POLANDER LAKE HABITAT REHABILITATION AND ENHANCEMENT PROJECT

EXECUTIVE SUMMARY

Polander Lake is located immediately upstream of lock and dam 5A on the Minnesota side of the Upper Mississippi River. This backwater area supports fish and wildlife populations typical of many backwater lakes on the Upper Mississippi River. Polander Lake is an important staging area for migrating waterfowl during both the spring and fall. Polander Lake lies within the Upper Mississippi River National Wildlife and Fish Refuge. The lake also provides good habitat for a variety of fish species that typically inhabit backwater lakes. Over time, wind, wave, and ice action have eroded many of the small islands and shallow areas formerly present in Polander Lake. This has resulted in a loss of emergent aquatic plant communities and an overall loss of habitat diversity. In addition, increased flows into Polander Lake from Pap Slough have reduced the habitat suitability for backwater fish species generally less tolerant of flows (i.e., centrarchids).

The plan formulation process considered several alternatives for rehabilitating and improving the habitat conditions in Polander Lake. This centered around methods to reduce flows into the lake from Pap Slough, and methods to offset the effects of wind and wave action. The alternatives focused on different structural solutions (islands and closure structures). The alternative that most closely achieved the habitat objectives for Polander Lake and provided the greatest habitat benefits for the cost was selected.

The selected plan calls the construction of a closure across a side channel carrying Pap Slough flows into the lake, a 1,000-foot island in the upper portion of the lake to reduce the effects of wind and wave action, the construction of an island complex (totaling about 6,000 linear feet of island) in the lower portion of the lake to reduce the effects of wind and wave action, and bank stabilization on two existing islands to prevent their further degradation due to erosion. The sand and fine material needed to construct the islands would be taken from backwater areas in and adjacent to Polander Lake to achieve improvements in fishery habitat. If sufficient sand to construct the islands cannot be found, ample material is available in Pap Slough for this purpose.

Total direct construction costs of the selected project for Polander Lake are $1,670,150. Indirect costs for plans and specifications and construction supervision and administration bring the total cost to $1,951,150. Because the project is located entirely within the National wildlife refuge, the construction cost of the project would be 100 percent Federal, in accordance with Section 906(e) of the Water Resources Development Act of 1986. Average annual operation and maintenance costs for the project are estimated to be $3,900. The operation and maintenance requirements would be the responsibility of the U.S. Fish and Wildlife Service, in cooperation with the non-Federal sponsor, the Minnesota Department of Natural Resources.

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POLANDER LAKE
HABITAT REHABILITATION AND ENHANCEMENT
POOL 5A, UPPER MISSISSIPPI RIVER
WINONA COUNTY, MINNESOTA (SP-14)

INTRODUCTION

AUTHORITY

The authority for this report is provided by Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662), which is summarized as follows:

Section 1103. UPPER MISSISSIPPI RIVER PLAN

(a)(1) This section may be cited as the Upper Mississippi River Management Act of 1986.

(2) To ensure the coordinated development and enhancement of the Upper Mississippi River system, it is hereby declared to be the intent of the Congress to recognize that system as a nationally significant ecosystem and a nationally significant commercial navigation system....The system shall be administered and regulated in recognition of its several purposes.

(e)(1) The Secretary, in consultation with the Secretary of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake, as identified in the Master Plan -

(A) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement....

PARTICIPANTS AND COORDINATION

Participants in project planning included the Upper Mississippi River Wildlife and Fish Refuge and Region 3 Office of the U.S. Fish and Wildlife Service, the Minnesota and Wisconsin Departments of Natural Resources, and the St. Paul District, Corps of Engineers. The U.S. Fish and Wildlife Service was a cooperating agency throughout the process as defined by the Council on Environmental Quality Regulations for implementing the National Environmental Policy Act (40 CFR 1500-1508). Meetings of the study participants were held at the project site and other locations to discuss project objectives and designs. During project development, coordination was supplemented by correspondence between the agencies.

PROJECT PURPOSE

The purpose of studies of this nature is to document existing habitat conditions, predict future habitat conditions, identify existing and future habitat deficiencies, define specific objectives, formulate and evaluate alternative plans that would address the objectives, and select and recommend a course of action for implementation. For Polander Lake, the ultimate goal was to develop a project that would provide greater diversity in this backwater area. The study focused on improvement in aquatic vegetation. This effort not only addressed methods of preserving and enhancing the existing aquatic plant beds which provide diverse habitat for fish and wildlife, but also looked for ways to encourage the growth of aquatic vegetation in areas where it does not currently exist. In addition, the long-term effects of sedimentation on habitat diversity in the Polander Lake area were assessed.

The immediate study area consists of a 1,200-acre backwater area of the Mississippi River, which extends 2 miles upstream of lock and dam 5A on the Minnesota side of the river. Although study efforts concentrated mainly on this reach of the river, the study area was expanded as necessary to determine all potential resource problems and opportunities and potential enhancement actions to fully analyze the effects on Polander Lake and adjacent areas.

PROJECT SELECTION PROCESS

ELIGIBILITY CRITERIA

A design memorandum (or implementation document) did not exist at the time of the enactment of Section 1103. Therefore, the North Central Division, U.S. Army Corps of Engineers, completed a "General Plan" for implementation of the Upper Mississippi River System Environmental Management Program (UMRS-EMP) in January 1986. The U.S. Fish and Wildlife Service (USFWS), Region 3, and the five affected States (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) participated through the Upper Mississippi River Basin Association. Programmatic updates of the General Plan for budget planning and policy development are accomplished through Annual Addendums.

Coordination with the States and the USFWS during the preparation of the General Plan and Annual Addendums led to an examination of the Comprehensive Master Plan for the Management of the Upper Mississippi River System. The Master Plan, completed by the Upper Mississippi River Basin Commission in 1981, was the basis of the recommendations enacted into law in Section 1103. The Master Plan report and the General Plan identified examples of potential habitat rehabilitation and enhancement techniques.

GENERAL SELECTION PROCESS

Under the EMP authority, the following procedures were used in selecting this project for inclusion and eventual study.

a. (First Annual Addendum). The Master Plan report...and the authorizing legislation do not pose explicit constraints on the kinds of projects to be implemented under the UMRS-EMP. For habitat projects, the main eligibility criterion should be that a direct relationship should exist between the project and the central problem as defined by the Master Plan; i.e., the sedimentation of backwaters and side channels of the UMRS. Other criteria include geographic proximity to the river (for erosion control), other agency missions, and whether the condition is the result of deferred maintenance....

b. (Second Annual Addendum).

(1) The types of projects that are definitely within the realm of Corps of Engineers implementation authorities include the following:

- backwater dredging
- dike and levee construction
- island construction
- bank stabilization
- side channel openings/closures
- wing and closing dam modifications
- aeration and water control systems
- waterfowl nesting cover (as a complement to one of the other project types)
- acquisition of wildlife lands (for wetland restoration and protection) Note: By letter of 5 February 1988, the Office of the Chief of Engineers directed that such projects not be pursued.

(2) A number of innovative structural and nonstructural solutions which address human-induced impacts, particularly those related to navigation traffic and operation and maintenance of the navigation system, could result in significant long-term protection of UMRS habitat. Therefore, proposed projects which include such measures will not be categorically excluded from consideration, but the policy and technical feasibility of each of these measures will be investigated on a case-by-case basis and recommended only after consideration of system-wide effects.

Projects are nominated for inclusion in the District's habitat program by the respective State natural resource agency or the U.S. Fish and Wildlife Service based on agency management objectives. To assist the District in the selection process, the States and USFWS agreed to use the expertise of the Fish and Wildlife Work Group (FWWG) of the River Resource Forum (RRF) to consider critical habitat needs along the Mississippi River and prioritize nominated projects on a biological basis. The FWWG consists of biologists responsible for managing the river for their respective agency. Meetings were held on a regular basis to evaluate and rank the nominated projects according to the biological benefits that they could provide in relation to the habitat needs of the river system. The ranking was forwarded to the RRF for consideration of the broader policy perspectives of the agencies involved. The RRF submitted the coordinated ranking to the District and each agency officially notified the District of its views on the ranking. The District then formulated and submitted a program which is consistent with the overall program guidance as described in the UMRS-EMP General Plan and Annual Addendums and supplemental management guidance provided by the North Central Division.

Projects have been screened by biologists closely acquainted with the river. Resource needs and deficiencies have been considered on a pool-by-pool basis to ensure that regional needs are being met and that the best expertise available is being used to optimize the habitat benefits created at the most suitable locations.

SPECIFIC SITE SELECTION

The Polander Lake project area was originally identified for study because it was one of the best habitat areas in pool 5A and was showing signs of degradation. Through the process described above, the Polander Lake project was recommended, and supported as capable of providing significant habitat benefits.

Polander Lake is an important staging area for waterfowl during their spring and fall migrations. Consequently, the U.S. Fish and Wildlife Service has closed a major portion of the lake to hunting. However, major changes in the aquatic plant vegetation have substantially reduced the lake's value for migrating waterfowl. The lake also supports a good fishery. However, increased flows through the lake due to erosion of an opening between it and Pap Slough have reduced the lake's suitability for a number of fish species present.

Since inundation following construction of the lock and dam system, barrier islands located parallel to the main channel of the river have eroded away, and flow paths and rates through the lake have changed significantly. These changes have been accompanied by a loss of emergent vegetation in the lake. Because of sedimentation problems observed immediately upstream of Polander Lake, concern was voiced over the possibility of increased sedimentation in Polander Lake in the near future. For the above reasons, this project was submitted by the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources at the outset of the UMRS-EMP as a high priority habitat project. After consideration of RRF recommended priorities, the public interest in the project, the value of the resource, and the opportunity for rehabilitation and enhancement, the Polander Lake project was ranked number 2 in the overall listing of the St. Paul District's top 20 projects in 1987 for Fiscal Year 1990 budget preparation. Based on the priority listing, project funds were made available to begin study on the project in Fiscal Year 1990.

ASSESSMENT OF EXISTING CONDITIONS

PHYSICAL SETTING

Pool 5A is part of the Upper Mississippi River navigation system which was created by the construction of lock and dam 5A. The entire pool is 9.6 river miles in length, extending from river mile (R.M.) 728.5 to 738.1. The Polander Lake study area stretches from about R.M. 728.5 (at lock and dam 5A) to R.M. 731. Cities in the immediate vicinity include Minnesota City and Goodview, Minnesota, which lie along the western side of Polander Lake. Winona, Minnesota, the closest major city, is located just downstream of lock and dam 5A. On the Wisconsin side of the river, Fountain City can be found about 2 miles upstream of Polander Lake. The study area is part of the Upper Mississippi River National Wildlife and Fish Refuge. See figures 1 and 2 for a location map and study map of the area. This latter map also shows the features discussed below.

Prior to inundation by the lock and dam system, a 73-acre backwater lake known as Polander Lake existed near the upstream end of the study area. The main channel of the Mississippi River flowed near the present-day Wisconsin mainland (as it does today), with a major slough known as Straight Slough running closely along the right side of the lake. The remainder of the area consisted of smaller sloughs, scattered ponds, and marshes among meadow and forest land. With construction of the lock and dam system, much of this floodplain became permanently submerged, although a number of small islands remained throughout the area. These islands were mostly concentrated along the sides of pre-existing sloughs and the main channel of the Mississippi River. After inundation, these islands were subjected to erosive forces from river currents, wind and navigation generated waves, and ice. Most of the low elevation islands; i.e., less than 2 feet over normal pool, disappeared. At the present time, the study area consists primarily of an enlarged backwater lake that has retained the name of Polander Lake. In the upper reaches of this area are several remnant islands. A series of islands that have been expanded by the placement of material dredged from the navigation channel can also be found along the main channel of the Mississippi River. Much of the lower part of the lake is open and windswept.

Several physical features immediately adjacent to Polander Lake are worthy of note at this time. These features were the focal point when assessing the potential impacts of outside influences on the study area as part of the project development process. Along the main navigation channel of the Mississippi River, at R.M. 732, the channel separates into two sloughs (Betsy Slough and Pap Slough) which recombine at R.M. 730. Commercial navigation traffic currently follows Betsy Slough which makes three sharp bends before straightening out approximately one mile upstream of lock and dam 5A. Pap Slough runs next to the upper northeastern portion of Polander Lake.

In addition to the features along the main channel, the backwater areas immediately upstream of Polander Lake were included in the evaluation process. Here, the major slough entering Polander Lake is Burleigh Slough which separates from the main channel of the Mississippi River at R.M. 735. Dark Slough and Crooked Slough, found along the Minnesota shoreline, are smaller sloughs upstream of Polander Lake which run into or out of Burleigh Slough. Another slough known as Honeymoon Slough leaves the main channel at about R.M. 733, flowing into the upper end of Polander Lake after traveling through a backwater area called Twin Lakes. Although it appears as part of Polander Lake and is not visible from the surface, Straight Slough still exists as a recognizable channel, as indicated by bathymetric surveys.

WATER RESOURCES

Water levels within Polander Lake are relatively stable. Pool 5A is controlled by lock and dam 5A, which was put into operation in 1936. Because pool 5A is so short, the theoretical control point is only 1.88 miles downstream of lock and dam 5. A pool elevation of 651.0 feet mean sea level (msl) is maintained at this primary control point by the operation of lock and dam 5A until the discharge at the dam exceeds 24,000 cubic feet per second (cfs). At this discharge, the maximum allowable drawdown at the dam of 1.0 foot to elevation 650.0 feet msl occurs, and the regulation of the pool is shifted to secondary control at the dam. As the discharge increases above 24,000 cfs, the pool level at the dam is held at elevation 650.0 feet msl, and the stage at all other points is allowed to rise. As the flow increases above 59,000 cfs, open river conditions are in effect, and the dam no longer controls the pool.

There are no major tributaries in pool 5A. However, Garvin Brook enters Burleigh Slough near river mile 733. It has a drainage area of approximately 100 square miles. The brook drains primarily agricultural lands.

Except for local runoff, flow enters the study area from the main channel and the aforementioned sloughs that exist in this reach of the river. In 1990 and 1991, flow measurements were taken in a number of locations in and around the study area. This information was used to calculate the distribution of flows through the area. To summarize the findings from this data, the main sources of inflow into Polander Lake are from the main channel and Burleigh Slough. Flows from the main channel enter the lake primarily through an opening midway down Pap Slough (about R.M. 731). This opening was not present in aerial photographs taken in the 1940's. It was observed on subsequent photographs and has continued to expand over time. Most of the flow entering from Pap Slough passes back into the navigation channel near R.M. 730. A smaller amount of flow enters from Honeymoon Slough (R.M. 733) via the Twin Lakes area.

Flow entering from Burleigh Slough generally moves down the old channel of Straight Slough. When discharges are high or when there is little vegetation (as is the case in the spring), this flow leaves the Straight Slough channel fairly evenly along its entire length within Polander Lake. In the late summer and early fall, vegetation causes the flow to remain in the Straight Slough channel longer and migrate across the lake nearer its lower end. Much of the flow in the lower portion of the lake (in both of these conditions) follows preinundation channels leading past Island 66 and back into the navigation channel (R.M. 730). Figure 3 shows a few spot velocity measurements taken in May 1991 during a river discharge of 72,300 cfs. No detailed surveys have been taken of the land formations found upstream of the study area. However, during floods larger than the 5-year event, most of the floodplain is overtopped and water passes over all land areas as well.

At the downstream boundary of the study area, a 1,000-foot-long spillway runs along the crest of the dam from the Minnesota shore across the old Straight Slough channel. Flow over the spillway does not occur until river discharges are greater than 59,000 cfs. The remaining discharge passes out of the lake into the main channel to be discharged through the primary spillway of lock and dam 5A. This appears to be the case for high flow as well as low flow conditions (figure 4).

Bathymetric surveys of Polander Lake were conducted during the summer of 1990. Figure 5 is a map showing the depths in regions of the study area. Generally, water depths in the lower half of Polander Lake are approximately 4 feet. More shallow areas having depths of 2 to 3 feet are present along the border of Straight Slough as well as just downstream of preinundation Polander Lake near Island 66. Deeper areas can still be found in the "original" Polander Lake and along the major sloughs which existed prior to inundation. Table 1 shows current water depths versus surface acreage for the lake.

Table DPR-1
Polander Lake Water Depths Versus Surface Area

Water Depths (ft)	Surface Area 1990 Acres	Percentage
0-1'	52.2	4.6
1-2'	126.5	11.1
2-3'	277.1	24.2
3-4'	299.0	26.1
4-5'	148.6	13.0
> 5'	240.3	21.0
Total	1143.7	

Note: (1) This is using the low control pool elevation of 650.4 feet msl.
(2) The Polander Lake study area is approximately 1,200 acres.

GEOLOGY AND SOILS/SUBSTRATE

Geology

The most significant geological event explaining the nature of the Mississippi River within pool 5A occurred at the end of the Pleistocene glaciation approximately 10,000 years ago. Tremendous volumes of glacial meltwater, primarily from the Red River Valley's glacial Lake Agassiz, eroded the preglacial Minnesota and Mississippi River valleys. As meltwaters diminished, the deeply eroded river valleys aggraded substantially to about the present levels. Since post-glacial times, a braided stream environment has dominated this reach of the Mississippi River, due to the river's low gradient and oversupply of sediment from its tributaries. Prior to the impoundment of pool 5A in the 1930's, the broad floodplain of the river was characterized by this braided stream system that consisted of swamps, depressions, sloughs, natural levees, islands, and lakes. Since impoundment, silts, clays, or sands have been deposited over most of the river bottom within the pool.

Soils/Substrate

During March 1990, eleven borings were taken in Polander Lake and adjacent Pap Slough areas. (See figure 6 for the locations of the borings.) Seven of the borings were taken in Pap Slough as part of a channel improvement project study. These were examined for potential suitability for use in island construction in Polander Lake. The borings showed that the sediments in Pap Slough consist entirely of clean sands.

One of the remaining four borings (90-7M) was taken to check foundation conditions in an area which, at the onset of the Polander Lake habitat study, appeared likely to require islands. It was taken at the outside of the curve in Pap Slough where it was felt that a closure might be required to reduce flows into the Polander Lake area. This boring had a top of ground elevation 6 feet below the water surface and consisted of approximately 2 feet of very soft organic silt over 2 feet of slightly silty sands which are over loose to medium dense clean sands.

The other three borings were taken in areas around Polander Lake to check the sediments in the backwater for potential use for island building. Two of the borings (90-9M and 90-10M) were located in shallow areas in the upstream end of Polander Lake. The borings taken in these areas had top of ground elevations approximately 4 feet below the water surface and showed thick (6 to 9 feet) layers of organic silt over clean sands. The third boring (90-11M) was taken in a location of an old slough near the main channel of the Mississippi River. This boring, with a ground surface 6 feet below the water line, showed the sediment present to be clean sands under a thin layer of silty sand.

The recent borings have supported expected trends in the location of materials deposited in the Mississippi River valley. Generally, clean or slightly silty sands are found in old slough areas. Areas that were marshes, woodlands, or backwaters before the Mississippi River dams were built generally consist of layers of silts, clays or silty sands.

Sedimentation

At the onset of this study, sedimentation problems were considered to be a primary area of concern. Information gathered from people familiar with this area of the river indicated that sedimentation had been occurring primarily upstream of Polander Lake. This had been noted in Burleigh Slough, along side channels of Burleigh Slough, and in Dark Slough (the aforementioned smaller channel that runs parallel to Burleigh Slough along the left (Minnesota) bank). This latter channel now has become virtually impassable to small-boat traffic. Shallow lakes upstream of Polander Lake such as Twin Lake and Snyder Lake (which is near the upstream end of Burleigh Slough) also appeared to be decreasing in depth. In the area immediately upstream of Polander Lake where the Burleigh Slough channel broadens into a more open backwater area, noticeable deposition had occurred predominantly on the southern side of the Burleigh Slough delta area.

Another visible source of sediment which has raised concerns to local residents was material coming from Garvin Brook. Following rainfall events over this watershed, it has been observed that flow coming down Burleigh Slough downstream of this creek is very turbid. While the flow from Garvin Brook may have considerable local effect on turbidity and sedimentation, the sediment load associated with the Mississippi River dominates sedimentation in Polander Lake.

In order to understand the processes of erosion and deposition in Polander Lake, two sources of data were explored: aerial photographs and survey information on bottom elevations.

Aerial photography was used by digitizing photographs taken in the 1940's and 1989 and analyzing them with a computer model known as the Geographic Information System (GIS). Two specific areas of interest in and around Polander Lake were examined closely: a stretch immediately upstream of Polander Lake (hereafter referred to as the Burleigh Slough delta area) and the open-water areas within Polander Lake itself. These were selected because it was felt that they would be most able to give information on present, past, and future conditions in the study area. Table 2 gives the numerical results of the GIS analyses. Figure 7 shows mapping of the GIS information.

Table DPR-2
1940 to 1989 Changes in Land Areas (GIS)

Polander Lake Area	Acres	Percent
Water common to 1940 and 1989	857.7	86.2
Land Lost	118.4	11.9
Land Gained	6.7	0.7
Land common to 1940 and 1989	12.1	1.2
Burleigh Slough Delta Area	**Acres**	**Percent**
Water common to 1940 and 1989	676.4	77.1
Land Lost	80.4	9.2
Land Gained	57.9	6.6
Land common to 1940 and 1989	62.7	7.1

As can be seen in table 2, the Polander Lake area has actually lost a large amount of land area with very little new land being formed. The Burleigh Slough delta area has seen a significant portion of its islands eroded, but has also seen the building of new islands or migration of older islands. An examination of the aerial photography shows that, generally, in the Burleigh Slough delta region, the total land area is being depleted, albeit at a slower rate than in Polander Lake itself. (Although not apparent from the GIS information, in addition to the degradation and formation of islands, some regions within the delta are experiencing more localized deposition due to the abandoning of old channels. An example of this is Crooked Slough which runs from Burleigh Slough into the harbor area of the Minnesota Boat Club. This channel was part of a running slough that has been lost due to the construction of the lock and dam 5A dike system. A new channel has opened and Crooked Slough no longer functions and is gradually filling in.)

Bathymetric data was collected both in Polander Lake and Burleigh Slough to further explore the two identified areas of interest. Bottom elevations were taken throughout Polander Lake in 1990. This survey data was compared with preinundation flowage easement survey data taken in the 1930's. This again was done by digitizing the two data sources and analyzing it using GIS. Figures 8 and 5 show Polander Lake depths in 1933 and 1990, respectively. Figure 9 shows the changes that have taken place since inundation (difference from 1933 to 1990). As discussed below, changes in bottom elevation fluctuate throughout the lake.

Examination of the changes in bottom elevation since inundation shows that the lake essentially can be divided into several distinct areas. Along the Straight Slough channel, as well as other channels in the Burleigh Slough delta area, water depths have increased over time. Deepening has also taken place along the old sloughs near Island 66. Some erosion has occurred in the areas between the downstream end of Straight Slough (near the spillway) and the sloughs along the east side of the lake. At this latter location, a connecting channel between these sloughs seems to be gradually forming.

Sediment deposition is occurring primarily in a band beginning just downstream of the Pap Slough opening south to the edge of the Straight Slough channel, and continuing along the Straight Slough channel to the lower end of the lake (see figure 9). Sediment in the upper portions of the lake downstream of the Pap Slough opening is composed predominantly of sands and muddy sand. Silts become more predominant along the left side (descending) of Straight Slough. A significant amount of sedimentation occurred in the preinundation Polander Lake basin. The upper two-thirds (approximate) of the basin lies in the flow path of water coming from Pap Slough.

In an area farther northeast, between the preinundation Polander Lake and the main channel, there has been an increase in depth. This is likely caused by a combination of two mechanisms: wind/wave action and river currents. Wave action dislodges sediment particles on the lake bottom and river currents can then transport the material to the main channel where it is removed from the lake system. This process is believed to be at work in this part of Polander Lake because it is also in the path of the flow from Pap Slough. The reason this particular area is an erosion area rather than a deposition area (as was true farther to the southwest) is that the area along Straight Slough is supplied by sediment from Burleigh Slough and Pap Slough.

Bathymetric data was also collected in Burleigh Slough to help determine what changes are occurring in the Burleigh Slough delta area. This was further used to make predictions on how changes in areas upstream of Polander Lake could affect the lake itself. Little historic survey data was available in the sloughs upstream of Polander Lake. Surveys had been taken in 1895 along the Mississippi River between St. Paul, Minnesota, and St. Louis, Missouri. Included in this work were depths in Burleigh Slough. The 1895 information was compared with soundings taken in the fall of 1990. This showed essentially no significant difference in bottom elevations in Burleigh Slough within this time frame. However, local deposition of sediment has occurred in various areas such as Crooked Slough.

To help round out the picture of possible sedimentation problems in and around the study area, a paper entitled "Sediment Transport in the Upper Mississippi River Within the St. Paul District," by the Engineering Research Center of Colorado State University (1979) was consulted. The paper was included in the GREAT 1 Technical Appendix, Volume 4. As part of this study, a coupled one-dimensional/two-dimensional water and sediment routing model was developed. The model was used to predict sediment transport in the pools of the Upper Mississippi River. The sediment data for pool 5A which was contained in the report is found in table 3.

Table DPR-3
Sedimentation Model Study Results for Pool 5A

	2-year annual hydrograph (tons/year)	10-year annual hydrograph (tons/year)
Bed-material load:		
Inflow from pool 5	230,000	569,000
Outflow to pool 6	242,000	352,000
	12,000 loss	217,000 gain
Wash load (suspended sediment)		
Lock and dam 5	906,000	2,487,000
Lock and dam 5A	910,000	2,493,000
	4,000 loss	6,000 loss

The bed material load and wash load to and from pool 5A, for the 2-year annual hydrograph (which is somewhat representative of long-term average annual conditions), are in relative equilibrium. Combined with the fact that the average annual dredging in pool 5A (1975-1989 data) is approximately 39,000 cubic yards, there would seem to be a deficit of coarse material for pool 5A. As is typical with most sediment transport studies, these results are subject to some error. However, because both deposition and erosion have occurred in Polander Lake, this data suggests that pool 5A is not an effective sediment trap. Instead, sediment deposition seems to be a local occurrence.

In conclusion, sediment transfer in Polander Lake includes erosion and deposition, depending on the location in the lake. The main factors affecting sediment movement include sediment supply, wave action (which erodes or resuspends sediments), river current velocities (which can erode bed material, or carry sediment to a different location or remove it from the system entirely) and ice action. Generally, over time, the major habitat losses in the Polander Lake area have been the disappearance of emergent islands and the shallow macrophyte beds associated with these islands and the reduction in deepwater habitat of preinundation Polander Lake. In other words, there has been a loss in habitat diversity. This loss in bathymetric and habitat diversity is similar to that in other marsh/lake dominated backwater areas such as lower pool 8 and Weaver Bottoms in pool 5. In lower pool 8, approximately 36 percent of the island area had eroded away in the first 10 years after inundation and 79 percent had been lost within 50 years.

Some sediment is entering the Polander Lake system through Burleigh Slough and is being deposited adjacent to the shallow submerged vegetation beds, northeast of Straight Slough. Except for preinundation Polander Lake, substantial increases in sediment deposition throughout most of the lake area have not occurred. A comparison of depths from the 1933 and 1990 surveys indicates that the mean lake bed elevation has deepened 0.03 foot. As alluded to previously, although a number of minor sloughs flow into Polander Lake, the majority of sediment enters from the two main flow sources: via Burleigh Slough and from the opening along Pap Slough. Except for the shallow water vegetation beds, northeast of Straight Slough and preinundation Polander Lake, it does not appear that sediment coming down Burleigh Slough is significantly affecting the depths in Polander Lake in the near term (i.e., within the next 50 years). Flows from Pap Slough are depositing sediment in preinundation Polander Lake and the vegetation beds adjacent to Straight Slough while eroding the lake bottom in other areas. Garvin Brook was not felt to be affecting the lake to any great extent, although local rainfall events in the Garvin Brook watershed may increase turbidity in Polander Lake. Drainage areas of this type usually yield predominantly fine sediment. Therefore, most of this suspended material remains suspended in the flowing channels and probably passes out of pool 5A.

Sediment Analysis

Sediment core samples were collected by the Corps of Engineers from various locations within the area of the proposed project during April 1990, and analyzed for bulk chemistry. Table 4a summarizes the results of this analysis. Contaminants of concern were found to be comparable to fine sediments of backwater areas of the Upper Mississippi River (table 4b). Pesticides or polychlorinated biphenyls (PCBs) were not detected. The laboratory report is contained in attachment 6.

Soil classification analysis for samples taken in Polander Lake (samples 90-7M, 90-9M, and 90-10M) indicates that the upper sediments are composed primarily of organic silts (table 4c). This sediment analysis suggests that serious water quality problems would not be anticipated with a habitat improvement project in Polander Lake.

TABLE DPR-4A

Sample Collected by: COE
Sample Date: April 10, 1990
Analyzed by: Pace, Inc.

PARAMETER	UNITS	MDL	SAMPLE NO./LOCATION COE #2 90-6M	COE #8	COE #10 90-7M	COE #13 90-10M	COE #14 90-9M	COE #15
Total Organic Carbon	mg/kg (dry)	100	460	810	3100	8800	7300	7100
INORGANIC ANALYSIS								
Arsenic	mg/kg	0.50	0.90	0.80	1.50	8.20	5.40	2.40
Cadmium	mg/kg	0.10	0.22	0.17	0.21	0.45	0.33	0.42
Chromium	mg/kg	1.00	6.80	4.60	8.40	20.00	15.00	9.40
Copper	mg/kg	0.10	3.50	2.40	4.70	8.80	7.60	4.80
Cyanide, Total	mg/kg	0.50	ND	ND	ND	ND	ND	–
Lead	mg/kg	1.00	2.40	2.10	3.40	9.00	7.40	6.50
Manganese	mg/kg	0.10	200.00	240.00	80.00	1600.00	940.00	220.00
Mercury	mg/kg	0.01	ND	ND	ND	0.02	0.02	0.03
Nickel	mg/kg	0.50	7.40	5.40	10.00	14.00	11.00	8.00
Nitrogen, Ammonia	mg/kg	20.00	36.00	26.00	33.00	82.00	91.00	130.00
Selenium	mg/kg	1.30	ND	ND	ND	ND	ND	ND
Solids, % Volatile	%	0.01	0.38	0.33	1.10			
Water Content	%	0.01	13.60	15.20	21.50	34.00	29.90	30.60
Zinc	mg/kg	1.00	17.00	12.00	17.00	43.00	34.00	23.00
ORGANIC ANALYSIS								
Moisture Content	%	1.00	13.30	15.40	27.50	33.50	29.10	–
ORGANOCHLORINE PESTICIDES AND PCBs-8080								
a-BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
b-BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
g-BHC (Lindane)	ug/kg	1.00	ND	ND	ND	ND	ND	–
d-BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
Chlordane (tech)	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'-DDD	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'-DDE	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'-DDt	ug/kg	1.00	ND	ND	ND	ND	ND	–
Dieldrin	ug/kg	1.00	ND	ND	ND	ND	ND	–
Endrin	ug/kg	1.00	ND	ND	ND	ND	ND	–
Heptachlor	ug/kg	1.00	ND	ND	ND	ND	ND	–
PCB-1016	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1221	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1232	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1242	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1248	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1254	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB-1260	ug/kg	5.00	ND	ND	ND	ND	ND	–

MDL – Method Detection Limit
ND – Not detected at or above the MDL

Analysis of samples was performed 'as received' and does not reflect analysis on a dry weight basis unless indicated.

TABLE DPR-4B

Summarization of Sediment Pollution Guidelines

Parameter	Great Lakes Criteria (MOE) MINISTRY ONTARIO ENVIRONMENT	(EPA) GREAT LAKES HARBORS MODERATE CLASS	(EPA) GREAT LAKES HARBORS HEAVY CLASS	MISSISSIPPI RIVER BACKGROUND DATA FOR BACKWATER SEDIMENTS MEAN	MEAN + 1 STANDARD DEVIATION	MEAN + 2 STANDARD DEVIATION	NUMBER SAMPLES
Arsenic	8	3	8	6	11	16	22
Barium		20	60	111	164	216	68
Cadmium	1		6	0.6	1.7	2.7	84
Copper	25	25	50	13	20	28	98
Chromium	25	25	75	19	29	39	98
Cyanide	0.1	0.1	0.25	<2			
Iron	1000	17000	25000	16379	24000	31620	71
Lead	50	40	60	15	23	31	99
Manganese		300	500	707	1205	1704	82
Nickel	25	20	50	16	24	31	98
Mercury	0.3		1	0.06	0.12	0.18	86
Zinc	100	90	200	58	87	115	98
COD	50000	40000	80000				
Ammonia	100	75	200				
TKN	2000	1000	2000				
Phosphorus	1000	420	650				
Oil&grease	1500	1000	2000				
Volatile Solids(%)	6	5	8				
PCB's (ng/g)	50		10000	<50(8:5)	(21:3)	(34:1)	(33)

Units are ug/g dry weight unless otherwise specified.

(MOE) is Ontario Ministry of the Environment, Guidelines for Inwater Disposal of Dredge Spoils
(EPA) is U.S. EPA Great Lakes Harbor Pollution Classification Guidelines

The data base uesd, only includes backwater sediment samples and does not include main channel sediments or boat harbor sediments. Data that had questionably high values, the FWS's mercury data for the Lake Onalaska area and the COE's 1987 data from the contractor, Precision Analytics, were not used. Detection limits varied substantially and samples with poor sensitivities were not included. In the calculations, half the detection limits were used. For PCB's; most of the data was reported as <50; except for 33 samples which had lower detection levels:

Data Source	Pools	Years	Contact Person	Number of Samples
U.S. Army Corps of Engineers	5,7	1984,1987,1988	Dennis Anderson	17
Wisconsin DNR	4,7,9	1984,1986,1987	John Sullivan	14
U.S. Fish and Wildlife Service	4 thru 10	1983,1984,1985	Stan Smith	68

TABLE DPR-4C

SOIL CLASSIFICATIO... RECORD SHEET

PROJECT: Wilds Bend, Polander Lake, Pool 5A

BORING: 90-1M through 90-11M

MRD LAB NO. 90/359

STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE:

DATE: 8 August 1990

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOIST-URE (%)	PLASTICITY (ATT. LIMITS) LL	PI	HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SAND 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67		REMARKS	PL
Hole	90-1M																								
1	9.5						3	16	79	96	99	100					0.32	0.22	0.14	2.29	1.08	Sand	SP		
Hole	90-2M																								
1	8.0						2	9	67	94	100						0.38	0.25	0.18	2.11	0.91	Sand	SP		
2	8.8						2	12	63	94	97	97	100				0.40	0.25	0.17	2.35	0.92	Sand	SP		
Hole	90-3M																								
1	4.0						1	6	77	98	100						0.34	0.24	0.18	1.89	0.94	Sand	SP		
3	10.0						6	25	90	98	100						0.28	0.18	0.10	2.80	1.16	Silty sand	SM-SP		
Hole	90-5M																								
1	6.5						3	27	84	98	100						0.29	0.19	0.10	2.90	1.24	Sand	SP		
3	9.0						2	10	74	98	100						0.35	0.24	0.17	2.06	0.97	Sand	SP		
Hole	90-6M																								
1	9.0						1	4	49	86	98	100					0.50	0.30	0.20	2.50	0.90	Sand	SP		
Hole	90-7M																								
1	8.6						45	55	82	96	100											Silty sand	SM		
2	12.0						4	13	73	95	100						0.35	0.23	0.16	2.19	0.94	Sand	SP		
3	14.0						4	13	71	93	99	100					0.36	0.23	0.16	2.25	0.92	Sand	SP		
Hole	90-8M																								
1	5.0						2	6	59	93	99	100					0.42	0.27	0.19	2.21	0.91	Sand	SP		
2	6.5						1	7	72	98	100						0.36	0.25	0.18	2.00	0.96	Sand	SP		
3	9.5						1	4	48	92	99	100					0.50	0.31	0.21	2.38	0.92	Sand	SP		
Hole	90-9M																								
1	9.4						70	88	98	100												Sandy silt	~~SM~~ ML		
2	14.0						4	15	67	91	97	98	100				0.38	0.23	0.14	2.71	0.99	Sand	SP		
Hole	90-10M																								
1	7.8						39	54	77	96	100											Silty sand	SM		
2	9.3						7	25	74	95	100						0.33	0.20	0.09	3.67	1.35	Silty sand	SM-SP		
Hole	90-11M																								
1	8.5						25	60	85	97	100											Silty sand	SM		
2	9.5						2	5	41	88	100						0.55	0.35	0.21	2.62	1.06	Sand	SP		

VEGETATION

Surveys conducted by the Minnesota Department of Natural Resources (MDNR) in 1988 and the U.S. Fish and Wildlife Service and the Corps of Engineers (COE) in 1990 indicate that sedges, cattails, river bulrush, softstem bulrush, arrowheads, pickerel-weed, and lotus are the primary emergent species in the Polander Lake project area. Emergent vegetation is found mainly on the west and south shorelines and around the islands of the lake. The 1990 survey found submerged and floating-leaf aquatic plants occupying areas up to approximately 2.5 feet in depth, with wild celery, sago pondweed, milfoil, white water lily, floating-leaf pondweeds, and water star grass being the primary species present. Figure 10 indicates the areas of vegetation identified by the USFWS and COE during their 1990 survey. Recent MDNR surveys also note the presence of yellow water lily, Canada waterweed, mud plantain, lesser and greater duckweed, water meal, and several additional pondweeds in Polander Lake.

A number of the aquatic plant species present in Polander Lake are important food sources for migrating waterfowl. Wild celery and sago pondweed, along with the other pondweeds, are submerged aquatic species used extensively by waterfowl before and during migration, while arrowheads and soft-stemmed bulrush are important emergent species. However, the area does not support enough aquatic vegetation, either submerged or emergent species, to provide ideal habitat conditions.

The riparian areas surrounding Polander Lake are typical of the area, consisting primarily of floodplain forests vegetated with lowland hardwoods and areas of various willow species.

HABITAT TYPES AND DISTRIBUTION

The Polander Lake study area, which encompasses approximately 1,200 acres, is principally a riverine-lake (backwater) containing areas of emergent vegetation, areas of submerged vegetation, and areas with no, or sparse, vegetation. Riparian areas consist of the backwater's shorelines and larger islands bordering the lake (approximately 19 acres of the designated study area). Polander Lake contains very few islands, and the majority of the lake is unprotected from wind and waves. Emergent vegetation is found primarily around the periphery of the lake, covering approximately 137 acres. During 1990, submerged aquatic plants occurred only in areas up to 2.5 feet in depth and occupied approximately 195 acres of the study area. The remainder of the lake, about 857 acres, is devoid of vegetation, or only sparsely vegetated.

FISH AND WILDLIFE

Polander Lake supports a number of fish and wildlife species and is used extensively during the spring and fall migrations by a wide variety of waterfowl. Muskrat, beaver, and raccoon are a few of the wildlife species common to the area. A bald eagle nest, currently vacant, is located near the lake. Other species noted during visits to the site include great blue heron, mallard, great egret, green heron, double-crested cormorant, wood duck, blue-winged teal, tree swallow, and osprey.

Polander Lake is an important staging area for waterfowl and historically has been used extensively during spring and fall migrations. It is located within the Upper Mississippi River National Wildlife and Fish Refuge, and the majority of the lake is closed to waterfowl hunting. Staging areas are important for migrating waterfowl, allowing the birds to build up the necessary fat reserves required for migration. These areas should provide an abundance of food along with a minimum of disturbance. Polander Lake currently provides minimal amounts of the basic requirements of a staging area. In particular, it is deficient in the amount of aquatic vegetation present, with only about 16 percent of the lake supporting submerged species and 11 percent of the lake supporting emergent species of aquatic vegetation during a typical year.

During a 1989 survey, MDNR sampling resulted in the identification of 29 species of fish in Polander Lake, including northern pike, walleye, sauger, black crappie, bluegill, pumpkinseed, largemouth and smallmouth bass, and channel and flathead catfish. The beds of emergent vegetation on the southern and western shorelines, the riprapped dike on the southern shoreline, the presence of numerous submerged stumps and fallen trees, and the submerged aquatic plant communities provide good spawning and overall habitat for a wide variety of fish species. However, flows through the lake decrease the area's suitability for species such as centrarchids which are relatively intolerant of flows.

A survey was conducted by Corps of Engineers personnel on June 26, 1991, to determine the presence and population of mussels in possible fill and borrow areas for the proposed project. Polander Lake supports a healthy mussel population with a total of 13 species of mussels collected. The most abundant species collected included threeridge, threehorn, deertoe, and pigtoe, followed by pimpleback, pocketbook, pink heelsplitter, black sandshell, pink papershell, fawnfoot, giant floater, paper floater, and white heelsplitter.

THREATENED AND ENDANGERED SPECIES

The area may be used by the bald eagle (Haliaeetus leucocephalus), a Federally- and State of Minnesota-listed threatened species, and the peregrine falcon (Falco peregrinus), a Federally- and State-listed endangered species, for roosting and feeding and during migration. No nests are known to exist in the project area for either of these species. There are two former bald eagle nesting areas within the project area. Although neither of these sites were active during 1991, the territory may still be active. The location of the current nest site is still unknown. Should an active nest site be found, the appropriate State and Federal authorities would be contacted, and project activities adjusted to avoid disturbance of the eagles.

Polander Lake is within the historic range of the Higgins' eye pearly mussel (Lampsilis higginsi), a Federally- and State-listed endangered species. However, recent surveys suggest that the species is no longer present in either pool 5A or its neighboring pools. No living or dead specimens of any Federally- or State of Minnesota-listed threatened or endangered species were encountered during the survey conducted on June 26, 1991.

CULTURAL RESOURCES

In accordance with the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. There are no sites on or determined eligible for the National Register in the project area. Coordination with the Minnesota State Historic Preservation Officer revealed that there are also no reported historic or archaeological sites in the project area that would be affected.

SOCIOECONOMIC RESOURCES

The project area is located in Winona County, Minnesota. The nearest large city is Winona, Minnesota. The population of the city is declining slightly while county population is slowly growing, as shown in table 5. (Information compiled by the Minnesota State Demographer's Office.)

Table DPR-5
Population Data

Year	Winona City	Percent change	Winona County	Percent change
1970	26,438		44,409	
1980	25,075	-5.2	46,256	4.2
1988 (est.)	24,844	-0.3	47,325	2.3

Approximately 54 percent of the population lives in the city of Winona. The city's median income in 1979 was $18,080 for families and $13,695 for households. The county's median income was higher both for families at $18,254 and for households at $15,142. Winona city has approximately 54 percent of the total people employed in Winona County. Table 6 displays the city and county employment statistics.

Table DPR-6
Employment Statistics

	Winona city	Percent of total	Winona County	Percent of total
Construction	447	4.0%	1,024	5.0%
Manufacturing	2,513	22.6%	4,492	21.8%
Transportation, Communications, and Utilities	612	5.5%	1,045	5.1%
Wholesale/ retail trade	2,416	21.7%	4,182	20.2%
Services	4,198	37.7%	6,650	32.2%
Public administration	353	3.2%	594	2.9%
Other (finance, agriculture, and mining)	585	5.3%	2,637	12.8%

Commercial navigation facilities in the Winona area include the 9-foot channel on the Mississippi River. Recreational boating facilities are discussed in the Recreation Resources section below. In 1989, lockages at lock and dam 5A for towboats, recreational craft, and vessels totaled 13,496 in 1989. Of that amount, 1,455 were tows, 11,934 were recreation crafts, and 107 other vessels. In addition, 12,998 barges were locked through. Lockage of recreation crafts has increased gradually each year since 1983. The number of tows and barges locked through varies each year, possibly due to length of season between spring thaw and winter freeze-up.

RECREATION RESOURCES

Pool 5A is popular for fishing, ice fishing, hunting, trapping, and bird watching. Several public and private boat landings on the Minnesota side of the pool provide recreation access to the area. Boat ramps at Upper and Lower McNally Landings, located close to the dike at the downstream end of the pool, are used for fishing access to the lower end of the pool. Verchota Landing, located several miles upstream, is used year-round for fishing and ice-fishing access to the lake. The three public landings have concrete ramps and are owned and managed by the U.S. Fish and Wildlife Service. A private boat ramp is available for public use on a fee basis at the Minnesota City Boat Club. The boat club is located on Corps-owned land at the upstream end of the Polander Lake/Straight Slough area.

PROJECT OBJECTIVES

INSTITUTIONAL FISH AND WILDLIFE MANAGEMENT GOALS

Fish and wildlife management goals and objectives for the area fall under those defined more broadly for the Upper Mississippi River National Wildlife and Fish Refuge as a whole and those defined specifically for Polander Lake in the Refuge Master Plan.

Polander Lake is an important staging area for waterfowl during the spring and fall migrations, and is closed to hunting. As identified in the Refuge Master Plan, the preferred alternative for Polander Lake Habitat Rehabilitation was to construct barrier islands and block selected channels to reduce wave action and sedimentation. The management objectives of the Upper Mississippi River National Wildlife and Fish Refuge which at the onset of this study appeared to most directly apply to the study area include:

<u>Environmental Quality</u>

+ Reduce the adverse impacts of sedimentation and turbidity entering the river system.

+ Eliminate or reduce adverse impacts of water quality degradation.

<u>Migratory Birds</u>

+ Restore species that are in critical condition (such as canvasbacks) and achieve national population or distribution objectives.

+ Maintain or improve habitat of migrating waterfowl using the Upper Mississippi River.

+ Contribute to the achievement of national population and distribution objectives identified in the North American Waterfowl Management Plan and flyway management plans.

Fisheries and Aquatic Resources

+ Maintain and enhance, in cooperation with the States, the habitat of fish and other aquatic life on the Upper Mississippi River.

Because the study area is within the Upper Mississippi River National Wildlife and Fish Refuge, these management objectives, together with input from State and Federal agency natural resource managers, will be used to guide the development of specific project objectives. However, this study is only one part of a larger cooperative natural resource management effort on the river.

