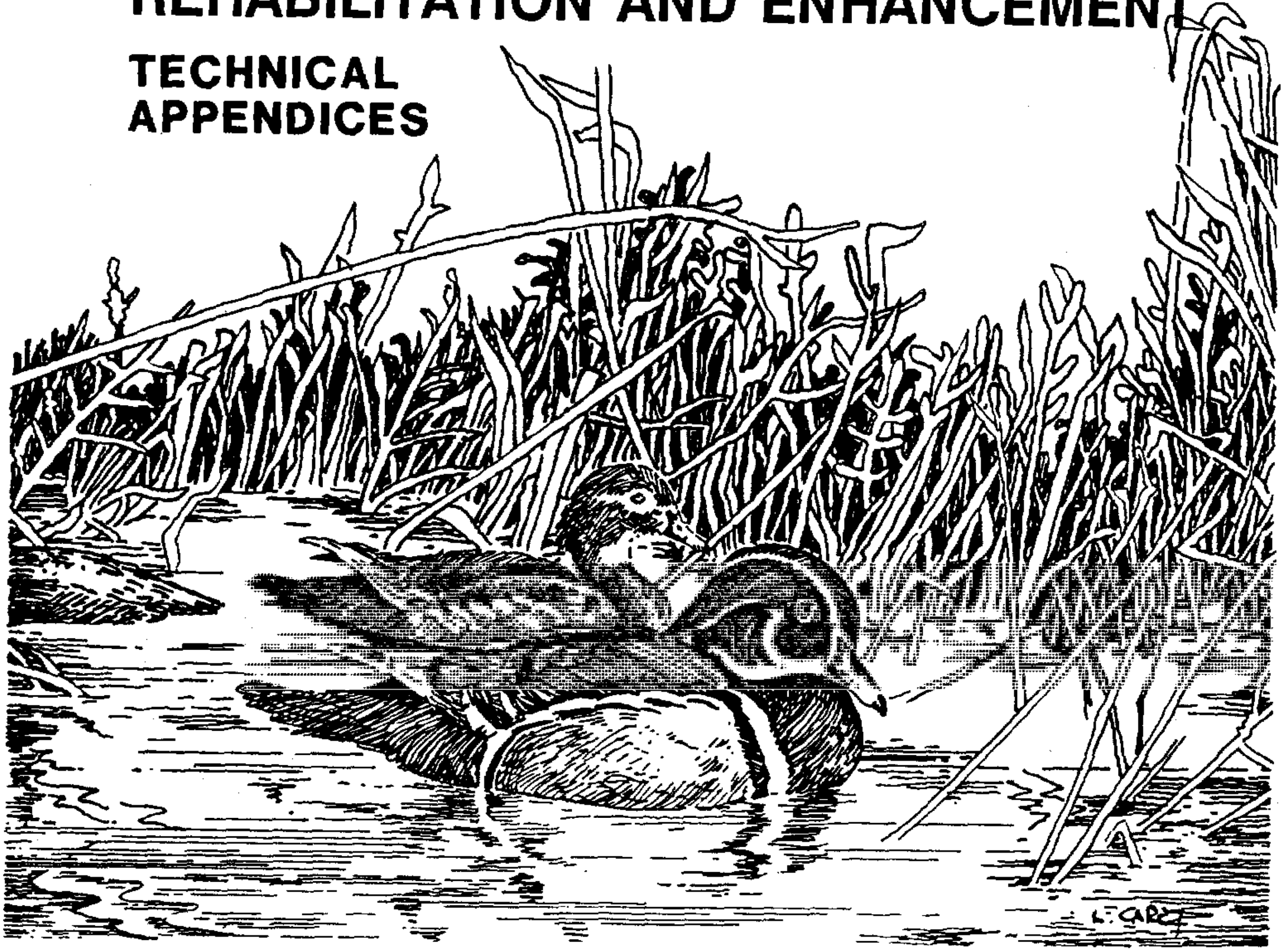
UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT (R-8)
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT

TECHNICAL APPENDICES



MARCH 1990

US Army Corps
of Engineers
Rock Island District

POOL 22
UPPER MISSISSIPPI RIVER
MARION COUNTY, MISSOURI

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT, CORPS OF ENGINEERS
CLOCK TOWER BUILDING—P.O. BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF:

CENCR-PD-W

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-8)

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

TECHNICAL APPENDICES

MARCH 1990

TECHNICAL APPENDICES

E - HYDROLOGY AND HYDRAULICS

F - NOT USED

G - GEOTECHNICAL CONSIDERATIONS

H - STRUCTURAL DESIGN

I - NOT USED

J - MECHANICAL AND ELECTRICAL CONSIDERATIONS

K - NOT USED

L - PROJECT OUTPUT QUANTIFICATION

HYDROLOGY AND HYDRAULICS

A
P
P
E
N
D
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X

E

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
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BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
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APPENDIX E
HYDROLOGY AND HYDRAULICS

GENERAL

The Bay Island Refuge area, shown on plate 1 of the main report, is located within the Mark Twain National Wildlife Refuge between River Miles (RM) 311 and 312 in Pool 22. This area, located about 2 miles north of Hannibal, Missouri, is currently managed as a wetland backwater refuge by the Missouri Department of Conservation (MDOC).

The purpose of this appendix is to present the development and evaluation of proposed improvements which will provide a water control system. This system will provide two interconnected Wetland Management Units (WMUs) with controlled water levels and reduce sedimentation into the refuge area. The elevation versus area and capacity curves for each unit and a total project curve are shown on plates E-1 through E-3.

CLIMATE

The climate in northeastern Missouri is characterized by extreme temperatures and moderate precipitation. The National Weather Service operates a weather station in Hannibal, Missouri, located about 2 miles south of Bay Island, which has over 39 years of record. Temperatures range from a maximum of 114 degrees Fahrenheit in the summer to a minimum of -8 degrees Fahrenheit in the winter.

Most of the precipitation occurs in summer and fall months, with April, May, June, and July normally the wettest months, having a monthly average of over 3.75 inches. Winters are normally the driest parts of the year. The average annual precipitation is 38.4 inches, and the average annual snowfall is 25 inches. Table E-1, shown below, lists the appropriate monthly precipitation amounts at the Hannibal gage for the 39 years of record during the periods 1948 to 1986.

TABLE E-1

Average Monthly Precipitation

Month	Inches	Month	Inches
January	1.68	July	4.71
February	1.77	August	3.63
March	3.05	September	3.74
April	3.77	October	3.27
May	4.29	November	2.47
June	3.75	December	2.24

HYDROLOGY

Mississippi River discharge frequency relationships and corresponding water surface profiles were promulgated by the Upper Mississippi River Basin Commission (UMRBC) in a November 1979 study entitled Upper Mississippi River Water Surface Profiles, River Mile 0.0 to River Mile 847.5. Plate E-4 presents pertinent data from this study. Actual water elevations are recorded daily at Hannibal, Missouri, (RM 309.9) and Lock and Dam 21 (RM 324.8). Plates 5 and 6 of the main report show daily stage hydrographs for the period of record 1964 through 1988. These data were used to compute monthly and year-round elevation duration relationships for the project site, as presented on plates E-5 through E-8. The 50-percent duration elevation can be interpreted as the average elevation. The months of August, September, and October have the lowest normal elevations, referenced to feet above MSL, of 460.0, 460.1, and 460.0, respectively. The year-round normal elevation is about 460.7 feet. Typical floods appear to last for at least 25 days and raise the water surface about 5 feet.

SEDIMENT CONDITIONS OF EXISTING PROJECT AREA

Historical records of past sedimentation rates are essentially nonexistent; however, recent EMP project data indicate rates averaging .4 to .8 inches per year in backwater areas adjacent to the Mississippi River. Comparing 1938 survey data of the project site with the topographical maps dated 1977 indicates an average sedimentation rate of .21 inch per year. This implies a rate of 7.0 acre-feet per year over the 400-acre backwater area.

The sedimentation rate is directly related to the amount of sediment brought into the area and the percent trapped in the area. An average entrapment ratio can be estimated by utilizing a known deposition rate, an average flow through the area, a sediment concentration, and a duration of flow. The Mississippi River and Clear Creek are possible sources of sediment for this area. Due to the relative small base flows of Clear Creek and the upstream drainage district pumping from a large lake where settling probably takes place, it is assumed that the sediment contribution from the creek is negligible. The following analysis assumes that 100 percent of the sedimentation in the project area is from the Mississippi River.

The average annual flood flow of 200,000 cubic feet per second (cfs) was selected from flood frequency data as the basis for estimating annual sediment delivery. An average sediment concentration of 300 parts per million (ppm) was estimated by evaluating the Hannibal gage sediment records. The duration of flow, about 36 days, was obtained by choosing the flow duration at elevations exceeding elevation 466, which is the elevation at which the study area would be three quarters inundated with water. A cross section of the Mississippi River in the vicinity of the project is shown on plate E-9. For a flood of 200,000 cfs flowing at elevation 468 feet, it is estimated that approximately 4 percent of the flow will be conveyed through the existing cross-sectional area to be occupied by the proposed project. This condition with the assumed sediment concentration and duration results in 171 acre-feet of sediment available for deposition in the project area on an average annual basis. Since 7 acre-feet has been deposited on the average, this represents 4 percent of the estimated available amount, or an entrapment ratio of 4 percent.

The concentrations are higher during flood flows, and often a substantial sediment load is deposited during only a few events. To estimate the volume of sediment that is deposited during flows greater than the 10-year frequency, the discharge through the study area, sediment concentration, duration of flow, and entrapment ratio were utilized. A flood flow of 313,000 cfs flowing through 8 percent of the entire flow area, with an average concentration of 400 ppm, for 3.65 days, would result in 49.9 acre-feet per year of sediment flowing through the study area. Using the entrapment ratio of 4 percent would result in a rate of 2.9 acre-feet per year of sediment being deposited due to floods greater than the 10-year. This implies that the volume of sediment deposited by floods less than the 10-year frequency is 4.1 acre-feet per year.

SEDIMENT CONDITIONS OF THE PROPOSED PROJECT AREA

The initial proposed project includes a deflection levee constructed to the 10-year flood event on the river side and a ring levee completely enclosing the area to the 2-year elevation. The deflection levee does not keep floodwaters out of the project area since it does not enclose the area. However, for floods up to the 10-year event, it does prevent water from continuously flowing through the area. Table E-2 is an estimate of the percentage of sediment deflected due to the proposed project.

TABLE E-2

Sedimentation Rates

	Existing (ac-ft/yr)	Proposed (ac-ft/yr)	% Reduction
< 15-Year	5.5	.4	93
> 15-Year	1.5	1.3	13
TOTAL	7.0	1.7	76

An estimate of the sedimentation caused by floodwaters less than the 10-year event was computed using the volume of water to fill the WMUs to elevation 468 and assuming the area fills once a year. The volume of water is 1,300 acre-feet and, assuming a concentration of 300 ppm, resulted in .4 acre-foot per year of sediment being deposited. This is a 91 percent reduction in the sedimentation rate caused by floods of less than a 10-year event.

The same analysis that was done for existing conditions was performed to estimate the sedimentation rate caused by floodwaters greater than the 10-year event with the proposed project. Assuming that water will fill the area to elevation 468, the flow area will be reduced approximately 50 percent, resulting in a sedimentation rate of 1.9 acre-feet per year and a 35 percent reduction.

LEVEE AND WATER CONTROL STRUCTURES

The proposed project includes a levee system constructed to provide two interconnected WMUs with protection from the 2-year flood event. All levee heights will be at least 468.0 feet MSL. The levee on the Mississippi River side will be at the 10-year flood level; however, it will not enclose the area and, therefore, it will not provide flood protection as shown on plates 9 and 18 of the main report.

A significant aspect of the project is the stop log water control structures between Clear Creek and each of the refuge areas as shown on plates 3 and 22 of the main report. The northernmost area is referred to as the forested WMU, and the southern unit is referred to as the non-forested WMU. Each of these control structures will have an effective weir length of 20 feet. The purpose of these structures is to control water levels in each WMU, independent of how the other is operated, and to allow floodwaters to enter the interior of the levee system during normal operation of the structures. The structures were sized to have a capacity to convey enough water to fill the interior of the levees before overtopping occurs during a flood event greater than the 2-year frequency. This will equalize the hydrostatic pressure and reduce damage during flood events. Routing a typical Mississippi River flood event, assuming a rate of rise of 1 foot per day, it is estimated that the interior of the levee system would fill to elevation 467.3. This would mean that the Mississippi River water elevation would be .7 foot higher than the interior elevations during overflow. Once overtopping occurs, the interior would fill and the head difference would be the same as the typical rate of river rise. A typical Mississippi River flood event will recede approximately .5 foot per day. The refuge areas will drain at about the same rate as the river.

Another stop log structure will be located between the forested and non-forested units as shown on plate 23 of the main report. This structure will have an effective weir length of 6 feet and will be able the pass the entire pump capacity without overtopping the levee. The stop log structure between the forested unit and Clear Creek will have a weir elevation at 464 when the logs are in place, which will enable a pool elevation of 464. The stop log structure between the non-forested unit and Clear Creek will have a weir elevation of 466 when the logs are in place, which will enable a pool elevation of 466. The stop log structure located between the forested and non-forested units will have a maximum weir elevation of 466 when the logs are in place. Either or both areas could be gravity dewatered in a 15-day time period during normal operation. All stop logs between the WMUs and Clear Creek must be removed when a Mississippi River high water event above elevation 468 is predicted. This is critical in order to assure filling the interior of the levee before overtopping occurs.

The area of conveyance for the 100-year flood event was computed for existing conditions and compared to that of the proposed conditions. There was approximately a 3 percent reduction in the cross-sectional area at the project site. The reduction occurs in the over bank area which does not normally convey much of the flood flow. The estimated difference in flood elevations for all floods is substantially less than 0.1 foot. A channel cross section for existing and proposed conditions is shown on plate E-9. Table E-3 lists the number of times per month the 2-year flood elevation was exceeded during the years 1965 through 1987 at the project site.

TABLE E-3

Number of Times the 2-Year Elevation
Was Exceeded (1965-1987)

Month	Number	Month	Number
January	0	July	2
February	1	August	0
March	5	September	1
April	7	October	1
May	8	November	0
June	3	December	0

PUMP SIZE

Another significant aspect of the project is the pump station located at the downstream end of the levee as shown on plate 12 of the main report. The station will be a one pump system with the capability to pump from the river into the non-forested WMU.

The pump was sized in order to fill the forested WMU to elevation 466 in at least 15 days and the non-forested WMU to elevation 464 in less than 30 days. This will be accomplished by a 6,000 gallons per minute (gpm) pump. The effects of evaporation, infiltration, and seepage were all considered in the pump sizing. It was assumed that under less than ideal conditions rainfall will not be a factor. Plate E-10 is a graph of alternative pump sizes and the corresponding pumping days. The 6,000 gpm pump was selected because it was the most cost-effective pump that would satisfy the MDOC requirements. A typical Mississippi River flood will recede approximately .5 foot per day. The WMUs will recede at about the same rate as the river; therefore, a pump to evacuate storage is not required.

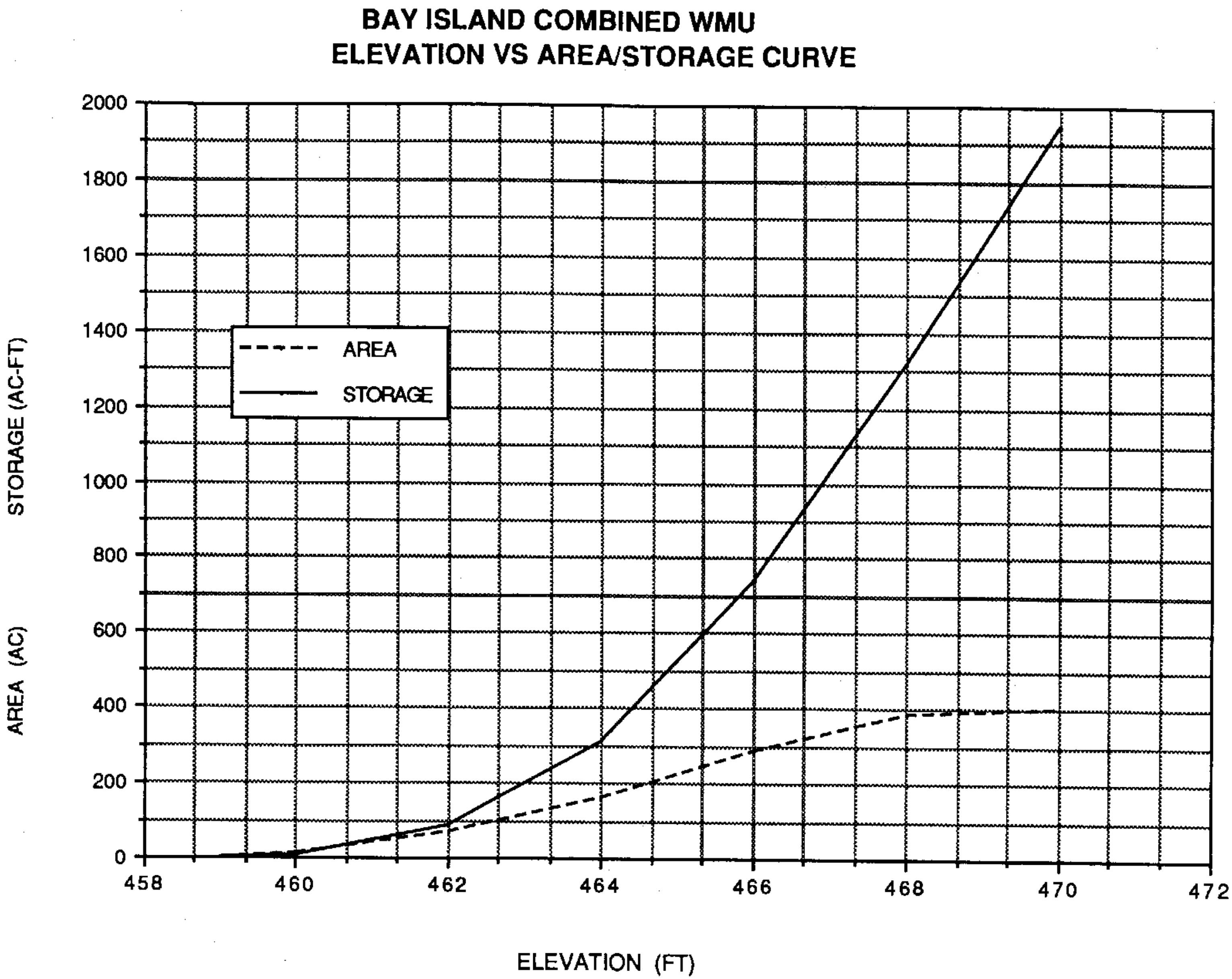
BRIDGE REPLACEMENT

The existing bridge across Clear Creek has deteriorating abutments and is generally considered to be in very poor condition. The proposed replacement bridge has a waterway opening of approximately 213 square feet below the low chord elevation of 463.6 feet compared to approximately 190 square feet below the existing low chord elevation of 462.5.

Hydraulic analyses were carried out to establish the effect of the proposed bridge and levee system on the water surface profiles for Clear Creek. The analyses were made using the Corps of Engineers standard step backwater computer program HEC-2. Starting water surface elevations were obtained using the slope area method. Two flows for Clear Creek were modeled, the 100-year flood and the maximum discharge from the South River Drainage District, comparing existing and proposed conditions. The 100-year discharge of 1,250 cfs includes the maximum pump discharge of 500 cfs and is assumed not to be coincidental with a Mississippi River flood event. For both flows, the flood elevations varied less than .1 foot at the upstream end of the project area, for with and without the proposed bridge and levee project.

As an alternative to the bridge replacement, a low water crossing was evaluated. This would consist of a set of culverts to handle low flows, and larger discharges would flow over the road. The design criteria for the culverts is that they must have a capacity of at least 500 cfs. This is the maximum discharge from the upstream drainage district pump station. It was calculated that four 4-foot culverts would be required to meet the criteria. A rating of the four culverts using a discharge of 500 cfs would raise the water surface elevation to 464 feet. This is about 3 feet higher than the existing conditions. Because of the higher water surface elevations and the expected maintenance problems, a bridge replacement was the recommended alternative.

PLATE E-1


BAY ISLAND COMBINED WMU
ELEVATION VS AREA/STORAGE CURVE
2000
1800
1600
1400
1200
1000
800
600
400
200
0
STORAGE (AC-FT)
AREA (AC)
AREA
STORAGE
458
460
462
464
466
468
470
472
ELEVATION (FT)

BAY ISLAND FORESTED WMU
ELEVATION VS STORAGE/AREA CURVE

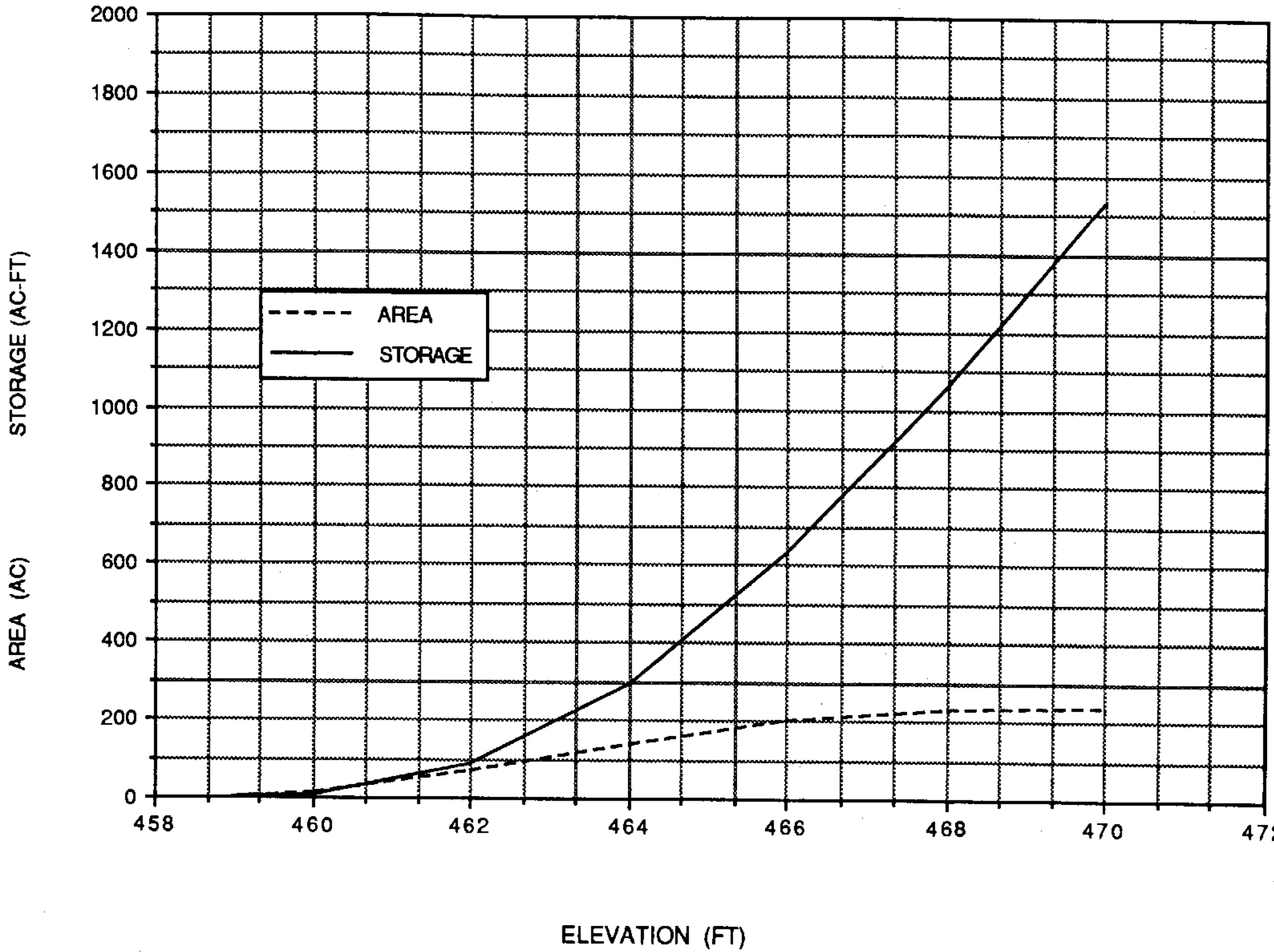


PLATE E-2

BAY ISLAND NONFORESTED WMU
ELEVATION VS STORAGE\AREA CURVE

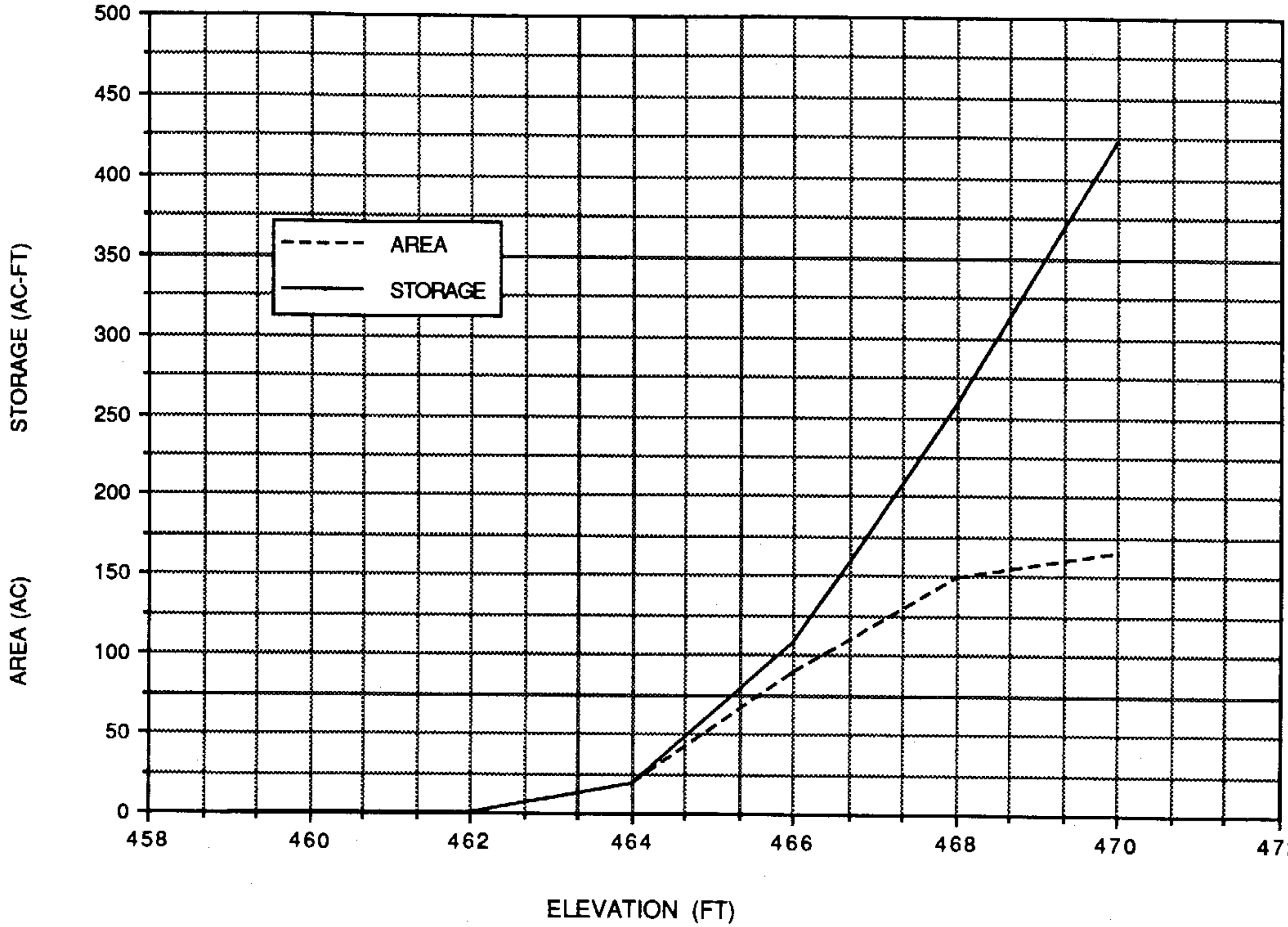
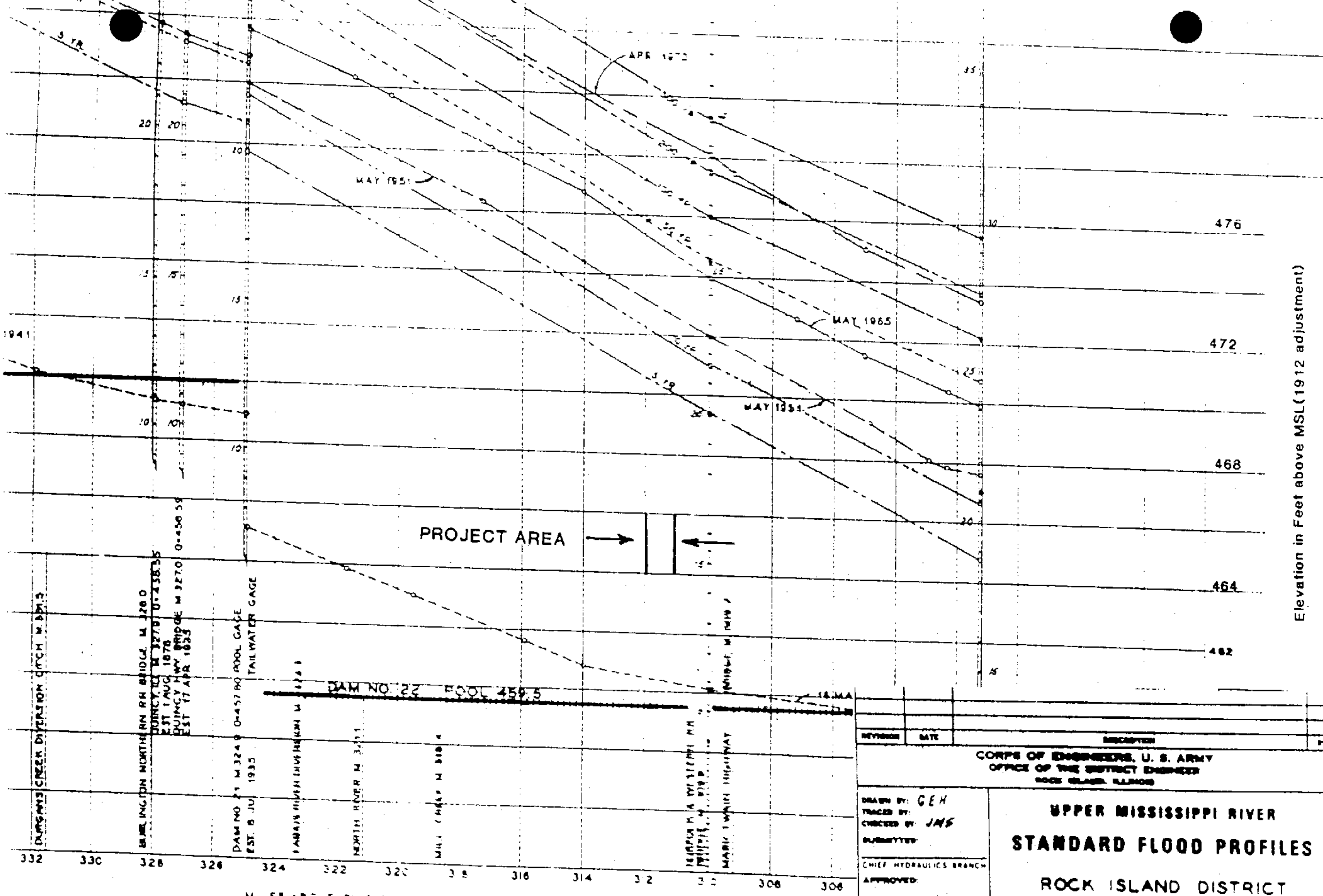


PLATE E-3



CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ROCK ISLAND, ILLINOIS

DRAWN BY: CEH
TRACED BY:
CHECKED BY: JMS
SUBMITTED:
CHIEF, HYDRAULICS BRANCH
APPROVED:
CHIEF, ENGINEERING DIVISION
DATE:

UPPER MISSISSIPPI RIVER

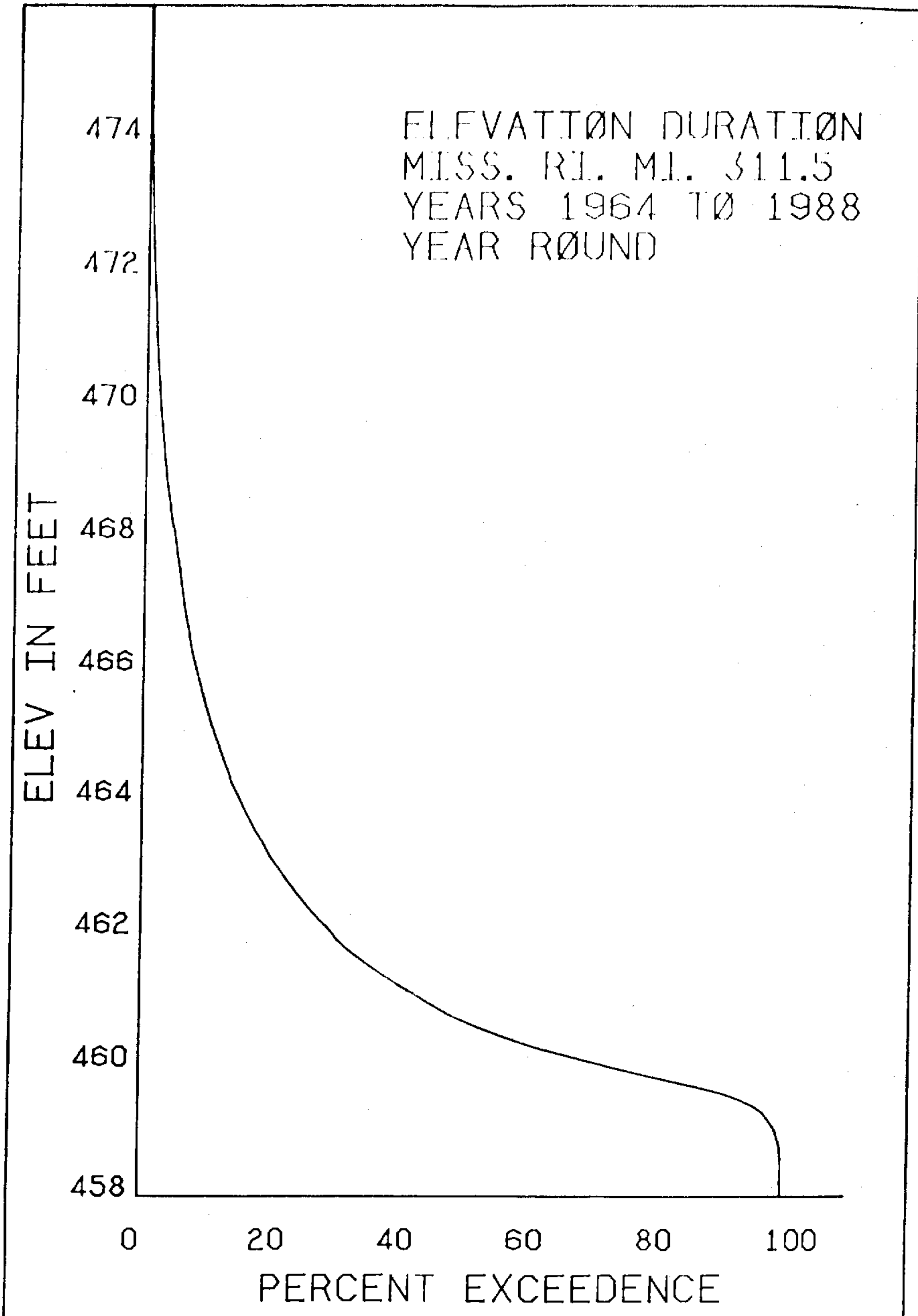
STANDARD FLOOD PROFILES

ROCK ISLAND DISTRICT

5, 10, 50, 100, 200, & 500 YEAR FLOOD

RIVER MILES 301.2 TO 343.2

PLATE E-4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YEARS 1964 TO 1988
YEAR ROUND
ELEV IN FEET
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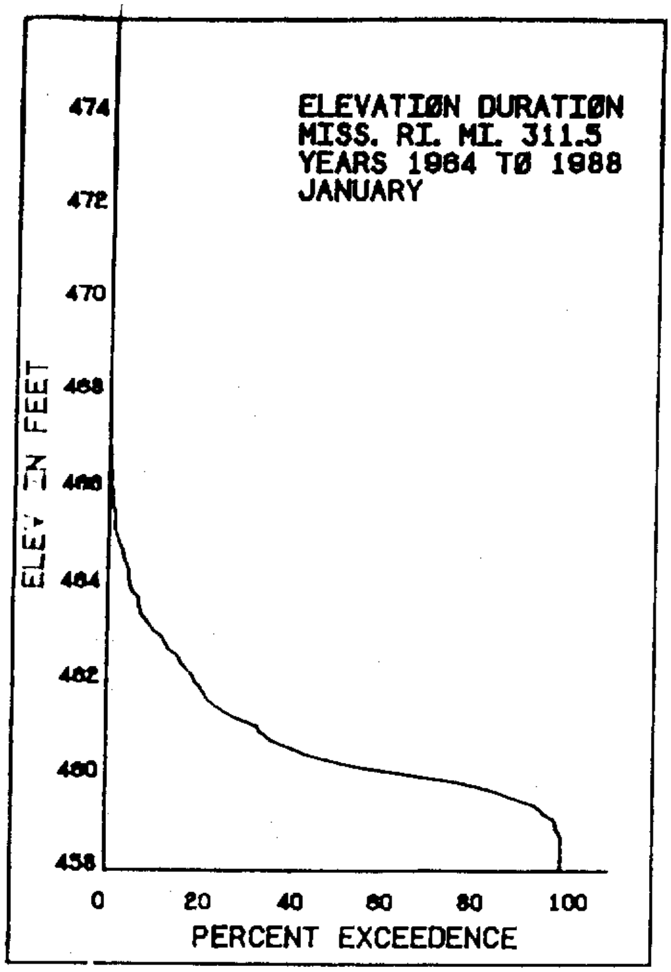
20
40
60
80
100
PERCENT EXCEEDENCE

