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Phase 1 Inspection Report: National Dam Safety Program. Missouri - Kansas City Basin. Binder Lake Dam, Cole County, Missouri

Hoskins-Western-Sonderegger, Inc. Consulting Engineers, Lincoln, Nebraska

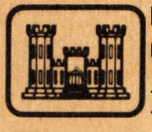
MISSOURI - KANSAS CITY BASIN

BINDER LAKE DAM

COLE COUNTY, MISSOURI

MO. 30051

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

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

FOR STATE OF MISSOURI

MAY, 1979

BINDER LAKE DAM
COLE COUNTY, MISSOURI
MISSOURI INVENTORY NO. 30051

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY, 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Binder Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Binder Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY SIGNED 13 DEC 1979
Chief, Engineering Division Date

APPROVED: SIGNED 13 DEC 1979
Colonel, CE, District Engineer Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Binder Lake Dam
State Located	Missouri
County Located	Cole County
Stream	Tributary Grays Creek
Date of Inspection	May 30, 1979

Binder Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions 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 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 an intermediate size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately 5.6 miles downstream of the dam. Within the damage zone are four crossings of the Missouri Pacific Railroad tracks, one county road, five dwellings and associated buildings and State Highway 179.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for an intermediate dam having a high hazard potential. The Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 40% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

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 analyses should be obtained in the future.

Other deficiencies observed during the inspection are erosion, spalling and weathering of the limestone at and under the downstream toe of the concrete weir control structure in the principal spillway and slight deterioration of the riprap on the upstream slope of the dam.

Maintenance of the dam is, in general, good. Items of preventative maintenance described in the report are addressed to the repair of the limestone deterioration in the principal spillway and to the riprap on the upstream face of the dam.

Rey S. Decker
E-3703

Gordon Jamison

Michael McMeekin
E-4776

H. P. Hoskins
Harold P. Hoskins
Chairman of Board
Hoskins-Western-Sonderegger, Inc.
E-8696

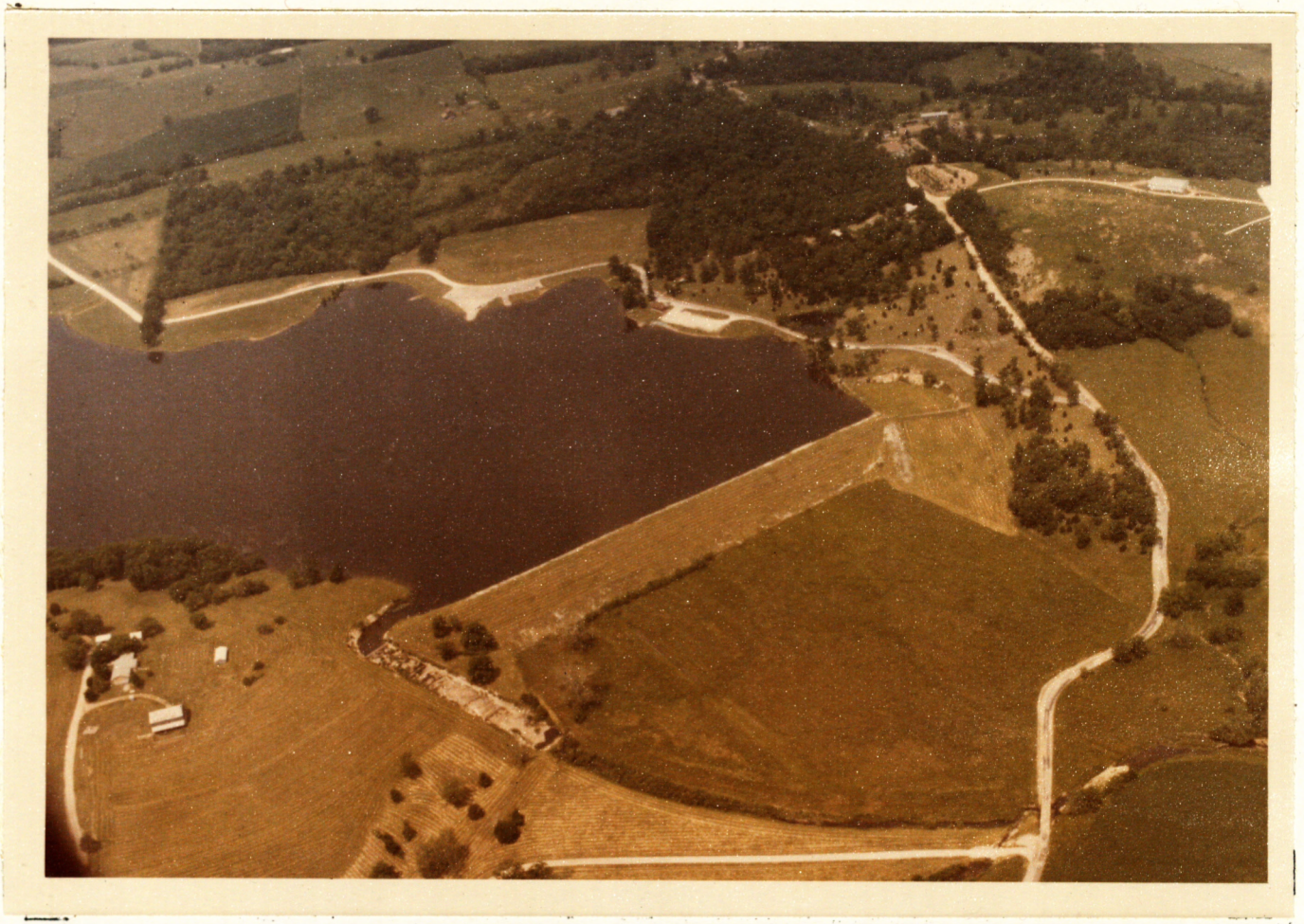


PHOTO NO. 1 - OVERVIEW

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BINDER LAKE DAM - MO 30051
COLE COUNTY, MISSOURI

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 St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Binder 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," Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth fill about 1210 feet in length with maximum height of 44.5 feet and height of 37.5 feet above the flood plain. The topography adjacent to the site is gently to steeply rolling. Uplands are covered with a thin mantle of loess. Valley slopes consist of limestone outcrops and residual cherty clay soils.

(2) The principal spillway consists of an uncontrolled channel 50 feet in width excavated through limestone bedrock in the right abutment. The spillway has a concrete weir control section.

(3) The emergency spillway consists of an uncontrolled vegetated channel cut through the left abutment. It has a bottom width of 150 feet and a rock gabion weir control section.

(4) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the northwestern portion of Cole County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the S½ of Section 36, T45N, R13W. The lake formed behind the dam is shown in the S½ of Section 36, T45N, R13W and the W½ of Section 1, T44N, R13W.

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, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining the hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends approximately 5.6 miles downstream of the dam. Within the damage zone are four crossings of the Missouri Pacific Railroad tracks, one county road, five dwellings and associated buildings and State Highway 179.

e. Ownership. The dam is owned by the Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102.

f. Purpose of Dam. The dam impounds about 1750 ac. ft. of water for recreational purposes.

g. Design and Construction History. The dam was constructed in 1966. The design and plans for construction were prepared by the Engineering Division of the Missouri Conservation Department, Jefferson City, Missouri. Portions of these plans are included with this report as Appendix C.

h. Normal Operating Procedure. Normal rainfall, transpiration and evaporation and the capacity of the uncontrolled spillways all combine to maintain a relatively stable reservoir elevation. It was reported by the Engineering Division of the Missouri Conservation Department that the highest reservoir elevation occurred in 1967 when the water surface approached the crest of the emergency spillway.

1.3 PERTINENT DATA

a. Drainage Area. 6.03 square miles (3,860 acres)

b. Discharge at Damsite.

(1) All discharges at the damsite are over the concrete weir principal spillway or through the vegetated earth emergency spillway.

(2) Estimated maximum flood - unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 640.0 (concrete weir crest) to 3,750 c.f.s. at elevation 647.5 (dam crest).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest elevation to 4,300 c.f.s. at elevation 647.5 (dam crest).

(5) Total spillway capacity at the minimum top of dam is 8,050 c.f.s. ±.

c. Elevations. (Feet above M.S.L.)

(1) Top of dam - 647.5 (plans)
(2) Principal spillway crest - 640.0 (plans)
(3) Emergency spillway crest - 643.0 (plans)
(4) Streambed at centerline - 603.0± (plans)
(5) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 8,200 feet±.

e. Storage (Acre-feet).

(1) Top of dam - 3,300 ±
(2) Principal spillway crest - 1,750 ±

f. Reservoir Surface (Acres).

(1) Top of dam - 215 ±
(2) Principal spillway crest = 150 ±

g. Dam.

(1) Type - earth fill
(2) Length - 1210 feet
(3) Height - 44.5 feet (maximum), 37.5 feet (flood plain)
(4) Top width - 16 feet (plans), 18 feet (measured)
(5) Side slopes
    (a) Downstream - 3H on 1V to el. 630 feet, 5H on 1V to toe (plans), 3.1H on 1V/5H on 1V (measured)
    (b) 3H on 1V with 10 feet berm at el. 631 feet (plans)
(6) Zoning - plans show homogeneous fill with rock toes.
(7) Impervious core - none on plans
(8) Cutoff - plans show cutoff to bedrock, 10 to 25 feet deep. Owner reports that cutoff depths exceeded plans in order to intercept all gravel strata.
(9) Grout curtain - none shown on plans
(10) Wave protection - Riprap, 1 foot thick, crest to berm (plans)
(11) Drains - plans show foundation trench drain about 5 feet in depth between stations 6+00 and 13+00 (stations according to plans).

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

(a) Type. Uncontrolled, rectangular channel excavated in rock on the right abutment. Approach section has 60 feet bottom width, control and outlet section has 50 feet bottom width. A concrete weir is embedded in foundation rock as control section.

(b) Crest (invert) elevation - weir crest = 640 feet (plans)
Outlet - 50 feet side rectangular channel cut in rock on grades of 7.65 to 19.6 to 0.0%

(c) Length - approach section = 240 feet ±, outlet section = 360 feet ±, energy dissipation pool = 70 feet.

(2) Emergency

(a) Type - uncontrolled vegetated earth, cut into soil and rock in the left abutment, 150 feet bottom width with 4H on 1V side slopes in soil and blasted slopes in rock.

(b) Control section - wire/rock gabion sill, 3 feet ± wide across spillway downstream from centerline of dam.

(c) Crest elevation - 643 feet (plans)

(d) Upstream Channel - level approach channel approximately 250 feet in length.

(e) Downstream Channel - exit channel 180 feet in length on grade of 10.5% with rock levee on the right (dam) side.

j. Regulating Outlets. Drawdown facility consists of 18 inch diameter cast iron pipe through the base of the dam (℄ Sta. 6+00) with an 18 inch manually operated gate valve at the downstream toe of the dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam. Construction plans (Appendix C) were supplied by the owner. A report on the geological investigations prepared by The Missouri Geological Survey is included with this report in Appendix C.

2.2 CONSTRUCTION

No construction data were available. It was reported that the dam was constructed in 1966.

2.3 OPERATION

No data were available on spillway operation. It was reported that the emergency spillway has not operated. The reservoir level approached the crest elevation in 1967 after a rain that was estimated to be equivalent to a 1 in 50 year occurrence.

2.4 EVALUATION

a. Availability. All available information was readily obtainable.

b. Adequacy. The construction plans, field surveys, and visual observation presented herein are considered adequate to support the conclusion of this report. 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 data available conform with accepted practice.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Binder Lake Dam was made on May 30, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were: Rey S. Decker, Geotechnical; Gordon Jamison, Hydrology; Michael McMeekin, Civil Engineer. No representative of the owner was present on the inspection.

b. Dam.

(1) Geology and Soils (abutment and embankment). The Missouri Geological Survey report (Appendix C) describes the geology of the site. The plans show that embankment materials were borrowed from the valley slopes, above elevation 630 feet and consisted of silt loam and clay loam (ML and CL) surface soils underlain by clay and clay loam (CL and CH) soils. Borings on the crest and downstream sections of the dam showed plastic CL and CH materials to depths of 2 feet.

(2) Upstream Slope. The upstream slope is completely covered with durable limestone riprap ranging in size from 8 to 10 inches up to 3 feet (long dimension). Some deterioration of the limestone was noted, but it did not appear to be significant. No erosion or deformation was observed on the slope.

(3) Crest. The crest is well vegetated with adapted grasses and was recently mowed. No cracks, rodent holes or deformations were noted along the crest.

