AD-A106 441 BLACK AND VEATCH KANSAS CITY MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. GREAT MIDWEST LAKE DAM (MO 11024),--ETC(U)
MAY 80 P R ZAMAN, E R BURTON, H L CALLAHAN DACW43-80-C-0074

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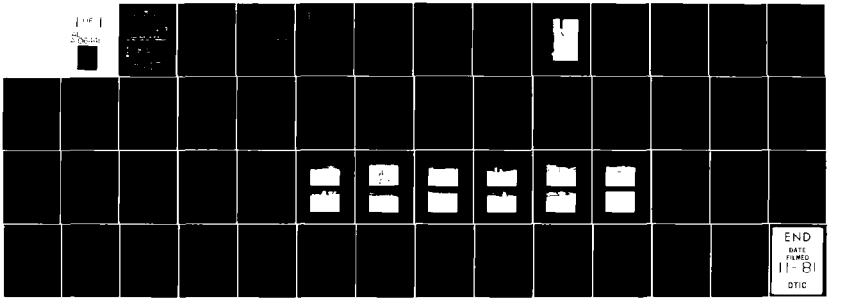

LEVEL II

MISSOURI-KANSAS CITY BASIN

AD A106441

GREAT MIDWEST LAKE DAM

CLAY COUNTY, MISSOURI

MO 11024

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

MAY 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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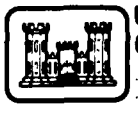
MISSOURI-KANSAS CITY BASIN

GREAT MIDWEST LAKE DAM

CLAY COUNTY, MISSOURI

MO 11024

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

MAY 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-PD

SUBJECT: Great Midwest Lake Dam, Mo. ID No. 11024

Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Great Midwest Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

APPROVED BY : _____ _____
Colonel, CE, District Engineer Date

GREAT MIDWEST LAKE DAM

CLAY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11024

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Great Midwest Lake Dam
State Located	Missouri
County Located	Clay County
Stream	Tributary to Shoal Creek
Date of Inspection	13 May 1980

Great Midwest Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and were developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately one mile downstream of the dam. Within the estimated damage zone and immediately downstream of Great Midwest Dam is lake and dam, MO. I.D. No. 10583. Below dam MO 10583 are 15 homes and one building. Contents of the estimated downstream damage zone were verified by the inspection team.

Our inspection and evaluation indicates the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass both the probable maximum flood and the one percent probability flood (100-year flood) without overtopping. The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded behind the dam, the presence of a lake below the dam with at least 350 acre-feet of storage capacity, and the hazard zone, the spillway design flood should be 50 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in good condition, however, the embankment slopes are steeper than desirable based on standard design practices. Deficiencies visually observed by the inspection team were small trees and brush on the upstream slope of the dam, two small trees on the downstream slope of the dam, and the partially blocked outlet pipes at the downstream end of the spillway. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Paul R. Zaman
Paul R. Zaman, PE
Illinois 62-29261

Edwin R Burton
Edwin R. Burton, PE
Missouri E-10137

Harry L Callahan
Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GREAT MIDWEST LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Great Midwest Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure with a paved road on the crest. It is located in the valley of a tributary of Shoal Creek (Plate 1). The watershed area is hilly consisting entirely of grassland. The dam is approximately 350 feet long along the crest and is 26 feet high. The dam crest is 15 feet wide. The downstream face of the dam slopes uniformly from the crest to a fill area downstream of the embankment toe. A reservoir and dam, MO. I.D. No. 10583, are located below the subject dam. This lower reservoir receives no inflow from the subject reservoir unless overtopping occurs.

(2) The principal spillway from the lake is an uncontrolled trapezoidal grass-lined channel. Three culverts are located approximately 100 feet downstream of the spillway crest in the channel (Plate 5). The upstream ends of the outlet pipes are 36-inch diameter corrugated metal pipes. The downstream ends of the outlet pipes are 24-inch diameter concrete pipes. Spillway discharge from the subject reservoir are diverted to a channel which discharges tc an area outside of the lower reservoir basin.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in southern Clay County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Liberty, Missouri in Section 2 of T50N, R32W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Great Midwest Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Great Midwest Lake Dam the estimated flood damage zone extends approximately one mile downstream of the dam. Within the estimated damage zone and immediately downstream of Great Midwest Dam is lake and dam MO. I.D. No. 10583. Below dam MO. 10583 are fifteen homes and one building. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by the Great Midwest Corporation, 8300 N.E. Underground Drive, Kansas City, Missouri, Telephone 816-455-2500.

f. Purpose of Dam. The dam forms a 4-acre lake used for livestock water supply.

g. Design and Construction History. Design and construction data were not available.

h. Normal Operating Procedure. The reservoir water surface elevation is controlled primarily by rainfall, runoff, evaporation, transpiration, and livestock water supply. It was apparent at the time of the inspection that the normal operating pool is consistently below the spillway crest.

1.3 PERTINENT DATA

a. Drainage Area - 32 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled grass spillway.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 116 cfs (50 Percent Probable Maximum Flood Pool El. 838.4 ft. m.s.l.).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 840.1 (see Plate 3)

(2) Principal spillway crest - 835.8

(3) Streambed at toe of dam - 814.4

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,900 feet ± (50 Percent probable maximum flood pool level)

(2) Length of pool at principal spillway crest - 880 feet ±

(3) Length of normal pool - 650 feet ± (Lake level at time of inspection = 825.7)

e. Storage (Acre-feet).

(1) Top of dam - 94

(2) Principal spillway crest - 65

(3) Normal pool (Elevation 825.7) - 12

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 7.3

(2) Principal spillway crest - 6.4

(3) Normal pool (Elevation 825.7) - 3.4

g. Dam.

(1) Type - Earth embankment

(2) Length - 350 feet

(3) Height - 26 feet ±

(4) Top width - 15 feet

(5) Side slopes - upstream face 1.0 V on 1.8 H, downstream face between 1.0 V on 2.0 H and 1.0 V on 2.4 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway.

(1) Type - A natural, open channel consisting of grass and broken rock.

(2) Crest elevation - 835.8 feet m.s.l.

(3) Gates - None.

(4) Upstream channel - The upstream channel is clear of trees and debris.

(5) Downstream channel - Discharge over the spillway crest flows through three culverts into a channel which diverts flow away from the lower reservoir, but discharges to the natural streambed below the lower reservoir.

j. Emergency Spillway - None.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

Construction records were unavailable.

2.3 OPERATION

Records of operation or of past floods were not available.

2.4 GEOLOGY

The site of the dam and reservoir is located in a shallow valley on rolling terrain in the bluffs north of the Missouri River. The dam impounds a very small, intermittent, headwater tributary of Shoal Creek, a tributary of the Missouri River.

The soil in the area of the dam and reservoir consists of the Knox soil series. The Knox is a deep, well-drained soil formed in thick loess on strongly dissected hills and bluffs. Bedrock is deeper than five feet and the soils are classified for engineering purposes as low-plastic, silty clay or clayey silt (CL-ML) and low-plastic, silty clay (CL).

The bedrock of the area consists of the Wyandotte formation of the Kansas City Group. The Wyandotte is composed of five members. These are, from the base upwards, the Frisbie, Quindaro, Argentine, Island Creek and Farley members. The Frisbie, Argentine and Farley members are composed of limestone and are separated by the Quindaro calcarous shale and the Island Creek shale, respectively.

2.5 EVALUATION

a. Availability. Engineering data were unavailable.

b. Adequacy. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Great Midwest Lake Dam was made on 13 May 1980. The inspection team consisted of Ed Burton, hydrologist-hydraulic engineer and team leader; Paul Zaman, geotechnical engineer; Bob Pinker, geologist; Russell Burnham, structural engineer; and Alan Reif, structural engineer. The dam appeared to be in good condition, however, the embankment slopes are steeper than would be normally considered based on standard design practices. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. The crest of the dam is paved. The upstream slope has riprap slope protection. There are small trees and brush on the upstream slope, but the riprap is in good condition. The downstream slope has a well-established grass cover and is grazed. There are two small trees on the downstream slope. An area of fill material at the downstream embankment toe separates the embankment from the lower lake. The lower lake level was considerably below the principal spillway drop inlet crest due to a rupture at the base of the drop inlet pipe. No cracks, sloughing, animal burrows, slides, nor seepage areas were observed on the embankment. There are no toe drains or relief wells. There is no evidence to indicate that the embankment has been overtopped.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The principal spillway consists of a trapezoidal grass-lined channel. There is riprap protection on the bottom and side slopes of the spillway. No erosion was noticed. Three culverts are located approximately 100 feet downstream of the spillway crest in the spillway discharge channel. The upstream ends of the outlet pipes are 36-inch diameter corrugated metal pipes secured by a concrete headwall. The downstream ends of the outlet pipes are 24-inch diameter concrete pipes secured by a concrete headwall. The outlet pipes are partially blocked - left 70 percent, middle 25 percent, and right 50 percent. Blockage may be attributed to deposition from runoff and erosion along the west side of the paved lane leading north. The culverts discharge into a road ditch that leads to a natural streambed. Discharge from the spillway discharge channel does not contribute to the inflow to the lower reservoir. A pump house is located near the downstream toe of the embankment, but is not consdered appurtenant to the dam. Inlet location and other pertinent information to the pump house are unknown.

d. Geology. The soil in the area of the dam and reservoir is formed in loess and consists of clayey silt of low plasticity (ML). The spillway is constructed in this soil.