PLATE E-5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ELEV IN FEET
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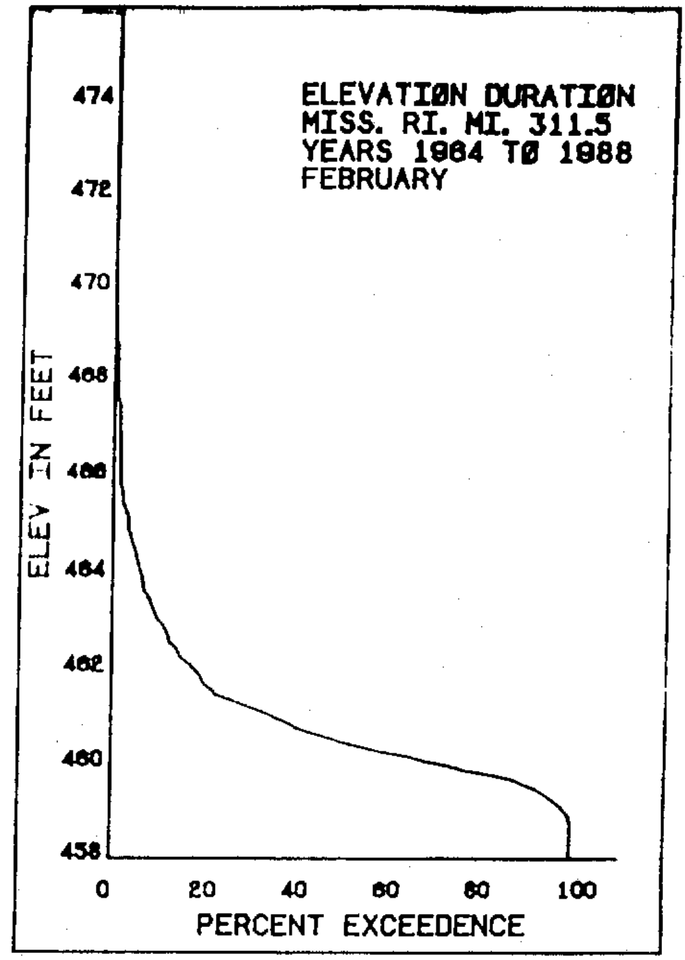
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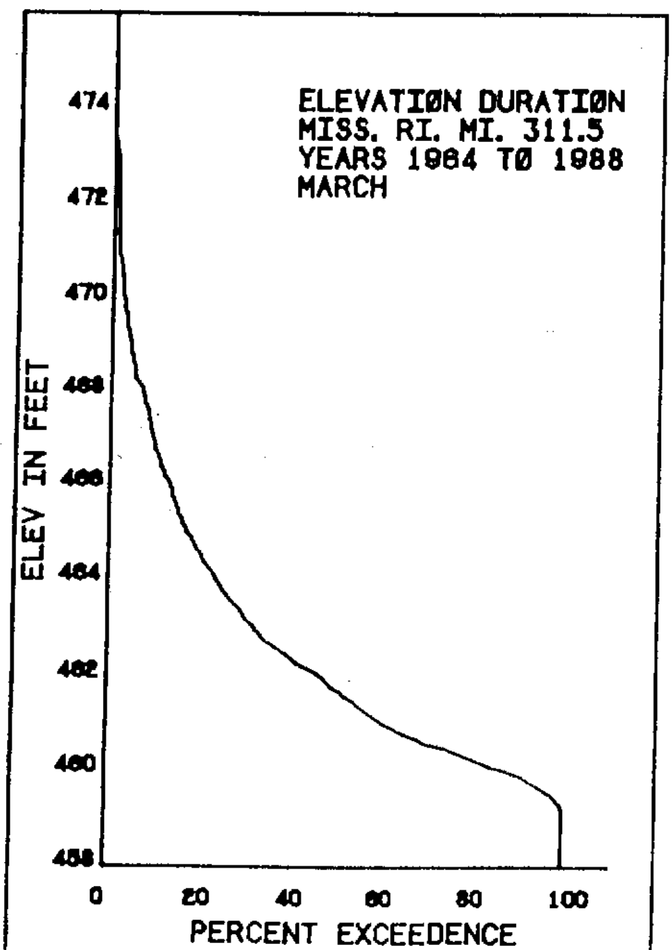
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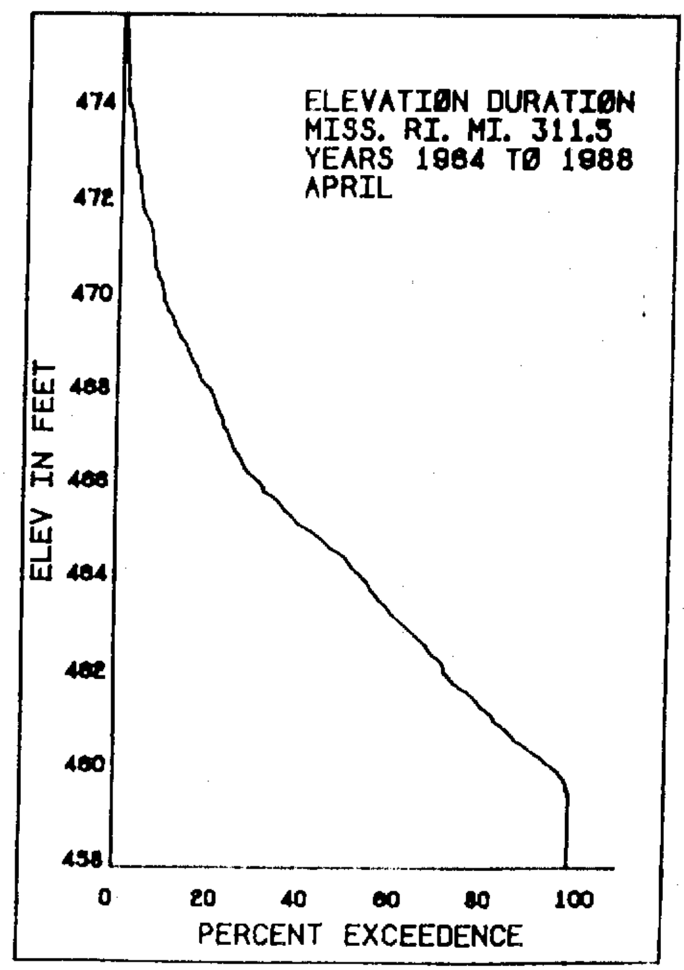
PERCENT EXCEEDENCE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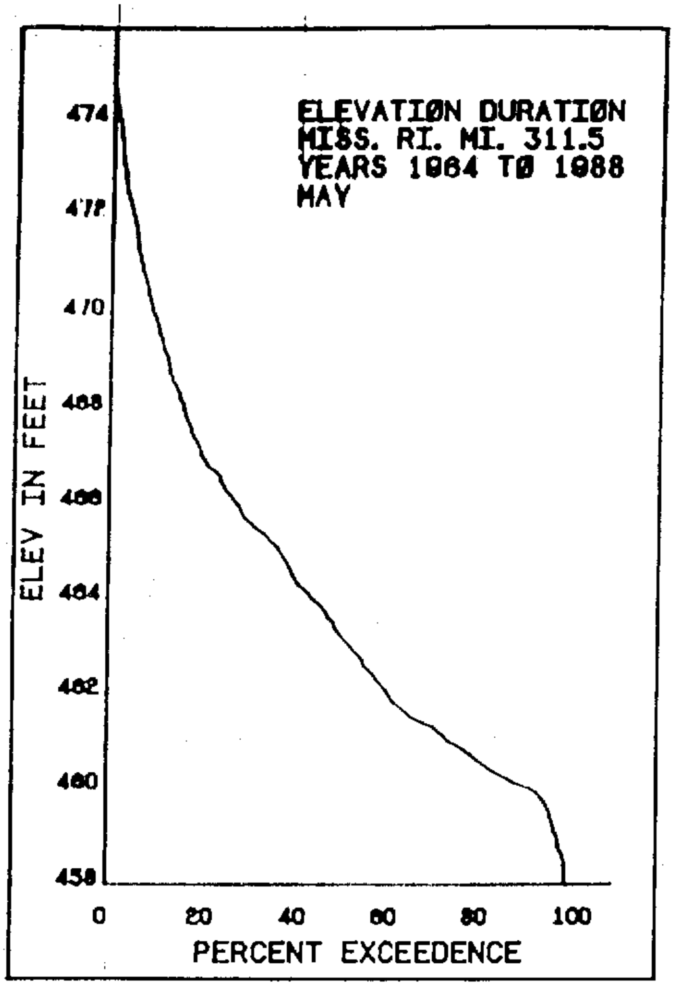
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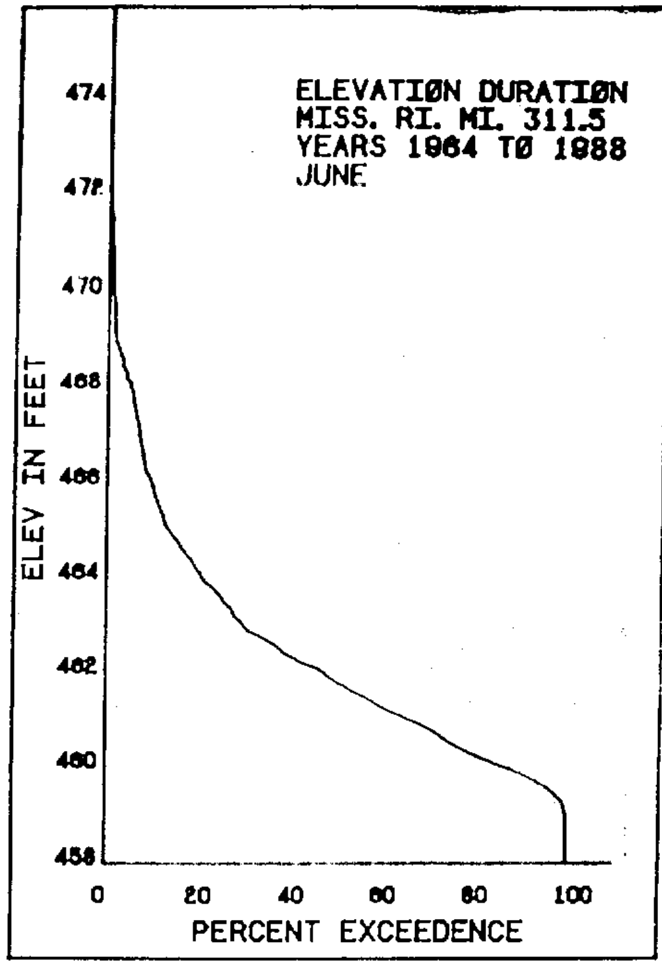
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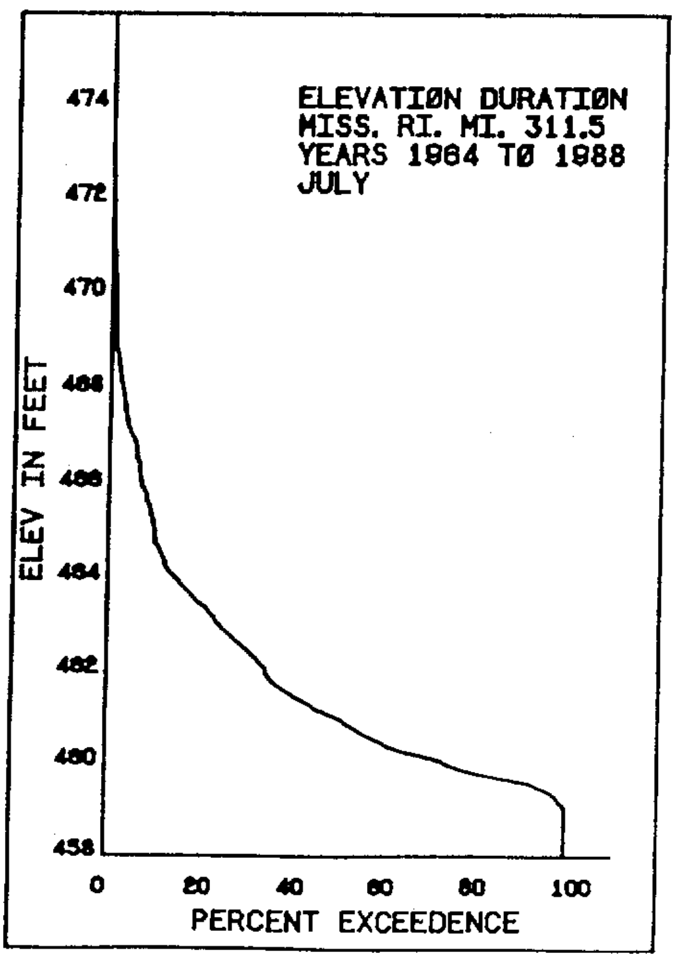
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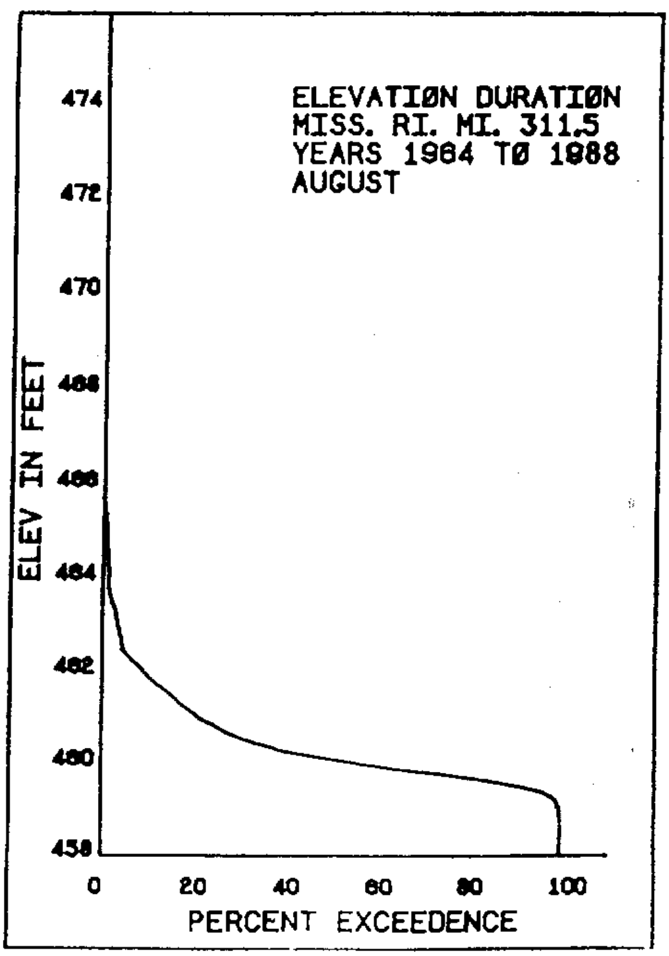
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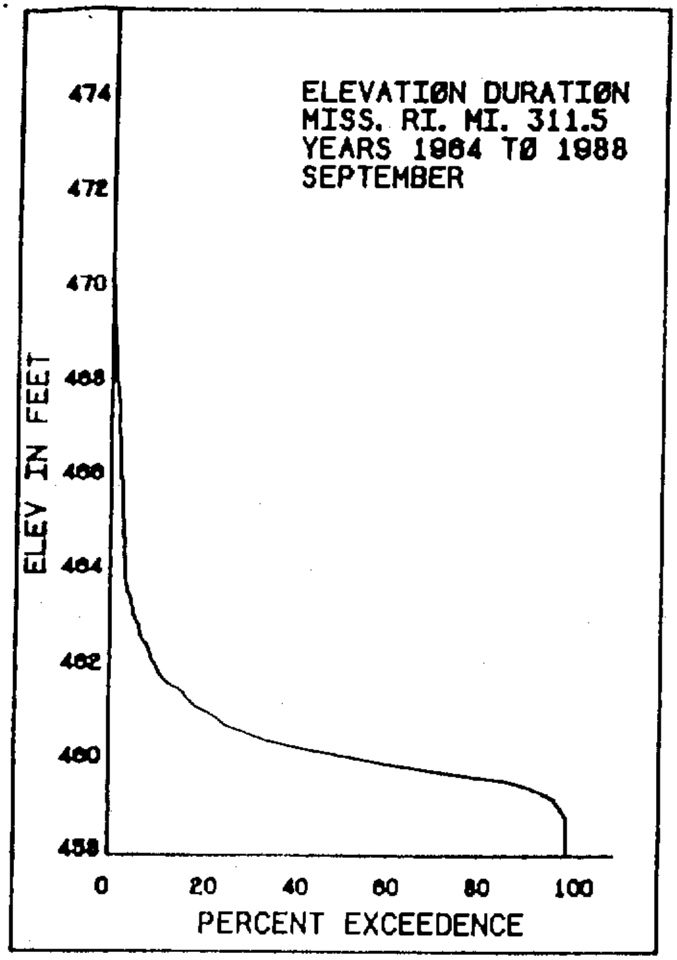
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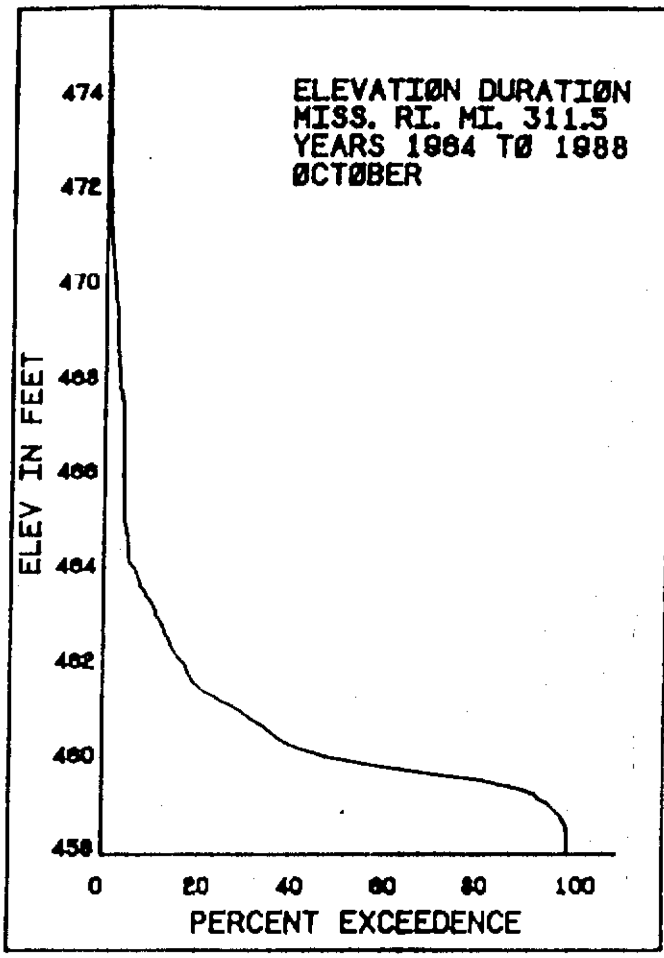
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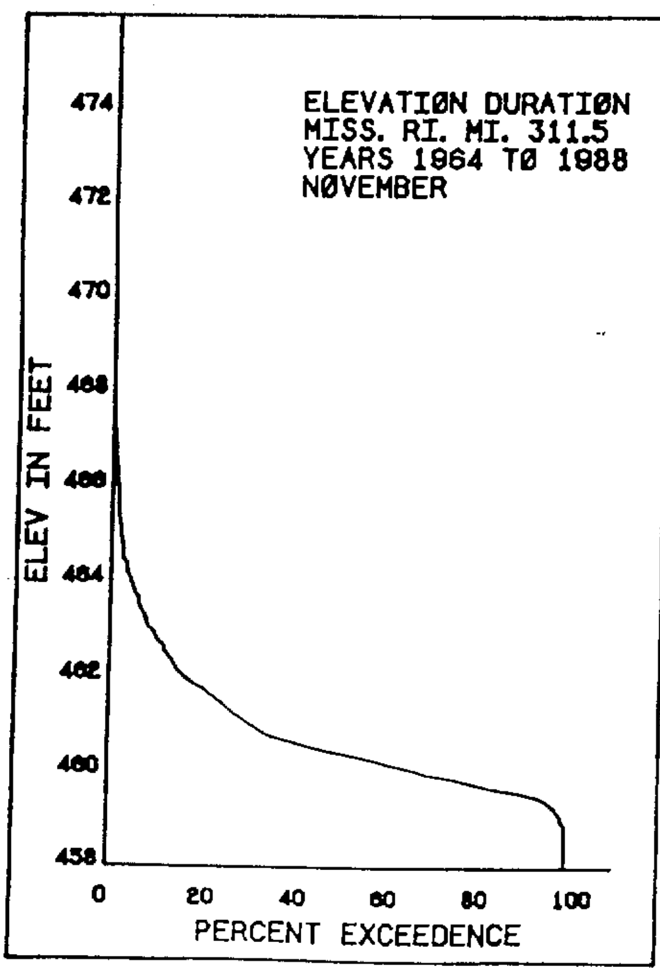
PERCENT EXCEEDENCE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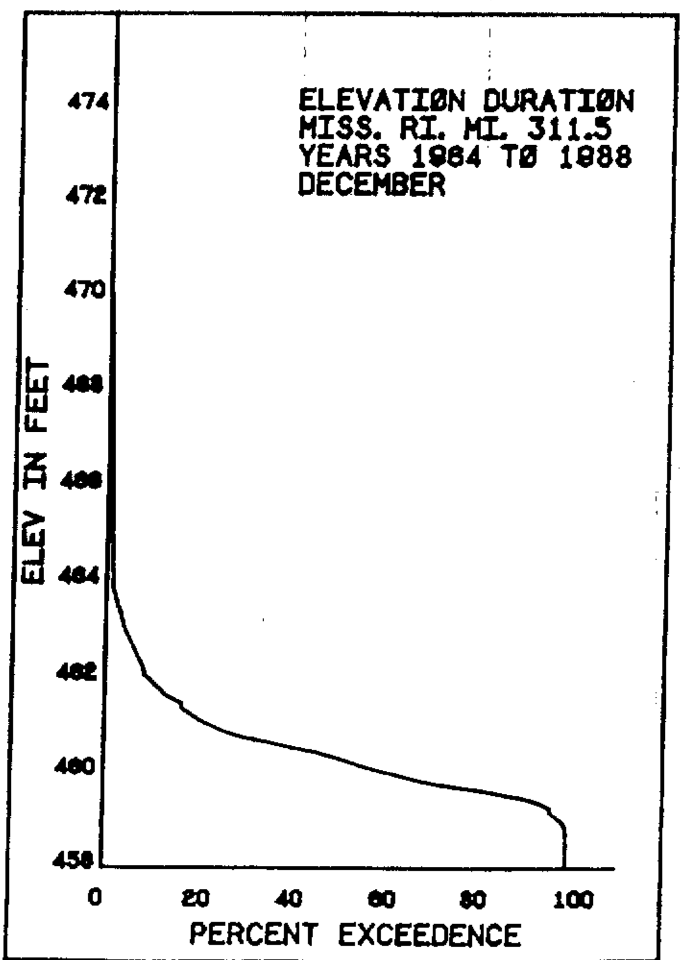
PERCENT EXCEEDENCE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MISS. RI. MI. 311.5
YEARS 1964 TØ 1988
DECEMBER
ELEV IN FEET
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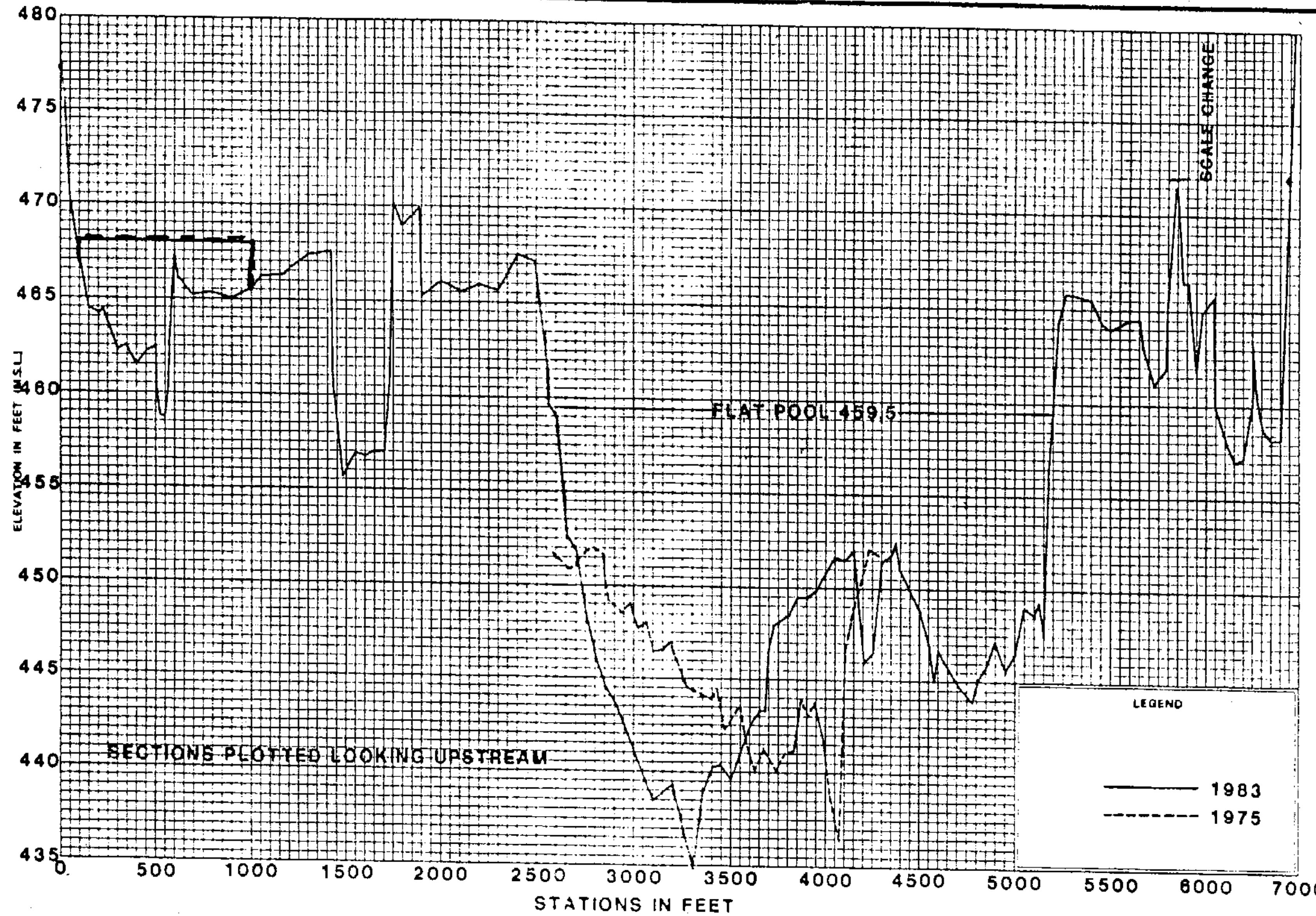
100
PERCENT EXCEEDENCE



CHANNEL SECTION AT RIVER MILE 311.0

MISSISSIPPI RIVER

BAY ISLAND

BAY ISLAND EMP
PUMP CAPACITY VS PUMPING DAYS

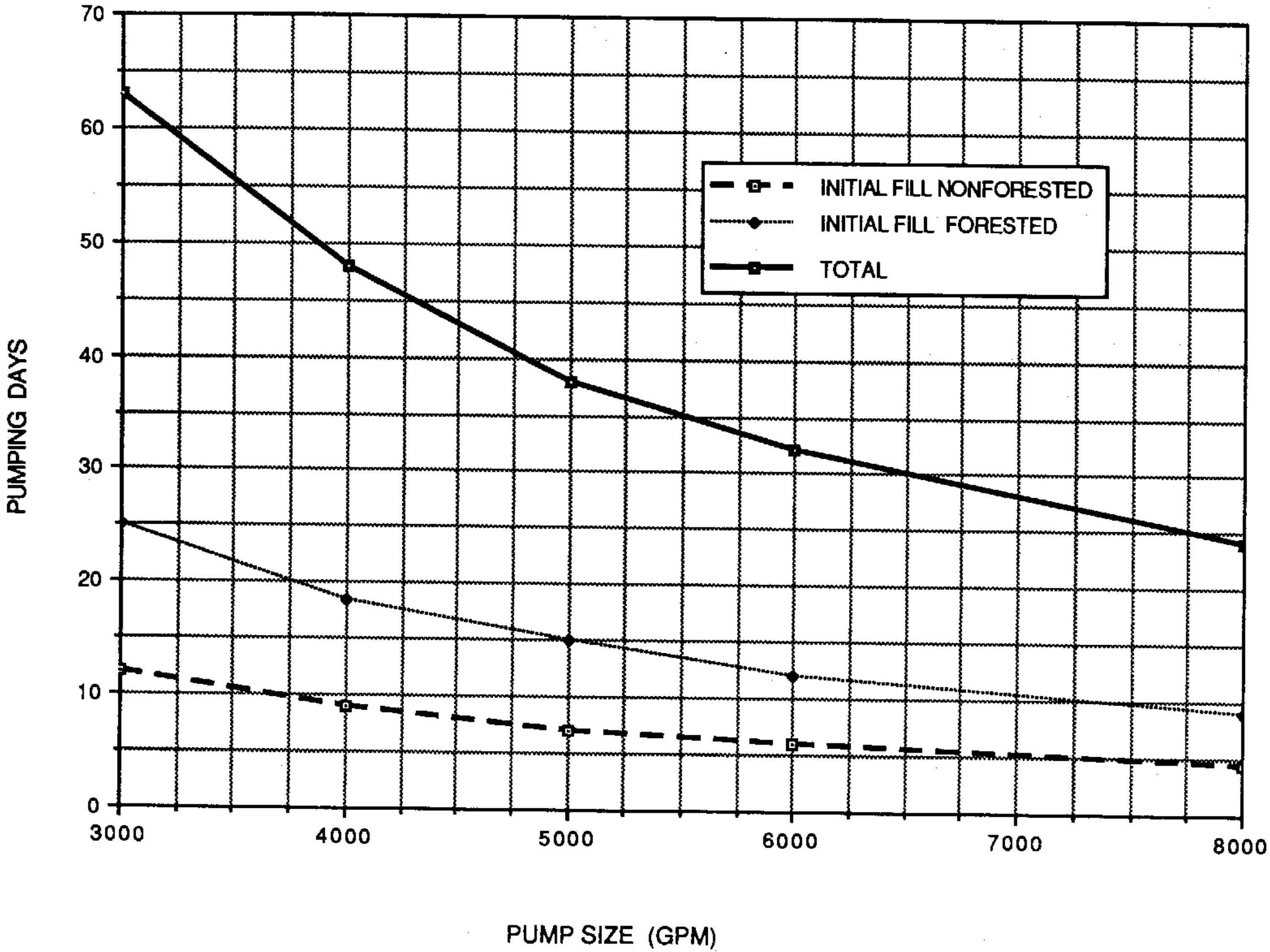


PLATE E-10

GEOTECHNICAL CONSIDERATIONS

APPENDIX G

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-8)

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX G
GEOTECHNICAL CONSIDERATIONS

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REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX G
GEOTECHNICAL CONSIDERATIONS

LOCATION

The Bay Island Rehabilitation and Enhancement project is situated within Marion County, Missouri, between Mississippi River miles 310.5 and 312. The site is located upstream from Hannibal, Missouri, and downstream from the South River Drainage District. The actual project area is at the extreme southern end of Bay Island. It is bounded by the Mississippi River and Ziegler Chute on the east and by the Bay de Charles on the southwest. The Bay Island area lies within the Dissected Till Plains section of the Central Lowlands Physiographic Province.

PHYSIOGRAPHY

The project also lies within the Mississippi River floodplain which is built on the glaciofluvial sand and gravel fillings of a former channel. The bottom of this channel lies more than 100 feet below the bed of the present channel. Bordering this plain are steep cliffs up to 200 feet in height. Mississippian age rocks are exposed along these bluffs. The surface soils of this area are mostly lean to fat clays varying from 3 to 24 feet in thickness. These soils are underlain by sands and gravels with an occasional lens of glacial till. There was no glaciation in this vicinity subsequent to Pre-Illinoisan. The Illinoisan terminated within a few miles of the site area. Bedrock of the Hannibal Shale Formation lies at a depth of approximately 110 feet.

SUBSURFACE EXPLORATIONS

Borings for this site were taken in January (BI-89-2, 4-9, 11-14), March (BI-89-1, 3, 10, 16 and 17), April 1989 (BI 89-15, 18), June 1989 (BI-89-19-26), and November 1989 (BI-89-27-29). These were primarily obtained with a 4-inch Iwan hand auger. A CME-45 drill rig with a 5-inch hollow stem auger was used for the deeper borings (BI-89-3, 10, 16, 19, 21-25, 27-29). Soil samples generally were taken at 2-foot intervals or at breaks in strata. For the deeper borings, samples were taken at 5-foot intervals if the material was consistent after penetration through the impervious top stratum. Shale bedrock was reached on BI-89-3, 28, and 29, approximate elevations 408.9, 413.3, and 417.9 feet MSL, respectively.

GROUNDWATER

Water levels are noted on the boring logs taken for this study. Based on interpretation of these logs, the ground water levels encountered in this area are fairly inconsistent. The elevations at which water was located ranged from 456.7 MSL to 463.5 MSL. The depths where water was encountered varied from 0.5 foot up to 8 feet. The highest elevation of the ground water level, 463.5 MSL, was found on boring BI-89-8, which was taken in a creek bottom. The lowest elevations were found in boring BI-89-9, located at the northwest corner of the project. Although levels are inconsistent, levels for borings taken during the same timeframe showed that groundwater flow appears to move from the bluffs to the river. The water levels should be expected to fluctuate with changes in climate conditions.

In lieu of the proposed pumping plant with channel to the Mississippi River for obtaining water to fill the wetland management units (WMUs), the possibility of using wells was investigated. The State of Missouri, Division of Geological Survey and Water Resources, provided copies of well logs and production rates for wells installed in Marion county and tapping the alluvial aquifer. These wells are located at the northern end of Bay Island near river mile 320. A review of production rates from these wells revealed that the aquifer's specific capacity is approximately 40 to 45 gallons per minute (gpm) per foot of drawdown (16-inch diameter well). To accommodate the WMU strategy, a pumping capacity of 6,000 gpm is required. This translates into four wells. This concept was not investigated further since it is more economical to build the pump plant.

SOILS AND SOIL TESTS

As mentioned before, the surface soils in this area are generally clays. In Marion County, based on information from the soil survey maps, there are three main series of clays: the Blase Series, Fatima Series, and Carlow Series.

a. Blase Series - This group consists of deep and poorly drained soils on the floodplain. Areas of the soils are usually elongated and higher than the plain. The layer on the surface is a dark gray clay that is silty and firm. This top layer is about 9 inches thick underlain by a 13-inch layer of a black, firm, silty clay. The substratum is a silt loam about 30 inches thick.

b. Fatima Series - These soils are moderately well drained soils of medium permeability on the bottom lands. They formed in silty alluvium. The surface layer is a dark, grayish brown, silt loam about 8 inches thick. The next layer is a 10-inch-thick silt loam. Surface runoff is slow in these soils. Available water capacity is high.

c. Carlow Series - This group consists of poorly drained soils formed in clayey alluvium in slack-water areas. These soils are level with the floodplain. The surface layer is a dark gray, silty clay about 6 inches thick. The subsurface layer is a 6-inch-thick dark gray, mottled, firm silty clay. Surface runoff is slow with a moderate capacity for water.

Using the Unified Classification System, these soils would be considered lean clay (CL) to silts (ML). This is seen in the boring logs, along with several sections of fat clays (CH) which were encountered.

Both field and laboratory visual classifications were performed on each soil sample obtained. The natural moisture content was determined on all impervious alluvium sediment soils. Atterberg limit tests also were run on select samples to aid in classification and to give some indication of the consistency of the natural materials. Additionally, gradation and minus number 200 sieve washes were performed on noncohesive materials. The D_{10} grain size, natural moisture content, Atterberg limits, encountered water level, strata changes, and visual classification are shown on boring logs plate 7 and 8 of the main report. Gradation curves are shown on plates G-12 through G-17.

PERIMETER LEVEE EMBANKMENT

The proposed perimeter levee, as shown on plate 3 of the main report, is 3 to 7 feet high and approximately 19,200 feet long. Its top elevation is constant at elevation 469 MSL at the northern end, sloping to 468 MSL at the southern end. The purpose of the levee is to create WMUs with controlled water levels for wildlife habitat in the interior of these units. The crown of the levee will be either 10 or 12 feet wide, depending on the need to have an access road located on it. The side slopes of the levee will be 1V on 4H. Construction of these levees will be accomplished using borrow from adjacent ditch cuts, or from borrow scraped from adjacent crop fields.

INTERMEDIATE LEVEE EMBANKMENT

The proposed intermediate levee embankment, as shown on plate 3 of the main report, is approximately 3 to 5 feet high and about 4,800 feet long. Its top elevation is constant at elevation 468 MSL. The purpose of the levee is to create the two separate WMUs, allowing different water levels to be maintained in each unit. The crown of the levee will be 10 feet wide. The side slopes of the levee will be 1V on 4H. Construction of these levees will be accomplished using borrow from adjacent ditch cuts.

FOUNDATION FOR EMBANKMENTS

The entire foundation beneath the proposed levee embankments will be stripped of vegetation and other deteriorated materials to a depth of 6 inches. All top roots, lateral roots, and trees within the embankment foundation areas will be removed to a depth of 3 feet below natural ground surface. An inspection trench is not considered necessary and will not be incorporated into the levee configuration.

An extensive field investigation and exploration program was accomplished to determine the foundation conditions. According to borings, which are pertinent to the perimeter levee embankment, the foundation material consists of recent alluvial deposits. Boring logs are shown on plates 7 and 8 of the main report. The top stratum varies in thickness from 7 feet to more than 16 feet and consists of normally consolidated impervious deposits (CL, CL-CH, CH, SC, and ML). The moisture content ranges from 25 to 44 percent for lean clay (CL) materials, 28 to 43 percent for medium clay (CL-CH) materials, 31 to 57 percent for fat clay (CH) materials, and 28 to 48 percent for silts (ML) materials.

Atterberg limits were performed on selected soil samples. These results are shown on the boring logs with typical results for CL soils ranging from 35/22 to 51/23, for CL-CH soils from 52/22 to 55/28, for CH soils from 57/23 to 79/25 and 31/24 to 48/29 for ML soils. For borings obtained using a rotary drill rig, standard penetration test "N" values were recorded during drilling and sampling operations. Values obtained for the top stratum ranged from 3 to 6 blow counts. Correlating these blow counts with shear strength, the shear strength of materials found at the project site are estimated to be 400 to 1,000 psf which correlates with pocket penetrometer tests run on selected clay samples.

Soils beneath the impervious top stratum are generally medium to fine sands (SP). Standard penetration test values for these materials range from 3 to 35 (disregarding the 45 obtained in B1-89-10 in the clayey, sandy gravel).

FOUNDATIONS FOR OTHER STRUCTURES

Five structures are proposed to be built as part of this project: three water control structures, a pump plant, and a bridge. Two of the water control structures are located in the perimeter levee (one in each WMU to allow independent water control in each area) at stations 95+80 and 79+50, with the third in the intermediate levee (allowing flow between the wetland management areas) at station 4+25A. The pump plant is located at station 8+00B. The bridge will be located near station 114+00 and will cross Clear Creek. Site-specific borings have been taken for each of the structures to determine the engineering characteristics of the foundation materials. Detailed descriptions of soils encountered are shown on boring logs (see plates 7 and 8 of the main report). The boring does not show undesirable or soft material. The unsuitable material which might not have been encountered by these borings will be replaced with appropriate fill if encountered. The replacement material will be placed and compacted to obtain a density equal to the adjacent undisturbed foundation. A dewatering system may be required to maintain the excavation area(s) in dry condition. Foundation design details of the proposed structures are given in Appendix H.

SLOPE STABILITY

The proposed perimeter levee near station 61+50 was found to be the most critical for slope stability analysis for the end of construction condition. Due to the low embankment heights and relatively firm foundation conditions encountered during subsurface explorations, only a hand analysis using slope stability charts was done. The chart used is shown on plate G-2 and is from "An Engineering Manual for Slope Stability Studies" by Duncan and Buchignani, published by the University of California, Berkeley.

Conservative shear strengths (UU) were assumed for the most critical configuration of embankment height and foundation conditions to estimate the stability of the embankment. Shear strength values assumed are shown on plate G-1 and are based on tests conducted on the samples both in the field and lab. The actual computations also are shown on plate G-1, along with the location of the critical failure surface. The computed minimum factor of safety of 2.6 for the perimeter levee embankment for the end-of-construction condition far exceeds the 1.3 required by EM 1110-2-1913, "Design and Construction of Levees," dated March 31, 1978. No slope stability problems are anticipated.

UNDERSEEPAGE

The occurrence of any underseepage-related distress due to this project was investigated. This included a study of the thickness and permeability of the top impervious stratum, the engineering characteristics of the pervious substratum, along with the lateral extent of the riverward and landward impervious blankets. Project operation also was taken into account.

The first item of concern is seepage from the northern WMU. Natural ground surface is in the vicinity of 462 to 463 MSL; the water elevation in the pond will be at elevation 464 MSL. The thickness of the impervious top stratum based on borings in the area is from 7 to 25 feet thick. By inspection, no problems due to underseepage are expected.

The second item of concern is seepage from the southern WMU. Natural ground surface in this vicinity is elevation 464 to 465 MSL; the water elevation in the pond will be at elevation 466 MSL. The thickness of the impervious top stratum based on borings in the area is from 8 to 40 feet thick. By inspection, no problems due to underseepage are expected.

Since the levees will be constructed from adjacent impervious materials, through-seepage will not be a problem. Depth of excavation during borrowing operations will be limited to ensure that no open entrance to the underlying sand stratum is created.

SETTLEMENT

The same level section that was analyzed for slope stability also was deemed most critical with respect to settlement. A settlement analysis was made using information contained in "Foundation Analysis and Design" by Joseph Bowles, 3rd Edition, 1982. Settlement prediction for the highest perimeter levee is 13 inches; the analysis is shown on plate G-3. Additionally, analyses were performed on "typical" levee section (plate G-4). For a 5-foot-high perimeter levee, the estimated settlement is 9 inches.

To account for this estimated settlement, as well as any unexpected settlement, a shrinkage allowance of 15 percent of the levee height will be provided in the specifications.

To ensure against no excessive settlement after construction, site-specific settlement analysis was performed for the water control structures. This analysis was performed to determine height of surcharge load versus time for 3, 6, 9, and 12 months. Six months is the minimum practical time to expect settlement to be achieved, which theoretically will require a surcharge depth of 9.1, 8.2, and 6.3 feet for stations 4+25A, 79+50, and 95+80, respectively. The results of this investigation are shown on plate G-10.

It is recommended that settlement plates also be used to ensure that a minimum of 85 percent of the expected settlement has taken place before construction of the structures.

SLOPE PROTECTION

Both levee embankments will be grass seeded since a heavy timber growth is evident on both sides of the levee. Therefore, it is anticipated that grass protection will be adequate against wave wash. From stations 121+63 to 46+51 and stations 0+00B to 72+17B, the profile of the levee will be placed on a steeper gradient than the natural river flood profile to ensure that overtopping occurs from the downstream end. Also, the water control structures have been designed to allow sufficient inflow into the units during a flood event that will result in a head differential of only 0.7 foot at overtopping. This will preclude the need for additional scour protection.

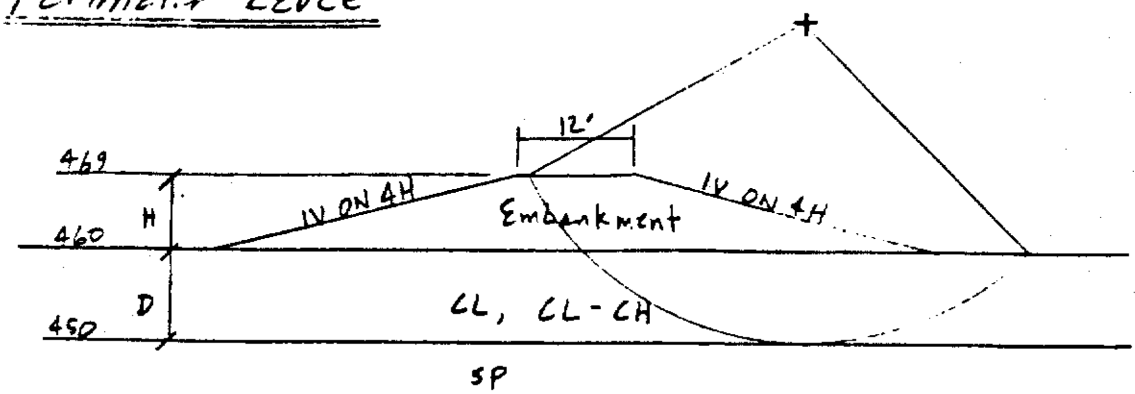
BORROW MATERIAL

Material for construction of all the levees involved in this project will be obtained from adjacent ditch cuts or from borrow scraped from adjacent crop fields. A 15-foot minimum area between the toe of the embankment and the ditch excavation will remain relatively undisturbed and in place. The depth of the excavation will be controlled to ensure that the impervious top stratum remains in place, thus not creating an open entrance for seepage to the underlying sand materials. (See plate G-5 for typical section.)

Based on information obtained from the boring logs regarding the materials in the area, this material should be suitable for use in levee construction. Due to the relative low heights and flat slopes of the embankments needed for this project, the semi-compacted method of material placement is recommended. It is not necessary to incur the expense of drying the materials to optimum moisture content, although for some reaches of embankment construction drying back of the adjacent materials may be required.