(4) Downstream Slope. The downstream slope is densely vegetated with adapted grasses and was recently mowed. A few small trees are growing along the toe of the dam downstream from about station 5+00 to 9+00 (stationing according to plans). These trees may be feeding on discharge from the rock toe drain but no water or seepage was observed in the area. No cracks, rodent holes or deformations were observed on the slopes or at the toe. There was no indication of seepage on the slope or at the toe of the dam. No discharge was observed from the trench drain. The bottom of the outlet channel for the drawdown facility, which is some 5 feet below natural ground level, was moist but did not show free water. There was no sign of leakage from the valve on the drawdown pipe.

(5) Miscellaneous. The excellent vegetation cover and the erosion resistant nature of the materials in the dam would indicate that this structure could withstand overtopping produced by the 0.5 PMF without serious damage.

c. Appurtenant Structures.

(1) Principal spillway. Some erosion, spalling, and weathering of the limestone, with resulting undercutting, was observed at and under the downstream toe of the concrete weir control structure. (See photos 10, 11 and 13.) There is seepage outcropping along the downstream edge of the weir, predominately on both ends. All seepage is clear and the total effluent was estimated at 0.5 ± gal./min. The exit channel is eroded bedrock with several small trees and shrubs growing in the cracks and erosion channels. The reservoir level was slightly below the crest of the weir.

(2) The emergency spillway. The emergency spillway is well vegetated with adapted grasses and was recently mowed. It looks very good with no evidence of erosion or deterioration. The plans show the crest of the rock gabion structure as 1 foot above the spillway grade line. At the time of inspection the top of the gabion sill was essentially at the same elevation as the bottom of the spillway. This may indicate that the spillway bottom was plated with about 1 foot of topsoil for vegetation purposes. The rock gabion structure looks good with very little deterioration but it has not been used or tested to date.

(3) Drawdown Facilities. Drawdown facilities consist of an 18 inch diameter cast iron pipe through the base of the dam with an 18 inch gate valve at the lower end. It is not known whether or not the gate valve is operable, but there was no indication at the outlet end that the valve had been recently opened. The outlet channel for the drawdown pipe is well vegetated and appears to be in good shape.

d. Reservoir Area. No slides or significant erosion were noted around the reservoir area. The reservoir was clear and beautiful.

e. Downstream Channel. The outlet channel for the principal spillway is pretty well overgrown with small trees and shrubs. It appears to be stable and the vegetation growth should not be detrimental to spillway operation.

3.2 EVALUATION

Field measurements indicate that this structure was constructed in accordance with the plans and specifications. The structure and appurtenances appear to be in good condition with only a slight potential of failure. None of the conditions observed indicate a need for immediate remedial action. Trees along the downstream toe will probably never penetrate through the rock toe drain. Continued deterioration of the bedrock under the principal spillway weir could ultimately alter the designed operation of the spillway but probably would not impair the integrity of the structure. Slight deterioration of the upstream riprap is a deficiency which might ultimately impair the safety of the dam if left uncontrolled or uncorrected.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

Maintenance, in general, appears to be good on this structure. Some minor deficiencies were noted in the deterioration and undermining of the control weir of the principal spillway and slight deterioration of the riprap. However, these deficiencies do not appear to threaten the safety of the structure.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities on this dam involve the 18 inch drawdown pipe. No information was available on the operation of this facility.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Construction plans for Binder Lake Dam were furnished by the Missouri Department of Conservation. Copies of these plans are included in Appendix C.

b. Experience. There are no available records of reservoir operation. It is known that the emergency spillway has never operated. In 1967 a flood estimated as having a 50-year recurrence interval caused the reservoir level to reach the crest of the emergency spillway.

c. Visual Observations.

(1) The concrete weir principal spillway is in good condition except for the undermining of the downstream side of the weir. Small trees and brush are growing in the principal spillway exit channel.

(2) The vegetated earth emergency spillway, located in the left abutment of the dam, is in excellent condition. Discharge from the emergency spillway will not endanger the dam.

Plans for the emergency spillway show the crest elevation of the gabion weir to be 1 foot above the grade elevation of the emergency spillway. Field observation, however, indicated that the crest of the gabion weir is at the same elevation as the emergency spillway.

d. Overtopping Potential. The existing spillways will not pass the PMF without overtopping of the dam. The spillways will pass the 100-year flood and 40% of the PMF without overtopping of the dam. The results of the routings are tabulated below:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 1065.1	Time Dam Overtopping Hr.
100 yr.	5,300	1,800	643.8	+3.7	0
0.50 PMF	13,900	12,100	648.2	-0.7	2±
PMF	27,700	26,800	649.7	-2.2	5±
0.40 PMF	11,100	8,100	647.5	0.0	0

The drainage area of the Binder Lake watershed was determined from the U.S.G.S. Lohman, Missouri, 7-½ minute topographic quadrangle map. Reservoir surface area was determined from a topographic map of the reservoir area included with the plans. Elevation-storage data were determined from the plans and from the U.S.G.S. quadrangle map. Computations for spillway and dam overtopping discharge ratings were based on data included in the plans and on surveys made during the field inspection. Hydraulic and hydrologic computations are described in Appendix D.

According to the guidelines of the Department of the Army, Office of the Chief of Engineers, Binder Lake Dam is classified as having a high hazard rating and intermediate size. The Probable Maximum Flood is the recommended design flood for evaluation of the adequacy of the dam and its spillways.

The estimated downstream damage zone is described in paragraph 1.2d of this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. There are no indications that this dam is structurally unstable. Embankment slopes and drainage measures should provide adequate safety against shear and/or piping failures. The effects of overtopping on the structural stability are not known, but it would appear that the estimated 2.2 feet of flow for 5 hours that could result from the Probable Maximum Flood would not adversely affect the integrity of the structure and appurtenances.

b. Design and Construction Data. The only design data available are shown on the plans in Appendix C. No construction data are available. 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. There are no controlled operating facilities for this dam. It is reported that the emergency spillway has not operated.

d. Post Construction Changes. The inspection team is not aware of any post construction changes for this structure.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. There does not appear to be any serious potential of failure of this structure. The few minor deficiencies in maintenance of the principal spillway and upstream riprap should be corrected and/or controlled. The spillways will pass 0.4 of the Probable Maximum Flood without overtopping the dam. Additional studies would be necessary to determine the effect of overtopping on the potential of failure. However, it would appear that overtopping would not cause serious damage to this structure.

b. Adequacy of Information. The construction plans available for this project and the visual observations and performance history are considered adequate to support the conclusions and recommendations presented in this report. Seepage and stability analyses comparable to the requirements of the guidelines were not available which is considered a deficiency.

c. Urgency. Action on remedial measures recommended in paragraph 7.2 concerning overtopping should be pursued on a high priority basis. There does not appear to be any urgency to accomplish the other remedial measures recommended in paragraph 7.2.

d. Necessity for Phase II. Phase II investigation is not considered necessary.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 REMEDIAL MEASURES

a. Alternatives. Additional information should be obtained to determine the detrimental effects of overtopping and the increase in the height of dam or the size of the spillway, if considered necessary, to pass the Probable Maximum Flood without overtopping the dam. The services of an engineer experienced in the design of dams should be obtained to evaluate the effects of overtopping, to provide seepage and stability analyses of the present dam, and to design protective measures, if required.

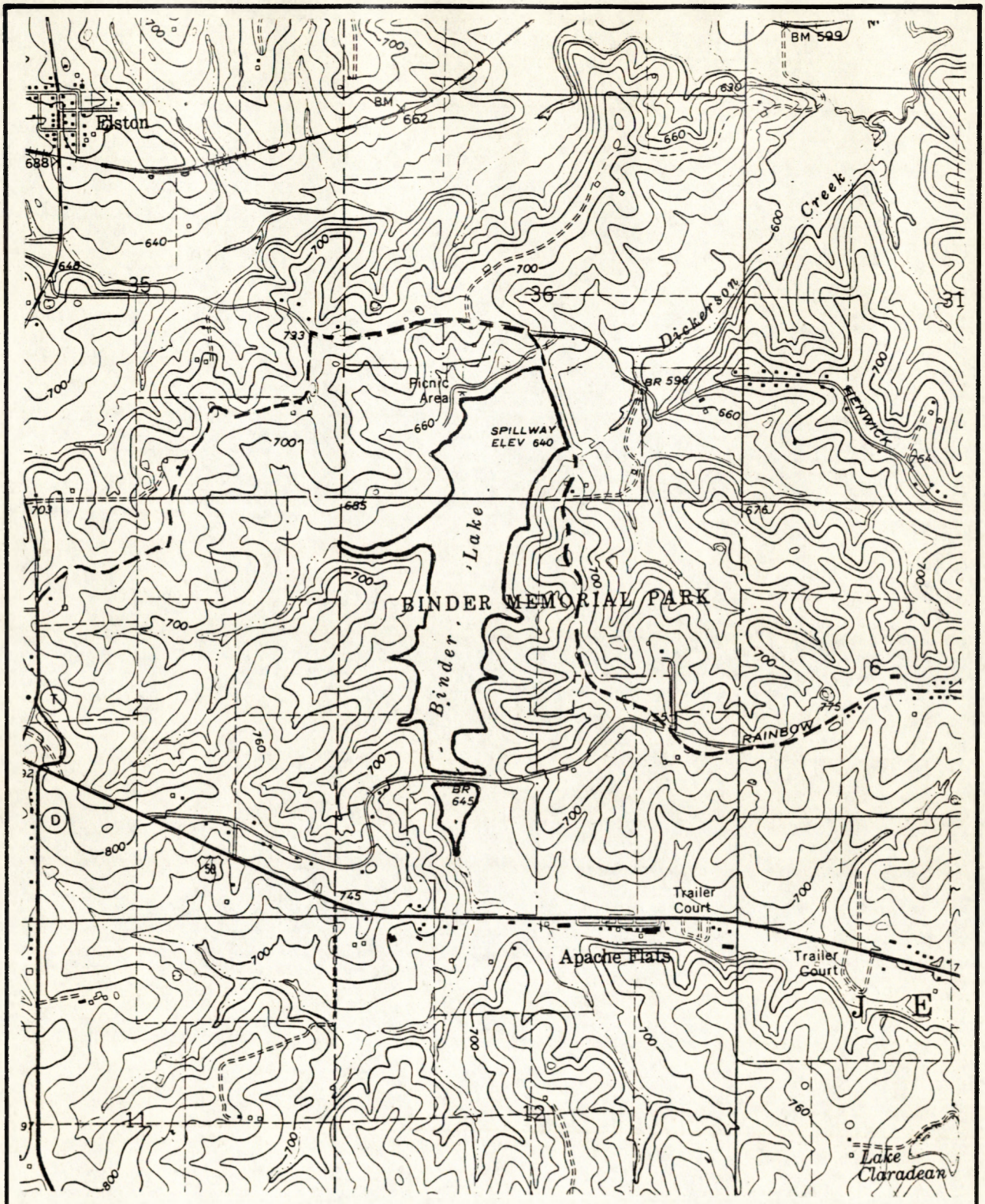
b. O & M Maintenance and Procedures.

(1) The present maintenance program is generally adequate.

(2) Erosion and deterioration of the bedrock foundation under the principal spillway weir should be repaired and controlled.