No outcrops of rocks were observed in the area of the dam and reservoir. The general depth to rock is anticipated to be thirty to forty feet. Numerous mines have been constructed in the Argentine limestone members of the Wyandotte formation which occurs at approximately elevation 800-850 at the base of the bluff. The extent of these mines is not known. They are currently used for storage and office space.

Samples of the embankment were obtained using an Oakfield soil sampler. The near-surface material in the embankment consists of a dry, low-plastic, clayey silt which is classified for engineering purposes as (ML). The samples were classified in accordace with ASTM D 2488-69. Based on these samples, it is anticipated the embankment consists of clayey silt of low plasticity.

The abutments and foundation for the embankment are anticipated to be clayey silt. These interpretations are based on visual observations and published data.

e. Reservoir Area. No erosion, animal burrows, cracks, sloughing, or slides were observed on the slopes of the reservoir area. A minor amount of lake siltation was observed.

f. Downstream Channel. The channel downstream of the principal spillway outlet culverts diverts flow away from the lower reservoir. The channel then discharges to the natural streambed downstream of the lower reservoir.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control. The growth of small trees and brush on the dam is not presently a problem; however, if allowed to go unchecked, it could cause deterioration of the embankment. The roots of trees can loosen the embankment material and leave voids through which water can pass. The brush growth can provide a habitat for burrowing animals which can damage the embankment. The partial blockage of the outlet culverts in the spillway discharge channel may impede flow through the spillway at large discharges.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is controlled by rainfall, runoff, evaporation, transpiration, and for livestock water supply.

4.2 MAINTENANCE OF DAM

The existing maintenance program is negligible. Cattle graze the downstream slope of the dam and the spillway, thereby keeping grass and vegetation short.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

The maintenance program should be expanded to include keeping brush and small tree growth to a minimum on the embankment.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Liberty, Missouri Quadrangle Map. The dam layout is from a survey made during the inspection. An inspection of the embankment dam, Mo. I.D. No. 10583, immediately downstream of the subject embankment was performed in September 1978 by Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska. A cursory analysis of the hydrology and hydraulics of the subject structure was performed. This analysis indicated that no overtopping would occur when the reservoir was subjected to a probable maximum flood.

c. Visual Observations.

The spillway appears to be in good condition. The lake level at the time of the inspection (El.825.7) was below the crest level of the spillway by approximately 10 feet. The spillway discharges through three partially blocked culverts into a road ditch that leads to a streambed other than the original streambed. There was no evidence of erosion at the time of the inspection. Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. Based on the hydrologic and hydraulic analyses outlined in Appendix A, the spillway will pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded behind the dam, the presence of a lake below the dam with at least 350 acre-feet of storage, and the hazard zone, the spillway design flood should be 50 percent of the probable maximum flood. The peak discharge from the probable maximum flood is 291 cfs. The maximum depth of water over the principal spillway crest from the probable maximum flood is 3.9 feet. This depth leaves a freeboard on the embankment of approximately 0.4 feet.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately one mile downstream of the dam. Within the estimated damage zone and immediately downstream

of Great Midwest Dam is lake and dam, MO. I.D. No. 10583. Below dam MO. 10583 are 15 homes and one building. Contents of the estimated downstream damage zone were verified by the inspection team.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. It is not known whether any post-construction changes have been made.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is considered a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservation should pose no serious stability problems during earthquakes in this zone.

The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. One condition observed during the visual inspection by the inspection team should be monitored and/or controlled. This is the growth of brush and trees on the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the inadequacy of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment was not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. No measures other than maintenance are recommended.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be implemented under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed.

(2) It is recommended that the spillway outlet pipes be cleaned for more efficient discharge, should the reservoir level reach the spillway crest.

(3) Seepage and stability analyses should be performed.

(4) A detailed inspection of the dam should be made periodically. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

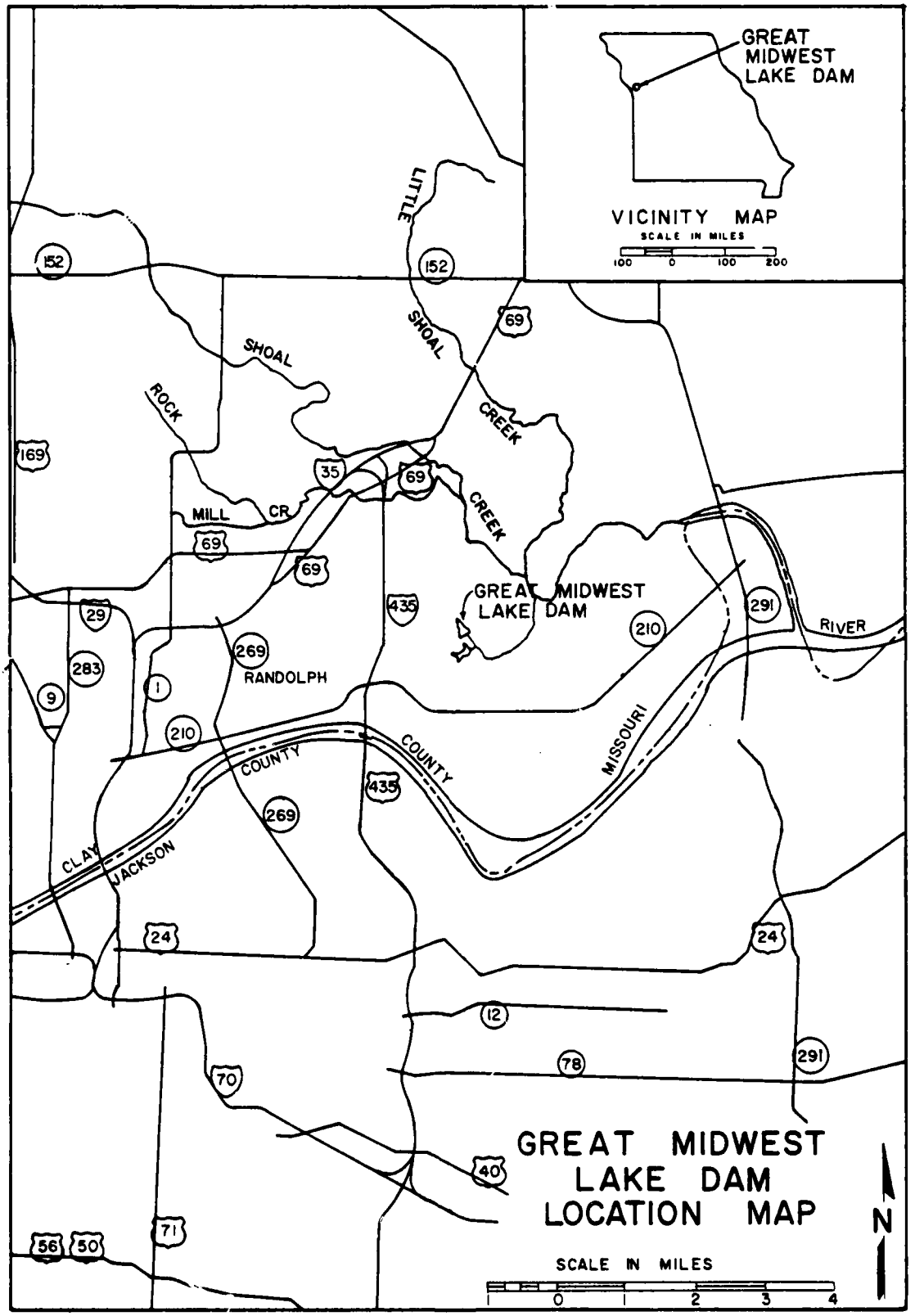
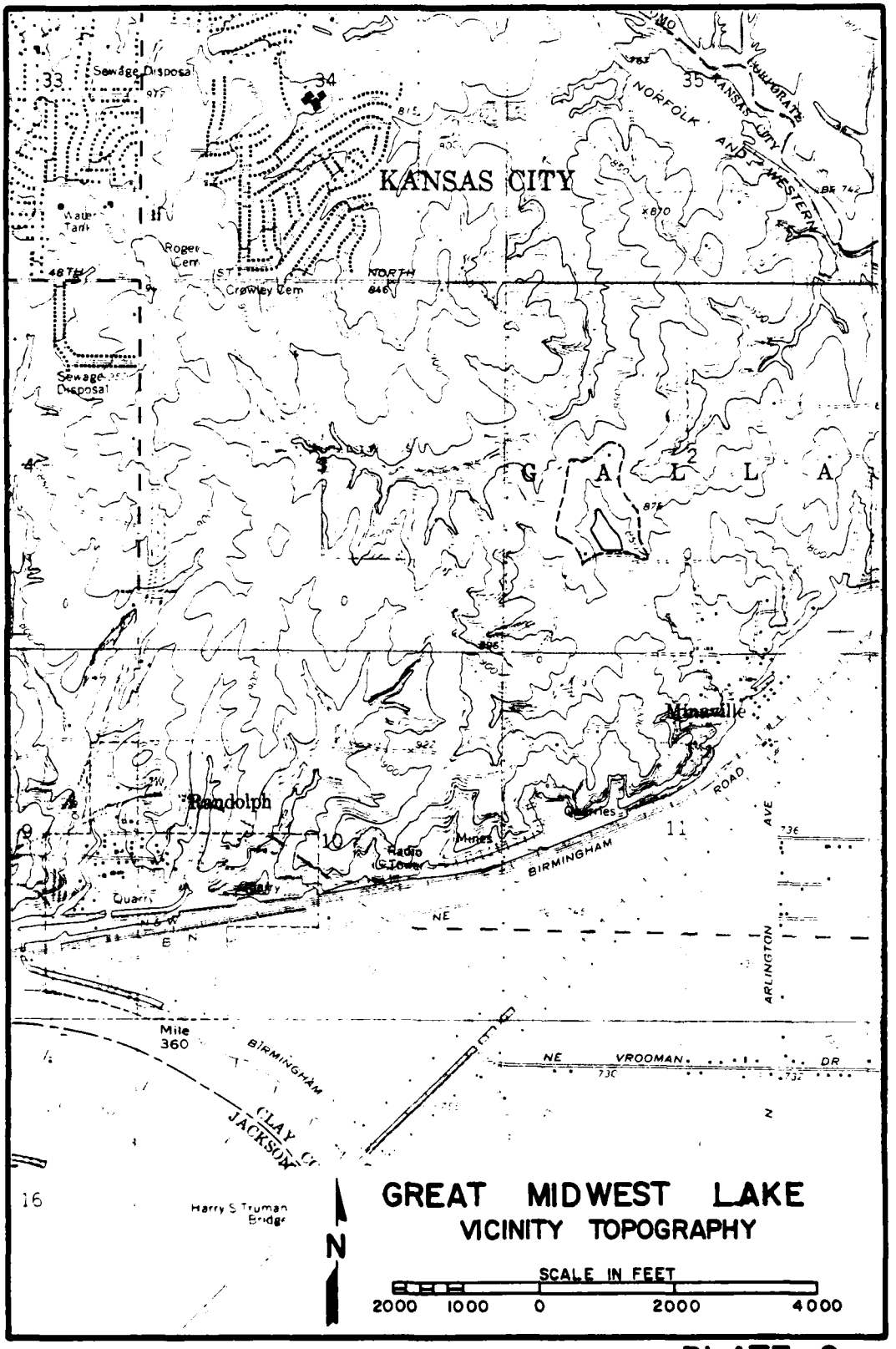