Subject		Date
Bay Island - Slope Stability Analysis		12 June 89
Computed by	Checked by	Sheet 1 of 2
Ejm	SZ	

Perimeter Levee



① Assume $c = 400$ psf throughout (conservative)

② $\gamma_m = 115$ pcf

Calculate depth factor d:

$$d = D/H = 10/9 = 1.11$$

Calculate P_d:

$$P_d = \gamma H = (115)(9) = 1035 \text{ lbs}$$

Coordinates for Critical Circle

$X = x_0 H$ where $x_0 = 1.7$ (from chart)

$$X = (1.7)(9) \doteq 15$$

$Y = y_0 H$ where $y_0 = 3.0$

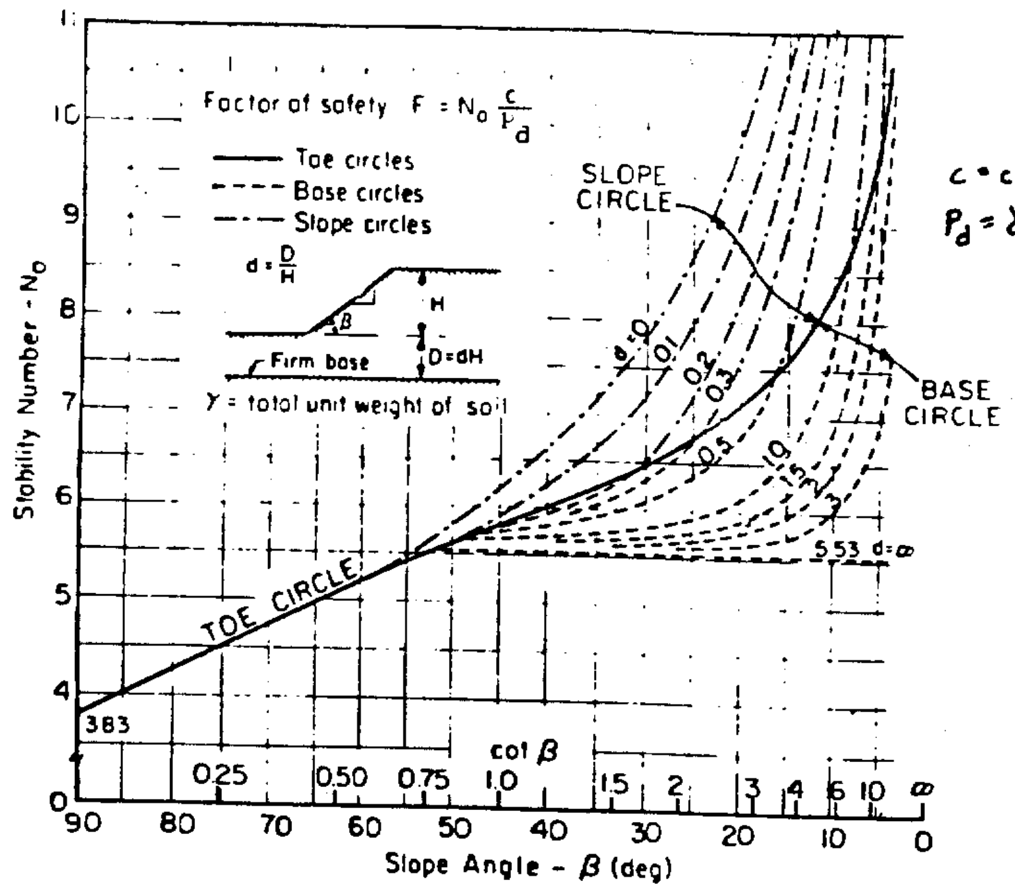
$$Y = (3)(9) = 27$$

Stability Number (from chart) N_0 using β (Slope ∢) and d

$N_0 = 6.7$ (Base circle is critical)

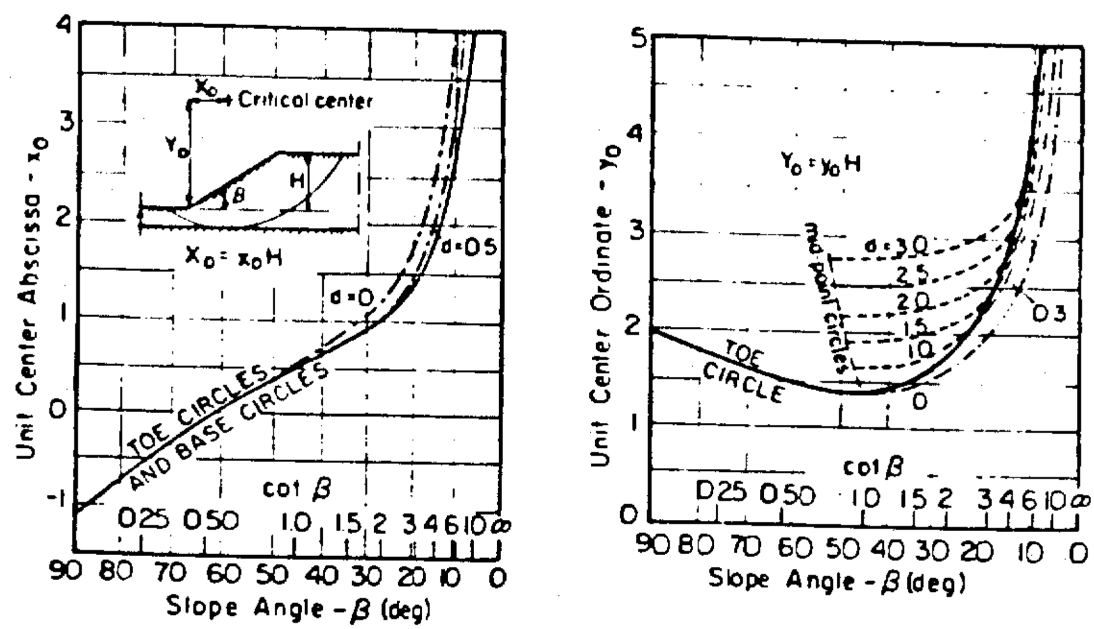
Factor of Safety $F = \dfrac{N_0 c}{P_d} = \dfrac{(6.7)(400)}{1035} \doteq \underline{\underline{2.6}}$ $\underline{\underline{OK}} > 1.3$

NCR Form 1 Aug 83 381b



c = cohesion
$P_d = \gamma H$

STABILITY NUMBER

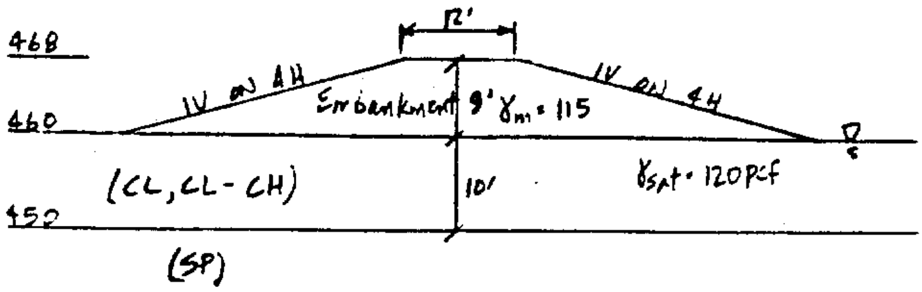


CENTER COORDINATES FOR CRITICAL CIRCLE

SLOPE STABILITY CHARTS FOR ϕ = 0 SOILS (after Janbu, 1968)

Subject		Date
Settlement Analysis Bay Island EMP		12 June 89
Computed by [illegible]	Checked by SZ	Sheet 1 of 2

Perimeter levee



from Borings BI-89-7 & 8

Average moisture content (disregard organic material) = 42% (W_n)

Average LL = 49% (WL)

Specific Gravity = 2.70 $\qquad e_o = WG_s = (.42)(2.70) = 1.134$

P = stress exerted by 9' high embankment = (9)(115) = 1035 lbs

P_o = Initial stress at midpoint of layer = (5)(120 - 62.4) = 288 lbs

$C_c = 0.37\,(e_o + 0.003\,WL + 0.0004\,W_n - 0.34)$ Fdn Analysis & Design by J. Bowles
$= 0.37\,(1.134 + .1470 + 0.0168 - 0.34)$
$= 0.3544$

Boussinesq Coefficient = 0.95

$$S = \frac{C_c}{1+e_o} H \log_{10} \frac{P_o + \Delta P_o}{P_o} = \frac{0.3544}{1+1.134}(10)\log_{10}\left(\frac{288 + (0.95)(1035)}{288}\right)$$

$= 1.07' \doteq 13''$

NCR Form 381b
1 Aug 80

Subject: Settlement Analysis Bay Island EMP		Date: 12 June 85
Computed by: Dym	Checked by: SZ	Sheet 2 of 2

Perimeter Levee Typical (5' high)

$F = (5)(115) = 575$ lbs

F_o = (as before) = 288 lbs see plate C-4

Boussinesq Coefficient = 0.86

$$S = \frac{0.3544}{1+1.134}(10)\log_{10}\left(\frac{288+(0.86)(575)}{288}\right) = 0.77' \doteq 9''$$

NCR Form 381b
1 Aug 80

Subject: Proposed Borrow Areas

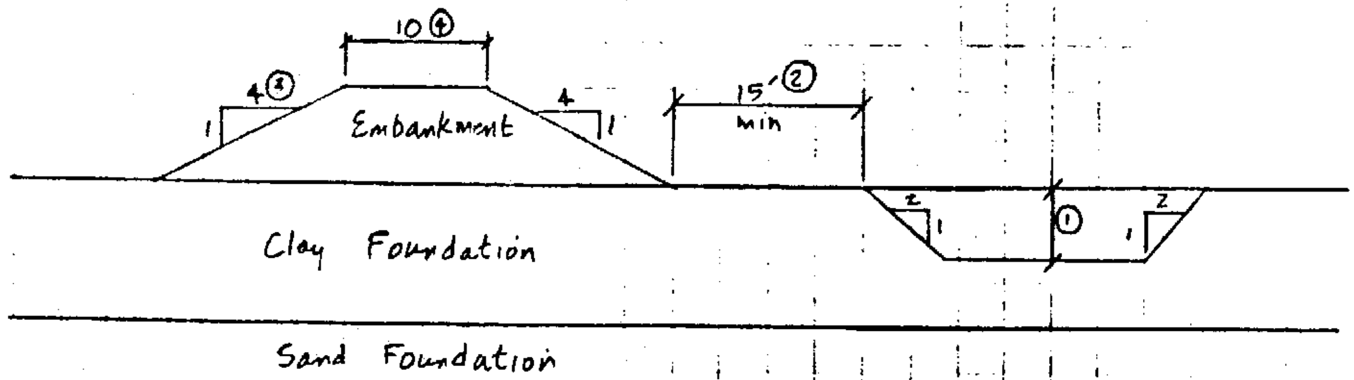
Computed by: [initials]

Checked by: SZ

Date: 14 June 89

Sheet 1 of 1

Proposed Borrow Areas.



Notes:

① Depth of excavation varies, 4 foot minimum thickness of impervious top stratum materials will remain. Side slopes of cut 1V on 2H.

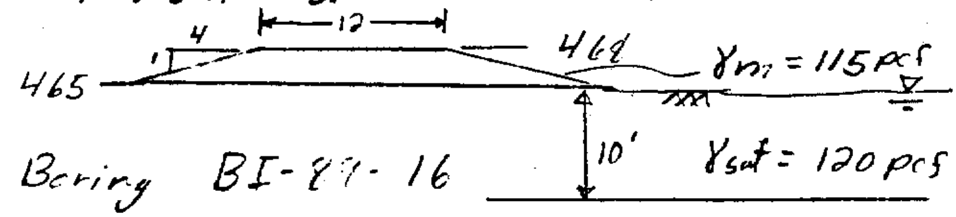
② Minimum distance from new levee embankment to top of cut slope will be 15 feet.

③ Side slopes of perimeter levee and intermediate levee embankments will be 1V on 4H. ~~Side~~ slopes of sediment deflection levee will be ~~1V on~~ 3H.

④ If access required top width will be 12 feet.

Subject		Date
Bay Island - Depth of Surcharge		12 Feb 1990
Computed by Eugene Reed	Checked by SAZ	Sheet 1 of 6

Station 4+25 F - water control



From Boring BI-89-16

$(W_n)_{avg} = 36\%$

$LL = (W_L)_{avg} = 61$

Specific Gravity $\cong 2.70 = G_s$

$e_o = W_n G_s = (.36)(2.70) = 0.972$

ΔP = stress by 3' high Levee $(3)(115)$

$= 345 \text{ lbs/ft}^2$

P_o : stress @ midpoint $= 5(120-62.4)$
$= 288 \text{ lbs/ft}^2$

$C_c = 0.37(e_o + 0.003 W_L + 0.0004 W_n - 0.34)$

$= 0.37(0.972 + 0.183 + 0.0144 - 0.34)$

$= 0.307$

$S = \frac{C_c}{1+e_o} H \log \frac{P_o + \Delta P}{P_o} = \frac{0.307}{1+0.972}(10)\log_{10}\left(\frac{288+345}{288}\right)$

$= 0.532' \approx 6\frac{1}{2}$ inches

NCR Form 381b
1 Aug 80

Subject: Depth of Surcharge	Date: 12 Feb
Computed by: Eugene Band · Checked by: SfZ	Sheet 2 of 6

$t = \frac{T_v (d)^2}{C_v (\ldots)} = \frac{10^2}{.09 (\ldots)} (T_v) = 37 T_v$

4+25 A

$C_v = 0.09 \frac{ft^2}{day}$

U%	Tv	t month	Settlement (in)
10	.00[illegible]	0.296	.63
20	.031	1.146	1.30
30	.071	2.620	1.95
50	.20	7.407	3.25
73	.48	~~17.778~~	4.87
90	.85	~~31.48~~	5.95
95	1.13	41.85	6.18
100			6.5

S = Settlement

for consolidation to be complete in 3 month

$\Rightarrow T_v = 0.081$ $T_v = \frac{\pi}{4}\left(\frac{U\%}{100}\right)^2$ $T_v \le 60\%$

$U\% = 32.1\ \%$

$\Rightarrow S = 2.02$

$\Rightarrow \Delta P = 3209$

depth of surcharge = 21.39

C = 6 month Tv = 0.162 U% = 45.4% S = 14.3 ΔP = 1390

deth of surcharge = 9.1 ft

C = 9 months Tv = 0.243 U% = 55.7 S = 11.67 ΔP = 926

depth of surcharge = 5.1 ft

C = 12 months depth of surcharge = 3.2 ft

NCR Form 381b
1 Aug 60

Subject: Depth of Surcharge		Date: 13 Feb
Computed by: Eugene Ras	Checked by: SAZ	Sheet 3 of 6

Station 19+50 - Water Control

Boring BI-81-6

$H_{void} = 8 ft$ $W_n = 33$ $LL = w_L = 44$ $G_s = 2.7$

$e_0 = (.33)(2.7) = 0.891$

$\Delta P = (8)(115) = 920 \text{ lb/ft}^2$ $P_0 = 288$

$C_c = 0.37(0.891 + 0.132 + 0.013 - 0.34) = 0.258$

$$S = \frac{0.258}{1+0.891}(10)\log_{10}\left(\frac{288+920}{288}\right) = 0.8581$$

$= 10$ inches

$C_v = 0.22 \text{ Ft}^2/\text{day}$

$$t = \frac{T_v(d^2)}{C_v(30)} = \frac{10^2}{(.22)(30)} T_v = 15.2\,T_v$$

For consolidation in 3 months

$T_v = 0.20$ $U\% = 51\%$ $S = 19.8''$

depth of surcharge = 30 feet

6 months

$T_v = 0.395$ $U\% = 70.1$ $S = 14.3''$

depth of surcharge = 8.2 feet

9 months

$T_v = 0.59$ $U\% \cong 85\%$ $S = 11.8$

depth of surcharge = 2.6 feet

12 months

$T_v = 0.79$ $U\% = 91\%$ $S = 11.4$

depth of surcharge = 1.9 feet

Subject: Depth of Surcharge	Date: 13 Feb
Computed by: Eugene Ray ✓ — Checked by: SIZ	Sheet 4 of 6

Station 45+80 Boring BI-84-3

$H_{levee} = 6.5 ft$ $\omega_n = 25$ $LL - WL = 51$ $G_s = 2.7$

$e_o = (.25)(2.7) = 0.675$ $\Delta P = 6.5(115) = 747.5$

$C_c = 0.37(.675 + .153 + .01 - 0.34) = 0.184$

$$S = \frac{0.184}{1+.841}(16)\log_{10}\left(\frac{288+747.5}{288}\right) = 0.54' = 6.5''$$

$C_v = 0.22$ $t = 15.2 T_v$

For consolidation in 3 months

$T_v = 0.2$ $U\% = 50.5\%$ $S = 12.9$

depth of surcharge = 22.7 feet

6 months

$T_v = 0.395$ $U\% = 71\%$ $S = 9.2$

depth of surcharge = 6.3 feet

9 months

$T_v = 0.59$ $U\% = 84\%$ $S = 7.7$

depth of surcharge = 2.5 feet

12 months

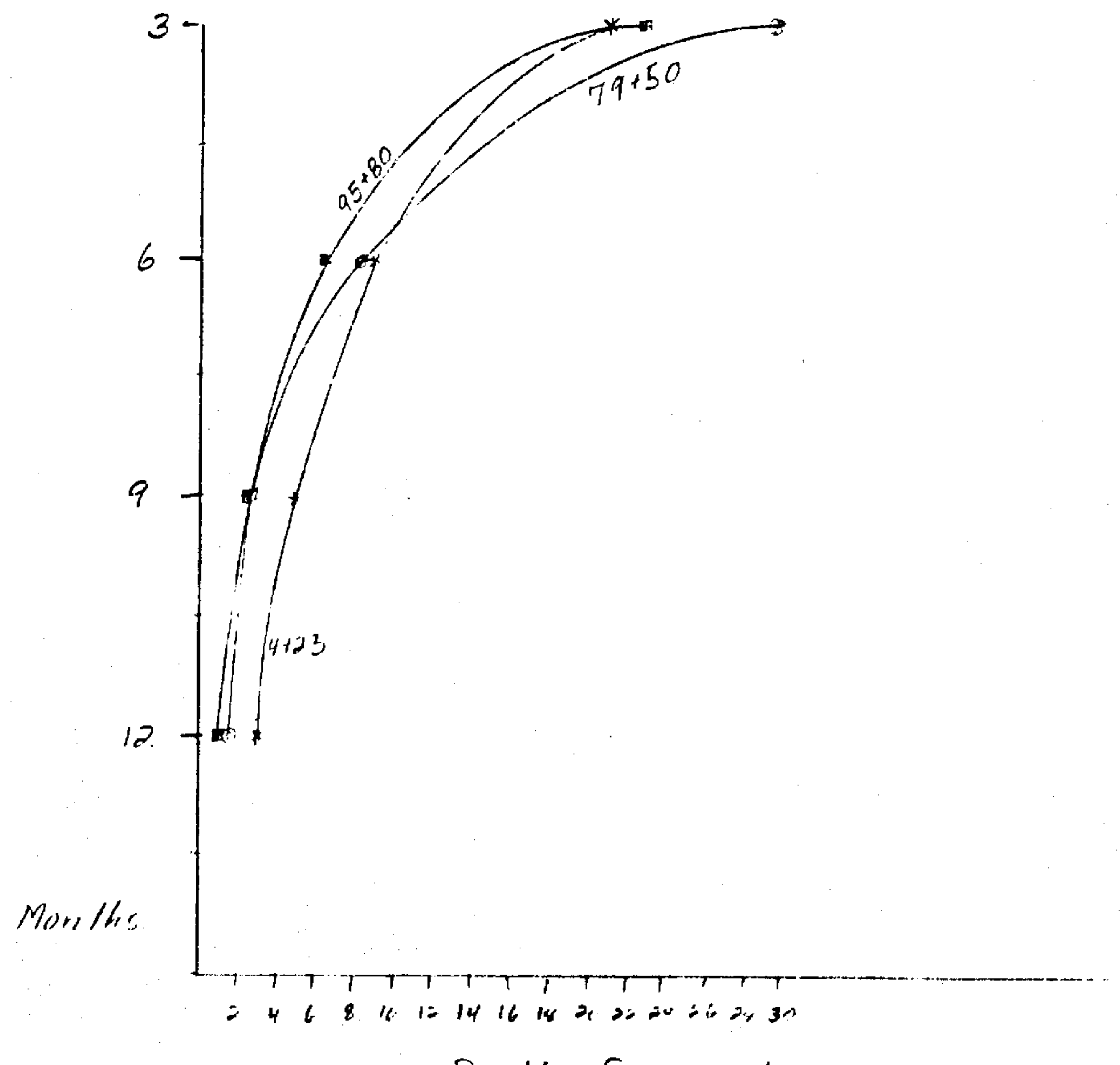
$T_v = 0.79$ $U\% = 88\%$ $S = 7.4$

depth of surcharge = 1.7 feet

NCR Form

PLATE G-9

Subject: Depth of Surcharge	Date: 13 Feb
Computed by: Eugene RaO / Checked by: SAZ	Sheet 5 of 6



Note: Depth of surcharge is the amount of material that will theoreticaly give 100% of the anticipated settlement due to the construction of the water control structures in the time indicated.

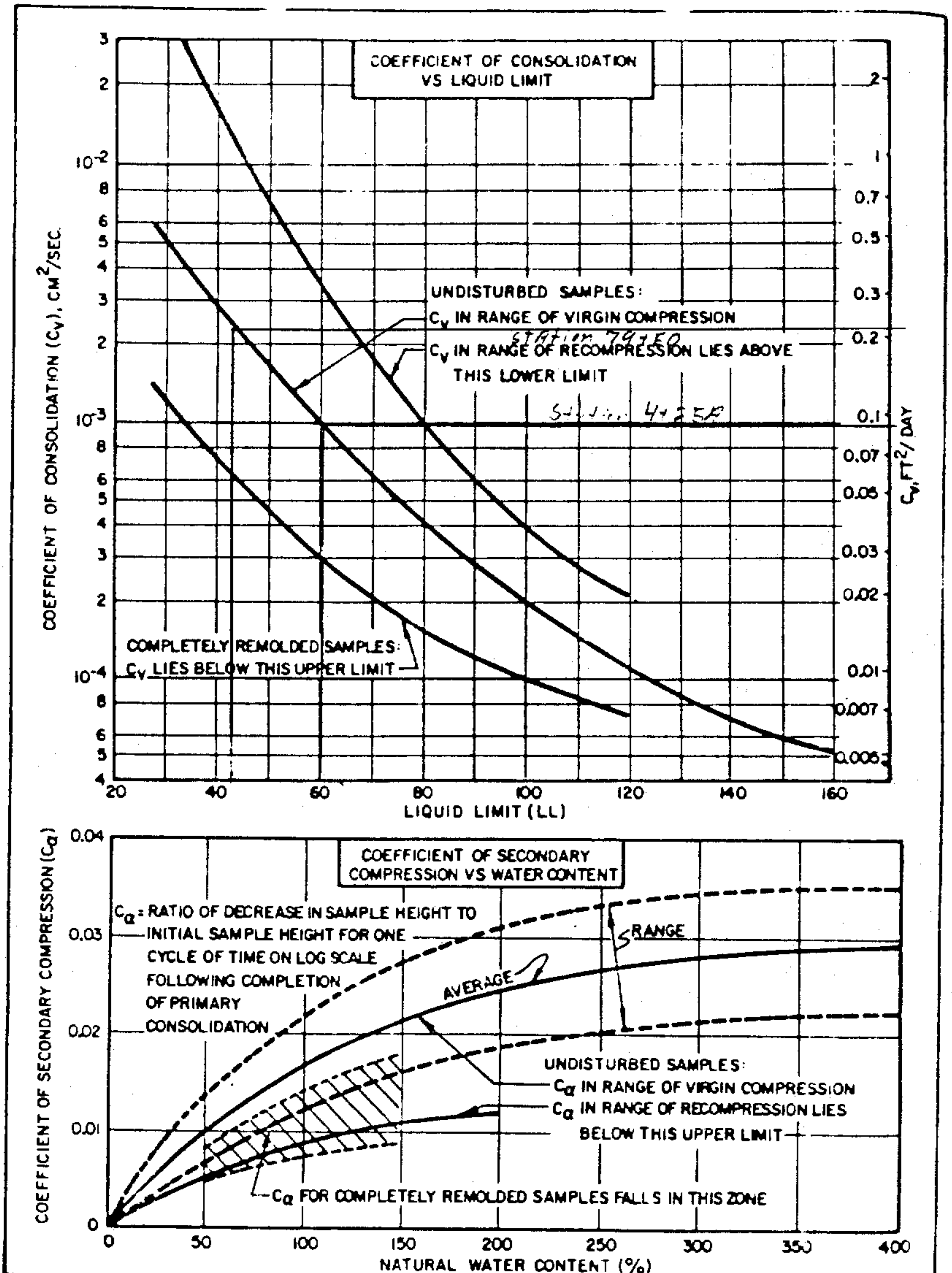
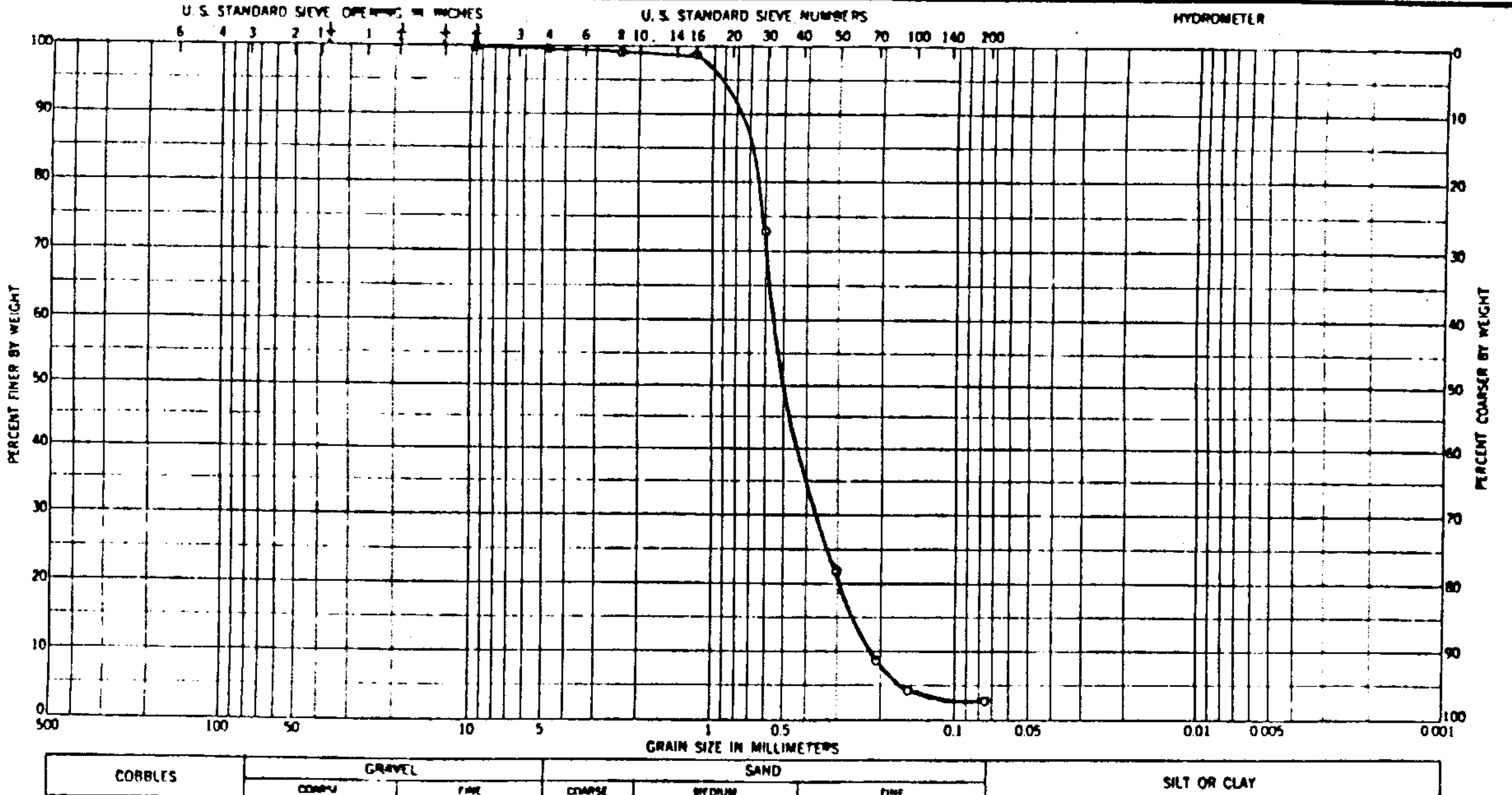


FIGURE 4
Approximate Correlations for Consolidation Characteristics of Silts and Clays



Sample No.	Elev or Depth	Classification			-#200	D10
13	50.0-51.0	SP GRAY MEDIUM TO FINE SAND			2.7%	0.22

Project BAY ISLAND EMP PROJECT

Area

Boring No. BI-89-3

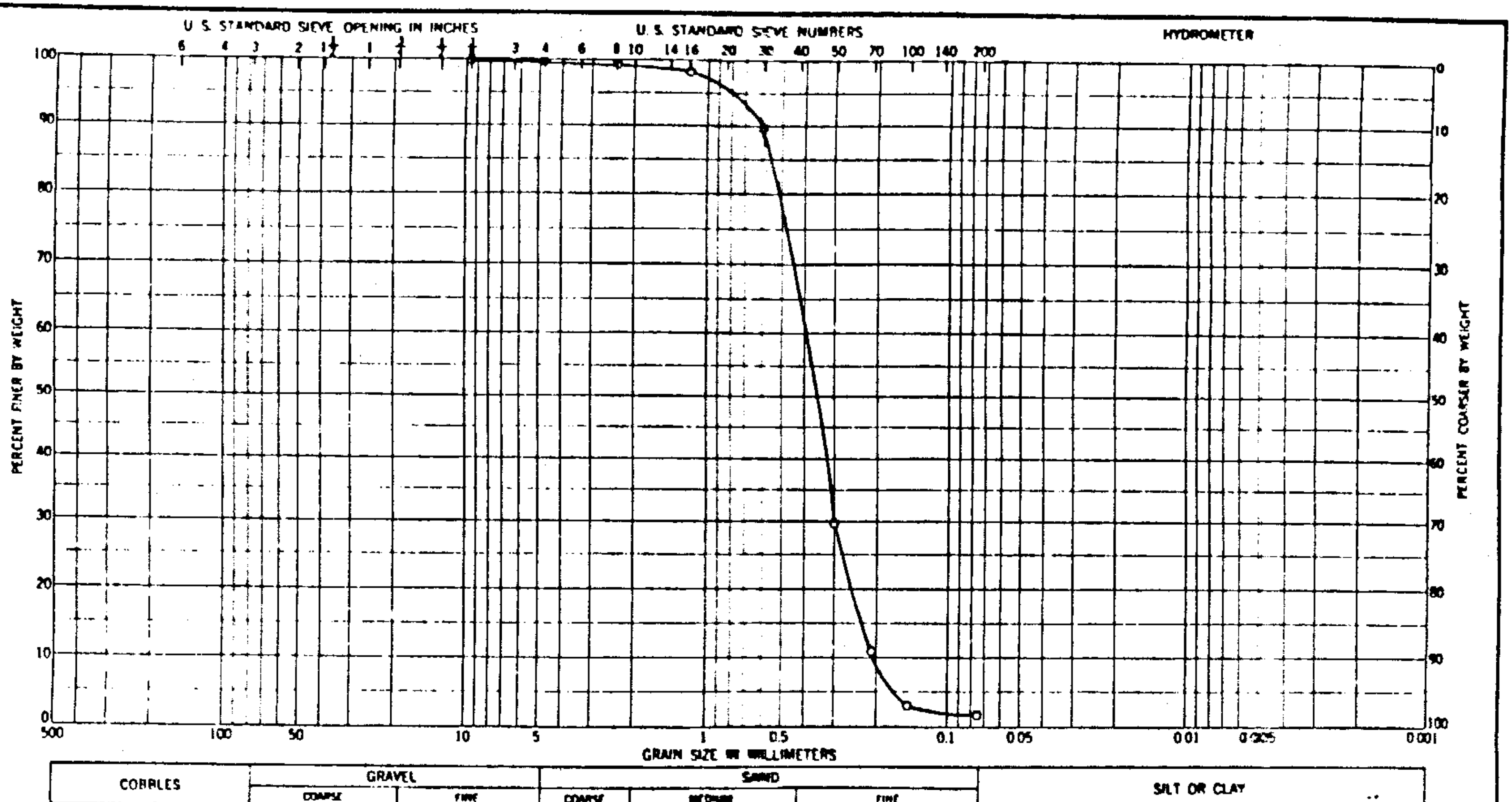
Date 30 MARCH 1989

GRADATION CURVES

PLATE G-12

ENG FORM 1 MAY 63 2087

GPO 926-280



Sample No	Elev or Depth	Classification			-#200	D_{10}
11	35.5-36.5	SP GRAY MEDIUM TO FINE SAND			1.9%	0,21

Project: BAY ISLAND EMP PROJECT

Area:

Boring No: BI-89-10

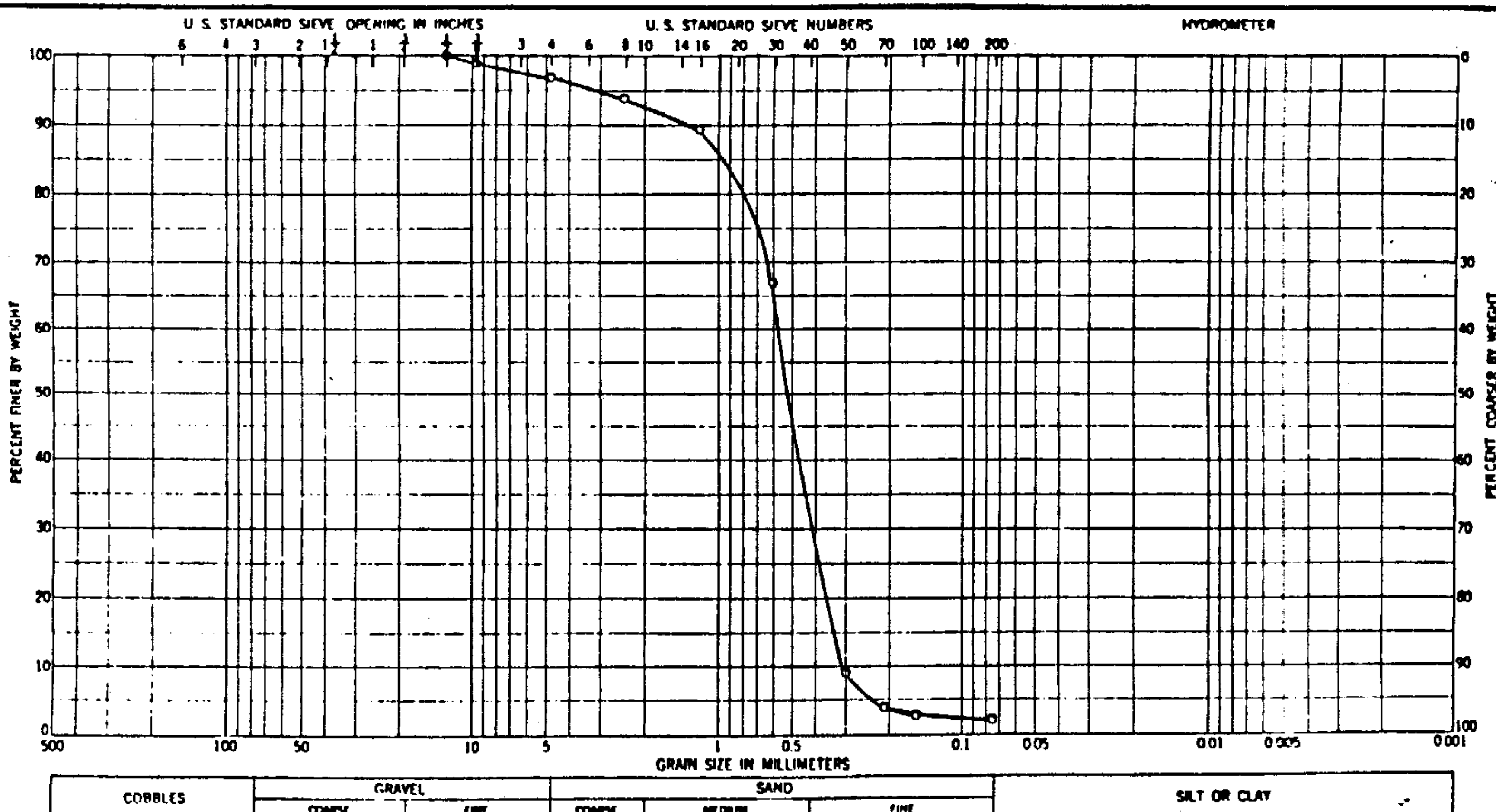
Date: 29 MARCH 1989

GRADATION CURVES

PLATE G-13

ENG FORM 1 MAY 63 2087

GPO 926-290



Sample No.	Elev or Depth	Classification			-#200	D_{10}
14	50.5-51.5	SP GRAY MEDIUM TO FINE SAND TRACE GRAVEL			1.8%	0.31

Project BAY ISLAND EMP PROJECT

Area

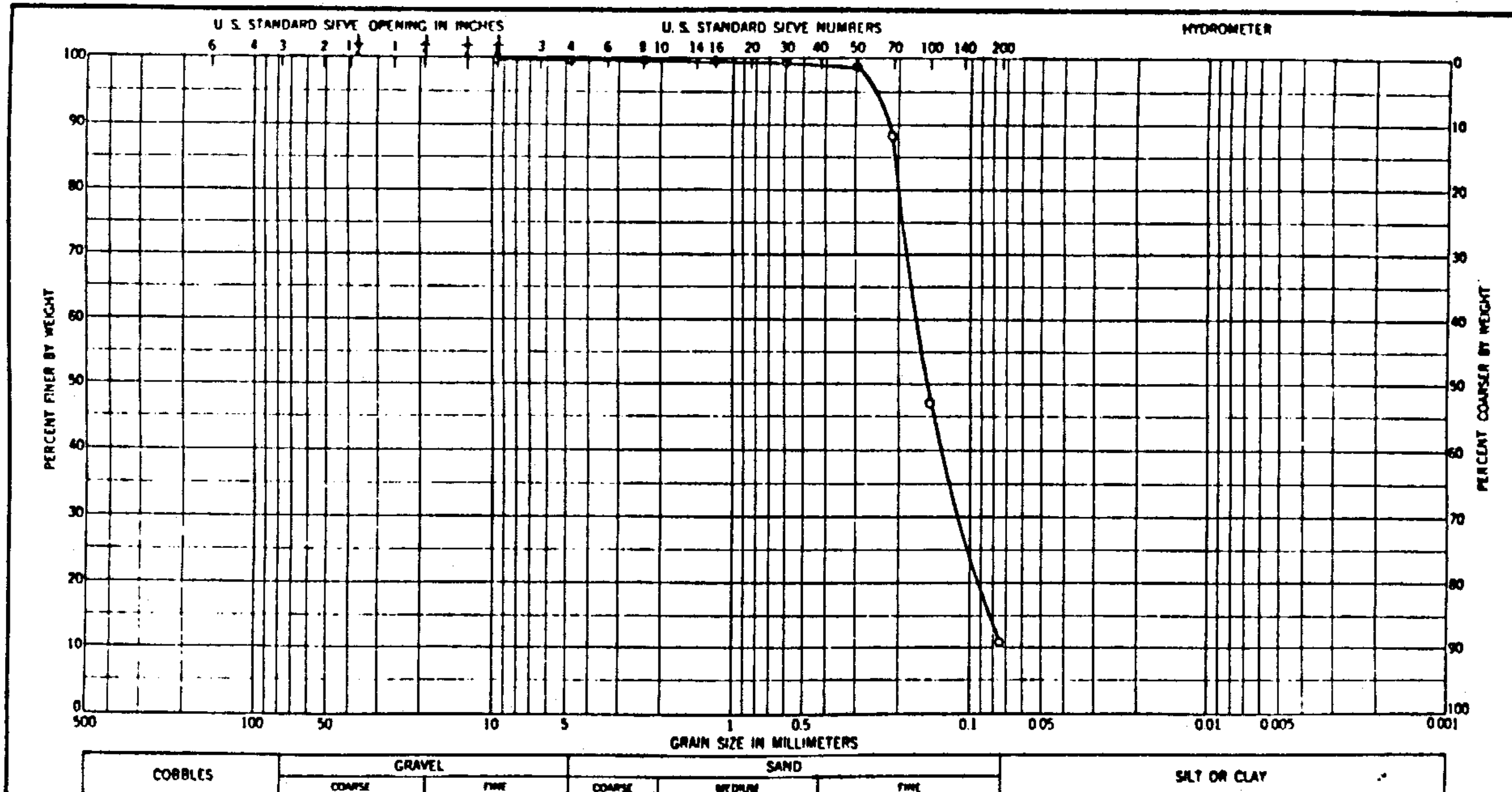
Boring No. BI-89-10

Date 29 MARCH 19[illegible]

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 926-230



Sample No	Elev or Depth	Classification			-#200	D_{10}
6	19.5-20.5	SP-SC GRAY CLAYEY FINE SAND			11.0%	0.07