(3) The condition of the upstream riprap should be evaluated regularly and rehabilitation measures provided, as needed.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval - 20'

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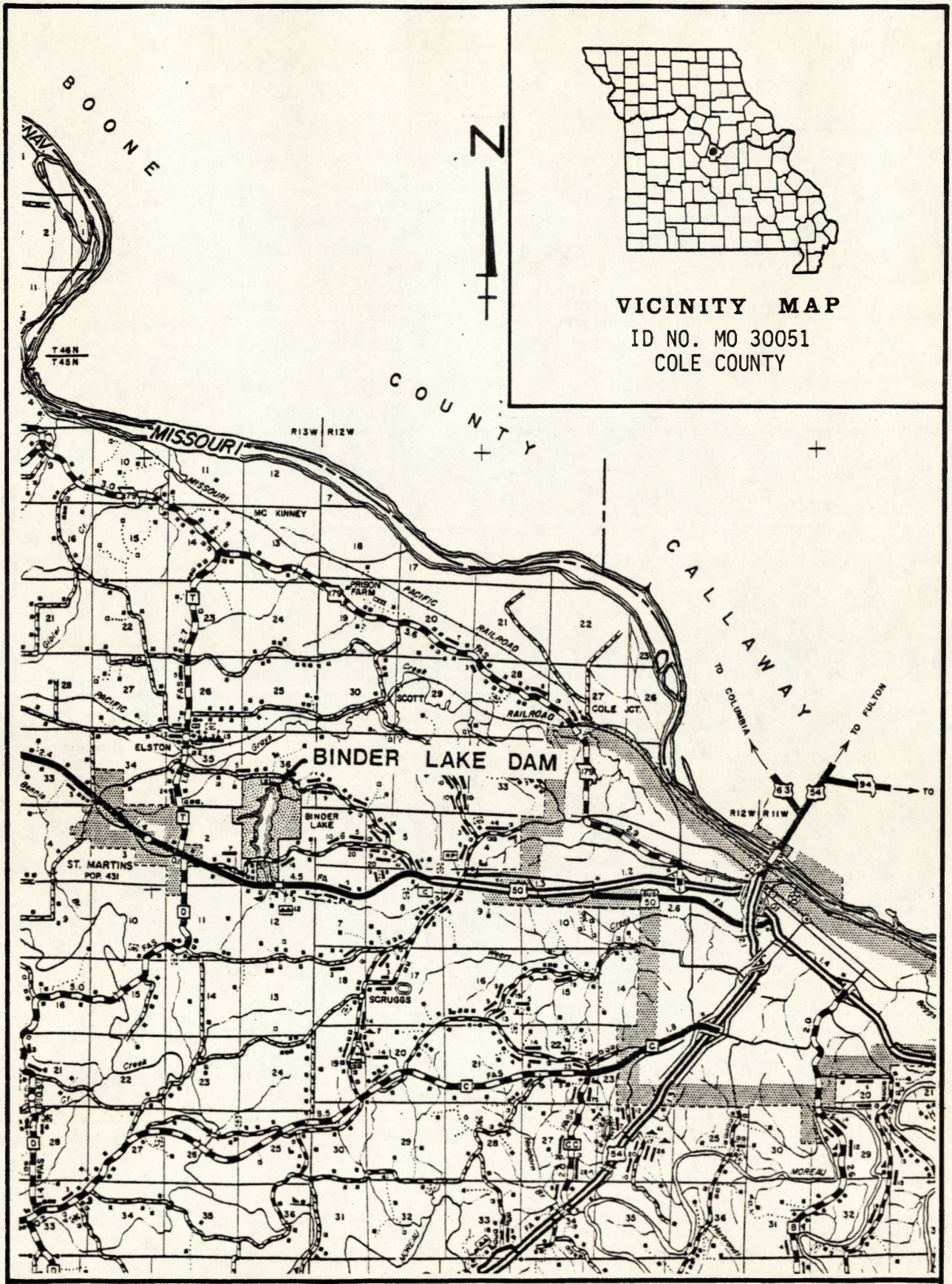
VICINITY TOPOGRAPHY

BINDER LAKE DAM

COLE COUNTY, MISSOURI

MO. 30051

PLATE A-1


BOONE
COUNTY
CALLAWAY
N
VICINITY MAP
ID NO. MO 30051
COLE COUNTY
MISSOURI
BINDER LAKE DAM
BINDER LAKE
ST. MARTINS
POP. 431
ELSTON
MC KINNEY
SCOTT
COLE JCT.
SCRUGGS
MOREAU
PRISON FARM
PACIFIC RAILROAD
TO COLUMBIA
TO FULTON
TO
T46N
T45N
R13W
R12W
R11W
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS

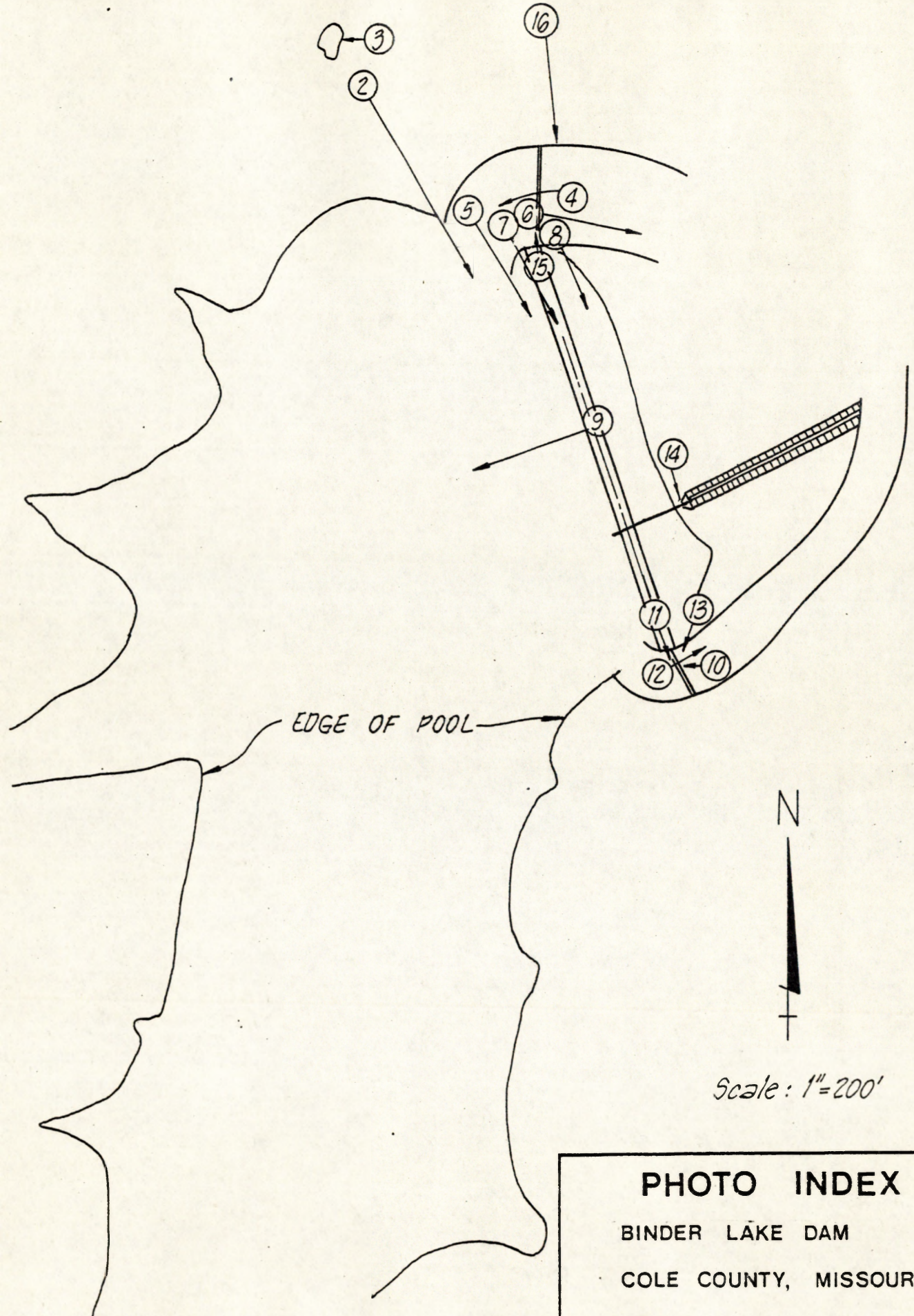


PHOTO INDEX

BINDER LAKE DAM

COLE COUNTY, MISSOURI

MO. 30051 PLATE B-1

PHOTO NO. 2 - OVERVIEW TAKEN FROM UPSTREAM LEFT ABUTMENT

PHOTO NO. 3 - MEMORIAL PLAQUE AT BINDER LAKE

PHOTO NO. 4 - LOOKING UPSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 5 - UPSTREAM FACE TAKEN FROM LEFT IN EMERGENCY SPILLWAY

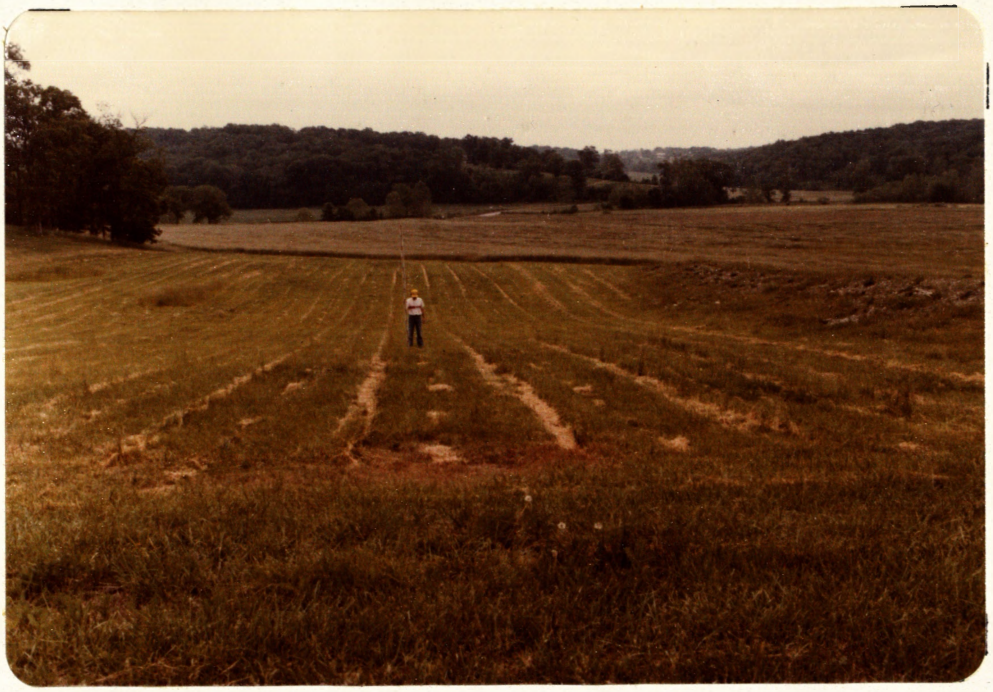


PHOTO NO. 6 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 7 - CREST TAKEN FROM LEFT END

PHOTO NO. 8 - DOWNSTREAM SLOPE FROM LEFT END

PHOTO NO. 9 - UPSTREAM ACROSS LAKE FROM CENTER OF DAM

PHOTO NO. 10 - UPSTREAM FROM RIGHT END SHOWING CONCRETE SILL IN PRINCIPAL SPILLWAY

PHOTO NO. 11 - PRINCIPAL SPILLWAY CONCRETE SILL TAKEN FROM TOP OF DAM

PHOTO NO. 12 - TAKEN FROM CONCRETE SILL LOOKING DOWNSTREAM IN PRINCIPAL SPILLWAY

PHOTO NO. 13 - PRINCIPAL SPILLWAY CONCRETE SILL. PHOTO TAKEN FROM DOWNSTREAM

PHOTO NO. 14 - OUTLET END OF 18" CAST IRON DRAWDOWN PIPE

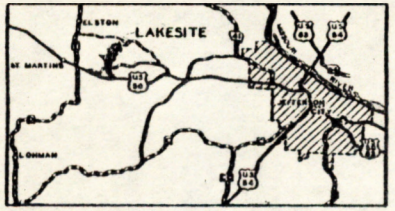
PHOTO NO. 15 -

GABION SILL IN
EMERGENCY SPILLWAY

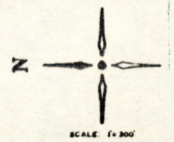
PHOTO NO. 16 - CREST AND DOWNSTREAM SLOPE FROM LEFT ABUTMENT

APPENDIX C
CONSTRUCTION PLANS
GEOLOGIC REPORT

PLATE C-1



VICINITY MAP



INDEX

SURVEY	L.H.& J.F.
DRAWN	R.L.H.
CHECKED	C.E.H.

MISSOURI
DEPARTMENT OF CONSERVATION

BINDER LAKE

GENERAL PLAN

APPROVED

CHIEF OF FISHERIES DIV.