GREAT MIDWEST LAKE DAM
VICINITY MAP
SCALE IN MILES
100 0 100 200
LITTLE SHOAL CREEK
SHOAL CREEK
ROCK CR
MILL CR
GREAT MIDWEST LAKE DAM
RANDOLPH
MISSOURI RIVER
CLAY COUNTY
JACKSON COUNTY
152
69
169
35
29
283
9
1
269
435
210
291
24
12
78
70
40
71
56
50
GREAT MIDWEST LAKE DAM LOCATION MAP
SCALE IN MILES
0 2 3 4
N

PLATE 1


KANSAS CITY
GALLA
Sewage Disposal
Water Tank
Roger Cem
Crowley Cem
NORTH
46TH ST
Sewage Disposal
Randolph
Quarries
Mines
Radio Tower
Quarry
Gravel Pit
Minneville
ROAD
AVE
BIRMINGHAM
NE
ARLINGTON
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BIRMINGHAM
CLAY
JACKSON
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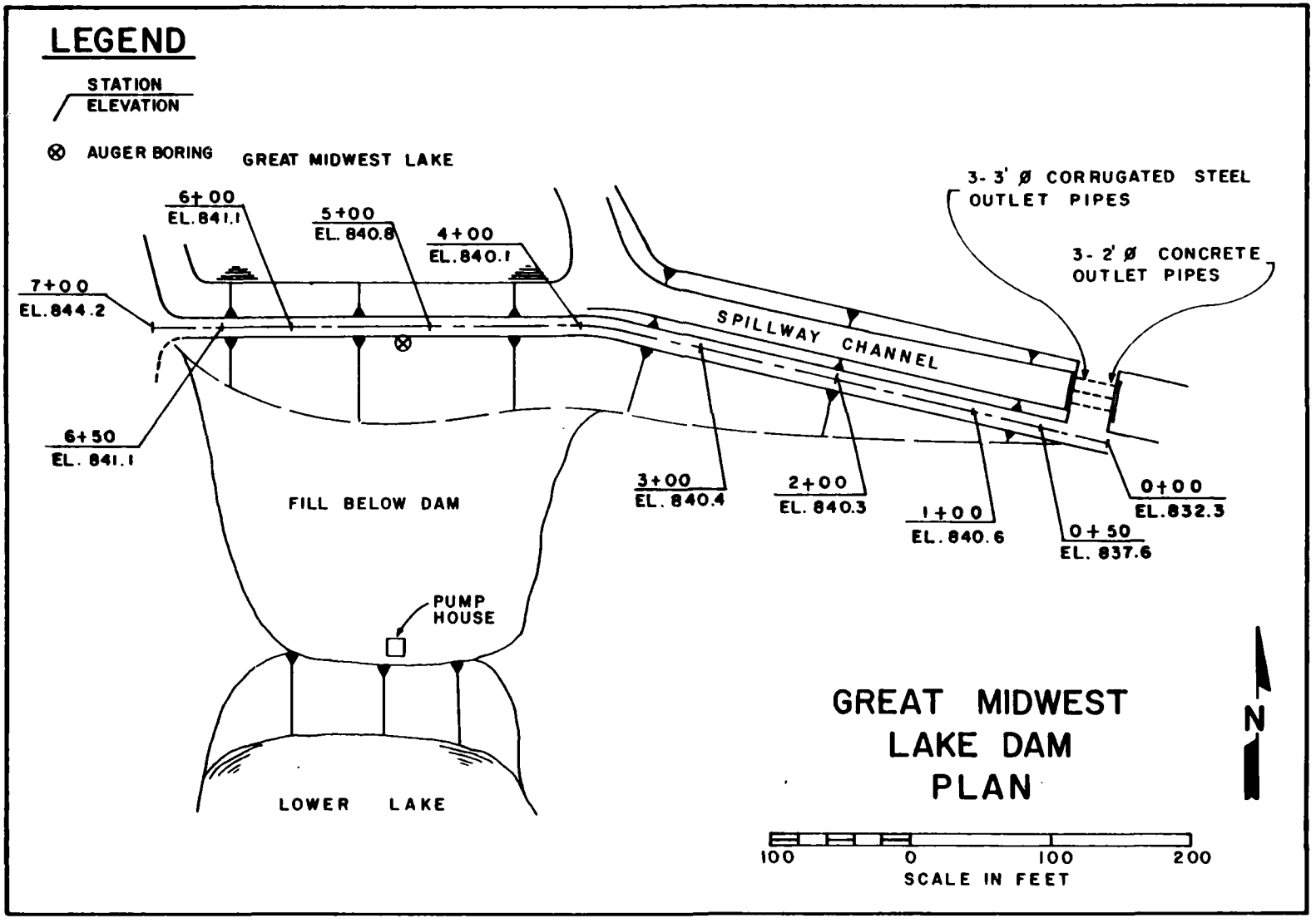
PLATE 2


LEGEND
STATION
ELEVATION
AUGER BORING
GREAT MIDWEST LAKE
6+00
EL. 841.1
5+00
EL. 840.8
4+00
EL. 840.1
7+00
EL. 844.2
3-3' Ø CORRUGATED STEEL
OUTLET PIPES
3-2' Ø CONCRETE
OUTLET PIPES
SPILLWAY CHANNEL
6+50
EL. 841.1
FILL BELOW DAM
3+00
EL. 840.4
2+00
EL. 840.3
1+00
EL. 840.6
0+50
EL. 837.6
0+00
EL. 832.3
PUMP
HOUSE
LOWER LAKE
GREAT MIDWEST
LAKE DAM
PLAN
N
100
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200
SCALE IN FEET