PROBLEM IDENTIFICATION

Existing Habitat Conditions

Historically Documented Changes in Habitat - Since inundation, with the creation of the locks and dams, Polander Lake and the surrounding areas have been undergoing gradual change. Prior to formation of pool 5A, the area surrounding Polander Lake was generally low-lying areas containing willows, marsh, and larger trees. Inundation flooded these areas and created a riverine-lake (backwater) with numerous low-lying and shallow submerged islands. These islands were located primarily along the banks of preimpoundment sloughs. In the first years after creation of the pool, the shallow areas continued to support many preinundation marsh species, although for some it provided only marginal habitat. A survey conducted by William E. Green of the Bureau of Sport Fisheries and Wildlife in 1941 showed extensive communities of emergent species such as *Phragmites sp.*, bulrush, burreed, arrowheads, and sedges in the area (figure 11).

Over time, flood events along with wind, wave, and ice action eroded many of the small islands and shallow areas. In addition, the barrier island separating Pap Slough from Polander Lake was breached, increasing flows through the lake. As discussed previously, over 100 acres of land were lost between 1940 and 1989. Based on the William Green report (discussed in detail below) and experience at pool 8, much of the island mass was probably lost quickly (within 20 years of lock and dam 5A construction). With the loss of its low-lying islands Polander Lake offers few areas of refuge for fish during high water events or for waterfowl from wind and wave action. Overall changes in depth in the study area have varied considerably depending on location and forces of influence (flows and wave action). This was thoroughly discussed in the SEDIMENTATION section of this report.

The combined effects of loss of shallow and wet soil areas (low-lying islands), a continually flooded environment, wind and wave action, increased flows, and major flood events have reduced the emergent plant communities dramatically. Many of the areas formerly occupied with emergent species have been colonized with submerged species. William E. Green reported in 1947 that emergent species had almost disappeared and that the lake was all open water with little vegetation. He also reported losses of submerged vegetation with American pondweed (Potamogeton nodosus), about the only species present during that year. Over time, in areas of the lake with gradually decreasing water depths, the submerged aquatic plant communities have gradually grown. However, plant communities have not been able to colonize the main flow regions in the lake.

Green's report indicates that in 1941 approximately 225 acres of Polander Lake contained emergent aquatic vegetation, with 33 acres containing submerged species. By comparison, the USFWS and COE survey conducted during 1990 indicates that only about 102 acres now support emergent species, with 158 acres supporting submerged plants. Although the total area occupied by aquatic plants is about the same, the area currently occupied by emergent species is less than half of what it was in 1941. As shown on figure 10, most of the emergent vegetation is located along the southwestern (right) side of Straight Slough and along the shallow areas downstream and west of the Pap Slough opening. In the lower two-thirds of the lake, much of the habitat diversity has been lost. During the 1990 plant survey referenced above, aquatic plants were not found at depths greater than 2.5 feet.

One final habitat change is worthy of note. In addition to affecting Polander Lake's plant communities, the additional inflows from Pap Slough have substantially increased current through the lake and reduced the area's suitability for fish species generally intolerant of flows (i.e., centrarchids).

Factors Influencing Change - Aquatic plant community composition is dependent upon a number of factors including, but not limited to: water depth; water clarity and turbidity which dictate the depth of adequate light penetration; substrate composition which provides anchorage and nutrients; flow rates; turbulence; susceptibility to wind and wave action; water chemistry; and phytoplankton densities. The inability of Polander Lake to support additional aquatic vegetation is believed to be due to flow patterns through the lake, wind-induced erosion of islands and plant beds, and reduced light penetration due to turbidity caused by wind and river flows.

After inundation, Polander Lake contained numerous islands and shallow areas. Although in many instances this new habitat was only marginal for the species present, extensive areas of emergent aquatic plants were present. The numerous small islands, the extensive plant communities, and the presence of stumps, logs, and other debris greatly retarded wind action and its erosive effects. However, over time, wave action along with flows through the lake eroded many of the low-lying islands and shallow areas. Based on experience with other areas of the river and limited aerial photography, it appears this probably occurred rather quickly. Increased flows through the lake, especially inflows from Pap Slough, changed the areas of the lake which were capable of supporting aquatic plants, and substantially reduced the area's ability to grow emergent species. In addition to the impact of flows, as areas of open water expanded and the emergent plant communities decreased, wind-induced wave action also increased.

Wind and waves increase turbidity, shift and resuspend bottom sediments, and loosen the root systems of aquatic plants. Turbidity in the lake is due to the input of suspended sediment from the Mississippi River via Pap and Burleigh Sloughs and the resuspension of sediments in the lake through wind induced waves. Water depths in much of the lake are too deep to allow sufficient light penetration to support aquatic plant growth.

Some species, such as Phragmites sp., which were prevalent after inundation, are intolerant of flows and wave action. Some are unable to sexually reproduce in constantly flooded environments. These species have gradually been replaced by species such as sago pondweed and wild celery which can occupy greater water depths and tolerate low to moderate flows. Examination of the vegetation information and bathymetric data obtained in 1990 indicates that submerged vegetation in the area generally is present only in lower flow areas 2.5 feet in depth or less.

Estimated Future Habitat Types and Distribution

It is anticipated that the present patterns of erosion and sedimentation will continue. The main flow channels of the lake may gradually deepen, while sediment will continue to be deposited in the shallower low flow areas. Erosion due to wave action will somewhat counteract the effects of sedimentation in some areas, keeping water depths at an estimated 1 to 2 feet or greater. Overall, the area of the lake with depths of 3 feet or less is expected to gradually decrease. Figure 12 shows the projected depth in Polander Lake in 50 years.

The bathymetric data collected in Polander Lake in 1990 and the 1933 surveys have been used to make a prediction of how the bathymetry in the lake will change over time. These changes have been predicted by assuming that 50 percent of the change observed in the period between 1933 and 1990 will occur between 1990 and 2040. The assumption that the rates of erosion and deposition will decrease over time is based on the fact that in other backwater areas, such as pool 8, the rates of erosion and deposition are decreasing. Therefore, choosing 50 percent of the observed change is reasonable. Table 7 shows the percentages of the total lake area at various depths for the 1933, 1990 and estimated 2040 conditions.

Light penetration will continue to be restricted due to the introduction of turbid river water into the lake and the resuspension of sediments due to wind and wave action. Consequently, plant growth is expected to remain confined to areas of 3-foot depths or less. Flows through the lake will continue to restrict plant community growth to areas out of the main flow paths.

Overall, over the next 50 years, the areal coverage of submerged aquatic vegetation in Polander Lake is expected to decrease slightly. Due to the locations of the emergent plant beds and the patterns of sedimentation and erosion, areal coverage of emergent plant species is expected to remain relatively unchanged.

Table DPR-7
Depth Characteristics of Polander Lake

	INCREMENTAL PERCENTAGES OF AREA		
	1933	1990	2040
land	1.3	1.2	4.1
0<D<1	4.1	4.5	6.7
1<D<2	16.0	10.9	10.8
2<D<3	24.2	23.9	21.1
3<D<4	25.7	25.7	19.8
4<D<5	12.3	12.7	12.9
5<D<6	7.7	8.7	8.0
6<D<7	4.6	4.8	5.4
7<D<8	2.2	2.3	3.5
8<D<9	1.1	1.5	2.1
9<D<10	0.6	1.0	1.2
10<D<11	0.2	0.9	1.0
11<D<12		0.9	0.7
12<D<13		0.5	0.7
13<D<14		0.3	0.7
14<D<15		0.1	0.7
15<D<16		0.1	0.4
16<D<17			0.2

Note: This is using the low control pool elevation of 650.4 ft (1912).
D = depth below water surface

Given these conditions, the following changes in habitat are anticipated in the study area. The existing shallow areas which are out of the major flow paths will continue to collect sediment, while the areas in the flow paths may become gradually deeper. In the Burleigh Slough delta area and immediately downstream of Pap Slough, sedimentation and delta formation will provide a small amount of additional habitat for emergent plant species. Overall, very little change in the aerial coverage of aquatic plants is anticipated.

PROJECT GOALS AND OBJECTIVES

General Habitat Goals

The general habitat goal for Polander Lake is to enhance its value for migrating waterfowl and for fish by improving habitat diversity. This means creating or maintaining areas of varying depth and providing conditions that would encourage the growth of aquatic vegetation.

Since inundation, Polander Lake has experienced decreased structural diversity and a subsequent change in the plant communities it supports. Although the areal coverage of aquatic vegetation has not changed significantly, the species composition has. The Polander Lake area currently supports less than half the emergent vegetation it did shortly after inundation. Plant interspersion has also decreased substantially, with the remaining emergent vegetation concentrated primarily along the lake's shorelines, with the highest concentrations in the western and northern portions of the lake. This is primarily a result of the gradual loss of low-lying islands and shallow areas due to wind and wave action, flood flows, and perhaps ice action. Changing flow patterns and increased turbidity have also limited the areas of the lake that are capable of supporting aquatic plants.

Pool 5A is an important staging area for waterfowl during the spring and fall migrations. The study area is within the Upper Mississippi River National Wildlife and Fish Refuge, and most of Polander Lake is closed to waterfowl hunting. However, the area does not provide ideal habitat. It could be substantially improved, to more closely meet the objectives of closed areas of the refuge, by increasing the quantity of plants important to waterfowl.

Polander Lake also supports an excellent and diverse fishery. However, increased flows have decreased the lake's suitability for a number of the fish species present. The area's suitability for these species could be increased considerably by the reduction of flows through the lake.

The general habitat goals for the 50-year future period have been defined as increasing the lake's aquatic plant communities;

maintaining or enhancing the lake's structural diversity; and decreasing current velocities in the lake. The goals could be met by reducing wave action, thereby decreasing the resuspension of bottom sediments and allowing light penetration to greater depths; and restricting inflows of turbid sediment-laden river water from Pap Slough which would also increase light penetration along with reducing flows through the lake. (Decreasing wave action typically is accomplished by constructing islands. This would also require dredging for island material which would increase structural diversity in the area.)

Specific Project Objectives

For the purposes of design and future evaluation, more specific project objectives were developed. Specific physical/ chemical objectives are required to arrive at an engineered solution to the habitat problems. The stated project objectives are narrowly defined to reflect those aspects of a project that could be designed for and then monitored and evaluated in the future. Meeting these objectives is not expected to be the only end products that result from a project. Net positive effects should also be experienced in other environmental aspects and outside the immediate project area.

Considering the general habitat goals for Polander Lake, the following specific objectives were developed:

1. Create a 50/50 interspersion of vegetation and open water scattered throughout the lake.

This objective was based on the professional judgement of waterfowl biologists working on the Upper Mississippi River. Observations of backwater areas providing high quality habitat for waterfowl have the characteristic of having an approximate 50/50 mix of open water and areas with aquatic vegetation.

2. With the 50-percent vegetation, 20 to 30 percent should be scattered beds of emergent aquatic vegetation.

This objective was based on the professional judgement of waterfowl biologists working on the Upper Mississippi River. This objective is primarily waterfowl oriented, though emergent vegetation does have some fisheries value. Emergent vegetation provides escape cover for waterfowl and certain species are used by waterfowl for food. The 20 to 30 percent figure was based on field observations of areas on the river receiving high waterfowl use.

3. Maintain a minimum of 400 acres of the deep water (≥ 4 feet) fish habitat that currently exists.

Deep backwater habitat on the Upper Mississippi River is critical for the support of backwater fish communities, especially in providing winter habitat. This type of habitat is steadily being lost all along the Upper Mississippi River due to the cumulative effective of backwater sedimentation. It was determined to be a reasonable objective for Polander Lake to attempt to maintain at least the existing condition in terms of acres of water equal to or deeper than 4 feet.

4. Reduce existing low flow velocities in a minimum of one-third of the lake by 50 percent.

Current velocities in much of Polander Lake have reached the point where they could be considered limiting for fry and juvenile fish during the summer, and limiting for adult and yound-of-the-year during the winter. This objective was established to reduce the limiting effects of current velocity in at least a portion of the lake. It was recognized current velocities could not practicably be reduced over a greater portion of the lake.

ALTERNATIVES

PLANNING OPPORTUNITIES

The physical characteristics of Polander Lake provide the opportunity for habitat improvements. The opportunity exists to use backwater material for island construction and, in turn, accomplish fish habitat improvement at the borrow site. The proximity of the navigation channel offers the opportunity to use channel maintenance material that could result in a cost savings.

PLANNING CONSTRAINTS

Much of the study area in Polander Lake is designated as a "closed area" where hunting and trapping are restricted during the fall waterfowl migration to provide resting and feeding stopovers for migratory waterfowl and to disperse waterfowl hunting opportunities on the refuge. Work in this area would be prohibited during the spring and fall migration seasons. Construction in the closed area would likely be permitted at other times of the year.

Hydraulic constraints include not causing an unacceptable increase in stage or producing unusual current patterns in the backwater area and main channel. Also, any project should not impede the functioning of the existing lock and dam 5A secondary spillway.

Engineering constraints could include difficulties in obtaining access to areas where construction could take place, high dredging costs because of potential placement restrictions, handling and placement of fine sediments, and providing stable island designs given the project goals.

Environmental concerns include potential impacts on mussel beds. Of prime concern is that the existing aquatic vegetation beds should not be adversely affected. Therefore, if at all possible, material (i.e., for construction of islands, etc.) should not be placed on identified productive beds. In addition, flow patterns should not be significantly altered in such a way as to increase impacts on these beds. The fish habitat in Polander Lake is good. Any project that is constructed should minimize impacts on the fishery.

There are three boat accesses in the immediate area, as well as the Minnesota City Boat Club marina. Given the popularity of the area to boaters, any project should minimize impacts to boating patterns.

ALTERNATIVES IDENTIFIED

There are several limiting factors with regard to aquatic vegetation within the study area that needed to be evaluated when seeking ways of meeting project objectives.

a. Turbidity and suspended solids reduce light penetration and restrict the depth of plant growth. In the summer of 1990, which was not a particularly good year for aquatic vegetation throughout much of this portion of the river, plant growth did not occur at depths greater than 2.5 feet.

b. Wind and wave action reduce the amount of shallow water areas (i.e., areas less than 3 feet) and resuspend sediment, thereby reducing light penetration. Wave action can actually deepen shallow areas through orbital motion created as the waves attack shallow areas and shorelines.

c. High flows along with wind were instrumental in the initial erosion of low-lying islands and shallow areas, weakening plant root systems and preventing the expansion of plant beds.

d. Erosion due to ice also may have helped erode low-lying islands.

Taking into account these limiting factors, along with the physical conditions of Polander Lake, it was determined that a reduction in velocity throughout much of the lake and a decrease in the wind and wave action could be accomplished. The turbidity in Polander Lake would be decreased by reducing wave action. However, given the physical setting of the study area, there appears to be little other opportunity (with the exception of the Pap Slough area) for reducing the amount of suspended solids coming into the lake. To significantly lower this input, a major portion of the incoming flow would need to be eliminated. This would require at least partially closing Burleigh Slough. Work done on the Lansing

Big Lake project in Iowa, which has a similar setting, shows that even partial closures to reduce inflow could raise water surface elevations during flood events to unacceptable levels.

It appeared that the method to accomplish the general goals and specific objectives was by increasing the diversity of habitat in Polander Lake. Structural alternatives were identified which would fulfill project objectives primarily by manipulating conditions that would affect one or more of the limiting factors that in some combination contribute most to the lack of aquatic plant growth in Polander Lake. In addition to looking at the direct effects that a structural alternative would have in achieving the objectives, opportunities for improving depths for fish through construction techniques were also considered. In addition to alternatives which could potentially fulfill the project objectives, the no action alternative was considered. The following are the basic alternatives initially identified.

Alternative 1. No Federal action.

Alternative 2. Creation of a modified moist soil unit.

Alternative 3. Creation of submerged island/barrier complex.

Alternative 4. Construction of a combination of islands, an island/barrier complex, and/or protection of existing islands.

ALTERNATIVES ELIMINATED FROM DETAILED EVALUATION

Following a preliminary review, most of the basic alternatives were eliminated from further consideration. These are discussed below along with the reasons for their elimination.

Alternative 1 - No Federal action

With this alternative, no project that would influence Polander Lake would be implemented using Federal funds. The aquatic plant communities within Polander Lake would decrease slightly from the current areal coverages of about 11 percent for emergent species and 16 percent for submerged species, to less than 10.55 and 14.5 percent, respectively. Flows through the lake would remain relatively unchanged. The area would continue to provide only marginal habitat for migrating waterfowl and good habitat for fish species present, such as centrarchids, which are generally intolerant of flows. The specific details of future conditions with the "No Action" alternative have been described in previous sections of this report. This alternative would be considered only if no feasible action alternative could be found.

Alternative 2 - Creation of a modified moist soil unit

This alternative would consist of enclosing an area extending from the inlet of Burleigh Slough (R.M. 734.5) to lock and dam 5A and from the navigation channel to the Minnesota shoreline. This was not conceived to be a true moist soil unit with a complete drawdown of water, but only an area in which water levels could be lowered by a foot or so to promote seed germination and aquatic plant growth in the shallow areas. Upon perusal of this proposal, it was determined that it was fraught with problems which in all probability did not make it worth the potential benefits. The primary reason for this decision was based on concerns of hydraulic impacts. Because of the configuration of the river in this area and past experience in other reaches of the river, it was felt that river stages for the more frequent flood events could increase by an undesirable amount with the construction of a dike to enclose the moist soil unit. There would also be a greater potential for increased rates of erosion on the main channel with this design. Secondary major design problems of dike stability, construction of a removable closure structure, and the need to assure the functioning of the lock and dam 5A spillway as well as the dam; environmental concerns about the effects of a drawdown on the area's fisheries and on areas already considered to have "good" habitat such as Twin Lakes; and the sheer cost of a study helped lead to the determination not to pursue this alternative.

Alternative 3 - Creation of submerged islands

This alternative would consist of the creation of submerged islands in strategic locations throughout the middle portion of Polander Lake and closing off the opening in Pap Slough by constructing a predominantly sand closure 800 feet long across this reach. With the construction of submerged islands, in addition to providing more habitat suitable for emergent and submerged aquatic plants, the areas of reduced flow behind the islands could also provide additional protected habitat for fish, such as centrarchids, which prefer areas with little or no flow during the winter months. Assuming that material used in construction of the islands could be obtained from backwater sources within Polander Lake, this could provide additional deepwater habitat for fish. This alternative was eliminated from consideration as a sole solution to the stated objectives because of concerns over longevity of the submerged islands. Unprotected submerged islands placed in a high energy environment like Polander Lake would be eroded fairly rapidly. Aerial photography taken in the lake since inundation shows that erosion of low islands and shallow areas has occurred historically. In all likelihood, this loss took place very quickly. Information gathered for another habitat project in pool 8 indicated that 36 percent of the islands present in the lower part of this pool disappeared over an 8-year period (from 1939 to 1947). Given the pool 8 data and the available information on Polander Lake, it appears that rapid erosion occurred in this pool as well.

Because of the potential benefits associated with submerged islands, this option was reassessed in conjunction with the island/barrier complex option. Here, low-lying islands with fairly substantial underwater extensions could be constructed in an environment protected from wave action. (See alternatives considered in detail.)

ALTERNATIVES CONSIDERED IN DETAIL

After elimination of the non-feasible alternatives, alternative 4, construction of a combination of islands, an island/barrier complex, and/or protection of existing islands, was considered in detail. A number of features were considered for incorporation into this alternative and are described below.

Island 1

This feature would be a closure structure which would close the Pap Slough opening (figure 21). From field observations and aerial photographs, it is apparent that the opening between Pap Slough and Polander Lake is continuing to expand. This opening allows sediment laden water to enter the backwater, and is responsible for much of the flow through the lake, especially in the northeast portion of the lake. It is anticipated that construction of a closure structure (Island 1) to prevent flows from Pap Slough from entering the backwater would provide a variety of benefits. Flows in the northeast section of the lake would be eliminated and flows throughout the remainder of the lake would be reduced. In fact, it is anticipated that a 50-percent reduction in current velocities in about one-third of Polander Lake could be realized with this alternative. Area 1 on figure 13 indicates the area of the lake in which flows would be eliminated or substantially reduced with this alternative. The reduction in the amount of turbid Mississippi River water entering the lake would allow for greater light penetration, allowing plant growth in deeper areas and in greater densities in the existing plant beds. The relationship between turbidity and aquatic plant growth on the Upper Mississippi River is not well understood. The LTRM is conducting studies to better define this relationship. For the evaluation of the effects of Island 1 and other potential features it was assumed that the reduction in turbidity would increase the depth to which aquatic plants would grow in Polander Lake from 3 feet to 4 feet.

It is anticipated that Island 1 would result in submerged aquatic plants occupying just under 22 percent and emergent plants just under 11.5 percent of the lake, a notable improvement over the coverages of 14.5 and 10.5 percent, respectively, which would result from the no action alternative.

The habitat suitability for all life stages of fish, such as centrarchids, would be improved by reduction in current velocities, additional vegetation, reduced turbidity, and warmer winter water temperatures.

Extending the barrier island that exists below the Pap Slough opening along the main channel was not considered, because of the desire to keep existing Burleigh Slough flow patterns undisturbed. In addition, a boat access channel between Polander Lake and the main channel is present in this area.

Island 2

This feature would involve construction of an island at the downstream end of the Pap Slough barrier system (figure 21). With the closure of Pap Slough, it was determined that a second island would be beneficial in assuring that the present bathymetric diversity in the upper portion of the lake would remain. Currently, the area of Polander Lake below the Pap Slough opening is very diverse in lake bottom elevations. This bathymetry was created and sustained by both deposition in some areas due to the influx of sediment and erosion due to Pap Slough flows. With the closure of the Pap Slough opening, these processes will be eliminated. There is reasonable expectation that the lake bottom in this area would level out due to wave action. The wave energy imposed on the shallow areas may also hinder aquatic vegetation from becoming established in the area. Consequently, construction of an island to protect this area was considered.

The island would be constructed at the downstream end of the Pap Slough island barrier system and would extend into Polander Lake. Orienting the island across the predominant wind direction would protect the upstream portion of the lake from wind and wave action and would maintain the existing bathymetric diversity in this area. It is anticipated that, with Island 2, wind and wave energy in a substantial part of the northeast portion of the lake would be reduced, allowing for the establishment of additional aquatic vegetation. It is expected that the construction of island 2 in addition to Island 1 would result in submerged aquatic plants occupying almost 25 percent and emergent plants 12.5 percent of the lake, a notable improvement over the coverages of 14.5 and 10.5 percent, respectively, which would result from the no action alternative.

The area's suitability for fish would be improved through increased plant coverage and any additional deep water habitat created through dredging of the material for island construction.

Island 2 was not considered as a stand-alone feature, but would be constructed only in conjunction with Island 1.

Island 6

This feature consists of construction of an island south of Islands 7 and 8 as shown on figure 14 to protect a plant bed located below Island 7 (see figure 10). Although construction of Island 6 would reduce wind and wave action in a portion of the lake, it would protect only about 1 acre of submerged aquatic plants. This equates to only 0.1 percent of the submerged aquatic plant community of the lake.

Islands 7 and 8

Polander Lake contains two remnant islands located in the southeast portion of the lake (figure 14) which are in jeopardy of being lost due to erosion. For cost estimation, these islands have been designated as 7 and 8; however, Island 7 is the aforementioned Island 66. These islands provide nesting habitat for waterfowl, reduce wind and wave action, and provide areas protected from flows. This feature includes protection of these islands with rock riprap to prevent further erosion. With this feature, the aquatic vegetation in the area of the islands would continue to receive protection. Future areal coverage of submerged aquatic vegetation would be about 15.8 percent and emergent aquatic vegetation about 10.6 percent, a slight improvement over the 14.3 and 10.4 percent coverages, respectively, anticipated with the no action alternative.

Island Complexes A, B, or C

In addition to the features considered for the upstream portion of the lake, construction of an island complex in the lower portion of the lake to reduce wind and wave action, provide additional areas for the establishment of aquatic vegetation, and provide flow-free areas, was also considered. Although at first glance it would be assumed that a wide variety of island complex designs and locations are possible, after careful consideration of the limiting factors and constraints, three final design alternatives (Island Complexes A, B, and C) were considered (figures 15-17). The island complexes considered avoid areas where vegetation is already established, do not disturb major flow patterns through the lake, are located in relatively shallow areas, and are situated to maximize the reduction of wind/wave action, encourage the growth of the greatest amount of vegetation, and protect existing vegetation beds. It was determined that one island complex, located in a large, fairly shallow, unvegetated area in the lower portion of Polander Lake, would best meet the desired criteria.

Island Complex A - This complex (figure 15) would consist of two major outer islands, each having inner bays formed through the construction of island offshoots from the major islands. One major island (approximately 2,400 feet long) would be located at the downstream end of the designated island complex area. A second 2,200-foot-long island would be constructed at the upper end of the same area. The two islands would be positioned perpendicular to the predominant wind direction. Between the protective outer islands, a series of smaller low-lying islands would be constructed to form embayments.

Island complex A would provide a variety of benefits to the Polander Lake area. It would provide habitat suitable for the establishment of both submerged and emergent aquatic plants, with ultimate coverages of 20.6 and 11.4 percent, respectively, a substantial improvement over the 14.3 and 10.4 percent coverages, respectively, anticipated with the no action alternative. Plant diversity would increase. The island would also be instrumental in reducing wind and wave action in a substantial portion of the lake, as shown on figure 18. Wind and wave action can resuspend bottom sediments, increase turbidity, and retard plant growth. It is anticipated that, with this feature, plant densities in existing plant beds would also improve.

The construction of this island complex would improve the area's suitability for fish in several ways. It would provide additional vegetation, reduce turbidity, provide additional deep water habitat, and provide areas with reduced current velocities.

Island Complex B - This island complex (figure 16) would affect wind and wave action, as shown on figure 19. With this feature, the resultant coverages of submerged and emergent aquatic vegetation are expected to be 18.5 and 11.1 percent, respectively, a substantial improvement over the 14.3 and 10.4 percent coverages, respectively, predicted with the no action alternative. In addition, plant diversity is expected to increase.

The construction of this island complex would improve the area's suitability for fish in several ways. It would provide additional vegetation, reduce turbidity, and provide areas with reduced current velocities.

Island Complex C - This complex (figure 17) would consist of a rectangular shaped island system. Its interior would be completely enclosed, creating a 36-acre protected area. Shallow depths would be created along the entire interior perimeter of the island by placing additional dredged material along its entire periphery. This island complex would also provide habitat suitable for the establishment of both submerged and emergent aquatic plants. It is anticipated that with the construction of this feature areal coverage of submerged aquatic plants within the lake would be 16.6 and 10.9 percent, respectively, a notable improvement over the 14.3 and 10.4 percent coverages, respectively, predicted with the no action alternative. Plant interspersion would also improve. Influencing virtually the same area of the lake as Island Complex B, this island complex would be instrumental in reducing wind and wave action in a substantial portion of the lake.

The construction of this island complex would improve the area's suitability for fish in several ways. It would provide additional vegetation, reduce turbidity, and provide areas with reduced current velocities.

Combinations of Features

Since none of the above features alone would provide the benefits necessary to meet the project objectives, combinations of features were considered. In most instances, the benefits realized with combinations of features are equal to the sum of the benefits listed separately for each measure. However, the combination of reduced flows through the closure of Pap Slough (Island 1) and reduced wind and wave action (other islands) is expected to reduce turbidity and increase light penetration to a degree greater than their individual sums. This in turn would produce greater benefits in terms of increased aquatic plant growth. The following paragraphs discuss the benefits achieved through selected combinations of features.

Islands 1, 2, & Complex A - With this combination of features submerged aquatic plants could be expected to become established in areas of the lake that are protected by the island complex, up to 3.5 feet in depth, and that are out of the remaining major flow paths. This would increase the percentage of the lake with suitable conditions for plant growth to about 45.9 percent. Aquatic plant coverage would be expected to increase from the current levels of 11.5 percent and 16.4 percent to 13.5 percent and 33.1 percent for emergent and submerged species, respectively. In addition, plant interspersion would improve substantially.

Islands 1, 2, & Complex B - This combination of features, would provide basically the same benefits as the preceding combination, except on a smaller scale. With this combination of features, it is anticipated that 43.5 percent of the area would provide acceptable depths for plant growth. It is anticipated that submerged and emergent aquatic plants would occupy 31.0 and 13.2 percent of the lake, respectively, a substantial improvement over the current 16.4 and 11.5 percent coverages. In addition, plant interspersion would improve substantially.

Islands 1, 2, & Complex C - This combination of features provides basically the same benefits as the two preceding combinations. With this combination, it is anticipated that 41.5 percent of the area would provide acceptable depths for plant growth. Submerged and emergent plants would occupy 29.2 and 13.0 percent of the lake, respectively.

Islands 1, 2, 7, 8, & Complex A - With this combination of features, submerged aquatic plants could be expected to become established in areas of the lake that are protected by the island complex, up to 3.5 feet in depth, and that are out of the remaining major flow paths. In addition, Islands 7 and 8 would continue to provide protection to the existing vegetation in their vicinities. This would increase the percentage of the lake with suitable conditions for plant growth to about 48.5 percent. Aquatic plant coverage would be expected to increase from the current levels of 11.5 percent and 16.4 percent to 13.7 percent and 34.8 percent for emergent and submerged species, respectively. In addition, plant interspersion would improve substantially.

Islands 1, 2, 7, 8, & Complex B - This combination of features would provide basically the same benefits as the preceding combination, except on a smaller scale. With this combination of features, it is anticipated that 46.1 percent of the area would provide acceptable depths for plant growth. It is anticipated that submerged and emergent aquatic plants would occupy 32.7 and 13.4 percent of the lake, respectively, a substantial improvement over the current 16.4 and 11.5 percent coverages. In addition, plant interspersion would improve substantially. Current and expected plant coverage with this alternative is shown on figure 20.

Islands 1, 2, 7, 8, & Complex C - This combination of features provides basically the same benefits as the two preceding combinations. With this combination, it is anticipated that 44.1 percent of the area would provide acceptable depths for plant growth. Submerged and emergent plants would occupy 30.9 and 13.2 percent of the lake, respectively.

ALTERNATIVE EVALUATION

To better quantify the benefits provided by each feature being considered for implementation in alternative 4, habitat evaluation analyses were conducted through the employment of two models. A draft diving duck model (developed by R.D. Devendorf, St. Paul District, COE in cooperation with the U.S. Fish and Wildlife Service) was selected as the most representative for evaluating waterfowl migratory habitat. In addition, to insure that the proposed project would maintain or enhance the area's suitability for the fish species present, several models developed by the U.S. Fish and Wildlife Service using Habitat Evaluation Procedures (HEP) were considered. The bluegill model was selected for use because of model modifications made to include an evaluation of winter habitat quality for the species. Attachment 7 provides a more detailed discussion on the application of the habitat evaluation procedures for this project.

Although slightly different, both habitat evaluation methodologies used provide a habitat suitability index which is multiplied by the number of acres of available habitat to obtain Average Annual Habitat Units (AAHU's). One habitat unit is defined as one acre of optimum habitat. By comparing existing and/or future without-project AAHU's to the number expected after the proposed action, outputs of proposed actions can be quantified.

An analysis comparing benefits (in terms of AAHU's) which would be realized, associated first and annualized costs for construction, and overall annual cost per AAHU for each feature being considered for implementation was prepared. Results of this analysis are shown in tables 8a and 8b.

As indicated in table 8a, construction of Island 1 proved to be the most cost effective. However, the construction of Island 1 alone would only provide about 33 percent aquatic plant coverage, which does not meet the project objective. Therefore, additional features were incorporated until the project objectives were met, or the cost per AAHU became prohibitive. An incremental analysis of the alternatives is shown in tables 9a and 9b.

This analysis indicates that the most cost effective combination of alternatives that provides the benefits required to meet the project objectives is construction of Islands 1 and 2, protection of Islands 7 and 8, and construction of island complex B. The overall cost per AAHU for this combination is $901.

Construction of Island 6 would provide less than 10 AAHUs for fish and none for waterfowl. The average annual incremental cost per habitat unit gained with this proposal was calculated to be $5,286. Because of the high cost per unit benefit, this feature was dropped from consideration.

An evaluation of potential floodplain effects was also conducted. The island complexes are situated in a portion of Polander Lake where they would not interfere with Burleigh Slough water reaching the lock and dam 5A spillway, or the main channel. Therefore, none of the island complex alternatives should affect river flood stages. The closing of the Pap Slough inlet recreates land that existed at that location prior to 1940. In addition, the Weaver Bottoms project in pool 5 is much more restrictive than the Polander Lake alternatives. Analysis of stage data at the headwater of dam 5, the pool 5 control point, and the dam 4 tailwater show no changes after the completion of the Weaver Bottoms project. This would indicate that the Polander Lake alternatives would also have no effect.

TABLE DPR-8A
AVERAGE ANNUAL COST PER HABITAT UNIT GAIN

ISLAND	INITIAL INVESTMENT (1)	ESTIMATED (2) AVE ANNUAL COST	ESTIMATED AVE ANNUAL OM&R	TOTAL AVE ANNUAL COST	AAHU GAIN (3)(4)			COST/AAHU FISH & FOWL
					DUCKS	FISH	AVERAGE	
1	$291,050	$25,857	$1,200	$27,057	27.10	178.94	103.02	$263
2	$306,900	$27,265	$1,000	$28,265	16.80	26.20	21.50	$1,315
6	$279,400	$24,822	$1,000	$25,822	0.00	9.77	4.89	$5,286
7 & 8	$119,600	$10,625	$1,100	$11,725	1.80	9.77	5.79	$2,027
COMPLEX A	$2,006,652	$178,271	$1,300	$179,571	28.30	78.34	53.32	$3,368
COMPLEX B	$1,302,000	$115,670	$1,100	$116,770	9.00	63.10	36.05	$3,239
COMPLEX C	$2,388,230	$212,171	$1,100	$213,271	16.20	70.87	43.54	$4,899
1 – 2 – A	$2,532,879	$225,021	$3,500	$228,521	140.70	283.44	212.07	$1,078
1 – 2 – B	$1,832,350	$163,082	$3,300	$166,382	116.60	268.24	192.42	$865
1 – 2 – C	$2,914,453	$258,920	$3,300	$262,220	117.80	276.04	196.92	$1,332
1 – 2 – 7 – 8 – A	$2,652,472	$235,646	$4,600	$240,246	142.50	291.70	217.10	$1,107
1 – 2 – 7 – 8 – B	$1,951,950	$173,411	$4,400	$177,811	118.40	276.50	197.45	$897
1 – 2 – 7 – 8 – C	$3,034,050	$269,545	$4,400	$273,945	119.60	284.30	201.95	$1,357

1) Initial investment is the estimated first cost of construction of the alternative. Costs are preliminary and used for the initial comparison of alternatives.
2) Estimated cost/year is the annualized first cost of construction based on a 50–year economic life and an 8–3/4 percent discount rate.
3) See attachment 7 "Habitat Evaluation Procedures" for methodology used in quantifying habitat gains.
4) Habitat Units (HU) reported are average annual habitat units and are the difference between the future–without and future–with project conditions.
5) Cumulative benefits are greater than the sum of the benefits of the individual features because of synergistic effects.

TABLE DPR-8B

Average Annual Cost/AAHU Gain

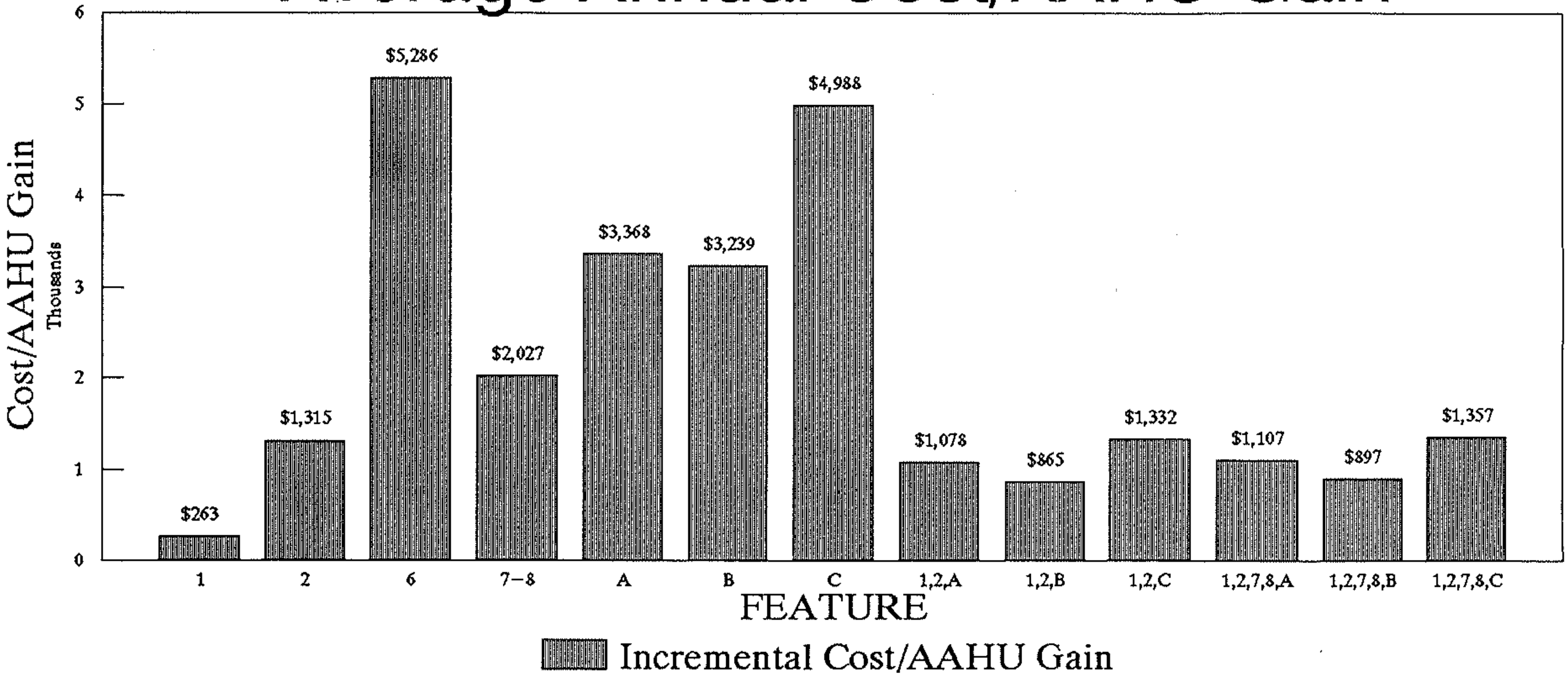


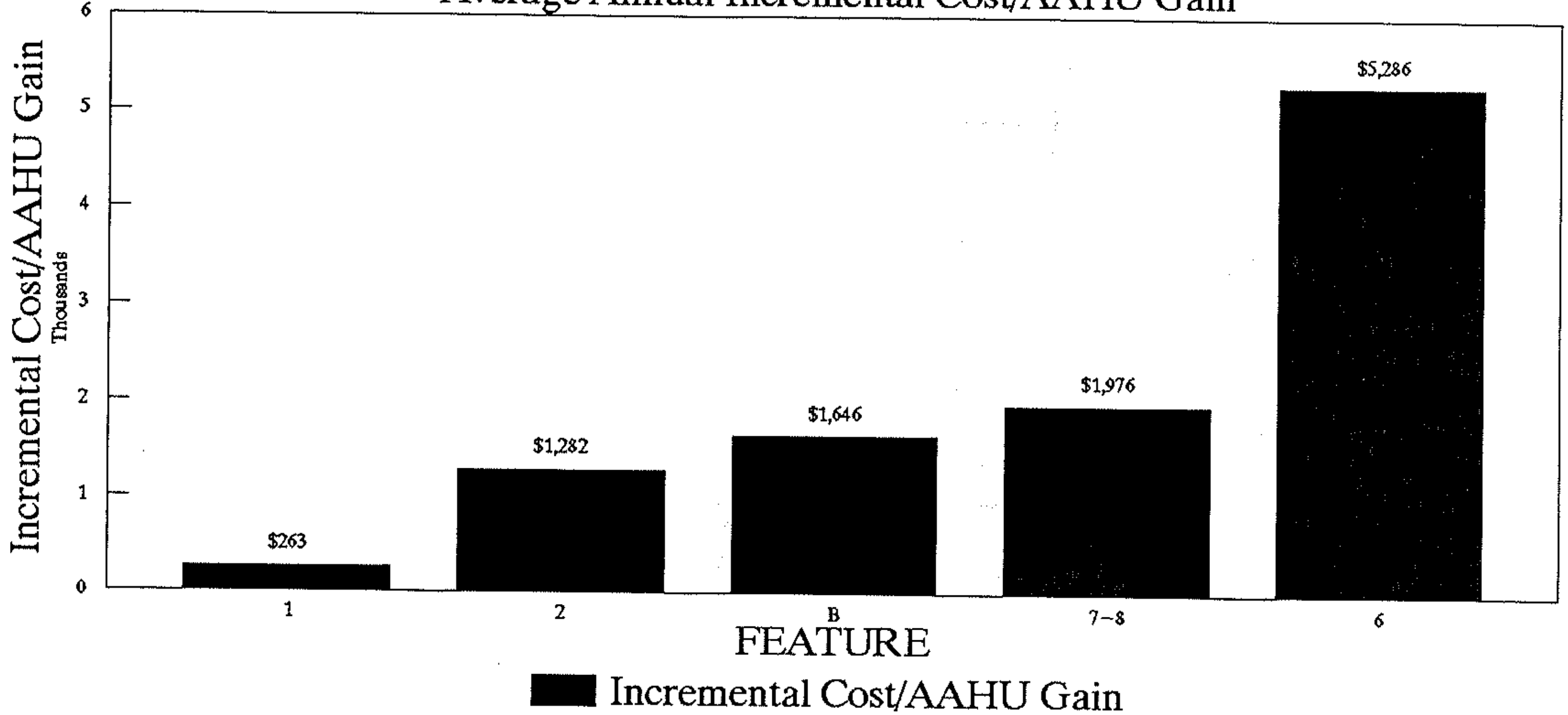
TABLE DPR-9A
Incremental Analysis of Alternatives

Alternative Increment	Ave Annual Cumulative Cost *	Ave Annual Incremental Cost	Species	Average Annual Habitat Unit Gain ** Incremental	Average Annual Habitat Unit Gain ** Total	Average Annual Incremental Cost/ Habitat Unit Gain	Cumulative Ave Ann Cost/ Habitat Unit Gain
Island 1	$27,057	$27,057	Diving Duck	27.10	27.10		
			Bluegill	178.94	178.94		
			Average	103.02	103.02	$263	$263
Island 2	$54,617	$27,560	Diving Duck	16.80	43.90		
			Bluegill	26.20	205.14		
			Average	21.50	124.52	$1,282	$439
Complex B	$166,382	$111,765	Diving Duck	72.70	116.60		
			Bluegill	63.10	268.24		
			Average	67.90	192.42	$1,646	$865
Islands 7 & 8	$177,811	$11,429	Diving Duck	1.80	118.40		
			Bluegill	9.77	278.01		
			Average	5.79	198.21	$1,976	$897
Island 6	$203,633	$25,822	Diving Duck	0.00	118.40		
			Bluegill	9.77	287.78		
			Average	4.89	203.09	$5,286	$1,003

* Cumulative cost is less than the sum of the individual costs because of elimination of duplicate costs.
** Cumulative benefits are greater than the sum of the benefits of the individual features because of synergistic effects.

TABLE DPR-9B

Average Annual Incremental Cost/AAHU Gain



SELECTED PLAN WITH DETAILED DESCRIPTION/ DESIGN AND CONSTRUCTION CONSIDERATIONS

The selected plan of action consists of a number of features which, when added together, would maintain and create additional diversity in the lake area. More specifically, the opening between Pap Slough and Polander Lake would be closed (Island 1), an island would be constructed at the downstream end of the existing barrier island system which runs between Pap Slough and Polander Lake (Island 2), two eroding islands in Polander Lake would be protected (Islands 7 and 8), and a series of islands would be constructed at the lower end of Polander Lake (Island Complex B). Each segment of the recommended plan is discussed below. Figure 21 shows a plan view, with cross sections for the major portions of each island shown on figure 22. (Attachment 8 gives in-depth information on island design features.)

The closure of Pap Slough (Island 1) would be accomplished by placing sand fill material along this 800-foot-wide opening. The maximum height of fill would be at elevation 656 feet msl, which is 5 feet above the normal pool elevation. The top width of the barrier island would be 20 feet. Sides slopes would be 1V:3H along the island cross section. Rock fill would be placed on the Pap Slough side of the barrier to protect it from the erosive forces caused by flow through the slough. Sand fill and rock protection riprap would be required on the existing island for 300 feet downstream of the proposed barrier. The Polander Lake side of this island would be constructed with a 40-foot-wide berm. The berm is designed to provide sufficient material so that a natural beach would form over time along this stretch. It is estimated that construction of this barrier would require approximately 21,340 cubic yards of sand. The sand fill would be capped by a 6-inch layer of topsoil (300 cubic yards) and seeded. It is estimated that 1,780 cubic yards of rock fill would be needed to protect this barrier. Dredging may be necessary for access. Every effort would be made to use this material for island construction.

The island at the downstream end of Pap Slough which extends into Polander Lake (Island 2) would be approximately 1,000 feet in length. This island would not be connected to the existing barrier island system, but would begin approximately 100 feet from the present shoreline. A gap was left in order to protect an existing vegetation bed that was found bordering the tip of the island. The new island would be at the same elevation as Island 1 and would have the same cross sectional configuration as this island. Riprap would be placed on the downstream side of the island to provide erosion protection due to both wind and boat generated waves. It is estimated that about 24,310 cubic yards of sand, 1,140 cubic yards of fines, and 2,160 cubic yards of riprap would be needed to construct this island.

Island Complex B at the lower end of the lake would consist of two major outer islands and three inner islands. The outer islands would provide protection from wave action to all inner islands. The major upstream island (Island 3) would have the same cross section configuration as the Pap Slough barrier island. Riprap is needed along the entire upstream portion of the island because of the lack of protection from winds (and the subsequent wave action) coming down the river valley. The inner side of this island would be protected by the second major island which is to be constructed about 1,000 feet downstream. For this lower major island (island 4), the upstream face is again protected by the presence of the upper island. The downstream side of the island has some protection from the dam. These features, plus the shape of the island (which maximizes its concave surfaces), should provide sufficient protection to this island from erosive forces over the long term. Riprap is required in areas where wave energy presents greater chances for erosion. This is typically in areas where waves can attack from more directions (the ends) and where there are unprotected convex shapes. (Riprapped areas are noted on figure 21.) The height of these outer islands is the same as discussed for Island 1.