Project BAY ISLAND EMP PROJECT

Area

Boring No BI-89-16

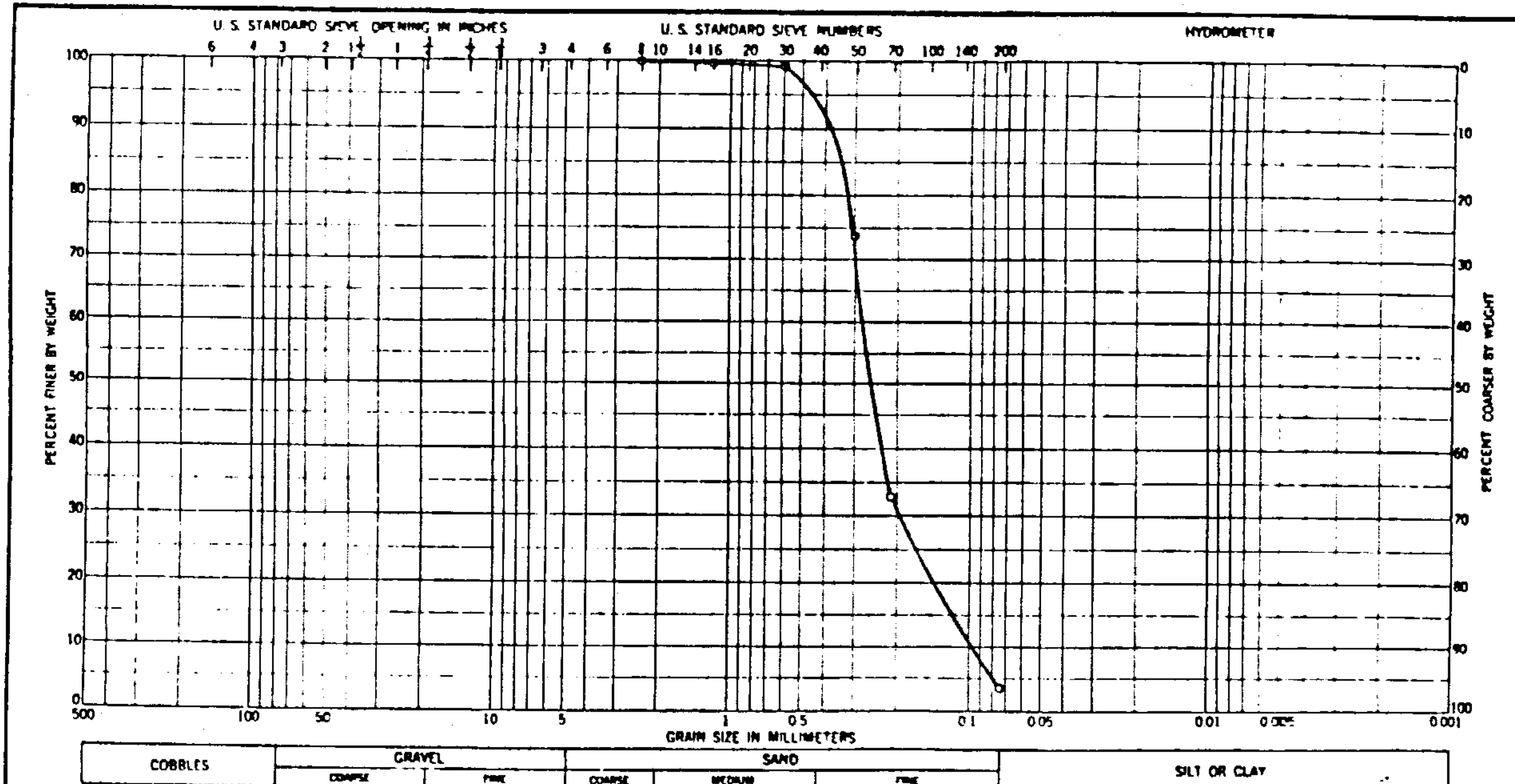
Date 30 MARCH 1989

GRADATION CURVES

PLATE G-15

ENG FORM 1 MAY 63 2087

GPO 828-260



Sample No.	Elev or Depth	Classification			-200	D_{10}
10	39.5-40.5	SP GRAY FINE SAND			3.5%	0.10

Project BAY ISLAND EMP PROJECT

Area

Boring No BI-89-16

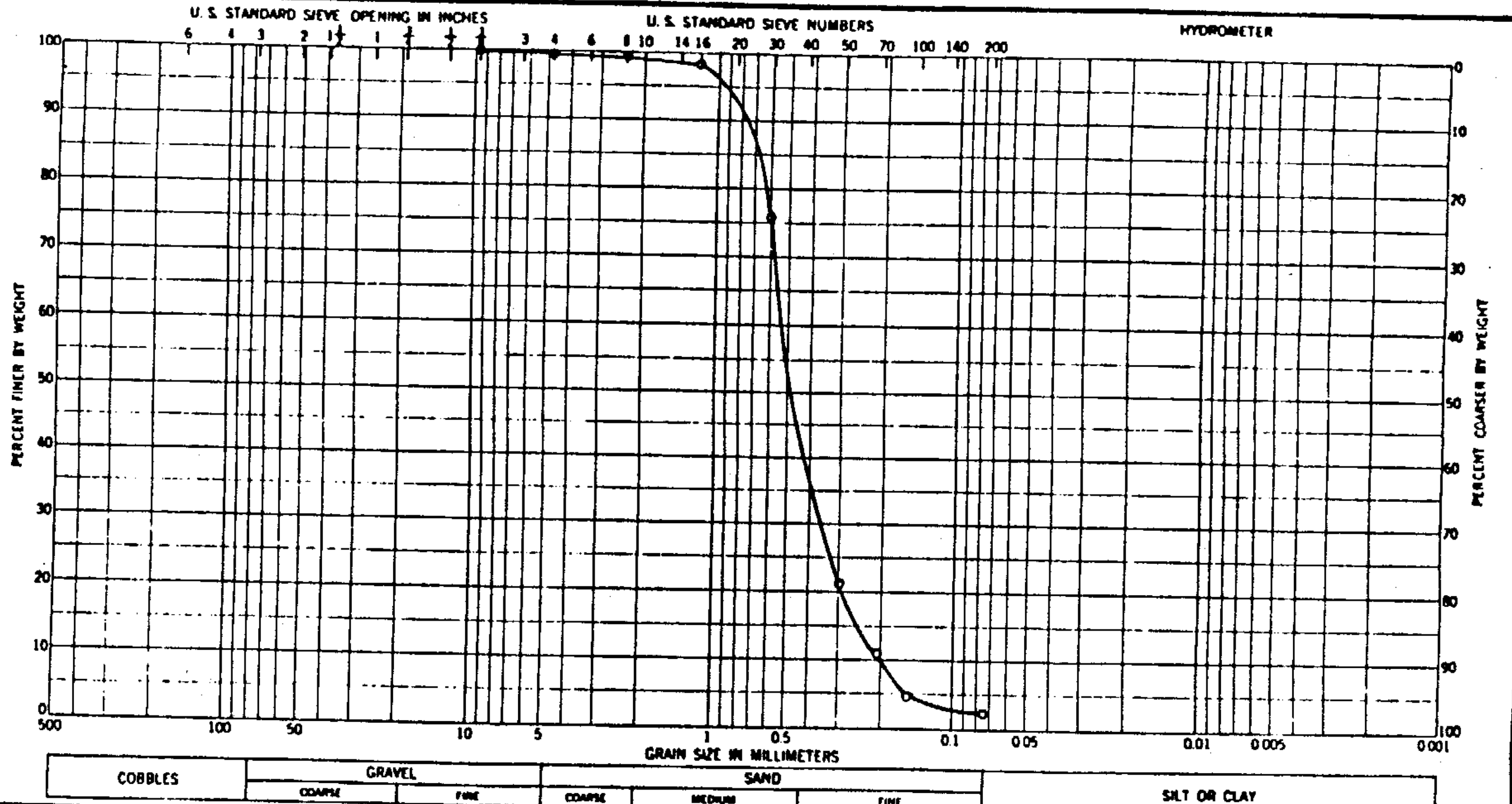
Date 30 MARCH 1989

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 926-290

PLATE G-16



Sample No.	Elev or Depth	Classification			-#200	D10
14	59.5-60.5	SP GRAY MEDIUM TO FINE SAND			2.3%	0.20

Project BAY ISLAND EMP PROJECT

Area

Boring No. BI -89-16

Date 30 MARCH 1989

PLATE G-17

GRADATION CURVES

ENG FORM 1 MAY 63 2087

GPO 920-280

STRUCTURAL DESIGN

A
P
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E
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D
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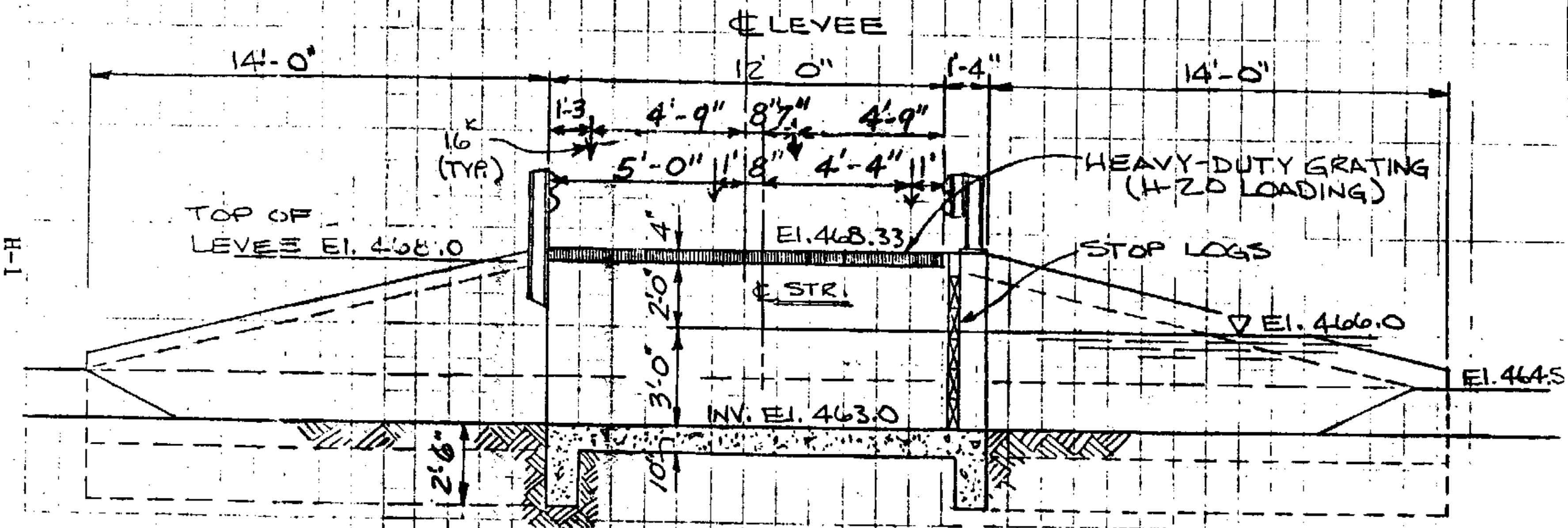
X

H

Subject
Computed by
Checked by DAP
Date 30 MAY 80
Sheet 1 of

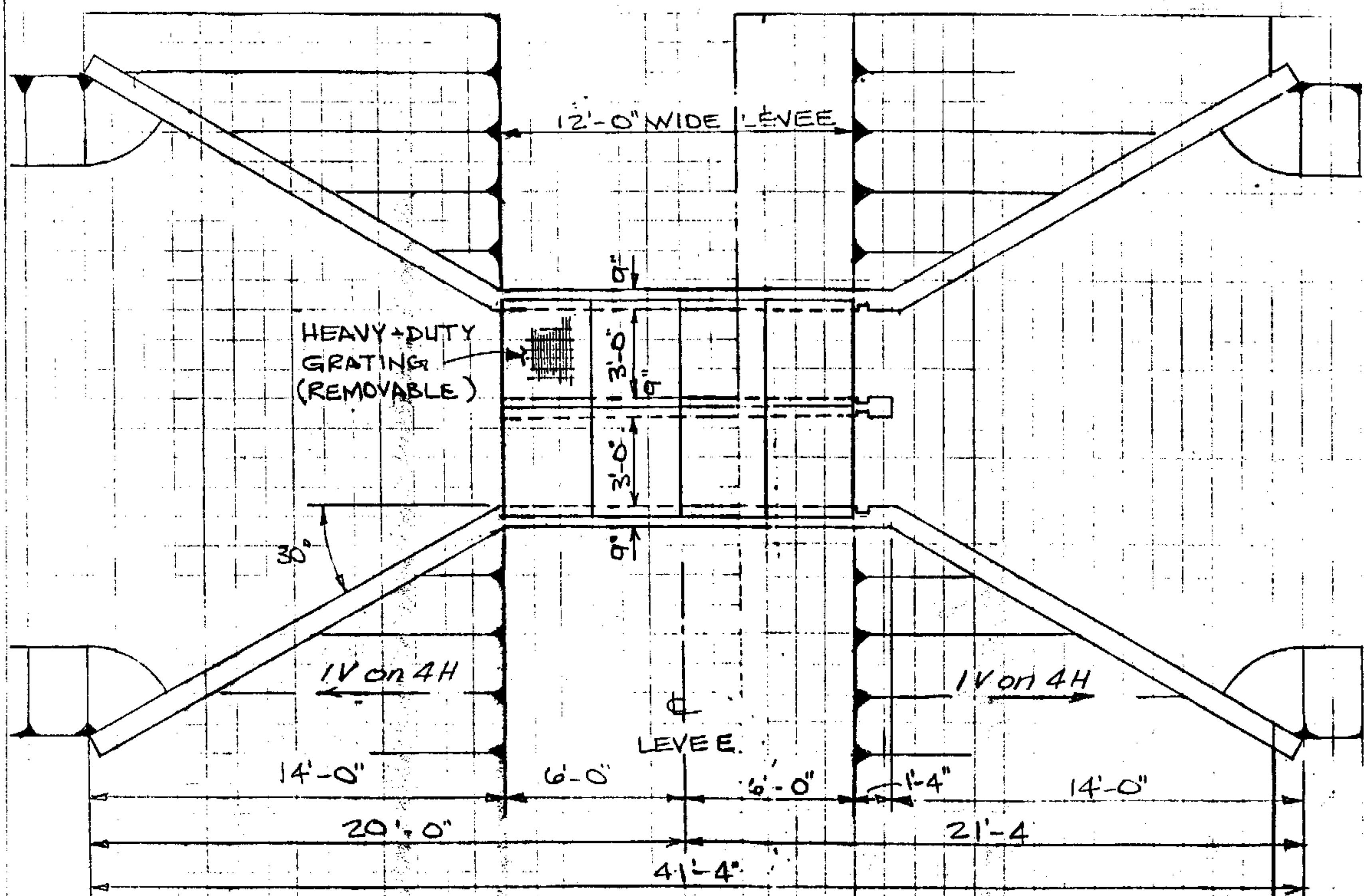


LONGITUDINAL SECTION

INTERMEDIATE LEVEE (SHOWN)

SCALE: APPROX. 3/16" = 1'-0"

H-1



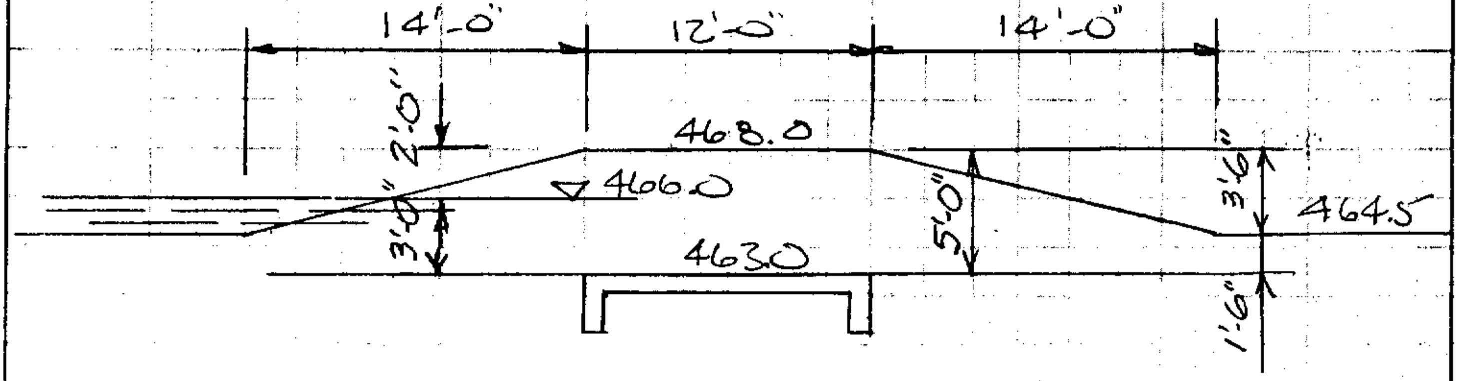
PLAN

SCALE: APPROX. 3/16" = 1'-0"

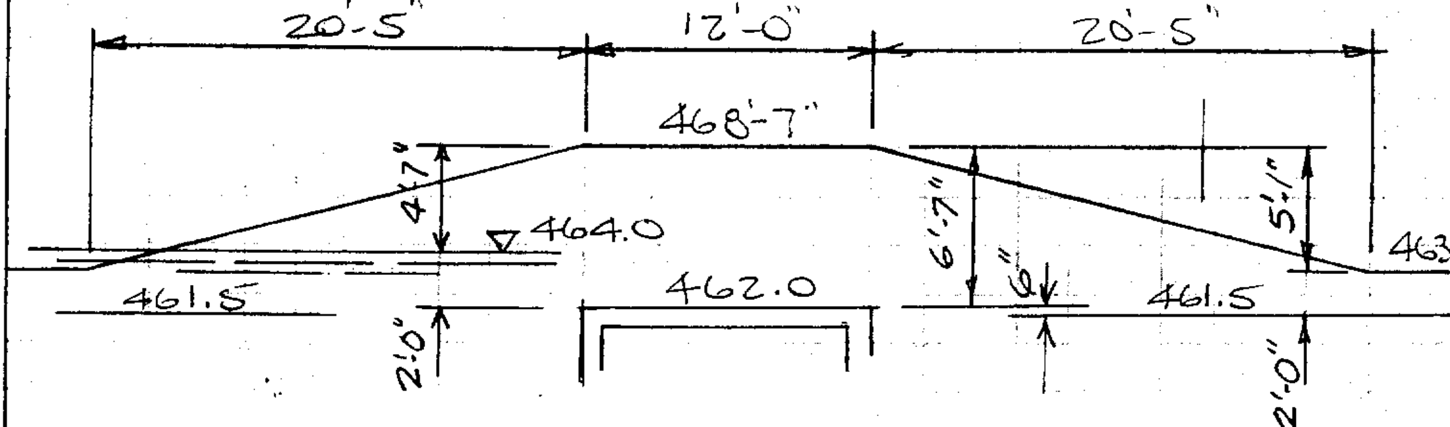
Subject: 3LV ISLAND - STOP LOG H2O CONTROL STRUCT.
Computed by K. WILSON
Checked by
Date 30 MAY 80
Sheet 2 of

Subject BAY ISLAND - STRUCTURE & CONTROL STRUCT'S.		Date 30 MAY 87
Computed by K. WILSON	Checked by DAP	Sheet 3 of

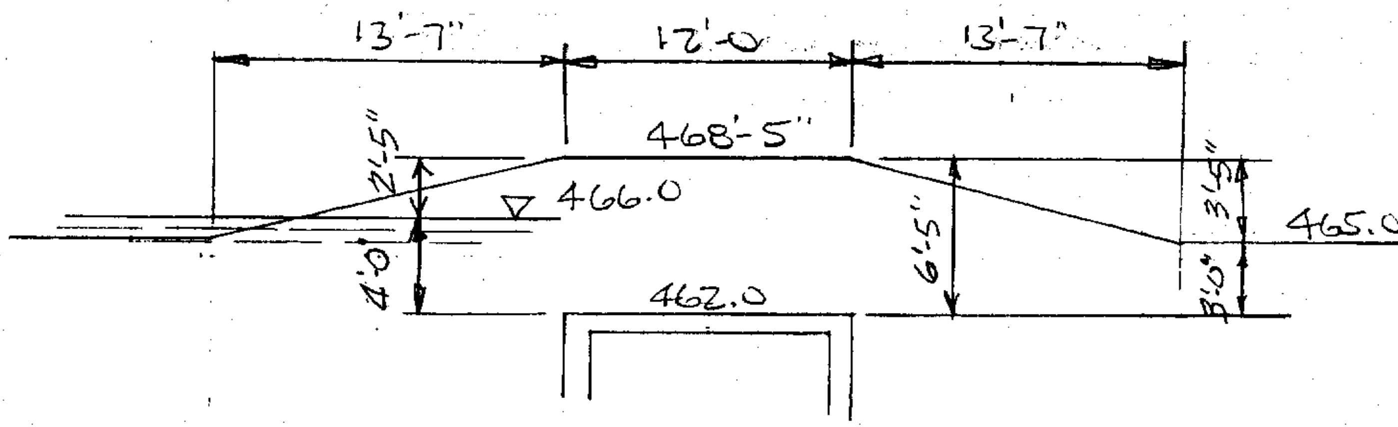
GENERAL PROFILES



INTERMEDIATE LEVEE 2 @ 3'-0"



NORTHERN PERIMETER 4 @ 5'-0"



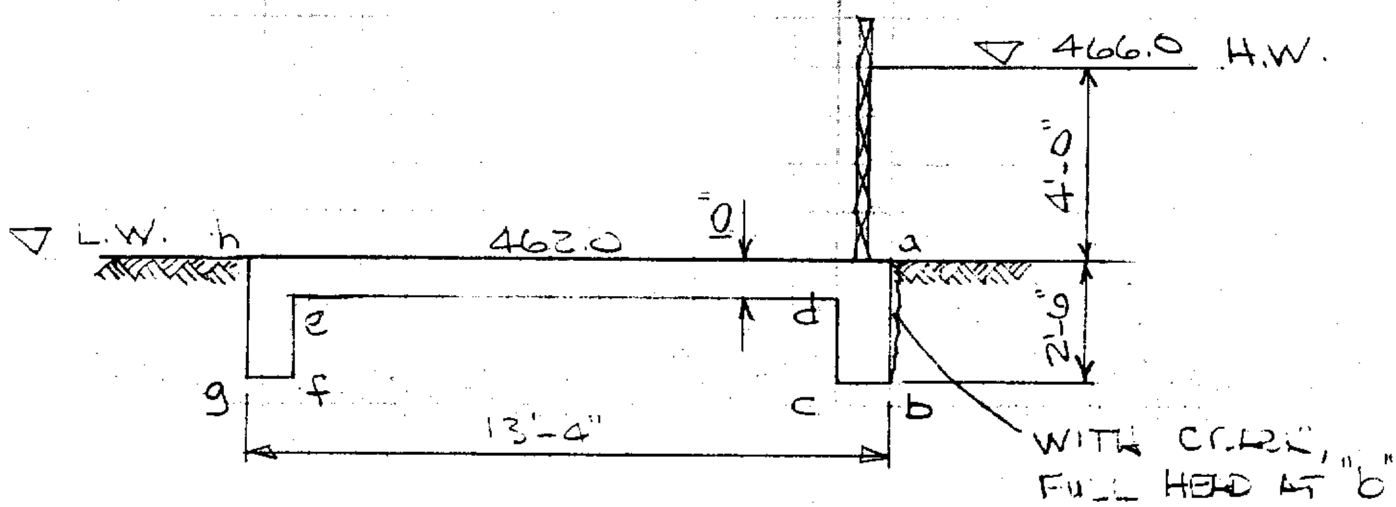
SOUTHERN PERIMETER 4 @ 5'-0"

NCR Form 381b
1 Aug 80

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$)

DETERMINE UPLIFT PRESSURES



REF: ①

CREEP DISTANCE $= 13'\text{-}4'' + 2(1'\text{-}8'') + 2'\text{-}6'' = 19.16^{FT}$

NET HEAD $= \delta H = 466.0 - 462.0 = 4.0^{FT}$

CREEP RATIO $= \dfrac{19.17}{4.0} = 4.79 > 4.0^{*}$ OKAY

* MINIMUM ALLOWABLE CREEP RATIO FOR GRANULAR FOUNDATION SOILS.

$$\delta p = \frac{\delta H}{L} = \frac{4.0}{19.17} = 0.2087 \ ^{FT/FT}$$

NOTE: STEEL SHEET PILES HAVE BEEN ADDED TO PROTECT AGAINST BORING ANIMALS, BUT HAVE NOT BEEN CONSIDERED IN UPLIFT COMPUTATIONS.

REF: ① EM 1110-2-2501 WALL DESIGN, FLOOD WALLS

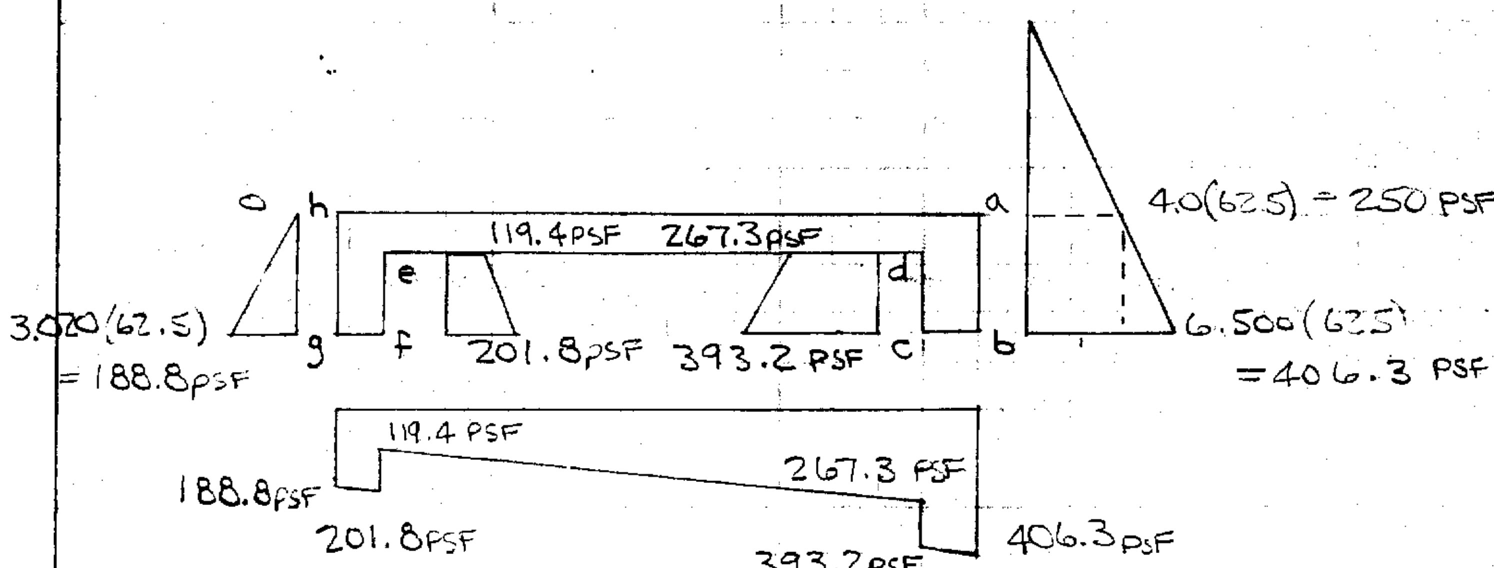
Subject [illegible]	Date 15 [illegible]
Computed by [illegible] · Checked by DAP	Sheet 5 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY $\bar{Y}$

UPLIFT PRESSURES

POINT	CREEP INCREMENT	TOTAL DISTANCE	LOST HEAD	POTENTIAL HEAD	POSITION HEAD	UPLIFT
a	0	0	0	4.000	0	4.000
b	0	0	0	4.000	2.500	6.500
c	1.00	1.00	0.209	3.791	2.500	6.291
d	1.67	2.67	0.557	3.443	0.833	4.276
e	11.33	14.00	2.923	1.077	0.833	1.910
f	1.67	15.67	3.271	0.729	2.500	3.229
g	1.00	16.67	3.480	0.520	2.500	3.020
h	2.50	19.17	4.000	0	0	0



195.3 PSF AVG

399.7 PSF AVG.

Subject: BAY ISLAND - STOP LOG H-20 [illegible]	Date: [illegible]
Computed by K. WILSON / Checked by DAP	Sheet 6 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.) +↓

UNIT	FORCE	ARM	MOMENT (↷+)
	#		FT-#
GRATING 33.15(12.00)(22.92)	9,118	-0.67	-6,109
STOP LOGS (OAK) 11.6(5.33)(4)(6)	1,484	5.67	8,414
WALLS 5(112.5)(13.33)(6.25)	46,864	—	—
2(62.5)(13.33)(0.33)	550	—	—
10" SLAB 125(13.33)(29.75)*	49,571	—	—
10" APRON 2(125)(1.67)(22.25)	9,290	—	—
	116,877#		2,305 FT-#
WING WALLS 4(112.5)(6.00)(15.40)	41,580#	—	—
4(112.5)(3.33/2)(15.40)	11,538	—	—
10" SLAB 4(125)(15.25)(4.50)	34,312	—	—
	87,430#		—
H20 TRUCK (TWO AXLES)	20,000#	0.583	11,660 FT-#
	20,000	-5.417	-108,340
	40,000#	OR	-96,680 FT-#
	20,000#	4.333	86,660 FT-#
	20,000	-1.667	-33,340
	40,000#		53,320 FT-#
EARTH 120(6.58)(2)(3.0*)(13.33)	63,152#	—	—
WING WALLS 120(4.67 AVG.)(4)(3.0)(14.00 APPROX.)	94,147	—	—
	157,299#		—

*ASSUME 3'-0" OUTSIDE OF ABUTMENT WALLS

Subject: BAY ISLAND [illegible] CONTROL STRUCT.		Date: 9 AUG. 80
Computed by: [illegible] WILSON	Checked by: DAP	Sheet 7 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY (Y) (ABOUT ℄ STR.)

UNIT	FORCE (+↓, →+)	ARM	MOMENT (↷+)
WATER (VERT) (MSU EMPTY)			
62.5 (4.0)(4)(5.0)(12.17)	60,850 #	−0.58	−35,293 FT-#
WATER (HORIZ) (MSU FULL)			
250 $(\frac{4.0}{2})$(23.75)	−11,875 #	3.83	−45,481 FT-#
250 (2.5)(23.75)	−14,844	1.25	−18,555
(406.3−250)$(\frac{2.5}{2})$(23.75)	−4,640	0.83	−3,851
−267.3(1.67)(23.75)	10,602	0.83	8,799
−(393.2−267.3)$(\frac{1.67}{2})$(23.75)	2,497	0.56	1,398
119.4 (1.67)(23.75)	−4,736	0.83	−3,931
(201.8−119.4)$(\frac{1.67}{2})$(23.75)	−1,634	0.56	−915
−188.8 $(\frac{2.5}{2})$(23.75)	5,605	0.83	4,652
(SEE SHT. 11)	−19,025 #		−57,884 FT-#
ACTIVE EARTH LOAD WITH CRACK @ a-b (SHT. 4) THERE IS NO ACTIVE PRESSURE	—		—
PASSIVE EARTH LOAD RESISTING SIDE AT-REST PRESSURE (SHT. 18)	−1943 #	0.83	1,613 FT-#

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Subject BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date 17 AUG. 89
Computed by K. WILSON	Checked by DAP	Sheet 8 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY (Y) (ABOUT ℄ STR.)

UNIT	FORCE (+↓)	ARM	MOMENT (↷+)
UPLIFT (SEE SHT. 5)	#		FT-#
−399.7(1.0)(29.75)	−11,891	6.17	−73,368
−195.3(1.0)(29.75)	−5,810	−6.17	35,848
−119.4(11.33)(29.75)	−40,246	—	—
−(267.3−119.4)(11.33/2)(29.75)	−24,926	1.89	−47,110
	−82,873#		−84,630 FT-#

IF UPLIFT ACTS ONLY ON THAT PORTION OF THE BASE SLAB BETWEEN OUT-TO-OUT OF EXTERIOR WALLS.

	FORCE		MOMENT
$FORCE = \frac{23.75}{29.75}(-82,873)$	−66,159#		−67,562 FT-#

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Subject: BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date: 17 AUG. 89
Computed by: [illegible]	Checked by: DAP	Sheet 9 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

SUMMATION OF FORCES

	Force (+↓, →+)	Moment (↷+)
NO WATER (CASE 1)		
CONTROL STRUCTURE W/O WINGWALLS	116,877#	2,305 FT-#
H2O TRUCK	40,000	-96,680
EARTH	63,152	—
↓	220,029#	-94,375 FT-#
WATER IN MSU (CASE 2)		
CONTROL STRUCTURE W/O WING WALLS	116,877#	2,305 FT-#
EARTH	63,152	—
UPLIFT	-82,873	-84,630
↓	97,156#	-82,325 FT-#
ADD H2O TRUCK (CASE 2A)	40,000	-96,680
↓	137,156#	-179,005 FT-#
LATERAL WATER LOADS P_{H_2O} ←	-19,025#	-57,884 FT-#
LATERAL EARTH RESISTANCE P_o →	1,943#	1,613 FT-#
↓ (2)	97,156#	-138,596 FT-#
(2A)	137,156#	-235,276 FT-#
FLOOD / MSU EMPTY (CASE 3)		
CONTROL STRUCTURE W/O WING WALLS	116,877#	2,305 FT-#
EARTH	63,152	—
WATER	60,850	-35,293
UPLIFT	-82,873	84,630
↓	158,006#	51,642 FT-#

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FORWARD

Subject: BLK ISLAND [illegible] H2O CONTROL STRUCT.		Date: [illegible] AUG. 89
Computed by: K. WILSON	Checked by: DAP	Sheet 10 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY (Y) (ABOUT ℄ STR)

SUMMATION OF FORCES (CONT)

		FORCE (+↓, →+)	MOMENT (↷+)
FLOOD/MSU EMPTY (CASE 3)			
	FORWARDED ↓	158,006#	51,642 FT-#
ADD H20 TRUCK (CASE 3A)		40,000	53,320
	↓	198,006#	104,962 FT-#
LATERAL WATER LOADS	→	19,025#	57,884 FT-#
LATERAL EARTH RESISTANCE	←	1,943#	− 1,613 FT-#
	↓ (3)	158,006#	107,913 FT-#
	(3A)	198,006#	161,233 FT-#

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Subject: BAY ISLAND - STOP LOG #2 CONTROL STRUCT.		Date: 17 AUG. 80
Computed by: K. WILSON	Checked by: DAP	Sheet 11 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

SOIL PRESSURES

NOTE: ASSUME CONTROL STRUCT. WITHOUT WING WALLS

CASE 1 $(e = 0.4284) < B/6 = 13.33/6 = 2.22$

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{220,029}{13.33(29.75)} \pm \frac{94,375(6.67)(12)}{29.75(13.33)^3}$$

$$= 554.8 \pm 107.2 = 662.0 \text{ PSF}$$

OR

447.6 PSF

CASE 2 $(e = 1.4265)$

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{97,156}{396.56} \pm \frac{138,596}{880.38}$$

$$= 245.0 \pm 157.4 = 402.4 \text{ PSF}$$

OR

87.6 PSF

CASE 2A $(e = 1.7154)$

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{137,156}{396.56} \pm \frac{235,276}{880.38}$$

$$= 345.9 \pm 267.2 = 613.1 \text{ PSF}$$

OR

78.7 PSF

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Project BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date 22 AUG. 87
Computed by K. WILSON	Checked by DAP	Sheet 12 of

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

CASE 3 ($e = 0.6830$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{158{,}006}{396.56} \pm \frac{107{,}913}{880.38}$$

$$= 398.4 \pm 122.6 = 521.0 \text{ PSF}$$

OR

275.8 PSF

CASE 3A ($e = 0.8143$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{198{,}006}{396.56} \pm \frac{161{,}233}{880.38}$$

$$= 499.3 \pm 183.1 = 682.4 \text{ PSF}$$

OR

316.2 PSF

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Subject BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date 14 AUG. 89
Computed by K. WILSON	Checked by DAP	Sheet 13 of

BEARING CAPACITY

SOIL BORING BI-89-3 AND BI-89-16 SHOW A BLOW COUNT OF 3 FOR THE CL BR LEAN CLAY AND CH BR MEDIUM CLAY AT BASE OF THE WATER CONTROL STRUCTURES (SOUTH PERIMETER AND INTERMEDIATE). THE BLOW COUNT DOES NOT INCREASE APPRECIABLY FOR APPROXIMATELY 30 FT BELOW THE BASE OF THE STRUCTURES. THIS CORRESPONDS TO A "SOFT" CONSISTENCY (REF. ② & ③)

q_u = UNCONFINED COMPRESSION STRENGTH = 0.375 TON/FT^2

$$c = \text{COHESION} = \frac{q_u}{2} = \frac{0.375}{2}(2000) = 375 \text{ PSF}$$

(REF. ④)

$$Q = \bar{B}\left[(\xi_{cd}\xi_{ci}\xi_{ct}\xi_{cg}\, c N_c) + (\xi_{qd}\,\xi_{qi}\,\xi_{qt}\,\xi_{qg}\, q_o N_q)\right]$$

$\phi = 0°$ ∴ $N_c = 5.16$ AND $N_q = 1.00$ TABLE 5-1

$\beta = 0°$ AND $\alpha = 0°$

δ = VALUES = $\arctan \frac{\Sigma H}{\Sigma V}$

$\bar{B} = B - 2e$

REF: ② "FOUNDATION DESIGN", WAYNE C. TENG, p. 15.
REF: ③ "FOUNDATION ENGINEERING", PECK, HANSON, THORNBURN, p 107 AND 29.
REF: ④ EM 1110-2-XXXX (DRAFT) 3 JUN 85, p 5-2 "RETAINING AND FLOOD WALLS"

ubject [illegible] H-C CONTROL STRUCT.		Date 14 [illegible]
omputed by K. WILSON	Checked by DAP	Sheet 14 of

BEARING CAPACITY

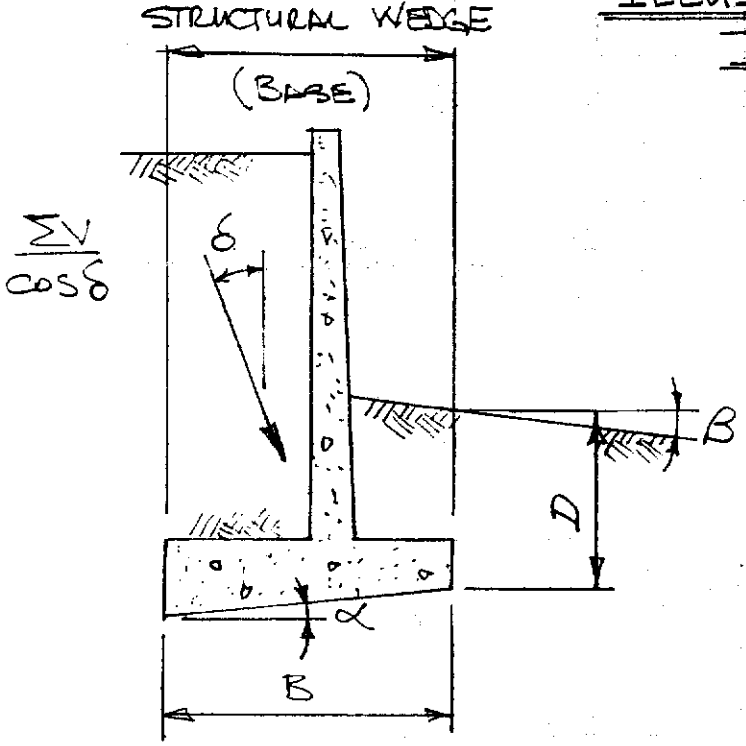

ILLUSTRATION OF TERMS

1. IF PART OF BASE IS NOT IN COMPRESSION, B SHALL EQUAL THAT PART THAT IS IN COMPRESSION

2. γ USED IN BEARING CAPACITY EQUATION SHALL BE THE EFFECTIVE WEIGHT OF THE FOUNDATION MATERIAL.