PLATE 3

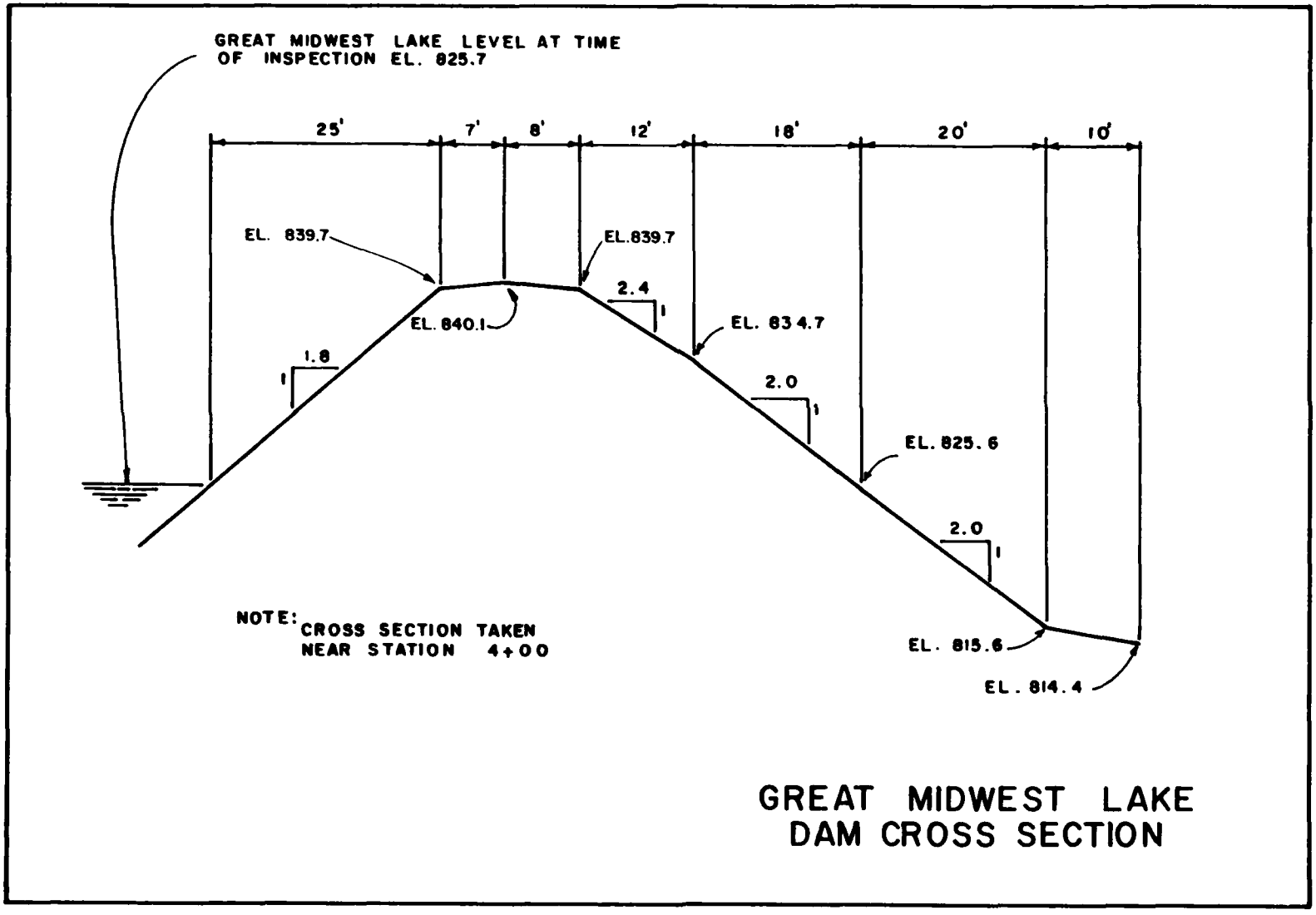


PLATE 4

GREAT MIDWEST LAKE DAM CROSS SECTION

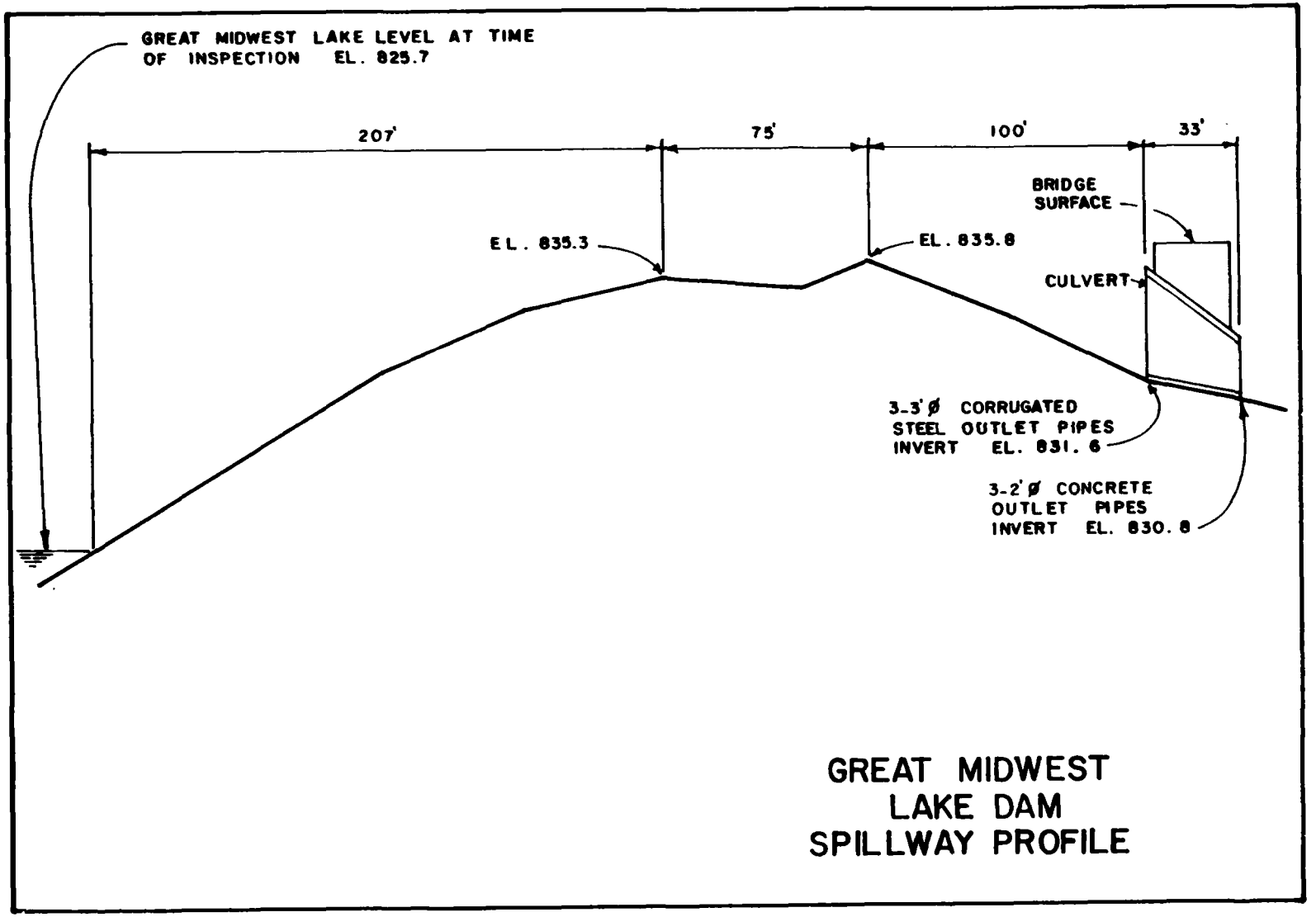
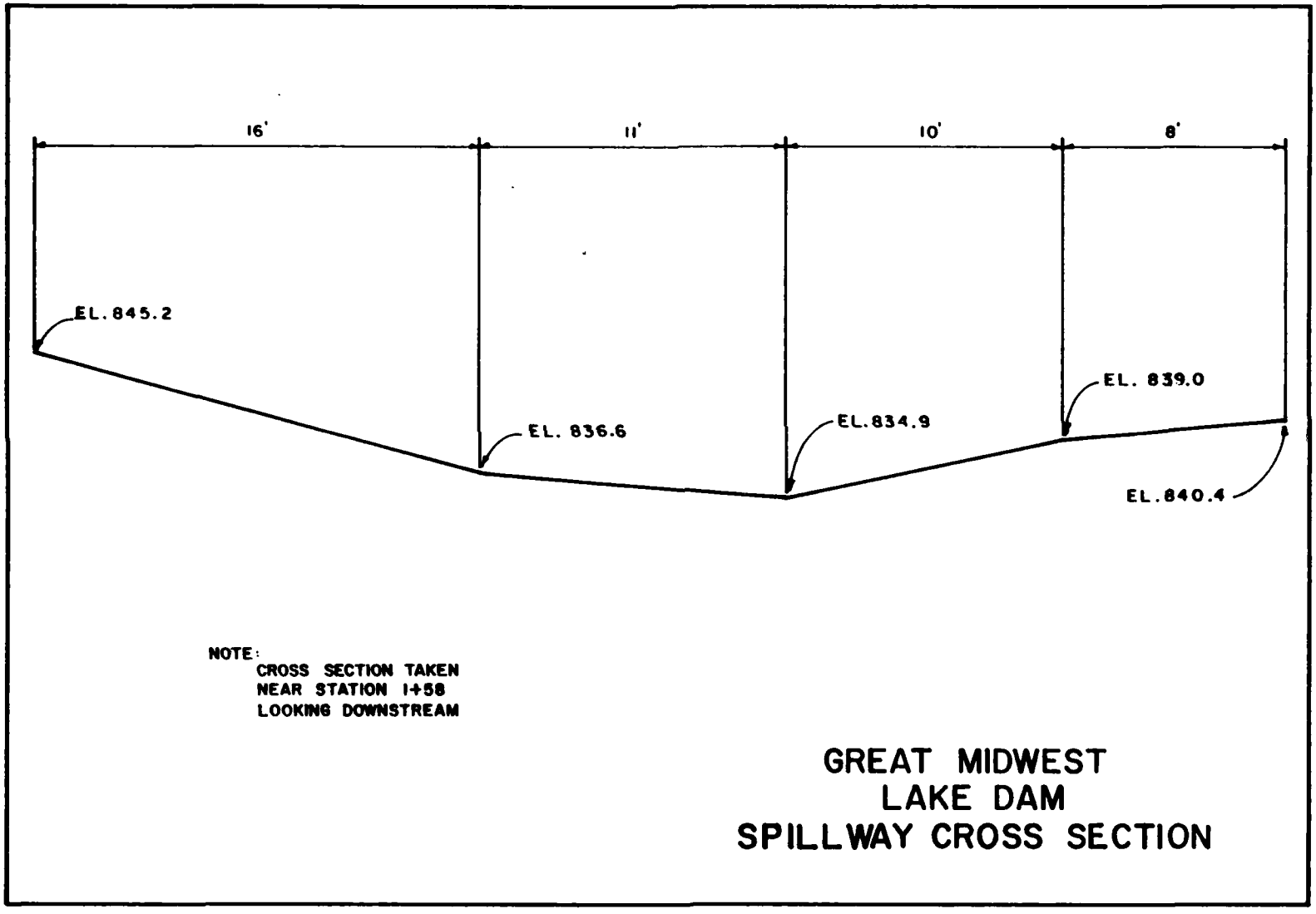