The inner connections, Islands 3a, 4a, and 4b, are about 675, 415, and 775 feet in length, respectively. Each would be at a lower height (elevation 654 feet msl) than the surrounding islands. This is possible because of the protection offered by the two major islands. Side slopes would be 1 foot vertical for each 10 feet horizontal. This gradual side slope allows for quicker establishment of more extensive aquatic vegetation beds.

The total amount of sand used to construct this entire island complex would be 129,830 cubic yards. The quantity of fines was estimated to be 37,250 cubic yards, with rock fill totaling 4,480 cubic yards. A breakdown of quantities for various segments of this lower island complex can be found by referring to the detailed cost estimate in attachment 5.

The two remnant islands (Islands 7 and 8) in Polander Lake would be protected by placing rock fill along their eroding banks. It is estimated that approximately 445 linear feet of shoreline would be riprapped on Island 7 and 365 feet on Island 8, requiring approximately 979 and 803 cubic yards of rock fill, respectively.

To promote the growth of emergent vegetation, plants of various species would be collected locally and planted in the upper end of Polander Lake in areas protected by the newly constructed barrier island system. Plants would also be placed along the interior islands of the major downstream complex. Willows would be planted along non-riprapped portions of all major islands. Species and quantities of plants collected, along with collection locations, would be coordinated with the appropriate State and Federal agencies.

Based on current information, the following is offered as the likely method of construction for the various project features. Given the quantity of island fill required, all sand material would likely be hydraulically dredged. The following criteria were used in identifying potential borrow sources.

a. The borrow material must be acceptable for its intended use, both from an engineering (particle size) and an environmental (contaminants, excavation impacts) perspective.

b. It is desirable for the borrow material to be within the practical reach of a hydraulic dredge (10,000 feet).

c. In order to obtain additional environmental benefits, the priority for obtaining borrow is backwater areas, side channels, and the main channel, in that order.

The expected method of construction for each of the structures is as follows:

<u>Island 1</u> - Sand for this structure would be taken from Pap Slough because it is a viable source of sand immediately adjacent to the structure. It is considered impractical to attempt to obtain sand for this structure from the backwater areas to the west because of the high quality habitat present and the poor access conditions for dredging equipment. In addition, no suitable sand deposits of sufficient quantity and quality have been identified in this backwater area. Fine material for capping this structure would be obtained adjacent to the structure or from the backwaters nearby (figure 23).

<u>Island 2</u> - Sand for this structure could possibly be taken from the Burleigh Slough delta area (figure 23). Further investigations are required to determine if suitable quantities of acceptable material are available from the Burleigh Slough delta area. If suitable sand for this structure cannot be found in backwater areas, the sand would be taken from Pap Slough. Fine material for capping Island 2 would be obtained from the downstream or southerly side of the island.

<u>Complex B</u> - Sand for the Complex B islands could be taken from the Lost Island area or possibly the Burleigh Slough delta area (figure 23). Further investigations are required to determine if suitable quantities of acceptable material are available from the Burleigh Slough delta area. Further testing of the Lost Island area sediments is required to determine their suitability for use in island construction. However, based on current information, it appears Lost Island material may be suitable for construction of the inner islands and/or the interior portions of the outer islands. If suitable material for the Complex B structures cannot be found in backwater areas, the sand would be taken from Pap Slough. Fine material for capping the islands within this complex

will come from the upstream side of Island 3 and the downstream side of Island 4 (figure 23).

In summary, Pap Slough provides a guaranteed source of sand material. During the plans and specifications stage, potential sources of suitable fill material from backwater sources such as Lost Island and the Burleigh Slough delta will continue to be pursued. In addition, if channel maintenance dredging is occurring at the time the project is being constructed, the use of channel maintenance material will be pursued. Channel maintenance material will be used if it is determined that the cost savings outweigh the environmental benefits that may be foregone by not using a backwater or side channel site.

The bank protection materials for Islands 7 and 8 would be barged to the islands and placed using mechanical equipment. Some shaping of the banks may be required prior to placing of the rock.

Access channels for construction will likely be required for some of the project features, most notably Complex B. Material excavated in the process of gaining access would be used as topsoil on the Complex B islands or disposed of on a barren area on the existing barrier islands located just upstream of lock and dam 5A.

ENVIRONMENTAL EFFECTS

An environmental assessment has been conducted for the proposed action, and a discussion of the impacts on habitat conditions follows. As specified by Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in the Environmental Impacts Matrix (table 10) were reviewed and considered in arriving at the final determination. In accordance with Corps of Engineers regulations (33 CFR 323.4(a)(2)), a Section 404(b)(1) evaluation was prepared and is included as attachment 2 of this report. Application will be made to the State of Minnesota regarding water quality certification under Section 401 of the Clean Water Act. The Finding of No Significant Impact (FONSI) will be signed after the public review period has elapsed, any issues have been resolved, and the water quality certification has been obtained.

Table DPR-10

ENVIRONMENTAL IMPACT ASSESSMENT MATRIX	MAGNITUDE OF PROBABLE IMPACT						
POLANDER LAKE EMP	<------ INCREASING BENEFICIAL IMPACT			NO APPRECIABLE EFFECT	INCREASING ADVERSE IMPACT ------>		
NAME OF PARAMETER	SIGNIFICANT	SUBSTANTIAL	MINOR		MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels					X (Temporary)		
2. Aesthetic Values			X				
3. Recreational Opportunities			X				
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)				X			
7. Community Growth & Development				X			
8. Business and Home Relocations				X			
9. Existing/Potential Land Use				X			
10. Controversy				X			
B. ECONOMIC EFFECTS							
1. Property Values				X			
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity			X				
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Flooding Effects				X			
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality					X (Temporary)		
2. Terrestrial Habitat				X			
3. Wetlands				X			
4. Aquatic Habitat		X					
5. Habitat Diversity and Interspersion		X					
6. Biological Productivity		X					
7. Surface Water Quality			X		X (Temporary)		
8. Water Supply				X			
9. Groundwater				X			
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL EFFECTS							
1. Historic Architectural Values				X			
2. Pre-Hist & Historic Archeological Values				X			

RELATIONSHIP TO ENVIRONMENTAL REQUIREMENTS

The proposed project complies fully with applicable environmental statutes and Executive Orders for the current stage of planning. Among the more pertinent are the National Environmental Policy Act of 1969, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; the Clean Water Act of 1977 (with acquisition of the water quality certification); the Clean Air Act, as amended; the National Historic Preservation Act of 1966, as amended; the National Wildlife Refuge System Administration Act; the Endangered Species Act of 1973, as amended; the Land and Water Conservation Fund Act of 1965, as amended; Executive Order 11990 - Protection of Wetlands; Executive Order 11988 - Floodplain Management; and USACE ER 1105-2-100.

NATURAL RESOURCE EFFECTS

Water Quality

The effects of the proposed project on water quality are described in detail in the attached Section 404(b)(1) Evaluation (attachment 2). Some short-term negative effects are possible due to construction activities. Localized turbidity plumes and increased suspended solids levels would be expected during dredging and open-water disposal during island construction. However, the use of clean sand for island construction and rock riprap should reduce the impacts on water quality. Releases of contaminants should be minimal due to the use of relatively uncontaminated material. Sediment core samples collected by the Corps of Engineers during April 1990 indicated that contaminants of concern were comparable to other backwater areas of the Upper Mississippi River. No pesticides or PCBs were present in detectable concentrations. Table 4 summarizes the results of the bulk chemical analysis of the samples taken. Once borrow and disposal areas are more closely identified, further sediment analysis may be required. The long-term effects on water quality are expected to be positive because of lower flow velocities and the introduction of less turbid river water into the backwater lake.

Reduced inflows of Mississippi River water with the closure of the Pap Slough opening should result in minor increases in water temperatures in the northeast portions of the backwater during the winter. Slightly higher water temperatures would provide improved habitat conditions for a variety of organisms, especially fish, during the winter months.

Aquatic Habitat

Construction of the proposed closure structure and islands would cover approximately 26.6 acres of lake bottom and eliminate any benthic organisms in that area. However, the new benthic habitat created would be quickly recolonized. Approximately 8 acres of the new substrate created through construction of the islands would be below low control pool elevation. This new substrate would provide habitat more variable in depth that which currently exists, and the rock riprap required on portions of the islands would provide a more diverse substrate. With increased water clarity and additional shallow areas, aquatic vegetation coverage would also increase. Aerial coverage of submerged species would increase from 16.4 to 32.7 percent and emergent species from 11.5 to 13.4 percent. The project would also provide a better interspersion of vegetation and open water areas. In addition, the densities of vegetation in existing plant beds are expected to increase.

Fish and Wildlife

The proposed project is designed to improve the habitat in Polander Lake for both fish and wildlife. Polander Lake is located within the Upper Mississippi River Wildlife and Fish Refuge and is an important staging area for migrating waterfowl. Consequently, it has been designated as an area closed to hunting and trapping. However, the area does not support adequate aquatic vegetation. This project would improve the habitat for waterfowl by increasing the submerged and emergent aquatic vegetation and its interspersion throughout the lake. In addition, the islands proposed for construction would provide areas protected from wind and waves. Once vegetation was established on the islands, they would provide additional waterfowl nesting habitat in the area. These areas would provide nesting areas relatively safe from predation.

Decreasing current velocities in a minimum of one-third of the lake by at least 50 percent would benefit fish species, such as centrarchids, which are generally intolerant of flows. In addition, the reduction of inflows of Mississippi River water during the winter should slightly increase water temperatures in the northeast portion of the lake, also benefiting fish. The increased vegetation would provide additional cover for fry and fingerlings.

In addition to providing spawning areas for fish, the rock riprap used for island protection would provide habitat much more productive for macroinvertebrates than that which currently exists. The increased macroinvertebrate production would increase the food available for fish.

Dredging would provide increased diversity by providing additional deepwater areas, also beneficial for the fish species present.

Construction of the proposed islands would bury and eliminate any benthic organisms, including mussels, in those locations. Dredging would eliminate any benthic organisms in borrow areas. However, mussel surveys conducted in the areas of proposed construction indicate that the proposed islands are located in areas supporting only sparse mussel populations. Areas designated for dredging of material for island construction have been selected to avoid areas containing substantial mussel populations.

Wetlands

The proposed project would involve work in a lacustrine setting. No wetlands would be affected.

Threatened and Endangered Species

A biological assessment of the proposed project was completed to determine the potential effects on Federally- and State of Minnesota-listed threatened and endangered species, including the following Federally-listed species: Higgins' eye pearly mussel (Lampsilis higginsi), peregrine falcon (Falco peregrinus), and bald eagle (Haliaeetus leucocephalus).

No nesting sites for the peregrine falcon are known to exist in the immediate vicinity of Polander Lake. However, they may use the area for feeding and roosting, and during migrations. Minor disturbances during construction should not influence their long-term use of the area.

Higgins' eye pearly mussels are not known to occur in Polander Lake. During a mussel survey conducted on June 16, 1991, no shells or living specimens of Higgins' eye pearly mussels or any other threatened or endangered species were collected.

There are two former bald eagle nesting sites located in the project area. Neither of these nests were active during 1991. However, the territory may still be active. Should an active nest be found, the appropriate State and Federal authorities would be contacted and project activities adjusted to avoid disturbance of the eagles.

It has been determined that the proposed project would not affect any threatened or endangered species. The proposed project has been coordinated with the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources, who agree with this determination (attachment 3, letters dtd. August 2, 1991).

Air Quality

The proposed project would have minor temporary effects on air quality. Exhaust emissions from construction equipment would degrade the air quality slightly for short periods. These temporary changes in air quality could disturb people and wildlife using adjacent areas, but the overall effect on people, wildlife, and vegetation would be negligible.

SOCIOECONOMIC EFFECTS

The proposed project could improve the economic and social benefits in the Polander Lake area. Improving the quality and quantity of aquatic vegetation and providing enhanced habitat for waterfowl and fish would have a minor positive impact on the aesthetic qualities of the area. Commercial fishing might also improve. During construction, there could be temporary disruption of normal activities. However, the long-term economic and social benefits would outweigh any adverse effects.

RECREATIONAL EFFECTS

The proposed project would improve recreation in the Polander Lake area as a by-product of the habitat improvements for fish and wildlife. Increasing the diversity of the lake bottom, improving the variety and quantities of aquatic vegetation, and improving the water quality would improve the habitat and attract fish and wildlife to the area. The improvements would probably result in increased recreational activity. Project construction may cause some temporary interruption of the recreation activities in the area. However, the long-term benefits would far outweigh any negative impacts.

CULTURAL RESOURCES EFFECTS

In accordance with the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. There are no sites on or determined eligible for the National Register in the project area. Coordination with the Minnesota State Historic Preservation Officer (attachment 3, letter dtd. May 9, 1990) revealed that there are no reported historic or archaeological sites in the project area that would be affected by the proposed project.

SUMMARY OF PLAN ACCOMPLISHMENTS

Habitat evaluation procedures were used to quantify projected benefits from the project. The details of the evaluation are presented in table 8. In summation, the proposed project would increase the habitat suitability index value of the area from 0.58 to 0.69 for migrating waterfowl and from 0.26 to 0.49 for bluegill, the representative fish species. The average annual habitat unit gain would be 118.40 and 276.50 for waterfowl and bluegills, respectively.

The proposed project would increase the aerial coverage of aquatic vegetation to approximately 46.1 percent, as near as practicable to the 50-percent optimum. Emergent species would compose about 29.1 percent of the vegetation and would be interspersed throughout the lake, meeting the project objective. The proposed project would not affect the existing deep water habitat (≥4 foot depth) of the lake. It is anticipated that with this project low flow velocities in at least one-third of the lake would be reduced by 50 percent, meeting the project objective.

The proposed project would substantially improve the quality of the habitat for migrating waterfowl and fish in the Polander Lake area, providing near optimal conditions for those species.

OPERATION, MAINTENANCE, AND REPAIR

GENERAL

Upon completion of construction, the U.S. Fish and Wildlife Service would accept responsibility for operation and maintenance (O&M) of the Polander Lake project in accordance with Section 906(e) of the Water Resources Development Act of 1986, Public Law 99-662, and subsequent Annual Addendums. The non-Federal sponsor would be the Minnesota Department of Natural Resources. Specific operation and maintenance features would be defined in a project operation and maintenance manual which would be prepared by the Corps of Engineers and coordinated with the involved agencies during the plans and specifications phase.

OPERATION

No operation is anticipated with the proposed project.

MAINTENANCE AND REPAIR

The project is designed to require little maintenance. The major islands are expected to be overtopped during the 4-year flood event, and erosion could occur during these times. Minor erosion and riprap displacement could also occur during storm events and/or due to ice action. Generally, maintenance and repair requirements would include maintaining vegetation on the major islands only and repairing minor erosion and riprap displacement on these islands. Some erosion would occur along the inner islands of the lower island complex. However, this should not reduce their function, which is to provide a substrate for aquatic vegetation and quiet bays. No maintenance of these islands would be required. Some erosion of the berm on the major islands (1,2,3 and 4) would also occur after construction. This is expected and is necessary for a stable shoreline to develop. An operation and maintenance manual detailing maintenance requirements would be prepared by the Corps during the plans and specifications phase. Development of the manual would be coordinated with the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources. Over the 50-year project life, the average annual operation and maintenance costs of the project are estimated to be $3,900. A breakdown of projected costs is contained in table 11.

Table DPR-11
Estimated Operation and Maintenance Costs

Item	Amount
a. Inspection and reporting	$ 400
b. Riprap replacement	2,500
c. Bank repair	1,000
Total annual cost	$3,900

Note: (1) Total projected operation and maintenance costs over a 50-year project life are estimated to be $195,000.

(2) Following are the calculations used to arrive at costs shown in the table. These are rounded off to the nearest $50 when shown in the above table.

a. Inspection: (1/2 man-day/job x 8 hr/man-day x $30/hr) + (50 miles/job x $0.25/mile) = $130/job, $130/job x 2 times/year = $260

Reporting: (1/2 man-day/job x 8 hr/man-day x $30/hr) = $120

b. Over the 50-year period, an average of 50 cy of riprap would be replaced per year: (50 cy/year * $50/cy) = $2,500

c. Island erosion: (100 cy/year * $10/cy) = $1,000

PROJECT PERFORMANCE EVALUATION

A monitoring plan for project evaluation was designed to directly measure the degree of attainment of the selected project objective. The plan is described below and presented in tables 12 through 14.

Monitoring activities would be closely coordinated with any similar efforts by the Long-Term Resource Monitoring program. Information gathered by local resource agencies on a routine basis, such as test netting or creel census and information on angling success, would also be used. The Polander Lake project has high potential to be included in a biological response monitoring program which would be designed to quantify the effects of constructed islands on wave energy, suspended solids, and aquatic plant growth.

TABLE DPR−12
PROJECT OBJECTIVES AND ENHANCEMENT FEATURES

(1) Objective	Project Accomplishment	Potential Enhancement Feature	Units	Enhancement Potential (2) Existing	Enhancement Potential Future Without	Enhancement Potential Future With
Create a 50/50 interspersion of vegetation and open water	46.1% vegetative cover	Island 1 Island 2 Complex B Island 7 & 8	Percent aerial coverage	27.9% vegetative cover	24.8% vegetative cover	46.1% vegetative cover
20−30% of vegetation emergent	29.1% of vegetation emergent	Island 2 Complex B Island 7 & 8	Percent aerial coverage	41% of vegetation emergent	42% of vegetation emergent	29.1% of vegetation emergent
Maintain 400+ acres =>4' in depth (fish habitat)	Maintains 400+ acres =>4' in depth (fish habitat)	Island 1 Island 2	Acres	400+ acres =>4' in depth (fish habitat)	400+ acres =>4' in depth (fish habitat)	Maintains 400+ acres =>4' in depth (fish habitat)
Reduce low flow velocities in 1/3+ of the lake by 50%+	Reduces low flow velocities in 1/3+ of the lake by 50%+	Island 1	Ft/sec and acres	Unacceptable low flow current velocities	Unacceptable low flow current velocities	Reduces low flow velocities in 1/3+ of the lake by 50%+

(1) Areas with reduced low−flow current velocities with the proposed project are shown on figure 19.
(2) Compilation of detailed flow rates and patterns is not complete as of the date of this report.

TABLE DPR-13
UMRS-EMP Monitoring and Performance Evaluation Matrix

Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source	Remarks
Sedimentation Problem Analysis	System-wide problem definition [to PA(S)9]*. Evaluate planning assumptions.	USFWS	USFWS (EMTC)	LTRM	Lead into pre-project monitoring; define desired conditions for plan formulation.
Pre-project Monitoring	Identify and define problems at specific sites.	Sponsor	Sponsor	Sponsor	Should attempt to begin defining baseline.
Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Field stations or sponsors thru Cooperative Agreements, or Corps.**	LTRM ****	Should be over several years to reconcile pertubations.
Data Collection for Design	1. Identify project objectives. 2. Design of project. 3. Develop Performance Evaluation Plan.	Corps	Corps	HREP	After fact sheet. Data may aid in defining baseline.
Construction Monitoring	Assure permit conditions met.	Corps	Corps	HREP	
Performance Evaluation Monitoring	Determine success of projects.	Corps	Field stations or sponsors thru Cooperative Agreements, sponsor thru O&M***, or Corps.**	LTRM ****	After construction.
Analysis of Biological Responses to Projects	1. Determine critical impact levels, cause-effect relationships, and long-term losses of significant habitat.	USFWS	USFWS (EMTC)	LTRM	Biological Response Study tasks beyond scope of Performance Evaluation, Problem Analysis, and Trend Analysis.
	2. Demonstrate success or response of biota.	Corps	Corps/USFWS (EMTC)/Others	LTRM ****	

*Refers to Sedimentation Problem Analysis Tasks, pages 35-36, LTRM Operating Plan

**Choice depends on logistics. When done by the States under a Cooperative Agreement, the role of the EMTC will be to: (1) advise and assist in assuring QA/QC consistency, (2) review and comment on reasonableness of cost estimates, and (3) be the financial manager. If a private firm or State is funded by contract, coordination with the EMTC is required to assure QA/QC consistency.

***Some limited reporting of information for some projects (e.g., waterfowl management areas) could be furnished by on-site personnel as part of O&M.

****Requires a transfer of allocations from the Habitat Project account to the LTRM account.

TABLE DPR–14
Pre– and Post–Construction Measurements

Goal	Project Objective	Enhancement Feature	Unit of Measure	Measurement Plan	Monitoring Interval	Projected Cost per Effort
Enhance the value of Polander Lake for migrating waterfowl	Create a 50/50 interspersion of vegetation and open water	Island 1 Island 2 Complex B Island 7 & 8	Percent aerial coverage	Yearly vegetation surveys	Annual 3 and 5 years post–construction	$5,000
Enhance the value of Polander Lake's fishery	20–30% of vegetation emergent in scattered beds	Island 2 Complex B Island 7 & 8	Percent aerial coverage	Yearly vegetation surveys	Annual, pre– 3 and 5 years post–construction	Included in above
	Maintain 400+ acres =>4' in depth	Island 1 Island 2	Acres	Bathymetric surveys	Annual, 1 and 5 years post–construction	$4,000
	Reduce low flow velocities in 1/3+ of the lake by 50%+	Island 1	Ft/sec acres	Measure low–flow velocities summer and winter	Biannual, pre– 1 and 5 years post–construction	$4,000
			Degrees	Measure temperatures summer and winter		

Average annual monitoring cost over the 50–year project life = $680.

COST ESTIMATE

The total project cost for the selected plan was estimated to be $1,951,150. This cost does not include prior allocations of $80,000 for general design (planning). A detailed cost estimate is contained in attachment 5. A summary of costs is shown in table 15.

Table DPR-15
Summary of Total Project Costs

Item	Cost
Island Construction	
Island 1	$199,750
Island 2	234,400
Island 7	50,000
Island 8	44,000
Island 3	398,500
Island 3a	148,400
Island 4	351,300
Island 4a	82,400
Island 4b	153,400
Plantings	8,000
Engineering and Design[1]	178,000
Supervision and Administration	103,000
Total	$1,951,150

[1] This does not include prior allocations of $80,000 for general design (planning).

REAL ESTATE REQUIREMENTS

All construction features of the proposed project would be located on land owned by the Corps of Engineers and managed by the U.S. Fish and Wildlife Service as part of the Upper Mississippi River National Wildlife and Fish Refuge. Appropriate agreements would be made with the U.S. Fish and Wildlife Service to construct the island system on the refuge.

SCHEDULE OF DESIGN AND CONSTRUCTION

Funds for plans and specifications can be provided by Headquarters, U.S. Army Corps of Engineers (HQUSACE), prior to approval of the project by the Assistant Secretary of the Army (Civil Works), upon a recommendation from Civil Works Planning after HQUSACE staff review of the final report. As described in this report, this work would include additional soil borings at the proposed island fill borrow sites. The remaining review and approvals, major work tasks, and a schedule for project construction follow:

Requirement	Scheduled Date
Submit final Definite Project Report to North Central Division, US Army Corps of Engineers	
Submit final Definite Project Report to Headquarters, US Army Corps of Engineers	
Obtain plans and specifications funds	
Obtain construction approval by Assistant Secretary of the Army (Civil Works)	
Complete plans and specifications	
Advertise for bids	
Award contract	June 1993
Complete construction	September 1994

IMPLEMENTATION RESPONSIBILITIES

The responsibilities of plan implementation and construction fall to the Corps of Engineers as the lead Federal agency. After construction of the project, project operation and maintenance would be required for features of the islands as outlined in the OPERATION, MAINTENANCE, AND REPAIR section of this report. These actions would be the responsibility of the U.S. Fish and Wildlife Service in cooperation with the Minnesota Department of Natural Resources.

Should rehabilitation of the Polander Lake project which exceeds the annual maintenance requirements be needed (as a result of a specific storm or flood), the Federal share of rehabilitation would be the responsibility of the Corps of Engineers. Performance evaluation, which includes monitoring of physical/chemical conditions and some limited biological parameters, would be a Corps responsibility. Attachment 4 contains a draft copy of the formal agreement that would be entered into by the Corps of Engineers and the U.S. Fish and Wildlife Service. The Memorandum of Agreement formally establishes the relationships between the Department of the Army, represented by the Corps of Engineers, and the U.S. Fish and Wildlife Service in constructing, operating, and maintaining the proposed Polander Lake project.

The Minnesota Department of Natural Resources provides technical data and advisory assistance during all phases of project development and acts as the non-Federal sponsor.

COORDINATION, PUBLIC VIEWS, AND COMMENTS

The proposed project has been coordinated with the USFWS, Wisconsin and Minnesota Departments of Natural Resources, the Minnesota State Historic Preservation Office, and the Minnesota State Archaeologist. Correspondence is contained in attachment 3.

This report will be sent to Congressional interests; appropriate Federal, State and local agencies; special interest groups; interested citizens; and others listed in attachment 3.

CONCLUSIONS

The Polander Lake habitat rehabilitation and enhancement project presents an opportunity to improve migrating waterfowl and fish habitat. At present, the area does not support adequate aquatic plant communities which provide the food necessary for waterfowl during migration. In addition, the high current velocities present in the lake degrade the habitat suitability for fish, especially centrarchids.

Numerous measures aimed at correcting these problems were considered. The recommended project consists of constructing a barrier island to prevent flows from entering the lake through Pap Slough, construction of an island at the lower end of the Pap Slough barrier complex, riprapping of two existing islands in the lower portion of the lake which are in danger of disappearing due to erosion, and construction of an island complex in the lower portion of the lake. With incorporation of these features, Polander Lake would provide near optimum conditions for migrating waterfowl and fish.

The habitat enhancement that would be gained by the Upper Mississippi River System from implementation of the recommended project justifies expenditure of public funds for preparation of plans and specifications and for construction.

RECOMMENDATION

I have weighed the accomplishments to be obtained from this habitat improvement project against its cost and have considered the alternatives, impacts, and scope of the proposed project. Construction and armoring of islands in Polander Lake would reduce flow velocities in the lake and provide ample additional habitat suitable for the establishment of aquatic vegetation. In my judgment, the cost of the proposed project is a justified expenditure of Federal funds. I recommend that higher authority approve construction of the habitat rehabilitation and enhancement features of the Polander Lake, Minnesota, project at a total estimated cost of $1,951,150, which would be a 100-percent Federal cost according to Section 906(e)(3) of the 1986 Water Resource Development Act.

Richard W. Craig
Colonel, Corps of Engineers
District Engineer

Planning Division
Environmental Resources

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, the St. Paul District, Corps of Engineers, has assessed the environmental impacts of the following project:

POLANDER LAKE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 5A, UPPER MISSISSIPPI RIVER
WINONA COUNTY, MINNESOTA

The purpose of the proposed project is to enhance the value of Polander Lake for migrating waterfowl and its fishery by constructing and/or armoring a collection of islands in the lake. Polander Lake is a backwater lake approximately 1,000 acres in size located between river miles (RM) 728.5 and 731 of the Upper Mississippi River immediately above Lock and Dam 5A. The proposed project would include construction of a closure structure to stop turbid Mississippi River water from entering the backwater from Pap Slough, construction of an island on the lower end of the Pap Slough barrier island complex, riprapping of two existing islands in the lower portion of the lake in danger of disappearing due to erosion, and the construction of an island complex in the lower portion of the lake.

This Finding of No Significant Impact is based on the following factors: the proposed project would have only minor and short-term adverse impacts on fish and wildlife resources; the project would have beneficial impacts on both fish and wildlife resources; the project would have no impact on the cultural environment; the project would have only minor and short-term impacts on the social environment; the project would have a minor beneficial impact on the aesthetic/recreation environment; and continued coordination will be maintained with appropriate State and Federal agencies.

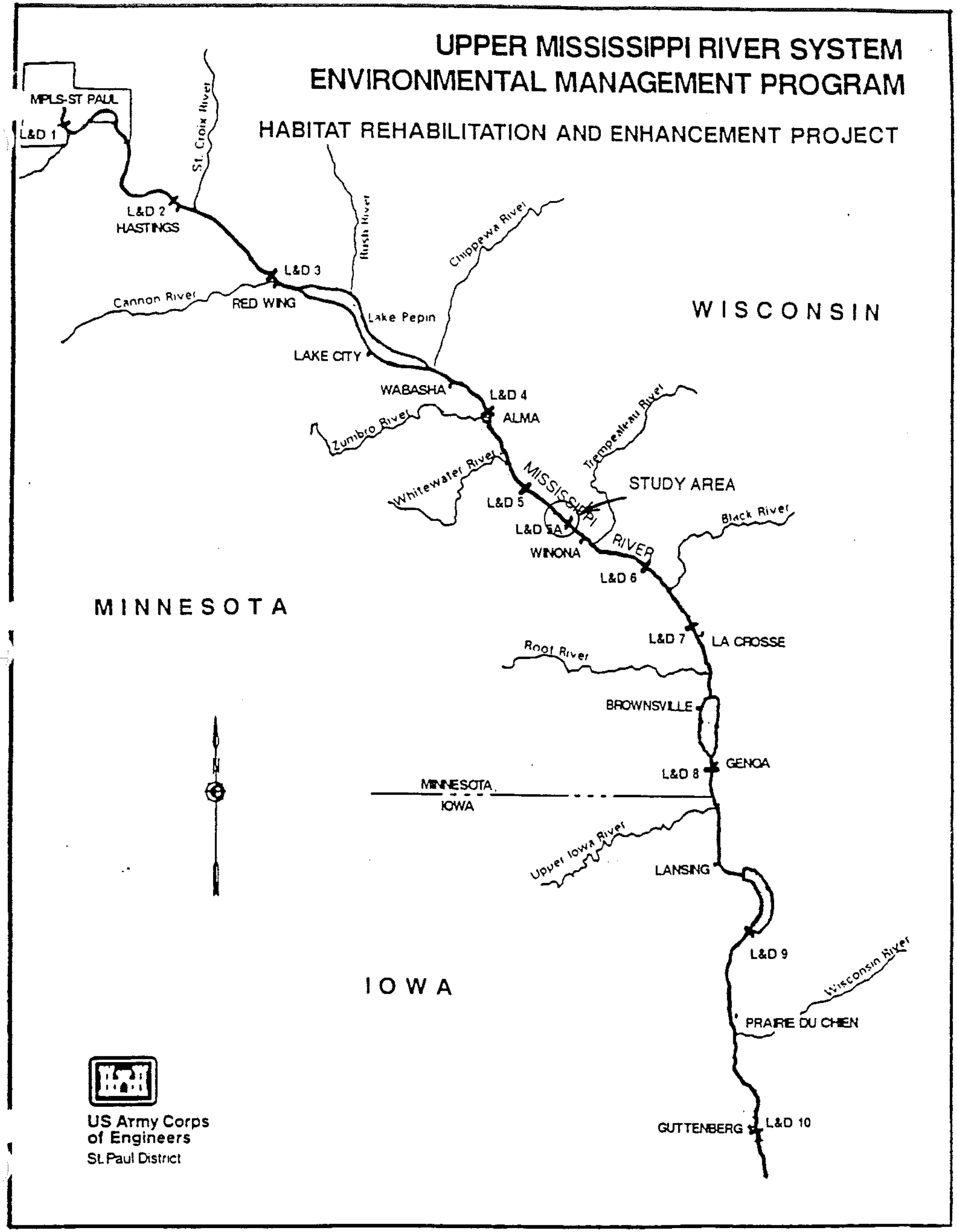
The environmental review process indicates that the proposed action does not constitute a major Federal action significantly affecting the quality of the environment. Therefore, an environmental impact statement will not be prepared.

14 Feb 92
Date

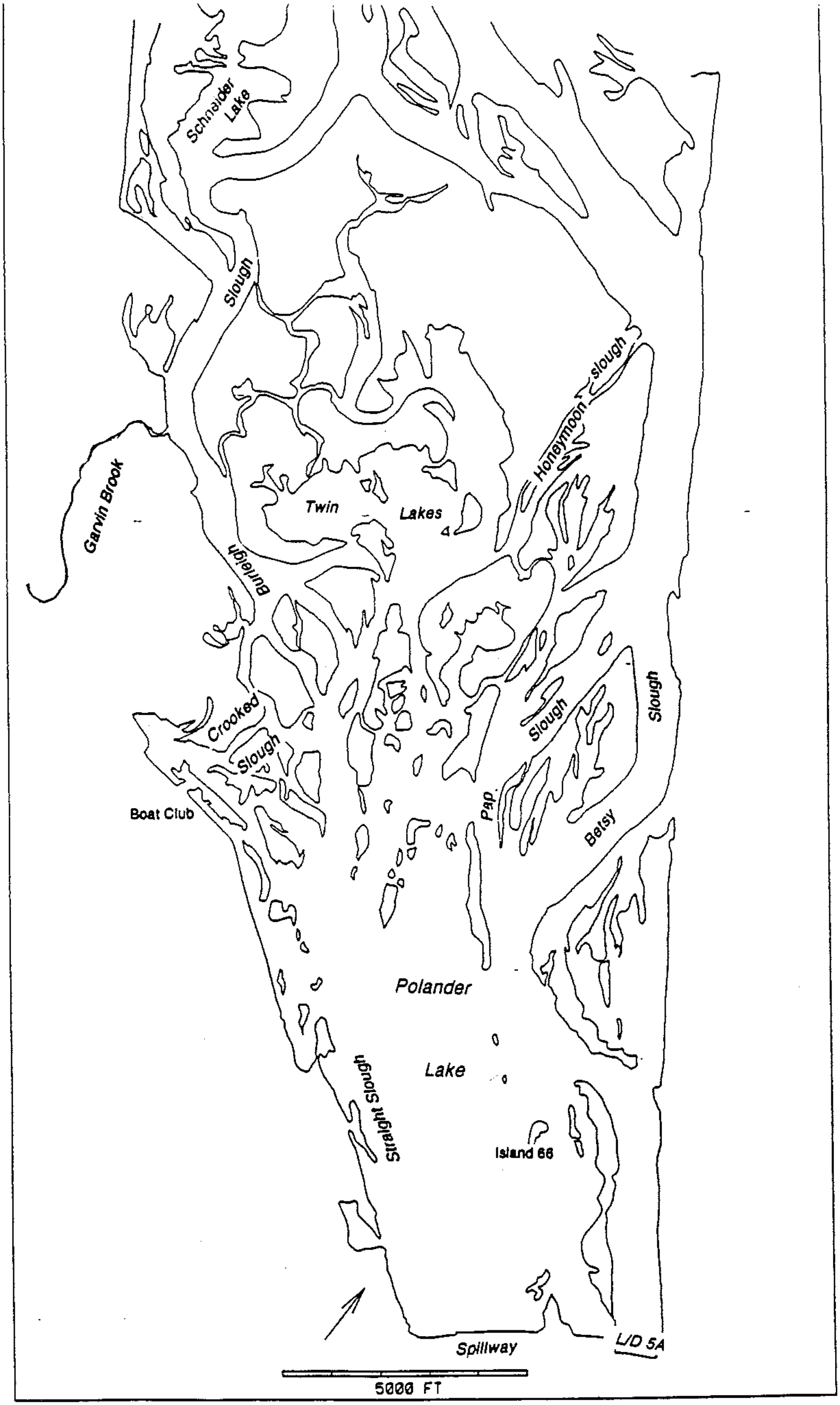
Richard W. Craig
Colonel, Corps of Engineers
District Engineer

ATTACHMENT 1

FIGURES

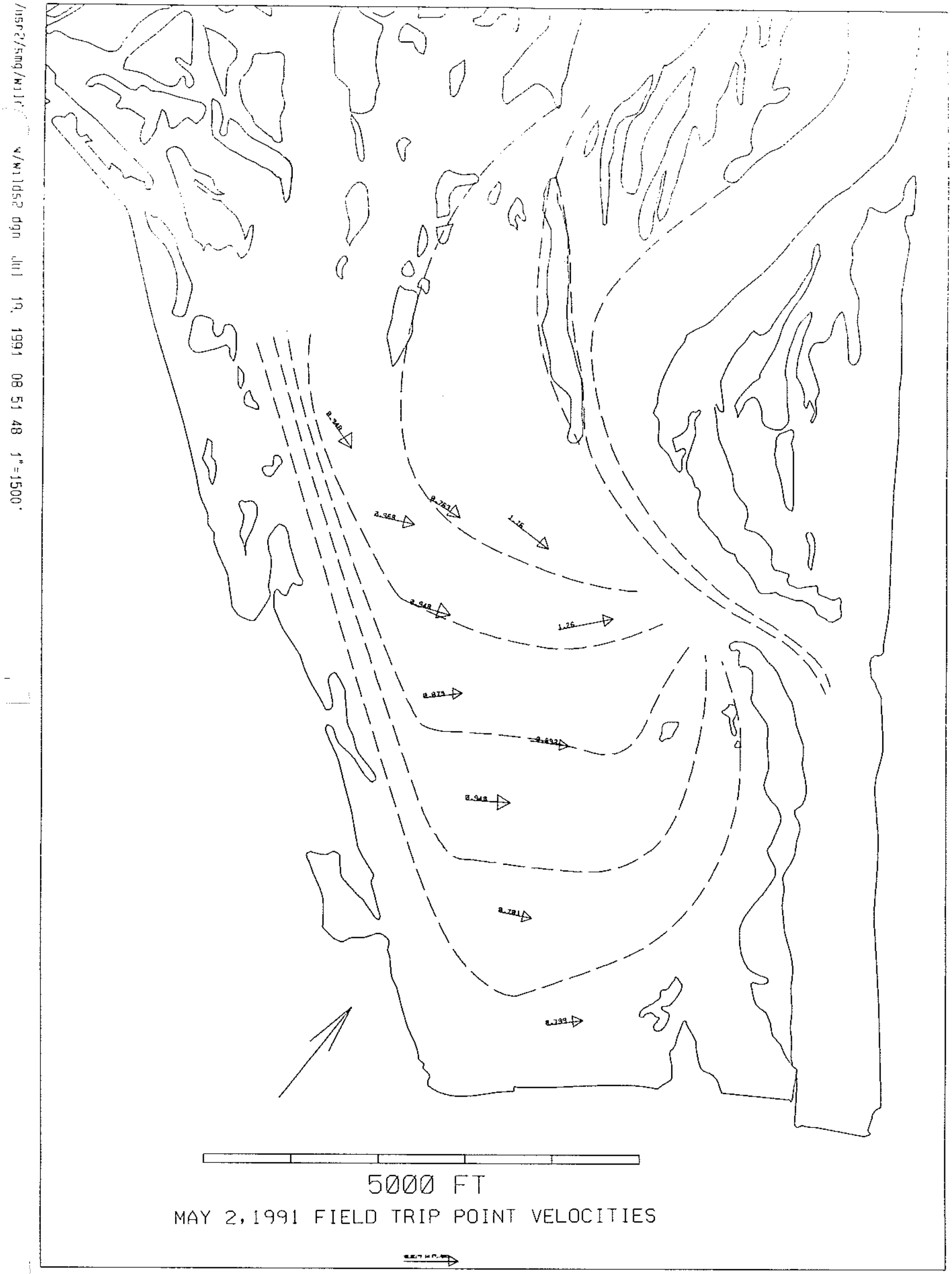


LOCATION MAP
Figure 1



STUDY AREA

Figure 2



Velocity Measurements
Figure 3

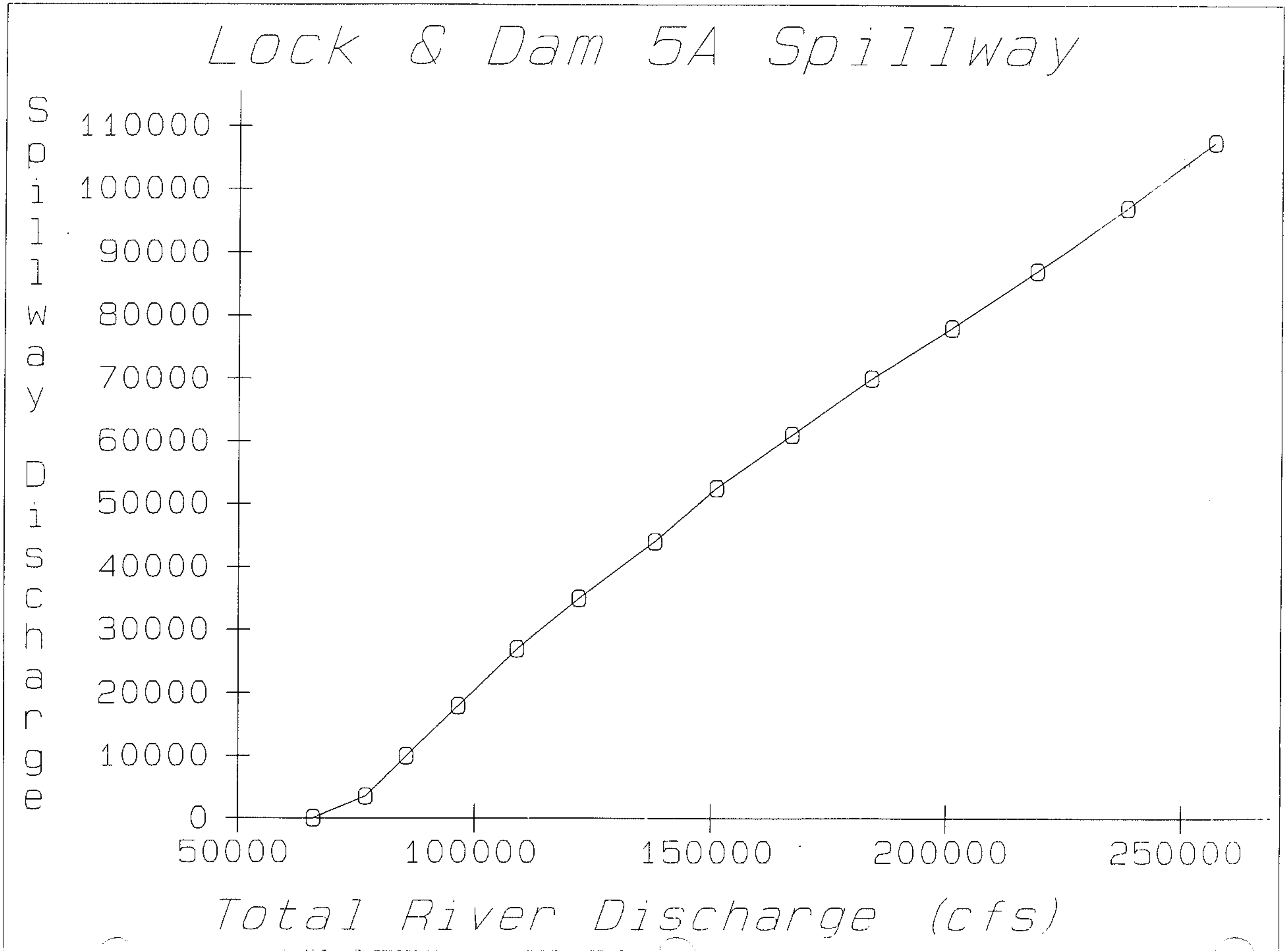
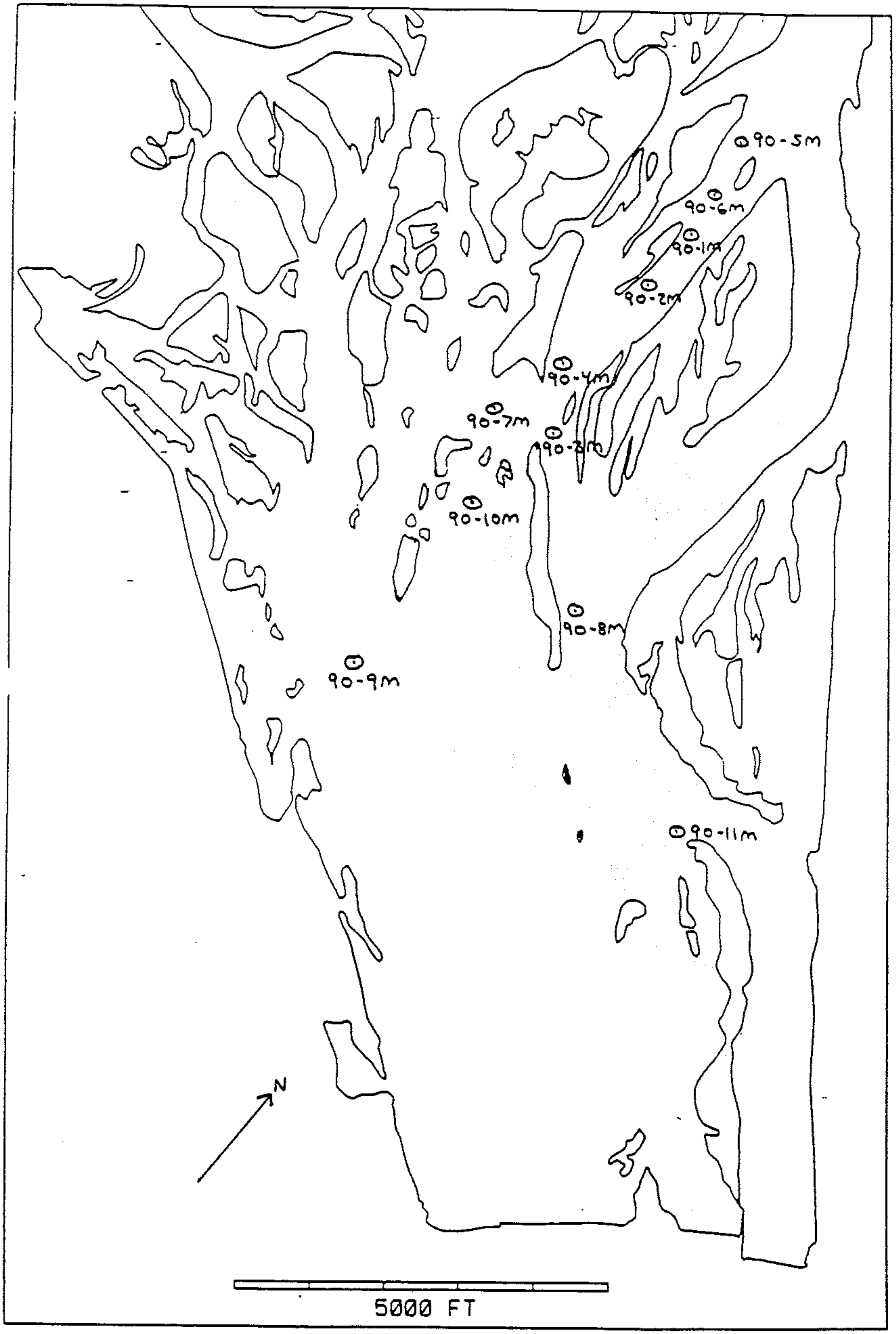