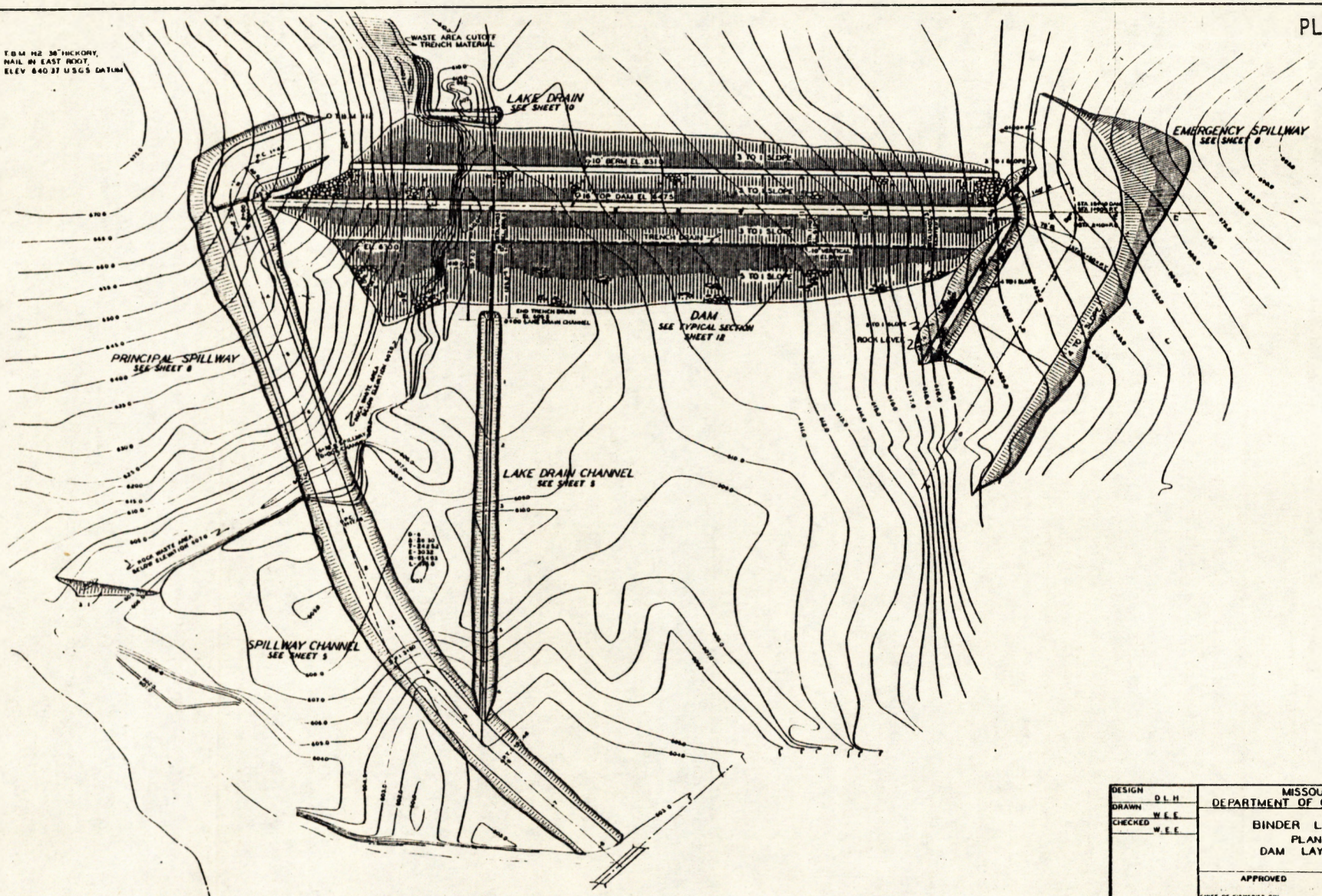
DIRECTOR MO. CONSERVATION DEPT.

SHEET 1 OF 23

DATE APRIL 1968

JOB NO. 84-18

PLATE C-2



DESIGN	D.L.H.
DRAWN	W.E.E.
CHECKED	W.E.E.

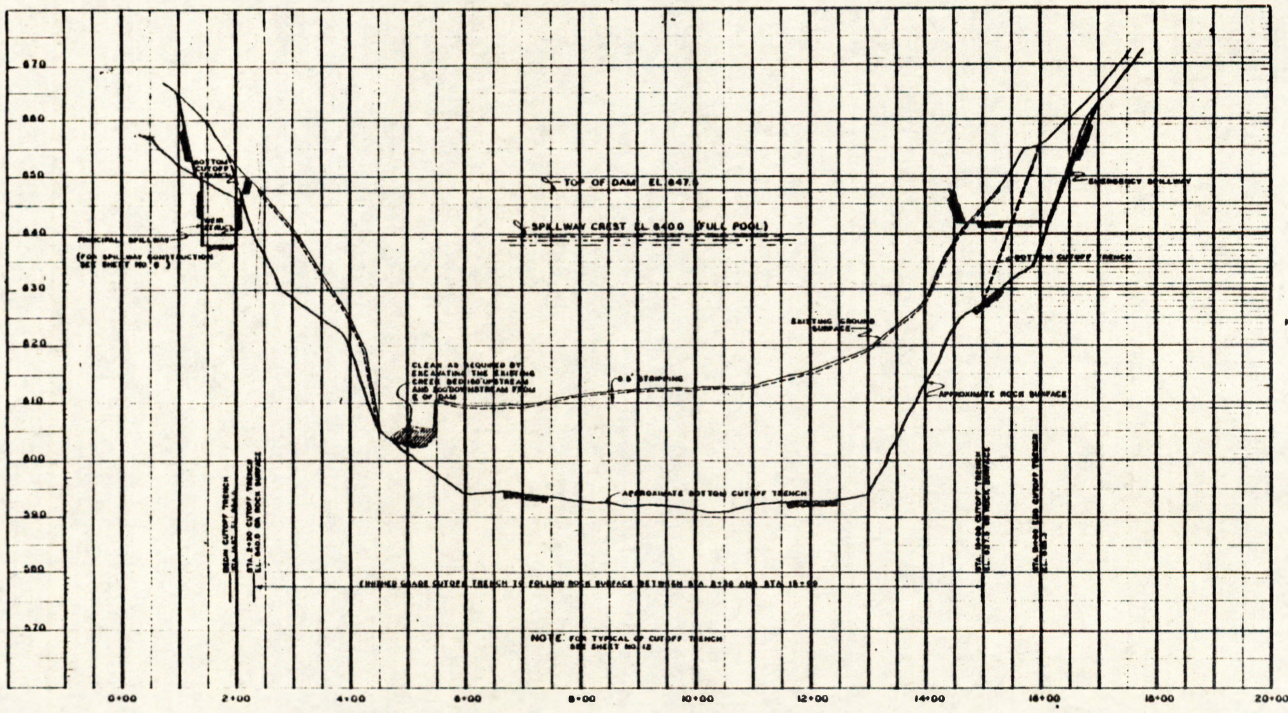
MISSOURI
DEPARTMENT OF CONSERVATION

BINDER LAKE
PLAN
DAM LAYOUT

APPROVED
CHIEF OF FISHERIES DIV.
DIRECTOR MO. DEPT. OF CONSERVATION

SHEET 2 OF 23
DATE APRIL 1966
JOB NO. 64-19

PLATE C-3

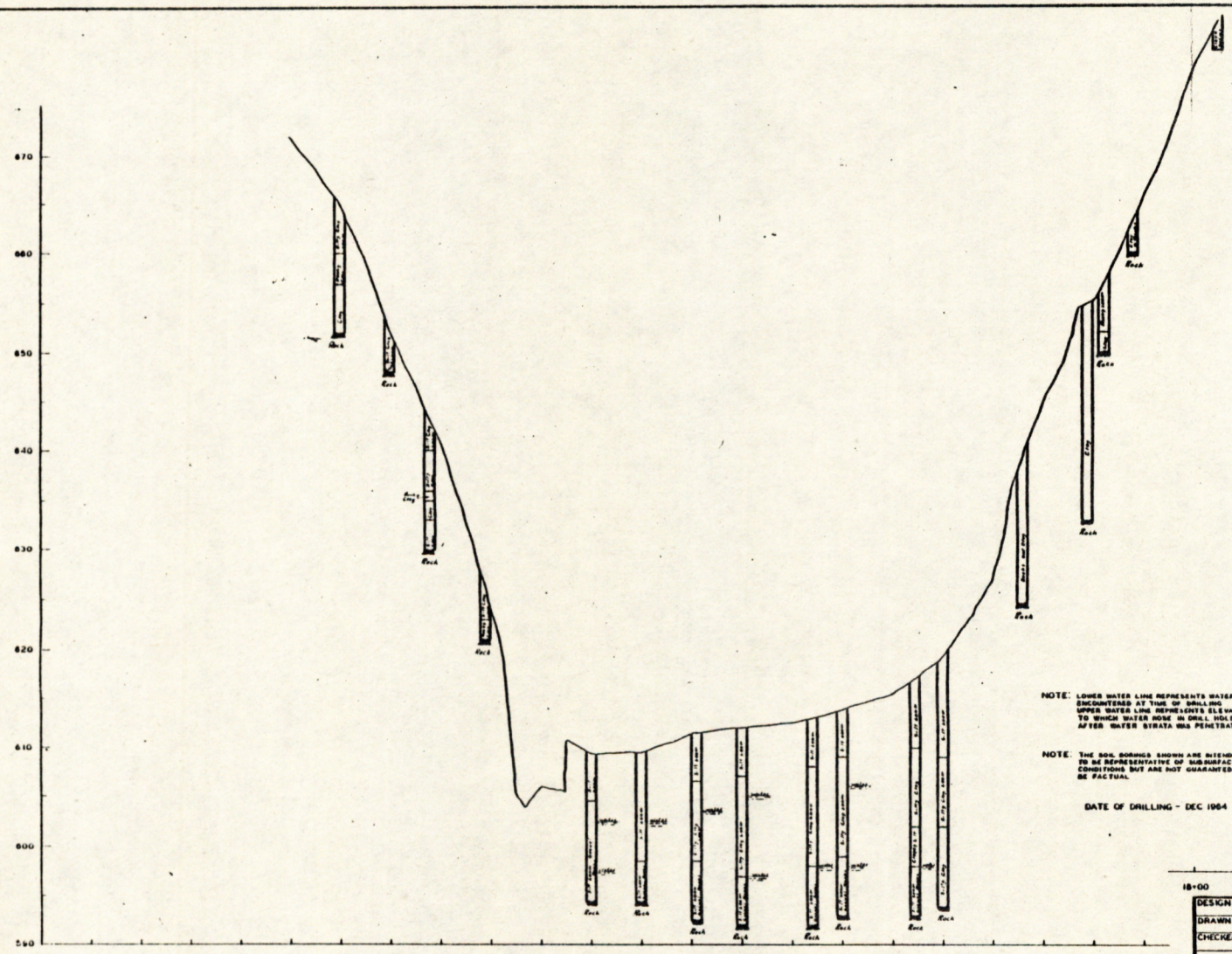


NOTES: ACCESS TO CUTOFF TRENCH, OTHER THAN THAT PROVIDED BY THE CUTOFF TRENCHES GRADE AS SHOWN ON THE PROFILE AND X-SECTIONS, TO BE PROVIDED AT CONTRACTORS EXPENSE.

PROFILE ℄ DAM

DESIGN	D.L.H.	MISSOURI DEPARTMENT OF CONSERVATION
DRAWN	B.L.H.	BINDER LAKE
CHECKED	D.L.H.	PROFILE DAM & CUTOFF TRENCH
APPROVED	CHIEF OF FISHERIES DIV.	SHEET 3 OF 23
	DIRECTOR MO CONSERVATION DEPT.	DATE APRIL 1968
		JOB NO. 64-18

PLATE C-4



NOTE: LOWER WATER LINE REPRESENTS WATER ENCOUNTERED AT TIME OF DRILLING
UPPER WATER LINE REPRESENTS ELEVATION TO WHICH WATER ROSE IN DRILL HOLE AFTER WATER STRATA WAS PENETRATED

NOTE: THE SOIL BORINGS SHOWN ARE INTENDED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS BUT ARE NOT GUARANTEED TO BE FACTUAL