PLATE 5

GREAT MIDWEST
LAKE DAM
SPILLWAY PROFILE



NOTE:
CROSS SECTION TAKEN
NEAR STATION 1+58
LOOKING DOWNSTREAM

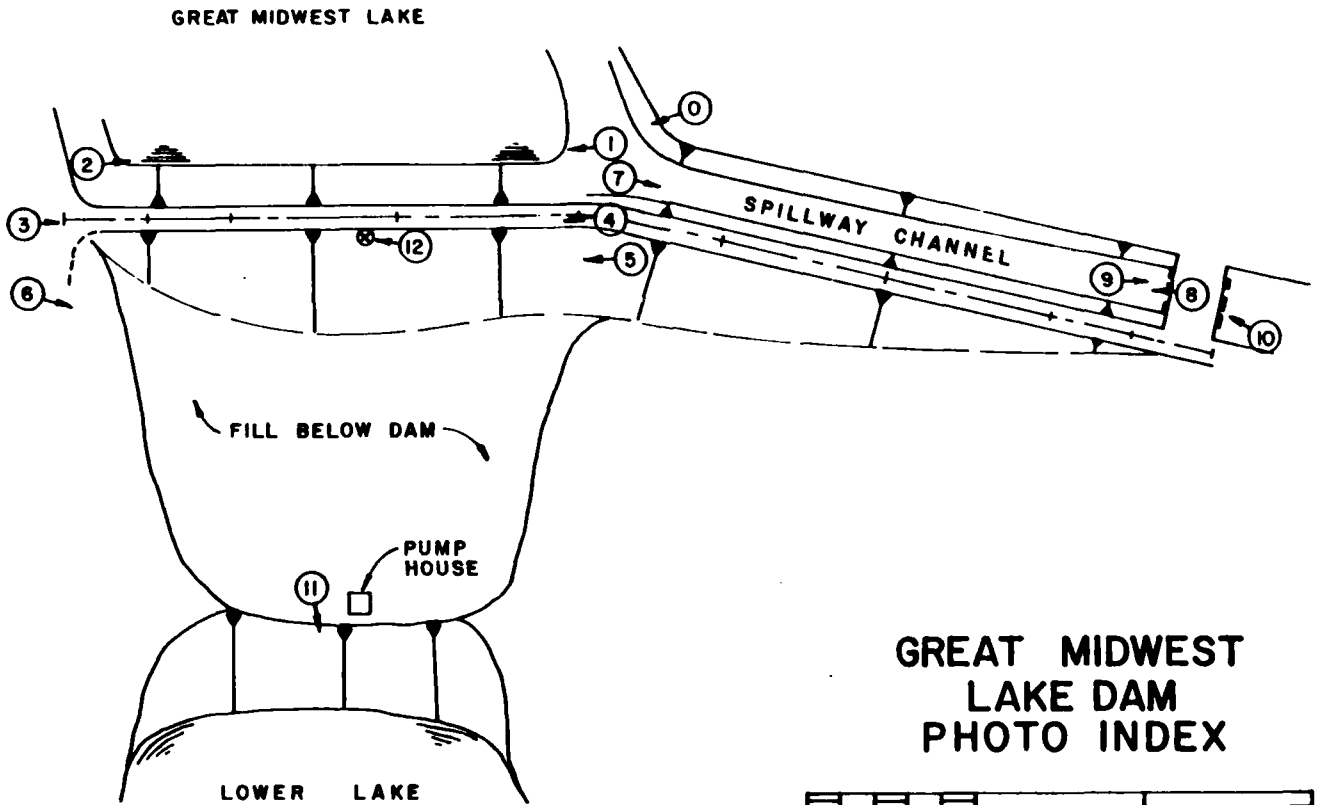
GREAT MIDWEST LAKE DAM SPILLWAY CROSS SECTION

PLATE 6

LEGEND

① PHOTO NUMBER & DIRECTION

⊗ AUGAR BORING



GREAT MIDWEST LAKE DAM PHOTO INDEX

N

100 0 100 200

SCALE IN FEET

PLATE 7

PHOTO 1: UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 3: CREST OF DAM LOOKING EAST