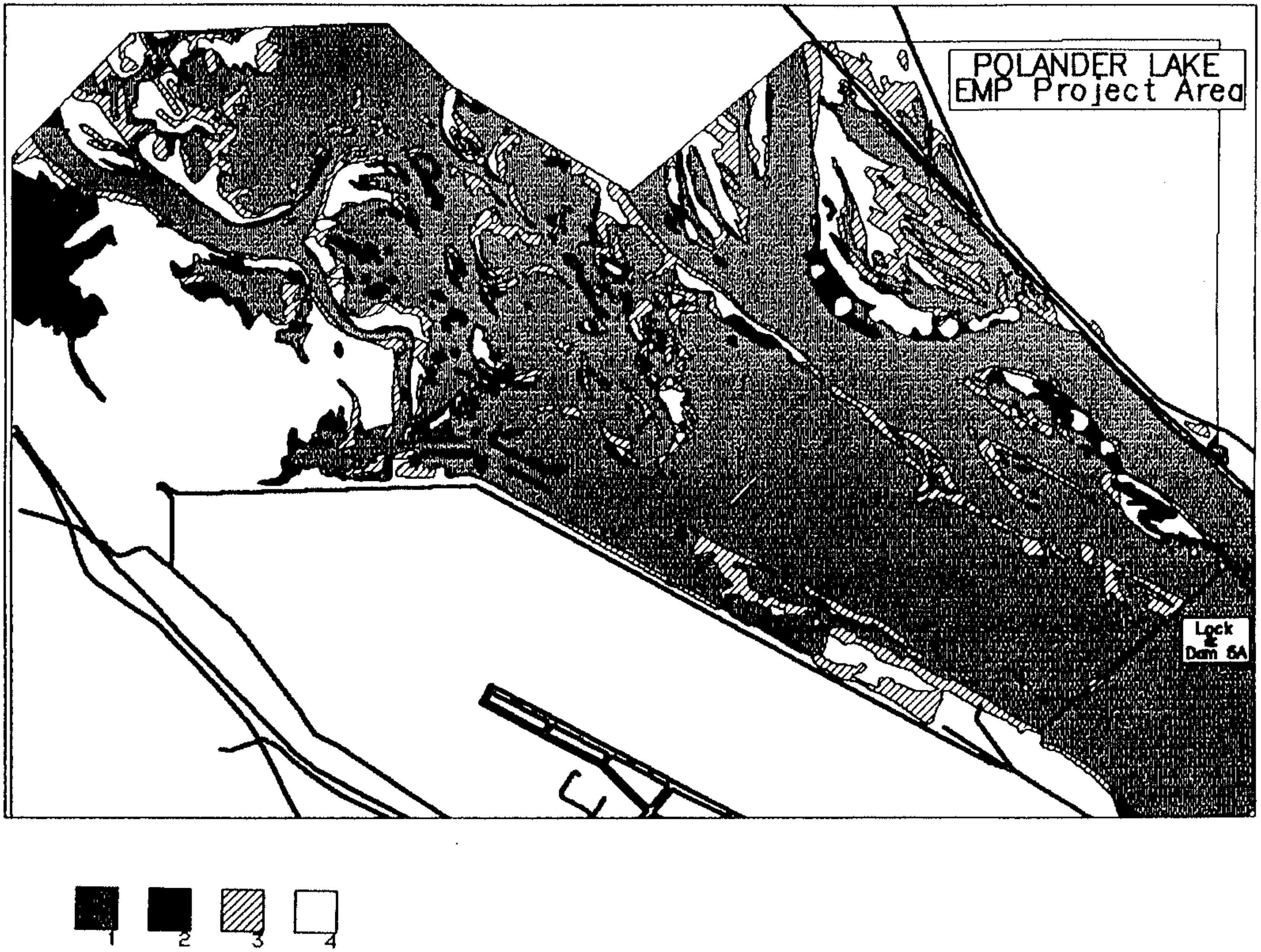
Figure 4
Lock and Dam 5A Spillway Discharge

DEPTH IN POLANDER LAKE (1990)

Figure 5



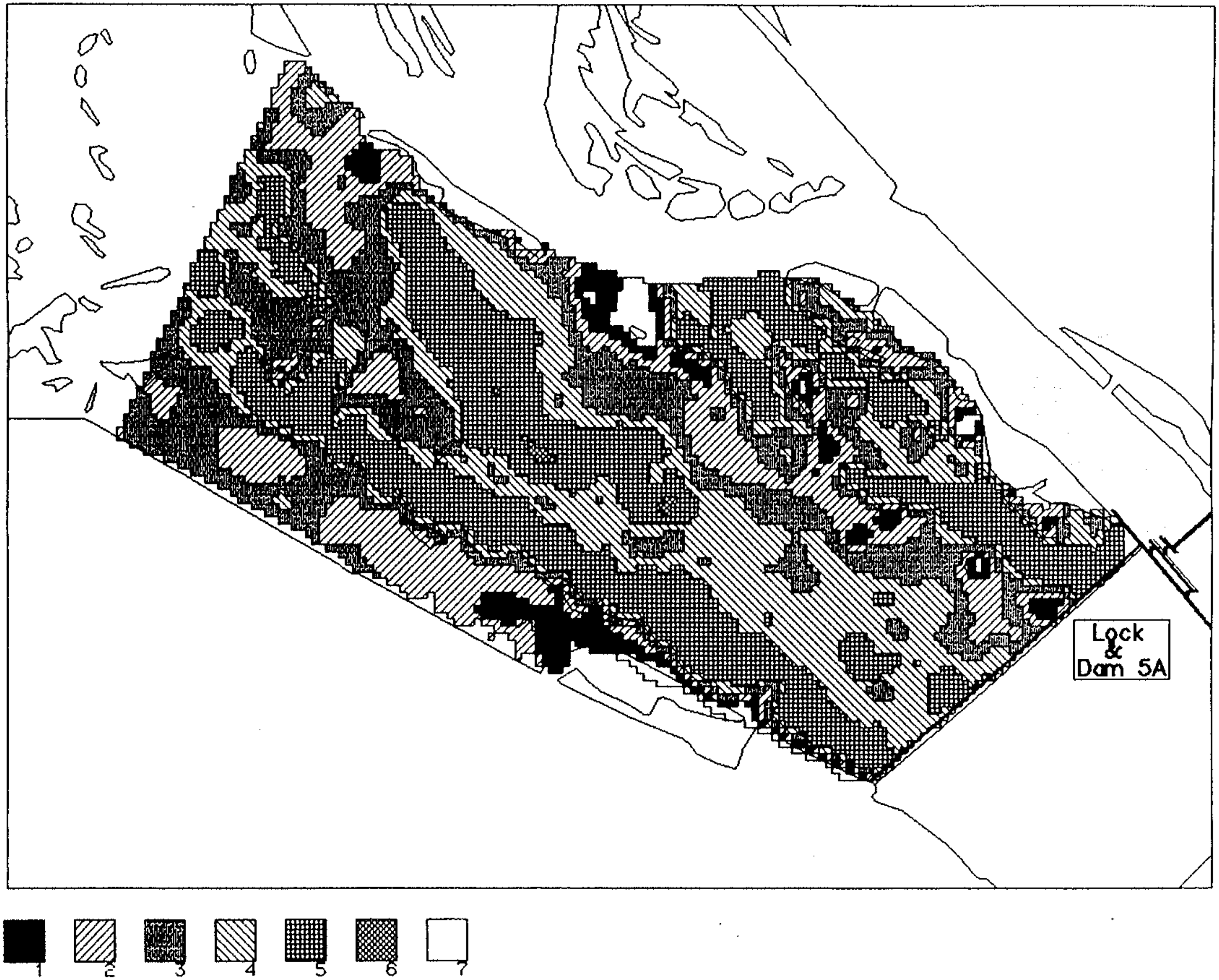
SOIL BORING LOCATIONS
Figure 6



1 Water - No Change
2 Land Gained --> 1940-1989
3 Land Lost ----> 1940-1989
4 Land - No Change

Figure 7

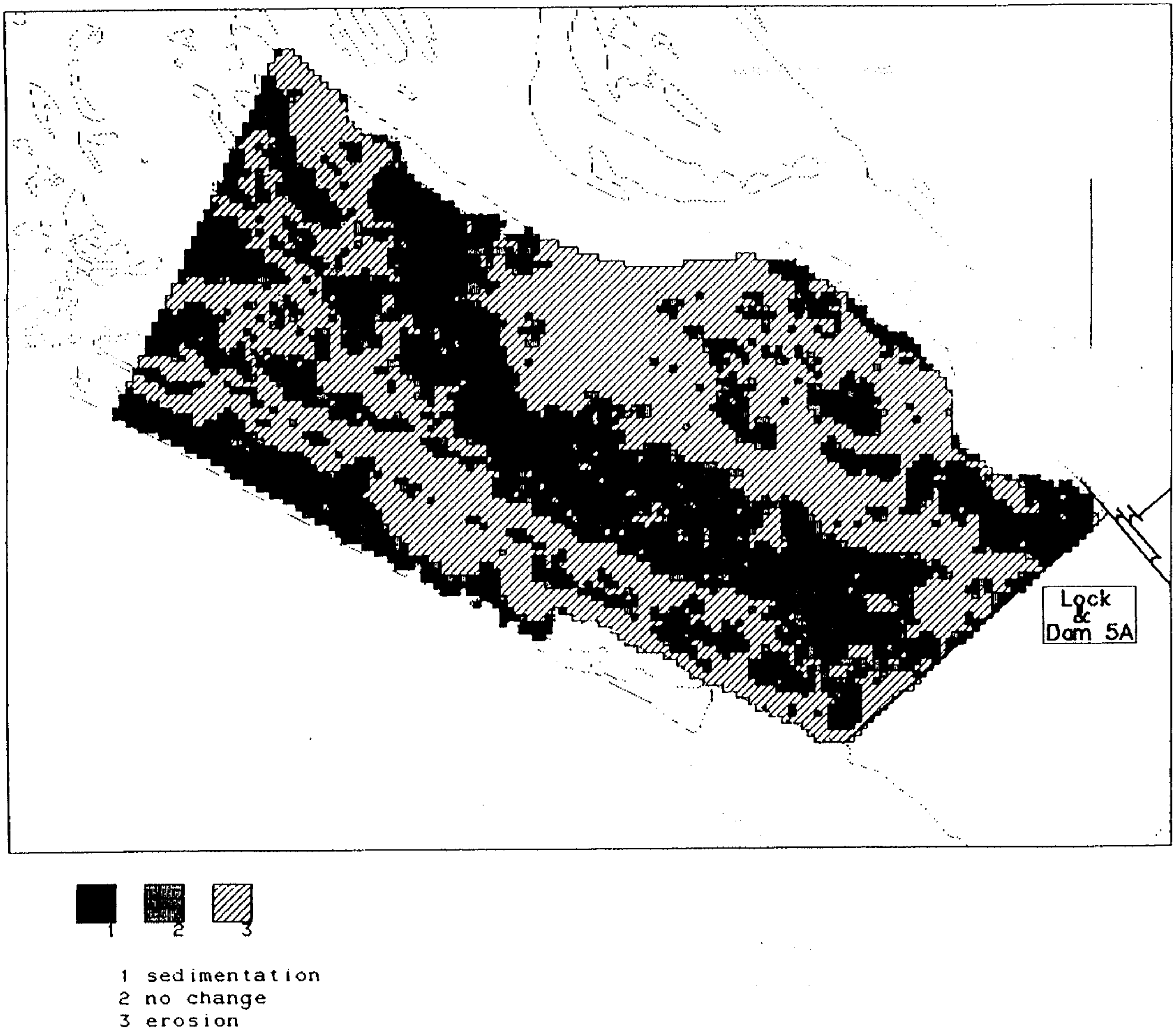
Land Water Changes 1940-1989



1 0-1 ft
2 1-2 ft
3 2-3 ft
4 3-4 ft
5 4-10 ft
6 10+
7 land

DEPTH IN POLANDER LAKE (1933)

Figure 8



CHANGES IN POLANDER LAKE (1933 TO 1990)

Figure 9

1 Emergent Vegetation
2 Submerged/Floatingleaf Vegetation
3 Terrestrial Vegetation

Figure 10

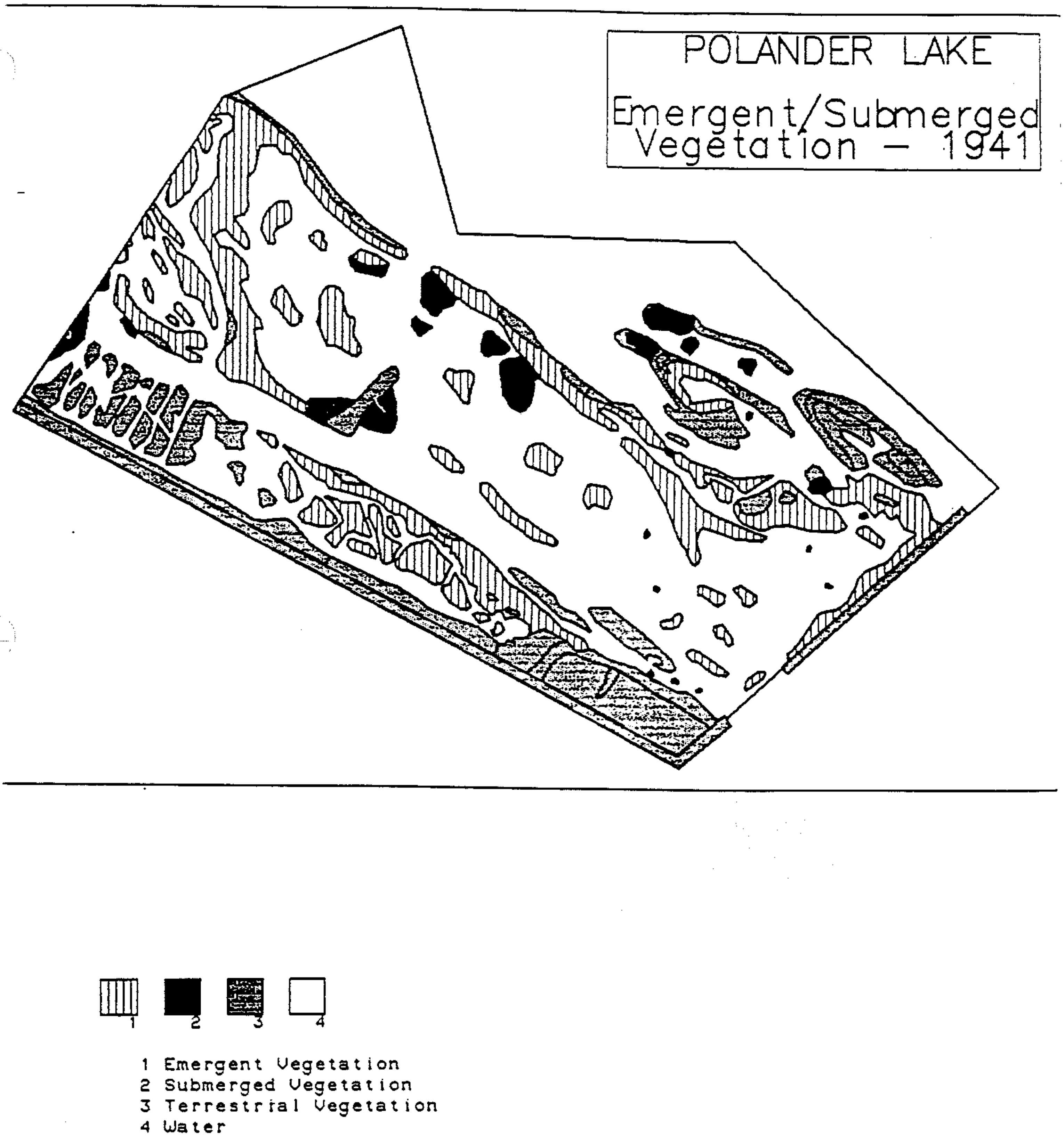
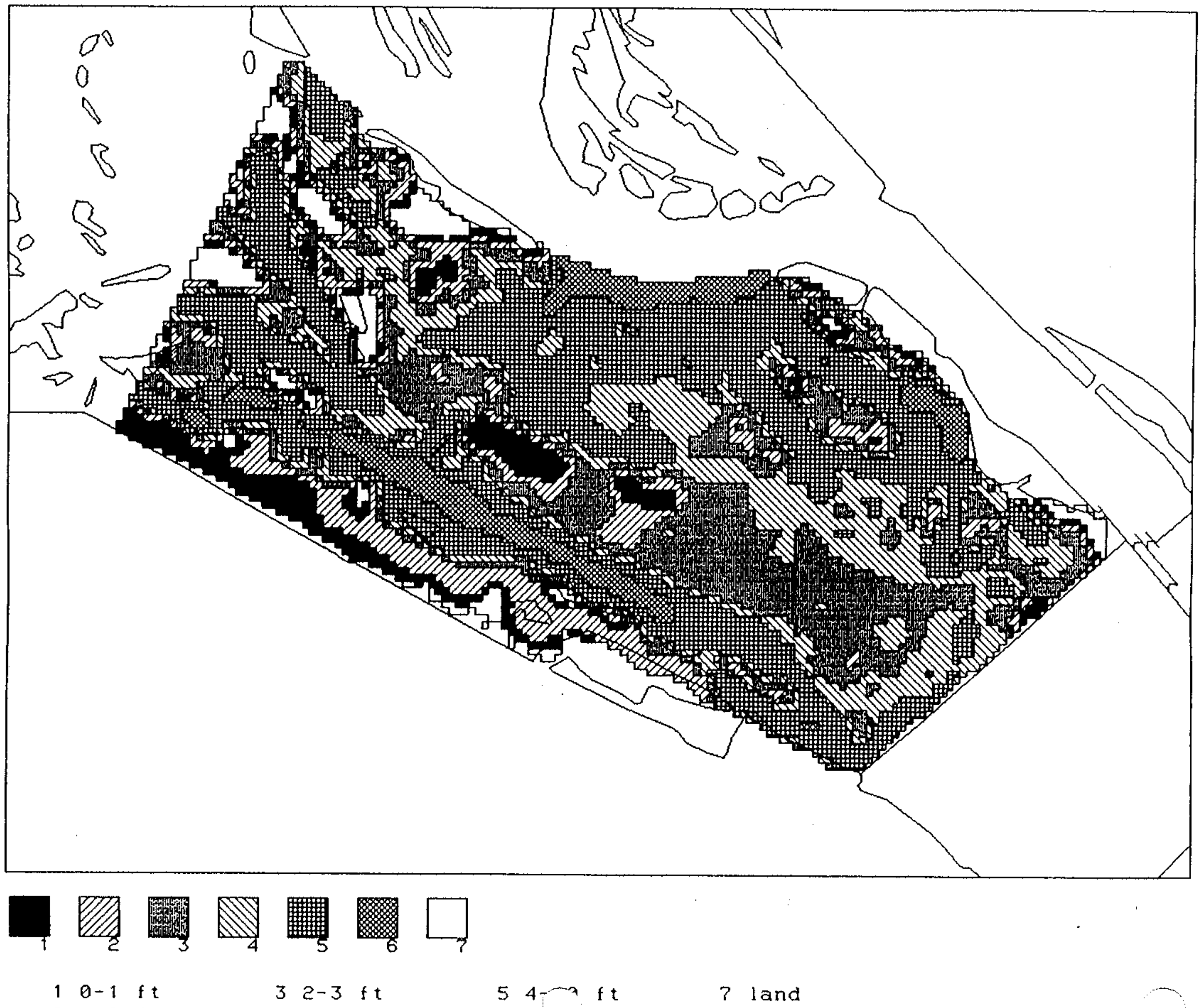
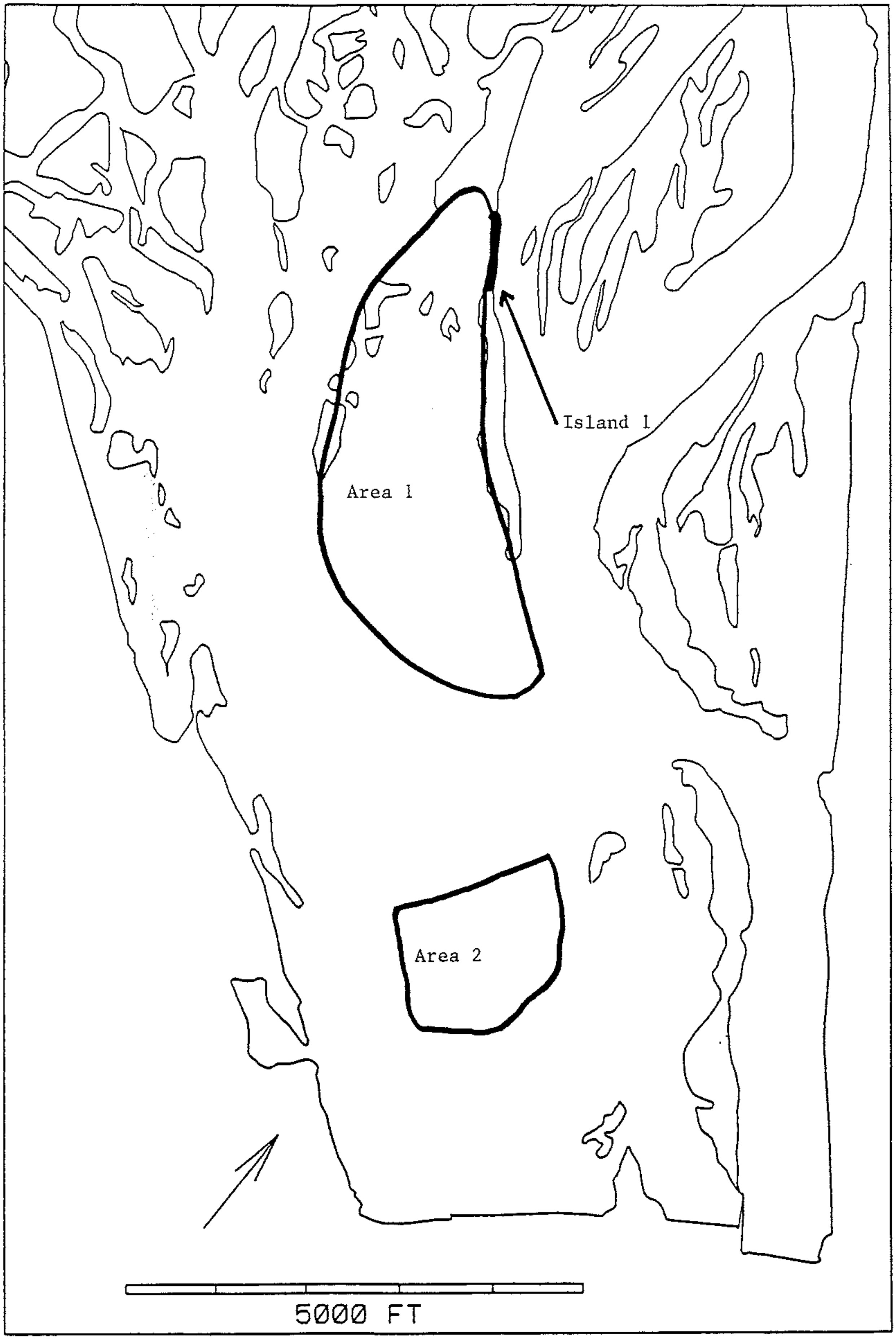

POLANDER LAKE
Emergent/Submerged Vegetation — 1941
1 2 3 4
1 Emergent Vegetation
2 Submerged Vegetation
3 Terrestrial Vegetation
4 Water

Figure 11



DEPTH IN POLANDER LAKE (2040)

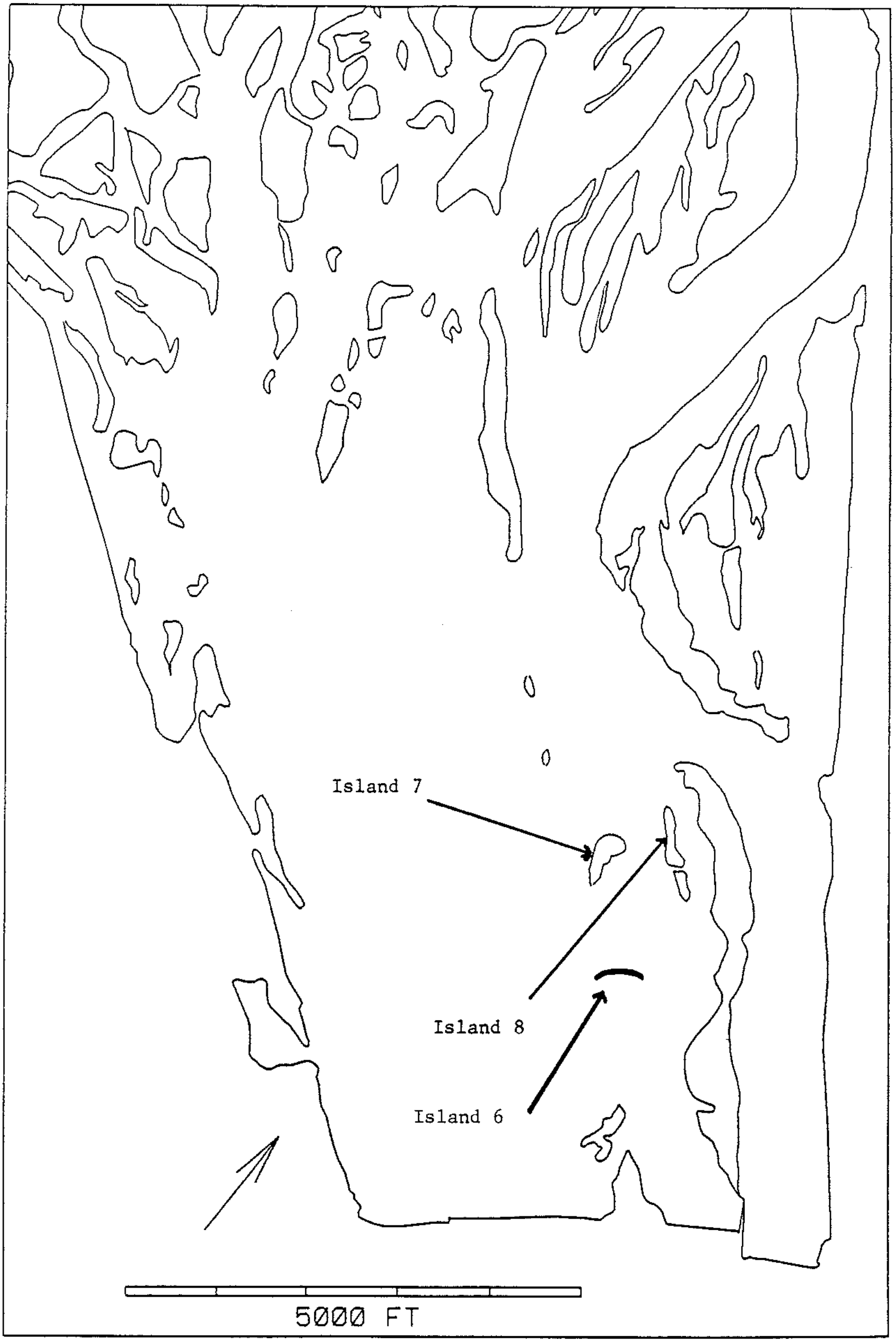
Figure 12



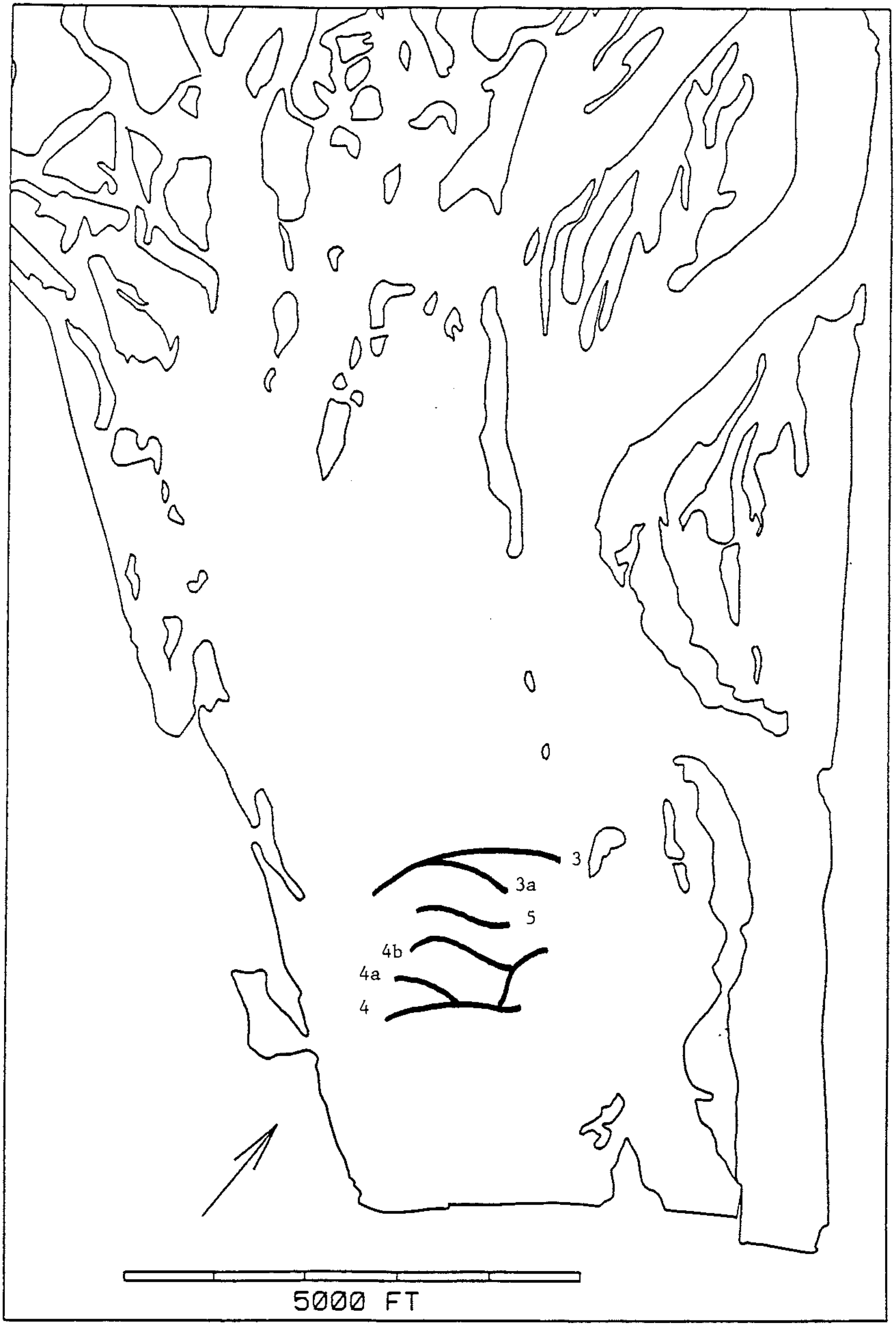
/usr/smg/wilds/draw/wilds.dgn Dec 6, 1990 10 10 12

Areas of Flow Reduction from Island 1 (Area 1) and Island Complex B (Area 2)

Figure 13



Locations of Islands 6, 7, & 8
Figure 14



Island Complex A
Figure 15

/usr/smg/wilds/draw/wilds.dgn Dec 6, 1990 10 10 12

Island Complex B
Figure 16

/usr/smg/wilds/draw/wilds.dgn Dec 6, 1990 10 18 12

Island Complex C
Figure 17

/usr/smq/winds ./waves dgn Jun 5 1991 10 05 53 1" 2000'

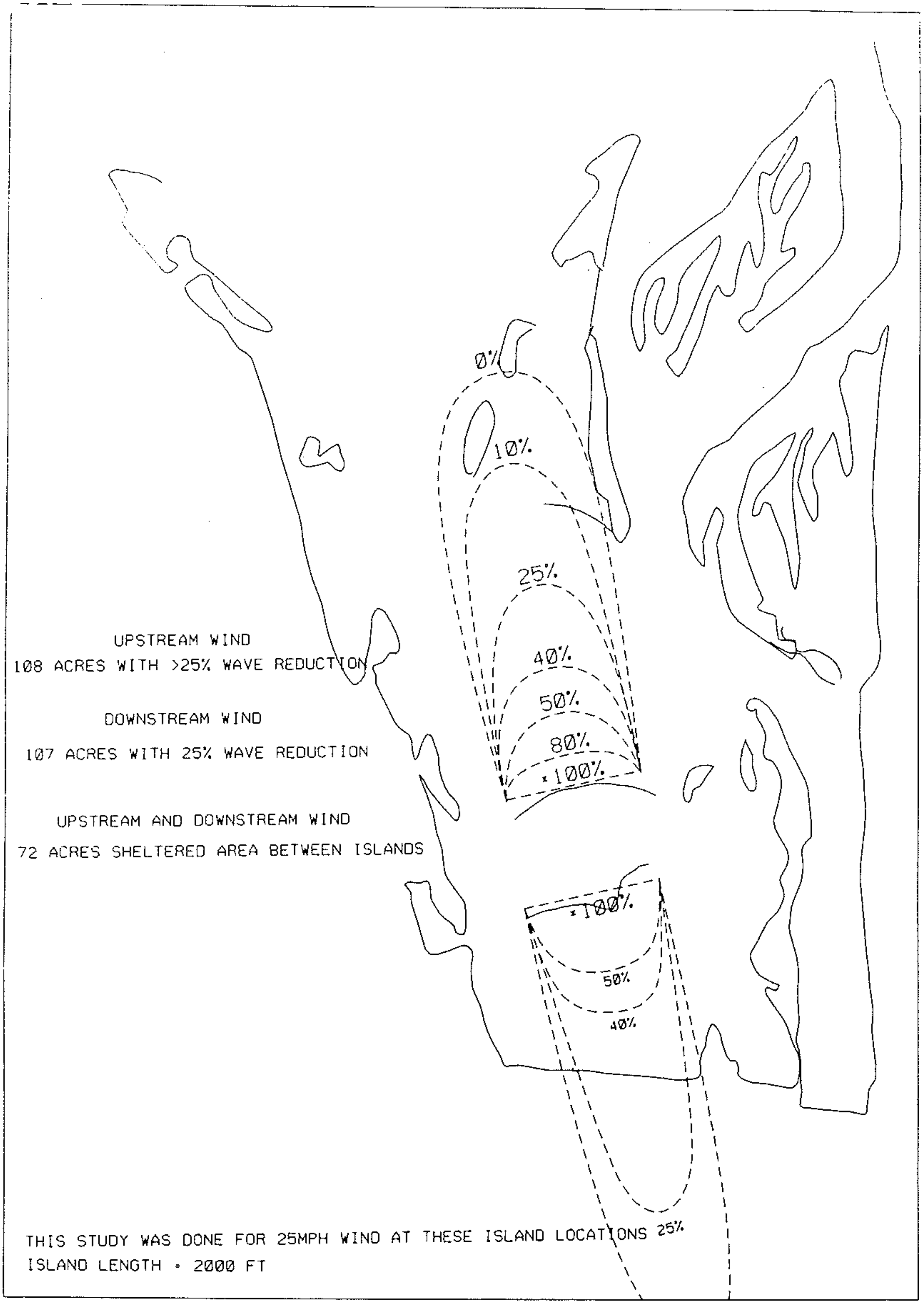


Figure 18

/usr/smg/wild /waves.dgn Jun. 5, 1991 10 04 31 1" 2000'

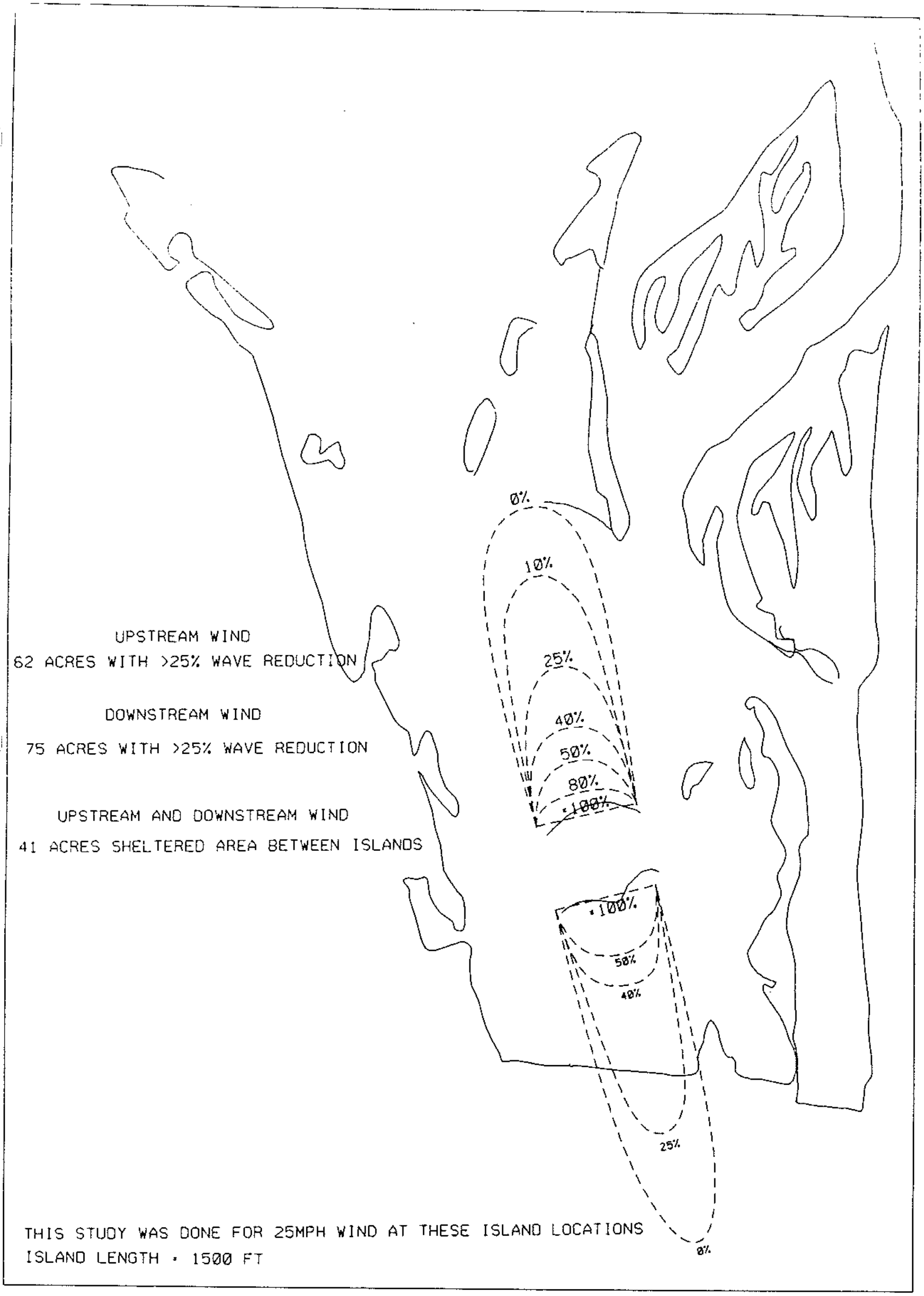
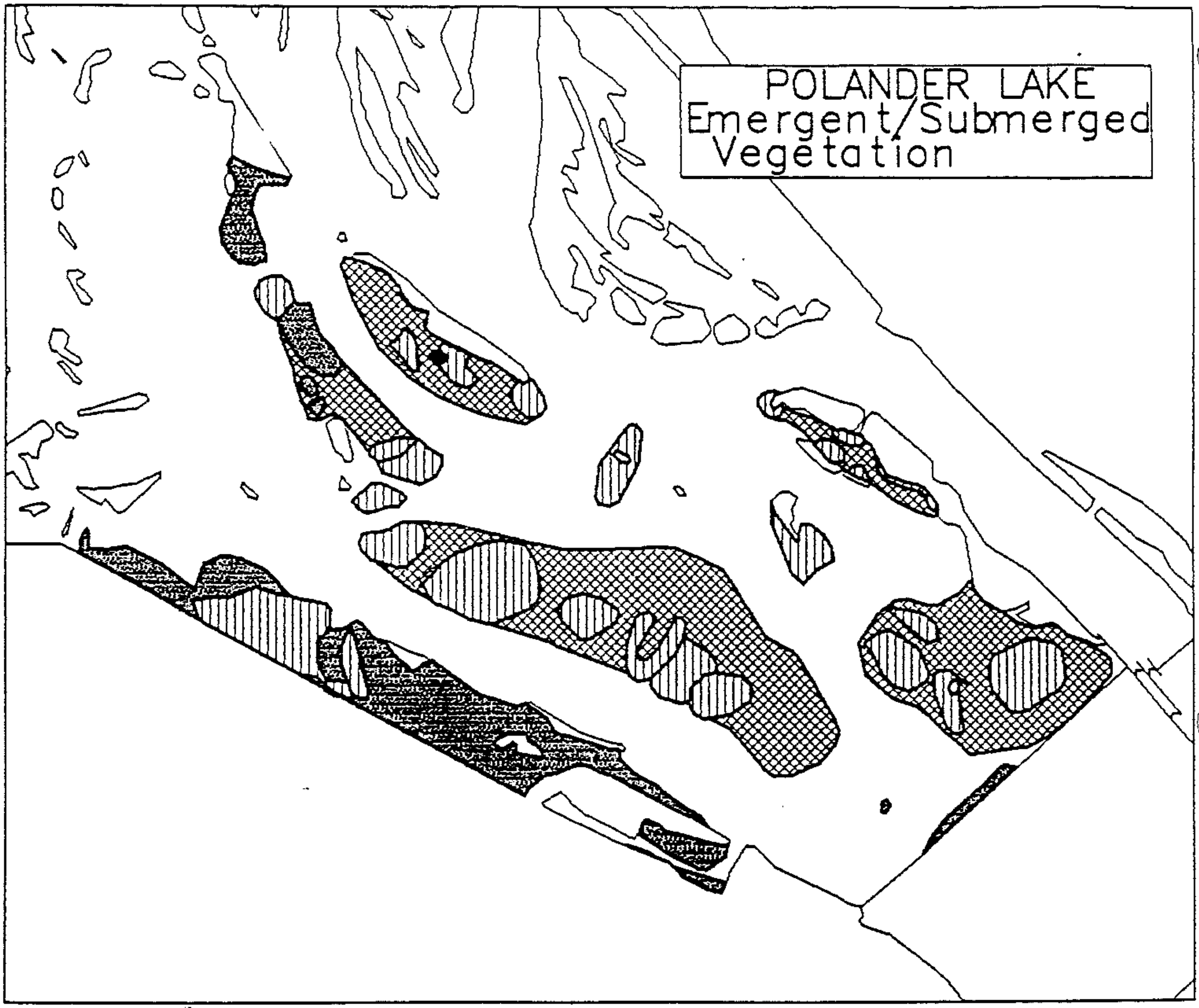
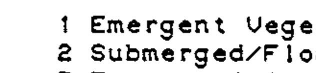