DATE OF DRILLING - DEC 1964

DESIGN	D L H
DRAWN	A L H
CHECKED	D L H

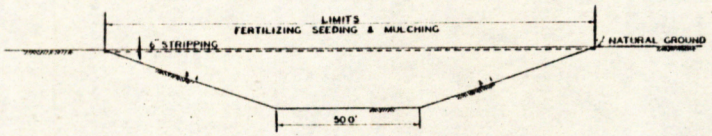
MISSOURI
DEPARTMENT OF CONSERVATION

BINDER LAKE
PROFILE
SOIL BORINGS

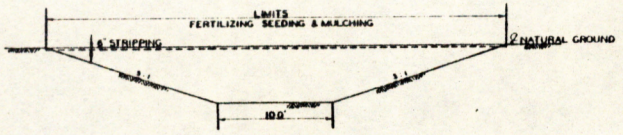
APPROVED
CHIEF OF FISHERIES DIV
DIRECTOR MO DEPT OF CONSERVATION

SHEET 4 OF 23
DATE APRIL 1966
JOB NO 64-19

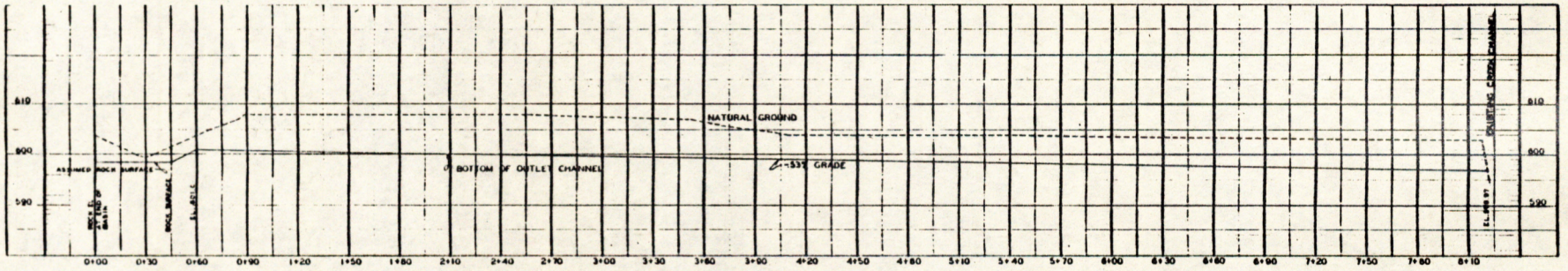
PLATE C-5



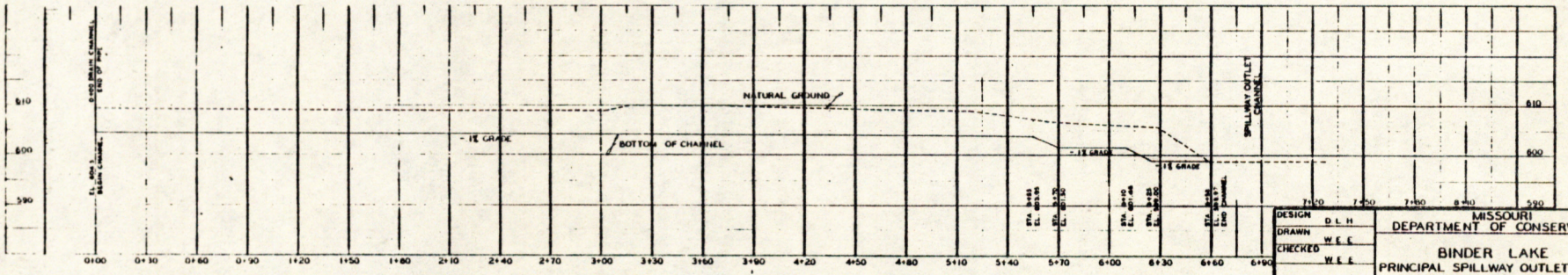
TYPICAL SECTION OF
PRINCIPAL SPILLWAY OUTLET CHANNEL



TYPICAL SECTION OF
LAKE DRAIN CHANNEL



PRINCIPAL SPILLWAY OUTLET CHANNEL



LAKE DRAIN CHANNEL

SCALE:
HOR. 1" = 30'
VERT. 1" = 10'

DESIGN	D L H
DRAWN	W E E
CHECKED	W E E

MISSOURI
DEPARTMENT OF CONSERVATION

BINDER LAKE
PRINCIPAL SPILLWAY OUTLET CHANNEL
AND LAKE DRAIN CHANNEL
PROFILES & TYPICAL SECTIONS

APPROVED

CHIEF OF FISHERIES DIV.

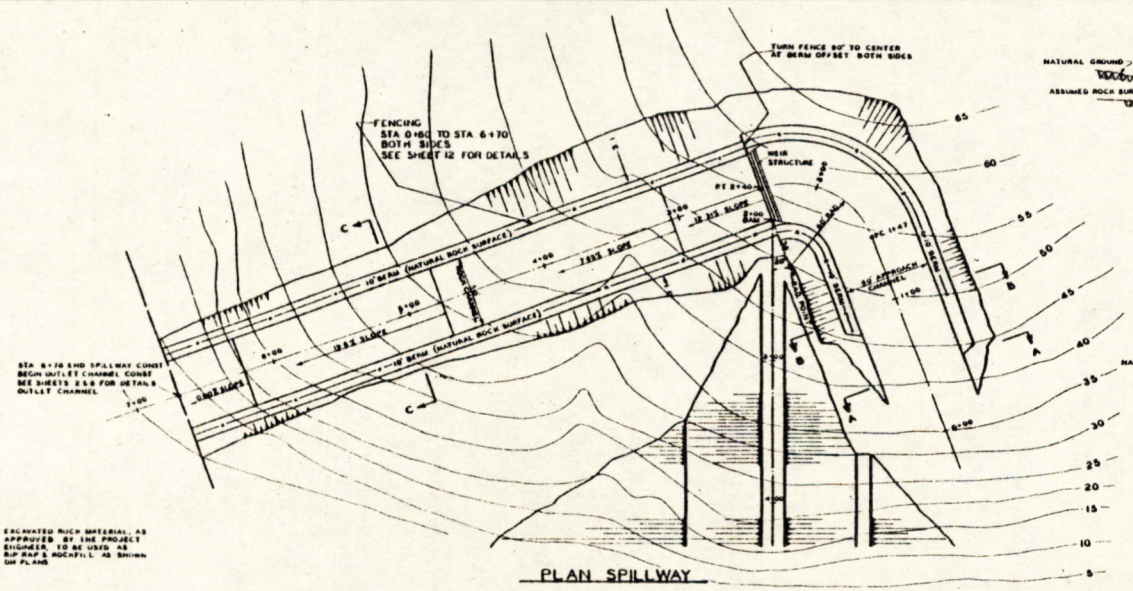
DIRECTOR MO DEPT OF CONSERVATION

SHEET 5 OF 23

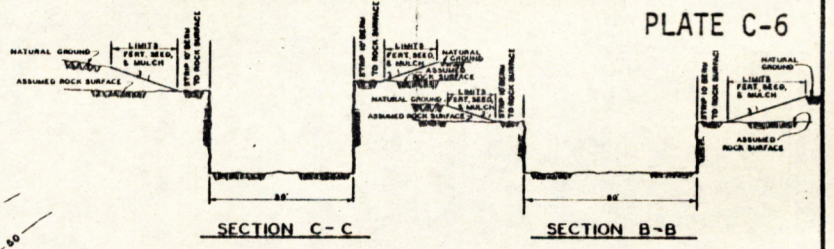
DATE APRIL 1969

JOB NO 64-19

PLATE C-6

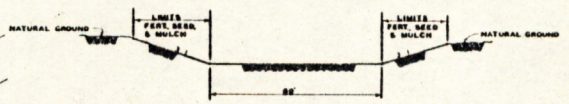


PLAN SPILLWAY

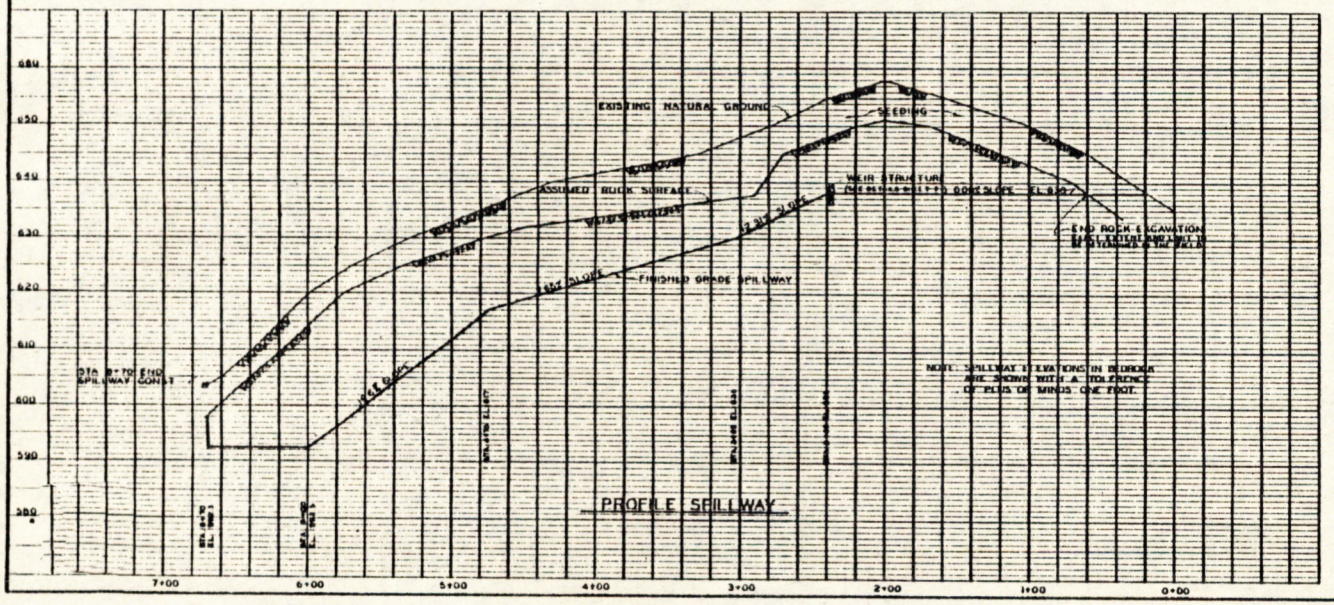


SECTION C-C

SECTION B-B



SECTION A-A



PROFILE SPILLWAY

DESIGN	D L H
DRAWN	A L H
CHECKED	D L H

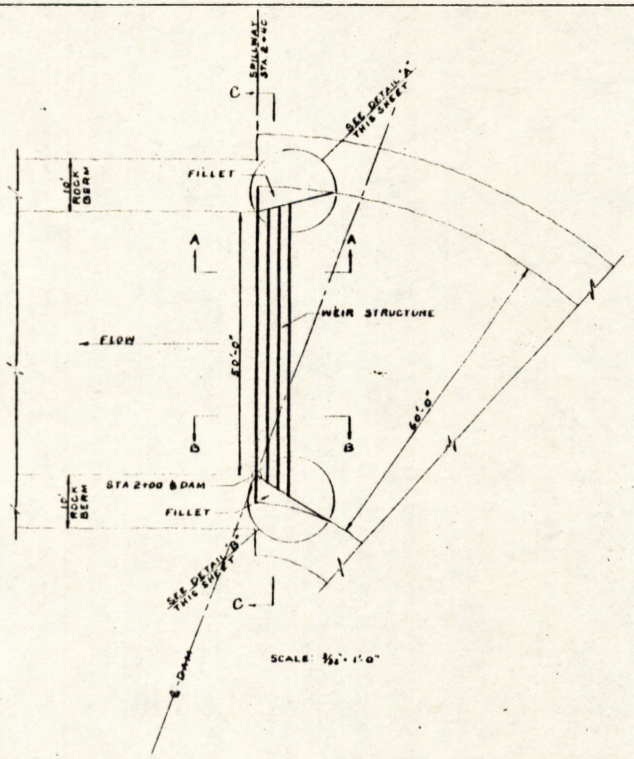
MISSOURI
DEPARTMENT OF CONSERVATION

BINDER LAKE
PRINCIPAL SPILLWAY
PLAN & PROFILE

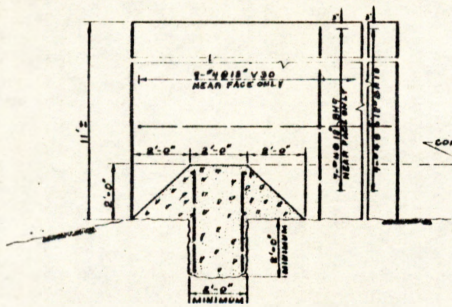
APPROVED
CHIEF OF FISHERIES DIV.
DIRECTOR MO DEPT OF CONSERVATION

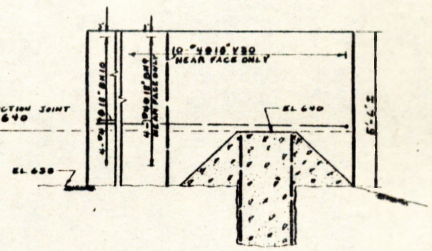
SHEET 8 OF 23
DATE APRIL 1966
JOB NO 64-19

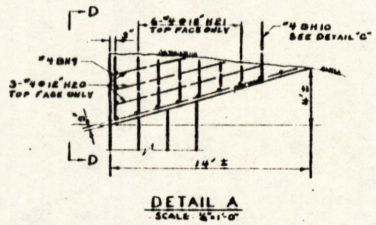
PLATE C-7

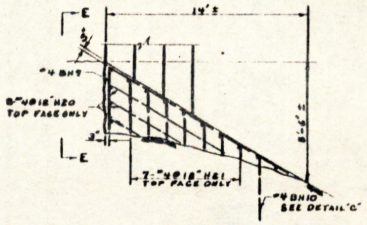


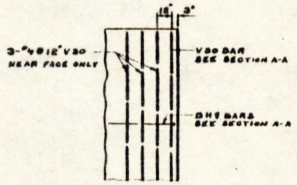
SCALE: 1/32"=1'-0"

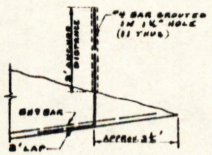


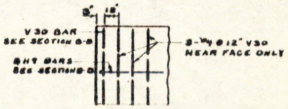


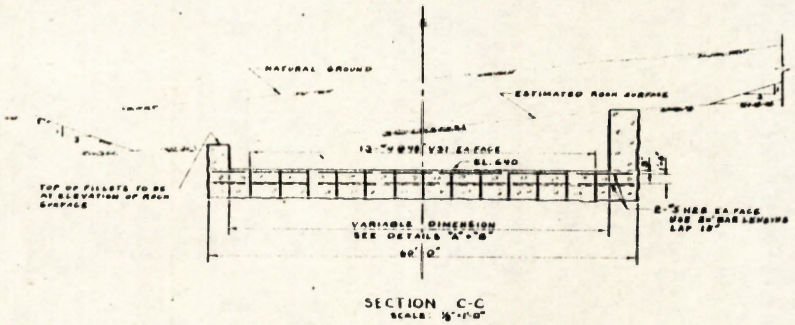












REINFORCING			
MARK	SIZE	NUMBER	LENGTH
WEIR			
DHS	#6	18	20'-0"
V31	#4	86	2'-2"

FILLETS

ALL FILLET BARS TO BE #6 EXACT LENGTHS AND BENDING TO BE DETERMINED IN THE FIELD BY THE PROJECT ENGINEER

APPROX. TOTAL LENGTH OF FILLET BARS = 690'

DESIGN	D.L.H.
DRAWN	D.L.H.
CHECKED	R.M.H.