PHOTO 4: CREST OF DAM LOOKING WEST

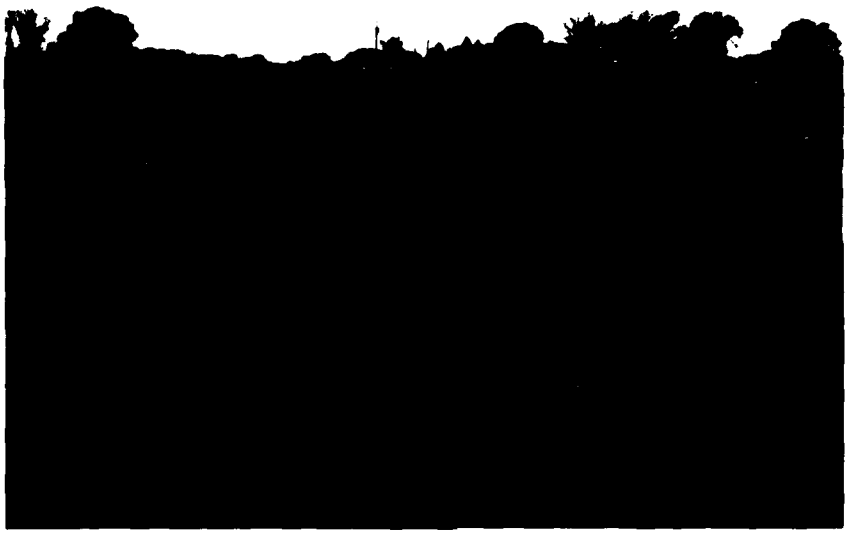


PHOTO 5: DOWNSTREAM SLOPE OF DAM

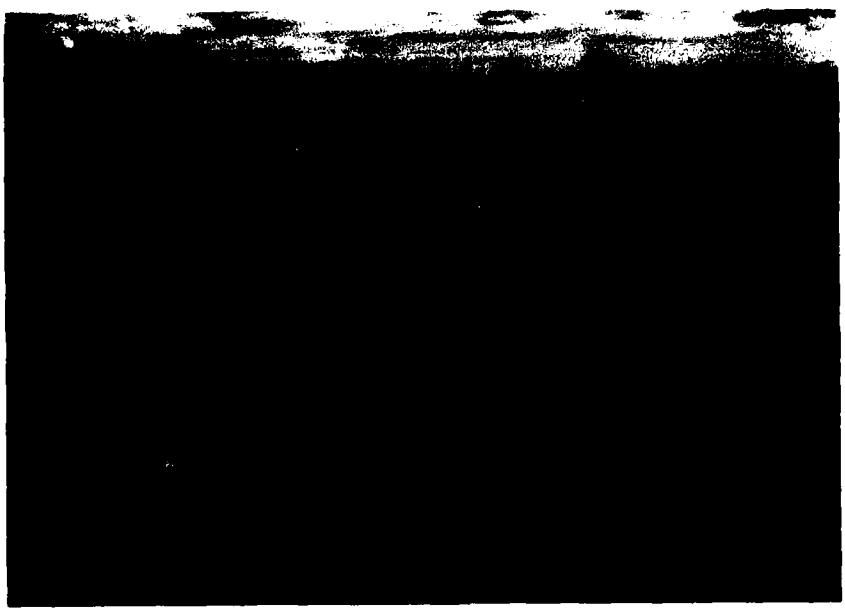


PHOTO 6: FILL AREA BELOW DAM

PHOTO 7: SPILLWAY CHANNEL LOOKING DOWNSTREAM

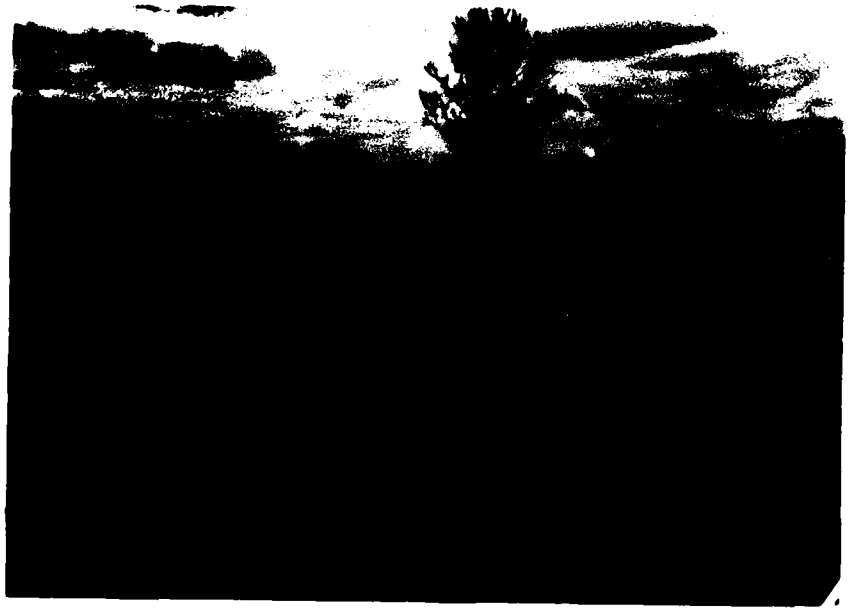


PHOTO 8: SPILLWAY CHANNEL LOOKING UPSTREAM

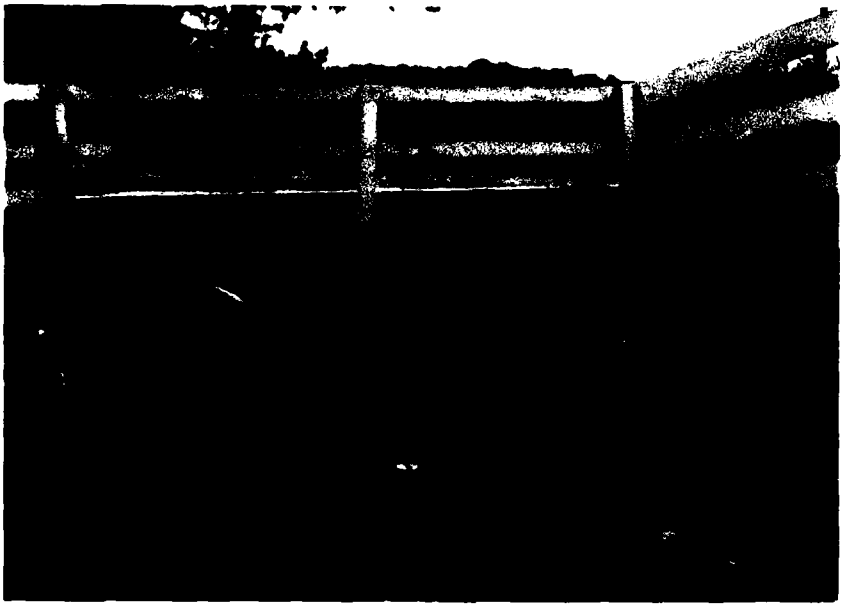


PHOTO 9: SPILLWAY CULVERTS, INLET END

PHOTO 10: SPILLWAY CULVERTS, OUTLET END

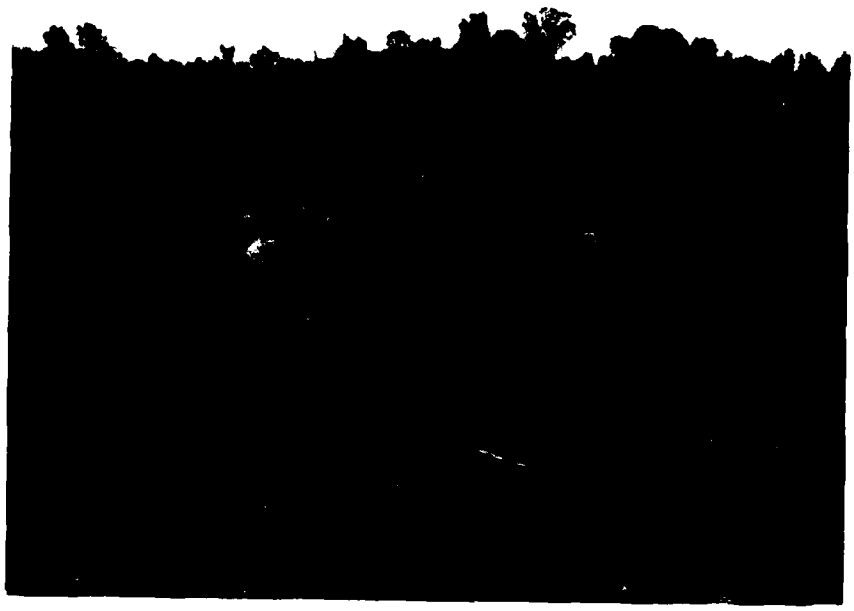


PHOTO 11: LOWER LAKE

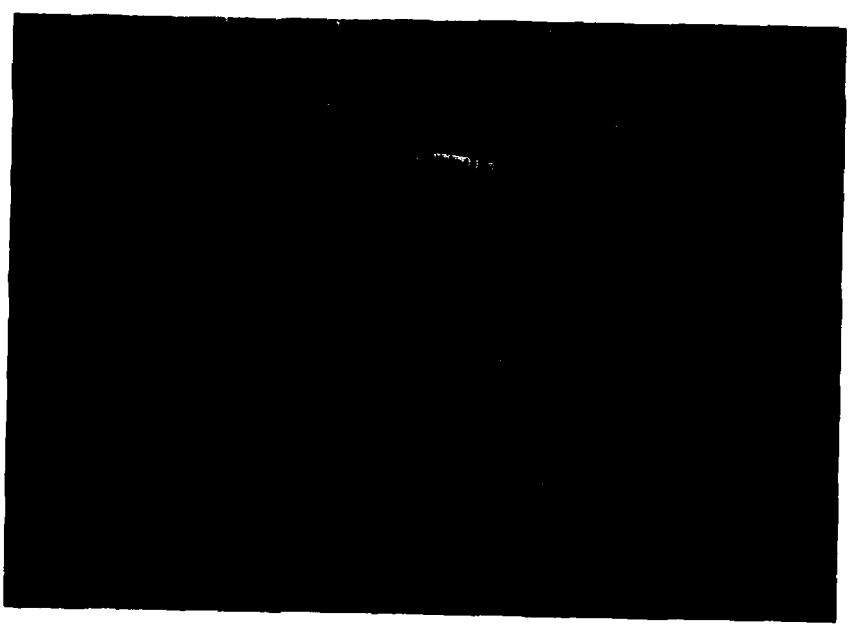


PHOTO 12: SAMPLE OF EMBANKMENT MATERIAL

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411. The Kansas City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoir and spillway.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Converation Service (SCS) method. The parameters for the unit hydrograph are shown in Table 1.

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the Modified Puls Method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the crest elevation of the principal spillway at elevation 835.8 feet m.s.l. in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (5). The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillway is shown in Table 4. The flow over the crest of the dam and spillway was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir with no effect resulting from the partially blocked culvert pipe at the lower end of the spillway channel.

The result of the routing analyses indicates that 100 percent of the PMF will not overtop the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	91 acres
Length of Watercourse (L)	0.152 miles
Difference in Elevation (H)	59 feet
Wave Velocity (V)	17.7 ft/sec.
Length of Reservoir (L_w)	650 feet
Time of concentration (T_c)	0.061 hours
Lag Time (L_g)	0.043 hours
Duration (D)	0.48 min. (use 5 min.)

Time (Min.) *	Discharge (cfs) *
0	0
5	271
10	80
15	16
20	3
25	0

* From HEC-1 computer output

FORMULAS USED:

$$T_c = \frac{(11.9\ L^3)}{H}^{0.385} + V/L_w \quad (2 \text{ and } 4)$$

$$D = 0.133\ T_c$$

$$L_g = 0.6\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	32.17	30.00	2.17

Additional Data:

1) The soil association in this watershed is Knox (3). 100 percent of drainage area in hydrologic soil group B. 100 percent of the land use was grassland (4).
2) SCS Runoff Curve CN = 84 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 69 (AMC II) for the one percent probability flood.

