Lincoln River as a natural waterway. This river also is a great water entrance for all kinds of fish migration, brown trout, steelheads, salmon, etc. This sport fishing is enjoyed by all people in this vicinity, if the entrance is blocked this will also cease to exist. The work on this Federal funded project must not take place during the summer months when all activity in the area is at its highest.

We would like to further share our opinions with you so as to come to a mutual agreement on this project without resorting to legal means, which we are prepared to do. We are looking forward to your immediate reply so that it can be discussed at our Annual Board Meeting held in early December.

Sincerely,

/m

Kai H. Hansen
Assembly Grounds Chairman

cc: Mr. Herbert W. Cooper - Epworth Assembly President
Dr. Miner W. Seymour - Grounds Committee
Mr. Norman A. Peterson - Executive Secretary

ECONOMIC DATA
EXTRACTED FROM
U.S. ARMY CORPS OF ENGINEERS
SECTION 111 DETAILED PROJECT REPORT
ON
SHORE DAMAGE AT
LUDINGTON HARBOR, MICHIGAN

Appendix E

U.S. Army Corps of Engineers
Detroit District
Dec. 1975

TABLE 1. SUMMARY OF COSTS FOR LUDINGTON HARBOR EROSION MITIGATION PROJECT

"ECONOMIC DATA EXTRACTED FROM U.S. ARMY CORPS OF ENGINEERS, SECTION 111 DETAILED PROJECT REPORT ON SHORE DAMAGE AT LUDINGTON HARBOR, MICHIGAN."

FIRST COSTS			
1. Added cost of depositing 42,500 cu yds of maintenance dredging in shallow water @ $0.60/cu yd			$ 25,500
2. 357,500 cu yds of additional dredging from lake borrow area by hopper dredge and deposition in shallow water @ $1.60/cu yd			572,000
Subtotal			$597,500
Contingencies	@ 12% ±	$71,600	
Engineering & design	@ 10% ±	59,700	
Supervision & Administration	7% ±	51,000	
			$182,300
Total			$779,800
TOTAL (rounded off)			$780,000
ANNUAL NOURISHMENT COST			
1. Added cost of depositing 42,500 cu yds of maintenance dredging in shallow water @ $0.60/cu yd			$ 25,500
2. 24,000 cu yds of additional dredging from lake borrow area by hopper dredge and deposition in shallow water @ $1.60/cu yd			38,400
3. Mobilization			3,000
Subtotal			$ 66,900
Contingencies	(12%)	$ 8,000	
Overhead	(13%)	8,700	
			$ 16,700
TOTAL			$ 83,600

TABLE 2. SUMMARY OF ANNUAL BENEFITS FOR LUDINGTON HARBOR EROSION MITIGATION PROJECT

"ECONOMIC DATA EXTRACTED FROM U.S. ARMY CORPS OF ENGINEERS, SECTION 111 DETAILED PROJECT REPORT ON SHORE DAMAGE AT LUDINGTON HARBOR, MICHIGAN."