BEARING CAPACITY

$$\xi_{cd} = 1 + 0.2\left(\frac{D}{B}\right)\tan\left(45^\circ + \frac{\phi}{2}\right) \qquad (5\text{-}4a)$$

$$= 1 + 0.2\left(\frac{D}{B}\right)\tan(45^\circ) = 1 + 0.2\left(\frac{D}{B}\right)$$

$$\xi_{ci} = \xi_{qi} = \left(1 - \frac{\delta^\circ}{90^\circ}\right)^2 = \left(1 - \frac{0}{90}\right)^2 = 1.00 \qquad (5\text{-}5a)$$

$$\xi_{cg} = 1 - \left(\frac{2\beta}{\pi + 2}\right) = 1 \qquad (5\text{-}7b)$$

$$\xi_{qd} = 1 \qquad (5\text{-}4b)$$

$$\xi_{qt} = (1 - \alpha \tan\phi)^2 = 1 \qquad (5\text{-}6a)$$

$$\xi_{qg} = (1 - \tan\beta)^2 = 1 \qquad (5\text{-}7a)$$

$$\xi_{ct} = 1 - \left(\frac{2\alpha}{\pi + 2}\right) = 1 \qquad (5\text{-}6b)$$

$$q_o = \gamma' D = 115(2.50) = 288 \qquad (5\text{-}8a)$$

Subject BAY ISLAND - STOP LOG H2O CONTROL STUDY		Date 21 AUG 87
Computed by K. WILSON	Checked by DAP	Sheet 16 of

REF. 20 FSL.2

PERIMETER LEVEE (4-5' CELLS)

BEARING CAPACITY

CASE 1 (NO WATER W/TRUCK)

$$\bar{B} = B - 2e = 13.333 - 2(0.428) = 12.477^{FT}$$

$$\xi_{cd} = 1 + 0.2\left(\frac{D}{\bar{B}}\right) = 1 + 0.2\,\frac{(2.5)}{12.477} = 1.040$$

$$Q = 12.477[1.040(1.0)(1.0)(1.0)(375)(5.16) + 1.0(1.0)(1.0)(1.0)(288)(1.0)]$$

$$= 12.477[2{,}012 + 288] = 28{,}697^{\#/FT}$$

$$Q_{TOTAL} = 28{,}697(29.75) = 853{,}735^{\#}$$

$$FS = \frac{853{,}735}{220{,}029} = 3.88 > 3.0$$

CASE 2A (WATER IN MSH W/ TRUCK)

$$\bar{B} = 13.333 - 2(1.7154) = 9.902^{FT}$$

$$\xi_{cd} = 1 + 0.2\left(\frac{2.5}{9.902}\right) = 1.050$$

$$\delta = \arctan\frac{\Sigma H}{\Sigma V} = \arctan\frac{17{,}082}{137{,}156} = 7.1^{\circ}$$

$$\xi_{ci} = \xi_{qi} = \left(1 - \frac{\delta}{90}\right)^2 = \left(1 - \frac{7.1}{90}\right)^2 = 0.848$$

$$Q = 9.902[1.050(0.848)(1.0)(375)(5.16) + 0.848(288)] = 19{,}525^{\#}$$

$$Q_{TOTAL} = 19{,}525(29.75) = 580{,}858^{\#}$$

Subject BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date 23 AUG 89
Computed by K. WILSON	Checked by DAP	Sheet 17 of

REV. 20 FEB. 90

PERIMETER LEVEE (4-5' CELLS)

BEARING CAPACITY

CASE 2A (CONT.)

$$FS = \frac{580,858}{137,156} = 4.24 > 3.0$$

CASE 3A (FLOOD / MSL EMPTY W/TRUCK)

$$\bar{B} = 13.33 - 2(0.8143) = 11.704^{FT}$$

$$\xi_{cd} = 1 + 0.2\left(\frac{2.5}{11.704}\right) = 1.043$$

$$\delta = \arctan \frac{\Sigma H}{\Sigma V} = \arctan \frac{17,082}{198,006} = 4.9^\circ$$

$$\xi_{ci} = \xi_{qi} = \left(1 - \frac{4.9}{90}\right)^2 = 0.89$$

$$Q = 11.704\left[1.043(0.89)(1.0)(375)(5.16) + 0.89(288)\right] = 24,023^{\#/FT}$$

$$Q_{TOTAL} = 24023(29.75) = 714,676^{\#}$$

$$FS = \frac{714,676}{198,006} = 3.61 > 3.0$$

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Subject: POLY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date: 2 AUG. 89
Computed by: K. WILCOX	Checked by: DAP	Sheet 18 of

REV. 20 FEB. 90

PERIMETER LEVEE (4-5' CELLS)

STABILITY ($\bar{Y}$)

LATERAL SOIL LOADS: REF: ④

USE SRF = 0.667 (FS = 1.50)

GRANULAR BACKFILL $\phi = 33°$, $C = 0$

$$\tan \phi_d = \frac{\tan 33°}{1.50} = 0.4329 \; ; \; \phi_d = 23.41°$$

$$K_A = \frac{1 - \sin \phi_d}{1 + \sin \phi_d} = \frac{1 - 0.3973}{1 + 0.3973} = 0.431$$

$$K_p = \frac{1}{K_A} = 2.318$$

$$K_o = 1 - \sin \phi = 0.4553$$

$$P_p = 2.318 (57.5) \frac{(2.5)^2}{2} (23.75) = 9{,}892^{\#}$$

$$P_o = 0.4553 (57.5) \frac{(2.5)^2}{2} (23.75) = 1{,}943^{\#} < \frac{P_p}{2}$$

OKAY

$$\Sigma \text{ LATERAL LOADS} = P_{H_2O} - P_o$$

$$= 19{,}025^{\#} \text{ (SHT. 7)}$$

$$- 1{,}943$$

$$17{,}082^{\#}$$

MUST BE RESISTED BY SLIDING RESISTANCE ALONG BASE OF STRUCTURE.

Subject: ELY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date: 23 AUG 89
Computed by: K. WILSON	Checked by: DAP	Sheet 10 of

REV. 26 FEB. 90

PERIMETER LEVEE (4-5' CELLS)

STABILITY (Y)

SLIDING RESISTANCE REF: (4)

RESIST SLIDING BY COHESION

C = 375 PSF (SHEET 13)

$$P_c = SRF(c)(B)(L) = 0.667(375)(13.33)(29.75)$$

$$= 99,19[illegible] > 19,025 - 1943$$

P_{H_2O} P_o

$\therefore$ SF >> 1.5 OKAY

Subject	BLUE ... - STOP LOG H_2O CONTROL STRUCT.	Date 22 AUG. 8?
Computed by K. WILSON	Checked by DAP	Sheet 20 of

INTERMEDIATE LEVEE (2-3'-CELLS)

STABILITY ($\overline{Y}$)

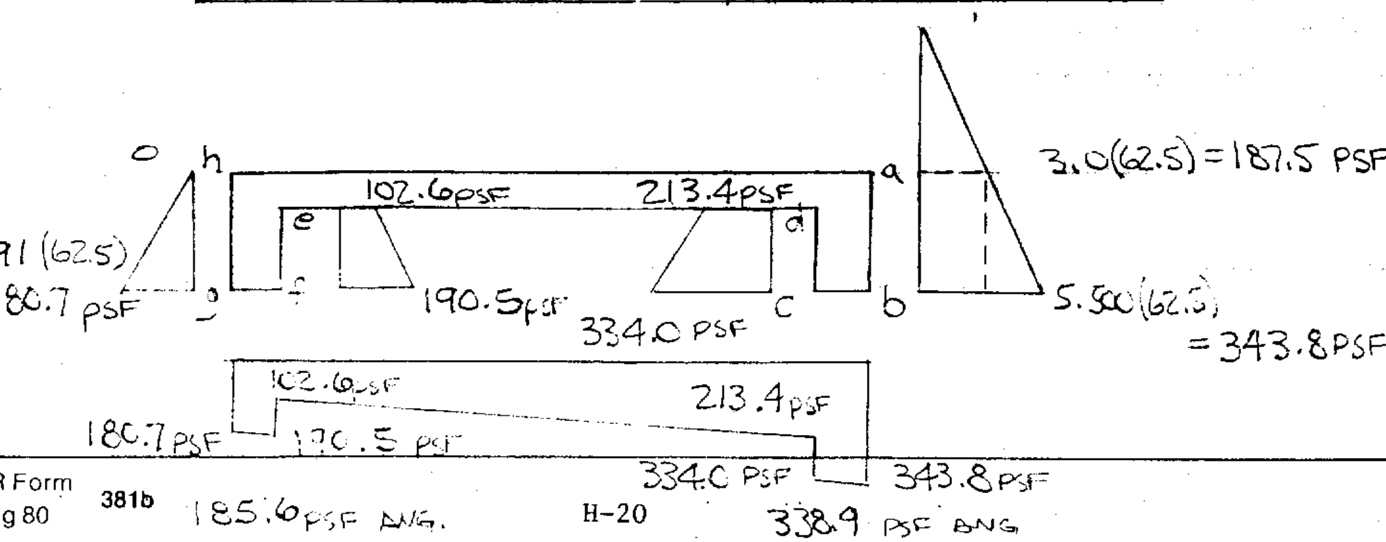
DETERMINE UPLIFT PRESSURES (ALSO SEE SHT. 4)

NET HEAD = $\delta H = 466.0 - 463.0 = 3.0^{FT}$

$$\delta p = \frac{\delta H}{L} = \frac{3.0}{19.17} = 0.1565 \ ^{FT/FT}$$

UPLIFT PRESSURES

POINT	CREEP INCREMENT	TOTAL DISTANCE	LOST HEAD	POTENTIAL HEAD	POSITION HEAD	UPLIFT
a	0	0	0	3.000	0	3.000
b	0	0	0	3.000	2.500	5.500
c	1.00	1.00	0.156	2.844	2.500	5.344
d	1.67	2.67	0.418	2.582	0.833	3.415
e	11.33	14.00	2.191	0.809	0.833	1.642
f	1.67	15.67	2.452	0.548	2.500	3.048
g	1.00	16.67	2.609	0.319	2.500	2.891
h	2.50	19.17	3.000	0	0	0



Subject: BAY ISLAND - STOP LOG H-C CONTROL STR.		Date: 19 JUL 8?
Computed by: [illegible]	Checked by: DAP	Sheet 21 of

INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

UNIT	FORCE (+↓)	ARM	MOMENT (↷+)
GRATING 33.15(12.00)(7.42)	2,952	-0.67	-1,978 FT-#
STOP LOGS (OAK) 11.6(3.33)(2)(5)	386	5.67	2,190
WALLS 3(112.5)(13.33)(5.00)	22,495	—	—
2(62.5)(13.33)(0.33)	550	—	—
10' SLAB 125(13.33)(12.25) *	20,412	—	—
10' APRON 2(125)(1.67)(8.25)	3,444	—	
	50,239		212 FT-#
WING WALLS 4(112.5)(4.50)(16.17)	32,744 #	—	—
4(112.5)(3.50/2)(16.17)	12,734	—	—
SLAB 4(125)(16.00)(3.50)	28,000	—	—
	73,478 #		—
H20 TRUCK (ONE AXIL)	16,000	0.583	9,328 FT-#
	16,000	-5.417	-86,672
	32,000	OR	-77,344 FT-#
	16,000	4.333	69,328 FT-#
	16,000	-1.667	-26,672
	32,000		42,656 FT-#
EARTH 120(5.33)(2)(2.0)(13.33) *	34,103 +	—	—
120(3.25 AVG)(4)(2.0)(15.5 APPROX)	49,140	—	—
	83,243 #		—

+ ASSUMED TO 2'-0" OUTSIDE OF [illegible] WALLS

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Subject BAY ISLAND - STOP LOG H2O CONTROL STRUCT.		Date 22 AUG. 80
Computed by	Checked by DAP	Sheet 22 of

INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.) +↓ →+

UNIT	FORCE	ARM	MOMENT ↷+
WATER (VERT.) (MSU EMPTY) $62.5(3.0)(2)(3.0)(12.17)$	13,691	-0.58	-7,940 FT-#
WATER (HORIZ.) (MSU FULL) $187.5\frac{(3.0)}{2}(8.25)$	2,320	3.50	- 8,120 FT-#
$187.5(2.5)(8.25)$	3,867	1.25	- 4,834
(SEE SHT 20) $(343.8-187.5)\frac{(2.5)}{2}(8.25)$	1,612	0.83	- 1,338
$-213.4(1.67)(8.25)$	-2,940	0.83	2,440
$-(334.0-213.4)\frac{(1.67)}{2}(8.25)$	- 831	0.56	465
$102.6(1.67)(8.25)$	1,414	0.83	- 1,174
$(190.5-102.6)\frac{(1.67)}{2}(8.25)$	606	0.56	- 339
$-180.7\frac{(2.5)}{2}(8.25)$	-1,863	0.83	1,546
	4,185 #		-11,354 FT-#
ACTIVE EARTH LOAD WITH CRACK @ a-b (SHT.20) THERE IS NO ACTIVE PRESSURE	—		—
PASSIVE EARTH LOAD RESISTING SIDE AT-REST PRESSURE (SHT. 18) $\frac{-1943}{23.75}(8.25)$	675 #	0.83	560 FT-#

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Subject BLH [illegible] Control Struct.		Date 22 Aug 89
Computed by K. WILSON	Checked by DAP	Sheet 23 of

INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY (Y) (ABOUT ℄ STR.)

UNIT	FORCE (+↓)	ARM	MOMENT (↷+)
UPLIFT (SEE SHT. 20)	#		FT-#
− 338.9 (1.0)(12.25)	−4,152	6.17	−25,618
− 185.6 (1.0)(12.25)	−2,274	−6.17	14,031
− 102.6 (11.33)(12.25)	−14,240	—	—
− (213.4 − 102.6)(11.33/2)(12.25)	−7,689	1.89	−14,532
	−28,355#		−26,119 FT-#

IF UPLIFT ACTS ONLY ON THAT PORTION OF THE BASE SLAB BETWEEN OUT-TO-OUT OF EXTERIOR WALLS.

	FORCE		MOMENT
FORCE = $\frac{8.25}{12.25}$ (−28,355)	−19,096#		−17,590 FT-#

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Subject BAY ISLAND - STOP LOG H_2O CONTROL STRUCT.		Date 22 AUG. 83
Computed by K. WILSON	Checked by DAP	Sheet 24 of

INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

SUMMATION OF FORCES

	FORCE (+↓, →+)	MOMENT (↷+)
NO WATER (CASE 1)		
CONTROL STRUCTURE W/O WINGWALLS	50,239 #	212 FT-#
H 20 TRUCK	32,000	- 77,344
EARTH	34,103	—
↓	116,342 #	- 77,132 FT-#
WATER IN MSU (CASE 2)		
CONTROL STRUCTURE W/O WING WALLS	50,239 #	212 FT-#
EARTH	34,103	—
UPLIFT	- 28,355	- 26,119
↓	55,987 #	- 25,907 FT-#
ADD H20 TRUCK (CASE 2A)	32,000	- 77,344
↓	87,987 #	- 103,251 FT-#
LATERAL WATER LOADS P_{H_2O} ←	- 4,185 #	- 11,354 FT-#
LATERAL EARTH RESISTANCE P_o →	675 #	560 FT-#
↓ (2)	55,987 #	- 36,701 FT-#
↓ (2A)	87,987 #	- 114,045 FT-#
FLOOD / MSU EMPTY (CASE 3)		
CONTROL STRUCTURE W/O WING WALLS	50,239 #	212 FT-#
EARTH	34,103	—
WATER	13,691	- 7,940
UPLIFT	- 28,355	26,119
FORWARD ↓	69,678 #	18,391 FT-#

Subject: BAY ISLAND - STOP LOG H2O CONTROL STRUCT.		Date: 23 AUG. 89
Computed by: K. WILSON	Checked by: DAP	Sheet: 25

INTERMEDIATE LEVEE (2 - 3' CELLS

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

SUMMATION OF FORCES (CONT.)

		FORCE (+↓, →+)	MOMENT (↷+)
FLOOD/MSU EMPTY (CASE 3)			FT-#
	FORWARDED ↓	69,678#	18,391
ADD H2O TRUCK (CASE 3A)		32,000	42,656
	↓	101,678#	61,047 FT-#
LATERAL WATER LOADS	→	4,185#	11,354 FT-#
LATERAL EARTH RESISTANCE	←	- 675#	- 560 FT-#
	↓ (3)	69,678#	29,185 FT-#
	↓ (3A)	101,678#	71,841 FT-#

Subject ZIM ISLAND - STR 1&3 AND CONTROL STRUCT.		Date 22 AUG. 87
Computed by K. WILSON	Checked by DAP	Sheet 26 of

INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

SOIL PRESSURES

CASE 1 ($e = 0.6630$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{116,342}{13.33(12.25)} \pm \frac{77,132(6.67)(12)}{12.25(13.33)^3}$$

$$= 712.5 \pm 212.8 = 925.3 \text{ PSF}$$

OR

$$499.7 \text{ PSF}$$

CASE 2 ($e = 0.6555$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{55,987}{163.29} \pm \frac{36,701}{362.51}$$

$$= 342.9 \pm 101.2 = 444.1 \text{ PSF}$$

$$241.7 \text{ PSF}$$

CASE 2A ($e = 1.2962$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{87,987}{163.29} \pm \frac{114,045}{362.51}$$

$$= 538.8 \pm 314.6 = 853.4 \text{ PSF}$$

OR

$$224.2 \text{ PSF}$$

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INTERMEDIATE LEVEE (2-3' CELLS)

STABILITY ($\bar{Y}$) (ABOUT ℄ STR.)

CASE 3 ($e = 0.4189$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{69,678}{163.29} \pm \frac{29,185}{362.51}$$

$$= 426.7 \pm 80.5 = 507.2 \text{ PSF}$$

OR

346.2 PSF

CASE 3A ($e = 0.7066$)

$$\frac{P}{A} \pm \frac{Mc}{I} = \frac{101,678}{163.29} \pm \frac{71,841}{362.51}$$

$$= 622.7 \pm 198.2 = 820.9 \text{ PSF}$$

OR

424.5 PSF

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Subject: [illegible] | Date: [illegible]
Computed by: K. WILSON | Checked by: DAP | Sheet 28 of

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INTERMEDIATE LEVEE (2-3' CELLS)

BEARING CAPACITY

CASE 1

$\bar{B} = B - 2e = 13.333 - 2(0.663) = 12.007^{FT}$

$\xi_{cd} = 1 + 0.2\left(\frac{D}{\bar{B}}\right) = 1 + 0.2\left(\frac{2.5}{12.007}\right) = 1.042$

$Q = 12.007[1.042(1.0)(1.0)(375)(5.16) + 1.0(1.0)(1.0)(1.0)(288)(1.0)]$

$= 12.007[2,016 + 288] = 27,667^{\#/FT}$

$Q_{TOTAL} = 27,667(12.25) = 338,921^{\#}$

$FS = \frac{338,921}{116,342} = 2.91 \simeq 3.0$ SEE THE NOTE ON SHT. 29.

CASE 2A

$\bar{B} = 13.333 - 2(1.2962) = 10.741^{FT}$

$\xi_{cd} = 1 + 0.2\left(\frac{2.5}{10.741}\right) = 1.0471$

$\delta = \arctan\frac{\Sigma H}{\Sigma V} = \arctan\frac{3,510}{87,987} = 2.28°$

$\xi_{ci} = \xi_{qi} = \left(1 - \frac{\delta}{90}\right)^2 = \left(1 - \frac{2.28}{90}\right)^2 = 0.950$

$Q = 10.741[1.047(0.950)(1.0)(375)(5.16) + 0.950(288)] = 23,609^{\#/FT}$

$Q_{TOTAL} = 23,609(12.25) = 289,210^{\#}$

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Subject BAY ISLAND - STOP LOG H2O CONTROL STRUCT.		Date 22 AUG 89
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INTERMEDIATE LEVEE (2-3' CELLS)

BEARING CAPACITY

CASE 2A (CONT)

$$FS = \frac{289,210}{87,987} = 3.29 > 3.0$$

CASE 3A

$$\overline{B} = 13.333 - 2(0.7066) = 11.920'$$

$$\xi_{cd} = 1 + 0.2\left(\frac{2.5}{11.920}\right) = 1.042$$

$$\delta = \arctan \frac{3,510}{101,678} = 1.98^{\circ}$$

$$\xi_{ci} = \xi_{qi} = \left(1 - \frac{\delta}{90}\right)^2 = \left(1 - \frac{1.98}{90}\right)^2 = 0.956$$

$$Q = 11.920\left[1.042(0.956)(1.0)(375)(5.16) + 0.956(288)\right] = 26,258 \text{ \#/FT}$$

$$Q_{TOTAL} = 26,258(12.25) = 321,661^{\#}$$

$$FS = \frac{321,661}{101,678} = 3.16 > 3.0$$

NOTE

THE H20 TRUCK LOAD WHICH IS PART OF THE TOTAL LOAD ON THE STRUCTURE IS EXTREME IN SIZE AND LOCATION. ∴ THE 2.91 FS FOR CASE 1 IS WITHIN REASON.

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INTERMEDIATE LEVEE

STABILITY ($\bar{Y}$)

LATERAL SOIL LOADS

$$P_p = 2.318(57.5)\left(\frac{2.5}{2}\right)^2(8.25) = 3{,}436^{\#}$$

$$P_o = .04553(57.5)\left(\frac{2.5}{2}\right)^2(8.25) = 675^{\#} < \frac{P_p}{2}$$

SLIDING RESISTANCE

$$P_c = 0.667(375)(13.33)(12.25) = 40{,}843^{\#}$$

$$= 40{,}843^{\#} > \underset{P_{H_2O}}{4{,}125} - \underset{P_o}{675}$$

$\therefore$ SF >> 1.5 OKAY

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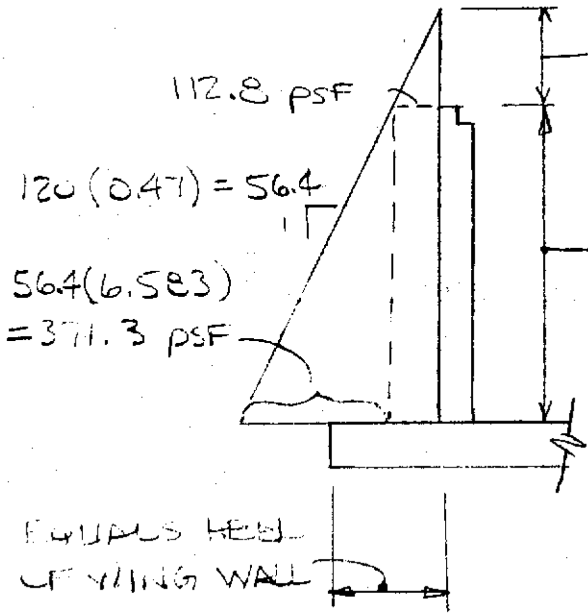
Subject: BAY [illegible] -STOP [illegible] H_2O CONTROL STUDY.	Date: [illegible]
Computed by: K.Y. [illegible] / Checked by: DAP	Sheet 31 of

PERIMETER LEVEES

ABUTMENT WALL



ASSUME NO RESISTANCE AT TOP OF WALL DUE TO GRATING

$$M_{u_{STEM}} = 1.9(112.8)\frac{(6.583)^2}{2} + 1.9(371.3)\frac{(6.583)^2}{6}$$

$$= 9{,}739.2 \text{ FT-\#}$$

REF. ⑤ "NOTES ON ACI 318-83", 4TH EDITION, 1984

$$\frac{M_u}{\phi f'_c b d^2} = \frac{9{,}739.2(12)}{0.90(3000)(12)(6.50)^2} = 0.0854$$

REF: ⑤ TABLE 9.2 $\omega = 0.0900$; $\rho = 0.0900\frac{(3)}{48} = 0.00563$ ✓ ρ_{min}

$$A_s = 0.00563(12)(6.50) = 0.439 \text{ IN}^2/\text{FT}$$

USE #5 @ 8" O.C. $= 0.465 \text{ IN}^2/\text{FT}$

$A_{s_{TEMP}} = 0.002(12)\frac{(9)}{2} = 0.108 \text{ IN}^2/\text{FT}$ INSIDE FACE

USE #4 @ 18" O.C. $= 0.133 \text{ IN}^2/\text{FT}$

PERIMETER LEVEE (4-5' CELLS)

ABUTMENT WALL (CONT.)

$A_{S\ TEMP} = 0.004(12)\left(\frac{9}{2}\right) = 0.216\ IN^2/FT$ EA. FACE

HORIZ RESTRAINED ONE EDGE

USE #4 @ 10" O.C. $= 0.240\ IN^2/FT.$

NOTE: THE WALL IS INTEGRAL WITH THE CONTROL STRUCT BASE SLAB.

COMPUTE CUT-OFF POINT FOR VERT. REINF.

1 FEB 90

$\#5 @ 16'' = 0.233\ IN^2/FT$

$\rho = \frac{0.233}{12(6.50)} = 0.00298 < \rho_{min}$

$\therefore \rho' = \frac{3}{4}(0.00298) = 0.00223$

$\omega = 0.00223\left(\frac{48}{3}\right) = 0.0358$

$\frac{M_u}{\phi f'_c b d^2} = 0.0349$

$M_u = 0.0349(0.9)(3000)\left(\frac{12}{12}\right)(6.5)^2 = 3,981.2$ FT-#/#

$1.9(112.8)\frac{(X)^2}{2} + 1.9(56.4)\frac{(X)^3}{6} = 3,981.2$ FT-#/#

$107.16X^2 + 17.86X^3 - 3,981.2 = 0$

$X^3 + 6.000X^2 - 222.91 = 0$

$X = 4.583'$ FROM THE TOP

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PERIMETER LEVEE (4-5' CELLS)

ABUTMENT WALL (CONT.)

CHECK SHEAR

$$V_{d_u} = 1.9(112.8)\left(6.583 - \frac{6.5}{12}\right) + \frac{1.9(56.4)\left(6.583 - \frac{6.5}{12}\right)^2}{2}$$

$$= 1,294.8 + 1,955.5 = 3,250.3^{\#}$$

$$\phi V_c = 0.85(2)\sqrt{f'c}\ bd = 0.85(2)\sqrt{3000}\,(12)(6.5)$$

$$= 7,262.8^{\#} > 3,250.3^{\#} \quad \text{OKAY}$$

Subject ELK ISLAND - PUMP STATION	Date 14 AUG 89
Computed by K. WILSON / Checked by DAP	Sheet 34 of

REV, 27 FEB. 90

STABILITY

1. THE WET WELL STRUCTURE IS COMPLETELY IN THE GROUND WITH THE EARTH ELEVATIONS BEING GENERALLY THE SAME ON ALL SIDES.

2. SLIDING AND OVERTURNING ARE NOT PROBLEMS

3. BY INSPECTION, THE WEIGHT OF THE STRUCTURE IS APPROX. EQUAL TO THE SOIL IT DISPLACES, THEREFORE, BEARING AND SETTLEMENT ARE NOT PROBLEMS.

4. THE OUTLET CHUTE IS STABLE, BY INSPECTION, AND WILL BE DESIGNED AS A "U" CHANNEL.

CHECK UPLIFT OF PUMP STATION

UNIT	WEIGHT
TOP SLAB 150 (6.67)(5.0)	5,002.5#
− 150 (π)(1.5)²	− 1,060.3
MANHOLE LID 1¼" THK.	505.0
INTERIOR WALL 150(4.67)(5.5)	3,852.3
PUMP SLAB 150(4.67)(5.0)	3,502.5
− 150 (π)(1.33)²	− 833.5
WIER WALL 112.5(4.67)(1.5)	788.1
EXIT WALLS 112.5(4.0)(4.0)(2)	3,600.0
EXIT SLAB 150(6.67)(4.0)	4,002.0
LANDSIDE WALL 150(4.67)(11.5)	8,055.8
RIVERSIDE WALL 150 (4.67)(7.0)	4,903.5
" " 150 (2.0)(8.0)	2,400.0
− 150 (π)(1.25)²	− 736.3
SUB-TOTAL	33,981.6#

Subject: [illegible]

Date: [illegible]

Computed by: [illegible]

Checked by: DAP

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REV. 31 FEB. 91

STABILITY

UNIT	WEIGHT
SUB-TOTAL	33,981.6#
INLET SLAB 150(7.0)(6.67)	7,003.5
(TOP) −150(7.0/2)(1.583)(2)	−1,662.2
SIDE WALLS 150(12.0)(15.0)(2)	54,000.0
150(2.0)(6.0)(2)	3,600.0
150(7.0)(8.0)(2)	16,800.0
BASE SLAB 150(1.35)(6.57)(19.0)	[illegible],761.8
−150(1.35)(7.0/2)(1.583)(2)	−2,077.7
EARTH ABOVE INLET SLAB 120(6.0)(7.0)(6.67)	33,616.8
−120(6.0)(7.0/2)(1.583)(2)	−7,978.3
	161,045.5#
UPLIFT	
HIGH GROUNDWATER (APPENDIX G) 463.5	
BOTT. EL. (PLATE 25) 451.75	
MAX. HEAD 11.75	
62.5(11.75)(6.67)(19.0)	93,067.3#
−62.5(11.75)(7.0/2)(1.583)(2)	−8,137.6
	84,929.7#

NOTE: GRNDWATER AT BI-87-1? = 456.1

$$SF = \frac{161{,}045.5}{84{,}929.7} = 1.90 > 1.5 \quad \text{OKAY}$$

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Subject BLAH ISLAND - PUMP STATION	Date 21 AUG. 89
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STABILITY

WEIGHT OF SOIL MASS DISPLACED BY PUMP STATION

GROUND ELEV. (PLATE 25) 465.00
BOTTOM OF STRUCTURE (PLATE 26) 451.75
13.25 FT

WEIGHT

115 (13.25)(6.67)(19.00) = 193,104.8 #
− 115 (13.25)(7.00/2)(1.583)(2) = − 16,884.7
176,220.1 #

WT. OF STRUCTURE = 161,045.5 # (SHT. 35)

NOTE: BORING BI-89-19 IS IN THE VACINITY OF THE PUMP STATION. THE SOIL BELOW THE BOTTOM ELEVATION HAS 0 BLOW COUNT. OVEREXCAVATION AND BACKFILL WITH GRANULAR MATERIAL MAY BE REQUIRED.

27 FEB. 90

BORING BI-89-27 TAKEN AT THE PUMP STATION INDICATES MED TO FINE SAND WITH A BLOW COUND OF 11 AT THE BOTTOM OF THE BASE SLAB, AND 11 + FOR ± 35 FT BELOW THAT POINT. OVEREXCAVATION WILL NOT BE REQUIRED.

Subject		Date
[illegible]		[illegible]
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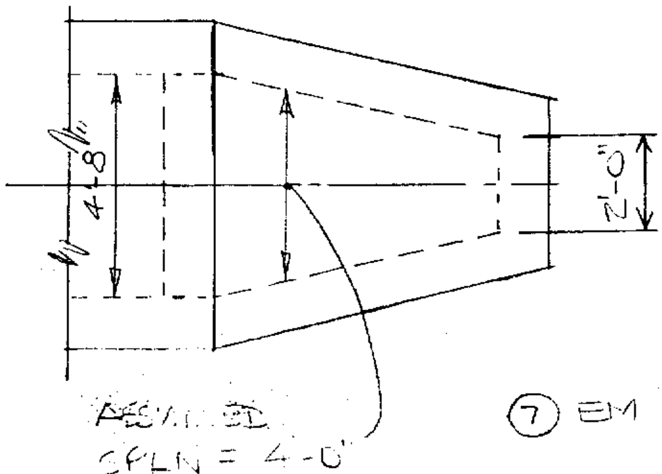
TOP SLAB AT INLET

TOP OF LEVEE 468.0
TOP OF SLAB 462.0
FILL OVER SLAB 6.0 FT



WEIGHT OF FILL = 120 PSF

REFERENCES

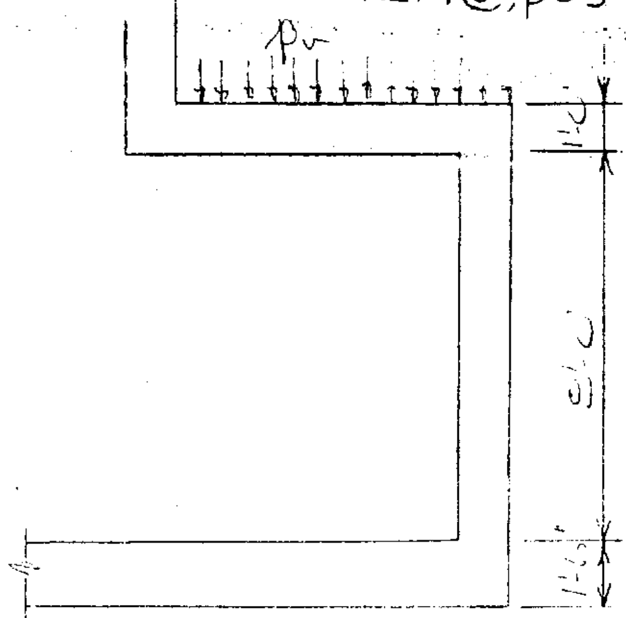
(6) AASHTO "STD. SPEC. FOR HIGHWAY BRIDGES"

(7) EM 1110-2-2902 "CONDUITS, CULVERTS AND PIPES"

(8) ETL 1110-2-265 "STRENGTH DESIGN CRITERIA FOR REINF. CONC. HYDRAULIC STRUC."

REF: (7) MAX. VERT. PRESSURE COEFF. = 1.5
LATERAL PRESSURE COEFF. 1.0
No WATER

REF: (6), p53 → $p_{LL} = \frac{16{,}000^{*}}{[1.75(6.0)]^2} = 145$ PSF



EARTH TRUCK SLAB

$p_v = 1.5(120)(6.0) + 145 + 150$

$= 1{,}375$ PSF

$p_{v_u} = 1{,}225(1.9) + 150(1.5)$

$= 2{,}552.5$ PSF

ASSUME SIMPLE SPAN

$M_u = 2{,}552.5\frac{(4.0)^2}{8} = 5{,}105$ FT-#

Subject BAY ISLAND - PUMP STATION		Date 12 AUG 89
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TOP SLAB AT INLET

$$\frac{M_u}{\phi f'_c b d^2} = \frac{5{,}105(12)}{0.90(3{,}000)(12)(9.5)^2} = 0.02095$$

REF (5) $\omega = 0.02125$ $\rho = 0.02125\frac{(3.0)}{48} = 0.00133 < \rho_{MIN} = 0.00417$

$$A_s = \frac{4}{3}(0.00133)(12)(9.5)$$

$= 0.202\ in^2/FT$ #4 @ 12" c.c.

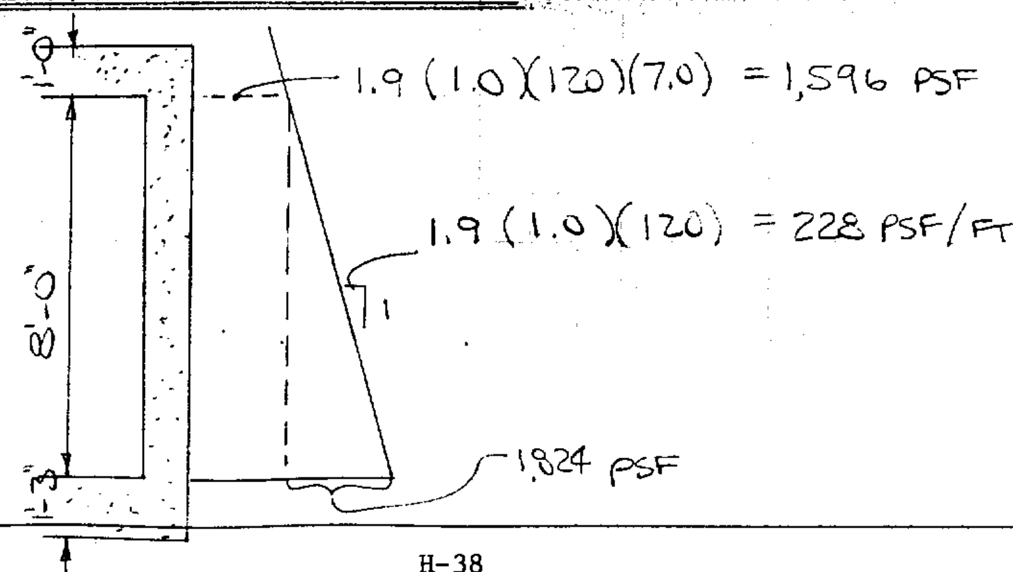
CHECK SHEAR

$$V_{u_d} \simeq 2{,}552.5\left(\frac{4.0}{2} - \frac{9.5}{12}\right) = 3{,}085^{\#}$$

$$V_c = 2\sqrt{f'_c}\, bd = 2\sqrt{3000}(12)(9.5) = 12{,}488^{\#}$$

$$\phi V_c = 0.85(12{,}488) = 10{,}615^{\#} > 3{,}085^{\#} \text{ OKAY}$$

SIDE WALL AT INLET



SIDE WALL AT INLET

ASSUME SIMPLE SPAN

$R_{TOP} = 1,596 \frac{8.0}{2} + 1,824\left(\frac{8.0}{2}\right)\left(\frac{1}{3}\right) = 8,816.0^{\#}$

$R_{BOT} = 1,596\left(\frac{8.0}{2}\right) + 1,824\left(\frac{8.0}{2}\right)\left(\frac{2}{3}\right) = 11,248.0^{\#} > \phi V_c$ (SHT. 38)

∴ MAKE $f'_c = 3,500$ psi

$\Sigma V = 0 = 8,816.0 - 1,596x - 228\frac{x^2}{2}$

$x^2 + 14x - 77.33 = 0$

so $x = 4.24$ FT

$4.24^2 + 14(4.24) - 77.33 = 0.008 \cong 0$ OKAY

$M_u = 8,816.0(4.24) - 1,596\frac{(4.24)^2}{2} - 228\left(\frac{4.24^2}{2}\right)\left(\frac{4.24}{3}\right)$

$= 37,380 - 14,346 - 2,896 = 20,138^{FT-\#}$

$\frac{M_u}{\phi f'_c b d^2} = \frac{20138(12)}{0.85(3,500)(12)(9.5)^2} = 0.07500$

$\omega = 0.0785 \quad \rho = 0.0785\frac{(3.5)}{48} = 0.00572 \quad \rho_{MIN}$

$A_s = 0.00572(12)(9.5) = 0.653\ IN^2/FT$

#6 @ 8" o.c. = 0.66 IN^2/FT

Subject BAY ISLAND ACCESS BRIDGE		Date 21 DEC. 89
Computed by K. WILSON	Checked by MCN	Sheet AB-1 of

GENERAL

LOAD CONDITIONS   REF ①

	GROUP	γ	β FACTORS: D	$(L+I)_n$	$(L+I)_p$	CF	E	B	SF	W	WL	LF	R+S+T	EQ	ICE	%
LOAD FACTOR DESIGN	I	1.3	β_D	1.67*	0	~~1.0~~	β_E	1	~~1~~	0	0	0	0	0	0	100
	~~IA~~	~~1.3~~	~~β_D~~	~~2.20~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~150~~
	~~IB~~	~~1.3~~	~~β_D~~	~~0~~	~~1~~	~~1.0~~	~~β_E~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~**~~
	II	1.3	β_D	0	0	0	β_E	1	~~1~~	1	0	0	0	0	0	125
	III	1.3	β_D	1	0	~~1~~	β_E	1	~~1~~	0.3	1	~~1~~	0	0	0	125
	~~IV~~	~~1.3~~	~~β_D~~	~~1~~	~~0~~	~~1~~	~~β_E~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~125~~
	~~V~~	~~1.25~~	~~β_D~~	~~0~~	~~0~~	~~0~~	~~β_E~~	~~1~~	~~1~~	~~1~~	~~0~~	~~0~~	~~1~~	~~0~~	~~0~~	~~140~~
	~~VI~~	~~1.25~~	~~β_D~~	~~1~~	~~0~~	~~1~~	~~β_E~~	~~1~~	~~1~~	~~0.3~~	~~1~~	~~1~~	~~1~~	~~0~~	~~0~~	~~140~~
	~~VII~~	~~1.3~~	~~β_D~~	~~0~~	~~0~~	~~0~~	~~β_E~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~0~~	~~133~~
	~~VIII~~	~~1.3~~	~~β_D~~	~~1~~	~~0~~	~~1~~	~~β_E~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~140~~
	~~IX~~	~~1.20~~	~~β_D~~	~~0~~	~~0~~	~~0~~	~~β_E~~	~~1~~	~~1~~	~~1~~	~~0~~	~~0~~	~~0~~	~~0~~	~~1~~	~~150~~
	X	1.30	1	1.67	0	0	β_E	0	0	0	0	0	0	0	0	100 CULVERT

1.) LOAD FACTORS WERE NOT USED IN THE STABILITY ANALYSIS.

2.) LOAD GROUPS I, II AND III GOVERN THE DESIGN.

D = DEAD LOAD ; $\beta_D = 1.0$
L = LIVE LOAD ; $\beta_L = 1.0$ FOR STABILITY
I = IMPACT (NOT USED ON SUBSTRUCTURES)
B = BOUYANCY
SF = STREAM FLOW PRESSURE
W = WIND ON STRUCTURE
I = ICE PRESSURE
E = EARTH PRESSURE ; $\beta_E = 1.0$

REFERENCES:

① "STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES", AASHTO
② ILL. BRIDGE STANDARDS
③ DATA FROM ED-HW
④ "REINFORCED CONCRETE DESIGN" 3RD ED., WANG & SALMON

Subject BAY ISLAND - ACCESS BRIDGE		Date 21 DEC. 89
Computed by K. WILSON	Checked by MCW	Sheet AB-2 of

GENERAL

✓ 3.) THE BRIDGE IS AN ACCESS BRIDGE FOR AREA FARMERS AND THE EMP PROPER. IT IS NOT A HIGHWAY BRIDGE.

✓ 4.) BECAUSE OF THE HEAVY EQUIPMENT USED IN FARMING OPERATIONS AND CONSTRUCTION AND/OR MAINTENANCE OF THE EMP HS20 HIGHWAY LOADING IS USED IN THE BRIDGE DESIGN, HOWEVER ONLY ONE TRUCK IS CONSIDERED ON THE BRIDGE AT ANY TIME, THEREFORE THE UNIFORM LANE LOAD CONDITION IS NOT CONSIDERED.

✓ 5.) CONSIDER THE BRIDGE SHORT ENOUGH THAT THERMAL FORCES HAVE NO EFFECT.

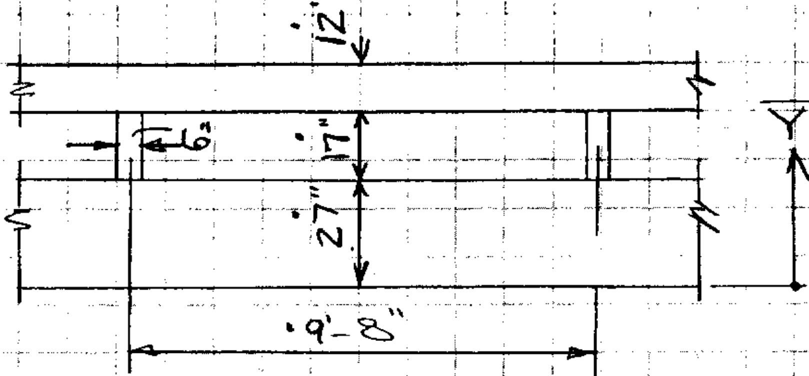
✓ 6.) EARTHQUAKE LOAD IS NOT CONSIDERED

✓ 7.) ASSUME 2" WEARING SURFACE (25 PSF) ON TOP OF BRIDGE DECK FOR DEAD LOAD, BUT NOT AS PART OF ELEVATION OF BRIDGE TO RESIST WIND LOADS.

✓ 8.) THE PRESTRESSED CONCRETE DECK BEAMS ARE TIED (FIXED) TO THE ABUTMENTS AT EACH END. ACTIVE EARTH PRESSURES ON ONE ABUTMENT AND LONGITUDINAL WIND LOADS ARE RESISTED BY PASSIVE EARTH PRESSURES ON THE OPPOSITE ABUTMENT. PASSIVE EARTH PRESSURES IN FRONT OF THE ABUTMENTS ARE NOT CONSIDERED.