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*835.8	6.4	65	0
**840.1	7.3	94	364

*Spillway crest elevation
**Top of dam elevation

The relationships in Table 3 were developed from the Liberty, Missouri. 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft)	Spillway Discharge (cfs)
835.8	0
836.0	1
837.0	16
838.0	77
839.0	206
*840.1	364

*Top of Dam Elevation

METHOD USED:

Spillway releases were computed by HEC-1 from spillway geometry data input on $L and $V cards. The following equations calculate the spillway discharge:

$$d_c = 2/3\ (H_m + 1/4\ \Delta Y)$$

$$A = 1/2\ T\ (2d_c - \Delta Y)$$

$$Q = (A^3 g/T)^{0.5}$$

where:

d_c = critical depth (feet)

H_m = available specific energy which is taken to be the height of the water surface in the reservoir above the bottom of the section (feet)

ΔY = change in elevation across the section (feet)

A = flow area (sq. ft.)

T = top width (feet)

Q = flow (cfs)

g = 32.2 ft/sec^2 = acceleration due to gravity.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*835.8	65	0	-
0.50	429	838.4	82	116	-
1.00	857	839.7	91	291	-

The PMF does not reach the top of the dam.

*Spillway crest elevation

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(3) U.S. Department of Agriculture, Soil Conservation Service, Preliminary Soils Report for Clay County, Missouri.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(6) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(7) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  06 FEB 80
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    1              A1MISSOURI DAM INSPECTION PROGRAM
    2              A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
    3              A3GREAT MIDWEST LAKE DAM
    4              D    288       0       5       0       0       0       0       0       0       0
    5              D1     5
    6              J     1       2       1
    7              J1   1.0      .5                                              3       1
    8              K      0       1
    9              K1   GREAT MIDWEST LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
   10              M      1       2    .048                                       1
   11              P            24.75     101     120     130
   12              T                                                             -1     -84
   13              W2           .043
   14              X                      1
   15              K      1       2                                              1
   16              K1   ROUTE THROUGH SPILLWAY
   17              Y                                      1       1
   18              Y1     1                                                  -835.8
   19              SA0.0   3.4     5.3     7.3    11.1
   20              SE815.  825.7   830.    840.    850.
   21              SS835.8
   22              SO840.1
   23              SL0.     16.     25.     32.     167.    288.    350.    390.    490.    600.
   24              SV835.8 837.5   839.9   840.1   840.3   840.4   840.5   840.8   841.1   844.2
   25              K     99
```


PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 06 FEB 80

MISSOURI DAM INSPECTION PROGRAM
ST. LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
GREAT MIDWEST LAKE DAM

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 2 LRTIO= 1
RTIOS= 1.00 .50

SUB-AREA RUNOFF COMPUTATION

GREAT MIDWEST LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.05	.00	.05	1.00	.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
.00	24.75	101.00	120.00	130.00	.00	.00	.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-84.00	.00	.00

CURVE NO = -84.00 WETNESS = -1.00 EFFECT CN = 84.00

UNIT HYDROGRAPH DATA
TC= .00 LAG= .04

RECESSION DATA
STRTQ= .00 QRCSN= .00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHR IS GT LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= .04 VOL= 1.00
271. 80. 16. 3. 0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.19	.01	59.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.19	.01	70.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.20	.01	72.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.20	.01	73.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.20	.01	73.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.20	.01	73.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.20	.01	74.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.20	.01	74.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.20	.01	74.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.20	.01	74.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.20	.01	74.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.20	.01	74.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.25	.24	.01	85.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.25	.24	.01	89.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.25	.24	.01	90.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.25	.24	.01	90.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.25	.24	.01	90.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.25	.24	.01	90.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.25	.24	.01	90.
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.25	.24	.01	90.
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.25	.24	.01	90.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.25	.24	.01	91.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.25	.24	.01	91.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.25	.24	.01	91.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.31	.31	.01	107.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.31	.31	.01	112.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.31	.31	.01	114.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.31	.31	.01	114.
1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.31	.31	.01	114.
1.01	2.30	30	.01	.00	.01	0.	1.01	14.30	174	.31	.31	.01	114.
1.01	2.35	31	.01	.00	.01	0.	1.01	14.35	175	.31	.31	.01	114.
1.01	2.40	32	.01	.00	.01	0.	1.01	14.40	176	.31	.31	.00	114.
1.01	2.45	33	.01	.00	.01	0.	1.01	14.45	177	.31	.31	.00	114.
1.01	2.50	34	.01	.00	.01	0.	1.01	14.50	178	.31	.31	.00	114.
1.01	2.55	35	.01	.00	.01	0.	1.01	14.55	179	.31	.31	.00	114.
1.01	3.00	36	.01	.00	.01	1.	1.01	15.00	180	.31	.31	.00	114.
1.01	3.05	37	.01	.00	.01	1.	1.01	15.05	181	.19	.19	.00	82.
1.01	3.10	38	.01	.00	.01	1.	1.01	15.10	182	.38	.38	.00	123.
1.01	3.15	39	.01	.00	.01	1.	1.01	15.15	183	.38	.38	.00	136.
1.01	3.20	40	.01	.00	.01	1.	1.01	15.20	184	.57	.56	.01	190.
1.01	3.25	41	.01	.00	.01	1.	1.01	15.25	185	.66	.66	.01	231.
1.01	3.30	42	.01	.00	.01	1.	1.01	15.30	186	1.61	1.60	.02	497.
1.01	3.35	43	.01	.00	.01	1.	1.01	15.35	187	2.66	2.64	.02	857.
1.01	3.40	44	.01	.00	.01	1.	1.01	15.40	188	1.04	1.04	.01	522.
1.01	3.45	45	.01	.00	.01	1.	1.01	15.45	189	.66	.66	.00	311.
1.01	3.50	46	.01	.00	.01	1.	1.01	15.50	190	.57	.57	.00	233.
1.01	3.55	47	.01	.00	.01	1.	1.01	15.55	191	.38	.38	.00	163.
1.01	4.00	48	.01	.00	.01	1.	1.01	16.00	192	.38	.38	.00	145.
1.01	4.05	49	.01	.00	.01	1.	1.01	16.05	193	.29	.29	.00	117.
1.01	4.10	50	.01	.00	.01	1.	1.01	16.10	194	.29	.29	.00	110.
1.01	4.15	51	.01	.00	.01	1.	1.01	16.15	195	.29	.29	.00	108.
1.01	4.20	52	.01	.00	.01	1.	1.01	16.20	196	.29	.29	.00	108.
1.01	4.25	53	.01	.00	.01	1.	1.01	16.25	197	.29	.29	.00	108.