MISSOURI DEPARTMENT OF CONSERVATION

BINDER LAKE

PRINCIPAL SPILLWAY CONTROL SECTIONS - DETAILS

APPROVED

CHIEF OF FISHERIES DIV.

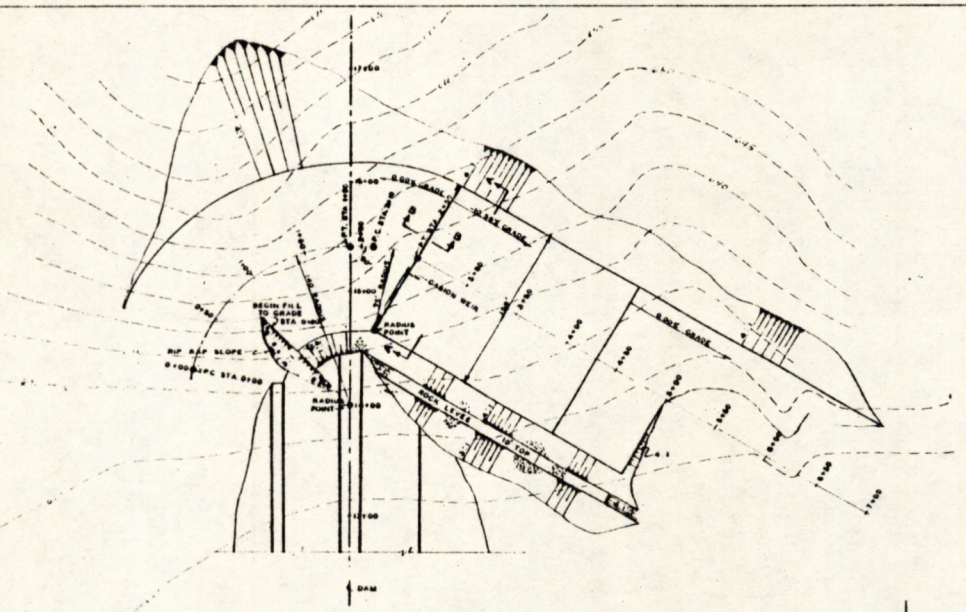
DIRECTOR MO DEPT OF CONSERVATION

SHEET 7 OF 23

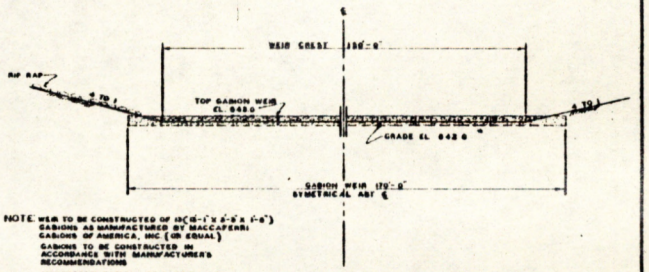
DATE APRIL 1966

JOB NO 64-19

PLATE C-8

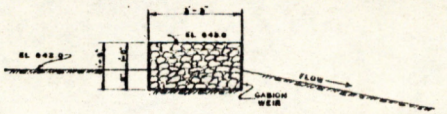


PLAN EMERGENCY SPILLWAY

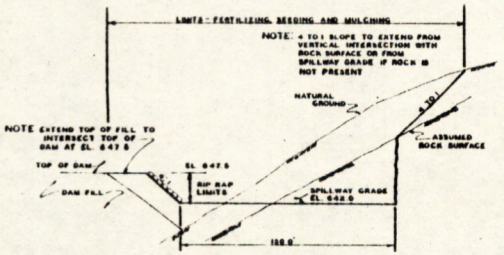


NOTE: WEIR TO BE CONSTRUCTED OF 18(6'-0" X 3'-0" X 1'-0") GABIONS AS MANUFACTURED BY MACCAFERRI GABIONS OF AMERICA, INC. (OR EQUAL)
GABIONS TO BE CONSTRUCTED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS
MACCAFERRI GABIONS OF AMERICA INC.
50 EAST 42 STREET
NEW YORK 17, N.Y.

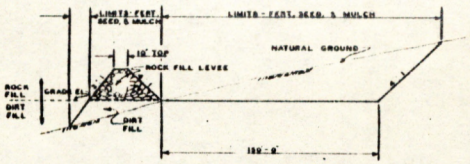
PARTIAL SECTION A-A
SPILLWAY CREST



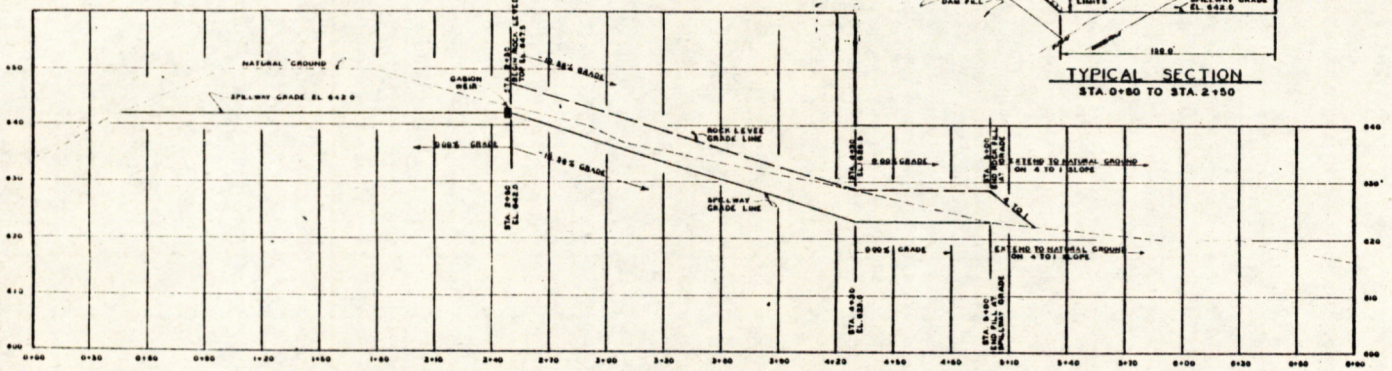
SECTION B-B



TYPICAL SECTION
STA. 0+80 TO STA. 2+50



TYPICAL SECTION
STA. 2+50 TO STA. 5+00



℄ PROFILE EMERGENCY SPILLWAY

DESIGN D.L.H.	MISSOURI DEPARTMENT OF CONSERVATION
DRAWN D.L.H.	BINDER LAKE
CHECKED C.E.H.	DETAILS - EMERGENCY SPILLWAY
APPROVED CHIEF OF FISHERIES DIV. DIRECTOR MO CONSERVATION DEPT.	SHEET 8 OF 24 DATE APRIL 1966 JOB NO 64-19

BINDER LAKE
EMERGENCY SPILLWAY
X - SECTIONS

PLATE C-9

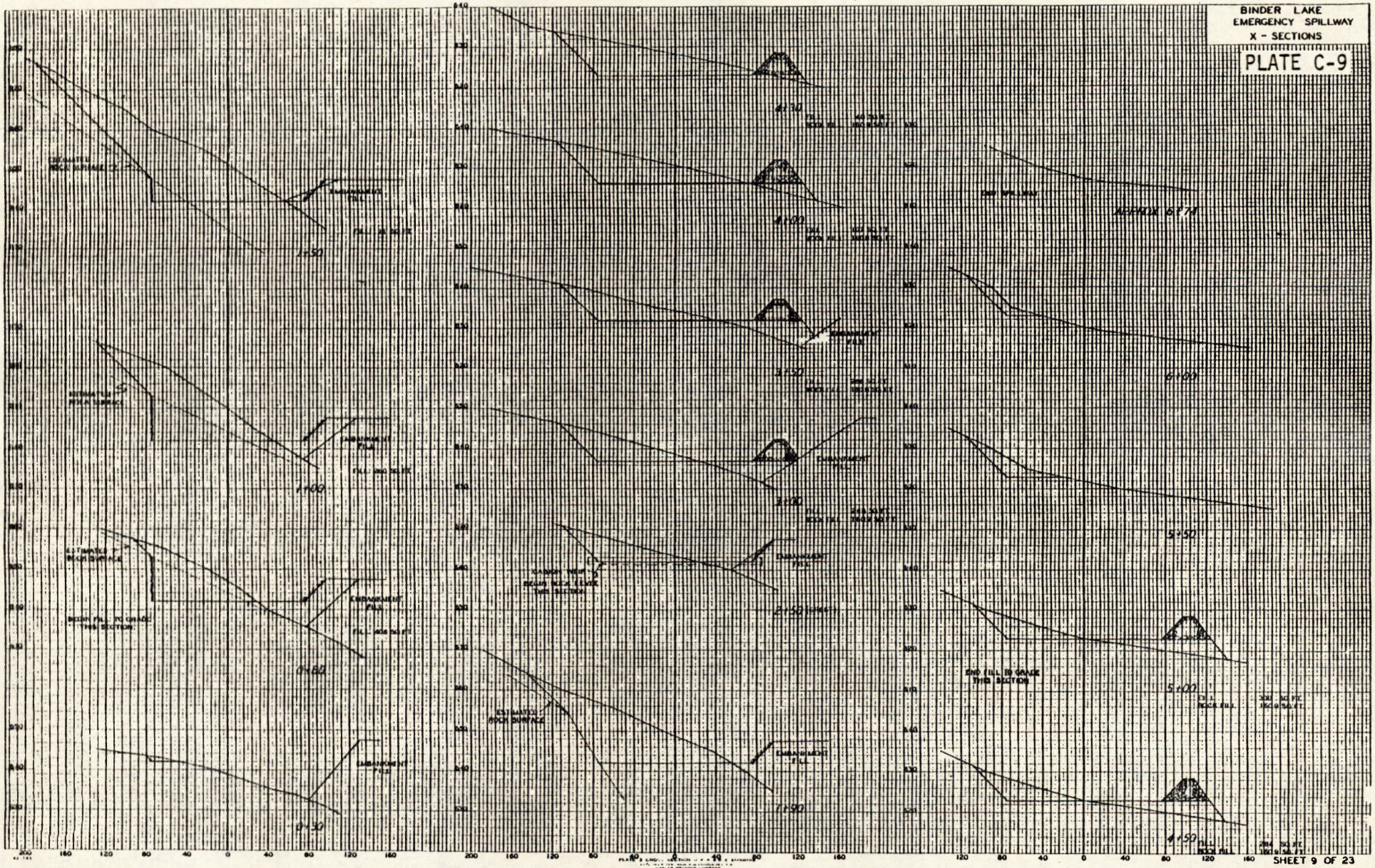
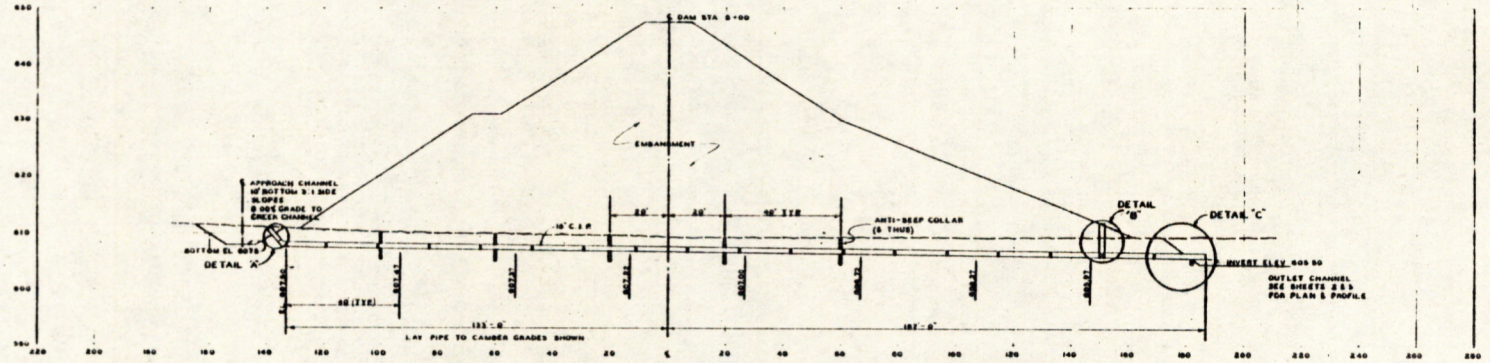
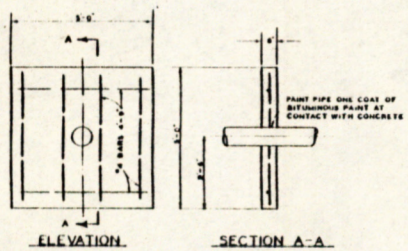
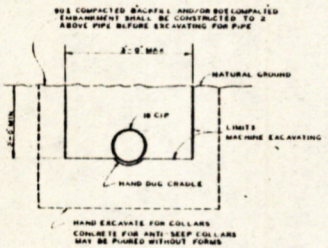