Subject BAY ISLAND - ACCESS BRIDGE		Date 26 DEC 89
Computed by K. WILSON	Checked by MCW	Sheet AB-3 of

WIND



	AREA		$\bar{Y}$	
27(9.6667)(12)	= 3,132	x	13.50	= 42,282 IN^3
12(9.6667)(12)	= 1,392	x	50.00	= 69,600
17(6.0000)	= 102	x	35.50	= 3,621
	4,626 IN^2			115,503 IN^3

$\bar{Y}$ = 24.968 IN = 2.081 FT

EXPOSED AREA = 478.55 IN^2/FT = 3.323 FT^2/FT

NOTE: AASHTO WINDS LOADS ARE FOR A BASE VELOCITY OF 100 MPH. THE BASE VELOCITY AT THE PROJECT SITE IS ASSUMED TO BE 80 MPH. PROPORTION THE WIND LOADS BY THE RATIO OF THE BASE VELOCITIES SQUARED.

$$\left(\frac{80}{100}\right)^2 = 0.64$$

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Subject BAY ISLAND - ACCESS BRIDGE		Date 26 DEC. 89
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WIND

FORCES ON SUPERSTRUCTURE

AASHTO 3.15.2.1.3

$W_{TRANSV.} = 50(0.64) = 32\ PSF$

$W_{LONGIT.} = 12(0.64) = 7.68\ PSF$ SAY 8 PSF

FORCES ON LIVE LOAD

AASHTO 3.15.2.1.3

$WL_{TRANSV.} = 100(0.64) = 64\ PLF$

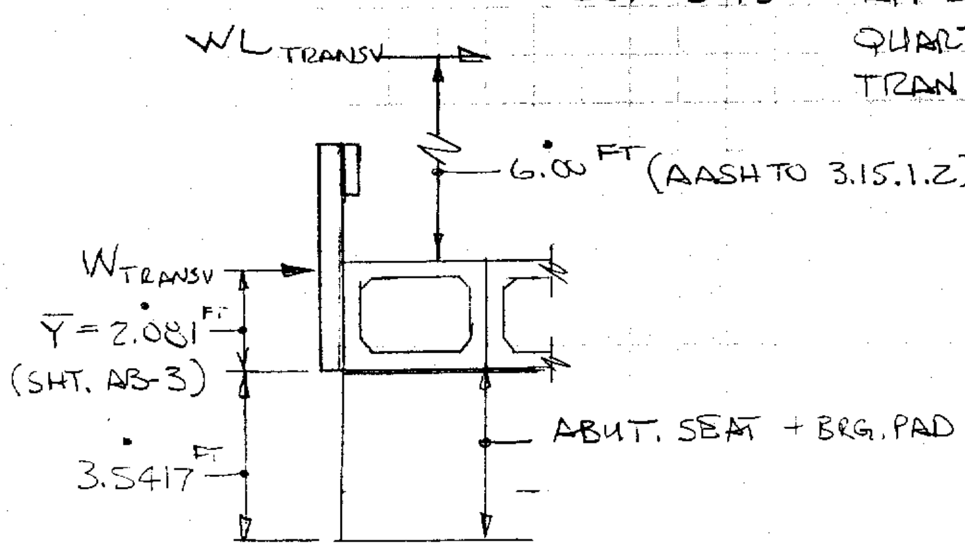
$WL_{LONGIT.} = 40(0.64) = 25.6\ PLF$ SAY 26 PLF

OVERTURNING FORCES

AASHTO 3.15.3

$W_{OVER} = 20(0.64) = 12.8\ PSF$

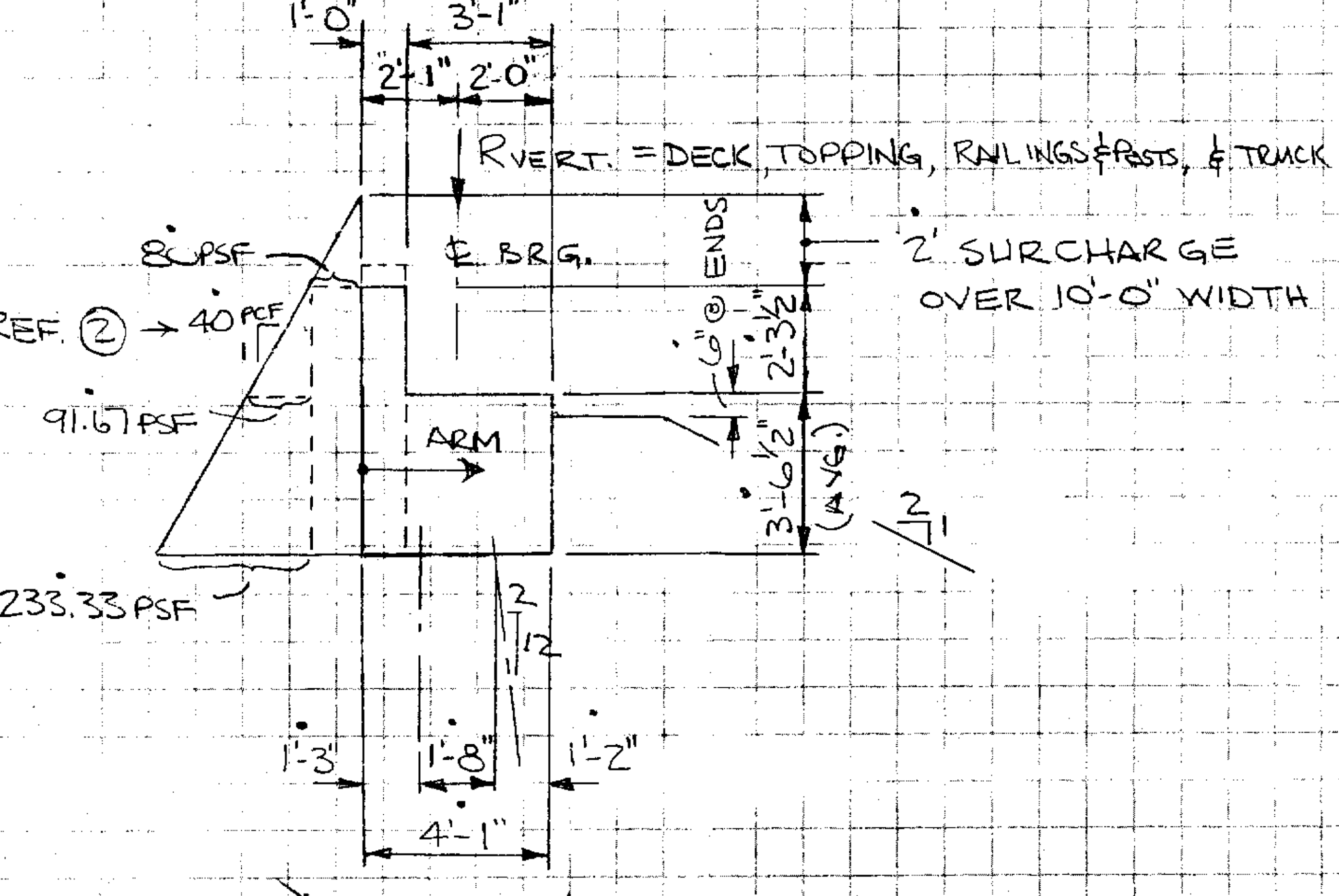
SAY 13 PSF APPLIED AT WINDWARD QUARTER POINT OF TRANSV. WIDTH



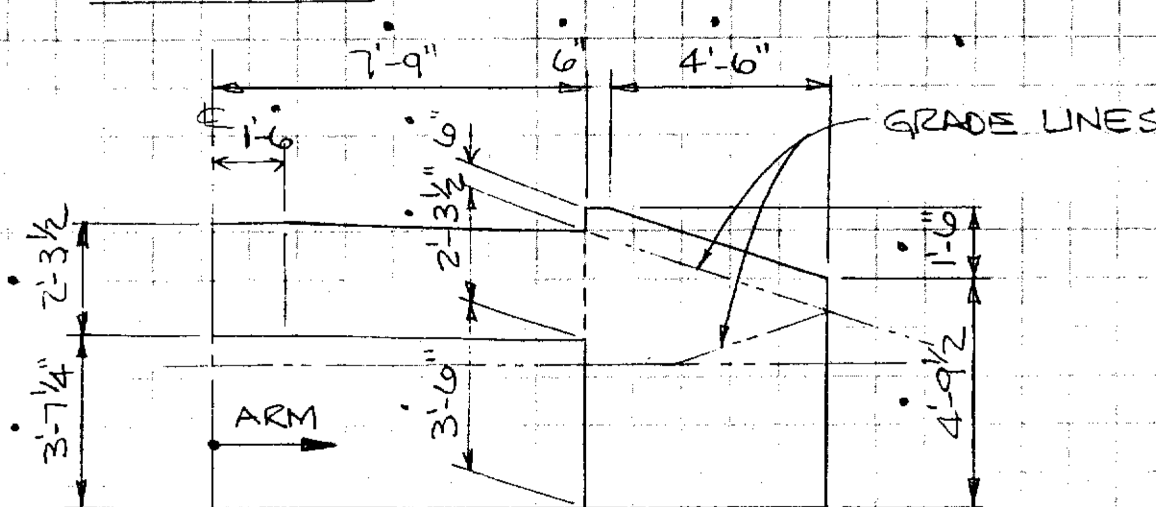
Subject BAY ISLAND - ACCESS BRIDGE		Date 27 DEC. 89
Computed by K. WILSON	Checked by MCW	Sheet AB-5 of

ABUTMENT DESIGN

SEE SHT. 1 FOR LOAD CONDITIONS AND REFERENCES.



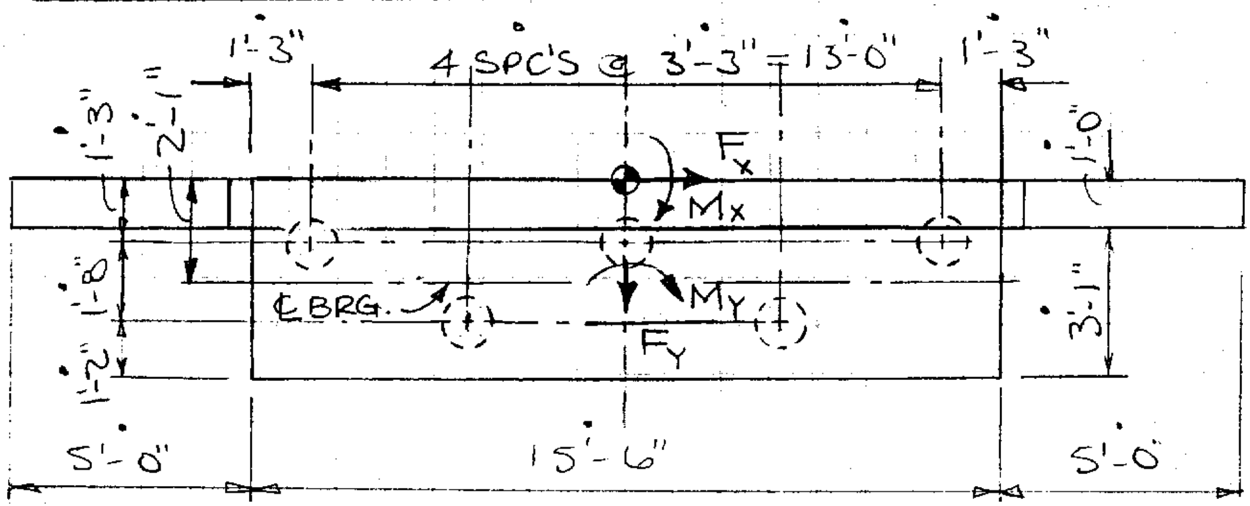
SECTION



HALF ELEVATION

Subject BAY ISLAND – ACCESS BRIDGE		Date 27 DEC 87
Computed by K. WILSON	Checked by MCW	Sheet AB-6 of

ABUTMENT DESIGN



PLAN

CALCULATE I'S OF PILE GROUP

$A_Y = 3(1.25) + 2(2.9167) = 9.5834$; $A = 3 + 2 = 5$

$\bar{Y} = \dfrac{9.5834}{5} = 1.9167$

$I_Y = 3(0.6667)^2 + 2(1.0000)^2 = 3.3334$

$I_X = 1(0.00)^2 + 2(3.25)^2 + 2(6.50)^2 = 105.6250$

$C_{Y\ \text{BACK ROW}} = 1.9167 - 1.250 = 0.6667$ FT

$C_{Y\ \text{FRONT ROW}} = 2.9167 - 1.9167 = 1.0000$ FT

$C_X = 2(3.25) = 6.50$ FT

AND

$= 1(3.25) = 3.25$ FT

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Subject BAY ISLAND - ACCESS BRIDGE		Date 27 DEC. 89
Computed by K. WILSON	Checked by MCW	Sheet AB-7 of

ABUTMENT DESIGN - STABILITY LONGIT.

UNIT	FORCE	ARM	MOMENT
DEAD LOAD			FT-#
WINGS 2(150)(1.00)(6.292)(5.00)	9,438#	0.500'	4,719
-2(150)(1.00)(1.50/2)(4.50)	-1,013	0.500'	-506
BACK WALL 150(1.00)(15.50)(2.292)	5,329	0.500'	2,665
SEAT 150(4.083)(15.50)(3.604)	34,212	2.042'	69,861
-2(150)(4.083)(6.25/2)(0.104)	-398	2.042'	-813
DECK BM'S 565(60.00/2)(15.00/3)	84,750	2.083'	176,534
TOPPING 150(0.167)(60.00/2)(15.00)	11,273	2.083'	23,482
RAILINGS 25.82(62.00)(2)/2	1,601	2.083'	3,335
POSTS 25(4.667)(7)(2)/2	817	2.083'	1,702
	146,009#		280,979 FT-#
(W/O TOPPING)	(134,736#)		(257,497 FT-#)
TRUCK - HS 20	32,000#	2.083'	66,656 FT-#
32,000(57.833-14.00)/57.833	24,254	2.083'	50,520
8,000(57.833-28.00)/57.833	4,127	2.083'	8,596
	60,381#		125,772 FT-#
WIND UPLIFT (OVERTURNING)			FT-#
GROUP II 13(15.00)(62.00/2 - 4.083)	-5,249#	2.083'	-10,934
GROUP III 4(15.00)(62.00/2 - 4.083)	-1,615#	2.083'	-3,364 FT-#

Subject BAY ISLAND - ACCESS BRIDGE		Date 10 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-8 of

ABUTMENT DESIGN - STABILITY LONGIT

UNIT	FORCE	ARM	MOMENT
BOUYANCY (@ H.W. EL. 462.7)			
- 62.5(2.5416)(4.0833)(15.500)	-10,054 #	2.042	- 20,530 FT-#
- 62.5(2.5416)(1.000)(10.000)	- 1,589	0.500	- 794
	-11,643 #		-21,324 FT-#

SEE GENERAL NOTE 8) ON SHEET AB-2

SUM HORIZ FORCES IN LONGIT. DIRECTION

ACTIVE EARTH LOADS (SHT. AB-5)

$233.33 \left(\frac{5.833}{2}\right)(25.5) = 17,353$ #

$80.00(5.833)(10.0) = 4,667$

WIND LOADS (SHT. AB-3 & AB-4)

$8(3.323)(62.00) + 26(62.00) = 3,260$

25,280 #

PASSIVE EARTH LOADS
(MAXIMUM THAT COULD BE DEVELOPED)

$\gamma = 115$ PCF ; $\phi \simeq 32°$; $c = 0$

$\therefore K_p = \tan^2(45 + \frac{32}{2}) = 3.255$

$P_H = 3.255(115)\left(\frac{5.833}{2}\right)^2(25.5) = 162,384$ #

$F.S. \frac{162,384}{25,280} = 6.42$

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Subject: BAY ISLAND - ACCESS BRIDGE		Date: 10 JAN 90
Computed by: K. WILSON	Checked by: MCW	Sheet: AB-9 of

ABUTMENT DESIGN – STABILITY TRANSV.

UNIT	FORCE	ARM	MOMENT
DEAD LOAD	146,009#	—	—
(W/O TOPPING)	(134,736)	—	—
TRUCK (32,000 + 24,254 + 4,127) / 2	30,190	0.167	5,042
	30,191	6.167	186,188
	60,381#		191,230 FT-#
WIND OVERTURNING (UPLIFT)			
GROUP II	−5,249#	−3.75	19,684 FT-#
GROUP III	−1,615#	−3.75	6,056 FT-#
WIND-TRANSV. (SHT. AB-4)			
GROUP II 32(3.323)(62.0)/2	3,296#	5.623*	18,533 FT-#
GROUP III 10(3.323)(62.0)/2	1,030	5.623*	5,792 FT-#
64(62.0)/2	1,984	11.792*	23,395
	3,014#		29,187 FT-#

* SEE BOTTOM OF SHT. AB-4

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Subject BAY ISLAND - ACCESS BRIDGE MCW		Date 10 JAN 90
Computed by K. WILSON	Checked by	Sheet AB-10 of

ABUTMENT DESIGN

LOADS TO PILES

GROUP I	FORCE	$M_X = M_{LONGIT.}$	$M_Y = M_{TRANSV.}$
DEAD LOAD	146,009	280,979	—
LIVE LOAD	60,381	125,772	191,230
	206,390#	406,751 FT-#	191,230 FT-#
		$\bar{Y} = 1.9708$ FT	$\bar{X} = 0.9265$ FT

$$\text{PILE LOAD} = \frac{P}{A} \pm \frac{P e_Y C_Y}{I_Y} \pm \frac{P e_X C_X}{I_X}$$

[SEE SHT AB-6 FOR PILE LAYOUT]

$$e_Y = \bar{Y}_{PILES} - \bar{Y}_{FORCE} = 1.9167 - 1.9708$$

$$= 0.0541^{FT} \text{ TOWARD FRONT ROW}$$

$$\text{PILE LOAD} = \frac{206,390}{5} + \frac{206,390(0.0541)}{3.3334}(-0.6667 \text{ OR } +1.0000)$$

$$+ \frac{206,390(0.9265)}{105.6250}(\pm 6.500;\ \pm 3.250;\ 0)$$

$$\text{PILE LOAD} = 41,278 \quad \begin{matrix} -2,233 \\ +3,350 \end{matrix} \quad \begin{matrix} \pm 11,767 \\ \pm 5,884 \\ \pm 0 \end{matrix}$$

$= 27,278\#;\ 39,045\#;\ 50,812\#$

$38,744\#;\ 50,512\#$

WHEN $M_Y = 0$:

39,045# ALL

44,628# ALL

Subject BAY ISLAND - ACCESS BRIDGE		Date 10 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-11 of

ABUTMENT DESIGN

LOAD TO PILES

GROUP I (a)	FORCE	$M_x = M_{LONGIT.}$	$M_y = M_{TRANSV.}$
DEAD LOAD (W/O TOPPING)	134,736	257,497	—
LIVE LOAD	60,381	125,772	191,230
BOUYANCY	− 11,643	− 21,324	—
	183,474#	361,945 FT-#	191,230 FT-#
		$\bar{Y} = 1.9727$ FT	$\bar{X} = 1.0423$ FT

$e_Y = 1.9167 - 1.9727$
$= 0.0560$ FT TOWARD FRONT ROW

$$\text{PILE LOAD} = \frac{183,474}{5} + \frac{183,474(0.0560)}{3.3334}(-0.6667 \text{ or } +1.0000)$$

$$+ \frac{183,474(1.0423)}{105.6250}(\pm 6.500; \pm 3.250; 0)$$

$$\text{PILE LOAD} = 36,695 \; - 2,055 \; \pm 11,768$$
$$+ 3,082 \; \pm 5,884$$
$$\pm 0$$

$= 22,872\#; 34,640\#; 46,408\#$

$33,893\#; 45,661\#$

Subject BAY ISLAND - ACCESS BRIDGE		Date 10 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-12 of

ABUTMENT DESIGN

LOADS TO PILES

GROUP II	FORCE	$M_X = M_{LONGIT.}$	$M_Y = M_{TRANSV.}$
DEAD LOAD	146,009	280,979	—
WIND ON STRUCT	− 5,249	− 10,934	19,684
" " "	—	—	18,533
	140,760#	270,045 FT-#	38,217 FT-#
		$\bar{Y} = 1.9185$ FT	$\bar{X} = 0.2715$ FT

$e_Y = 1.9167 - 1.9185$
$= 0.0018$ FT TOWARD FRONT ROW

$$\text{PILE LOAD} = \frac{140,760}{5} + \frac{140,760(0.0018)}{3.3334}(-0.6667 \text{ OR } +1.0000)$$

$$+ \frac{140,760(0.2715)}{105.625}(\pm 6.500; \pm 3.250 \pm 0)$$

PILE LOAD = 28,152 − 51 ± 2,352
+ 76 ± 1,176
± 0

= 25,749#; 28,101#; 30,453#

27,052#; 29,404#

Subject BAY ISLAND - ACCESS BRIDGE		Date 10 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-13 of

ABUTMENT DESIGN

LOAD TO PILES

GROUP III	FORCE	$M_x = M_{LONGIT.}$	$M_y = M_{TRANSV.}$
DEAD LOAD	146,009	280,979	—
LIVE LOAD	60,381	125,772	191,230
WIND ON STRUCT	− 1,615	− 3,364	6,056
" " "	—	—	5,792
WIND ON LIVE L.	—	—	23,395
	204,775 #	403,387 FT-#	226,473 FT-#
		$\bar{Y}$ = 1.9699	$\bar{X}$ = 1.1060 FT

$e_Y = 1.9167 - 1.9699$
$= 0.0532$ FT TOWARD FRONT ROW

$$\text{PILE LOAD} = \frac{204,775}{5} + \frac{204,775(0.0532)}{3.3334}(-0.6667 \text{ OR } +1.0000)$$

$$+ \frac{204,775(1.1060)}{105.6250}(\pm 6.50; \pm 3.25; 0)$$

$$= 40,955 \quad -2,179 \quad \pm 13,937$$
$$\quad\quad +3,268 \quad \pm 6,969$$
$$\quad\quad\quad\quad \pm 0$$

$= 24,839\#;\ 38,776\#;\ 52,713\#$

$37,254\#;\ 51,192\#$

Subject: BAY ISLAND - ACCESS BRIDGE		Date: 12 JAN 90
Computed by: K. WILSON	Checked by: MCW	Sheet: AB-14 of

ABUTMENT DESIGN - PILE FOUNDATION

FROM BORINGS BI-89-28 & BI-89-29:

a) THE PILES WILL BE DRIVEN THROUGH MEDIUM TO FINE SAND WITH AN AVERAGE BLOW COUNT OF 7 BLOWS PER FT.

b) THE PILE TIPS WILL BE DRIVEN INTO MATERIAL WITH A BLOW COUNT OF AT LEAST 20 BLOWS PER FT.

c) PENETRATION INTO GRANULAR MATERIAL WILL BE APPROX. 30 FT.

d) APPROX. 15 FT. OF GR. LEAN CLAY ABOVE THE SAND STRATA WILL CAUSE NEGATIVE FRICTION (PULL-DOWN) ON THE PILES. ASSUME C = 250 PSF.

e) THE PILES WILL BE BELOW THE WATER LINE.

FOR GR. LEAN CLAY

$\gamma = 115$ PSF ; $\gamma_{SUB} = 52.5$ PSF

FOR MEDIUM TO FINE SAND

$\phi = 30°$; $\gamma = 120$ PSF ; $\gamma_{SUB} = 57.5$ PSF

$N_q = 21$ REF. (5), PAGE 12 & REF. (6), PAGE 7.2-194

REFERENCES:

(5) "FOUNDATION DESIGN", WAYNE C. TENG, 1962.
(6) "FOUNDATIONS & EARTH STRUCTURES", NAVFAC DM-7.2, MAY 1982.

Subject BAY ISLAND - ACCESS BRIDGE		Date 12 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-15 of

ABUTMENT DESIGN - PILE FOUNDATION

AT PILE TIP ELEVATION

$\phi = 35^\circ$; $N_q = 50$

SINGLE PILE CAPACITY

$$Q_{ULT_S} = P_T N_q A_T + \sum_{H=H_0}^{H=H_0+D} K_{HC} P_o \tan\delta \, S$$ REF ⑥ PAGE 7.2-193

WHERE A_T = AREA OF PILE TIP = πR_T^2

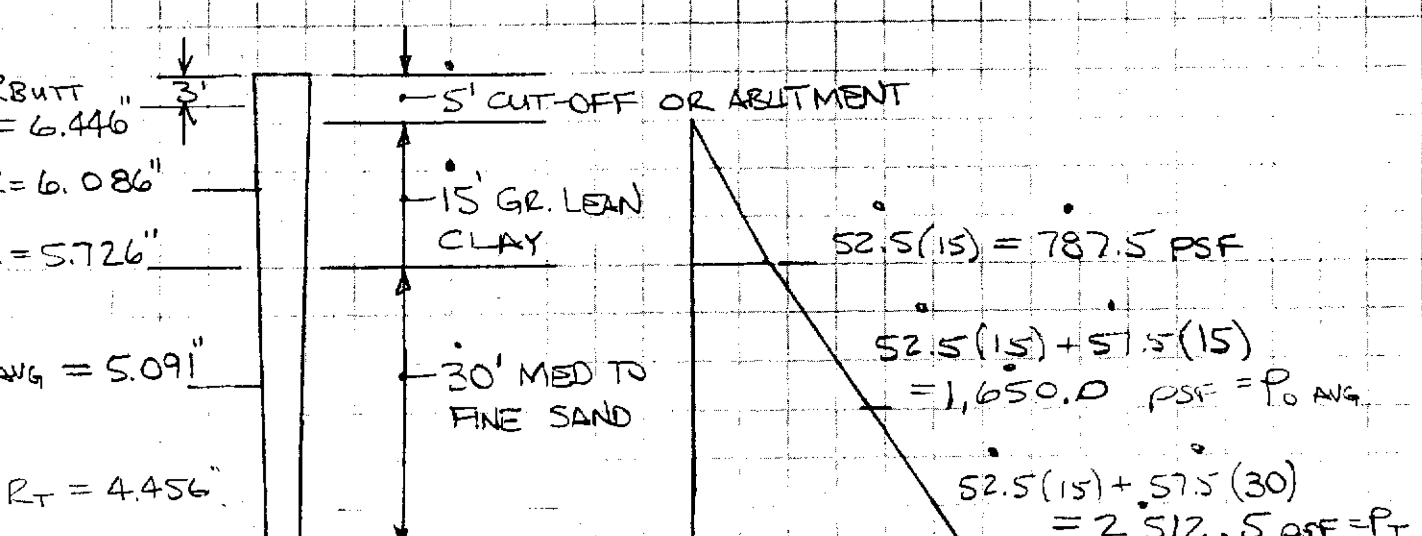
K_{HC} = COEFFICIENT OF LATERAL EARTH PRESSURE = 1.50

S = SURFACE AREA OF PILE / FT. LENGTH = $2\pi R$

P_T = EFFECTIVE VERTICAL STRESS AT PILE TIP

P_o = EFFECTIVE VERTICAL STRESS OVER LENGTH OF EMBEDMENT

(SEE DIAG. BELOW)



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Subject BAY ISLAND - ACCESS BRIDGE		Date 12 JAN 96
Computed by K. WILSON	Checked by MCW	Sheet AB-16 of

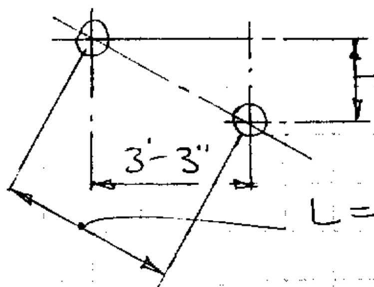
ABUTMENT DESIGN - PILE FOUNDATION

$$Q_{ULT_S} = 2,512.5(50)(\pi)\left(\frac{4.456}{144}\right)^2$$

$$+ 1.50(1,650)(2)(\pi)\left(\frac{5.091}{12}\right)(30)\tan \tfrac{3}{4}(35)$$

$$= 54,419 + 97,605 = 152,024^{\#}$$

CALCULATE REDUCTION DUE TO GROUP ACTION



$$L = \sqrt{3.25^2 + 1.667^2} = 3.652^{FT}$$

NOTE: THE ABOVE SPACING IS LESS THAN 7 PILE DIAMETERS, THEREFORE, CALCULATE THE EFFICIENCY FACTOR (F) OF A SINGLE IN THE GROUP. ALTHOUGH STAGGERED, ASSUME THE PILES ARE IN A SINGLE ROW

$$F = 1 - \left(2 - \frac{1}{n} - \frac{1}{m}\right)\frac{\theta}{90} \qquad \text{REF (7), PAGE 11}$$

WHERE n = NUMBER OF PILES IN A ROW
m = NUMBER OF ROWS
$\theta = \tan^{-1}\frac{d}{s}$; d = PILE DIAM.
s = PILE SPACING

REF. (7) "DESIGN OF PILE FOUNDATIONS AND STRUCTURES", EM 1110-2-2906

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Subject BAY ISLAND - ACCESS BRIDGE		Date 12 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet AB-17 of

ABUTMENT DESIGN - PILE FOUNDATION

$$F = 1 - \left(2 - \frac{1}{5} - \frac{1}{1}\right) \frac{\tan^{-1}\left[2\left(\frac{5.726}{12}\right) / 3.652\right]}{90} = 0.8743$$

$$\therefore Q_{ULT_G} = 0.8743(152,024) = 132,914^{\#}$$

CALCULATE "PULL-DOWN" OF GR. LEAN CLAY

$$-Q = 250(2\pi)\left(\frac{5.841}{12}\right)(15) = 11,468^{\#}$$

ASSUMING A F.S. OF 2.0

$$Q_{ALL} = \frac{132,914 - 11,468}{2} = 60,723^{\#} / \text{PILE}$$

OR

30.36 TONS

ASSUMING A F.S. OF 3.0

$$Q_{ALL} = \frac{132,914 - 11,468}{3} = 40,482^{\#} / \text{PILE}$$

OR

20.24 TONS

Subject BAY ISLAND - ACCESS BRIDGE	Date 15 JAN 90
Computed by K. WILSON / Checked by MCW	Sheet AB-18 of

ABUTMENT DESIGN - PILE FOUNDATION

THE MAXIMUM LOADS ON THE ABUTMENT PILES INCLUDE LIVE LOAD AND WIND. THESE LOADS ARE TEMPORARY, THEREFORE A FACTOR OF SAFETY OF 2.0 CAN BE USED.

∴ PILE LOAD = 52,713# (SEE SHT. AB-13)

= 26.36 TON < Q_{ALL} = 30.36 TON

IF DEAD LOAD ONLY IS CONSIDERED A FACTOR OF SAFETY OF 3.0 SHOULD BE USED.

$$\text{PILE LOAD} = \frac{P}{A} \pm \frac{P e_Y C_Y}{I_Y}$$ (SEE SHT. AB-10)

P = 146,009#

M = 280,979 FT-#; $\bar{Y}$ = 1.9244; e_Y = 1.9167 - 1.9244 = 0.0077 FT TOWARD FRONT ROW

$$\text{PILE LOAD} = \frac{146{,}009}{5} + \frac{146{,}009(0.0077)}{3.3334}(-0.6667 \text{ OR } +1.0000)$$

= 29,202 - 225
+ 337

= 28,977#

29,539# = 14.77 TON < Q_{ALL} = 20.24 TON

NCR Form 1 Aug 80 381b

Subject BAY ISLAND - ACCESS BRIDGE		Date 18 JAN 90
Computed by K. WILSON	Checked by [illegible]	Sheet AB-19 of

ABUTMENT DESIGN - PILE FOUNDATION

ASSUME THE LENGTH OF PILE IN THE GR. LEAN CLAY TO BE UNSUPPORTED. CHECK THE ALLOWABLE LOAD ON THE PILE BASED ON ALLOWABLE WOOD STRESS

$$F'_a = \frac{\pi^2 E S}{4.0 \left(\frac{KL}{r_A}\right)^2}$$ REF. (8), PAGE A3

F.S. → 4.0 (SEE SHT AB-14)

WHERE: $S = \frac{D_B}{D_A} = \frac{\text{PILE DIAM. AT ABUTMENT}}{\text{PILE DIAM. AT SOIL SUPPORT}}$

$E = 1,500,000$ PSI

$K = 0.70$ FOR PINNED-FIXED END CONDITIONS.

r_A = RADIUS OF GYRATION OF PILE AT SOIL SUPPORT (SEE SHT. AB-14)

L = UNSUPPORTED LENGTH OF PILE.

$$F'_a = \frac{\pi^2 (1,500,000)\left(\frac{6.361}{5.726}\right)}{4.0\left[\frac{0.7(16.4)(12)}{\frac{2(5.726)}{4}}\right]^2} = 1,775.8 \text{ ps}$$

$= 1,775.8$ PSI $> F_a = 1,000$ PSI FOR SO. PINE

$\therefore$ PILE $\text{LOAD}_{ALL} = \frac{1,000(\pi)(5.726)^2}{2,000} = 51.50$ TON $> Q_{ALL} = 30.36$ TON (SEE SHT. AB-17)

REF. (8) "BASIC PILE GROUP BEHAVIOR", TECH. REPORT K-83-1, U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION.

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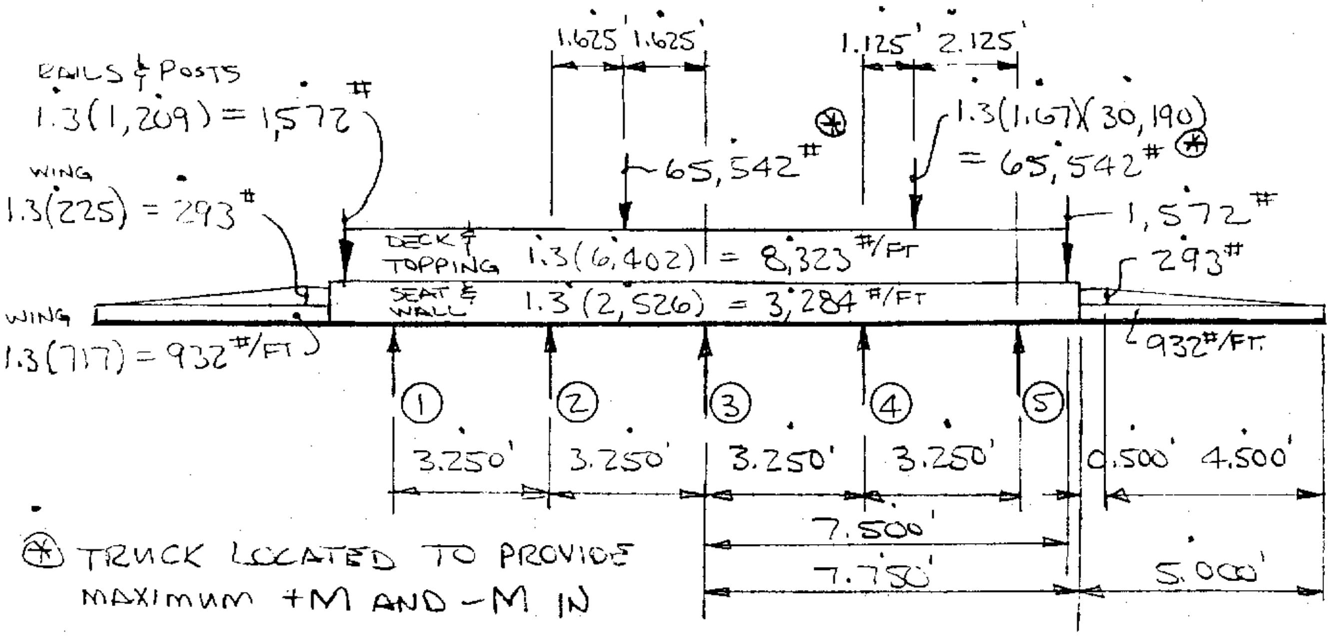
Subject: BAY ISLAND - ACCESS BRIDGE		Date: 22 JUN 90
Computed by: K. WILSON	Checked by: MCW	Sheet AB-20 of

ABUTMENT DESIGN - SEAT



(*) TRUCK LOCATED TO PROVIDE MAXIMUM +M AND -M IN SEAT.

FACTORED LOADS - GROUP I

$$M_{CANT_{1\&5}} = 932(5.000)\left(\frac{5.000}{2}+1.25\right) + 293\left(\frac{4.500}{2}\right)\left(\frac{4.500}{3}+1.75\right)$$

$$+ 293(0.500)\left(\frac{0.500}{2}+1.25\right) + 1,572(1.000)$$

$$+ 3,284\frac{(1.25)^2}{2} + 8,323\frac{(1.000)^2}{2}$$

$$= 17,475 + 2,142 + 220 + 1,572 + 2,566 + 4,162$$

$$= 28,137 \text{ FT-\#}$$

$$FEM_{1-2,2-1,3-4,4-3} = (8,323+3,284)\frac{(3.250)^2}{12} = 10,217 \text{ FT-\#}$$

$$FEM_{2-3,3-2} = 10,217 + 65,542\frac{(3.250)}{8} = 36,843$$

$$FEM_{4-5} = 10,217 + 65,542\frac{(1.125)(2.125)^2}{(3.250)^2} = 41,740 \text{ FT-\#}$$

Subject: BAY ISLAND – ACCESS BRIDGE		Date: 22 Jan 90
Computed by: K. WILSON	Checked by: MCW	Sheet AB-21 of

ABUTMENT DESIGN – SEAT

$$FEM_{5-4} = 10{,}217 + 65{,}542\,\frac{(1.125)^2(2.125)}{(3.25)^2} = 26{,}905^{\text{FT-\#}}$$

	①		②		③		④		⑤
	1.00	0.50	0.50	0.50	0.50	0.50	0.50	1.00	
28,137	-10,217	10,217	-36,843	36,843	-10,217	10,217	-41,740	26,905	-28,137
	-17,920	13,313	13,313	-13,313	-13,313	15,761	15,762	1,232	
	6,656	-8,960	-6,656	6,656	7,880	-6,656	616	7,881	
	-6,656	7,808	7,808	-7,268	-7,268	3,020	3,020	-7,881	
	3,904	-3,328	-3,634	3,904	1,510	-3,634	-3,940	1,510	
	-3,904	3,481	3,481	-2,707	-2,707	3,787	3,787	-1,510	
	1,740	-1,952	-1,353	1,740	1,893	-1,353	- 755	1,893	
	-1,740	1,652	1,652	-1,816	-1,817	1,054	1,054	-1,893	
28,137	-28,137	22,231	-22,232	24,039	-24,039	22,196	-22,196	28,137	-28,137

$$V_{CANT_{1\,\&\,5}} = 932(5.000) + 293\left(\frac{4.500}{2}\right) + 293(0.5) + 1{,}572$$

$$+\ 3{,}284(1.25) + 8{,}323(1.00)$$

$$= 4{,}660 + 659.3 + 146.5 + 1{,}572 + 4{,}105 + 8{,}323 = 19{,}466^{\#}$$

$$V_{1-2} = (8{,}323 + 3{,}284)\left(\frac{3.25}{2}\right) + \left(\frac{28{,}137 - 22{,}231}{3.25}\right)$$

$$= 18{,}861.4 + 1{,}817.2 = 20{,}679^{\#}$$

$$V_{2-1} = 18{,}861.4 - 1{,}817.2 = 17{,}044^{\#}$$

$$V_{2-3} = (8{,}323 + 3{,}284)\left(\frac{3.25}{2}\right) + \frac{65{,}542}{2} - \left(\frac{24{,}039 - 22{,}232}{3.25}\right)$$

$$= 18{,}861.4 + 32{,}771.0 - 556.0 = 51{,}076^{\#}$$

$$V_{3-2} = 18{,}861.4 + 32{,}771.0 + 556.0 = 52{,}188^{\#}$$

Subject BAY ISLAND - ACCESS BRIDGE		Date 22 JAN 90
Computed by K. WILSON	Checked by MCW	Sheet HS-22 of

ABUTMENT DESIGN - SENT

$$V_{3-4} = (8,323 + 3,284)\left(\frac{3.25}{2}\right) + \frac{(24,039 - 22,196)}{3.25}$$

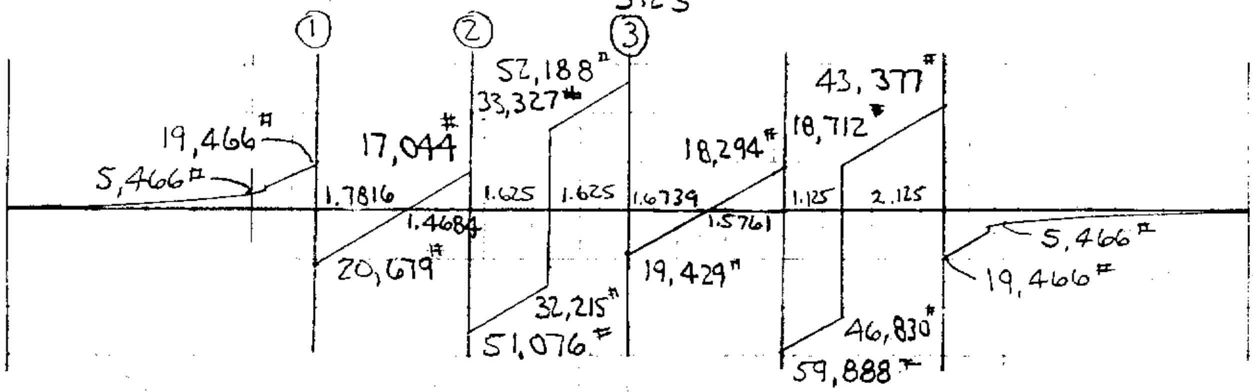
$$= 18,861.4 + 567.1 = 19,429^{\#}$$

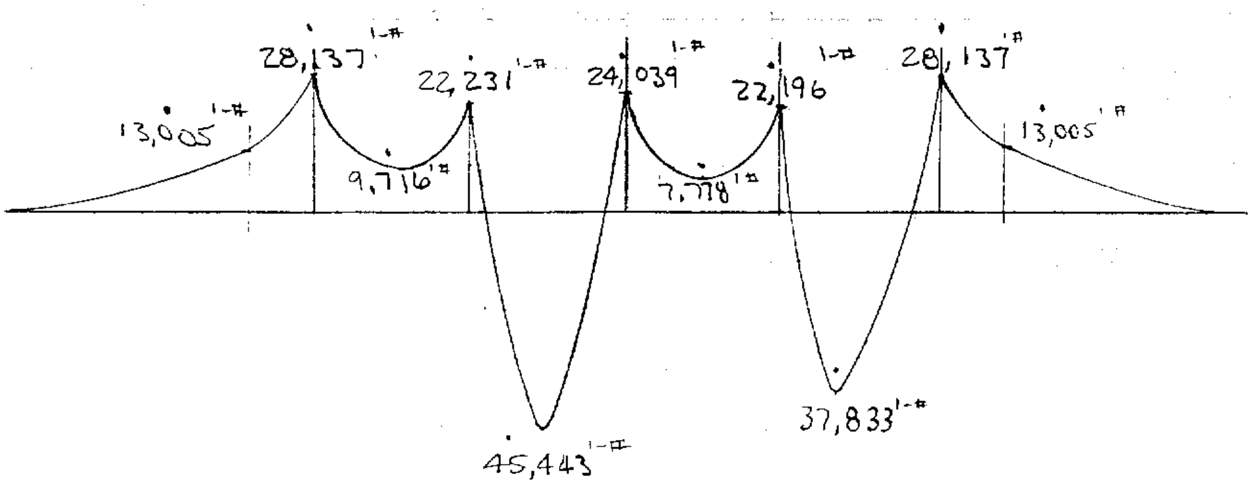
$$V_{4-3} = 18,861.4 - 567.1 = 18,294^{\#}$$

$$V_{4-5} = (8,323 + 3,284)\left(\frac{3.25}{2}\right) + 65,542\frac{(2.125)}{3.25} - \frac{(28,137 - 22,196)}{3.25}$$

$$= 18,861.4 + 42,854.4 - 1,828.0 = 59,888^{\#}$$

$$V_{5-4} = 18,861.4 + 65,542\frac{(1.125)}{3.25} + 1,828.0 = 43,377^{\#}$$





ABUTMENT DESIGN - SEAT

MINIMUM SEAT DEPTH	= 3'-6"
- CLEARANCE TO REINF.	= - 3"
- #4 HOOP REINF.	= - 1/2"
- HALF MAIN REINF. BAR	= - 3/8"

$d = 3'\text{-}2\tfrac{1}{8}" = 38.125"$

SAY 38"

$b_{TOP} = 4'\text{-}1" = 49"$

$b_{BOTT} = 4'\text{-}1" - \text{PILE DIAM.} = 49" - 2(6.445)$ ← SHT AB-15

$= 36"$

SHEAR

NOTE: REF. ①, SEC. 8.16.6.6.1 (a) STATES THE CRITICAL SECTION FOR SHEAR UNDER BEAM ACTION IS LOCATED A DISTANCE "d" FROM THE FACE OF THE CONCENTRATED LOAD OR REACTION AREA. "d" > PILE SPACING - PILE DIAM., ∴ SHEAR IS NOT A PROBLEM. PROVIDE #4 @ ± 12" O.C. AS A MINIMUM.