1.01	4.30	54	.01	.00	.01	1.	1.01	16.30	198	.29	.29	.00	108.	
1.01	4.35	55	.01	.00	.01	2.	1.01	16.35	199	.29	.29	.00	108.	
1.01	4.40	56	.01	.00	.01	2.	1.01	16.40	200	.29	.29	.00	108.	
1.01	4.45	57	.01	.00	.01	2.	1.01	16.45	201	.29	.29	.00	108.	
1.01	4.50	58	.01	.00	.01	2.	1.01	16.50	202	.29	.29	.00	108.	
1.01	4.55	59	.01	.00	.01	2.	1.01	16.55	203	.29	.29	.00	108.	
1.01	5.00	60	.01	.00	.01	2.	1.01	17.00	204	.29	.29	.00	108.	
1.01	5.05	61	.01	.00	.01	2.	1.01	17.05	205	.23	.23	.00	91.	
1.01	5.10	62	.01	.00	.01	2.	1.01	17.10	206	.23	.23	.00	86.	
1.01	5.15	63	.01	.00	.01	2.	1.01	17.15	207	.23	.23	.00	85.	
1.01	5.20	64	.01	.01	.01	2.	1.01	17.20	208	.23	.23	.00	85.	
1.01	5.25	65	.01	.01	.01	2.	1.01	17.25	209	.23	.23	.00	85.	
1.01	5.30	66	.01	.01	.01	2.	1.01	17.30	210	.23	.23	.00	85.	
1.01	5.35	67	.01	.01	.01	2.	1.01	17.35	211	.23	.23	.00	85.	
1.01	5.40	68	.01	.01	.01	2.	1.01	17.40	212	.23	.23	.00	85.	
1.01	5.45	69	.01	.01	.01	2.	1.01	17.45	213	.23	.23	.00	85.	
1.01	5.50	70	.01	.01	.01	2.	1.01	17.50	214	.23	.23	.00	85.	
1.01	5.55	71	.01	.01	.01	2.	1.01	17.55	215	.23	.23	.00	85.	
1.01	6.00	72	.01	.01	.01	2.	1.01	18.00	216	.23	.23	.00	85.	
1.01	6.05	73	.07	.03	.04	8.	1.01	18.05	217	.02	.02	.00	28.	
1.01	6.10	74	.07	.03	.03	11.	1.01	18.10	218	.02	.02	.00	12.	
1.01	6.15	75	.07	.03	.03	12.	1.01	18.15	219	.02	.02	.00	8.	
1.01	6.20	76	.07	.03	.03	12.	1.01	18.20	220	.02	.02	.00	8.	
1.01	6.25	77	.07	.04	.03	13.	1.01	18.25	221	.02	.02	.00	8.	
1.01	6.30	78	.07	.04	.03	13.	1.01	18.30	222	.02	.02	.00	8.	
1.01	6.35	79	.07	.04	.03	14.	1.01	18.35	223	.02	.02	.00	8.	
1.01	6.40	80	.07	.04	.03	14.	1.01	18.40	224	.02	.02	.00	8.	
1.01	6.45	81	.07	.04	.03	15.	1.01	18.45	225	.02	.02	.00	8.	
1.01	6.50	82	.07	.04	.02	15.	1.01	18.50	226	.02	.02	.00	8.	
1.01	6.55	83	.07	.04	.02	16.	1.01	18.55	227	.02	.02	.00	8.	
1.01	7.00	84	.07	.04	.02	16.	1.01	19.00	228	.02	.02	.00	8.	
1.01	7.05	85	.07	.04	.02	16.	1.01	19.05	229	.02	.02	.00	8.	
1.01	7.10	86	.07	.04	.02	17.	1.01	19.10	230	.02	.02	.00	8.	
1.01	7.15	87	.07	.05	.02	17.	1.01	19.15	231	.02	.02	.00	8.	
1.01	7.20	88	.07	.05	.02	17.	1.01	19.20	232	.02	.02	.00	8.	
1.01	7.25	89	.07	.05	.02	17.	1.01	19.25	233	.02	.02	.00	8.	
1.01	7.30	90	.07	.05	.02	18.	1.01	19.30	234	.02	.02	.00	8.	
1.01	7.35	91	.07	.05	.02	18.	1.01	19.35	235	.02	.02	.00	8.	
1.01	7.40	92	.07	.05	.02	18.	1.01	19.40	236	.02	.02	.00	8.	
1.01	7.45	93	.07	.05	.02	18.	1.01	19.45	237	.02	.02	.00	8.	
1.01	7.50	94	.07	.05	.02	18.	1.01	19.50	238	.02	.02	.00	8.	
1.01	7.55	95	.07	.05	.01	19.	1.01	19.55	239	.02	.02	.00	8.	
1.01	8.00	96	.07	.05	.01	19.	1.01	20.00	240	.02	.02	.00	8.	
1.01	8.05	97	.07	.05	.01	19.	1.01	20.05	241	.02	.02	.00	8.	
1.01	8.10	98	.07	.05	.01	19.	1.01	20.10	242	.02	.02	.00	8.	
1.01	8.15	99	.07	.05	.01	19.	1.01	20.15	243	.02	.02	.00	8.	
1.01	8.20	100	.07	.05	.01	19.	1.01	20.20	244	.02	.02	.00	8.	
1.01	8.25	101	.07	.05	.01	20.	1.01	20.25	245	.02	.02	.00	8.	
1.01	8.30	102	.07	.05	.01	20.	1.01	20.30	246	.02	.02	.00	8.	
1.01	8.35	103	.07	.05	.01	20.	1.01	20.35	247	.02	.02	.00	8.	
1.01	8.40	104	.07	.05	.01	20.	1.01	20.40	248	.02	.02	.00	8.	
1.01	8.45	105	.07	.05	.01	20.	1.01	20.45	249	.02	.02	.00	8.	
1.01	8.50	106	.07	.05	.01	20.	1.01	20.50	250	.02	.02	.00	8.	
1.01	8.55	107	.07	.05	.01	20.	1.01	20.55	251	.02	.02	.00	8.	
1.01	9.00	108	.07	.06	.01	20.	1.01	21.00	252	.02	.02	.00	8.	
1.01	9.05	109	.07	.06	.01	21.	1.01	21.05	253	.02	.02	.00	8.	

1.01	9.10	110	.07	.06	.01	21.	1.01	21.10	254	.02	.02	.00	8.
1.01	9.15	111	.07	.06	.01	21.	1.01	21.15	255	.02	.02	.00	8.
1.01	9.20	112	.07	.06	.01	21.	1.01	21.20	256	.02	.02	.00	8.
1.01	9.25	113	.07	.06	.01	21.	1.01	21.25	257	.02	.02	.00	8.
1.01	9.30	114	.07	.06	.01	21.	1.01	21.30	258	.02	.02	.00	8.
1.01	9.35	115	.07	.06	.01	21.	1.01	21.35	259	.02	.02	.00	8.
1.01	9.40	116	.07	.06	.01	21.	1.01	21.40	260	.02	.02	.00	8.
1.01	9.45	117	.07	.06	.01	21.	1.01	21.45	261	.02	.02	.00	8.
1.01	9.50	118	.07	.06	.01	21.	1.01	21.50	262	.02	.02	.00	8.
1.01	9.55	119	.07	.06	.01	21.	1.01	21.55	263	.02	.02	.00	8.
1.01	10.00	120	.07	.06	.01	21.	1.01	22.00	264	.02	.02	.00	8.
1.01	10.05	121	.07	.06	.01	22.	1.01	22.05	265	.02	.02	.00	8.
1.01	10.10	122	.07	.06	.01	22.	1.01	22.10	266	.02	.02	.00	8.
1.01	10.15	123	.07	.06	.01	22.	1.01	22.15	267	.02	.02	.00	8.
1.01	10.20	124	.07	.06	.01	22.	1.01	22.20	268	.02	.02	.00	8.
1.01	10.25	125	.07	.06	.01	22.	1.01	22.25	269	.02	.02	.00	8.
1.01	10.30	126	.07	.06	.01	22.	1.01	22.30	270	.02	.02	.00	8.
1.01	10.35	127	.07	.06	.01	22.	1.01	22.35	271	.02	.02	.00	8.
1.01	10.40	128	.07	.06	.01	22.	1.01	22.40	272	.02	.02	.00	8.
1.01	10.45	129	.07	.06	.01	22.	1.01	22.45	273	.02	.02	.00	8.
1.01	10.50	130	.07	.06	.01	22.	1.01	22.50	274	.02	.02	.00	8.
1.01	10.55	131	.07	.06	.01	22.	1.01	22.55	275	.02	.02	.00	8.
1.01	11.00	132	.07	.06	.01	22.	1.01	23.00	276	.02	.02	.00	8.
1.01	11.05	133	.07	.06	.01	22.	1.01	23.05	277	.02	.02	.00	8.
1.01	11.10	134	.07	.06	.01	22.	1.01	23.10	278	.02	.02	.00	8.
1.01	11.15	135	.07	.06	.01	22.	1.01	23.15	279	.02	.02	.00	8.
1.01	11.20	136	.07	.06	.01	22.	1.01	23.20	280	.02	.02	.00	8.
1.01	11.25	137	.07	.06	.01	22.	1.01	23.25	281	.02	.02	.00	8.
1.01	11.30	138	.07	.06	.01	22.	1.01	23.30	282	.02	.02	.00	8.
1.01	11.35	139	.07	.06	.01	22.	1.01	23.35	283	.02	.02	.00	8.
1.01	11.40	140	.07	.06	.00	22.	1.01	23.40	284	.02	.02	.00	8.
1.01	11.45	141	.07	.06	.00	22.	1.01	23.45	285	.02	.02	.00	8.
1.01	11.50	142	.07	.06	.00	22.	1.01	23.50	286	.02	.02	.00	8.
1.01	11.55	143	.07	.06	.00	23.	1.01	23.55	287	.02	.02	.00	8.
1.01	12.00	144	.07	.06	.00	23.	1.02	.00	288	.02	.02	.00	8.
								SUM		32.17	30.00	2.18	11168.
										(817.)	(762.)	(55.)	(316.24)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	857.	126.	39.	39.	11138.
CMS	24.	4.	1.	1.	315.
INCHES		24.51	29.98	29.98	29.98
MM		622.57	761.49	761.49	761.49
AC-FT		63.	77.	77.	77.
THOUS CU M		77.	95.	95.	95.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	857.	126.	39.	39.	11138.
CMS	24.	4.	1.	1.	315.
INCHES		24.51	29.98	29.98	29.98
MM		622.57	761.49	761.49	761.49

AC-FT 63 77 77 77

AC-FT	63.	77.	77.	77.
THOUS CU M	77.	95.	95.	95.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	429.	63.	19.	19.	5569.
CMS	12.	2.	1.	1.	158.
INCHES		12.26	14.99	14.99	14.99
MM		311.29	380.74	380.74	380.74
AC-FT		31.	38.	38.	38.
THOUS CU M		39.	47.	47.	47.

HYDROGRAPH ROUTING

ROUTE THROUGH SPILLWAY

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

RLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
.0	.000	.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-836.	0

SURFACE AREA=	0.	3.	5.	7.	11.
CAPACITY=	0.	12.	31.	93.	185.
ELEVATION=	815.	826.	830.	840.	850.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
835.8	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
840.1	.0	.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0.	16.	25.	32.	147.	288.	350.	390.	490.	600.
	835.8	837.5	839.9	840.1	840.3	840.4	840.5	840.8	841.1	844.2

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	1	.05	1	857.	429.
		(.12)		(24.27)(	12.14)(
ROUTED TO	2	.05	1	291.	116.
		(.12)		(8.25)(	3.28)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	835.80	835.80	840.10
STORAGE	65.	65.	94.
OUTFLOW	0.	0.	364.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	839.68	.00	91.	291.	.00	15.75	.00
.50	838.38	.00	82.	116.	.00	15.83	.00

END

DATE
FILMED

11-81

DTIC