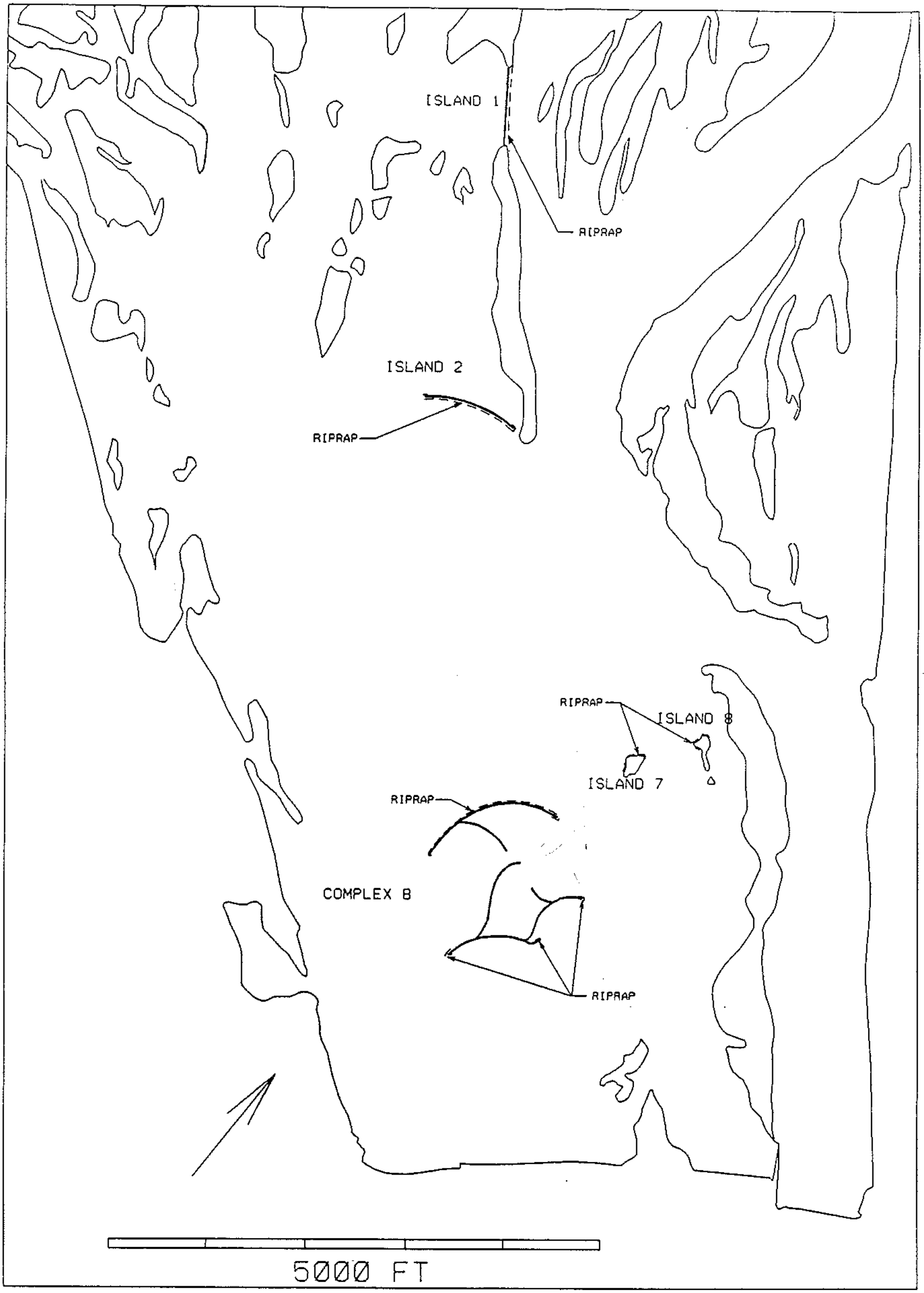
Figure 19



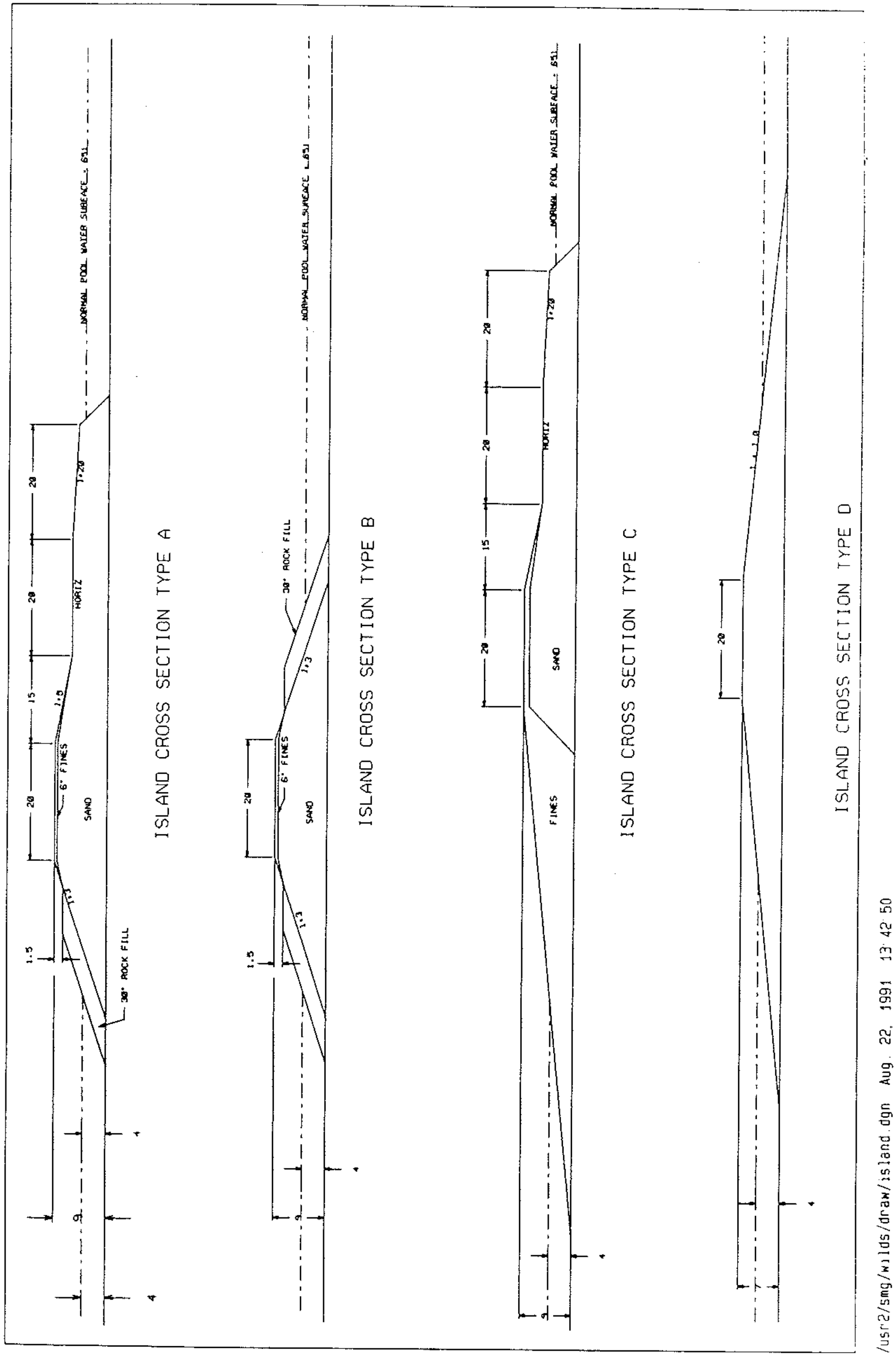


1 Emergent Vegetation
2 Submerged/Floatingleaf Vegetation
3 Terrestrial Vegetation
6 New Vegetation w/Project

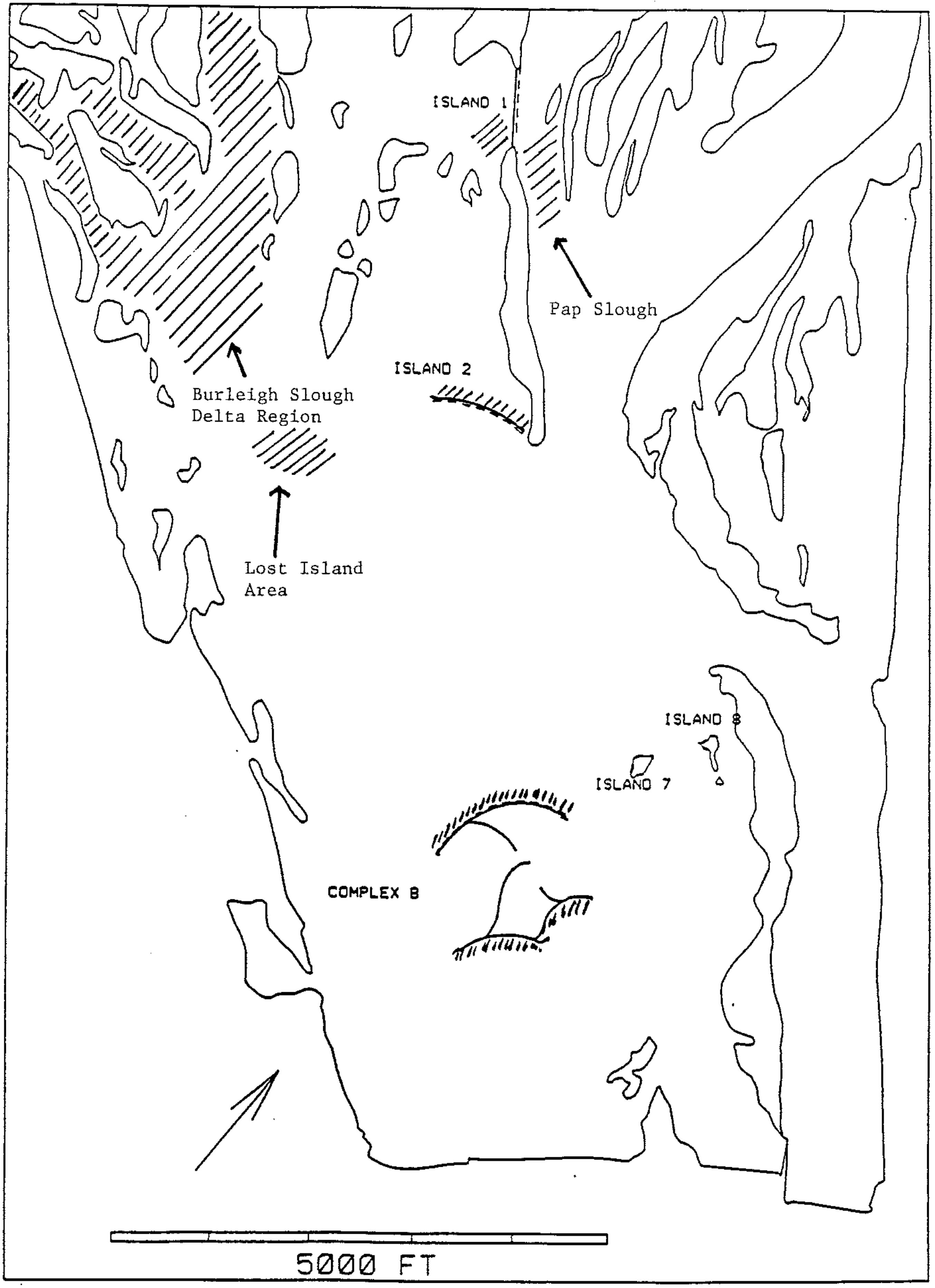
With Project Aquatic Vegetatic
Figure 20



Proposed Project Features
Figure 21



Island Cross Sections
Figure 22



Potential Borrow Areas
Figure 23

ATTACHMENT 2

SECTION 404 (B) (1) EVALUATION

SECTION 404(b)(1) EVALUATION

POLANDER LAKE
HABITAT REHABILITATION AND ENHANCEMENT PROJECT
POOL 5A, UPPER MISSISSIPPI RIVER
WINONA COUNTY, MINNESOTA

I. PROJECT DESCRIPTION

A. Location

Polander Lake is a backwater lake, encompassing approximately 1,000 acres, located on the Minnesota side of the Upper Mississippi River immediately upstream of Lock and Dam 5A. The lake stretches from about river mile (R.M.) 728.5 to R.M. 731 (figures 1 and 2).

B. General Description

This evaluation addresses the impacts resulting from the placement of fill material in waters of the United States, in compliance with Section 404 of the Clean Water Act. The proposed fill activities would consist of construction of a closure structure (Island 1) to prevent inflows of Mississippi River water through Pap Slough, the construction of several islands (Island 2 and Island Complex B) to protect against wind and wave action, and riprapping of two existing islands (Islands 7 and 8) which are seriously eroding. The locations of these islands are shown in figure 3.

Island 1, the Pap Slough closure structure, would consist of sand fill material being placed across the 800 foot-wide opening. The maximum height of the fill would be approximately 5 feet above normal pool elevation, at 656 feet mean sea level (msl). The top width of the island would be 50 feet. Side slopes would vary. Typical island cross sections are shown in figure 4. Rock riprap would be placed on the Pap Slough side of the structure to prevent erosion caused by flow. The Polander Lake side of the structure would be constructed with a 30 foot-wide berm.

Island 2 would be approximately 1,000 feet in length beginning about 100 feet from the present shoreline of the lower end of the Pap Slough barrier islands. This island would be at the same elevation and have the same cross section as island 1. The downstream side of the island would be riprapped to provide erosion protection from both wind and boat generated waves.

Islands 7 and 8 would be protected with rock riprap in eroding areas. Approximately 445 linear feet of island 7 and 365 feet of island 8 would require riprap.

Island Complex B would consist of two major outer islands and three inner islands. The outer islands would provide protection from wind and wave action for the inner islands. The major upstream island (Island 3) would be approximately 1,700 feet in length and have the same cross-sectional configuration as Island 1. The entire upstream portion of this island would be riprapped for erosion protection. The downstream side would be protected by the major downstream island (Island 4) of the complex which would be located approximately 1,000 feet downstream. The downstream island would be approximately 1,900 feet in length and have a top width of 20 feet. Due to its configuration only portions of this island would require riprap (riprapped areas are noted on figure 3). Top elevations for both of these islands would be 656 msl.

The three inner islands (Islands 3a, 4a, and 4b) would be about 675, 415, and 775 feet in length respectively, with top widths of about 20 feet. Each would be at a lower height (elevation 654 feet msl) than the two major islands which protect them. Side slopes for these islands would be 1 foot vertical for each 10 feet horizontal to allow for growth of vegetation.

Construction of the proposed islands may require some limited dredging to provide equipment access. This dredged material would be used in the construction of the islands, or would be placed on a barren area of the existing barrier island system just upstream of Lock and Dam 5A (figure 5).

C. <u>Authority and Purpose</u>

Section 1103 of the Water Resources Development Act of 1986 (Public Law 99-662) provides authorization and appropriations for an environmental management program for the Upper Mississippi RIver System that includes fish and wildlife habitat rehabilitation and enhancement. The islands referenced above would be constructed and/or armored under this authority.

The purpose of the proposed project is to improve the lake's value for migrating waterfowl while maintaining, or enhancing, its fishery. The specific objectives for the proposed project include maintaining the emergent and submerged vegetation beds which currently exist, increasing the areas of the lake supporting aquatic vegetation from 17.9 to 46.1 percent, maintaining a minimum of 400 acres of deep water (≥ 4 feet) habitat which currently exists, and reducing existing flow velocities in a minimum of one-third of the lake by 50 percent.

It is anticipated that the project goals can be met by constructing and/or armoring the islands referenced above. Island 1 would eliminate the flows entering the backwater from Pap Slough, reducing flows through a minimum of one-third of the lake by at least 50 percent. Island 7 and 8 would be armored with rock riprap to stop the erosion that is currently taking place and threatening to eliminate them. Island 2 would reduce wind and wave action in the northeast portion of the lake and help provide suitable conditions for the establishment of both submerged and emergent aquatic plants in that area. Island Complex B would provide suitable habitat and conditions for the establishment of additional aquatic vegetation and would substantially reduce wind and wave action in areas adjacent to the complex.

D. General Description of Dredged or Fill Material

1. General Characteristics of Material

All of the islands proposed for construction would be constructed of clean sand, protected with riprap where required, and capped with fines.

Islands 7 and 8 would be protected by the placement of rock riprap.

2. Quantity of Material

The quantities of materials required for construction of the proposed project are shown in the following table.

FEATURE	SAND	FINES (TOPSOIL)	RIPRAP
Island 1	21,340cy	300cy	1,780cy
Island 2	24,310cy	1,140cy	2,160cy
Island 7			979cy
Island 8			803cy
Complex B	129,830cy	37,250cy	4,480cy
TOTAL	175,480cy	38,690cy	10,202cy

3. Source of Material

The sand material required for the proposed project would be dredged hydraulically from one or more borrow areas located within a reasonable distance of the island creation sites. The delta region of Burleigh Slough (in particular Crooked Slough), and Pap Slough have been identified as areas containing coarse clean sand and have been proposed as the primary borrow sites for sand material. Proposed borrow areas are shown in figure 5.

Fine material would be spread over all non-riprapped portions of the islands proposed for construction. The source of this topsoil would vary depending upon the location of the island. Where possible, the material needed for all of the major islands would be excavated from the lake bottom along the length of the island. Fine material for the major islands of the island complex would be dredged from the outer sides of the islands. The fine material needed to cap the inner islands of the complex would be dredged from a small bay located at the upper end of Pap Slough or from the vicinity of Lost Island (figure 5).

Rock riprap would be obtained from any of several active quarries located in the vicinity.

E. Description of the Proposed Discharge Sites

1. Location

The locations of the proposed islands and the disposal site for material dredged for equipment access are shown in figures 3 and 5 respectively.

2. Size

Island 1 would be approximately 800 feet in length with a 50 foot top width. The maximum height of the fill would be at elevation 656 msl, about 5 feet above normal pool elevation. A typical cross section for this island is shown in figure 4. The island would cover approximately 2.18 acres of lake bottom.

Island 2 would be approximately 1,000 feet in length, with a 50 foot top width. The islands configuration an elevation would be the same as those of Island 1. Island 2 would cover about 3.86 acres of lake bottom.

Island Complex B would consist of two major islands (Islands 3 and 4) located parallel to each other and approximately 1,000 feet apart. Island 3 would be approximately 1,700 feet in length and Island 4 about 1,900. These islands would also have a top elevation of 656 msl. Top width of the islands would be 50 feet. Cross sectional configurations of these islands are shown in figure 7. The three inner islands (Islands 3a, 4a, and 4b) would be 675, 415, and 775 feet in length respectively. would have side slopes of 1 foot vertical to 10 feet horizontal. Top elevation of these islands would be 654 feet msl. The top width of these islands would be 20 feet.

Approximately 445 linear feet of Island 7 and 365 linear feet of Island 8 require protection from erosion, by placement of rock riprap along their eroding banks.

The proposed disposal site for material dredged for equipment access covers approximately 75,000 square yards

3. Type of Site

Polander Lake is a backwater lake of the Upper Mississippi River. The main sources of inflows into the lake are from the main channel via the Pap Slough opening and Burleigh Slough. A smaller amount of flow enters from Honeymoon Slough via the Twin Lakes area. Figure 6 depicts the flow patterns of the lake.

Island 1 is a structure closing the opening between Pap Slough and Polander Lake. As such it is located in an area with continuous flows. Water depths range from 1 to 4 feet and the substrate consists mainly of sand.

Island 2 is located in an area 2 to 4 feet in depth with a substrate varying from silt to sand. The area between the proposed island location and the shoreline supports a healthy population of submerged aquatic plants.

Island complex B is located in an area between 3 to 4 feet in depth with a silty substrate. The location was chosen because it was sufficiently shallow, supports only a minimal amount of aquatic vegetation, and is situated such that construction of an island complex would protect vegetation beds adjacent to it.

Islands 7 and 8 are existing islands experiencing serious erosion problems. The islands are vegetated with trees, shrubs, grasses, and a variety of other ground cover.

The proposed island disposal site is a barren area located on the existing barrier island system just upstream of Lock and Dam 5A. The area is a repaired breach area and is devoid of vegetation.

4. Types of Habitat

The proposed island construction would be done in relatively shallow aquatic habitat of a backwater lake. The disposal site for material dredged for equipment construction is a barren sand area of an existing barrier island.

F. Description of Disposal Method

All sand for construction of the proposed islands would be dredged and placed hydraulically. Fine material would be dredged and placed mechanically. Rock riprap would be obtained from existing local quarries and placed mechanically. Any required dredging for equipment access would be done mechanically.

II. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope

Island 1, the structure closing the opening between Pap Slough and Polander Lake, would be located in an area between 1 and 4 feet in depth with continuous flows. This opening was formed during the 1950's when the barrier between Pap Slough and Polander Lake was breached. The opening is gradually increasing in width.

Water depths in the area proposed for the construction of Island 2 vary from 2 to 6 feet in depth.

Island Complex B is located in area of 3 to 4 foot water depths.

The proposed disposal site for material dredged for equipment would be located on an existing barrier island between Polander Lake and the main channel above normal pool elevation.

2. Sediment Type

The substrate in the area proposed for construction of Island 1 is composed primarily of sand. Island 2 would be constructed in an area with a substrate varying from silt overlaying sand to sand. Island complex B would be located in an are with a substrate consisting of silts overlaying sand.

The area of islands 7 and 8 proposed for riprapping consist of sand and topsoil.

Material dredged for equipment access would primarily consist of silt or silty sand.

3. Dredged/Fill Material Movement

Once construction is complete, fill material movement should be minimal. Areas prone to erosive forces such as those bordering flow areas and those affected by wind and wave action would be protected with rock riprap. All non-riprapped areas above the normal waterline would be covered with topsoil and seeded with willows and native plants and grasses.

4. Physical Effects on Benthos

Any organisms in the fill areas would be covered and eliminated. Mussel surveys were conducted on June 16, 1991, in the areas proposed for dredging and island construction. A copy of the results of the survey are shown in attachment 1.

Islands 1 and 2 are located in areas with sand substrates and steady flows. They support healthy but scattered populations of mussels. Numerous aquatic macroinvertebrates were encountered during the survey. Approximately 2.18 acres of benthic habitat would be covered and eliminated by the construction of Island 1, and 3.86 acres by Island 2. However, the substrate created by the islands would offset much of this loss. The substrates of the islands would consist of areas of sand and rock riprap and should provide an excellent substrate for benthic organisms.

The construction of Island 1 would eliminate flows entering the Polander Lake backwater from Pap Slough, and would subsequently affect flow patterns in much of the northeast quarter of the lake. Benthic organisms suited for areas with flows would be affected by the project. The new habitat would be only minimally suited for the survival of some of these species, and their populations would be expected to decline. However, these areas should provide suitable habitat for other species which would be expected to colonize the area.

Construction of the islands of Complex B would cover and eliminate 20.63 acres of benthic habitat. Any benthic organisms in this area would be covered and eliminated. However, the sand and rock substrates created through construction of these islands would provide a more stable and diverse substrate than currently exists. The new substrate would be expected to be quickly colonized by benthic species.

Protecting Islands 7 and 8 with rock riprap would provide a stable habitat which would be more suitable for benthic organisms than the unstable substrate currently found in those areas.

5. **Actions Taken to Minimize Impacts**

No special actions to minimize adverse impacts on the substrate would be taken.

B. **Water Circulation, Fluctuation, and Salinity Determination**

1. **Water**

a. **Salinity**

Not applicable.

b. **Water Chemistry**

The use of clean fill materials should preclude any significant impacts on water chemistry.

c. **Clarity**

Some minor, short-term decreases in water clarity are expected from the proposed fill activities. Hydraulic dredging and placement of sand materials for island construction would create local turbidity plumes and increased suspended solids. Dredging and placement of fines would also be expected to result in localized decreases in water clarity. However, the long-term effect from fill placement should be an improvement in water clarity. The closure of the Pap Slough opening would eliminate the inflows of Mississippi River water, while Islands 2 and Island Complex B would be instrumental in reducing the affects of wind and wave action. Riprapping of Islands 7 and 8 would eliminate the erosion taking place in those areas.

d. **Color**

The proposed fill activities should have no effect on water color.

e. **Odor**

The proposed fill activities should have no effect on water odor.

f. **Taste**

The proposed fill activities should have no effect on water taste.

g. **Dissolved Oxygen Levels**

The proposed fill activities should have no effect on dissolved oxygen levels. Although inflows from Pap Slough would be eliminated, inflows from other areas would provide sufficient water exchange to insure adequate dissolved oxygen levels are maintained.

h. **Nutrients**

The proposed fill activities should have no effect on nutrient levels in the water.

i. **Eutrophication**

The proposed fill activities should have only minor effects on the level or rate of eutrophication of the water.

j. **Temperature**

With the elimination of flows entering the backwater from the Mississippi River through Pap Slough, water temperatures in the backwater are expected to be somewhat higher during the winter months than under current conditions. Slightly higher water temperatures during the winter would provide improved habitat for a variety of organisms, especially fish wintering in the area.

2. **Current Patterns and Circulation**

a. **Current Patterns and Flow**

The closure of the Pap Slough opening with the construction of Island 1 would affect current patterns and flows in the northeast portion of Polander Lake. Current and with-project flow patterns are shown in figures 6 and 7 respectively.

Island 2 and Island Complex B are situated such that they would have only a minimal affect, if any, on the present flow patterns within the lake.

b. **Velocity**

Construction of Island 1, with the resultant elimination of flows from Pap Slough, would affect current velocities in the northeast portion of Polander Lake. Current velocities would be virtually eliminated in the portion of the lake affected by construction of the island. Figure 8 depicts the area of the lake in which flows would be affected by the proposed project.

c. **Stratification**

The proposed fill activities should have no effect on stratification conditions.

d. **Hydrologic Regime**

The proposed project would alter the hydrologic regime within Polander Lake. With the closure of Pap Slough, flows entering the lake from the Mississippi River would be eliminated. Inflows from Burleigh Slough and Honeymoon Slough would not be affected. Flow patterns within the lake would change, primarily in the northeast portion of the lake. Construction of the proposed islands, with the exception of island 1, would not affect flow patterns or rates within the lake. They would, however, substantially reduce the affects of wind and wave action.

3. Normal Water Level Fluctuations

The proposed fill activities would have no effect on normal water level fluctuations.

4. Salinity Gradient

Not applicable.

5. Actions Taken to Minimize Impacts

No special actions would be taken to minimize the affects of the proposed project on current patterns or flow.

C. Suspended Particulate/Turbidity Determination

1. Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site

Hydraulic dredging and placement of sand for construction of the proposed islands would cause localized turbidity plumes. However, the sand material proposed for use is relatively coarse and suspended particles would be expected to dissipate rapidly. Mechanical dredging and placement of fines would also be expected to cause some localized turbidity. However, the majority of the fines proposed for use in this project would be placed above the normal pool elevation and would not be subject to resuspension in the aquatic system.

After project completion, conditions would quickly return to normal. The use of rock riprap in high energy areas would eliminate the resuspension of material in those areas. Emergent aquatic vegetation would be planted in a number of areas, also helping to insure against the resuspension of bottom sediments from wind and wave action. Areas above normal pool elevation would be planted with willows and native grasses.

2. Effects on Chemical and Physical Properties of the Water Column

No effects are expected on dissolved oxygen, toxic metals, organisms, pathogens, or the aesthetics of the water column after the project is in place.

Reduced inflows of water from the Mississippi River, reduced flow rates in the northeast portion of the lake, and reduced wind and wave action would allow light penetration to greater depths than currently experienced in the lake.

3. Effects on Biota

The proposed project would cover and eliminate the benthic organisms occupying approximately 26.67 acres of Polander Lakes substrate. However, the sand and rock substrates created by the islands would be quickly colonized. The sand and rock substrates created would provide a more stable and diverse habitat than currently exists.

Elimination of flows in the northeast portion of the lake would provide habitat less suitable than under current conditions for a number of species currently occupying the area, for instance some of the mussel species. However, other species would colonize the area. Reduced flows along with less resuspension of bottom sediments due to wind and wave action would result in improved water clarity and the establishment of additional aquatic vegetation benefiting the fish and waterfowl which use this area. Warmer winter water temperatures and decreased current velocities would also improve the habitats suitability for fish, especially centrarchids.

4. Actions Taken to Minimize Impacts

Construction would take place during periods of low to normal water levels. Dredging and placement of fine materials would be done mechanically to minimize suspension of particulates in the water column.

D. Contaminant Determinations

Sediment core samples were collected from several areas within the Polander Lake area during April 1990 and analyzed for bulk chemistry. Results of the analysis are shown in attachment 2. Contaminants of concern were found to be comparable to those of other fine sediments of backwaters of the Upper Mississippi River. No pesticides or PCBs were present in detectable concentrations. This sediment analysis suggests that serious water quality problems would not be anticipated with the proposed habitat improvement project at Polander Lake. Further sediment analysis will be conducted at selected borrow sites. Should any of these areas are found to be contaminated, they would not be dredged or their material used for construction.

Rock riprap would be obtained from existing local quarries. These areas do not have a history of contamination and use of this material should not introduce any contaminants into the aquatic ecosystem.

E. Aquatic Ecosystem and Organism Determination

1. Effects on Plankton

During construction, increases in turbidity and suspended solids near the fill activities would have a localized suppressing effect on phytoplankton productivity. However, these local effects are not considered significant. The plankton populations would recover quickly once construction activities ceased.

2. Effects on Benthos

The proposed project would cover and eliminate the benthic organisms occupying approximately 26.67 acres of Polander Lakes substrate. However, the sand and rock substrates created by the islands would be quickly colonized. The sand and rock substrates created would provide a more stable and diverse habitat than currently exists.

Elimination of flows in the northeast portion of the lake would provide habitat less suitable than under current conditions to a number of species currently occupying the area, for instance some of the mussel species. However, other species would colonize the area. Reduced flows along with less resuspension of bottom sediments due to wind and wave action would result in improved water clarity and the establishment of additional aquatic vegetation benefiting the fish and waterfowl which use this area.

3. Effects on Nekton

During construction, increases in turbidity and suspended solids near the dredge and fill areas would have a localized suppressing effect on nekton productivity. However, these effects would be local and not considered significant. The nekton populations would recover quickly once construction activities ceased.

4. Effects on Aquatic Food Web

With the exception of during construction, the proposed project would improve the total productivity of the Polander Lake area. Flows would be eliminated from the northeast portion of the lake, a substantial area of the lake would gain protection from wind and wave action, water clarity would improve, and winter water temperatures would increase. These changes are expected to allow for the establishment of a substantial amount of additional emergent and submerged aquatic vegetation, with aerial coverage of aquatic vegetative increasing from 17.9 to an anticipated 46.1 percent. The areas suitability as a resting and feeding area for migrating waterfowl would increase, as would the areas suitability for a number of fish species, particularly centrarchids.

5. Effects on Special Aquatic Sites

No special aquatic sites are located in the project area.

6. Threatened and Endangered Species

No known Federally- or State-listed threatened or endangered species would be effected by the project.

7. Other Wildlife

The fill activities would not result in the significant loss of aquatic or terrestrial habitat. The general diversity and productivity of the affected areas would increase.

8. Actions Taken to Minimize Impacts

No special actions are required.

F. Proposed Disposal Site Determinations

1. Mixing Zone Determination

A localized turbidity plume is anticipated during island construction. However, the sand fill material proposed for use would be sufficiently large and relatively clean so that very little exposed material could be suspended in the water column. Localized turbidity plumes are also anticipated during dredging and placement of the fine material proposed for use as topsoil in capping the proposed islands. Mechanical dredging and placement of fines would minimize the amount of material susceptible to suspension in the water column.

2. Determination of Compliance with Applicable Water Quality Standards

The State of Minnesota's water quality standards are contained in Minnesota Rules, Chapter 7050. It is not anticipated that Minnesota's standards for toxicity would be violated by the proposed project. Minnesota's standard of 30 milligrams per liter for total suspended solids would most likely be exceeded in the turbidity plumes generated through hydraulic dredging and placement of sand material for island construction. However, the material proposed for use is relatively coarse sand and should settle quickly from the water column.

Rock Riprap would be obtained from approved pits and quarries in the project area. This area does not have a history of contamination, which should insure that State water quality standards would not be violated during placement of this material.

Material dredged for equipment access would be placed mechanically above normal pool elevation. Minnesota water quality standards would not be violated because of placement of this material.

3. Potential Effects on Human Use Characteristics

a. **Municipal and Private Water Supply**

No private or municipal water supplies would be affected by the proposed project.

b. **Recreational and Commercial Fisheries**

One of the objectives of the proposed project is to improve the fishery of Polander Lake. As such, recreational fishing should improve. The project may also result in a slight improvement to the commercial fishery.

c. **Water Related Recreation and Aesthetics**

The aesthetics of the area would be reduced during construction because of the presence and operation of dredging and other construction equipment. After project completion, wind and wave action would be reduced and the area would see increased usage by waterfowl and other wildlife benefiting water related recreation and the aesthetic value of the area.

d. **Cultural Resources**

In accordance with the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. There are no sites on, or determined eligible for, the National Register in the project area. Coordination with the Minnesota State Historic Preservation Officer revealed that there are no reported historic or archaeological sites in the project area that would be impacted by the proposed project.

G. **Determinations of Cumulative Effects on the Aquatic Ecosystem**

The proposed project would result in the establishment of additional aquatic vegetation, better water clarity, reduced current velocities in the northeast portion of the lake, and areas protected from wind and wave action. Because of these improvements, implementation of the proposed action would have a cumulative affect of improving the overall value of the project area for fish and waterfowl.

H. **Determination of Secondary Effects on the Aquatic Ecosystem**

No significant secondary effects on the aquatic ecosystem would be expected from the proposed action.

III. FINDING OF COMPLIANCE WITH RESTRICTIONS ON DISCHARGE

1. No significant adaptations of the guidelines were made relative to this evaluation. State Section 401 water quality certification has been applied for.

2. The proposed fill activity would comply with the Section 404(b)(1) guidelines of the Clean Water Act. The placement of fill is required to provide the desired benefits. Other alternatives would not provide the desired results.

3. The proposed fill activity would comply with all State water quality standards. The disposal operation would not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4. Use of the selected disposal sites would not harm any endangered species or their critical habitat.

5. The proposed fill activities would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing. It would not adversely affect plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife would not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity, and stability and on recreational, aesthetic, and economic values would not occur.

6. To minimize the potential for adverse impacts, fill would be placed during periods of low water levels and fines would be dredged and placed mechanically. Since the proposed action would result in few adverse effects, no additional measures to minimize impacts would be required.

7. On the basis of this evaluation, I specify that the proposed disposal site complies with the requirements of the guidelines for discharge of fill material.

14 Feb 92
Date

Richard W. Craig
Colonel, Corps of Engineers
District Engineer

MUSSEL SURVEY DATA SHEET

LOCATION: Polander Lake

DATE: June 26, 1991 TIME: 09:30 – 14:30

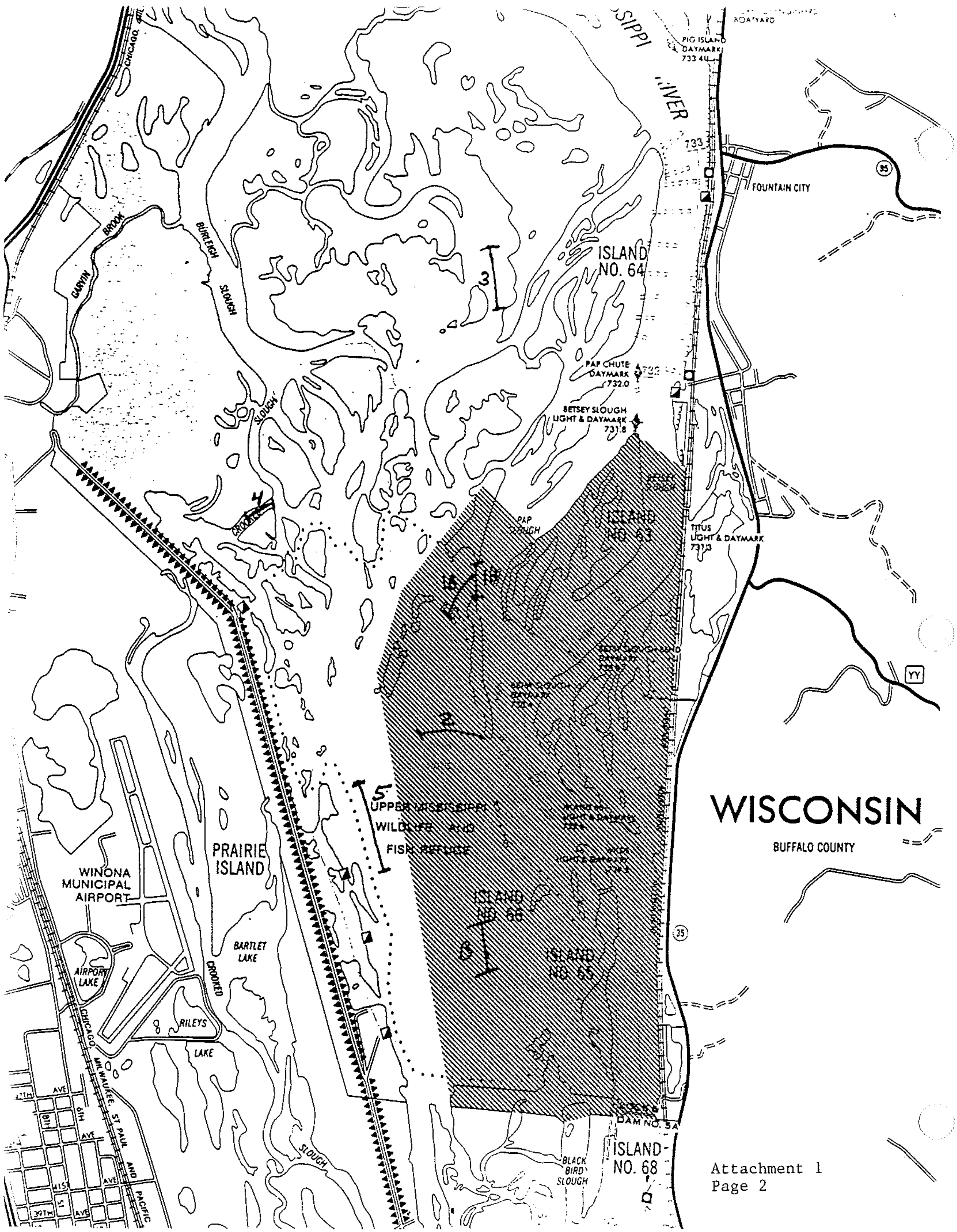
PERSONNEL: Dennis Anderson, Tim Peterson, Janine Harrison

SURVEY METHOD: Mussel Sled (XX) Pollywog ( ) Brail ( ) Diver ( ) Other ( )

TRANSECT	WATER DEPTH	SUBSTRATE	PLOT SIZE	DESCRIPTION
TRANSECT B:	4 feet	Mud		Proposed location for island complex
TRANSECT 1A:	1 – 4 feet	Sand	1300 ft	Across Pap Slough opening
TRANSECT 1B:	1 – 4 feet	Sand/Mud	2000 ft	Perpendicular to mouth
TRANSECT 2:	2 – 4 feet	Sand/mud	2000 ft	Area of proposed island 2
TRANSECT 3:	> 5 feet	Mud	2000 ft	From mouth half way up Twin Lake
TRANSECT 4:	1 – 3 feet	Sand	1000 ft	Minnesota City boat channel
TRANSECT 5:	> 5 feet	Sand	2000 ft	North portion of Straight Slough

SPECIES			TRANSECT B		TRANSECT 1A		TRANSECT 1B		TRANSECT 2		TRANSECT 3		TRANSECT 4		TRANSECT 5		TOTALS		
			LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE SPEC.	SHELLS	LIVE	SHELLS	TOTAL
MAPLELEAF	*Quadrula quadrula*	Rafinesque															0	0	0
WARTYBACK	*Quadrula nodulata*	Rafinesque				1											0	1	1
PIMPLEBACK	*Quadrula pustulosa*	Lea				6		1	1				1		9	16	11	23	34
PIGTOE	*Fusconaia flava*	Rafinesque	4			10		1	19		33	2			46	7	102	20	122
OHIO RIVER PIGTOE	*Pluerobema sintoxia*	Rafinesque															0	0	0
SPIKE	*Elliptio dilatata*	Rafinesque															0	0	0
BLACK SANDSHELL	*Ligumia recta*	Lamark	4	1													4	1	5
FRAGILE PAPERSHELL	*Leptodea fragilis*	Rafinesque												2		6	0	8	8
PINK PAPERSHELL	*Proptera laevissima*	Lea									1					1	1	1	2
PINK HEELSPLITTER	*Proptera alata*	Say	1	9		1		1		2	3					9	4	22	26
POCKETBOOK	*Lampsilis ovata ventricosa*	Barnes				3			4						2	19	6	22	28
FAT MUCKET	*Lampsilis radiata siliquoidea*	Barnes															0	0	0
YELLOW SANDSHELL	*Lampsilis teres*	Rafinesque															0	0	0
HIGGINS' EYE	*Lampsilis higginsi*	Lea															0	0	0
HICKORYNUT	*Obovaria olivaria*	Rafinesque				3										5	0	8	8
MUCKET	*Actinonaias carinata*	Barnes															0	0	0
WHITE HEELSPLITTER	*Lasmigona complanata*	Barnes							1								1	0	1
BUTTERFLY	*Ellipsaria lineolata*	Rafinesque															0	0	0
DEERTOE	*Truncilla truncata*	Lea													11	5	11	5	16
FAWNFOOT	*Truncilla donaciformis*	Lea													1	1	1	1	2
THREEHORN	*Obliquaria reflexa*	Rafinesque	4		10	11	3	2	2	1	70	10	5		21	101	115	125	240
THREERIDGE	*Amblema plicata*	Say	16	1	13	5	6		38	3	47		2		132	86	254	95	349
ROCKSHELL	*Arcidens confragosus*	Say															0	0	0
WASHBOARD	*Megalonaias gigantea*	Barnes															0	0	0
BUCKHORN	*Tritogonia verrucosa*	Rafinesque															0	0	0
LILUPUT	*Carunculina parva*	Barnes															0	0	0
FLAT FLOATER	*Anodonta suborbiculata*	Say															0	0	0
PAPER FLOATER	*Anodonta imbecillis*	Say				4					1						1	4	5
GIANT FLOATER	*Anodonta grandis*	Say	1	1												2	1	3	4
STRANGE FLOATER	*Strophitus undulatus*	Say				1											0	1	1
																	0	0	0
																	0	0	0
																	0	0	0
		TOTALS	30	12	23	45	9	5	65	8	155	12	8	2	222	256	512	340	852

NOTE: 1/2 shells are counted as 1 shell in tabulating totals



Attachment 1
Page 2

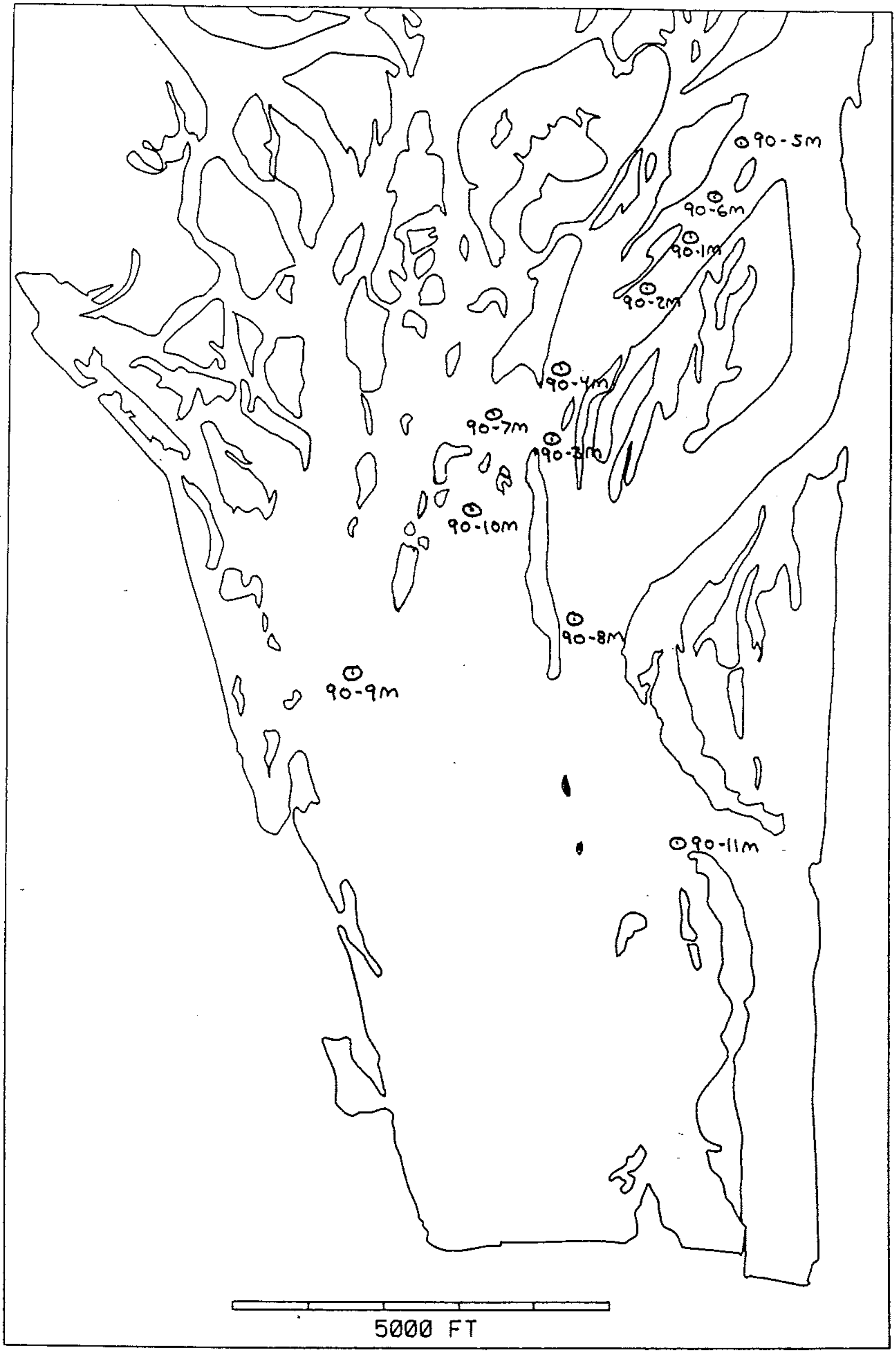
ATTACHMENT 2
SEDIMENT ANALYSIS – POLANDER LAKE EMP

Sample Collected by: COE
Sample Date: April 10, 1990
Analyzed by: Pace, Inc.

PARAMETER	UNITS	MDL	SAMPLE NO./LOCATION COE #2 90–6M	COE #8	COE #10 90–7M	COE #13 90–10M	COE #14 90–9M	COE #15
Total Organic Carbon	mg/kg (dry)	100	460	810	3100	8800	7300	7100
INORGANIC ANALYSIS								
Aresenic	mg/kg	0.50	0.90	0.80	1.50	8.20	5.40	2.40
Cadmium	mg/kg	0.10	0.22	0.17	0.21	0.45	0.33	0.42
Chromium	mg/kg	1.00	6.80	4.60	8.40	20.00	15.00	9.40
Copper	mg/kg	0.10	3.50	2.40	4.70	8.80	7.60	4.80
Cyanide, Total	mg/kg	0.50	ND	ND	ND	ND	ND	–
Lead	mg/kg	1.00	2.40	2.10	3.40	9.00	7.40	6.50
Manganese	mg/kg	0.10	200.00	240.00	80.00	1600.00	940.00	220.00
Mercury	mg/kg	0.01	ND	ND	ND	0.02	0.02	0.03
Nickel	mg/kg	0.50	7.40	5.40	10.00	14.00	11.00	8.00
Nitrogen, Ammonia	mg/kg	20.00	36.00	26.00	33.00	82.00	91.00	130.00
Selenium	mg/kg	1.30	ND	ND	ND	ND	ND	ND
Solids, % Volatile	%	0.01	0.38	0.33	1.10			
Water Content	%	0.01	13.60	15.20	21.50	34.00	29.90	30.60
Zinc	mg/kg	1.00	17.00	12.00	17.00	43.00	34.00	23.00
ORGANIC ANALYSIS								
Moisture Content	%	1.00	13.30	15.40	27.50	33.50	29.10	–
ORGANOCHLORINE PESTICIDES AND PCBs–8080								
a–BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
b–BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
g–BHC (Lindane)	ug/kg	1.00	ND	ND	ND	ND	ND	–
d–BHC	ug/kg	1.00	ND	ND	ND	ND	ND	–
Chlordane (tech)	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'–DDD	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'–DDE	ug/kg	1.00	ND	ND	ND	ND	ND	–
4,4'–DDt	ug/kg	1.00	ND	ND	ND	ND	ND	–
Dieldrin	ug/kg	1.00	ND	ND	ND	ND	ND	–
Endrin	ug/kg	1.00	ND	ND	ND	ND	ND	–
Heptachlor	ug/kg	1.00	ND	ND	ND	ND	ND	–
PCB–1016	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1221	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1232	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1242	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1248	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1254	ug/kg	5.00	ND	ND	ND	ND	ND	–
PCB–1260	ug/kg	5.00	ND	ND	ND	ND	ND	–

MDL – Method Detection Limit
ND – Not detected at or above the MDL

/usr/smg/wil[illegible]/wilds.dgn Aug. 24, 1990 14:41:58



Attachment 2 Sediment Sample Locations

ATTACHMENT 3

COORDINATION/DISTRIBUTION LIST

MINNESOTA HISTORICAL SOCIETY
FOUNDED IN 1849
Fort Snelling History Center, St. Paul, MN 55111 • (612) 726-117'

May 9, 1990

Mr. Robert J. Whiting
St. Paul District, Corps of Engineers
1421 U. S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Whiting:

Re: Protection of Drury Island, Pool 4 below Reeds Landing,
S19, T111, R10, Wabasha County
Rehabilitation of Polander Lake, Pool 5A near Winona
S4-9, T107, R7, Winona County
MHS Referral File Number: 90-0961-962

Thank you for the opportunity to review and comment on the above-referenced projects. They have been reviewed pursuant to responsibilities given the State Historic Preservation Office by the National Historic Preservation Act of 1966 according to 36 CFR Part 800: Protection of Historic Properties, the regulations of the Advisory Council on Historic Preservation governing the Section 106 review process.