Subject BLUE ISLAND - ACCESS BRIDGE		Date
Computed by	Checked by	Sheet AB-22 of

ABUTMENT DESIGN - SEAT

REINFORCING REF: (9), TABLE 9-2

$$\frac{+M_u}{\phi f'_c b d^2} = \frac{45,443(12)}{0.9(3,000)(49)(38)^2} = 0.00286$$

$$\omega = 0.00286 \; ; \; \rho = 0.00286 \frac{(3)}{60} = 0.000143$$

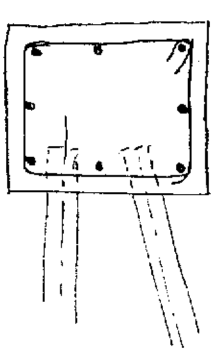
$$+A_s = \frac{4}{3}(0.000143)(49)(38) = 0.36 \text{ IN}^2$$ REF. (1), SEC 8.17.1.2

$$\frac{-M_u}{\phi f'_c b d^2} = \frac{28,137\ (12)}{0.9(3,000)(36)(38)^2} = 0.00241$$

$$\therefore -A_s \simeq +A_s = 0.36 \text{ IN}^2$$

SHRINKAGE AND TEMPERATURE REINFORCING

$$A_{S_{TEMP}} = 0.0018(49)(38) = 3.35 \text{ IN}^2 \text{ TOTAL}$$



$$A_s/\text{BAR} = \frac{3.35}{8} = 0.42 \text{ IN}^2$$

SAY 8 - #6'S

REF. (9) "NOTES ON ACI 318-83 BLDG. CODE REQUIREMENTS FOR REINFORCED CONCRETE"

Subject: ELY [illegible] - ACCESS BRIDGE		Date: 23 JAN. 90
Computed by: K. WILSON	Checked by: MCW	Sheet AB-25 of

ABUTMENT DESIGN - SEAT

WING REINFORCING

WING DEPTH @ JUNCTION W/ SEAT	= 4'-9½"
- CLEARANCE TO REINF.	- 3"
- HALF MAIN REINF. BAR	- ½

$d = 4'\text{-}6" = 54"$

$b = 12"$

$$\frac{M_u}{\phi f'_c b d^2} = \frac{13{,}005(12)}{0.9(3{,}000)(12)(54)^2} = 0.00165$$

$$\omega = 0.00165 \quad ; \quad \rho = 0.00165\frac{(3)}{60} = 0.000083$$

$$A_s = \frac{4}{3}(0.000083)(12)(54) = 0.071 \text{ IN}^2$$

$$A_{S_{TEMP}} = 0.0018(144) = 0.26 \text{ IN}^2/\text{FT}$$

SAY #4 @ 12" EA. WAY
EA. FACE

BACK WALL REINFORCING (SEE SHEET AB-5)

$$M_u = 1.3(80)\frac{(2.292)^2}{2} + 1.3(91.67)\left(\frac{2.292}{2}\right)\left(\frac{2.292}{3}\right)$$

$$= 273.2 + 104.3 = 377.5 \text{ FT-\#/FT}$$

$d = 12" - 2" - ½" = 9½"$

ABUTMENT DESIGN - SEAT

[illegible] REINFORCING

$$\frac{M_u}{\phi f'_c b d^2} = \frac{377.5(12)}{0.9(3000)(12)(9.5)^2} = 0.00155$$

$$\omega = 0.00155 \quad ; \quad \rho = 0.00155 \frac{(3)}{60} = 0.000078$$

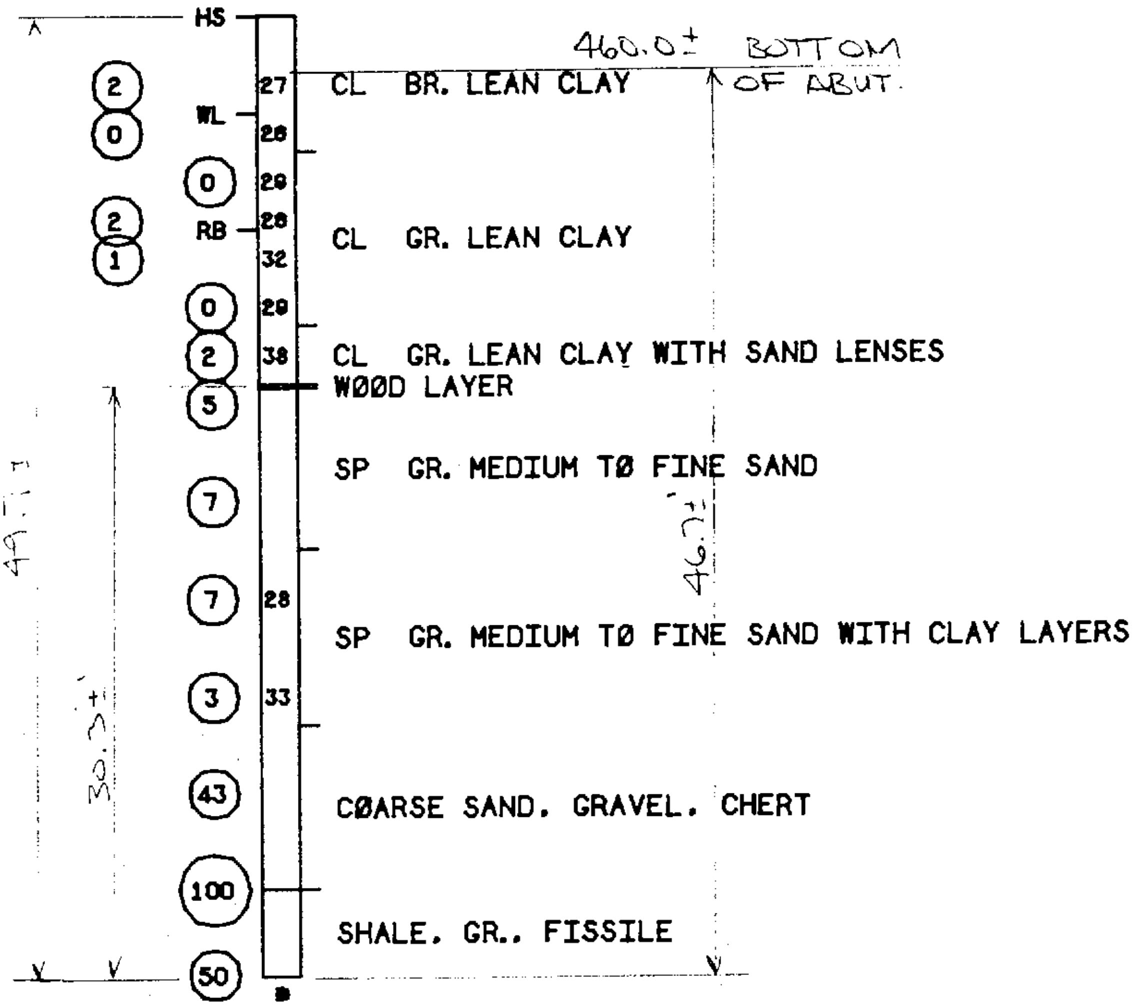
$$A_s = \frac{4}{3}(0.000078)(12)(9.5) = 0.012 \ \text{IN}^2/\text{FT}$$

SAY #4 @12" EA. WAY
EA. FACE

BRIDGE - WEST ABUTMENT

BI-89-29

TØP ELEVATIØN 462.9



STA 113+73
128' R
21 NØVEMBER 1989

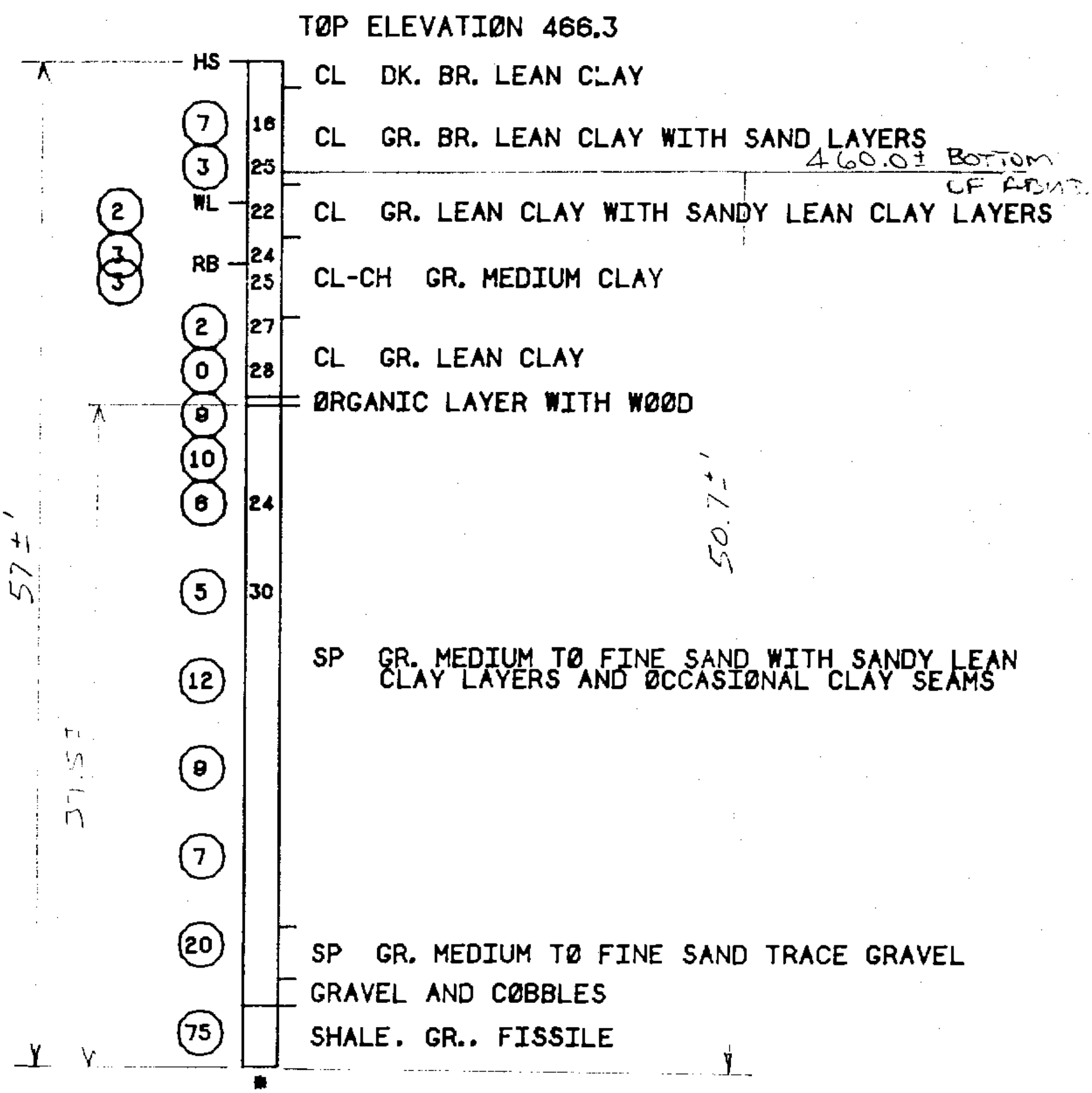
NØTE: SPLIT SPØØN REFUSAL IN SHALE (50 BLØWS / 4")
ABLE TØ ADVANCE HØLE WITH RØLLER BIT

BAY ISLAND EMP PRØJECT

SCALE: 1IN= 10FT

BRIDGE - EAST ABUTMENT

BI-89-28



STA 113+73
29' R
20 NØVEMBER 1989

NØTE. SPLIT SPØØN REFUSAL AT 54.8' (75 BLØWS / 2")
ABLE TØ ADVANCE HØLE WITH RØLLER BIT

MECHANICAL AND ELECTRICAL CONSIDERATIONS

A

P

P

E

N

D

I

X

J

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-8)

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX J
MECHANICAL AND ELECTRICAL CONSIDERATIONS

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BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX J
MECHANICAL AND ELECTRICAL CONSIDERATIONS

PURPOSE AND SCOPE

The purpose of this appendix is to present the preliminary design of the pump station for the Bay Island, Missouri, project. Pump manufacturers' engineering information for standard catalog units were used to develop the design presented in this appendix. Pump sizing and layout are based on the efficient operation of the station, ease of normal maintenance, and the flooding requirements determined by the Missouri Department of Conservation (MDOC) for each particular Wetland Management Unit (WMU).

GENERAL

A pump station containing one submersible propeller-type pump is proposed for the Bay Island project. The function of the pump station will be to discharge river water into the non-forested WMU for the purposes of creating a flooded marsh in this region and the interconnected forested WMU to the north of the non-forested WMU. The flooded marshes then would be utilized by wintering or nesting waterfowl.

The pump station will be located on the southern end of the non-forested WMU and will be protected from the main channel of the river and associated debris. The pump station will draw water from the side chute west of Zeigler Island and be constructed integrally with the sediment deflection levee.

The pump unit is sized to complete a flooding sequence of the forested WMU in 15 days; thus, the most restrictive flooding requirement set by the MDOC will be met. Manual operation of the pump unit will be utilized for setting and maintaining water elevations in the non-forested and forested WMU's. Water elevation in the forested WMU will be further controlled via an intermediate stop log water control structure located between the units, as well as stop log structures located adjacent to Clear Creek. All necessary power and control equipment for the pump unit will be located outside of the pump station. Pump unit removal will be accomplished through one of two secured sealed equipment access hatches located on top of the pump station and directly overhead of the pump unit discharge tube. Hand-cleanable trash racks will be provided at the intake pipe entrance for protection of the pump impeller against large debris. Dewatering of the sump for maintenance purposes will be via a portable sump pump after isolating the sump from the river by the use of a portable dam at the intake pipe entrance.

STATION FEATURES

The pump station structure will consist of cast-in-place concrete sections. The pump station will be fed by a 122-foot-long (approximate) 24-inch reinforced concrete intake pipe from Zeigler Chute passing through the sediment deflection levee and entering the sump region wall. One 6,000-gpm submersible propeller-type pump with motor will be utilized to flood the WMU's. The discharge from the pump will enter a 30-foot-long (approximate) cast-in-place sloped concrete channel, approximately 5 feet wide, which passes through the remainder of the sediment deflection levee enroute to the non-forested WMU. Access to the sump region will be by an embedded ladder through the second equipment access hatch. System head computations and an example pump selection are shown on plates J-1 through J-9. The estimated annual operating energy cost of $1,020 is shown on plates J-10 and J-11.

OPERATION

The pump unit will be completely manually operated, except for the automatic pump shutoff protection capability for a low sump level condition. The automatic pump shutoff protection capability will be accomplished with two redundant float switches located in the sump. The float switches contacts will open (de-energizing the pump) at a sump water level elevation of 455 feet, 10 inches. The selected setpoint maintains an adequate margin of protection for the pump and motor according to the pump minimum submergence requirement.

ELECTRICAL

The submersible pump at the station will be operated by a directly attached electric motor. Power will be provided by the Missouri Rural Electric Cooperative (REC) of Palmyra, Missouri. Missouri REC is interconnected with Northeast Power Cooperative and Associate Electric which have coal-fired and hydroelectric generating plants. These utilities are considered to be a reliable source of power.

Three medium voltage power systems are available within the area: 7.2KV-2 phase, 12.5KV-3 phase, and 7.2KV single phase. The 7.2KV-2 phase and 12.5KV-3 phase lines are located 5 miles from the site; therefore, 5 miles of new power line will have to be constructed for direct utilization of 2-phase or 3-phase power. The 7.2KV single-phase line can be tapped within one-quarter mile of the pump station location. Utilization of the 7.2KV single-phase power option seems to be the most cost effective. Near the pump station, the 7.2KV line will be transformed down with a 37.5KV transformer to 240V single phase, which in turn will be converted to 480V 3-phase, using a power phase converter. The transformer, kilowatt-hour meter, power phase converter, and pump control panel will be mounted on a 2-pole platform structure located approximately 40 feet from the pump station. Cables to the pump station will be installed in underground conduit.

Local ownership of the power source will be on the load side of the kilowatt-hour meter. The Government, through its contractor, will pay for connection charges pertaining to the power line, transformer, kilowatt-hour meter, and power converter. The Missouri REC will own and maintain the medium voltage service, transformer, and meter.

The pump station will have motor loads of approximately 30 KW, which includes a 30 HP submersible pump motor and a 0.75 HP portable sump pump.

Load and short circuit analyses for the pump station are shown on plates J-12 through J-18. An electrical one-line diagram and details are shown on plate 27 of the main report.

Pump Station system Loss Calculations
For Pump Selection

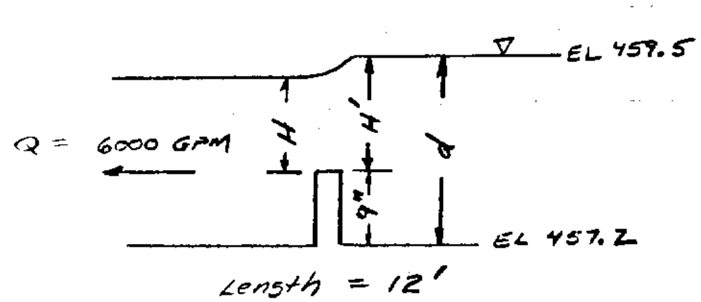
I. Assumptions

1. Elevation of River Pool ~ 459.5'
2. Elevation of channel ~ 466.0'
3. Minimum Static lift required ~ 466.0' - 459.5' ~ 6.5'
4. Length of 24" RCP ~ 122.0' @ slope of 0.0344
5. Top of pump discharge tube ~ 467.5'
6. Top of discharge tube weir ~ 467.5'
7. Flow ~ 6000 GPM thru RCP & pump tube
8. Bottom of pump discharge tube ~ 454.17'

II System Losses

1. Intake weir loss
2. Trashrack loss
3. RCP friction loss w/ Discharge loss & entrance loss
4. Pump pipe friction loss
5. Discharge loss
6. Static head

1. Intake weir loss



L = 12'
H' = depth of water producing discharge ~ 1.55'
P = Height of weir ~ 0.75'
d = P + H
Q' = Free discharge

Using "Handbook of Hydraulics" 6th Ed, Brater and King chapter 5

$$Q' = C L H'^{3/2} \quad \underline{(Eq\ 5\text{-}10)}$$

Free Velocity over weir : 41739 GPM x $\frac{1\,min}{60\,sec}$ x $\frac{1\,ft^3}{7.48\,Gallon}$ x $\frac{1}{12\,ft}$ x $\frac{1}{1.55\,ft}$

Assume < 5.0 ft/s

: 5.0 ft/s

$$\therefore \quad C = 3.33\left(1 + 0.259\,\frac{H'^2}{d^2}\right) \quad \underline{(Eq\ 5\text{-}23)}$$

$$C = 3.33\left(1 + 0.259\left(\frac{1.55^2}{2.3^2}\right)\right)$$

$$C = 3.722$$

$$\therefore \quad Q' = 3.722\,(12)(1.55)^{3/2}$$

$$Q' = 86.183 \text{ cfs}$$

$$Q' = 38680 \text{ GPM}$$

∴ use of eq 5-23 ok

$$\frac{Q}{Q'} = \left[1 - \left(\frac{H}{H'}\right)^n\right]^{0.385} \quad \underline{(Eq\ 5\text{-}50)}$$

$$\frac{6000}{38680} = \left[1 - \left(\frac{H}{1.55}\right)^{3/2}\right]^{0.385}$$

$$H = 1.542'$$

$$h_L \text{ weir} = H' - H = 1.55 - 1.542$$

h_L weir = 0.008'

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2. Trashrack loss

Assume velocity to trashrack

$v = 6000 \text{ GPM} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 \text{ ft}^3}{7.48 \text{ Gallon}} \times \frac{1}{12 \text{ ft}} \times \frac{1}{1.55'}$

$v = 0.72 \text{ ft/s}$

Reference "New concepts in the design of propeller pumping stations" Vincenzo Bixio chapter 7

Assume bar aspect ratio = 5 (bar length / bar width)
Assume bar width = 1"
Assume bar length = 5"
Assume rectangle bar
Assume center to center distance = 5"
# of bars = Length / center to center distance
= 28
g_o = Gap of bars = 4"
S_1 = center to center distance = 5"
$g_o/S_1 = 0.8 \Rightarrow K_1 = 0.16$ (Figure 7.3)

Assume angle of trash rack ≈ 30° (ϕ)

Figure 7.3 $\Rightarrow \beta_1 = 2.34$

$h_{LTR} = \Delta h = \frac{V^2}{2g} \beta_1 K \sin(\phi)$

$= \frac{0.72^2}{2(32.2)} (2.34)(0.16)(\sin 30)$

$\boxed{h_{LTR} = 0.002'}$

Re actual > 1×10^4
∴ Use of Figure 7.3 ok

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3. RCP friction loss w/ discharge loss & Entrance loss

A. Pipe friction loss

Pipe flows full based on top of pipe elevation vs entry water elevation

Reference "Handbook of Hydraulics" 6th Ed, Brater and King Chapter 6

$$V_{pipe} = Q/A = \frac{\frac{6000\ \text{Gallons}}{\text{min}} \times \frac{1\ ft^3}{7.48\ \text{gallons}} \times \frac{1\ \text{min}}{60\ \text{sec}}}{\pi \frac{(2\ ft)^2}{4}}$$

$$V_{pipe} = 4.26\ ft/s$$

$$V^2/2g = 0.2812\ ft$$

Assume $n = 0.016$

Assume $S = 0.0344$, length $l = 122'$

$$V_{max} = \frac{0.590}{n} d^{2/3} S^{1/2} \quad (\text{Eq } 6\text{-}26a)$$

$$V_{max} = \frac{0.590}{0.016} (2)^{2/3} (0.0344)^{1/2}$$

$V_{max} = 10.86\ ft/s$ ∴ pipe sized ok

$$h_{friction} = \frac{2.87\, n^2\, l\, V^2}{d^{4/3}} \quad (\text{eq } 6\text{-}26c)$$

$$h_{friction} = \frac{2.87 (0.016)^2 (122')(4.26\ ft/s)^2}{(2\ ft)^{4/3}}$$

$$h_{friction} = \underline{0.646'}$$

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Subject: Bay Island		Date: Aug 89
Computed by: RVC	Checked by: BLK	Sheet 5 of 11

8. discharge loss & entrance loss

$h_{discharge} = f \frac{V_{pipe}^2}{2g}$ (Eq 6-35 w/ $V_2 = 0$)
$\theta = 30°$
$\Rightarrow f = 0.49$

$h_{discharge} = \underline{0.1378}$

$h_{entrance} = K_c \frac{V_{pipe}^2}{2g}$ Assume $K_c = 0.5$ (page 6-21)

$h_{entrance} = 0.5(0.2812)$

$h_{entrance} = \underline{0.1406'}$

$\therefore h_{L\,RCP} = h_{friction} + h_{discharge} + h_{entrance}$
$= 0.646' + 0.1378' + 0.1406'$

$\boxed{h_{L\,RCP} = 0.924'}$

4. Pump pipe friction

Pipe head losses are included into the Manufacturer's pump curves up to 20 inches above unit. Assume unit height equals 50 inches. Total pipe length accounted for equals 20" + 50" = 70" = 5.83 ft, 27" ID

$V_{pipe} = \left(6000\ GPM\right)\left(\frac{1\ ft^3}{7.48\ gallon}\right)\left(\frac{1\ min}{60\ sec}\right)\left(\frac{4}{\pi(2.25\ ft)^2}\right)$

$V_{pipe} = 3.362$ ft/s

$\frac{V_{pipe}^2}{2g} = \frac{(3.362\ ft/s)^2}{2(32.2)} = 0.1756$ ft

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Subject: Bay Island		Date: Aug 89
Computed by: A/C	Checked by: BLK	Sheet 6 of 11

Assume $\nu_{H_2O} @ 68°F = 1.082 \times 10^{-5}$ ft²/s
$\epsilon_{steel} = 0.0002$ ft

$$\therefore R_e = \frac{VD}{\nu} = \frac{3.362 \text{ ft/s}(2.25 \text{ ft})}{1.082 \times 10^{-5} \text{ ft}^2/\text{s}} = 7.0 \times 10^5$$

$$\epsilon/D = \frac{0.0002 \text{ ft}}{2.25 \text{ ft}} = 0.0001$$

From p 6-10 (Moody chart) "Handbook of Hydraulics" 6th Ed, Brater and King
$\therefore \Rightarrow f = 0.014$

$$h = f \; l/d \; \frac{V^2}{2g} \quad (\text{Eq } 6\text{-}19)$$

$$h_{tube} = 0.014\left(\frac{467.5' - 454.17' - 5.83'}{2.25}\right)(0.1756 \text{ ft})$$

$$\boxed{h_{tube} = 0.0082'}$$

5. Discharge Loss
Reference Flygt "Pumping Stations with Submersible propeller and large low lift pumps: Design and Dimensions" p. 14 (width = 1.53 m)

$$\boxed{h_{L \, discharge} \approx 0.35 \text{ M} \approx 1.15'}$$

for $Q = 0.4$ m³/s

Subject		Date
Das Island		Aug 89
Computed by	Checked by	Sheet of
RJC	BLK	7 of 11

6. Static Head

Static head requirement is length from top of discharge tube (EL 467.5') to level in sump (EL 459.5)

h_L static = 8.0'

TOTAL system Loss (TDH) = h_L weir + h_L TR + h_L RECP + h_L tube + h_L disch. + h_L static

TDH = 0.008' + 0.002' + 0.924' + 0.0022' + 1.15' + 8.0'

TDH = 10.1' @ 6000 GPM

III Pump Selection

FYLGT submersible propeller pump (20KW shaft input) Model 7050, 700 RPM 4 blade @ 14° blade angle Q = 6100 GPM @ 10.1 TDH w/ 81.0 efficiency

1. Pump Specific Speed @ BEP

$$N_S = \frac{N Q^{1/2}}{H^{3/4}} = \frac{700 (5600)^{1/2}}{(10.5)^{3/4}} = 8980$$ ∴ ok for propeller type

2. Pump input power Requirement

Assume η_{motor} = 0.85

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Subject: Ea Island		Date: Aug 89
Computed by: AVC	Checked by: BLF	Sheet 8 of 11

Input Power (IP) = $\frac{\text{Water horsepower}}{\eta_{pump}\ \eta_{motor}}$

$= \frac{GPM \times TDH}{3960\ \eta_{pump}\ \eta_{motor}}$

$= \frac{6100 \times 10.1}{3960\ (0.807)(0.85)}$

$= 22.7\ Hp = 16.9\ KW\ \therefore$ ok

3. Submersence Requirement
- per manufacturer 20" min from inlet flange
- actual submergence = sump water elevation — bottom of tube elevation
$= (459.5' - 1.068') - 454.17'$
$= 51''\ \therefore$ OK

4. NPSH

$NPSH_{req} \overset{?}{\leq} NPSH_{actual}$

$4M \overset{?}{\leq} \frac{P_a - P_v}{\gamma} + H_{submergence}$

(per manufacturer)
$P_a = P$ @ surface = 14.7 PSIA
P_v = vapor pressure H_2O @ 90 F = 0.6982 PSIA
$\gamma = 62.11\ lb/ft^3$
H = 51" (from part 3)

$13.1\ ft \overset{?}{\leq} \frac{(14.7 - 0.6982)\ PSIA}{62.11\ lb/ft^3} \times \frac{144\ in^2}{1\ ft^2} + 51\ in \times \frac{1\ ft}{12''}$

$13.1\ ft < 36.7\ ft$ ∴ NPSH requirement met

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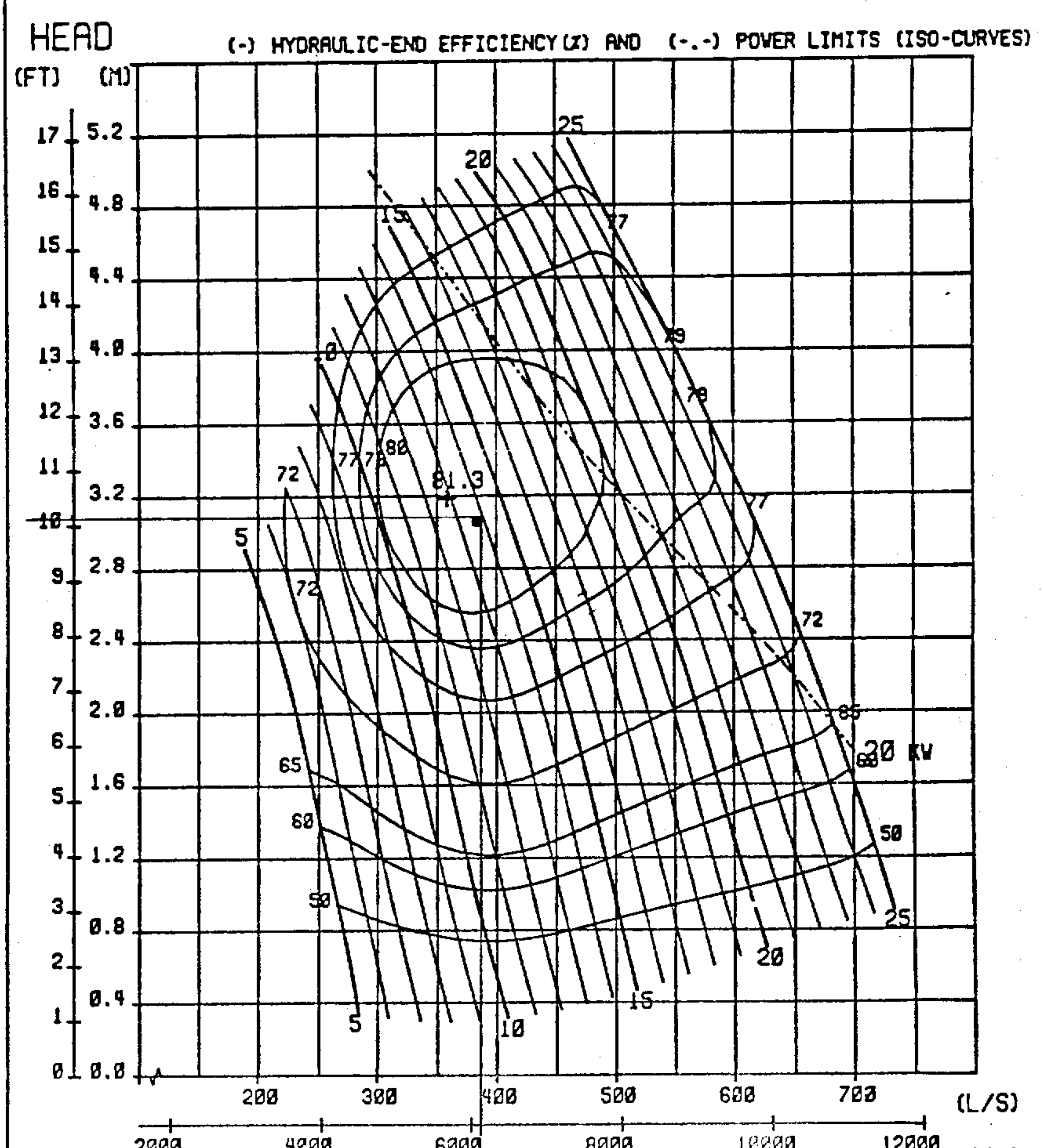
PLATE J-8

FLYGT	PERFORMANCE CURVE					PROD. 7050
						CURVE NO 63-700B4
DATE 1984-06-05	ISSUE 3	FREQ 60 HZ	NOMINAL HYDRAULIC-END SPEED 700 RPM			
IMPELLER/HUB DIAMETER 460/260 MM	TYPE OF BLADES B				NO. OF BLADES 4	AVAILABLE BLADE ANGLES EVERY DEG. FROM 5 TO 25 DEG

MOTOR	POLES	SHAFT POWER	GEARTYPE	GEAR RATIO	GEAR EFFICIENCY (1/1-3/4 LOAD)	RATED SPEED
35-24-1	10	20.0 KW				700 RPM
35-28-1	10	33				700
40-30-1	10	45				695



FLOW

NOTE:

CURVES ARE BASED ON NOMINAL CONSTANT HYDRAULIC-END SPEED AND SHOW PERFORMANCE WITH CLEAR WATER.

ALL HYDRAULIC LOSSES UP TO 500 MM. ABOVE THE PUMP/MOTOR TOP ARE INCLUDED

PLATE J-9

Subject: Bay Island		Date: Aug 89
Computed by: RVC	Checked by: BLK	Sheet 10 of 11

IV Operating Costs

Per utility involved with project

1. Rate (Monthly)

   a. \$7.5 + 8¢/kWHR (0-500 kw-hr) + 5.9¢/kWHR (>500 kw-hr)

2. 37.5\$/Month minimum transformer charge for 1 year (\$1/kVA)

Calculate $\frac{kw\text{-}hr}{Month}$ average

Total # pumping days ≈ 33 (see sheet 11 of 11)

Total pump input power = 19.1 kW (part III)

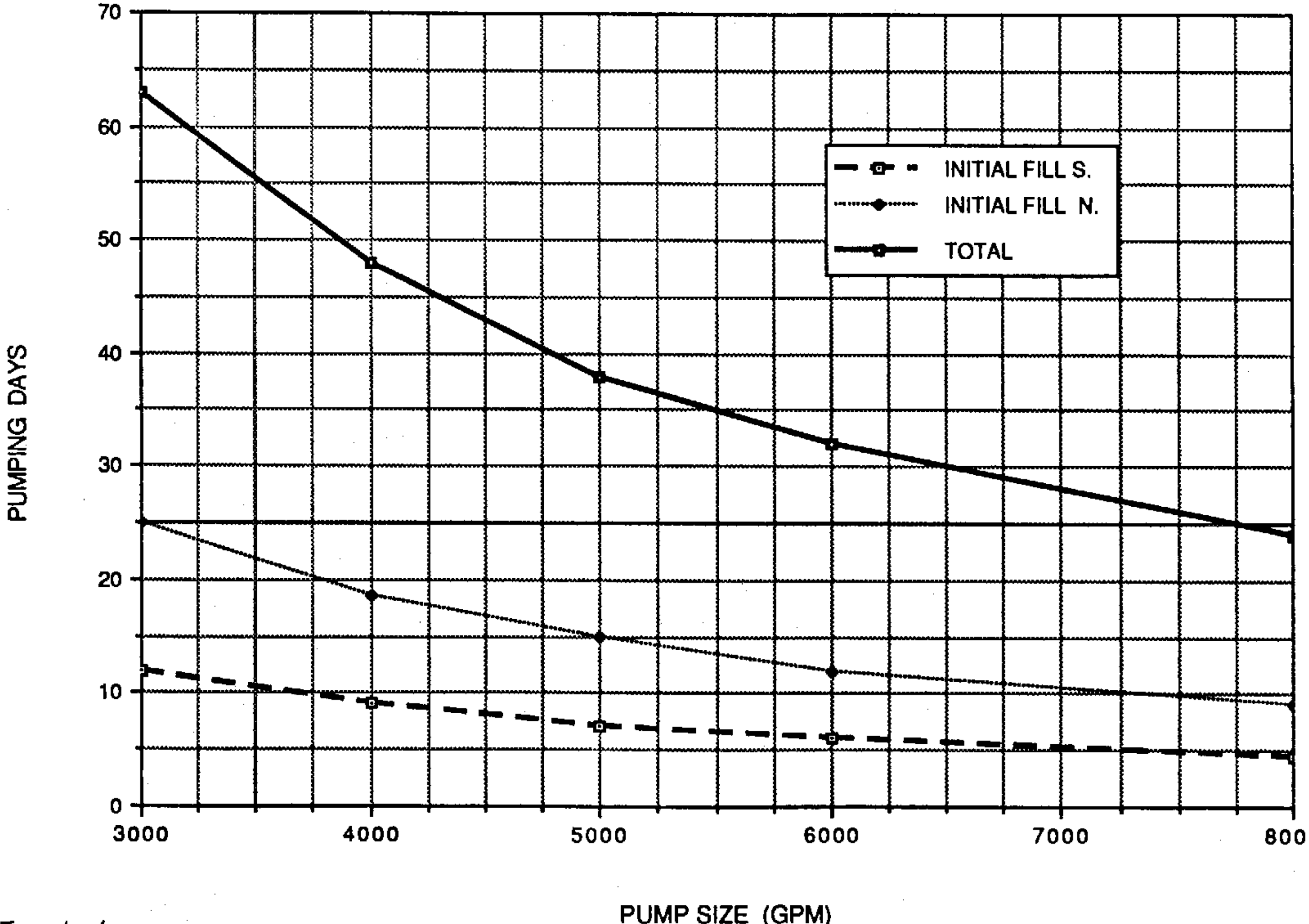
$$\frac{kw\text{-}hr}{Month} = \frac{33\ days}{year} \times 19.1\ kW \times \frac{24\ hour}{1\ day} \times \frac{1\ year}{12\ months} = 1261\ \frac{kw\text{-}hr}{Month}$$

$$\$/month = \frac{0.08\$}{kw\text{-}hr} \times \frac{500\ kw\text{-}hr}{1} + \frac{0.059\$}{kw\text{-}hr} \times \frac{761\ kw\text{-}hr}{1} + 37.5\$$$

\$/year = 12 x \$/Month =

\$1470/year for 1st year
\$1020/year thereafter

BAY ISLAND EMP
PUMP CAPACITY VS PUMPING DAYS



N. ⇒ Forested WMU
S. ⇒ Non-Forested WMU

Subject BAY ISLAND PUMP STATION		Date AUG. 14, 79
Computed by CJA	Checked by [signature]	Sheet 1 of 7

TRANSFORMER SIZING

CONNECTED LOAD - 30 HP, 460 V, 3ϕ SUBMERSIBLE PUMP
I_{FL} = 40A (NEC - TABLE 430-150)

3/4 HP, 230 V, 1ϕ SUMP PUMP
I_{FL} = 6.9A (NEC - TABLE 430-148)

$$KW = \frac{V \times I_{FL} \times PF \times \sqrt{3}}{1000}$$

$$KW_{3\phi} = \frac{480 \times 40 \times .90 \times 1.732}{1000} = 29.9$$

$$KW_{1\phi} = \frac{240 \times 6.9 \times .90}{1000} = 1.5$$

TOTAL CONNECTED LOAD = 29.9 + 1.5 = 31.4 KW

$$KVA = \frac{31.4\,KW}{.9} = 34.9$$

$\therefore$ A 37½ KVA TRANSFORMER WILL BE USED

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Subject		Date
BAY ISLAND PUMP STATION		AUG. 14, 1980
Computed by CJA	Checked by	Sheet 2 of 7

CONDUCTOR SIZING (SECONDARY)

TOTAL CONNECTED LOAD - 31.4 KW

$I_{FL} = \frac{31400 VA}{240V} = 130.8 A$

$125\% \times I_{FL} = 1.25 \times 130.8A = 163.5A$

#2/0 CU - 175A (NEC - TABLE 310-16)

#3/0 CU - 200A

∴ USE # 2/0 CU, # 1/0 CU GROUND

CONDUCTOR SIZE BETWEEN PHASE CONVERTER AND PUMP CONTROLLER:

30HP - 40A

125% × 40A = 50A

#6 CU - 55A, #4CU - 70A

∴ USE #4 CU, #8 GROUND

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Subject: BAY ISLAND PUMP STATION		Date: AUG. 12, 19
Computed by: CJA	Checked by: [illegible]	Sheet 3 of 7

PERCENT VOLTAGE DROP (% V_D)

$$\Omega = \frac{3\% \times V \times 1{,}000}{I_{FL} \times L \times 2 \times 100}$$

Ω = DC RESISTANCE - OHM/1000 FEET

L = ONE WAY LENGTH

$$\Omega = \frac{3 \times 480 \times 1{,}000}{40 \times 80 \times 2 \times 100} = 2.25$$

$$\% V_D = \frac{I_{FL} \times L \times \sqrt{3} \times \Omega}{V \times 1{,}000} \times 100$$

Ω = 0.0967 FOR #2/0 CU (NEC - TABLE 8)

$$\% V_D = \frac{40 \times 80 \times \sqrt{3} \times 0.0967}{480 \times 1{,}000} \times 100$$

$\% V_D = 0.1$ WELL BELOW 3% (FOR 30 HP MOTOR)

Ω = 1.98 FOR # 12 CU (NEC - TABLE 8)

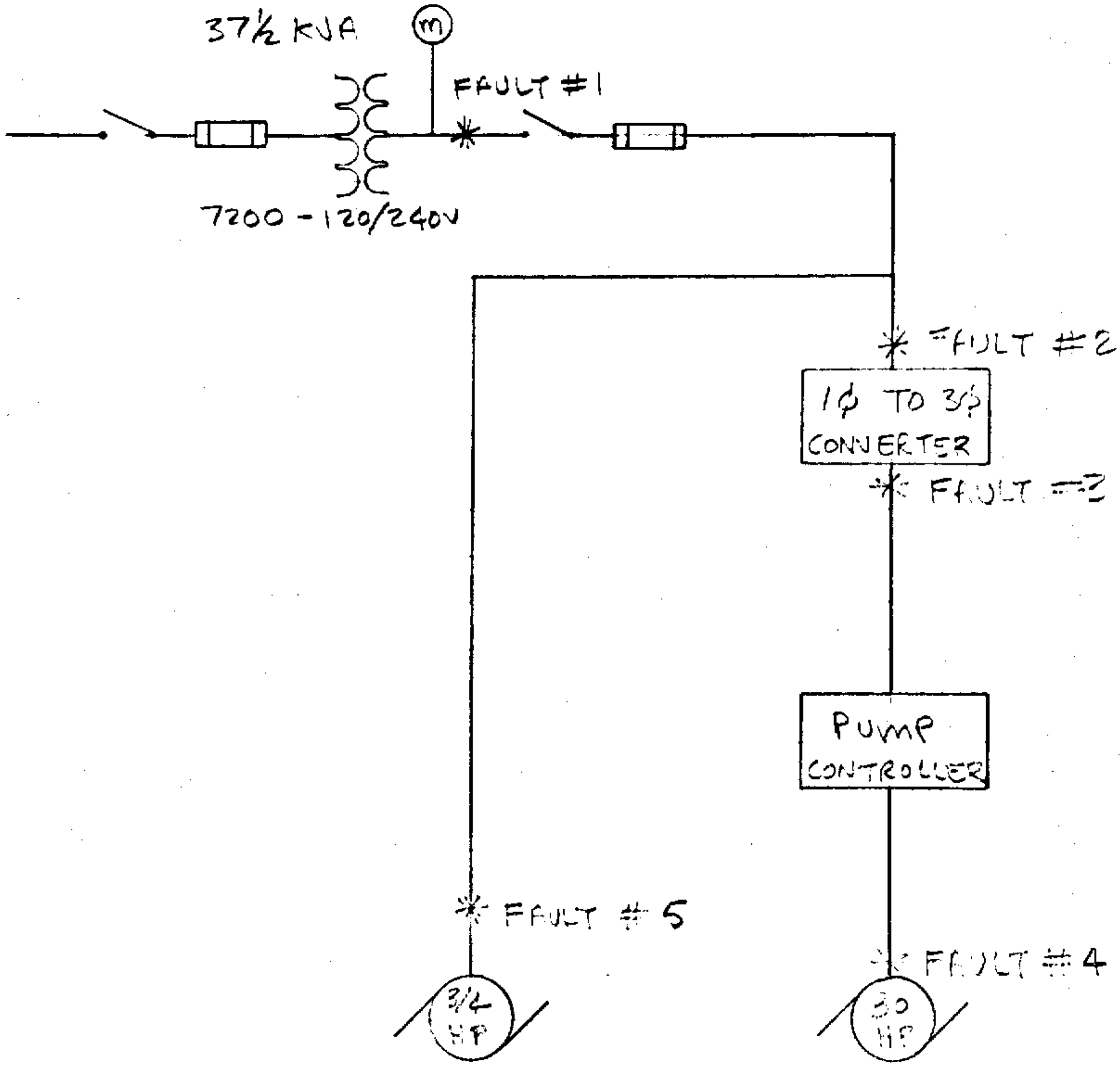
$$\% V_D = \frac{6.9 \times 70 \times 2 \times 1.98}{240 \times 1{,}000} \times 100$$

$\% V_D = 0.8$ WELL BELOW 3% (FOR 3/4 HP MOTOR)

Subject		Date
BAY ISLAND PUMP STATION		AUG. 14 1070
Computed by CJA	Checked by	Sheet of

FAULT (SHORT-CIRCUIT) STUDY

ONE-LINE DIAGRAM



Subject: BAY ISLAND PUMP STATION		Date: AUG. 16, 1979
Computed by: CJF	Checked by: [signature]	Sheet 5 of 7

SHORT-CIRCUIT CALCULATIONS

ASSUMPTIONS: INFINITE BUS ON TRANSFORMER PRIMARY. 100% MOTOR LOAD AT TRANSFORMER SECONDARY.
TRANSFORMER %Z = 1.0
37½ KVA, 1φ, 7200-120/240V

$$I_{FL} = \frac{KVA \times 1000}{E_{LL}} = \frac{37.5 \times 1000}{240} = 156A$$

$$\text{MULTIPLIER} = \frac{100}{\text{TRANSF. \%Z}} = \frac{100}{1.6} = 62.5$$

$$I_{SCA} = \text{TRANSF}_{FL} \times \text{MULTIPLIER} + \text{MOTOR LOAD}(80A \times 4)$$

$$= 156A \times 62.5 + 80A \times 4 = 9750 + 320 = 10,070A$$

@ TRANSF. SECONDARY

$$f = \frac{2 \times L \times I}{C \times E_{LL}} = \frac{2 \times 10 \times 10,070}{2700 \times 240} = 0.096$$

$$m = \frac{1}{1+f} = \frac{1}{1+0.096} = 0.912$$

$$*I_{SCA\,1\phi} = 10,070 \times .912 = 9,174\text{ A @ FAULT \#1}$$

DEVICES SHALL HAVE AN INTERRUPTING CAPACITY OF 22,000 RMS. SYM.

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1 Aug 80

PLATE J-16

Subject BAY ISLAND PUMP STATION		Date AUG. 14, 198-
Computed by CJA	Checked by	Sheet 6 of

SHORT-CIRCUIT CALCULATIONS

$$f = \frac{2 \times L \times I}{C \times E_{LL}} = \frac{2 \times 70 \times 9{,}124A}{617 \times 240} = 8.68$$

$$m = \frac{1}{1+f} = \frac{1}{1+8.68} = 0.103$$

$I_{SCA\ \phi} = 9{,}124A \times 0.103 = 946A$ @ FAULT # 5

FOR 3ϕ FAULT CURRENTS —

$$I_{FL} = \frac{KVA \times 1{,}000}{\sqrt{3} \times E_{LL}} = \frac{37.5 \times 1{,}000}{1.73 \times 480} = 45A$$

$$\text{MULTIPLIER} = \frac{100}{\text{TRANSF. \% Z}} = \frac{100}{1.6} = 62.5$$

I_{SCA} = TRANSF$_{FL}$ × MULTIPLIER + MOTOR LOAD

= 45A × 62.5 + (40 × 4)

= 2,973A @ TRANSF. SECONDARY

Subject: BAY ISLAND PUMP STATION		Date: AUG. 14, 19..
Computed by: CJA	Checked by:	Sheet 7 of 7

SHORT-CIRCUIT CALCULATIONS

$$f = \frac{\sqrt{3} \times L \times 2{,}973A}{8700 \times 480} = \frac{1.73 \times 10 \times 2973}{8700 \times 480} = .0123$$

$$m = \frac{1}{1+f} = \frac{1}{1+.0123} = 0.988$$

$$I_{SCA\,3\phi} = 2{,}973A \times 0.988 = 2{,}937A$$ @ FAULT # 2

$$f = \frac{1.73 \times 60 \times 2937}{3060 \times 480} = 0.2075$$

$$m = \frac{1}{1+f} = \frac{1}{1+.2075} = 0.828$$

$$I_{SCA\,3\phi} = 2{,}937 \times 0.828 = 2{,}432A$$ @ FAULT # 4

NCR Form 381b
1 Aug 80

APPENDIX L

PROJECT OUTPUT QUANTIFICATION

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-8)

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX L
PROJECT OUTPUT QUANTIFICATION

TABLE OF CONTENTS

UPPER MISSISSIPPI RIVER SYSTEM
ENVIRONMENTAL MANAGEMENT PROGRAM
DEFINITE PROJECT REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT (R-8)

BAY ISLAND, MISSOURI
REHABILITATION AND ENHANCEMENT
POOL 22, MISSISSIPPI RIVER MILES 311 THROUGH 312
MARION COUNTY, MISSOURI

APPENDIX L
PROJECT OUTPUT QUANTIFICATION

I. PURPOSE

The purpose of this appendix is to present an overview of the process used for quantification of benefits for this specific project. The method was applied by an interagency team composed of staff from the Missouri Department of Conservation (MDOC), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers.

II. BACKGROUND

The need for quantification of EMP-HREP outputs has been discussed by various agencies associated with the EMP as a project performance evaluation tool, a project ranking tool, and a project planning tool. This application involves quantification solely for the purpose of project planning.

The benefits to be derived from habitat rehabilitation and enhancement projects are not readily convertible to actual monetary units as is customarily required for traditional benefit-cost analyses. A method of quantification is needed to adequately evaluate project features for planning, design, and administrative purposes.

Measurable changes in habitat value can be described by suitability indices, habitat units, animal numbers, or animal use days.

The selected approach is referred to as a habitat unit (HU) accounting methodology. Several similar methodologies exist at this time, such as Habitat Evaluation Procedures (HEP), which was developed by the USFWS as an impact assessment tool; Habitat Evaluation System (HES), which was developed by the Corps of Engineers also as an impact assessment method; and Habitat Management Evaluation Method (HMEM), which was developed by the Bureau of Reclamation. Of the three methodologies referenced, HEP is likely the most familiar to all participants in the EMP.

III. METHODOLOGY

For this project, HU's were chosen as the unit of comparison for project features or alternative plans. HU's are derived from multiplication of habitat acreages by habitat suitability indices (HSI's). HSI's result from numeric ranking of site characteristics at sample sites throughout a given project area. Numeric ranking was done using the Wildlife Habitat Appraisal Guide (WHAG) field data sheets and computer program developed by the MDOC and the Soil Conservation Service.

This project did not involve aquatic habitat and therefore no aquatic enhancement goals. The Rock Island District Corps of Engineers is currently working with the MDOC, the USFWS, and the Corps of Engineers Waterways Experiment Station to develop an aquatic habitat appraisal guide methodology similar in function to WHAG. No aquatic methodology has been completed as of this date. A draft aquatic appraisal guide has been distributed for agency review and response to MDOC.

HU's may be averaged and annualized for specific target years to project anticipated changes in habitat values over time. The HU represents a measure of available habitat based on acreage and estimated habitat quality.

Computer results are provided for estimated total HU's, HSI's, and animal numbers. After existing conditions are determined, the Bay Island study team reviewed the habitat appraisal guides to determine where habitat quality can be improved. HU's were annualized for target years using the USFWS's HEP 80 program in order to evaluate changes in project features over time. As an example, initially, pin oak plantings will have little value as forest habitat but gain value over the 50-year period of analysis. As the overall project matures, forest evaluation characteristics such as stems per acre, percent canopy closure, snags per acre, and cavity trees per acre are assumed to change in a relatively predictable succession. It is the rate of succession that is then used to select target years for project evaluation.

Habitat quality ratings can be improved by: 1) increasing acreages for particular habitat types that may be limited or lacking; 2) altering a limiting factor, such as unpredictable water levels; 3) altering a management strategy such as cropping practice, or cover crop composition; or 4) a combination of the preceding, depending on management goals, target species requirements, or available funds.

For the Bay Island, Missouri, project the project goal was enhancement of wetland values for migratory waterfowl. Therefore, the study team selected the appraisal guides for wetland habitats, and selected the mallard as a target species or species of emphasis. The WHAG study team was comprised of staff from the MDOC, the USFWS, and the Corps of Engineers. Prior to site sampling, the study team reviewed aerial photography, topographic maps, and preliminary design drawings to select representative sample sites for WHAG application.

During site sampling, assumptions were developed regarding existing conditions and projected post-project conditions, relative to limiting factors and management practices.

IV. ASSUMPTIONS

a. Water levels throughout the project area are unpredictable during waterfowl migrations. Lack of shallow water over and within wetland food resources (crops and mast-producing forested areas) limits wetland value during migrations.

b. Forest values regarding mast production limit wetland values during waterfowl migrations.

c. Current cropping practices are sufficient to provide an alternate food source to naturally occurring moist soil species during waterfowl migrations.

d. Alternatives evaluated represent all available options to modify habitat suitability for migratory waterfowl, as represented by the resource categories of forested wetland, non-forested wetland, cropland, and grassland.

e. Target years of 0, 1, 15, and 50 will be sufficient to annualize HU's and to characterize habitat changes over the estimated project life.

f. The mallard is a suitable species of emphasis and adequately characterizes life requisite requirements of the migratory waterfowl group for the purpose of incremental analysis of this project.

g. The Canada goose, green heron, wood duck, beaver, northern parula, and prothonotary warbler are suitable species for comparative evaluation of overall wetland values and changes in wetland values resulting from project construction.

V. RESULTS

Ten features or alternatives originally were evaluated relative to stated objectives. These included: a. no action; b. water level management in three increments defined by impoundment capability (1,165 acres; 2,240 acres; and 3,405 acres in tandem subunit operation); c. sediment deflection; d. Clear Creek snagging and excavation; e. interior excavation; and f. Cover management in three increments defined by strategy (1, pin oak planting; 2, clearing and passive vegetation management; and 3, clearing and active vegetation management). Following consideration of the overall goal, Alternatives D and E were determined to be unresponsive to enhancement of wetland values. Analysis of these alternatives using WHAG would reveal no change in HSI's or HU's for the target group of migratory waterfowl. Water level management and sediment deflection originally were considered to be one alternative or feature for the purpose of this analysis. This was due to the anticipated need for sediment reduction in long-term maintenance of wetland values. However, reconsideration of sediment deflection as a separable cost item resulted in its analysis as a separable habitat enhancement alternative. Therefore, seven action alternatives or features originally were analyzed using appraisal guide methodology: B, B1, B2, and C, and F, F1, F2. Summarized results of WHAG application are provided as attachments to this appendix.

As currently proposed, water control will be provided to cropped areas, forested wetlands, and non-forested wetlands. Cropland, which will show no succession over time, was not considered for target year selection. Forested wetlands, including mast species plantings, are assumed to show definite successional changes, but not within the first several years. Non-forested wetlands are likely to succeed to forested wetlands over the 50-year period of analysis, as sedimentation eliminates remaining shallow (less than 10 inches) areas. Evaluation target years were selected by the study team to be 0 (existing conditions), 1 (post-construction), 15, and 50 (project life).

Analysis of sediment deflection as a separate alternative or feature revealed a potential overall reduction in annualized HU output due to anticipated filling of existing non-forested wetlands and conversion to early stage forested wetland. However, only minimal incremental changes in habitat values due to sediment reduction alone could be identified.

Water level management alone is estimated to increase habitat suitability by over 60 percent and provides the greatest overall improvement in wetland habitat values.

Increasing mast tree dominance through pin oak planting and release of existing pecans was estimated to further increase wetland values by a relatively slight margin.

Conversion of forested wetland to non-forested wetland also provides a slight increase in wetland values, as does conversion of forested wetland to cropland.

VI. DISCUSSION

Results of WHAG application for seven alternatives were compared as increments to costs associated with implementation of each alternative plan. This incremental analysis is discussed in the Detailed Project Report in Section 6 - Evaluation of Alternatives.

Water level control is the key limiting factor in wetland values for the project area. Levee construction for impoundment provides the largest single increase in habitat suitability for migratory waterfowl. Three impoundment sizes were considered. These are noted as Alternatives B, B1, and B2. WHAG application revealed the greatest benefits from tandem operation of two units versus operation of either single smaller unit. Therefore, the WHAG study team determined that tandem unit water level control should remain as part of any selected plan for the study area.

Cover management, specifically Alternative F - Selective Thinning and Pin Oak Planting, represents a measurable increase in habitat value when analyzed separately and in conjunction with water level control. In addition to consideration of HU analysis results, the WHAG study team recognized the general dominance of silver maple-elm association forest at the project site and recommended the inclusion of thinning and pin oak planting in the selected plan.

Cover management in the form of clearing forested wetlands to create non-forested wetlands, Alternative F1, or clearing forested wetlands and actively planting moist soil food plants, Alternative F2, also increased habitat value over water level control. Projected HU output increased measurably from existing conditions to pin oak planting, to clearing, to clearing and active planting as the highest potential improvement in cover management.

VII. CONCLUSION

HU accounting using WHAG or HEP appears to provide adequate quantification necessary to portray planning and design rationale of habitat enhancement projects.

During early planning and design, the sediment deflection portion of this project was presumed to be a necessary feature, based on the intuitive judgment of the interagency planning team. Following clarification of the project goal and potential enhancement for the Bay Island area, WHAG application revealed that sediment deflection, in fact, did not provide significant benefit as measured in HU's for the species of emphasis.

Removal of the sediment deflection portion of the proposed project resulted in substantial savings without measurably reducing the total potential HU output of the project.

Based on this application of WHAG, it appears that HU accounting has the potential to form a sound basis for alternative evaluation and output optimization. Further application of this methodology and refinement should be pursued in the interest of non-traditional projects and their success.

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	WITHOUT PROJECT	TYOO
ALTERNATIVE	A	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	131	524.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	540	108.0
WOOD DUCK	519	26.0
BEAVER	519	26.0
AMERCIAN COOT	21	4.2
NORTHERN PARULA	519	259.5
PROTHONOTARY WARBLER	519	207.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	366.9	0.14	91.7
CANADA GOOSE	53.4	0.10	13.4
LEAST BITTERN	6.2	0.59	12.5
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.7	0.34	7.2
GREEN-BACKED HERON	22.8	0.21	113.9
WOOD DUCK	9.8	0.38	197.0
BEAVER	9.5	0.37	190.8
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	134.1	0.52	268.2
PROTHONOTARY WARBLER	25.4	0.12	63.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION WITHOUT PROJECT TY15

ALTERNATIVE A

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	124	496.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	540	108.0
WOOD DUCK	526	26.3
BEAVER	526	26.3
AMERCIAN COOT	14	2.8
NORTHERN PARULA	526	263.0
PROTHONOTARY WARBLER	526	210.4

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	366.9	0.14	91.7
CANADA GOOSE	50.6	0.10	12.7
LEAST BITTERN	3.9	0.55	7.7
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.4	0.30	4.2
GREEN-BACKED HERON	22.3	0.21	111.7
WOOD DUCK	10.0	0.38	199.6
BEAVER	9.7	0.37	193.3
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	135.9	0.52	271.8
PROTHONOTARY WARBLER	25.8	0.12	64.4

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION WITHOUT PROJECT TY50

ALTERNATIVE A

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	110	440.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	540	108.0
WOOD DUCK	540	27.0
BEAVER	540	27.0
AMERCIAN COOT	0	0.0
NORTHERN PARULA	540	270.0
PROTHONOTARY WARBLER	540	216.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	366.9	0.14	91.7
CANADA GOOSE	45.0	0.10	11.3
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	25.3	0.23	126.5←
WOOD DUCK	10.9	0.40	218.0←
BEAVER	10.9	0.40	217.4
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	135.0	0.50	270.0←
PROTHONOTARY WARBLER	31.3	0.15	78.3

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI' PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION TANDEM TY01

ALTERNATIVE . B

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	625	2,500.0
CANADA GOOSE	145	580.0
LEAST BITTERN	19	9.5
LESSER YELLOWLEGS	19	38.0
MUSKRAT	19	19.0
KING RAIL	19	1.9
GREEN-BACKED HERON	524	104.8
WOOD DUCK	505	25.3
BEAVER	505	25.3
AMERCIAN COOT	19	3.8
NORTHERN PARULA	505	252.5
PROTHONOTARY WARBLER	505	202.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	1,553.9	0.62	388.5
CANADA GOOSE	89.0	0.15	22.3
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	24.3	0.23	121.4
WOOD DUCK	11.1	0.44	222.7
BEAVER	11.1	0.44	221.5
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	130.5	0.52	260.9
PROTHONOTARY WARBLER	24.7	0.12	61.9

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION TANDEM TY15

ALTERNATIVE B

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	625	2,500.0
CANADA GOOSE	138	552.0
LEAST BITTERN	12	6.0
LESSER YELLOWLEGS	12	24.0
MUSKRAT	12	12.0
KING RAIL	12	1.2
GREEN-BACKED HERON	524	104.8
WOOD DUCK	512	25.6
BEAVER	512	25.6
AMERCIAN COOT	12	2.4
NORTHERN PARULA	512	256.0
PROTHONOTARY WARBLER	512	204.8

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	1,553.3	0.62	388.3
CANADA GOOSE	85.3	0.15	21.3
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	24.5	0.23	122.4
WOOD DUCK	11.3	0.44	225.7
BEAVER	11.2	0.44	224.6
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	132.3	0.52	264.5
PROTHONOTARY WARBLER	25.1	0.12	62.7

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION TANDEM TY50

ALTERNATIVE B

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	625	2,500.0
CANADA GOOSE	126	504.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	524	104.8
WOOD DUCK	524	26.2
BEAVER	524	26.2
AMERCIAN COOT	0	0.0
NORTHERN PARULA	524	262.0
PROTHONOTARY WARBLER	524	209.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	1,625.6	0.65	406.4
CANADA GOOSE	78.8	0.16	19.7
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	25.9	0.25	129.3
WOOD DUCK	14.1	0.54	281.8
BEAVER	10.7	0.41	213.3
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	144.1	0.55	288.2
PROTHONOTARY WARBLER	29.9	0.14	74.7

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION LOWER UNIT TYOO

ALTERNATIVE B1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	165	660.0
CANADA GOOSE	91	364.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	74	14.8
WOOD DUCK	74	3.7
BEAVER	74	3.7
AMERCIAN COOT	0	0.0
NORTHERN PARULA	74	37.0
PROTHONOTARY WARBLER	74	29.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	154.4	0.23	38.6
CANADA GOOSE	37.3	0.10	9.3
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	3.0	0.20	14.8
WOOD DUCK	1.4	0.38	28.1
BEAVER	1.4	0.37	27.2
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	19.1	0.52	38.2
PROTHONOTARY WARBLER	3.6	0.12	9.1

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	LOWER UNIT	TY01-50
ALTERNATIVE	B1	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	149	596.0
CANADA GOOSE	96	384.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	69	13.8
WOOD DUCK	69	3.5
BEAVER	69	3.5
AMERCIAN COOT	0	0.0
NORTHERN PARULA	69	34.5
PROTHONOTARY WARBLER	69	27.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	425.5	0.71	106.4
CANADA GOOSE	60.4	0.16	15.1
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	3.3	0.24	16.3
WOOD DUCK	1.5	0.44	30.4
BEAVER	1.5	0.44	30.3
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	17.8	0.52	35.7
PROTHONOTARY WARBLER	3.4	0.12	8.5

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION LOWER UNIT OUTER TYOO

ALTERNATIVE B1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	485	1,940.0
CANADA GOOSE	40	160.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	466	93.2
WOOD DUCK	445	22.3
BEAVER	445	22.3
AMERCIAN COOT	21	4.2
NORTHERN PARULA	445	222.5
PROTHONOTARY WARBLER	445	178.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	212.5	0.11	53.1
CANADA GOOSE	16.2	0.10	4.0
LEAST BITTERN	6.2	0.59	12.5
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.7	0.34	7.2
GREEN-BACKED HERON	19.8	0.21	99.1
WOOD DUCK	8.4	0.38	168.9
BEAVER	8.2	0.37	163.6
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	115.0	0.52	229.9
PROTHONOTARY WARBLER	21.8	0.12	54.5

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION LOWER UNIT OUTER TY01

ALTERNATIVE · B1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	485	1,940.0
CANADA GOOSE	40	160.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	466	93.2
WOOD DUCK	445	22.3
BEAVER	445	22.3
AMERCIAN COOT	21	4.2
NORTHERN PARULA	445	222.5
PROTHONOTARY WARBLER	445	178.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	212.5	0.11	53.1
CANADA GOOSE	16.2	0.10	4.0
LEAST BITTERN	6.2	0.59	12.5
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.7	0.34	7.2
GREEN-BACKED HERON	19.8	0.21	99.1
WOOD DUCK	8.4	0.38	168.9
BEAVER	8.2	0.37	163.6
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	115.0	0.52	229.9
PROTHONOTARY WARBLER	21.8	0.12	54.5

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI-
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION LOWER UNIT OUTER TY15

ALTERNATIVE B1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	485	1,940.0
CANADA GOOSE	33	132.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	466	93.2
WOOD DUCK	452	22.6
BEAVER	452	22.6
AMERCIAN COOT	14	2.8
NORTHERN PARULA	452	226.0
PROTHONOTARY WARBLER	452	180.8

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	212.5	0.11	53.1
CANADA GOOSE	13.4	0.10	3.3
LEAST BITTERN	3.9	0.55	7.7
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.4	0.30	4.2
GREEN-BACKED HERON	19.4	0.21	96.9
WOOD DUCK	8.6	0.38	171.6
BEAVER	8.3	0.37	166.1
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	116.8	0.52	233.5
PROTHONOTARY WARBLER	22.1	0.12	55.4

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	LOWER UNIT OUTER	TY50
ALTERNATIVE	B1	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	485	1,940.0
CANADA GOOSE	19	76.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	466	93.2
WOOD DUCK	466	23.3
BEAVER	466	23.3
AMERCIAN COOT	0	0.0
NORTHERN PARULA	466	233.0
PROTHONOTARY WARBLER	466	186.4

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	212.5	0.11	53.1
CANADA GOOSE	7.8	0.10	1.9
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	18.6	0.20	93.2
WOOD DUCK	8.8	0.38	176.9
BEAVER	8.6	0.37	171.3
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	120.4	0.52	240.8
PROTHONOTARY WARBLER	22.8	0.12	57.1

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION UPPER UNIT TYOO

ALTERNATIVE B2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	240	960.0
CANADA GOOSE	20	80.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	234	46.8
WOOD DUCK	220	11.0
BEAVER	220	11.0
AMERCIAN COOT	14	2.8
NORTHERN PARULA	220	110.0
PROTHONOTARY WARBLER	220	88.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	101.8	0.11	25.5
CANADA GOOSE	8.1	0.10	2.0
LEAST BITTERN	4.1	0.59	8.3
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.5	0.34	4.8
GREEN-BACKED HERON	10.2	0.22	50.8
WOOD DUCK	4.2	0.38	83.5
BEAVER	4.0	0.37	80.9
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	56.8	0.52	113.7
PROTHONOTARY WARBLER	10.8	0.12	27.0

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION UPPER UNIT TY01

ALTERNATIVE B2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	223	892.0
CANADA GOOSE	37	148.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	217	43.4
WOOD DUCK	203	10.1
BEAVER	203	10.1
AMERCIAN COOT	14	2.8
NORTHERN PARULA	203	101.5
PROTHONOTARY WARBLER	203	81.2

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	525.2	0.59	131.3
CANADA GOOSE	20.5	0.14	5.1
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	9.9	0.23	49.4
WOOD DUCK	4.5	0.44	89.5
BEAVER	4.5	0.44	89.0
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	52.4	0.52	104.9
PROTHONOTARY WARBLER	9.9	0.12	24.9

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION UPPER UNIT TY15

ALTERNATIVE B2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	223	892.0
CANADA GOOSE	32	128.0
LEAST BITTERN	9	4.5
LESSER YELLOWLEGS	9	18.0
MUSKRAT	9	9.0
KING RAIL	9	0.9
GREEN-BACKED HERON	217	43.4
WOOD DUCK	208	10.4
BEAVER	208	10.4
AMERCIAN COOT	9	1.8
NORTHERN PARULA	208	104.0
PROTHONOTARY WARBLER	208	83.2

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	524.8	0.59	131.2
CANADA GOOSE	17.8	0.14	4.5
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	10.0	0.23	50.1
WOOD DUCK	4.6	0.44	91.7
BEAVER	4.6	0.44	91.2
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	53.7	0.52	107.5
PROTHONOTARY WARBLER	10.2	0.12	25.5

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI' PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION UPPER UNIT TY50

ALTERNATIVE B2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	223	892.0
CANADA GOOSE	23	92.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	217	43.4
WOOD DUCK	217	10.9
BEAVER	217	10.9
AMERCIAN COOT	0	0.0
NORTHERN PARULA	217	108.5
PROTHONOTARY WARBLER	217	86.8

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	524.2	0.59	131.0
CANADA GOOSE	13.0	0.14	3.3
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	10.3	0.24	51.4
WOOD DUCK	4.8	0.44	95.7
BEAVER	4.8	0.44	95.2
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	56.1	0.52	112.1
PROTHONOTARY WARBLER	10.6	0.12	26.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	UPPER UNIT OUTER	TYOO
ALTERNATIVE	B2	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	410	1,640.0
CANADA GOOSE	111	444.0
LEAST BITTERN	7	3.5
LESSER YELLOWLEGS	7	14.0
MUSKRAT	7	7.0
KING RAIL	7	0.7
GREEN-BACKED HERON	306	61.2
WOOD DUCK	299	15.0
BEAVER	299	15.0
AMERCIAN COOT	7	1.4
NORTHERN PARULA	299	149.5
PROTHONOTARY WARBLER	299	119.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	265.0	0.16	66.3
CANADA GOOSE	45.4	0.10	11.3
LEAST BITTERN	2.1	0.59	4.1
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.2	0.34	2.4
GREEN-BACKED HERON	12.6	0.21	63.2
WOOD DUCK	5.7	0.38	113.5
BEAVER	5.5	0.37	109.9
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	77.2	0.52	154.5
PROTHONOTARY WARBLER	14.7	0.12	36.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT
PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	UPPER UNIT OUTER	TY 01-50
ALTERNATIVE	B2	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	410	1,640.0
CANADA GOOSE	111	444.0
LEAST BITTERN	7	3.5
LESSER YELLOWLEGS	7	14.0
MUSKRAT	7	7.0
KING RAIL	7	0.7
GREEN-BACKED HERON	306	61.2
WOOD DUCK	299	15.0
BEAVER	299	15.0
AMERCIAN COOT	7	1.4
NORTHERN PARULA	299	149.5
PROTHONOTARY WARBLER	299	119.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	265.0	0.16	66.3
CANADA GOOSE	45.4	0.10	11.3
LEAST BITTERN	2.1	0.59	4.1
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.2	0.34	2.4
GREEN-BACKED HERON	12.6	0.21	63.2
WOOD DUCK	5.7	0.38	113.5
BEAVER	5.5	0.37	109.9
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	77.2	0.52	154.5
PROTHONOTARY WARBLER	14.7	0.12	36.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION SEDIMENT DEFL @ 90% TY01

ALTERNATIVE C

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	642	2,568.0
CANADA GOOSE	133	532.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	538	107.6
WOOD DUCK	517	25.9
BEAVER	517	25.9
AMERCIAN COOT	21	4.2
NORTHERN PARULA	517	258.5
PROTHONOTARY WARBLER	517	206.8

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	357.8	0.14	89.5
CANADA GOOSE	0.0	0.10	0.0
LEAST BITTERN	6.2	0.59	12.5
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.7	0.34	7.2
GREEN-BACKED HERON	22.7	0.21	113.5
WOOD DUCK	9.8	0.38	196.2
BEAVER	9.5	0.37	190.0
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	133.6	0.52	267.1
PROTHONOTARY WARBLER	25.3	0.12	63.3

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION SEDIMENT DEFL @ 90% TY15

ALTERNATIVE C

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

BAY-C15

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	642	2,568.0
CANADA GOOSE	132	528.0
LEAST BITTERN	20	10.0
LESSER YELLOWLEGS	20	40.0
MUSKRAT	20	20.0
KING RAIL	20	2.0
GREEN-BACKED HERON	538	107.6
WOOD DUCK	518	25.9
BEAVER	518	25.9
AMERCIAN COOT	20	4.0
NORTHERN PARULA	518	259.0
PROTHONOTARY WARBLER	518	207.2

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	357.8	0.14	89.5
CANADA GOOSE	0.0	0.10	0.0
LEAST BITTERN	5.9	0.59	11.9
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.7	0.34	6.9
GREEN-BACKED HERON	22.6	0.21	113.2
WOOD DUCK	9.8	0.38	196.6
BEAVER	9.5	0.37	190.4
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	133.8	0.52	267.6
PROTHONOTARY WARBLER	25.4	0.12	63.5

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	SEDIMENT DEFL @ 90%	TY50
ALTERNATIVE	C	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	642	2,568.0
CANADA GOOSE	128	512.0
LEAST BITTERN	16	8.0
LESSER YELLOWLEGS	16	32.0
MUSKRAT	16	16.0
KING RAIL	16	1.6
GREEN-BACKED HERON	538	107.6
WOOD DUCK	522	26.1
BEAVER	522	26.1
AMERCIAN COOT	16	3.2
NORTHERN PARULA	522	261.0
PROTHONOTARY WARBLER	522	208.8

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	357.8	0.14	89.5
CANADA GOOSE	0.0	0.10	0.0
LEAST BITTERN	4.7	0.59	9.5
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.5	0.34	5.5
GREEN-BACKED HERON	22.4	0.21	112.1
WOOD DUCK	9.9	0.38	198.1
BEAVER	9.6	0.37	191.9
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	134.9	0.52	269.7
PROTHONOTARY WARBLER	25.6	0.12	63.9

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION PIN OAK TY01

ALTERNATIVE F

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	131	524.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	540	108.0
WOOD DUCK	519	26.0
BEAVER	519	26.0
AMERCIAN COOT	21	4.2
NORTHERN PARULA	519	259.5
PROTHONOTARY WARBLER	519	207.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	480.0	0.18	120.0
CANADA GOOSE	62.9	0.12	15.7
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	25.0	0.23	124.9
WOOD DUCK	11.4	0.44	228.8
BEAVER	11.4	0.44	227.6
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	134.1	0.52	268.2
PROTHONOTARY WARBLER	25.4	0.12	63.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME	BAY ISLAND HREP	
PLANNING CONDITION	PIN OAK	TY15
ALTERNATIVE	F	

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	114	456.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	550	110.0
WOOD DUCK	536	26.8
BEAVER	536	26.8
AMERCIAN COOT	14	2.8
NORTHERN PARULA	536	268.0
PROTHONOTARY WARBLER	536	214.4

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	809.7	0.31	202.4
CANADA GOOSE	55.1	0.12	13.8
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	34.3	0.31	171.6
WOOD DUCK	9.5	0.35	190.0
BEAVER	12.4	0.46	247.9
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	130.7	0.49	261.3
PROTHONOTARY WARBLER	25.1	0.12	62.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI
PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION PIN OAK TY50

ALTERNATIVE F

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	100	400.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	550	110.0
WOOD DUCK	550	27.5
BEAVER	550	27.5
AMERCIAN COOT	0	0.0
NORTHERN PARULA	550	275.0
PROTHONOTARY WARBLER	550	220.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	818.8	0.31	204.7
CANADA GOOSE	49.5	0.12	12.4
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	34.9	0.32	174.6
WOOD DUCK	9.8	0.35	195.0
BEAVER	12.7	0.46	254.4
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	134.1	0.49	268.1
PROTHONOTARY WARBLER	25.7	0.12	61.3

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSITY PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W PASSIVE MGMT TY01

ALTERNATIVE F1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	171	684.0
LEAST BITTERN	61	30.5
LESSER YELLOWLEGS	61	122.0
MUSKRAT	61	61.0
KING RAIL	61	6.1
GREEN-BACKED HERON	540	108.0
WOOD DUCK	479	24.0
BEAVER	479	24.0
AMERCIAN COOT	61	12.2
NORTHERN PARULA	479	239.5
PROTHONOTARY WARBLER	479	191.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	542.7	0.21	135.7
CANADA GOOSE	87.2	0.13	21.8
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	23.9	0.22	119.5
WOOD DUCK	10.6	0.44	211.2
BEAVER	10.5	0.44	210.1
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	123.7	0.52	247.5
PROTHONOTARY WARBLER	23.5	0.12	58.7

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W PASSIVE MGMT TY15

ALTERNATIVE F1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	164	656.0
LEAST BITTERN	54	27.0
LESSER YELLOWLEGS	54	108.0
MUSKRAT	54	54.0
KING RAIL	54	5.4
GREEN-BACKED HERON	540	108.0
WOOD DUCK	486	24.3
BEAVER	486	24.3
AMERCIAN COOT	54	10.8
NORTHERN PARULA	486	243.0
PROTHONOTARY WARBLER	486	194.4

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	834.0	0.32	208.5
CANADA GOOSE	83.4	0.13	20.9
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	31.9	0.30	159.7
WOOD DUCK	8.6	0.36	172.9
BEAVER	11.4	0.47	227.7
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	118.5	0.49	236.9
PROTHONOTARY WARBLER	22.7	0.12	56.8

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSI PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W PASSIVE MGMT TY50

ALTERNATIVE F1

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	110	440.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	540	108.0
WOOD DUCK	540	27.0
BEAVER	540	27.0
AMERCIAN COOT	0	0.0
NORTHERN PARULA	540	270.0
PROTHONOTARY WARBLER	540	216.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	1,270.5	0.49	317.6
CANADA GOOSE	109.0	0.25	27.2
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	42.2	0.39	210.9
WOOD DUCK	16.9	0.63	338.3
BEAVER	14.6	0.54	291.3
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	168.8	0.63	337.5
PROTHONOTARY WARBLER	35.1	0.16	87.8

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W MS SPECIES MAINT TY01

ALTERNATIVE F2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	171	684.0
LEAST BITTERN	21	10.5
LESSER YELLOWLEGS	21	42.0
MUSKRAT	21	21.0
KING RAIL	21	2.1
GREEN-BACKED HERON	500	100.0
WOOD DUCK	479	24.0
BEAVER	479	24.0
AMERCIAN COOT	21	4.2
NORTHERN PARULA	479	239.5
PROTHONOTARY WARBLER	479	191.6

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	662.9	0.25	165.7
CANADA GOOSE	107.7	0.16	26.9
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	23.1	0.23	115.5
WOOD DUCK	10.6	0.44	211.2
BEAVER	10.5	0.44	210.1
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	123.7	0.52	247.5
PROTHONOTARY WARBLER	23.5	0.12	58.7

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W MS SPECIES MAINT TY15

ALTERNATIVE F2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	164	656.0
LEAST BITTERN	14	7.0
LESSER YELLOWLEGS	14	28.0
MUSKRAT	14	14.0
KING RAIL	14	1.4
GREEN-BACKED HERON	500	100.0
WOOD DUCK	486	24.3
BEAVER	486	24.3
AMERCIAN COOT	14	2.8
NORTHERN PARULA	486	243.0
PROTHONOTARY WARBLER	486	194.4

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	961.4	0.37	240.4
CANADA GOOSE	104.9	0.16	26.2
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	31.1	0.31	155.7
WOOD DUCK	8.6	0.36	172.9
BEAVER	11.4	0.47	227.7
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	118.5	0.49	236.9
PROTHONOTARY WARBLER	22.7	0.12	56.8

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS

PROJECT NAME BAY ISLAND HREP

PLANNING CONDITION CLEARING W MS SPECIES MAINT TY50

ALTERNATIVE F2

AVAILABLE HABITAT (ACRES) BY SPECIES AND MAXIMUM NUMBER IF HABITAT RATED 1.0

SPECIES	ACRES	MAXIMUM NUMBER
MALLARD	650	2,600.0
CANADA GOOSE	150	600.0
LEAST BITTERN	0	0.0
LESSER YELLOWLEGS	0	0.0
MUSKRAT	0	0.0
KING RAIL	0	0.0
GREEN-BACKED HERON	500	100.0
WOOD DUCK	500	25.0
BEAVER	500	25.0
AMERCIAN COOT	0	0.0
NORTHERN PARULA	500	250.0
PROTHONOTARY WARBLER	500	200.0

PROJECTED ANIMAL NUMBERS AND MEAN HSI's

SPECIES	ANIMAL NUMBERS	MEAN HSI	TOTAL HABITAT UNITS
MALLARD	1,004.3	0.39	251.1
CANADA GOOSE	91.4	0.15	22.9
LEAST BITTERN	0.0	0.10	0.0
LESSER YELLOWLEGS	0.0	0.10	0.0
MUSKRAT	0.0	0.10	0.0
KING RAIL	0.0	0.10	0.0
GREEN-BACKED HERON	32.0	0.32	160.0
WOOD DUCK	13.8	0.55	275.6
BEAVER	10.9	0.43	217.1
AMERCIAN COOT	0.0	0.10	0.0
NORTHERN PARULA	131.3	0.53	262.5
PROTHONOTARY WARBLER	28.3	0.14	70.6

IF MEAN HSI EQUALS .1, THEN HABITAT QUALITY IS TOO LOW TO MAKE RELIABLE DENSIT PROJECTIONS