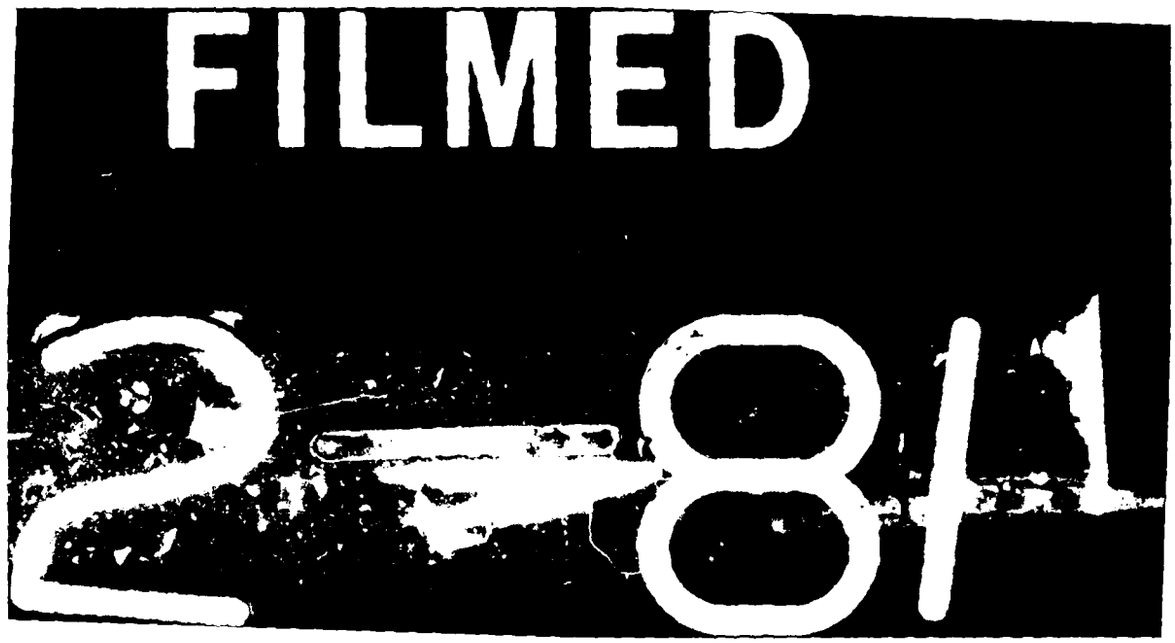
BENEFIT	PRESENT WORTH	ANNUAL BENEFIT (Dollars)
1. Prevent loss of land		$ 12,000
2. Prevent damage to structures		$ 20,000
3. Reduce need for shore protective structures		$ 25,000
4. Enhancement of property value	$2,400,000	$102,000
5. Recreation		$ 10,000
TOTAL		$169,000

The first cost of the recommended plan of improvement is estimated at $780,000 and includes both the direct costs (plant, labor, materials) and the indirect costs (engineering, design, supervision and administration). An added charge of $0.60 per cubic yard over the present dredging price was incorporated to allow for the additional costs of labor and equipment associated with the deposition activities. The annual maintenance cost is calculated at $83,600. Incorporated in this charge are the allowances for mobilization, overhead, and contingencies. When the interest and amortization factors are added, the total annual cost increases to $134,000. First costs and annual costs are summarized in Table 1.

Justification for the proposed action was evaluated in terms of damage prevention, improvement of property values, and recreational enhancement. Lakefront land property and houses were given prime consideration in this regard. Present worth costs were amortized at 5-1/8% interest over a projected project life of 50 years. Since only a slight change in population growth is projected over the next 20 years, the creation of new public beaches is not expected to yield a large benefit. However, some benefit will be realized, especially since the public beaches in the area are used extensively. An estimated value of $10,000 annually is assigned to this benefit.

A summary of the annual benefits which can be realized from the proposed action (if implemented) are presented in Table 2. As shown, the net annual benefit amounts to about $169,000 per year. Based on an annual implementation cost of $134,000 (see Table 1), a benefit-cost ratio of approximately 1.26 is derived, thereby providing economic justification of this project.

There are various intangible benefits on which a dollar value cannot be placed. These include general improvement in areal aesthetics, alleviation in owners' concern over potential property losses, partial relief from future expenses for shore protective structures, and intangible benefits derived by shoreline alteration and stabilization (i.e., more stable vegetation, improved habitats for wildlife, etc.). These, of course, must be offset by projected losses of shoreline rocky habitats for aquatic life, and corresponding losses of shoreline fishing areas. In weighing these gains and losses, it is expected that the result would be a net benefit of some unknown dollar value which, if incorporated into the benefit/cost formula, would yield a slightly higher benefit/cost ratio than stated above.


FILMED
2-81