We find no record of any reported historic or archaeological sites in the vicinity of either project. The descriptions of these projects is brief. In both cases it appears that the work will involve the creation of land from dredged materials. If this the case, then construction is most unlikely to affect any unreported historic or archaeological sites.

If you have questions regarding this matter, please contact me at the address and telephone number on the letterhead.

Sincerely,

Ted Lofstrom

Ted Lofstrom
Review and Compliance Officer
State Historic Preservation Office

TL:dmb

July 26, 1991

Environmental Resources Branch
Planning Division

Ms. Lynn Lewis
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 East 80th Street
Bloomington, Minnesota 55420

Dear Ms. Lewis:

In accordance with the Endangered Species Act, we wish to obtain your comments on the potential impacts of the proposed action at Polander Lake, Pool 5A, Upper Mississippi River on Federally designated threatened and endangered species. A map and sketch showing the approximate locations of borrow and fill areas are attached.

Polander Lake is being considered for implementation under the fish and wildlife habitat rehabilitation and enhancement provisions of the Upper Mississippi River System Environmental Management Program. Polander Lake is a backwater lake, encompassing approximately 1,000 acres, located on the Minnesota side of the Upper Mississippi River immediately upstream of Lock and Dam 5A from about river mile (R.M.) 728.5 to R.M. 731 (see attachment 1).

The principle goal of the proposed project is to improve the lake's value for migrating waterfowl while maintaining, or enhancing, its fishery. The specific objectives for the proposed project include maintaining the emergent and submergent vegetation beds which currently exist, increasing the areas capable of supporting aquatic vegetation from 17.9 to 46.1 percent of the lake, maintaining a minimum of 400 acres of the deep water ($\geq$ 4 feet) habitat which currently exists, and reducing existing flow velocities in a minimum of one-third of the lake by 50 percent.

It is anticipated that the project goals can be met by constructing and/or armoring the islands shown on the attached sketch. Island 1 would eliminate flows from Pap Slough from entering the backwater and would reduce flows through a minimum of one half of the lake by at least 50 percent. Island 7 and 8 would be armored with rock riprap to stop the erosion that is currently taking place and which threatens to eliminate them. Island 2 would reduce wind and wave action in the northeast portion of the lake and help provide suitable conditions for the establishment of both submerged and emergent aquatic plants in that area. Island complex B would provide suitable habitat and conditions for the establishment of additional aquatic vegetation, and would substantially reduce wind and wave action in areas adjacent to the complex.

We have conducted a biological assessment of these activities to determine the potential effects on Minnesota-listed species, including: the Higgins' eye pearly mussel (Lampsillis higginsi), peregrine falcon (Falco peregrinus), and bald eagle (Haliaeetus leucocephalus). We have determined that individuals of these species would not be affected by our activities.

No active eagle or falcon nests are known to exist in the immediate project area. Minor disturbances during project construction should not significantly effect either peregrine falcon or bald eagle use of the area.

A mussel survey of the borrow and fill areas for the proposed project was conducted on June 26, 1991. No shells or live specimens of any Minnesota-listed threatened or endangered mussels were encountered during the survey. With no recent live records from Pool 5A, the proposed project should not affect the Higgins' eye pearly mussel.

Island construction and borrow areas would be located in areas containing no or only sparse aquatic vegetation. Mobile species, such as fish, could temporarily migrate from areas of construction.

Based on these determinations and findings, we conclude that the proposed project would have no effect on Minnesota-listed threatened or endangered species. We would appreciate your comments on this conclusion.

Sincerely,

Robert J. Whiting
Chief, Environmental Resources Branch
Planning Division

PETERSON PD-ER ____
ANDERSON PD-ER ____
WHITING PD-ER ____

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TWIN CITIES FIELD OFFICE
4101 East 80th Street
Bloomington, Minnesota 55425-1665

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

FWS/AFWE-TCFO

AUG 02 1991

Mr. Robert J. Whiting
Chief, Environmental Resources Branch
Planning Division
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Whiting:

This concerns your July 26, 1991, letter requesting U.S. Fish and Wildlife Service (Service) comments on potential impacts to federally endangered or threatened species from the proposed Polander Lake Project located in Pool 5A of the Upper Mississippi River. The project is proposed for implementation under the Environmental Management Program.

Based on information contained in your above referenced letter and the nature of the proposed project, its location, and the habitat requirements of the federally threatened bald eagle (Haliaeetus leucocephalus), endangered peregrine falcon (Falco peregrinus), and endangered Higgins' eye pearly mussel (Lampsilis higginsi), we support your determination that the proposed project will not affect federally listed threatened or endangered species. In addition, the recent mussel survey did not find any specimens of L. higginsi. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. Should this project be modified or new information indicates that listed species may be affected, consultation with this office should be reinitiated.

These comments have been prepared under the authority of and in accordance with provisions of the Endangered Species Act of 1973, as amended.

Sincerely,

Lynn M. Lewis

Lynn M. Lewis
Field Supervisor

CC: Minnesota Department of Natural Resources, St. Paul, MN
Wisconsin Department of Natural Resources, LaCrosse, WI

July 26, 1991

Environmental Resources Branch
Planning Division

Ms. Bonita Eliason
Minnesota Department of Natural Resources
Division of Fish and Wildlife
Natural Heritage Program
500 Lafayette Road
St. Paul, Minnesota 55155

Dear Ms. Eliason:

We wish to obtain your comments on the potential impacts of the proposed habitat improvement project being planned for Polander Lake, Pool 5A, Upper Mississippi River on Minnesota designated threatened and endangered species. A map and sketch showing the approximate locations of borrow and fill areas are attached.

Polander Lake is being considered for implementation under the fish and wildlife habitat rehabilitation and enhancement provisions of the Upper Mississippi River System Environmental Management Program. Polander Lake is a backwater lake, encompassing approximately 1,000 acres, located on the Minnesota side of the Upper Mississippi River immediately upstream of Lock and Dam 5A from about river mile (R.M.) 728.5 to R.M. 731.

The principle goal of the proposed project is to improve the lake's value for migrating waterfowl while maintaining, or enhancing, its fishery. The specific objectives for the proposed project include maintaining the emergent and submergent vegetation beds which currently exist, increasing the areas supporting aquatic vegetation by at least 12 acres, maintaining a minimum of 400 acres of deep water (≥ 4 feet) habitat which currently exists, and reducing existing flow velocities in a minimum of one-third of the lake by 50 percent.

It is anticipated that the project goals can be met by constructing and/or armoring the islands highlighted on the attached sketch. Island 1 would eliminate flows from Pap Slough from entering the backwater and would reduce flows through a minimum of one-third of the lake by at least 50 percent. Island 7 and 8 would be armored with rock riprap to stop the erosion that is currently taking place and which threatens to eliminate them. Island 2 would reduce wind and wave action in the northeast portion of the lake and help provide suitable conditions for the establishment of both submerged and emergent aquatic plants in that area. Island complex B would provide suitable habitat conditions for the establishment of additional aquatic vegetation, and would substantially reduce wind and wave action in areas adjacent to the complex.

We have conducted a biological assessment of these activities to determine the potential effects on the following species: Higgins' eye pearly mussel (Lampsillis higginsi), peregrine falcon (Falco peregrinus), and bald eagle (Haliaeetus leucocephalus). We have determined that individuals of these species would not be affected by our activities.

No active eagle or falcon nests are known to exist in the immediate project area. Minor disturbances during project construction should not significantly effect either peregrine falcon or bald eagle use of the area.

A mussel survey of the borrow and fill areas for the proposed project was conducted on June 26, 1991. No Higgins' eye pearly mussel shells or live specimens were encountered during the survey. With no recent live records from Pool 5A, the proposed project should not affect the Higgins' eye pearly mussel.

Based on these determinations and findings, we conclude that the proposed project would have no effect on Federally-listed threatened or endangered species. We would appreciate your comments on this conclusion.

Sincerely,

Robert J. Whiting
Chief, Environmental Resources Branch
Planning Division

PETERSON PD-ER ____
ANDERSON PD-ER ____
WHITING PD-ER ____

August 2, 1991

Robert Whiting
Environmental Resources Branch
Planning Division
St. Paul District, Corps of Engineers
1421 U.S. Post Office and Custom House
St. Paul, MN 55101-1479

Re: proposed habitat improvement project at Polander Lake, Pool 5A, Upper Mississippi River

Dear Mr. Whiting:

The Minnesota Natural Heritage database has been reviewed to determine if any rare plant or animal species or other significant natural features are known to occur within one mile of the above referenced project. Based on this review, it does not appear that the proposed project, as described in your 7/26/1991 letter, will negatively affect any known locations of rare or endangered species. Therefore, we concur with your "no effect" determination, assuming the work is done this calendar year. However, I do want to point out that there are two former Bald Eagle nesting sites in the project area, one near island No. 63, and one on island No. 66 (island numbers are those which appear on USGS 7.5 minute quad maps). Although neither of these nesting sites was active in 1991, we suspect that the territory is still active. Unfortunately we do not know where the current nest site is located. In case the project will not be completed in 1991, I wanted to alert you to the possibility that an active nest site may be discovered in the project area between now and when the proposed work is begun. As you know, certain activities are restricted in proximity to eagle nests during sensitive periods of the nesting cycle. The discovery of an active eagle nest in the project area might result in the need to change the timing of certain project activities to avoid disturbance to the eagles. Aerial surveys to determine eagle nesting activity are conducted each year in April and May. Information on the status of this territory in a given year should be available by May 1.

The Natural Heritage database is maintained by the Natural Heritage Program and the Nongame Wildlife Program, units within the Section of Wildlife, Department of Natural Resources. It is the most complete source of data on Minnesota's rare, endangered, or otherwise significant plant and animal species, plant communities, and other natural features, and is used in fostering better understanding and protection of these rare features. The information in the database is drawn from many parts of Minnesota, and is constantly being updated, but it not based on a comprehensive survey of the state. Therefore, there are currently many significant natural features present in the state which are not represented by the database. We are in the process of addressing this problem via the Minnesota County Biological Survey, a county-by-county inventory of rare natural features, which is now underway. However, Winona county has not been surveyed, and is not scheduled for survey within the next few years. Because there has not been an on-site survey of the biological resources of the project area, it is possible that ecologically significant features exist for which we have no record.

Thank you for consulting us on this matter, and for your interest in minimizing impacts on Minnesota's rare resources. Please be aware that review by the Natural Heritage and Nongame Programs focuses only on rare natural features. It does not constitute review or approval by the Department of Natural Resources as a whole.

Sincerely,

Bonita Eliason

Bonita Eliason
Endangered Resource/Environmental Review Specialist
Natural Heritage and Nongame Wildlife Programs
612/296-8324

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Upper Mississippi River Refuge Complex
51 East 4th Street
Winona, Minnesota 55987

IN REPLY REFER TO:

September 19, 1991

Mr. Gary Palesh
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
180 E. Kellogg Boulevard
St. Paul, Minnesota 55101

Dear Mr. Palesh:

This provides U.S. Fish and Wildlife Service (Service) comments on the draft Definite Project Report and Environmental Documentation (SP-14) for the Polander Lake Habitat Rehabilitation and Enhancement Project. This project will benefit the biological resources of the Upper Mississippi River National Wildlife and Fish Refuge (Refuge).

The project is being built on federal lands managed as part of the Refuge, therefore, a Refuge compatibility determination and Refuge approval is required before the project can be constructed. Enclosed is a signed compatibility determination for the selected alternative discussed in this draft report. Approval of the project will be formally provided by the Regional Director after completion of the final project report.

The final draft definite project report must include a copy of the draft Memorandum of Agreement for the operation, maintenance, and rehabilitation. In accordance with the Fourth Annual Addendum the Service will cover operation and maintenance costs as discussed in this report, except "Item D" in Table DPR11. After construction and seeding the Service may actively manage vegetation using prescribed burning and other techniques. On some sites, natural selection may be allowed to occur. Seeding of islands should include a mixture of forbs and warm season species if possible. The Regional Director's letter on the final draft definite project report will include the certification of support for operation and maintenance.

The Service strongly recommends that a pre- and post-physical monitoring program be implemented to measure the effects of Island Complex "B" on reduction of wind and wave energy. Turbidity should also be monitored at some locations and times. Details on what is proposed and how the monitoring plan will be implemented should be a part of the final draft definite plan.

The Service's priority for Island construction is to complete Islands 1, 7 and 8 first; then Island 2, and finally island Complex B.

Page 14, DPR (Sediment Analysis) and Table DPR-4
It is not clear that the reported results for inorganic analyses are dry weight, as suggested by their comparison to previously obtained Mississippi River sediment chemistry data. The laboratory performing the present analyses recently provided an analytical report for another EMP project which stated that, unless specifically indicated, all results were to be assumed to be "as received" (wet weight). In that previous report, the organic analyses results were clearly labeled as dry weight while the inorganic results were not. The transcribed results for the Polander Lake Project do not indicate that either organic or inorganic results represent dry weight concentrations. The difference between dry weight and wet weight reported contaminant concentrations can be considerable, depending upon moisture content of the samples in question. To eliminate future uncertainties and misunderstandings, we request that results for all future contracted sediment analyses be specified as reportable on a dry weight basis only. We also request that the original laboratory data, including quality assurance test results, be appended to the DPR or provided as a separate attachment.

Page 43, Water Quality
In view of the preceding comments and the fact that minimal sediment sampling was conducted near areas of proposed project-related sediment disturbance, we concur in the need for further site-specific sediment sampling and analysis as the locations of project features become more clearly defined. Please provide a copy of the plans for such future sampling for our review prior to sample collection.

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

This report illustrates the cooperation evident between the U.S. Army Corps of Engineers and the Service. These efforts at working together on this project as well as the environmental management program as a whole help ensure the success of mutual concerns for improvements on the Upper Mississippi River System.

Sincerely,

James R Leonardson

for Richard F. Berry
Complex Manager

Enclosure

cc: SPFO
LTRM
Winona FAO
MN DNR/WI DNR
Winona District
RO--SS

UPPER MISSISSIPPI RIVER NATIONAL
WILDLIFE AND FISH REFUGE
Established 1924
COMPATIBILITY STUDY
POLANDER LAKE REHABILITATION

Establishment Authority:
Public Law No. 268, 68th Congress, The Upper Mississippi River Wildlife and Fish Refuge Act.

Purpose for Which Established:
"The Refuge shall be established and maintained (a) as a refuge and breeding place for migratory birds included in the terms of the convention between the United States and Great Britain for the protection of migratory birds, concluded August 16, 1916, and (b) to such extent as the Secretary of Agriculture may by regulations prescribe, as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and (c) to such extent as the Secretary of Commerce may by regulations prescribe a refuge and breeding place for fish and other aquatic animal life."

Description of Proposed Use:
The proposal is a Habitat Rehabilitation and Enhancement project authorized by the Water Resource Development Act of 1986 (Pub. L. 99-662). The proposed project consists of construction of a closure structure (Island 1) to prevent inflows of Mississippi River water through Pap Slough, the construction of several islands (Island 2 and Island Complex B) to protect against wind and wave action, and riprapping of two existing islands (Islands 7 and 8) which are seriously eroding.

Island 1, the Pap Slough closure structure, consists of sand fill material being placed across the 800 foot-wide opening. The maximum height of the fill will be approximately 5 feet above normal pool elevation, at 656 feet mean sea level (msl). Rock riprap will be placed on the Pap Slough side of the structure to prevent erosion caused by flow.

Island 2 will be approximately 1,000 feet in length beginning about 100 feet from the present shoreline of the lower end of the Pap Slough barrier islands. This island will be at the same elevation and have the same cross section as Island 1. The downstream side of the island will be riprapped to provide erosion protection from both wind and boat generated waves.

Islands 7 and 8 will be protected with rock riprap in eroding areas. Approximately 445 linear feet of Island 7 and 365 feet of Island 8 will require riprap.

Island Complex B will consist of two major outer islands and three inner islands. The outer islands will provide protection from wind and wave action for the inner islands. The major upstream island (Island 3) will be approximately 1,700 feet in length. The entire upstream portion of this island will be riprapped for erosion protection. The downstream side will be protected by the major downstream island (Island 4) of the complex which will be located approximately 1,000 feet downstream. The downstream island will be approximately 1,900 feet in length. Due to its configuration only portions of this island will require riprap. Top elevations for both of these islands will be 656 msl.

The three inner islands (Island 3a, 4a, and 4b) will be about 675, 415, and 775 feet in length respectively. Each will be at a lower height (elevation 654 feet msl) than the two major islands which protect them. Side slopes for these islands would be 1 foot vertical for each 10 feet horizontal to allow for growth of vegetation.

The habitat goal for this Polander Lake project is to enhance its value for migratory birds and for its fishery. This will be accomplished as described above by improving the structural habitat diversity in the lake area. This means creating areas of varying depth, reducing flow velocities, and providing conditions which will encourage the growth of aquatic vegetation. This construction project is the engineering solution to solve this habitat problem and to restore and enhance the biological values of the Polander Lake complex.

Complete details of the project, including maps and engineering drawings, are contained in the draft report entitled, "Upper Mississippi River System Environmental Management Program Definite Project Report with Integrated Environmental Assessment (SP-14) Polander Lake Habitat Rehabilitation and Enhancement, Pool 5A, Upper Mississippi River, Winona County, Minnesota," prepared by the St. Paul District, Corps of Engineers.

Anticipated Impacts on Refuge Purposes:
As a result of the project the fish and wildlife populations should increase. The above mentioned report contains detailed information on the project's impacts.

Justification:
The proposed project works toward the accomplishment of the purposes and stated objectives of the Refuge.

Determination:
The proposed project is compatible with purposes for which the Refuge was established.

Determined by:	James R. Lennartson Refuge Manager	8/15/91 Date
Reviewed by:	Richard F. Berry Complex Manager	8/15/91 Date
Reviewed by:	J. C. Bryant WAM-1	8/22/91 Date
Concurred by:	[signature] Regional Director	8/26/91 Date

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

FWS/ARW-SS

DEC 10 1991

Colonel Richard W. Craig
District Engineer
U.S. Army Engineering District, Saint Paul
1421 U.S. Post Office and Custom House
Saint Paul, Minnesota 55101-1479

Dear Colonel Craig:

Thank you for your notice dated November 20, 1991, requesting our comments on the draft Definite Project Report/Environmental Assessment (SP-14), "Polander Lake Habitat Rehabilitation and Enhancement Project." This project would be located on the Minnesota side of Pool 5A at Mississippi River miles 728.5-731. The Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge, may be providing additional comments for your consideration.

The U.S. Fish and Wildlife Service (Service) will assure operation and maintenance requirements of the project will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986. In accordance with the policies stated in the Fourth Annual Addendum, the Service will perform the operation and maintenance requirements for this project as listed on pages 52-53.

This project is located on Refuge lands. Therefore, the Service will complete its finding of no significant impact upon learning from you that the public review period produced no substantive changes in the Definite Project Report/ Environmental Assessment.

We look forward to continued cooperative efforts in developing habitat rehabilitation and enhancement projects under the Environmental Management Program.

Sincerely,

John R. Eadie

John R. Eadie
Acting Regional Director

United States Department of the Interior
BUREAU OF MINES
INTERMOUNTAIN FIELD OPERATIONS CENTER
P.O. BOX 25086
BUILDING 20, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

December 26, 1991

Colonel Richard W. Craig
District Engineer, St. Paul District
U.S. Army Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

Dear Colonel Craig:

Subject: Review of the Draft Definite Report and Environmental Assessment of Habitat Rehabilitation Polander Lake, Winona County, Minnesota (ER 91/1147)

At the request of the Director, Office of Environmental Affairs, Department of the Interior, personnel of the Bureau of Mines reviewed the subject document (report and EA). With a project such as this the Bureau is primarily concerned that possible impacts to mineral resources and related production facilities are adequately addressed during the environmental review process.

The subject document addresses known mineral resources, the quantity of material needed for construction, and the source area of the material. Accordingly, all concerns of the Bureau of Mines have been addressed. Because all construction activities for the selected plan would occur within the Upper Mississippi River Wildlife and Fish Refuge, we believe that mineral resources would not be impacted beyond existing restrictions in the refuge. We therefore believe the report and EA are adequate with regard to minerals, and we have no objection to the document as presented.

Sincerely,

George R. Schadm

for Richard B. Grabowski, Acting Chief
Intermountain Field Operations Center

ekp/rr

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

(612) 345-3331
PHONE NO.

Section of Ecological Services
Route 2, Box 230
Lake City, MN 55041-9015

FILE NO.

December 26, 1991

Richard W. Craig, District Engineer
St. Paul District, Corps of Engineers
180 Kellogg Boulevard East, Room 1421
St. Paul, Minnesota 55101-1479
ATTN: CENCS-PD-WR

Dear Mr. Craig:

We have reviewed the Definite Project Report including the Environmental Assessment and FONSI for Polander Lake, Winona County, Minnesota.

We do have a few concerns which we would like to bring to your attention.

1. Throughout the development of this project we have heard concerns expressed by local citizens and our field biologists over the sedimentation which is occurring in the area immediately upstream of Polander Lake. Because of this we would like to see the area included in future bathymetric surveys to be done as part of the project's performance evaluation. Over the next fifty years, sediment being delivered to this area by Burleigh Slough is likely to enter Polander Lake and threaten the project. Burleigh Slough itself is a valuable fisheries resource and should be included in any bathymetric survey work so that its status over time can be established.

2. Please inform me when work to establish borrow sites for island construction is being done. We would like to actively participate in borrow site selection so that habitat benefits associated with this dredging can be maximized. We would also like to participate in any preconstruction meetings or field trips which may take place regarding this project.

After January 15, 1992 please address any correspondence on this or other Mississippi River Environmental Management Program projects to Mike Davis, Minnesota Department of Natural Resources, Ecological Services Section, 1801 South Oak St., Lake City, MN 55041.

Sincerely,

Mike Davis

Mike Davis
Habitat Project Coordinator

cc: Rick Berry, USFWS Refuge Complex
Keith Beseke, USFWS Refuge EMP Coordinator
Jeff Janvrin, Wisconsin DNR
Dan Dieterman, MNDNR Area Fisheries
Nick Gulden, MNDNR Area Wildlife Manager
Bruce Hawkinson, MNDNR Chief of Ecological Services
Walt Popp, MNDNR Pool 4 Field Station
Steve Johnson, MNDNR Office of Planning

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

500 LAFAYETTE ROAD, ST. PAUL, MINNESOTA 55155-4037

OFFICE OF THE
COMMISSIONER

DNR INFORMATION
(612) 296-6157

December 31, 1991

Col. Richard W. Craig
District Engineer
St. Paul District
Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101-1479

Re: Polander Lake HREP

Dear Col. Craig:

The Minnesota Department of Natural Resources supports the Upper Mississippi River System Environmental Management Program Habitat Rehabilitation and Enhancement Project at Polander Lake in Pool 5A of the Upper Mississippi River.

Upon completion and final acceptance of this project by the Corps of Engineers and the U.S. Fish and Wildlife Service, the Department agrees to cooperate with the Fish and Wildlife Service and the Corps of Engineers to ensure that operation, maintenance and any mutually agreed upon rehabilitation as described in the Definite Project Report will be accomplished in accordance with Section 906(e) of the Water Resources Development Act of 1986.

Yours truly,

Rod Sando

Rodney W. Sando
Commissioner

cc: Steve Johnson

JAN 07 1992

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

State Office Building, Room
3550 Mormon Coulee
La Crosse, WI 54...
TELEPHONE 608-785-9000
TELEFAX 608-785-9990

Carroll D. Besadny
Secretary

January 7, 1992

File Ref: 1600-1-3

Col. Richard W. Craig, District Engineer
St. Paul District, Corps of Engineers
ATTN: CENCS-PD-WR
180 Kellogg Boulevard East, Room 1421
St. Paul, MN 55101-1479

Dear Col. Craig:

The Wisconsin Department of Natural Resources has reviewed the Draft Definite Project Report and Environmental Assessment, Polander Lake, Winona County, Minnesota, dated December 1991 and supports the project as described. The comments that we provided to your office after reviewing the September 1991 Draft DPR were incorporated into the December 1991 DPR. We have no additional comments concerning the Polander Lake DPR.

We appreciated the opportunity to participate in the planning of the Polander Lake Habitat Rehabilitation and Enhancement Project and look forward to its completion.

Sincerely,

Jeffrey A. Janvrin
Mississippi River Habitat Specialist

c: Terry Moe, WI DNR
Ron Benjamin, WI DNR
Rick Berry, USFWS
Keith Beseke, USFWS
Steve Johnson, MN DNR
Mike Davis, MN DNR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

FWS/AFWE-FAC

JAN 16 1992

ER-91/1147

Colonel Richard W. Craig
District Engineer
U.S. Army Engineer District, St. Paul
180 East Kellogg Boulevard
St. Paul, Minnesota 55101-1479

Dear Colonel Craig:

The U.S. Fish and Wildlife Service (Service) has reviewed the Draft Definite Report and Environmental Assessment for the Polander Lake Habitat Rehabilitation and Enhancement Project, Winona County, Minnesota.

The Service's letter of September 19, 1991, included our comments on the proposed project. We have no additional comments at this time.

We appreciate the opportunity to provide comments. If you have questions regarding this response, please contact Dr. Mamie Parker of my staff at 725-3536.

Sincerely,

John A. Blankenship

John A. Blankenship
Assistant Regional Director
Fish and Wildlife Enhancement

Minnesota Pollution Control Agency
520 Lafayette Road, Saint Paul, Minnesota 55155-3898
Telephone (612) 296-6300

January 17, 1992

RECEIVED
JAN 27 1992
U.S. CORPS OF Engineers
St. Paul District
TREATMENT WKS SECTION

Colonel Richard W. Craig
St. Paul District
U.S. Army Corps of Engineers
1421 U.S. Post Office & Custom House
St. Paul, Minnesota 55101-9808

Dear Colonel Craig:

RE: Polander Lake Habitat Rehabilitation and Enhancement Project
Wetland, Upper Mississippi River Pool 5A Winona County

This letter is submitted by the Minnesota Pollution Control Agency (MPCA) under authority of Section 401 of the Clean Water Act (33 USC 1251 et seq.) and State Statutes Chapters 115 and 116. The referenced project involves a proposal to construct a closure across a side channel carrying Pap Slough flows into the lake, a 1,000 foot island in the upper portion of the lake, a island complex (about 6,000 lineal feet of island) in the lower portion of the lake and bank stabilization on two existing islands.

The MPCA will waive certification of the referenced project with the following condition since the project impacts do not appear to be significant as defined by present water quality standards.

1) Additional information is planned to be developed on the site specific locations that may contain contaminated sediments. That information and the proposed actions regarding those contaminants must be submitted to the Minnesota Pollution Control Agency for review and determination of compliance with state laws and rules.

The project impacts should be minimized in accordance with the requirements of Section 404(b)(1) guidelines.

This action does not exempt the applicant from the responsibility of complying with all applicable local, state and federal requirements, nor does it grant any right to violate personal or property rights.

If you have any questions on this, please call Lawrence S. Zdon at (612) 297-8219.

Sincerely,

Duane L. Anderson

Duane L. Anderson, Manager
Assessment and Planning Section
Water Quality Division

DLA/jmg
cc: Mr. Ted Rockwell, U.S. Environmental Protection Agency, St. Paul
Ms. Lynn Lewis, Field Supervisor, U.S. Fish and Wildlife Service
Mr. Kent Lokkesmoe, Director, Division of Waters, MDNR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JAN 06 1992

REPLY TO THE ATTENTION OF:

Colonel Richard W. Craig
Department of the Army
St. Paul District
Corps of Engineers
1421 U.S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Dear Colonel Craig:

We have reviewed the Definite Project Report and Environmental Assessment (EA) on the proposed habitat rehabilitation and enhancement project at Polander Lake, Winona County, Minnesota. Polander Lake is a backwater lake, encompassing approximately 1,000 acres. The lake is an important staging area for waterfowl, but the area does not support enough aquatic vegetation to provide ideal habitat conditions. The purpose of the project is to improve the habitat for migrating waterfowl and maintain or enhance its fishery. The project's objectives are to maintain the existing emergent and submergent vegetation beds, increase the areas supporting aquatic vegetation by at least 12 acres, maintain a minimum of 400 acres of existing deep water habitat, and reduce existing flow velocities in a minimum of one-third of the lake by 50 percent.

To reduce the effects of wind and wave action, your agency proposes to construct a closure across a side channel (Pap Slough), construct a 1,000 foot island in the upper portion of the lake, construct an island complex in the lower portion of the lake, and stabilize two existing islands to prevent further degradation due to erosion. We offer the following comments.

According to the EA, construction of the closure of Pap Slough and of the various islands would require approximately 130,000 cubic yards of sand and about 38,000 cubic yards of fines. The borrow material proposed for use as fill must be acceptable both from an engineering and an environmental perspective. The EA states that most of the material is located within the project area and that in order to obtain additional environmental benefits, the priority for obtaining borrow material is backwater areas, side channels and the main channel. Our concern with regard to the use of material from these areas is that the species found in it are the same as those found in the lake so that the balance is not upset. We are particularly concerned that exotic species not be introduced into the lake. Also, if it is determined that some of the material in the backwater areas is not suitable borrow material or is not easily accessible, information should be provided on the type and source of material proposed for use to ensure that it is clean and that use of such material would not adversely impact the environment.

The EA states that a total of approximately 5,000 cubic yards of rock fill would be needed to provide erosion protection due to wind and boat generated waves. We concur with your agency's statement that any rock material proposed to be used in this project is to be supplied by quarries in the area. This will ensure that wetlands or other unique area habitats are not impacted in obtaining this material. We recommend that the contract being put out for bid state that the use of a local quarry for rock material is required.

The proposed project may affect the water quality of the lake. Describe the types of turbidity-control measures proposed to be implemented during dredging and filling activities. Secondary water quality impacts of the project need to be assessed as well, including the potential increase in recreational use. An improved fishery may cause an increase in the use of motor boats, resulting in increased turbidity and hydrocarbons. Your agency may want to consider placing speed/horsepower limits on boats using the lake, or even temporarily restrict the use of the lake by motor boats until vegetation is established.

Finally, to minimize erosion, we recommend that a staging area for the construction equipment be established in an environmentally non-sensitive area, that the number of access points to the site be limited, and that all disturbed soils be revegetated upon completion of the project.

Thank you for the opportunity to provide comments on the proposed habitat rehabilitation and enhancement project at Polander Lake, Winona County, Minnesota. We have no objections to the proposed project as long as the aforementioned issues are adequately addressed. If you have any questions, please call Holly Wirick of my staff at (312)/FTS 353-6704.

Sincerely yours,

William D. Franz

William D. Franz, Chief
Environmental Review Branch
Planning and Management Division

January 23, 1992

Environmental Resources Branch
Planning Division

Mr. William D. Franz
Chief, Environmental Review Branch
Planning and Management Division
U.S. Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Dear Mr. Franz:

Thank you for your comments on the proposed habitat rehabilitation and enhancement (HREP) project at Polander Lake, Winona County, Minnesota. The following addresses the concerns voiced in your letter.

All proposed borrow areas are located close to the lake and are directly connected to the lake. Consequently, use of these areas should not introduce any new or exotic species to the lake.

If suitable material for construction of the proposed islands cannot be obtained from backwaters close to the project area, sand for island construction will be obtained from Pap Slough. Sediment in this area is relatively clean, as detailed in Table DPR-4A of the Definite Project Report.

The Corps generally does not designate off-site sources for obtaining fill material. However, it is specified that the source must be acceptable to the Corps. In most instances, contractors choose to obtain construction materials from existing commercial concerns near the project area.

No special turbidity control measures have been determined feasible for implementation during construction of the proposed project. Sand material would be dredged and placed through hydraulic dredging. Fine material would be dredged and placed mechanically to minimize turbidity. Construction would be done during periods of normal to low water levels to help keep turbidity plumes to a minimum.

A limited amount of additional usage by recreational boaters is anticipated after completion of the proposed project. The Corps has no authority to control recreational use of the area. However, experience with other similar projects indicates that there should be no problem due to increased usage. The lake's bathymetry and the existence of numerous stump fields in the lake restrict the type of recreational craft using the area, limiting potential use of the area to smaller fishing boats.

Construction of the proposed project would consist of dredging, dredged material placement, and placement of protective rock riprap. Dredging and dredged material placement would be conducted from barges. No on-shore staging areas would be required for these activities. Rock riprap would be loaded onto barges at either the loading dock at Lock and Dam 5 or at dredged material disposal site 5A-731.9-LW located at river mile 731.9 at Fountain City, Wisconsin. Use of either of these areas should not have any notable environmental impacts. The project would include the establishment of vegetation on all of the islands proposed for construction.

If you have any questions or any additional comments on the proposed Polander Lake HREP project, please contact Mr. Tim Peterson at (612) 220-0274.

Sincerely,

Louis Kowalski
Chief, Planning Division

The Draft Definite Project Report/Environmental Assessment and/or Public Notice was sent to the following agencies and interests:

Congressional

Sen. Rudy Boschwitz (St. Paul)
Sen. Dave Durenberger (Mpls)
Rep. Tim Penny (Rochester)
Sen. Robert W. Kasten, Jr. (Madison)
Sen. Herbert Kohl (Madison)
Rep. Steve Gunderson (Black Riv. Falls)

Federal

Department of Transportation (Chicago)
Environmental Protection Agency (Chicago)
U.S. Coast Guard (St. Louis)
U.S. Fish and Wildlife Service (La Crosse - Berry , Rasmussen ; Twin Cities FO - Lewis, Wege; Winona - Beseke, Lennartson ; Twin Cities RO - Gritman, Gibbons, Dobrovolny)
U.S. Geological Survey (St. Paul; Madison)
National Park Service (Omaha)
Soil Conservation Service (Madison, St. Paul)
Advisory Council on Historic Preservation (Wash DC)
Office of Environmental Compliance - DOE (Wash DC)
Office of Environmental Project Review - DOI (Wash DC)
Corps of Engineers (LMS - Hawickhorst; LMV - Arnold; NCD - Hempfling; NCR - Bruzewicz; OCE - Howell ; NCS - Fountain City - Krumholz; LaCrescent- Otto; L&D 5A - Farrand ; St. Paul - Bischoff , Blomker, Geisen, Goodfellow, Krumholz , Oksness , Palesh, Powell; Winona - Peterson)

State of Wisconsin

Department of Administration (Madison)
Department of Natural Resources (Madison - Besadny , La Crosse - Moe; Eau Claire - Bourget)
Department of Transportation (La Crosse - Gruendler)
State Historic Preservation Officer (Madison)
State Archeologist (Madison)

State of Iowa

Department of Natural Resources (Des Moines - Szcodronski)

State of Minnesota

Department of Natural Resources (Frontenac - Davis, Johnson, Johnson; Rochester - Heather, Shepperd ; St. Paul - Sando , Norris; Winona - Gulden)
Pollution Control Agency
Department of Administration
Department of Transportation
Department of Agriculture
Department of Health & Human Services
State Historic Preservation Officer
Department of Energy, Economics, and Development
State Archeologist
State Planning Agency
Water and Soil Resources Board

Local

Winona County Commissioners
Winona County Highway Department
Winona Public Library.
City of Winona
City of Goodview
County of Minnesota City

Other Interests
Upper Mississippi River Conservation Committee (Rock Island)
Sierra Club (Madison, Mpls)
Izaak Walton League (Mpls, Wabasha)
Minnesota/Wisconsin Boundary Area Commission (Hudson)
National Audubon Society (Mpls)
Upper Mississippi River Basin Association (St. Paul)
Mississippi River Regional Planning Commission (La Crosse)
Cochrane - Fountain City Recorder
Buffalo County Journal
Winona Daily NEWS
La Crosse Tribune
KWNO Radio (Winona)
KSMR Radio (Winona)
KAGE Radio (Winona)
WXOW-TV (La Crosse)
WKBT-TV (La Crosse)
Ducks Unlimited (Mpls)
Minnesota City Boat Club
Winona Rod and Gun Club

Individuals
Jim Bamberek
Jon Bitu
James Drier
Calvin Fremling
John Kane
Mike Kolstad
Charles Kubreck
Lloyd Livingstone
Warren Matzke
Reggie McLeod
Cliff Murray
James Nowlan
Robert Olson
Wayne Purtzer
Don Riedeman
Henry Rollinger
Michael Rompa
Charles Smith
Will Snyder
Leroy Tibesar
Ed Tomashek
Rich Twait
John Tweedy
Eugene Sxeazy

ATTACHMENT 4

MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT

BETWEEN

THE UNITED STATES FISH AND WILDLIFE SERVICE

AND

THE DEPARTMENT OF THE ARMY

FOR

ENHANCING FISH AND WILDLIFE RESOURCES

OF THE

UPPER MISSISSIPPI RIVER SYSTEM

AT

POLANDER LAKE

WINONA COUNTY, MINNESOTA

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (FWS) and the Department of the Army (DOA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the Polander Lake separable element of the Upper Mississippi River System - Environmental Management Program (UMRS-EMP).

II. BACKGROUND

Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. Under conditions of Section 906(3) of the Water Resources Development Act of 1986, Public Law 99-662, with the exception of a control structure on a culvert that is located outside of the Upper Mississippi River National Wildlife and Fish Refuge, all construction costs of those fish and wildlife features for the Polander Lake project are 100% Federal, and all operation, maintenance, repair, and rehabilitation costs are to be cost shared 75% Federal and 25% non-Federal.

III. GENERAL SCOPE

The Polander Lake project rehabilitates and improves the fish and wildlife habitat in the lake primarily through features to improve habitat diversity in the lake. This would be accomplished through the construction of a side channel closure, six new islands, and the protection of two existing islands. These features would reduce flow through the lake, reduce wind and wave induced turbidity, and increase structure diversity in the lake.

IV. RESPONSIBILITIES

A. DOA is responsible for:

1. Construction: Construction of the Project which consists of constructing a side channel closure, constructing three large and three smaller islands, and applying riprap to two existing islands. Material to construct the islands would be taken from Polander Lake and adjacent side channels.

2. Major Rehabilitation: Any mutually agreed upon rehabilitation of the project that exceeds the annual operation and maintenance requirements identified in the Definite Project Report and that is needed as a result of specific storm or flood events.

3. Construction Management: Subject to and using funds appropriated by the Congress of the United States, DOA will construct the Polander Lake project as described in the Definite Project Report/Environmental Assessment, Polander Lake, Habitat Rehabilitation and Enhancement, dated March 1992, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The FWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If DOA encounters potential delays related to construction of the Project, DOA will promptly notify FWS of such delays.

4. Maintenance of Records: DOA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with

construction of the Project to the extent and in such detail as will properly reflect total costs. DOA shall maintain such books, records, documents, and other evidence for a minimum of three years after completion of construction of the Project and resolution of all relevant claims arising therefrom, and shall make available at its offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the FWS.

B. FWS is responsible for:

1. Operation, Maintenance, and Repair: Upon completion of construction as determined by the District Engineer, St. Paul, the FWS shall accept the Project and shall operate, maintain, and repair the Project as defined in the Definite Project Report entitled "Polander Lake Habitat Rehabilitation and Enhancement," dated March 1992, in accordance with Section 903(e) of the Water Resources Development act, Public Law 99-662.

2. Non-Federal Responsibilities: In accordance with Section 906(e) of the Water Resources Development Act, Public Law 99-662, the FWS shall obtain 25% of all costs associated with the operation, maintenance, and repair of the Project from the Minnesota Department of Natural Resources.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of no more than 50 years after initiation of construction of the Project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties:

FWS: Regional Director
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

DOA: District Engineer
U.S. Army Corps of Engineers, St. Paul
180 Kellogg Boulevard East, Room 1421
St. Paul, Minnesota 55101-1479

VII. EFFECTIVE DATE OF MOA

This MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY

BY:

(signature)
RICHARD W. CRAIG
Colonel, Corps of Engineers
St. Paul District

Date

THE U.S. FISH AND WILDLIFE SERVICE

BY:

(signature)
JAMES C. GRITMAN
Regional Director
U.S. Fish and Wildlife Service

Date

ATTACHMENT 5

DETAILED COST ESTIMATE

********FEASIBILITY COST ESTIMATE********

POLANDER LAKE EMP PROJECT

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT	REASON
06.-.-.-	FISH AND WILDLIFE FACILITIES							
06.3.3.-	HABITAT AND FEEDING FACILITIES							
06.3.3.B	ISLAND 1							
06.3.3.B	SAND	CY	21343	4.00	85,000	26,000	31%	1,2,3
06.3.3.B	FINES	CY	300	3.00	1,000	350	35%	1,2,3
06.3.3.B	RIPRAP	CY	1,782	38.00	68,000	17,000	25%	1,2,3
06.3.3.B	SEEDING	AC	1	2,000.00	2,000	400	20%	1,2,3
06.3.3.B	ISLAND 2							
06.3.3.B	SAND	CY	24310	4.00	97,000	29,000	30%	1,2,3
06.3.3.B	FINES	CY	1,143	3.00	3,000	1,000	33%	1,2,3
06.3.3.B	RIPRAP	CY	2,160	38.00	82,000	20,000	24%	1,2,3
06.3.3.B	SEEDING	AC	1	2,000.00	2,000	400	20%	1,2,3
06.3.3.B	ISLAND 7							
06.3.3.B	RIPRAP	CY	979	41.00	40,000	10,000	25%	1,2,3
06.3.3.B	ISLAND 8							
06.3.3.B	RIPRAP	CY	803	43.00	35,000	9,000	26%	1,2,3
06.3.3.B	ISLAND 3							
06.3.3.B	SAND	CY	37627	4.00	151,000	45,000	30%	1,2,3
06.3.3.B	FINES	CY	528	3.00	2,000	700	35%	1,2,3
06.3.3.B	RIPRAP	CY	4,108	38.00	156,000	39,000	25%	1,2,3
06.3.3.B	SEEDING	AC	2	2,000.00	4,000	800	20%	1,2,3
06.3.3.B	ISLAND 3a							
06.3.3.B	SAND	CY	20529	4.00	82,000	24,000	29%	1,2,3
06.3.3.B	FINES	CY	2,482	12.00	30,000	10,000	33%	1,2,3
06.3.3.B	SEEDING	CY	1	2,000.00	2,000	400	20%	1,2,3
06.3.3.B	ISLAND 4							
06.3.3.B	SAND	CY	39784	4.00	159,000	47,000	30%	1,2,3
06.3.3.B	FINES	CY	30,195	3.00	91,000	32,000	35%	1,2,3
06.3.3.B	RIPRAP	CY	373	38.00	14,000	3,500	25%	1,2,3
06.3.3.B	SEEDING	AC	2	2,000.00	4,000	800	20%	1,2,3
06.3.3.B	ISLAND 4a							
06.3.3.B	SAND	CY	11122	4.00	44,000	13,000	30%	1,2,3
06.3.3.B	FINES	CY	1,411	12.00	17,000	6,000	35%	1,2,3
06.3.3.B	SEEDING	AC	1	2,000.00	2,000	400	20%	1,2,3
06.3.3.B	ISLAND 4b							
06.3.3.B	SAND	CY	20770	4.00	83,000	25,000	30%	1,2,3
06.3.3.B	FINES	CY	2,635	12.00	32,000	11,000	34%	1,2,3
06.3.3.B	SEEDING	AC	1	2,000.00	2,000	400	20%	1,2,3
06.3.3.B	PLANTINGS (FOR ALL ISLANDS)	EA	7,000	1.00	7,000	1,000	14%	1,2,3
30.-.-.-	ENGINEERING AND DESIGN	JOB	1	*****	155,000	23,000	15%	4

********FEASIBILITY COST ESTIMATE********

POLANDER LAKE EMP PROJECT

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	CONTINGENCIES PERCENT	REASON
31.-.-.-	SUPERVISION AND INSPECTION	JOB	1	*****	90,000	13,000	14%	4
	SUBTOTAL CONSTRUCTION COSTS				1,542,000			
	SUBTOTAL CONTINGENCIES		26.5%			409,150		
	TOTAL					1,951,150		

REASONS FOR CONTINGENCIES

1. QUANTITY UNKNOWNS
2. UNIT PRICE UNKNOWNS
3. UNKNOWN SITE CONDITIONS
4. MANHOUR UNKNOWNS

NOTES

1. EXTENSIONS ARE ROUNDED TO THE NEAREST $1,000
2. PRICE LEVEL EQUALS MAY 1991.

ATTACHMENT 6

LABORATORY DATA FOR SEDIMENT ANALYSIS

PACE INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

May 24, 1990

Mr. Dick Beatty
U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

RE: PACE Project No. 900413.500

Dear Mr. Beatty:

Enclosed is the report of laboratory analyses for samples received April 12, 1990.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Helen L.S. Addie
Project Manager

Enclosures

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

Offices: Minneapolis, Minnesota; Tampa, Florida; Iowa City, Iowa; San Francisco, California; Kansas City, Missouri; Los Angeles, California; Charlotte, North Carolina; Asheville, North Carolina

pace INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

U.S. Army Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

May 24, 1990
PACE Project
Number: 900413500

Attn: Mr. Dick Beatty

PACE Sample Number:			136690	136700	136710
Date Collected:			04/10/90	04/10/90	04/10/90
Date Received:			04/12/90	04/12/90	04/12/90
Parameter	Units	MDL	COE #2	COE #8	COE #10
SUBCONTRACT ANALYSIS					
INDIVIDUAL PARAMETERS					
Total Organic Carbon	mg/kg dry	100	460	810	3100
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Arsenic	mg/kg	0.5	0.9	0.8	1.5
Cadmium	mg/kg	0.10	0.22	0.17	0.21
Chromium	mg/kg	1.0	6.8	4.6	8.4
Copper	mg/kg	0.10	3.5	2.4	4.7
Cyanide, Total	mg/kg	0.50	ND	ND	ND
Lead	mg/kg	1.0	2.4	2.1	3.4
Manganese	mg/kg	0.10	200	240	80
Mercury	mg/kg	0.01	ND	ND	ND
Nickel	mg/kg	0.50	7.4	5.4	10
Nitrogen, Ammonia	mg/kg	20	36	26	33
Selenium	mg/kg	1.3	ND	ND	ND
Solids, Percent Volatile	%	0.01	0.38	0.33	1.1
Water Content	%	0.01	13.6	15.2	21.5
Zinc	mg/kg	1.0	17	12	17
ORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Moisture content	%	1.0	13.3	15.4	27.5
ORGANOCHLORINE PESTICIDES AND PCBS-8080					
Date Analyzed			J 05/08/90	J 05/08/90	J 05/08/90
Date Extracted			04/17/90	04/17/90	04/17/90

MDL Method Detection Limit
ND Not detected at or above the MDL.