PLATE C-10

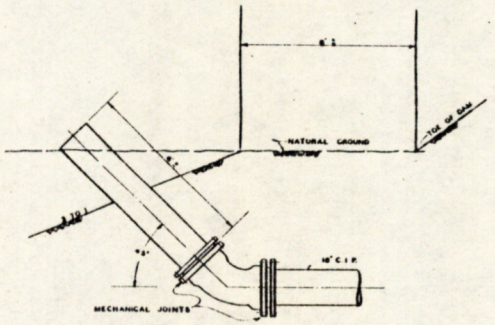




ANTI-SEEP COLLAR
5 THUS

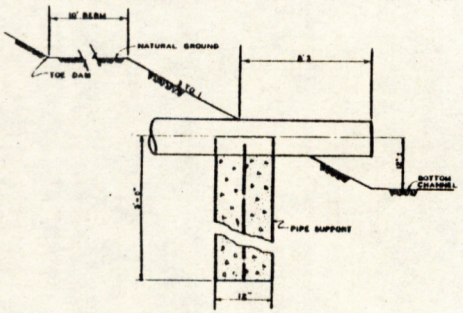


TYPICAL SECTION DRAIN

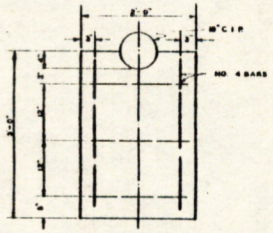


ALL PIPE AND FITTINGS SHALL BE CAST IRON, WITH MECHANICAL JOINTS MEETING A.S.A. SPECIFICATION A 21.8 - 1962 AND A 21.11 - 1953, CLASS 150

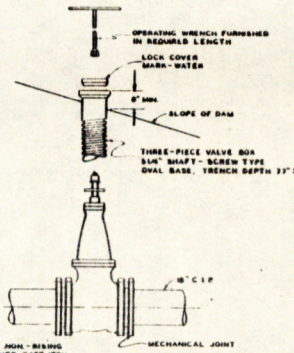
DETAIL 'A'



DETAIL 'C'



DETAIL PIPE SUPPORT

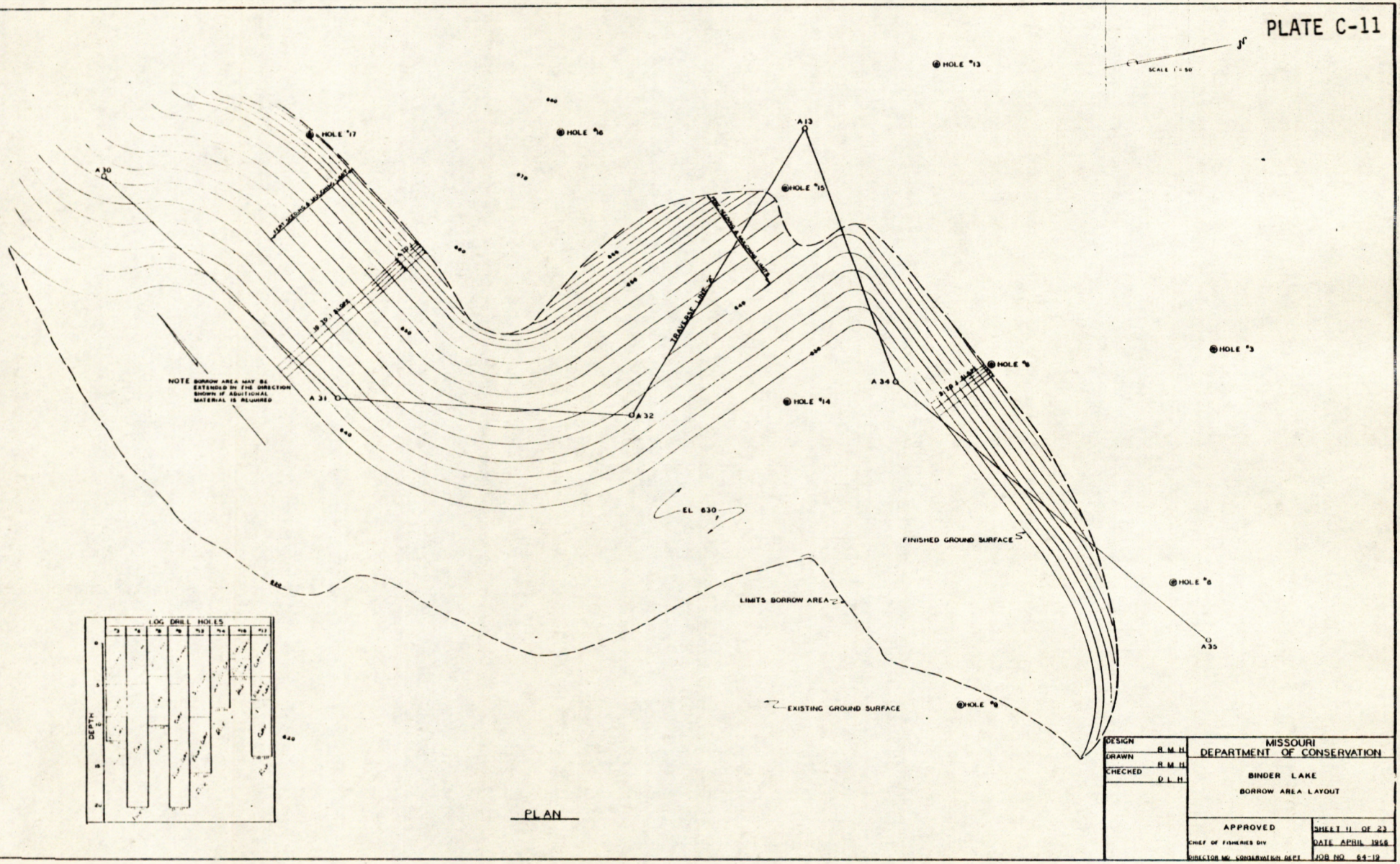


8" GATE VALVE WITH NON-RISING STEM, BRONZE TRIMMED, CAST IRON BODY, DOUBLE DISC, 'O' RING SEAL, 2" SQ. OPERATING NUT, MECHANICAL JOINT ENDS, CLASS 150 M & H VALVE 67 M (OR EQUAL)

DETAIL 'B'

DESIGN	D.L.H.	MISSOURI DEPARTMENT OF CONSERVATION
DRAWN	R.L.H.	BINDER LAKE
CHECKED	D.L.H.	LAKE DRAIN PROFILE & DETAILS
APPROVED		SHEET 10 OF 23
CHIEF OF FISHERIES DIV		DATE APRIL 1966
DIRECTOR MO. CONSERVATION DEPT.		JOB NO. 64-19

PLATE C-11



DESIGN	R M H
DRAWN	R M H
CHECKED	D L H

MISSOURI
DEPARTMENT OF CONSERVATION

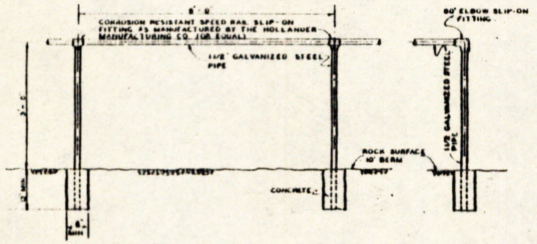
BINDER LAKE

BORROW AREA LAYOUT

APPROVED
CHIEF OF FISHERIES DIV
DIRECTOR MO. CONSERVATION DEPT.

SHEET 11 OF 23
DATE APRIL 1968
JOB NO 64-19

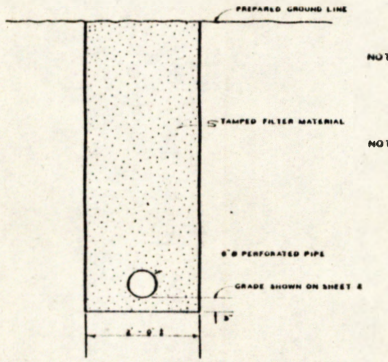
PLATE C-12



TYPICAL SECTION TYPICAL END SECTION

NOTE FENCE TO BE PLACED IN THE CENTER OF ROCK BERM

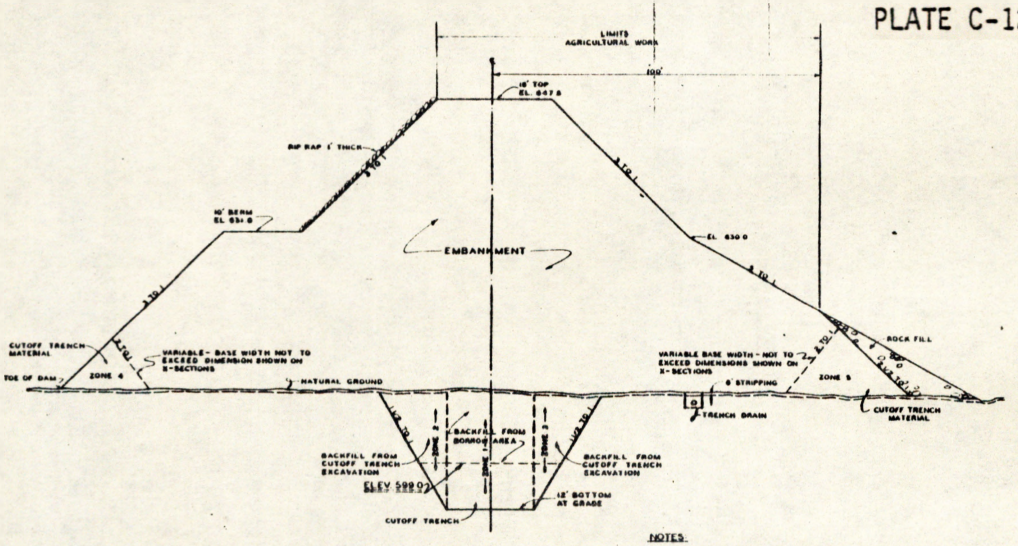
FENCING



NOTE FILTER MATERIAL SHALL BE NATURAL SAND IN ACCORDANCE WITH SPECIFICATION, DIVISION III, SECTION A, PARAGRAPH 2

NOTE PERFORATED PIPE SHALL BE ASBESTOS CEMENT OR BITUMINOUS COATED CORRUGATED METAL MEETING MO HWY DEPT SPECS NO 188 OR 402, 1961 EDITION METAL PIPE SHALL BE BITUMINOUS COATED AND CARE SHALL BE TAKEN TO INSURE THAT THE PERFORATIONS ARE NOT BLOCKED BY SAND COATING.

TYPICAL SECTION - TRENCH DRAIN



TYPICAL SECTION DAM

NOTES:
1 - EXCAVATED CUTOFF TRENCH MATERIAL BELOW EL 599.0 TO BE WASTED IN ACCORDANCE WITH SPECIFICATIONS.
2 - EXCAVATED CUTOFF TRENCH MATERIAL ABOVE EL 599.0 TO BE USED AS BACKFILL IN ZONES 2, 3, AND/OR 4 & 5, IN ACCORDANCE WITH SPECIFICATIONS, AND WITH APPROVAL OF THE PROJECT ENGINEER.
3 - ZONE 1 TO BE BACKFILLED IN ACCORDANCE WITH SPECIFICATIONS, WITH MATERIAL OBTAINED FROM THE BORROW AREA.

DESIGN D.L.H.	MISSOURI DEPARTMENT OF CONSERVATION
DRAWN B.L.H.	BINDER LAKE
CHECKED D.L.H.	TYPICAL SECTIONS
APPROVED CHIEF OF FISHERIES DIV.	SHEET 12 OF 23
DIRECTOR MO. CONSERVATION DEPT.	DATE APRIL 1966
	JOB NO. 64-19

Eng Geol
Reservoirs
Cole Co.