REPORT OF LABORATORY ANALYSIS

pace INCORPORATED
THE ASSURANCE OF QUALITY

Mr. Dick Beatty
Page 2

May 24, 1990
PACE Project
Number: 900413500

PACE Sample Number:			136690	136700	136710
Date Collected:			04/10/90	04/10/90	04/10/90
Date Received:			04/12/90	04/12/90	04/12/90
Parameter	Units	MDL	COF #2	COF #8	COF #10
ORGANIC ANALYSIS					
ORGANOCHLORINE PESTICIDES AND PCBS-8080					
a-BHC	ug/kg	1.0	ND	ND	ND
b-BHC	ug/kg	1.0	ND	ND	ND
g-BHC (Lindane)	ug/kg	1.0	ND	ND	ND
d-BHC	ug/kg	1.0	ND	ND	ND
Chlordane (tech)	ug/kg	1.0	ND	ND	ND
4,4'-DDD	ug/kg	1.0	ND	ND	ND
4,4'-DDE	ug/kg	1.0	ND	ND	ND
4,4'-DDT	ug/kg	1.0	ND	ND	ND
Dieldrin	ug/kg	1.0	ND	ND	ND
Endrin	ug/kg	1.0	ND	ND	ND
Heptachlor	ug/kg	1.0	ND	ND	ND
PCB-1016	ug/kg	5.0	ND	ND	ND
PCB-1221	ug/kg	5.0	ND	ND	ND
PCB-1232	ug/kg	5.0	ND	ND	ND
PCB-1242	ug/kg	5.0	ND	ND	ND
PCB-1248	ug/kg	5.0	ND	ND	ND
PCB-1254	ug/kg	5.0	ND	ND	ND
PCB-1260	ug/kg	5.0	ND	ND	ND

MDL Method Detection Limit
ND Not detected at or above the MDL.

pace INCORPORATED THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

Mr. Dick Beatty
Page 3

May 24, 1990
PACE Project Number: 900413500

PACE Sample Number:			136890	136900	136910
Date Collected:			04/10/90	04/10/90	04/10/90
Date Received:			04/12/90	04/12/90	04/12/90
Parameter	Units	MDL	COF #13	COF #14	COF #15
SUBCONTRACT ANALYSIS					
INDIVIDUAL PARAMETERS					
Total Organic Carbon	mg/kg dry	100	8800	7300	7100
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Arsenic	mg/kg	0.5	8.2	5.4	2.4
Cadmium	mg/kg	0.10	0.45	0.33	0.42
Chromium	mg/kg	1.0	20	15	9.4
Copper	mg/kg	0.10	8.8	7.6	4.8
Cyanide, Total	mg/kg	0.50	ND	ND	-
Lead	mg/kg	1.0	9.0	7.4	6.5
Manganese	mg/kg	0.10	1600	940	220
Mercury	mg/kg	0.01	0.02	0.01	0.03
Moisture content	%	0.01	-	-	34
Nickel	mg/kg	0.50	14	11	8.0
Nitrogen, Ammonia	mg/kg	20	82	91	130
Selenium	mg/kg	1.3	ND	ND	ND
Solids, Percent Volatile	%	0.01	3.4	3.3	2.7
Water Content	%	0.01	34.0	29.9	30.6
Zinc	mg/kg	1.0	43	34	23
ORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Moisture content	%	1.0	33.5	29.1	-
ORGANOCHLORINE PESTICIDES AND PCBS-8080					
Date Analyzed			A 05/09/90	J 05/16/90	-
Date Extracted			04/17/90	04/17/90	-
a-BHC	ug/kg	1.0	ND	ND	-
b-BHC	ug/kg	1.0	ND	ND	-

MDL Method Detection Limit
ND Not detected at or above the MDL.

REPORT OF LABORATORY ANALYSIS

PACE INCORPORATED
THE ASSURANCE OF QUALITY

Mr. Dick Beatty
Page 4

May 24, 1990
PACE Project
Number: 900413500

PACE Sample Number:			136890	136900	136910
Date Collected:			04/10/90	04/10/90	04/10/90
Date Received:			04/12/90	04/12/90	04/12/90
Parameter	Units	MDL	COE #13	COE #14	COE #15
ORGANIC ANALYSIS					
ORGANOCHLORINE PESTICIDES AND PCBS-8080					
g-BHC (Lindane)	ug/kg	1.0	ND	ND	-
d-BHC	ug/kg	1.0	ND	ND	-
Chlordane (tech)	ug/kg	1.0	ND	ND	-
4,4'-DDD	ug/kg	1.0	ND	ND	-
4,4'-DDE	ug/kg	1.0	ND	ND	-
4,4'-DDT	ug/kg	1.0	ND	ND	-
Dieldrin	ug/kg	1.0	ND	ND	-
Endrin	ug/kg	1.0	ND	ND	-
Heptachlor	ug/kg	1.0	ND	ND	-
PCB-1016	ug/kg	5.0	ND	ND	-
PCB-1221	ug/kg	5.0	ND	ND	-
PCB-1232	ug/kg	5.0	ND	ND	-
PCB-1242	ug/kg	5.0	ND	ND	-
PCB-1248	ug/kg	5.0	ND	ND	-
PCB-1254	ug/kg	5.0	ND	ND	-
PCB-1260	ug/kg	5.0	ND	ND	-

MDL Method Detection Limit
ND Not detected at or above the MDL.

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

Offices: Minneapolis, Minnesota
Tampa, Florida
Iowa City, Iowa
San Francisco, California
Kansas City, Missouri
Los Angeles, California
Charlotte, North Carolina
Asheville, North Carolina

REPORT OF LABORATORY ANALYSIS

Mr. Dick Beatty
Page 5

May 24, 1990
PACE Project
Number: 900413500

The analyses of soil samples were performed 'as received' and do not reflect analyses on a dry weight basis unless indicated.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

Liesa A. Shanahan
Organic Chemistry Manager

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

Offices: Minneapolis, Minnesota
Tampa, Florida
Iowa City, Iowa
San Francisco, California
Kansas City, Missouri
Los Angeles, California
Charlotte, North Carolina
Asheville, North Carolina

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pace laboratories, inc.

24570

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Corps of Engineers
Address: 1421 US PO + CH
St. Paul, Mn 55101
Phone: 220-0273

Report To:
Bill To:
P.O. # / Billing Reference
Project Name / No.

Pace Client No.
Pace Project Manager
Pace Project No.
*Requested Due Date:

Sampled By (PRINT): Corps of Engineers
Sampler Signature: Richard J. Beatty
Date Sampled: April 10+11, 1990

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA			TOC	TVS, H_2O, NH_3	CN	8080	Metals	REMARKS
1	COE #2			13669	4							✓	✓	✓	✓	✓	
2	COE #8			70	4							✓	✓	✓	✓	✓	
3	COE #10			71	3							✓	✓	✓	✓	✓	
4	COE #13			~~72~~ 89	4							✓	✓	✓	✓	✓	
5	COE #14			90	4							✓	✓	✓	✓	✓	
6	COE #15			91	2							✓	✓	✓		✓	
7																	
8																	

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
		[signature]	4/12/90	8:40
		[signature] PACE	4/13/90	

Additional Comments

ORIGINAL

SEE REVERSE SIDE FOR INSTRUCTIONS

ATTACHMENT 7

HABITAT EVALUATION PROCEDURES

HEP EVALUATION
POLANDER LAKE REHABILITATION AND ENHANCEMENT PROJECT

PURPOSE

The purpose of this HEP evaluation is to determine and quantify what habitat benefits could be achieved at Polander Lake for each of the alternatives being considered for implementation.

MODEL SELECTION

The Polander Lake area is an important staging area for waterfowl during their spring and fall migrations. However, the area is deficient in the amounts of aquatic vegetation present and is anticipated to lose additional vegetation due to erosion caused by increased flows from Pap Slough along with wind and wave action.

A draft Diving Duck (WHAG methodology) model developed by R.D. Devendorf, U.S. Army Corps of Engineers, was selected as most representative of the species the proposed project is intended to benefit. The model was modified, taking into consideration the professional opinions of specialists of the Government agencies cooperating on the project. A copy of the model used is attached.

The Polander Lake area also supports an excellent fishery. To insure that the proposed project would maintain, or enhance, the areas suitability for the fish species present, several fish models developed by the U.S. Fish and Wildlife Service were considered. The bluegill model was selected for use because it has been modified to include an evaluation of winter habitat quality.

MODEL APPLICATION

DIVING DUCK

Following is a discussion of the values applied for the Suitability Index variables in the model.

Existing Conditions

V1 Size of waterbody

The size of the waterbody is important since large waterbodies provide better protection from predators and minimize human disturbance. Polander Lake encompasses approximately 962 acres, which is considered to be within the optimal range for waterbody size. Therefore, a value of **10.0** has been assigned for this variable.

V2 Water depth

Water depth is important in determining the types and amounts of aquatic vegetation present.. Since different species of waterfowl prefer to feed at different depths, a range of depths over which all of the target species can feed is ideal. Since, under current conditions, submerged aquatic vegetation grows only to depths of approximately 3 feet, the Diving Duck model was modified to use the percent of the area between the depths of 1 and 3 feet for this variable. Approximately 39.3% of Polander Lake is currently within this range of depths. Therefore a value of **4.0** has been assigned to this variable.

V3 Percent submerged vegetation

A combination of 50 percent water and 50 percent vegetation, with 20 to 30 percent of the vegetation consisting of emergent species was considered to ideal by the participants involved with this project. The model used was revised to reflect these figures, with 35 percent coverage of submerged aquatic vegetation considered optimal. Submerged aquatic plant coverage in Polander Lake is currently at about 16.4 percent. Therefore, a value of **2.8** has been assigned to this variable.

V4 Species of submerged aquatic vegetation present

Key species of submerged aquatic vegetation which are important as food for diving ducks include: wild celery (Vallisneria americana), sago pondweed (Potamogeton pectinatus), coontail (Ceratophyllum demersum), and other pondweeds. The value for this variable is determined by the percentage of the submerged aquatic vegetation which is comprised of the key species. From recent aquatic plant surveys it is estimated that between 30 and 60 percent of the area covered by submerged aquatic vegetation contains a minimum of at least 2 of these key species. Therefore, a value of **7.0** has been assigned to this variable.

V5 Emergent vegetative cover

Although emergent vegetation is not critically important to diving duck migratory habitat, it does serve to provide cover and a source of food. The Diving Duck model used was modified to consider 15 percent coverage ideal. From recent aquatic plant surveys it is estimated that emergent aquatic plant coverage at Polander Lake is about 11.5 percent. Therefore, a value of **4.9** has been assigned to this variable.

V6 Species of emergent vegetation present

Key emergent plant species include: arrowhead (Sagittaria rigida), soft-stemmed bulrush (Scirpus validus), and wild rice (Zizania aquatica). The value for this variable is determined by the percent of emergent vegetation present which is comprised of the key species. It is estimated that in the Polander Lake study area about 50 percent of the emergent aquatic bed contains at least 1 of the key species. Therefore, a value of **6.0** has been assigned to this variable.

V7 Plant interspersion

In addition to the quantities and species of aquatic plants present, the location of the plant communities is also considered important. Subsequently, this variable was added to the model. Under ideal conditions, smaller plant communities should be interspersed throughout the waterbody. Plant interspersion was determined for this model by dividing the project area into a number of sections through the use of a randomly placed grid and computing the percent of the sections containing submerged and the percent containing emergent aquatic vegetation. The lower of the two figures was used in final determination of a suitability index value. 41.8 percent of the sections contained emergent vegetation and a value of **6.5** was assigned to this variable.

V8 Disturbance

The majority of the Polander Lake study area is closed to waterfowl hunting, although recreational boating and fishing are allowed. Therefore, a value of **7.0** has been assigned to this variable.

Future Without Project

The Polander Lake project area is expected to gradually degrade over the next 50 years. The opening between Pap Slough and the lake is expected to continue to increase in size, with resultant increased flows through the lake. Erosion caused by increased flows and wind and wave action is expected to decrease the area of the lake within the 1 to 3 foot range to 38.6 percent. The 2 remaining small islands in the lower portion of the lake are expected to disappear due to erosion. Subsequently, percent coverage by submerged and emergent aquatic plants are expected to drop to 14.4 and 10.4 percent respectively. In addition, plant interspersion is expected to decrease, with only 36.4 percent of the sections containing emergent vegetation with the grid used. Therefore, variables V2, V3, V5, and V7 were adjusted as follows for this alternative:

V2	-	3.9	V5	-	4.2
V3	-	2.6	V7	-	5.8

Following is a discussion of the various features proposed for implementation with the Polander Lake HREP Project. The changes in variables are based upon gains (or losses) above conditions with no Federal project at the end of the 50 year project life.

Island 1

It is anticipated that construction of a closure structure (Island 1) to prevent flows from Pap Slough from entering Polander Lake would provide a variety of benefits. Flows in the northeast section of the lake would be eliminated and flows throughout the remainder of the lake would be substantially reduced. In fact, it is anticipated that a 50 percent reduction in current velocities in a minimum of half of Polander Lake can be accomplished with this alternative. Water depths would remain relatively unchanged with this alternative. The reduction in the amount of turbid Mississippi River water entering the lake should also allow for greater light penetration allowing plant growth in deeper areas and in greater densities in the existing plant beds. It is anticipated that with the reduced flows the coverage of submerged aquatic plants can be increased to about 21.8 percent and emergent species to about 11.4 percent. Plant interspersion would also improve with emergent plants occupying 45.5 percent of the sections of the grid model used. Therefore, variables V3, V5, and V7 were adjusted as follows for this alternative:

V3 - 3.5
V5 - 4.8
V7 - 7.3

Islands 1 & 2

Construction of Island 2 in conjunction with Island 1 would improve the Polander Lake area by allowing for the establishment of additional aquatic plants in areas which without the island would have wind and wave energies too high for plant establishment. It is anticipated that with this alternative submerged aquatic plant coverage would increase to about 24.9 percent and emergent coverage to 12.5 percent. Plant interspersion would also improve with emergent plants occupying 47.3 percent of the sections of the grid model used. Accordingly, the following variables were adjusted for this alternative:

V3 - 3.9
V5 - 5.5
V7 - 7.6

Island 6

Although Island 6 would reduce wind and wave action in a portion of the lake it would protect only about 1 acre of submerged aquatic plants. This equates to only 0.1 percent of the submerged aquatic plant community of the lake. No variables would be affected by this alternative.

Islands 7 & 8

This alternative consists of armoring the 2 existing islands (Islands 7 & 8) with riprap thereby stopping the erosion processes which threaten to eliminate these islands in the upcoming years. With this project, submerged aquatic plant coverage would be increased to 15.8 percent and emergent coverage to 10.6 percent. In addition, plant interspersion would be maintained, with emergent plants occupying 40.0 percent of the sections of the grid model used. The following variables were adjusted for this alternative:

V3 - 2.8
V5 - 4.4
V7 - 6.4

Island Complex A

Island complex A would provide a variety of benefits to the Polander Lake study area. It would provide habitat suitable for the establishment of both submerged and emergent aquatic plants increasing their coverage to 20.6 and 11.4 percent respectively. Plant diversity would increase with emergent plants occupying 47.3 percent of the sections of the grid model used. The island would also be instrumental in reducing wind and wave action in a substantial portion of the lake. Wind and wave action can resuspend bottom sediments, increase turbidity, and retard plant growth. It is anticipated that with this alternative plant densities in existing plant beds can be improved. The following variables were adjusted for this alternative:

V3 - 3.4
V5 - 4.8
V7 - 7.6

Island Complex B

Island complex B is almost identical to island complex A only on a smaller scale. With this alternative submerged and emergent plant coverage is expected to increase to 18.5 and 11.1 percent respectively. In addition plant diversity is expected to increase with emergent plants occupying 40.0 percent of the sections of the grid model used. The following variables were adjusted for this alternative:

V3 - 3.1
V5 - 4.7
V7 - 6.4

Island Complex C

Island complex C would also provide a variety of benefits to the Polander Lake study area. It would provide habitat suitable for the establishment of both submerged and emergent aquatic plants increasing their coverage to 16.6 and 10.9 percent respectively.

Plant diversity would increase with emergent plants occupying 45.5 percent of the sections of the grid model used. The island would also be instrumental in reducing wind and wave action in a substantial portion of the lake. Wind and wave action can resuspend bottom sediments, increase turbidity, and retard plant growth. It is anticipated that with this alternative plant densities in existing plant beds can be improved. The following variables were adjusted for this alternative:

V3 - 2.9
V5 - 4.6
V7 - 7.3

Islands 1, 2, & Complex A

None of the above alternatives alone would improve the Polander Lake project area enough to provide habitat considered sufficient for a closed area of the refuge. However, an alternative such as this one involving a combination of measures would substantially improve the area. In most instances the benefits realized with this combination of measures are equal to the sum of the benefits listed above for each measure separately. However, the combination of reduced flows through the closure of the Pap Slough opening and reduced wind and wave action should allow greater light penetration and plant growth greater than the sum of that achieved through each separate measure. With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with suitable water depths for plant growth to about 41.4 percent. Aquatic plant coverage would increase to 32.7 percent for submerged species and 12.6 for emergent species. Plant interspersion would improve with emergent plants occupying 58.2 percent of the sections of the grid model used. The variables affected are as follows:

V2 - 5.2
V3 - 8.8
V5 - 6.1
V7 - 8.9

Islands 1, 2, & Complex B

This combination of alternatives would provide basically the same benefits as the preceding alternative, except on a somewhat smaller scale. With this alternative it is anticipated that 40.3 percent of the area would provide acceptable depths for plant growth, submerged and emergent aquatic plants would occupy 30.7 and 12.3 percent of the lake respectively, and emergent plants would occupy 49.1 percent of the sections of the grid model used. The variables affected are as follows:

V2 - 5.0
V3 - 7.9
V5 - 5.9
V7 - 8.2

Islands 1, 2, & Complex C

This combination of alternatives would also provide basically the same benefits as the two preceding alternatives. With this alternative it is anticipated that 41.4 percent of the area would provide acceptable depths for plant growth, submerged and emergent aquatic plants would occupy 28.8 and 12.1 percent of the lake respectively, and emergent plants would occupy 56.4 percent of the sections of the grid model used. The variables affected are as follows:

V2 - 5.2
V3 - 7.3
V5 - 5.8
V7 - 8.8

Islands 1, 2, 7, 8, & Complex A

This alternative would provide basically the same benefits as a combination of construction of Islands 1, 2, and Complex A, but with the added benefits realized through the elimination of the erosion occurring to Islands 7 & 8. With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with suitable water depths for plant growth to about 41.4 percent. Aquatic plant coverage would increase to 34.8 percent for submerged species and 13.7 for emergent species. Plant interspersion would improve with emergent plants occupying 61.8 percent of the sections of the grid model used. The variables affected are as follows:

V2 - 5.2
V3 - 8.9
V5 - 6.2
V7 - 8.9

Islands 1, 2, 7, 8, & Complex B

This combination of alternatives would provide basically the same benefits as the preceding alternative, except on a somewhat smaller scale. With this alternative it is anticipated that 40.3 percent of the area would provide acceptable depths for plant growth, submerged and emergent aquatic plants would occupy 32.7 and 13.4 percent of the lake respectively, and emergent plants would occupy 52.7 percent of the sections of the grid model used. The variables affected are as follows:

V2	-	5.0
V3	-	8.0
V5	-	6.0
V7	-	8.2

Islands 1, 2, 7, 8, & Complex C

This combination of alternatives would also provide basically the same benefits as the two preceding alternatives. With this alternative it is anticipated that 41.4 percent of the area would provide acceptable depths for plant growth, submerged and emergent aquatic plants would occupy 30.9 and 13.2 percent of the lake respectively, and emergent plants would occupy 60.0 percent of the sections of the grid model used. The variables affected are as follows:

V2	-	5.2
V3	-	7.4
V5	-	5.9
V7	-	8.8

BLUEGILL (Summer)

Existing Conditions

(Summer)

V1 Percent Pool Area

In riverine habitats, bluegills are mostly restricted to areas of low velocity. Adults prefer current velocities ≤10 cm/sec but will tolerate up to 45 cm/sec.

The average low flow velocities of a cross section across Polander Lake indicate that the average current velocity is approximately 18.5 cm/sec. Polander Lake has few areas with low flow current velocities of less than 10 cm/sec. These areas are mainly situated close to shorelines and protected areas behind islands. Therefore a value of **0.25** has been assigned to this variable.

V2 Percent cover (e.g. logs, brush, and debris) within pools or littoral areas during summer

Bluegills exhibit cover-seeking behavior. A suitability rating of 1.00 is suggested if the percent cover is between 20 and 60 percent of the littoral areas.

A suitability index rating of **0.50** is being assigned to Polander Lake based on the assumption from observations made during field visits that less than 20 percent of the littoral areas contain logs, brush, or other debris.

V3 Percent cover (aquatic vegetation, submersed, dense strands, finely divided leaves)

Aquatic vegetative cover is utilized by young and adult bluegills. However, too much cover can inhibit the predator-prey relationships between bluegills and other fish species and result in stunted fish populations.

Based on recent vegetative survey data, approximately 16 percent of Polander lake supports submerged aquatic vegetation. Of this, about half fits the description presented for this variable. Therefore, a value of **0.50** has been assigned for variable V3.

V4 Percent littoral area during summer stratification

For an area to receive a suitability index rating of 1.0, between 20 and 60 percent should be littoral area. Using the area of lake which supports aquatic vegetation as the littoral zone, about 27 percent of the lake qualifies. Therefore, a suitability rating of **1.00** has been assigned to this variable.

V5 Average TDS level during the growing season

TDS levels during the growing season are not available at this time. However, it is assumed that TDS is a contributing factor in suppressing plant growth in areas of the lake greater than 3 feet in depth. Therefore, a suitability rating of **0.85** has been assigned for this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

Turbidity due to inflows of Mississippi River water and resuspension of bottom sediments due to wind and wave action are believed to be the major factor contributing to reduced plant growth in Polander Lake. A habitat suitability rating of **0.70** has been assigned for this variable.

V7 pH range during the growing season

Available data indicate that pH in the Polander Lake area is generally in the range of 7.4 to 7.8. Therefore, a suitability rating of **1.00** has been assigned for this variable.

V8 Minimum dissolved oxygen level during the summer

Dissolved oxygen is not known to be a limiting factor for habitat suitability in the study area. Therefore a suitability index rating of **1.00** has been assigned to this variable.

V9 Maximum monthly average salinity during the growing season

A suitability index rating of **1.00** has been assigned to this variable.

V10 Maximum midsummer temperature within pools or littoral areas (adult)

Detailed temperature data on Polander Lake is not available at this time. Suitability ratings for V10 through V13 have been assigned assuming temperatures in the area are suitable for the species present.

A suitability rating of **1.00** has been assigned for variable V10

V11 Average of mean weekly water temperature within pools or littoral areas (embryo)

A suitability index rating of **1.00** has been assigned for this variable.

V12 Maximum early summer temperature within pools or littoral areas (fry)

A suitability index rating of **1.00** has been assigned to this variable

V13 Maximum midsummer temperature within pools or littoral areas (juvenile)

A suitability index rating of **1.00** has been assigned to this variable

V14 Average current velocity in pools and backwater areas during the growing season (adult)

The limited data available indicate that the average current velocity in Polander Lake is about 18.5 cm/sec. Therefore a suitability index rating of **0.75** for this variable.

V15 Average current velocity in spawning areas (embryo)

A suitability index ratinc of **0.70** has been assigned to this variable.

V16 Average current velocities in pools and backwater areas during early summer (fry)

Ideal habitat for bluegill fry encompasses areas with average current velocities of less than 4.5 cm/sec. With the current velocities present in Polander Lake and the lack of flow free areas, a suitability index rating of **0.10** has been assigned to this variable.

V17 average current velocity in pools and backwater areas during the growing season (juvenile)

Ideal habitat for juvenile bluegill encompasses areas with average current velocities of less than 4.5 cm/sec. Using the limited data on current velocities available, it is assumed that very few appropriate areas exist within the lake. Therefore, a suitability index rating of **0.10** has been assigned to this variable.

V18 Stream gradient within the representative reach

A suitability rating of **1.00** has been assigned for this variable.

V19 Reservoir drawdown during spawning

Water level fluctuations during the spawning season are minimal. Therefore a suitability index rating of **1.00** has been assigned to this variable.

V20 Substrate composition within pools or littoral areas during spawning (embryo)

Information available at this time indicate that fines and gravel are present in spawning areas. Therefore, a suitability index rating of **1.00** has been assigned to this variable.

(Winter)

Va Backwater water depths

Only approximately 35 percent of the Polander Lake study area is 4 feet or greater in depth. Therefore a suitability index rating of **0.82** has been assigned to this variable.

Vb Winter dissolved oxygen

The information available on Polander Lake indicates that dissolved oxygen is not a problem during the winter months. Therefore, a suitability index rating of **1.00** has been assigned to this variable.

Vc Winter water temperature

There is a constant flow of Mississippi River water through Polander Lake. Although no data is available at this time it is assumed that winter water temperatures drop below 4° C. Therefore a suitability index rating of **0.85** has been assigned to this variable.

Vd Current velocity

The average low flow current velocity in Polander Lake is approximately 18.5 cm/sec. Therefore, a suitability index rating of **0.10** has been assigned to this variable.

FUTURE WITHOUT PROJECT

(Summer)

Without a project the percent of vegetation in Polander Lake is expected to decrease to approximately 14 percent. Of this only about half would fit the description for variable V3. Therefore, a value of **0.40** has been assigned to this variable.

(Winter)

It is anticipated that with no project the opening between Pap Slough and Polander Lake will gradually increase in size with some resultant increases in current velocities in the lake. Therefore a suitability index rating of **0.09** has been assigned to variable Vd.

Island 1

(Summer)

The construction of a closure structure (Island 1) to prevent the inflow of Mississippi River from Pap Slough into Polander Lake would result in a change in the values assigned to a number of variables.

V1 Percent pool area during average summer flow

With this alternative a flow free area of about 50 acres would be created in the northeast section of the lake. In addition, flows throughout at least half of Polander Lake would be reduced by about 50 percent. Therefore, a value of **0.40** has been assigned for this variable.

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With implementation of this alternative submerged aquatic vegetation would increase covering approximately 21.8 percent of the lake. Therefore a suitability index rating of **0.70** has been assigned for this variable.

V5 Average TDS level during the growing season

Preventing flows from Pap Slough from entering Polander Lake would substantially reduce the TDS levels in the lake. Therefore, a value of **0.90** has been assigned to this alternative.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

With the reduction in Mississippi River water inflows, turbidity in Polander Lake is expected to decrease. A habitat suitability index of **0.85** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

The limited data available indicate an average current velocity of 18.5 cm/sec across Polander Lake. With this alternative a flow free area of approximately 50 acres (0.5 percent of the lake) would be created in the northeast portion of the lake. In addition, flows in at least half of the lake are expected to be reduced by a minimum of 50 percent. The habitat suitability ratings for variables V14 through V17 are based on these assumptions.

A habitat suitability rating of **0.85** has been assigned to variable V14.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.85** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.35** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **0.35** has been assigned to this variable.

(Winter)

Vc Water temperature

With this alternative a slight increase in winter water temperatures is anticipated. Therefore, a habitat suitability rating of **0.90** has been assigned to this variable.

Vd Current velocity

This alternative would create an approximate 50 acre flow free area in the northeast portion of the lake, and is expected to reduce flow velocities in at least 50 percent of the lake by one-half. Therefore, a habitat suitability rating of **0.25** has been assigned to this variable.

Islands 1 & 2

Construction of Island 2 in conjunction with Island 1 would improve the Polander Lake area by allowing for the establishment of additional aquatic plants in areas which without the island would have wind and wave energies too high for plant establishment. It is anticipated that with this alternative submerged aquatic plant coverage would increase to about 24.9 percent. Therefore a rating of **0.80** has been assigned to variable V3.

Island 6

No variables would change with implementation of this alternative.

Islands 7 & 8

This alternative consists of armoring the 2 existing islands with riprap thereby stopping the erosion processes which threaten to eliminate these islands in the upcoming years. No variables would change with implementation of this alternative.

Island Complex A

(Summer)

This alternative would result in the adjustment of several variables.

V1 Percent pool area during average summer flow

The shadow effect of the islands would result in protected areas for young and wintering fish. Therefore, with this alternative a habitat suitability rating of **0.30** has been assigned.

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With implementation of this alternative it is estimated that submerged aquatic vegetation would increase to about 20.6 percent. Therefore, a suitability index rating of **0.70** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

The creation of strategically located islands would greatly reduce wind and wave action and reduce the resuspension of bottom sediments. Subsequently, turbidity in Polander Lake is expected to decrease substantially. A habitat suitability index of **0.75** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

The limited data available indicate an average current velocity of 18.5 cm/sec across Polander Lake. With this alternative flow free areas and areas with greatly reduced flows would be provided by the protection of the islands. The habitat suitability ratings for variables V14 through V17 are based on this assumptions.

A habitat suitability rating of **0.85** has been assigned to variable V14.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.85** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of 0.20 has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of 0.20 has been assigned to this variable.

(Winter)

Vd Current velocity

This alternative would create low flow and flow free areas protect by strategically located islands Therefore, a habitat suitability rating of 0.15 has been assigned to this variable.

Island Complex B

(Summer)

This alternative would result in the adjustment of several variables.

V1 Percent pool area during average summer flow

The shadow effect of the islands would result in protected areas for young and wintering fish. Therefore, with this alternative a habitat suitability rating of 0.30 has been assigned.

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With implementation of this alternative it is estimated that submerged aquatic vegetation would increase to about 18.5 percent. Therefore a suitability index rating of 0.60 has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

The creation of strategically located islands would greatly reduce wind and wave action and reduce the resuspension of bottom sediments. Subsequently, turbidity in Polander Lake is expected to decrease substantially. A habitat suitability index of 0.75 has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

The limited data available indicate an average current velocity of 18.5 cm/sec across Polander Lake. With this alternative flow free areas and areas with greatly reduced flows would be provided by the protection of the islands. However, the areas protected by the island complex would be somewhat smaller than with Complex A. The habitat suitability ratings for variables V14 through V17 are based on this assumptions.

A habitat suitability rating of **0.82** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.82** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.18** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **0.18** has been assigned to this variable.

(Winter)

Vd Current velocity

This alternative would create low flow and flow free areas protected by strategically located islands Therefore, a habitat suitability rating of **0.14** has been assigned to this variable.

Island Complex C

(Summer)

This alternative would result in the adjustment of several variables.

V1 Percent pool area during average summer flow

The shadow effect of the island would result in protected areas for young and wintering fish. Therefore, with this alternative a habitat suitability rating of **0.29** has been assigned.

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With implementation of this alternative it is estimated that submerged aquatic vegetation coverage would increase slightly to 16.6 percent. Therefore a suitability index rating of **0.55** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

The creation of strategically located islands would greatly reduce wind and wave action and reduce the resuspension of bottom sediments. Subsequently, turbidity in Polander Lake is expected to decrease substantially. A habitat suitability index of **0.75** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

The limited data available indicate an average current velocity of 18.5 cm/sec across Polander Lake. With this alternative flow free areas and areas with greatly reduced flows would be provided by the protection of the island. However, the area protected by this island complex would be slightly smaller than with Complex A or Complex B. The habitat suitability ratings for variables V14 through V17 are based on these assumptions.

A habitat suitability rating of **0.80** has been assigned to variable V14.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.80** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.15** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **0.15** has been assigned to this variable.

(Winter)

Vd Current velocity

This alternative would create low flow and flow free areas protect by the island. Therefore, a habitat suitability rating of **0.13** has been assigned to this variable.

Islands 1, 2, & Complex A

It is anticipated that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

(Summer)

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **0.44.**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 32.7 percent. Therefore a suitability index rating of **0.90** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index of **0.90** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of **0.90** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.90** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of 0.40 has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of 0.40 has been assigned to this variable.

(Winter)

Vd Current velocity

A habitat suitability rating of 0.37 has been assigned to this variable.

Islands 1, 2, & Complex B

As with the previous combination of features, it is anticipated that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

(Summer)

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **0.44.**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 30.7 percent. Therefore a suitability index rating of **0.90** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index c: **0.85** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of <u>0.88</u> has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of <u>0.88</u> has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of <u>0.38</u> has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of <u>0.38</u> has been assigned to this variable.

<u>(Winter)</u>

Vd Current velocity

A habitat suitability rating of <u>0.35</u> has been assigned to this variable.

<u>Islands 1, 2, & Complex C</u>

As with the previous two combinations of features, it is anticipated that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

<u>(Summer)</u>

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **<u>0.43.</u>**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 28.8 percent. Therefore a suitability index rating of **0.90** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index of **0.85** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of **0.86** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.86** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.35** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **0.35** has been assigned to this variable.

(Winter)

Vd Current velocity

A habitat suitability rating of **0.36** has been assigned to this variable.

Islands 1, 2, 7, 8, & Complex A

It is anticipated that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

(Summer)

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **0.45.**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 34.8 percent. Therefore a suitability index rating of **1.00** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index of **0.90** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of **0.95** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.95** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.40** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of <u>0.40</u> has been assigned to this variable.

<u>(Winter)</u>

Vd Current velocity

A habitat suitability rating of <u>0.37</u> has been assigned to this variable.

<u>Islands 1, 2, 7, 8, & Complex B</u>

It is anticipate that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

<u>(Summer)</u>

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **<u>0.45.</u>**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 32.7 percent. Therefore a suitability index rating of **<u>1.00</u>** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index of **<u>0.90</u>** has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of **<u>0.92</u>** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of __0.92__ has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **__0.38__** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **__0.38__** has been assigned to this variable.

__(Winter)__

Vd Current velocity

A habitat suitability rating of **__0.35__** has been assigned to this variable.

__Islands 1, 2, 7, 8, & Complex C__

It is anticipate that the combination of measures being considered in this alternative would not only provide the benefits which would be realized with each measure separately, but would also provide some additional benefits.

__(Summer)__

V1 Percent pool area during average summer flow

With this alternative, variable V1 has been assigned a value of **__0.44.__**

V3 Percent cover (aquatic vegetation, submersed, dense stands, finely divided leaves).

With this alternative submerged aquatic plants could be expected to become established in areas of the lake up to which are protected by the island complex, up to 3.5 feet in depth, and which are out of the remaining flow paths. This would increase the percentage of the lake with submerged aquatic plant coverage to about 30.9 percent. Therefore a suitability index rating of **__1.00__** has been assigned to this variable.

V6 Maximum monthly average turbidity during average summer flow or summer stratification

A habitat suitability index of 0.90 has therefore been assigned to this alternative.

V14 Average current velocity in pools and backwater areas during the growing season (adult)

A habitat suitability rating of **0.90** has been assigned to this variable.

V15 Average current velocity in spawning areas (embryo)

A habitat suitability rating of **0.90** has been assigned to this variable.

V16 Average current velocity in pools and backwater areas during early summer (fry)

A habitat suitability rating of **0.35** has been assigned to this variable.

V17 Average current velocity in pools and backwater areas during the growing season (juvenile)

A habitat suitability rating of **0.35** has been assigned to this variable.

(Winter)

Vd Current velocity

A habitat suitability rating of **0.36** has been assigned to this variable.

POLANDER LAKE EMP

Habitat Suitability (Bluegill) POLANDER LAKE EMP
SUMMER HSI DETERMINATIONS

Variable	Description	Existing	Future w/o (@ 50 Years)	Island 1	Islands 1 & 2	Island 8	Islands 7 & 8	Complex A	Complex B	Complex C	1 - 2 - A	1 - 2 - B	1 - 2 - C	1-2-7-8-A	1-2-7-8-B	1-2-7-8-C
V1	% Pool Area	0.25	0.25	0.40	0.40	0.25	0.25	0.30	0.30	0.29	0.44	0.44	0.43	0.45	0.45	0.44
V2	% Cover (Logs & Brush)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.60	0.50
V3	% Cover (Vegetation)	0.50	0.40	0.70	0.80	0.50	0.50	0.70	0.60	0.55	0.95	0.95	0.95	1.00	1.00	1.00
V4	% Littoral Area	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V5	Ave. TDS	0.85	0.85	0.90	0.90	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.85
V6	Ave. Turbidity	0.70	0.70	0.85	0.85	0.70	0.70	0.75	0.75	0.75	0.85	0.85	0.85	0.90	0.90	0.90
V7	pH Range	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V8	Min. D.O. Summer	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V9	Salinity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V10	Max. Midsummer Temp. (Adult)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V11	Ave. Water Temp. (Spawning)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V12	Max. Early Summer Temp. (Fry)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V13	Max. Midsummer Temp. (Juvenile)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V14	Ave. Current	0.75	0.75	0.85	0.85	0.75	0.75	0.85	0.82	0.80	0.90	0.88	0.88	0.95	0.92	0.90
V15	Ave. Current (Spawning)	0.70	0.70	0.85	0.85	0.70	0.70	0.85	0.82	0.80	0.90	0.88	0.88	0.95	0.92	0.90
V16	Ave. Current (Fry)	0.10	0.10	0.35	0.35	0.10	0.10	0.20	0.18	0.15	0.40	0.38	0.35	0.40	0.38	0.35
V17	Ave. Current (Juvenile)	0.10	0.10	0.35	0.35	0.10	0.10	0.20	0.18	0.15	0.40	0.38	0.35	0.40	0.38	0.35
V18	Stream Gradient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V19	Reservoir Drawdown	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
V20	Substrate Composition	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Food (Cf)	0.40	0.37	0.52	0.54	0.40	0.40	0.47	0.45	0.43	0.59	0.59	0.59	0.61	0.61	0.60
	Cover (Cc)	0.50	0.45	0.60	0.65	0.50	0.50	0.60	0.55	0.53	0.73	0.73	0.73	0.75	0.75	0.75
	Water Quality (Cwq)	0.96	0.96	0.98	0.98	0.96	0.96	0.96	0.96	0.96	0.98	0.98	0.98	0.99	0.99	0.99
	Reproduction (Cr)	0.89	0.89	0.95	0.95	0.89	0.89	0.95	0.94	0.93	0.97	0.96	0.96	0.98	0.97	0.97
	Other (Cot)	0.66	0.66	0.76	0.76	0.66	0.66	0.71	0.70	0.68	0.78	0.77	0.76	0.79	0.78	0.77
	HSI	0.69	0.67	0.77	0.79	0.69	0.69	0.75	0.73	0.71	0.82	0.82	0.82	0.84	0.83	0.83
	HSI x 962 Acres = HU's	662.07	642.53	744.19	759.60	662.07	662.07	720.57	700.79	687.56	792.09	789.41	786.69	805.62	802.20	797.93
	HU Gain [HU - ((HU Existing + HU Future w/o)/2)]			91.89	107.50	9.77	9.77	68.27	48.49	35.26	135.31	132.67	128.46	153.33	149.90	145.63

WINTER DETERMINATIONS

Variable	Description	Existing	Future w/o (@ 50 Years)	Island 1	Islands 1 & 2	Island 8	Islands 7 & 8	Complex A	Complex B	Complex C	1 - 2 - A	1 - 2 - B	1 - 2 - C	1-2-7-8-A	1-2-7-8-B	1-2-7-8-C
Va	Water Depth	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Vb	Winter Dissolved Oxygen	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vc	Water Temperature	0.85	0.85	0.90	0.90	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.86
Vd	Current Velocity	0.10	0.09	0.25	0.28	0.10	0.10	0.15	0.14	0.15	0.37	0.35	0.36	0.37	0.36	0.36
	Winter Cover (Cw-q)	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	Winter Water Quality (Cw-wq)	0.95	0.95	0.97	0.97	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	Corrected Cw-wq	0.95	0.95	0.97	0.97	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	Winter Other (Cw-ot)	0.10	0.09	0.25	0.28	0.10	0.10	0.15	0.14	0.15	0.37	0.35	0.36	0.37	0.36	0.36
	Note: If Vb or Vc is < or = 0.4, Cw-wq equals the lowest of these variables.															
	Winter HSI	0.52	0.51	0.66	0.68	0.52	0.52	0.58	0.57	0.58	0.72	0.71	0.72	0.72	0.71	0.72
	Corrected Winter HSI (see no	0.10	0.09	0.25	0.28	0.10	0.10	0.15	0.14	0.15	0.37	0.35	0.36	0.37	0.36	0.36
	Note: If Vb, Vc, or Vd is < or = 0.4, use the lowest variable as the Winter HSI.															
	Composite HSI	0.26	0.25	0.44	0.47	0.26	0.26	0.34	0.32	0.33	0.55	0.53	0.54	0.56	0.54	0.55
	HU's (HSI x 962a)	252.37	235.86	423.08	449.26	253.89	253.89	322.46	307.22	314.98	529.06	513.80	522.12	536.82	520.62	528.41
	HU's gained			178.94	205.14	9.77	9.77	78.34	63.10	70.87	283.44	268.24	276.04	291.70	276.50	284.30

POLANDER LAKE EMP

Habitat Suitability
Diving Ducks

Variable	Description	Existing	Acres	%	Future W/O (@ 50 Years)	Acres	%	Based on Gains above Future w/o at the end of 50 year life: Island 1	Acres	%	Island 1 & 2	Acres	%	Island 6	Acres	%	Island 7 & 8	Acres	%
V1	Size of waterbody	10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0	
V2	Water depth	4.0	378.0	39.3	3.9	371.0	38.6	4.0	378.0	39.3	4.0	378.0	38.6	3.9	371.0	38.6	3.9	371.0	38.6
V3	% Submergent Vegetation	2.8	158.0	16.4	2.6	138.0	14.3	3.5	210.0	21.8	3.9	240.0	24.9	2.6	139.0	14.4	2.8	152.0	15.8
V4	Species of above	7.0			7.0			7.0			7.0			7.0			7.0		
V5	% Emergent vegetation	4.9	111.0	11.5	4.2	100.0	10.4	4.8	110.0	11.4	5.5	120.0	12.5	4.2	100.0	10.4	4.4	102.0	10.6
V6	Species of Above	6.0			6.0			6.0			6.0			6.0			6.0		
V7	Plant interspersion	6.5	23/55	41.8	5.8	20/55	36.4	7.3	25/55	45.5	7.6	26/55	47.3	5.8	20/55	36.4	6.4	22/55	40.0
			26/55	47.3		23/55	41.8		31/55	56.4		32/55	58.2		23/55	41.8		25/55	45.5
V8	Disturbance	5.0			5.0			5.0			5.0			5.0			5.0		
HSI		5.78			5.56			5.95			6.13			5.56			5.69		
HU's - (HSI x 0.1) x 962 acres		555.6			535.1			572.4			589.2			535.1			547.1		
HU's Gained [HU - (HU Existing + HU Future w/o)/2]								27.1			43.9			0.0			1.8		

Variable	Description	Based on Gains above Future w/o at the end of 50 year life: Complex A	Acres	%	Complex B	Acres	%	Complex C	Acres	%	1 - 2 - A Combined	Acres	%	1 - 2 - B Combined	Acres	%	1 - 2 - C Combined	Acres	%
V1	Size of waterbody	10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0		10.0	962.0	
V2	Water depth	3.9	371.0	38.6	3.9	371.0	38.6	3.9	371.0	38.6	5.2	398.0	41.4	5.0	388.0	40.3	5.2	398.0	41.4
V3	% Submergent Vegetation	3.4	198.0	20.6	3.1	178.0	18.5	2.9	160.0	16.6	8.8	315.0	32.7	7.9	295.0	30.7	7.3	277.0	28.8
V4	Species of above	7.0			7.0			7.0			7.0			7.0			7.0		
V5	% Emergent vegetation	4.8	110.0	11.4	4.7	107.0	11.1	4.6	105.0	10.9	6.1	121.0	12.6	5.9	118.0	12.3	5.8	116.0	12.1
V6	Species of Above	6.0			6.0			6.0			6.0			6.0			6.0		
V7	Plant interspersion	7.6	26/55	47.3	6.4	22/55	40.0	7.3	25/55	45.5	8.9	32/55	58.2	8.2	27/55	49.1	8.8	31/55	56.4
			28/55	50.9		27/55	49.1		27/55	49.1		39/55	70.9		36/55	65.5		38/55	69.1
V8	Disturbance	5.0			5.0			5.0			5.0			5.0			5.0		
HSI		5.96			5.76			5.84			7.13			6.88			6.89		
HU's - (HSI x 0.1) x 962 acres		573.6			554.4			561.6			686.0			662.0			663.2		
HU's Gained		28.3			9.0			16.2			140.7			116.6			117.8		

Variable	Description	1 - 2 - 7 - 8 - A Combined	Acres	%	1 - 2 - 7 - 8 - B Combined	Acres	%	1 - 2 - 7 - 8 - C Combined	Acres	%
V1	Size of waterbody	10.0	962.0		10.0	962.0		10.0	962.0	
V2	Water depth	5.2	398.0	41.4	5.0	388.0	40.3	5.2	398.0	41.4
V3	% Submergent Vegetation	8.9	335.0	34.8	8.0	315.0	32.7	7.4	297.0	30.9
V4	Species of above	7.0			7.0			7.0		
V5	% Emergent vegetation	6.2	132.0	13.7	6.0	129.0	13.4	5.9	127.0	13.2
V6	Species of Above	6.0			6.0			6.0		
V7	Plant interspersion	8.9	34/55	61.8	8.2	29/55	52.7	8.8	33/55	60.0
			41/55	74.5		38/55	69.1		40/55	72.7
V8	Disturbance	5.0			5.0			5.0		
HSI		7.15			6.90			6.91		
HU's - (HSI x 0.1) x 962 acres		687.8			663.8			665.0		
HU's Gained		142.5			118.4			119.6		

ATTACHMENT 8

ISLAND DESIGN - HYDRAULIC INPUT

Polander Lake HREP Island Design

This Attachment has been written to give a more detailed account of the criteria and methods used in the design in the recommended plan of the Polander Lake HREP.

FACTORS INVOLVED IN ISLAND LAYOUT

Before describing the specific attributes of each of the recommended islands, it is useful to point out generalized design considerations that make an island physically stable and environmentally useful. The attached summary report describes some of these considerations.

DISCUSSION OF RECOMMENDED ISLANDS

The selected plan of action consists of a number of features which, when added together, would maintain and create additional diversity in the project area. More specifically, the opening between Pap Slough and Polander Lake would be closed (Island 1), an island would be constructed at the downstream end of the existing barrier island system which runs between Pap Slough and Polander Lake (Island 2), two eroding islands in Polander Lake would be protected (Islands 7 & 8), and a series of islands would be constructed at the lower end of Polander Lake (Island Complex B). Each segment of the recommended plan is discussed below. Figure 1 shows a plan view of the proposed design. Cross sections used in the various islands are shown in Figure 2.

The closure of Pap Slough (Island 1) would be accomplished by placing sand fill material along this 800-foot-wide opening. Cross section Type A from Figure 2 would be used for this barrier. The maximum height of fill would be at elevation of 656 feet (msl 1912 datum), which is 5 feet above the normal pool elevation. This elevation is at the 5 year flood stage. Observations of existing islands indicate that islands higher than the 5 year flood or above elevations 4 feet or more above normal pool are much more likely to remain intact after larger flood events. The top width of the barrier island is 20 feet. Sides slopes are as shown on Figure 2. Rock fill would be placed on the Pap Slough side of the barrier to protect it from erosion caused by flow through the slough. Sand fill and rock protection are required on the existing island for 300 feet downstream of the proposed barrier. The Polander Lake side of this island would be constructed with a 40-foot-wide berm. The berm is designed to provide sufficient material so that a natural beach will form. The sand fill will be capped by a 6-inch layer of topsoil (300 cubic yards) and seeded. If dredging is necessary for access, this material will be used for island construction.

The island at the downstream end of Pap Slough which extends into Polander Lake (Island 2) is approximately 1,000 feet in length. Cross section Type A is also used for this island. This island would not be connected to the existing barrier island system, but will begin approximately 100 feet from the present shoreline. A gap was left in order to protect an existing vegetation bed that was found near the tip of the existing island. The orientation of Island 2 is as perpendicular to the valley (predominant wind directions) as was possible to maximize the area protected from wave action. The positioning of Island 2 was adjusted so that the islands footprint would avoid the remaining pre-inundation Polander Lake basin. The Island 2 will be constructed to the same elevation as Island 1. A 40 foot berm will be constructed on the north side of the island to allow for development of a stable beach zone. Riprap would be placed on the downstream side of the island to provide erosion protection against both wind and boat generated waves.

Island Complex B at the lower end of the lake would consist of two major outer islands and three interior islands. The outer islands provide protection from wave action to all interior islands. Island 3 has the same cross section configuration as the Pap Slough barrier island (Type A). Riprap is needed along the entire upstream portion of the island because of the large wind fetch and the associated large wind generated waves. The inner side of this island would be protected by the second major island (Island 4) which is to be constructed about 1,000 feet downstream. This island will substantially reduce the wind fetch and the size of waves reaching this side of island 3. The upstream face of Island 4 is again protected by the presence of the upper island . The downstream side of the island is not exposed to a large wind fetch as is the upstream side of Island 3. These features, plus the shape of the island (which maximizes its concave surfaces), should provide sufficient protection to Island 4 from erosive forces. Island cross section Type C will be used for Island 4. Riprap is required in areas where wave energy presents greater chances for erosion. This is typically in areas where waves can attack from more directions (the ends) and where there are unprotected convex shapes. Cross section Type B will be used for areas such as island ends where riprap is required on both sides of the island. (Riprapped areas are noted on Figure 1 of Attachment 1.) The height of these outer islands are the same as discussed for Island 1. Islands 3 and 4 were oriented perpendicular to the valley. This provides the maximum area benefitted by wave reduction. This orientation also affords favorable conditions for a sustainable concave beach zones on Island 4.

The inner connections, Islands 3a, 4a, and 4b, are about 675, 415, and 775 feet in length respectively. Each would be at a lower height (elevation 654 feet msl 1912 datum) than the surrounding islands. This is possible because of the protection offered by the two major islands. Cross section Type D would be used for these islands. Side slopes would be 1 foot vertical for each 10 feet horizontal. This gradual side slope allows for quicker establishment of vegetation.

The two remnant islands (Islands 7 and 8) in Polander Lake will be protected by placing rock fill along their eroding banks. It is estimated that approximately 445 linear feet of shoreline will be riprapped on Island 7 and 365 feet on Island 8.

RIPRAP

Riprap will be required where water velocities or wave action could cause significant erosion. Riprap will need to be placed at exposed island surfaces which are not concave to the predominant wind directions. Very large fetches would require riprap in any layout. All ends of islands require riprap because of the strongly convex geometry and exposure to waves from many fetch directions.

Island 1 is the only island which needs riprap to prevent erosion due to flowing water (Pap Slough). Erosion is evident on the bank of the existing island downstream of the proposed Island 1. Water velocities during high flow conditions along this side of the island are not known. Experience obtained from previous studies done on the river indicate that velocities seldom rise to 6 ft/sec in sloughs of this size. A velocity of 8 ft/sec will be used to design riprap. This should be very conservative.

Riprap was designed using EM-1110-2-1601 "Hydraulic Design of Flood Control Channels". The following table shows riprap gradation dictated by the procedures in the EM.

Table 1 Minimum Riprap Gradation from Current Erosion

	Weight Limits (lbs)	
	Maximum	Minimum
W100	86	35
W50	26	17
W15	13	5

A riprap layer thickness of 12 inches is required for this gradation. This thickness would be increased by fifty percent (18 inches) for underwater placement.

Quarry run stone is expected to be used on this project for erosion protection to help minimize costs. EM-1110-2-1601 recommends increasing the layer thickness by 1.5 to 2.0 times to accommodate quarry run stone. This would give a layer thickness of 18 to 36 inches. Final layer thicknesses of 18 inches for above water placement and 27 inches for underwater placement have been adopted.

Riprap required for protection against wind generated waves was designed using the method described in the Soil Conservation Service's "Slope Protection For Dam's and Lakeshores, Minnesota Technical Release 2, April 1988".

A wind fetch of 1 mile, wind speed of 28 miles per hour, and a water depth of 4 to 9 feet was used to design the riprap. The method recommended a riprap layer thickness of 13.3 inches. This is nearly the same as the 12 inches recommended for flow along Pap Slough. Similar increases in layer thickness for the use of quarry run stone and underwater placement and would also give final layer thicknesses of 18 and 27 inches for above water and below water placement respectively. Table 2 shows the riprap sizing required for wave protection.

Table 2 Minimum Riprap Gradation for Wave Protection

	Weight Limits (lbs)	
	Maximum	Minimum
W100	67	34
W85	40	18
W50	15	14
W15	0.5	0.1

The above listed weights for riprap protection from flow and wave action will be increased for the following reasons: a. to allow for use of quarry run stone, b. to better resist displacement due to ice action, and c. to accommodate some long-term breakdown due to weathering over the life of the project. Table 3 shows the proposed riprap gradation to be used for erosion protection for the Polander Lake Project.

Table 3 Proposed Riprap Gradation for Island Protection

	Weight Limits (lbs)	
	Maximum	Minimum
W100	300	100
W50	130	40
W 5	15	5

This gradation has been used successfully for several completed EMP projects with layer thicknesses of 18 inches above water and 27 inches below water, on a geotextile filter. This gradation is also suitable for use in the proposed rock fill shoreline protection and existing Islands 7 and 8. However, a separate rock fill gradation having a larger maximum stone size and smaller minimum stone size may be used, if final quantity estimates justify tow riprap gradations.

EFFECTS OF ISLANDS ON FLOOD STAGES

The islands proposed for construction for the Polander Lake EMP are 5 feet above normal pool elevation. The island tops would be submerged by 7 to 8 feet of water during the 100 year flood.

The closing of the Pap Slough inlet by Island 1 recreates an island where one existed in 1940. During the 100 year flood, flow will be occurring over the entire flood plain. Flow will also be passing over the top of Island 1 by 7 to 8 feet. The river will be flowing through forested areas as well as in the channels. The predominant flow direction will be down the valley. Island 1 will be roughly parallel to the flow direction and therefore would be a minimal obstruction during large floods. River water will continue to have access to the channels by way of flow over Island 1 and by flow from overland sources. The channels downstream of the proposed Pap Slough closure site will still be utilized as conveyance pathways for the river during the 100 year flood.

Island 2 is located downstream of the closure at Island 1. This island is more perpendicular to the valley flow direction. The island will be overtopped by 7 to 8 feet. However, the percent reduction of conveyance through this short reach would be very small.

During all flow levels there is movement of water from the Polander Lake area into the main channel. Flow entering Polander Lake from Burleigh Slough either passes over the spillway or migrates back into the main channel. Island Complex B was situated in a part of the lake where it would have the least effect on these flow patterns. The island complex should not effect river flood stages.

The island design proposed for the Polander Lake EMP study would have an extremely small impact on river stages in Pool 5A. Whatever stage increases that might be caused by the island construction would be further reduced by a development of increased conveyance in the main navigation channel.

The Weaver Bottoms project in Pool 5 is much more restrictive to the floodplain than is the Polander Lake project. Analysis of stage data at the headwater elevation of Dam 5, the control point elevation of Pool 5, and the tailwater elevation of Dam 4 show no change in stages after the completion of the Weaver Bottoms Project. The reasons for this appear to be that conveyance in the main channel of the Mississippi River has increased to accommodate the flow that no longer passes through the Weaver Bottoms backwater area.

Considering the above factors, the impacts of the proposed island design would be insignificant.

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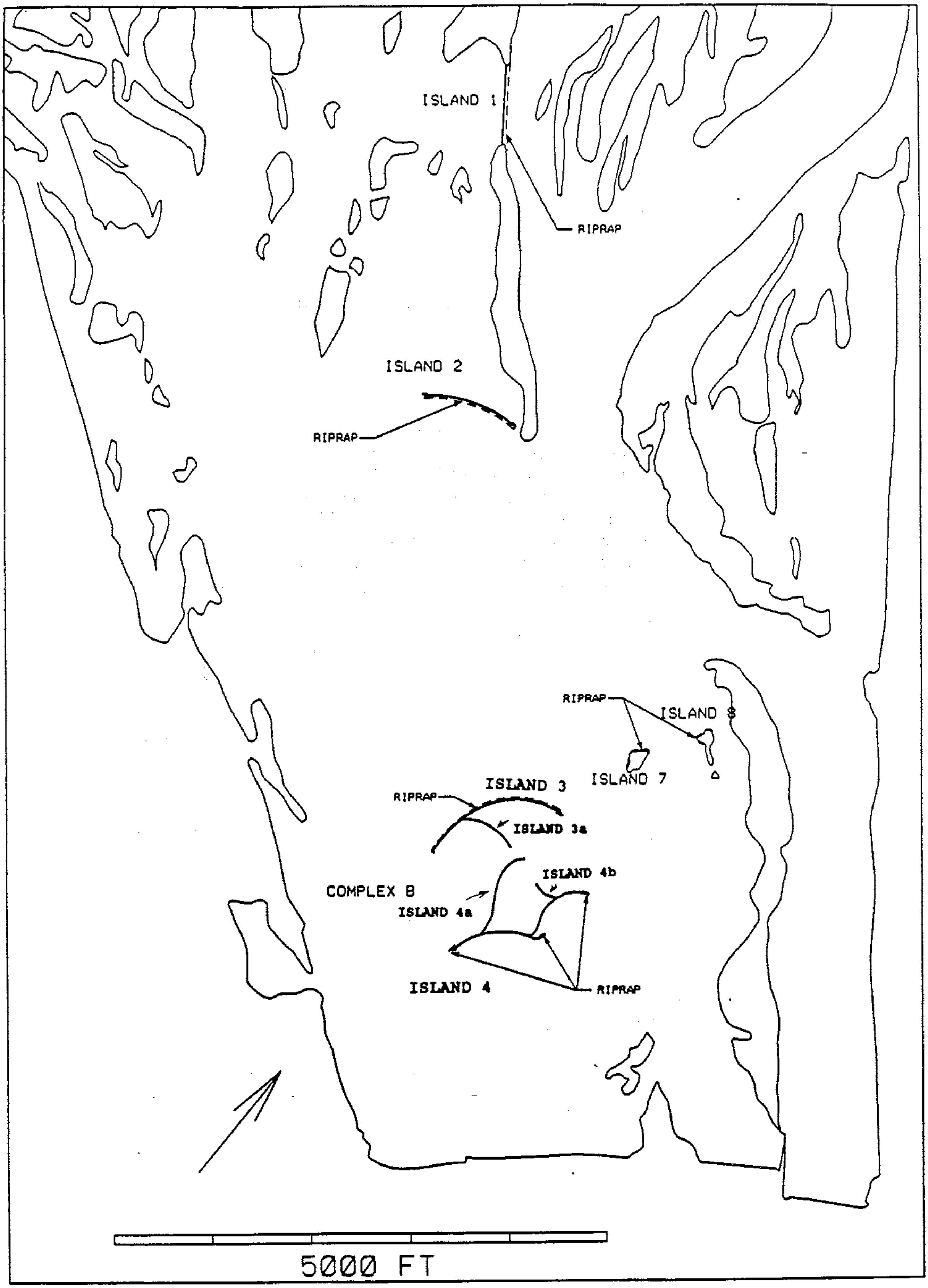
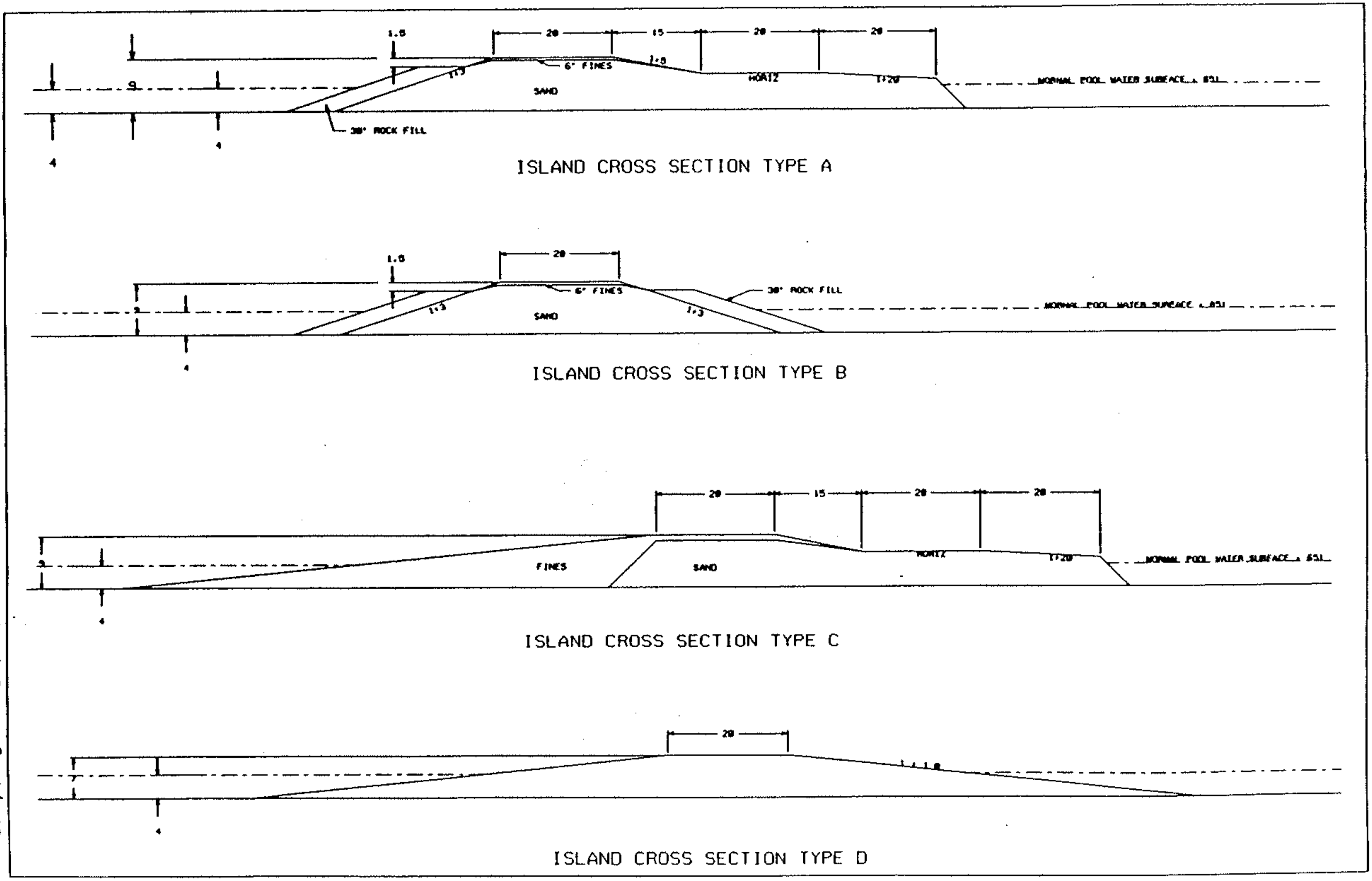


Proposed Project Features
Figure 1



Island Cross Sections
Figure 2

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Summary Report

Islands Design on the Upper Mississippi River

December 17, 1991

Jon Hendrickson
Hydraulic Engineer
Corps of Engineers

INTRODUCTION

Prior to the 1930's, the geomorphic plan form of the Mississippi Valley consisted of irregularly braided channels with adjacent marshes, lakes, and bottom land forest. A natural levee formed adjacent the channels due to sediment deposition. These natural levees often were the highest feature in the floodplain. With construction of the Locks and Dams in the 1930's the lower landforms were submerged leaving the natural levees and other high areas of flood plain forest as islands. In the lower half of the navigation pools, the natural levees often formed narrow islands known as barrier islands between channels and extensive backwater areas. The elevation of these islands typically varied from just a few inches to 5 feet over normal pool elevation. Dredging practices prior to the 1970's sometimes resulted in sand being placed on these natural barrier islands or in the creation of new islands. These barrier islands acted as a boundary between high and low energy hydraulic environments, dissipating energy from the high energy environment. Energy, in this case, is in the form of wave action or river currents. More specifically, the islands reduce wind fetch and wave heights, serve as a barrier between sediment laden channel flow and backwater areas, and reduce disturbances in backwater areas caused by commercial and recreational navigation. This results in conditions more conducive to fish and waterfowl. Since barrier islands act as an energy dissipator they are subject to erosion and many of the original barrier islands have suffered severe erosion or disappeared completely. For example, since inundation, island land mass in lower pool 8 has been reduced approximately 80 percent with many islands disappearing completely. One form of habitat improvement used in recent times involves the reconstruction of islands.

PHYSICAL PROCESSES CAUSING EROSION

The processes affecting islands include wind, surface waves generated by wind or watercraft, river currents, and ice movement. The loss of wind borne sand to the aquatic system and the uprooting of trees are the main negative impacts of wind on natural and dredge material islands. Surface waves caused by wind or watercraft may cause erosion of island shorelines, however wind generated waves usually are of greater concern than those from watercraft. Both island erosion and formation occur due to river currents, with erosion being the dominant process. Formation of islands due to sediment deposition sometimes occurs on the downstream side of existing islands or other obstructions in flowing water. Ice may result in upheaval of shoreline material and general deformation of the shoreline, however this is only a problem if material is lost from the beach zone. Often what happens is ice will push material up in a berm along the beach and then wave action will redistribute this material back out into the beach.

PHYSICAL EFFECTS OF ISLANDS

The physical effects of islands include reduced wave energy downwind of the islands and reduced flow and advective transport in a zone downstream of the island. These are briefly summarized as follows.

Wave Energy

An analysis of various wave parameters versus fetch for a constant wind speed of 25 mph can be found in the appendix to this summary report. Figure A-1 in the appendix is a plot of these wave parameters. For a fetch of 6000 feet, the wave height obtained from figure A-1 is 0.75 feet. If this fetch were reduced 50 percent to 3000 feet, the wave height would be 0.60 feet, a 20 percent reduction. The corresponding bottom wave velocities for 6000 and 3000 foot fetches are 0.67 fps and 0.34 fps respectively. In other words the reduction in bottom wave velocity is nearly proportional to the reduction in fetch. The calculated maximum bottom shear stress varies greatly with the friction factor used and as discussed in the appendix , a friction factor of 0.032 appeared to be reasonable for Mississippi River Backwaters. Using the shear stress curve for a friction factor of .032, the bottom shear stress for 6000 and 3000 foot fetches is 0.014 psf and 0.0036 psf, a 74 percent decrease. While this is a significant decrease, a more important criteria is whether or not the shear stress has been reduced below the critical value for sediment resuspension or aquatic plant growth. Numerous studies (mainly in estuary environments) have been done to predict resuspension of bottom sediments due to shear stresses exerted on the sediments. Typically a critical shear stress is determined and if ambient shear stresses due to river currents or waves exceed this value, a mass transport function is used to estimate resuspension. The difficulty lies in determining the critical shear stress and the ambient shear stress. Values of critical shear stress found in the literature vary over 2 orders of magnitude. Even if this value could be determined via laboratory tests, the existence of aquatic plants also effects bottom resuspension. A few values of critical shear stress are plotted on figure A-1 in the appendix. If it is assumed that the critical shear stress for resuspension is equal to .01 psf (a value used in a recent study on Petenwell Reservoir, Wisconsin), reducing fetches from 6000 to 3000 feet reduces the bottom shear stress to a point where sediment resuspension should be minimized

Flow and Advective Transport

If the island is constructed to form a bay with its mouth facing the downstream direction, flow and advective transport into the bay will be minimal. Also, a zone of reduced flow and reduced advective transport will be created downstream of islands. This is sometimes referred to as a sheltered zone. Theoretically the sheltered zone will extend downstream of the island, but gradually will decrease in width due to lateral mixing and flow. At some distance downstream the effects of the island will disappear. However, the downstream extent and shape of the sheltered zone could be affected by factors such as wind generated flow into the sheltered zone from the downstream direction, and local bathymetry which may increase lateral flow into the sheltered zone. Since advective transport is reduced, water quality in the sheltered zone may be different than in the surrounding flowing water. For example, the sheltered zone will remain less turbid than surrounding areas during high water events. However, depending on the amount of mixing and lateral inflows, the turbidity in the sheltered zone may gradually increase.

The existence of sheltered zones was observed on July 27, 1991 during aerial reconnaissance at the Lake Onalaska and the Pool 8 Islands HREP's, and at the Weaver Bottoms project. The following figure is a plot of the visual extent of the sheltered zone downstream of the Lake Onalaska Islands. Visually these zones appeared to be less turbid than surrounding water. At Broken Gun Island the sheltered zone extended downstream in a triangular shape as was described above. At Arrowhead and Cormorant Islands, however, the downstream extent of the sheltered zone seemed to be limited by local bathymetry and flow patterns. Based on this reconnaissance, it is apparent that a sheltered zone will be created by islands for certain conditions, however more field work is needed to quantify the physical and biological properties of these zones and ultimately what their effects on aquatic plant growth and fish and wildlife habitat will be.

ADDITIONAL FACTORS AFFECTING ISLAND DESIGN

In addition to considering the physical processes causing island erosion and the physical effects of islands as discussed above there are several other factors that influence island design. A brief summary of additional observations and findings based on work done to date for the various island creation projects is provided below.

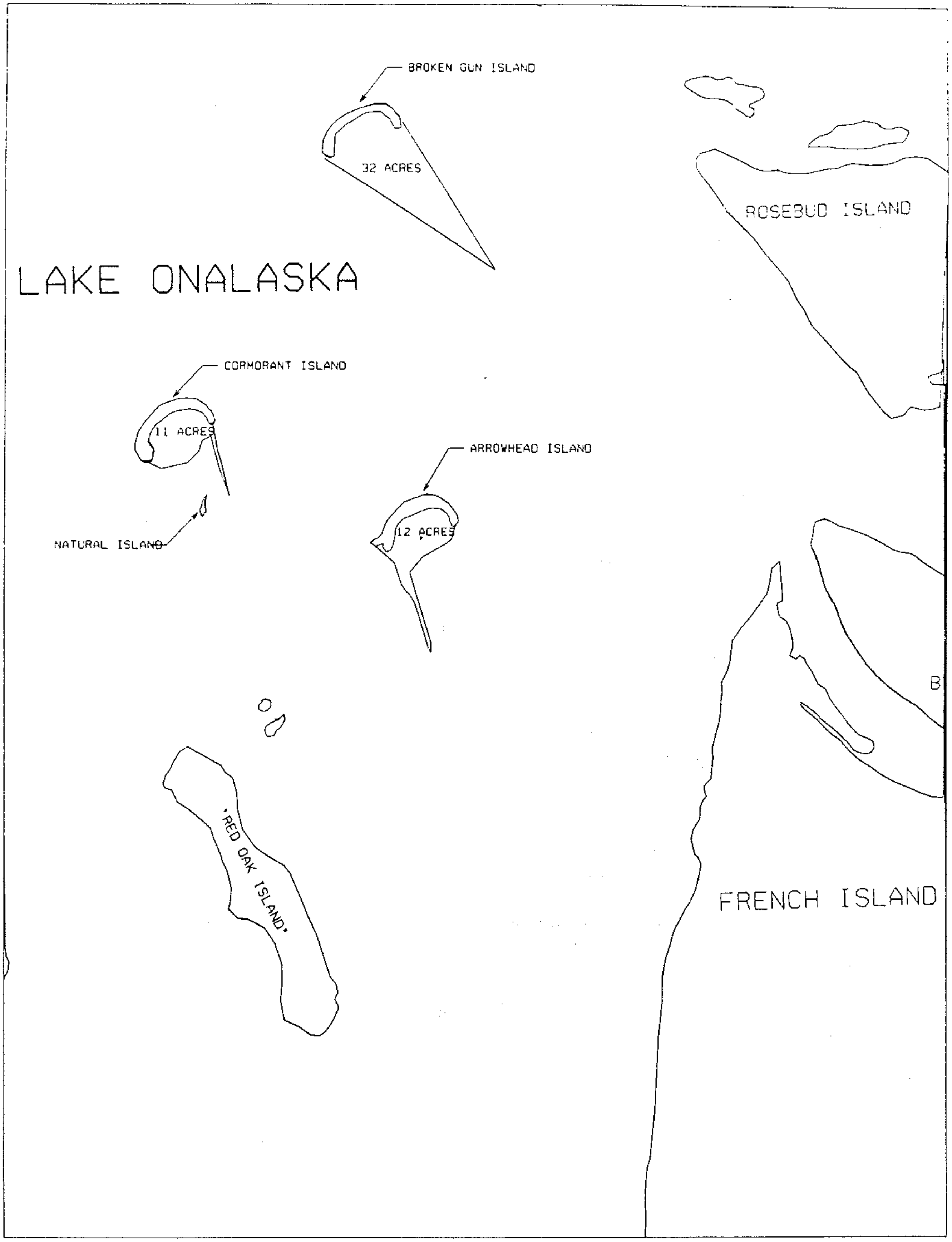
a. Sand based shorelines on the Mississippi River influenced mainly by wave action generally will have a nearshore zone (ie. underwater beach) with slopes of 1V:8H to 1V:20H extending out into the water 25 to 40 feet, a backshore zone (ie. above water) 5 to 10 feet wide, and a steep faced bank between the backshore and uplands. This profile can be modified by high water conditions and ice action.

b. Higher islands with top elevations greater than 4 feet over normal pool tend to be more stable than lower islands with top elevations lower than 3 feet. Many of the low islands created in the lower portions of the navigation pools after construction of the Locks and Dams have suffered from erosion with most disappearing completely. Obviously, there is more material in high islands. However, it is also true that low islands are overtopped more frequently, and thus are exposed to the erosive effects of wave action and flow at the crest of the island more frequently. These conditions accelerate the loss of material.

c. Sand based islands are more stable than islands made of fine material. This is because fine sediments, once they are dislodged from the shoreline, may remain in suspension for a long period of time and may be transported out of the island system. Sand will usually end up in the beach area adjacent the island.

d. Vegetation desirable for erosion protection, such as willows and grasses, generally grows best at lower elevations closer to the water table.

e. Shorelines with shallow offshore zones (ie. less than 3 feet deep) tend to to have less erosion. This is because wave erosion is dissipated in the shallow water, and because these areas often support aquatic vegetation during the summer growing season which also dissipates wave energy.



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SHELTERED ZONES AT
LAKE ONALASKA HREP
27 JULY 91

ISLAND DESIGN PHILOSOPHY

The design philosophy that has evolved based on information obtained to date is as follows:

a. The orientation of the island is often a function of the local planform of the river valley, however if possible islands should be oriented based on flow directions in the project area and prevailing wind directions. An island oriented with its long axis perpendicular to the dominant flow direction will result in the largest sheltered area downstream of the island. An island oriented with its long axis perpendicular to prevailing wind directions will maximize the area of reduced wave energy, and will tend to be more stable since net littoral drift is minimized.

b. Islands should be positioned to offer the greatest benefits to the project area. Conversely, the project area should be chosen so that the greatest chance of project success is possible. For most projects this means choosing areas that currently have marginal aquatic vegetation growth which should be improved by island construction. How an island will affect downwind wave characteristics can be determined using the various analytical techniques available. Unfortunately the relationship between various wave characteristics such as wave height or oscillatory wave velocity and aquatic plant growth is not well defined.

c. Islands exposed to wave action should be constructed with a sand base. Fines may be used on top of a sand base and in sheltered areas.

d. Island height should be 4 feet over normal pool elevation or greater. In most navigation pools in the St. Paul District, this will result in a height corresponding to the 5 to 10 year flood elevations.

e. Rock is usually required on shorelines exposed to significant wave action throughout most of the year, especially if the shape is unstable (ie. convex). In some cases shorelines orientation may eliminate the need for rock.

f. On less exposed shorelines, low level berms 20 to 40 feet wide with elevations varying from 1 to 2.5 feet over normal pool elevation should be constructed except where rock is placed. Topsoil with plantings of woody vegetation and indigenous grasses should be applied as a surface treatment. These berms have 2 purposes. The first purpose is to provide sand that will eventually be transported to the near shore beach zone through wave action. Depending on the local wave environment and bathymetry, the edge of the berm will migrate 10 to 25 feet towards the island center as material is redistributed into the beach. The second purpose is to provide a surface close to the water table where vegetation (grasses and willows) can grow and provide erosion protection for the island. This also will provide a buffer between wave action and the main part of the island so that vegetation can be established on the main part of the island. Willows and other woody vegetation are needed to provide shoreline protection to the main body of the island. during high water events when grasses are submerged and/or dormant. A 10 to 20 foot wide strip of woody vegetation is desirable.

g. Natural features such as shallow flats, island remnants, or emerged aquatic vegetation should be used to provide shoreline protection where possible.

h. A concave shape tends to be more stable than a convex shape. This is because littoral drift is less likely to transport beach material out of the bay that is formed by a concave shape.

i. The use of material taken from backwater areas is often desirable for habitat projects. Typically a cross section consisting of a sand base capped with varying amounts of fine material results. Shorelines constructed of fines with no other forms of erosion protection can only be done in extremely sheltered areas. The island cross section should be designed and constructed within reasonable tolerances, however, rather than attempting to construct an underwater beach, enough material should be supplied in the berm so that a beach will be created through off-shore material transport due to wave action.

APPENDIX

Wave Characteristics Analysis

INTRODUCTION

Since one of the physical effects of islands is to reduce wind fetch lengths, it is desirable to quantify this effect on wave characteristics. The best way to do this is to collect the necessary field data and calibrate an analytical or numerical technique to fit the field data. At the present time the necessary field data doesn't exist, however analytical techniques based on previous research are available. This analysis will show the relationships between wave characteristics and fetch lengths based on these techniques. The wave characteristics that will be considered include wave height, wave velocity, and bottom shear stress do to wave action.

VARIABLES

H = wave height in transitional water depths (feet)
T = wave period in transitional water depths (seconds)
L = wave length (feet)
d = local water depth (feet)
Um = maximum bottom orbital wave velocity (fps)
rho = water density (assume 1.94 slugs/cubic feet)
fw = bottom friction factor
Tb = bottom shear stress (psf)

METHODOLOGY

Pages 2-9, 2-10, and 3-55 of the 1984 SPM (Shore Protection Manual) give criteria defining when to use shallow, transitional, or deep water wave analysis.

Deep Water Wave Conditions

pg. 2-9, SPM - "Thus, when the relative depth d/L is greater than one-half, the wave characteristics are virtually independent of depth." For these conditions deep water wave conditions exist and Figure 3-24 and equations 2-7a through 2-8b in the 1984 SPM may be used to define wave height, period, celerity and length.

Transitional Wave Conditions

pg. 3-55, SPM - "Water depth affects wave generation. For a given set of wind and fetch conditions, wave heights will be smaller and wave periods shorter if generation takes place in transitional or shallow water rather than in deep water." Wave heights and periods for these conditions should be determined using figures 3-27 to 3-36 or equations 3-39 to 3-40 which these figures are based on. Optional figures to use for wave height and period are figures 3-21 and 3-22. These two figures give the same answer as the shallow water nomograms but also give results for deep water conditions.

pg. 2-10, SPM - "If a wave is traveling in transitional depths, equations 2-2 and 2-3 must be used without simplification." Transitional depths are defined as relative depths (d/L) of 0.5 to 0.04. These 2 equations relate wave celerity, wave length, and wave period. This also implies that equation 2-4a, which was derived from equation 2-1 and 2-3, should be used to determine L. However, the SPM also gives equation 2-4b for L which is correct to within about 5 percent. Whether equation 2-4a or 2-4b is used, the wave period must first be determined.

Shallow Water Wave Conditions

pg. 2-10, SPM - When the relative depth (d/L) is less than .04, shallow water wave methodologies should be used.

The Soil Conservation Service, Minnesota Technical Release 2, "Slope Protection for Dams and Lakeshores" assumes deep water conditions even when the conditions are transitional. Thus equation 2-7b is used. This is probably adequate for designing rock protection in most conditions that this manual is used for.

Since conditions on Mississippi River backwaters will almost always result in transitional wave conditions (ie. wave height is affected by water depth), the wave analysis should reflect transitional conditions. The following procedure will be used to determine wave characteristics.

1. Determine H and T using equations 3-39 and 3-40 or figures 3-21 and 3-22 of the 1984 SPM .

2. Determine an approximate value of L using equation 2-4b of the 1984 SPM. This is accurate to within 5 percent. Optionally, a more accurate value of L could be determined by iteratively solving equation 2-4a (Table C-1 in Appendix C could be used to do this.)

3. Check the relative depth, d/L, and determine wave type. The relative depth will almost always be between 0.5 and 0.04 for conditions on the Mississippi River (ie. Transitional wave conditions).

Once the wave characteristics are determined (steps 1 through 3 above), the maximum orbital velocity (Um) and corresponding shear stress (Tb) due to wave action on the lake bed can be determined using equations given in a paper by Sheng and Lick (1979). titled "The Transport and Resuspension of Sediments in a Shallow Lake."

H = wave height in transitional water depths
T = wave period in transitional water depths
L = wave length

$$Um = \frac{3.14 * H}{T * \sinh (2 * 3.14*d/L)}$$

$$Tb = rho * fw * Um^2 / 2$$

RESULTS

Conditions

Water Depth = 3'
U = wind speed = 25 mph = 36.7 fps
Ua = wind stress factor = 30.8 mph = 45.2 fps,
The wind stress factor is obtained from wind speed using equation 3-28b in the 1984 SPM.

$$Ua=0.589*U^{1.23} \text{ (mph)}$$

Assumptions

No flow
Aquatic vegetation doesn't influence wave characteristics

Wave Characteristics

The wave heights, maximum bottom orbital wave velocities, and maximum bottom shear stresses given in the table below are plotted in figure 1.

Fetch (feet)	TRANSITIONAL WAVE H	T (feet)	L (feet)	Um (feet)	Tb (fps) fw=.004	Tb fw=.01	Tb (psf) fw=.032
1320	0.43	1.04	5.54	0.08	0.00003	0.00007	0.00023
2640	0.57	1.28	8.30	0.29	0.00033	0.00081	0.00259
3960	0.66	1.43	10.20	0.46	0.00082	0.00205	0.00656
5280	0.72	1.54	11.62	0.60	0.00140	0.00349	0.01117
7920	0.80	1.71	13.82	0.80	0.00248	0.00621	0.01987
10560	0.84	1.83	15.35	0.92	0.00328	0.00821	0.02627

Error/Sensitivity Analysis

The major source of error is in choosing an appropriate friction factor. Friction factor values of .004 (Sheng and Lick, Lake Erie), .01 (1984 SPM, Figure 3-37, for smooth sandy bottoms), and .032 (corresponds to a Mannings n value of 0.02 which is extremely low for 3 foot water depths) were used to calculate bottom shear stresses in the above table. Since there is a linear relationship between shear stress and friction factor, the increase in shear stress is proportional to the increase in friction factor. For instance, the shear stress values obtained using a friction factor of .032 are 8 times greater than those obtained using a friction factor of .004.

Another source of error is in the wave theory used to determine the wave characteristics. Existing literature suggests that conditions in Mississippi River Backwaters should be analyzed assuming transitional water depth conditions. This means that equations and nomograms for shallow water waves are used to determine wave height and period. The alternative would have been to used the equations and nomograms for deep water conditions. The following table gives wave characteristics based on the deep water nomograms and essentially represents the maximum wave characteristics that could exist.

Fetch (feet)	DEEP WATER WAVE Ho'	T (feet)	L (feet)	Um (feet)	Tb (fps) (psf) fw=.004
2640	0.65	1.45	10.76	0.50	0.00097
3960	0.76	1.60	13.11	0.75	0.00218
5280	0.90	1.77	16.04	1.09	0.00461
7920	1.15	2.00	20.48	1.71	0.01134
10560	1.30	2.20	24.78	2.22	0.01912

CONCLUSIONS

This analysis was done to determine wave characteristics that may affect backwater areas on the Mississippi River. Analytical techniques based on empirical and theoretical equations were used to determine these characteristics. Some simplifying assumptions, such as no frictional effects from aquatic vegetation and a constant water depth were made. The 3 main characteristics considered were wave height, maximum orbital velocity of the wave affecting the bottom, and the corresponding maximum bottom shear stress.

Wave Height

The increase in wave height with fetch indicates a nonlinear relationship with a decreasing rate of wave height increase with fetch. For example, for a fetch of 3000 feet the wave height is 0.6 feet, however over the next 3000 feet (total fetch equals 6000 feet) the wave height only increases another 0.15 feet to 0.75 feet. A similar result would be obtained if deep water wave conditions were assumed, however the overall wave heights would be greater.

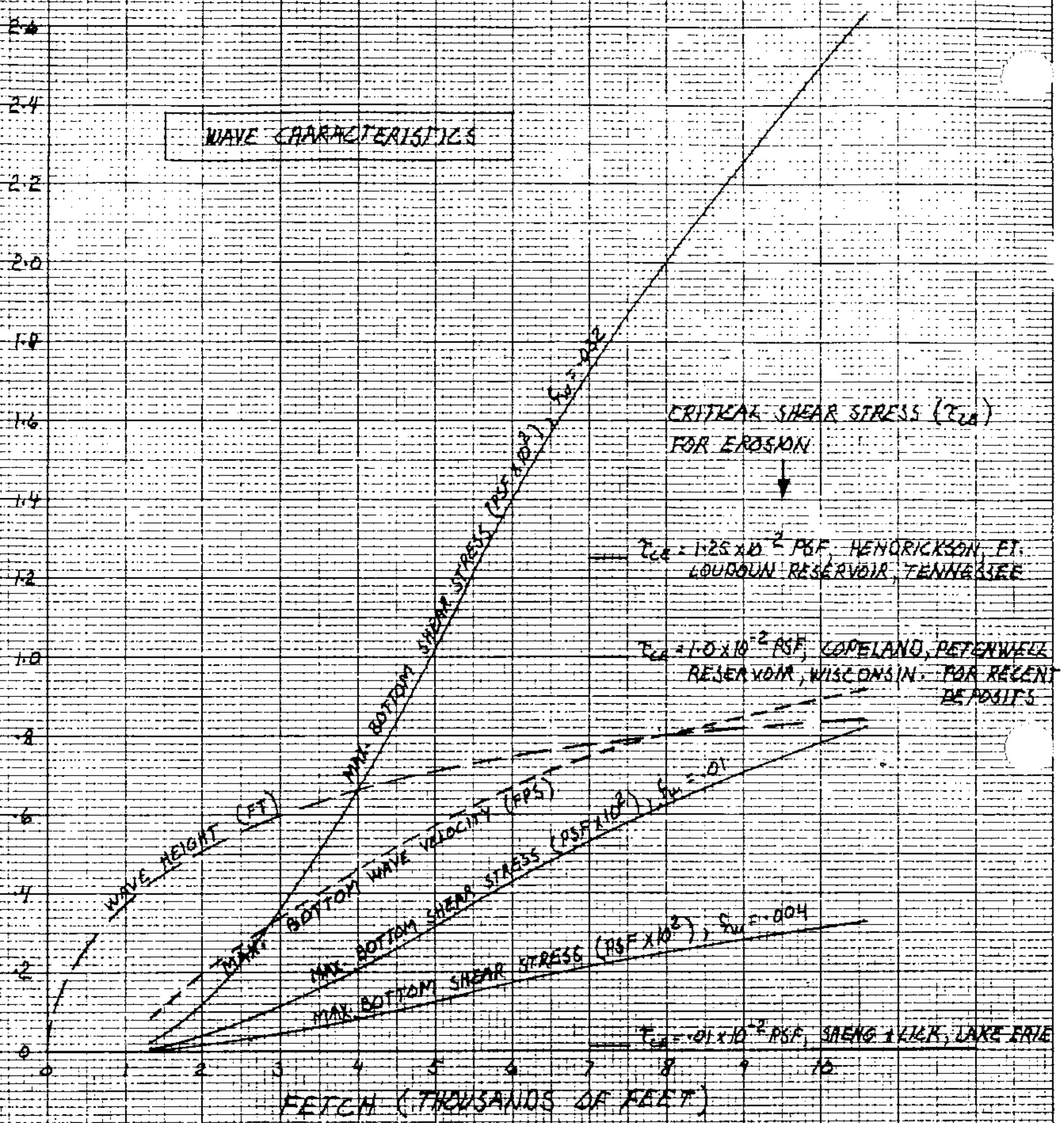
Wave Velocity

The increase in maximum bottom orbital wave velocity with fetch also indicates a nonlinear relationship, although the rate of decrease doesn't change as rapidly as it did for wave heights. If the curve for maximum orbital velocity were extended to fetches less than 1000 feet, a velocity of zero would be reached at a fetch of approximately 900 feet. Physically this means that the wave heights are small enough so that there is minimal interaction between the wave and the bottom (deep water wave conditions theoretically exist).

Bottom Shear Stress

Maximum bottom shear stress were plotted for friction factors of 0.004, 0.01, and 0.032. This was done to show the sensitivity of bottom shear stresses to friction factors (see discussion above). It also indicates why it is difficult to predict resuspension of bottom sediments due to wave action, and why there is a need for field data to calibrate to. Sheng and Lick, in their 1979 study on sediment resuspension in Lake Erie, used measured suspended sediment data to develop and calibrate a numerical model which incorporated the predicted shear stresses due to waves into an entrainment function. The friction factor used by Sheng and Lick is extremely low which may have been appropriate for the relatively deep water in their study area, but is several times too low for the shallow water found in Mississippi River backwaters.

Several values of critical shear stress for erosion are plotted on figure A-1. The critical shear stress for erosion is defined as the shear stress when resuspension of sediment particles begins. The extremely low critical shear stress (.0001 psf) used by Sheng and Lick is directly related to the fact that they used a low friction factor and thus it probably isn't applicable to conditions on the Mississippi River. The values used in Ft. Loudoun Reservoir, Tennessee and in Petenwell Reservoir, Wisconsin (.0125 PSF and .01 PSF respectively) are probably reasonable for Mississippi River backwaters. Assuming that the critical shear stress of .01 PSF were correct, it then appears that the maximum bottom shear stress based on a friction factor of 0.032 should be used for the Mississippi River backwaters. This means that resuspension of bottoms sediments due to waves generated from a 25 mph wind in 3 feet of water begins at fetches greater than 5000 feet. Intuitively, and without field data, this seems reasonable. The shear stresses obtained using friction factors of 0.004 and 0.01 are to low for a critical shear stress of .01 PSF.



CONDITIONS: DEPTH = 3', WIND SPEED = 25 mph → U_A = 30.8 mph

ASSUMPTIONS: NO FLOW, NO VEGETATION EFFECTS, TRANSITIONAL WAVE CONDITIONS

METHODS: WAVE HEIGHT FROM EQUATION 3-39, 1984 SPM
BOTTOM WAVE VELOCITY (MAXIMUM) FROM $U_m = \pi H / [T \sinh(2\pi d/L)]$
BOTTOM SHEAR STRESS FROM $\tau_b = \rho f_w U_m^2 / 2$
ρ = WATER DENSITY, f_w = FRICTION FACTOR, H = WAVE HEIGHT,
T = WAVE PERIOD, L = WAVE LENGTH, d = WATER DEPTH

FIGURE A-1

HENDRICKSON
6 DEC. 91