GEOLOGIC REPORT ON CONSERVATION COMMISSION LAKE SITE, COLE COUNTY, MISSOURI

Lake Site Two

Lake Site Two, with a dam located in the center of the S½ sec. 36, T. 45 N., R. 13 W., is in a valley lined with dolomite of the Jefferson City formation with a generally shallow soil cover. The valley floor is relatively flat and it is probable that the Jefferson City bedrock surface across the valley is also relatively uniform. The valley alluvium is a permeable silt loam 5 to 10 feet in thickness, underlain by 5 to 10 feet of very permeable gravelly loam. Depth of valley alluvium to bedrock is estimated to average 15 feet. Soil cover on the valley slopes will vary from nothing to perhaps 15 feet although 8 to 10 feet may be a closer average. No natural terraces were observed. Much of the lake area is under an improved farming operation with farm terraces on the valley slopes and intensified grain farming in the valley lowland.

The Jefferson City formation is a firm generally water tight bedrock in this area. The rock beds are relatively even but show gentle inclination in erratic directions. Thick rock beds, 2 to 3 feet in thickness, are interlayered with 5 to 10 foot thick zones of thin rock beds which may not be more than 1 or 2 inches per bed. The thicker more resistent rock beds normally project over the less resistent zones of thin rock beds. An isolated deposit of sandstone is present on the hillslope near the northern abutment in the SW¼ NW¼ SE¼ sec. 36, T. 45 N., R. 13 W. This sandstone probably Pennsylvanian in age, will be a very irregular and a non-persistent unit. Some evidence of Pennsylvanian residual clays were noted in the stream channel.

There are two geologic factors that may increase the overall cost. The relatively thin cover of soil indicates that borrow may be either inadequate or will have to be extended over a wide area. Secondly, the bedrock abutments should have key trenches excavated a few feet in depth so that an earthen core can intercept near surface weathered openings in the bedrock. This may require some blasting to obtain a uniform slope where thick dolomite ledges project over the zones of thin beds. Also a key trench should cut into firm bedrock across the valley floor.

The permeable alluvium will not retain impounded lake water. Therefore, a highly saturated soil environment will be created under the earthen fill at the core of the dam. This permeable alluvium may become so saturated

that the resultant pore pressures under the front of the dam may be a hazard to the stability of the earthen foundation of the dam. Therefore depending on many factore such as water depth it may be worthy to consider that the core trench should have a greater than normal width or that the slopes of the dam should be modified.

Overall Site Two is suitable geologically. The major problem is the lack of borrow with two hazards, bedrock core trenching and permeable alluvium,as features which detract from the site.

James H. Williams
Engineering Geologist
Missouri Geological Survey
December 4, 1964

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs.

   a. The 24-hour, 100-year rainfall for the dam location was taken from the data for the rainfall station at Jefferson City, Mo., as supplied by the St. Louis District, Corps of Engineers, per their letter dated 6 March 1979. The 24-hour probable maximum precipitation was taken from the curves of Hydrometerological Report No. 33 and current Corps of Engineers and St. Louis District policy and guidance for hydraulics and hydrology.

   b. Drainage area = 6.03 square miles (3860 acres).

   c. Time of concentration of runoff = 1.885 hours (computed from "Kirpich" formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperature for the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the principal spillway crest (Elev. 640.0).

   e. The total losses for the 100-year storm were 3.46 inches. The total losses for the 48-hour PMF storm were 2.03 inches. These losses are based on SCS Runoff Curve Nos. 85 and 70 for antecedent moisture conditions, SCS AMC III and AMC II respectively. The soils in the watershed are composed of approximately 40% SCS Soil Group B, 30% Soil Group C, and 30% Soil Group D. Land use in the watershed is approximately 50% woods and 50% pasture.

   f. Average soil loss rate = 0.04 inch per hour for the PMF.

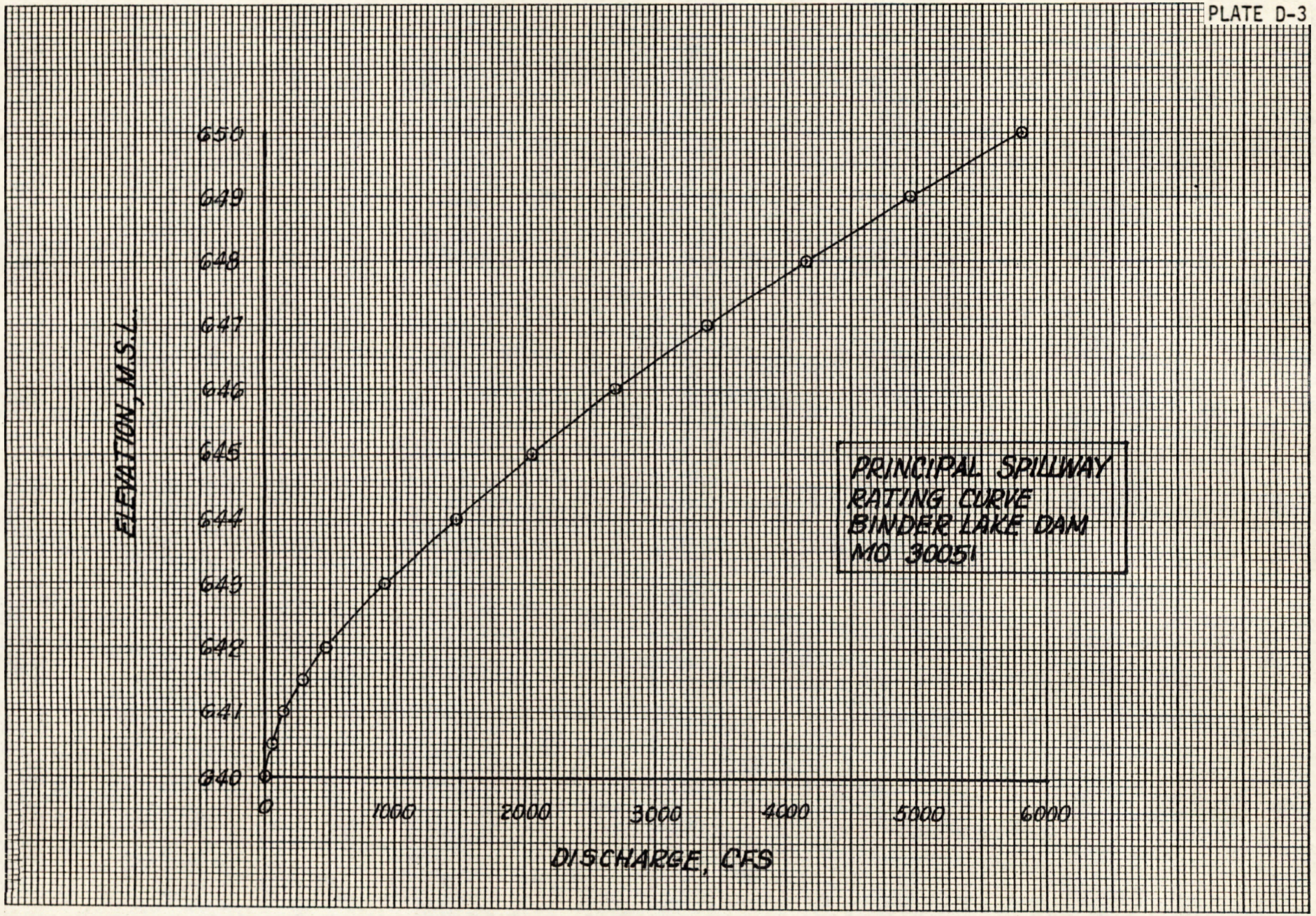
2. The discharge rating for the emergency spillway was developed using the Corps of Engineers Water Surface Profiles HEC-2 computer program.

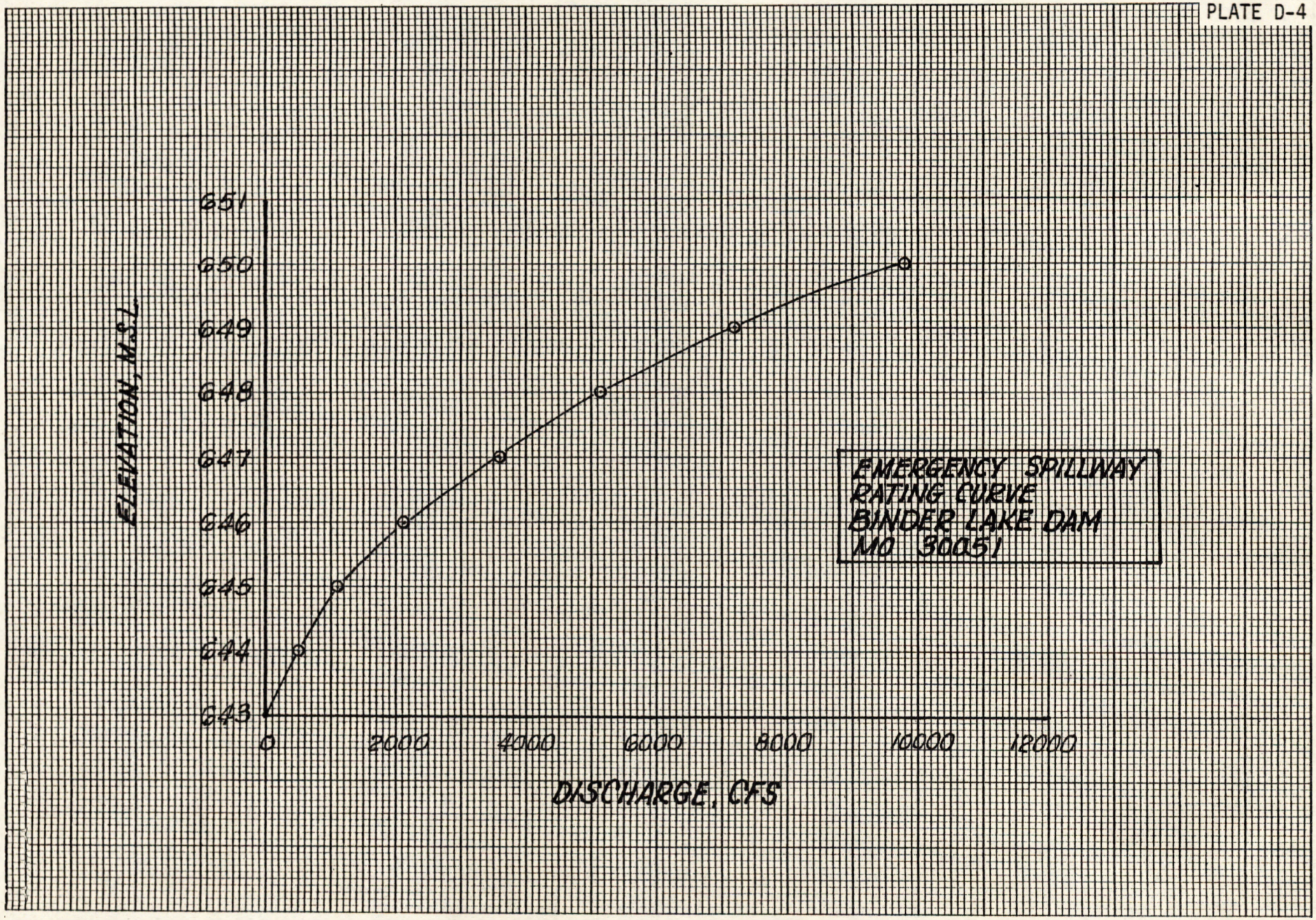
The Discharge rating for the concrete weir principal spillway was based on the broad-crested weir equation, Q = CLH 3/2, where C is a discharge coefficient, L is the width of the weir crest, and H is the total head above the weir crest. The discharge coefficient "C", which varies with head, was taken from the USGS publication "Measurement of Peak Discharge at Dams by Indirect Methods". The values for "C" ranged from 2.9 to 3.7.

The discharge rating for flow over the dam crest was developed using the HEC-1 (Dam Safety Version) program. The discharge coefficient used for the weir equation was 3.0.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program. The input, output, and plotted hydrographs are included with this report.

PLATE D-3


650
649
648
647
646
645
644
643
642
641
640
ELEVATION, M.S.L.
0
1000
2000
3000
4000
5000
6000
DISCHARGE, CFS
PRINCIPAL SPILLWAY
RATING CURVE
BINDER LAKE DAM
MO 30051


651
650
649
648
647
646
645
644
643
ELEVATION, M.S.L.
0
2000
4000
6000
8000
10000
12000
DISCHARGE, CFS
EMERGENCY SPILLWAY
RATING CURVE
BINDER LAKE DAM
MO 30051

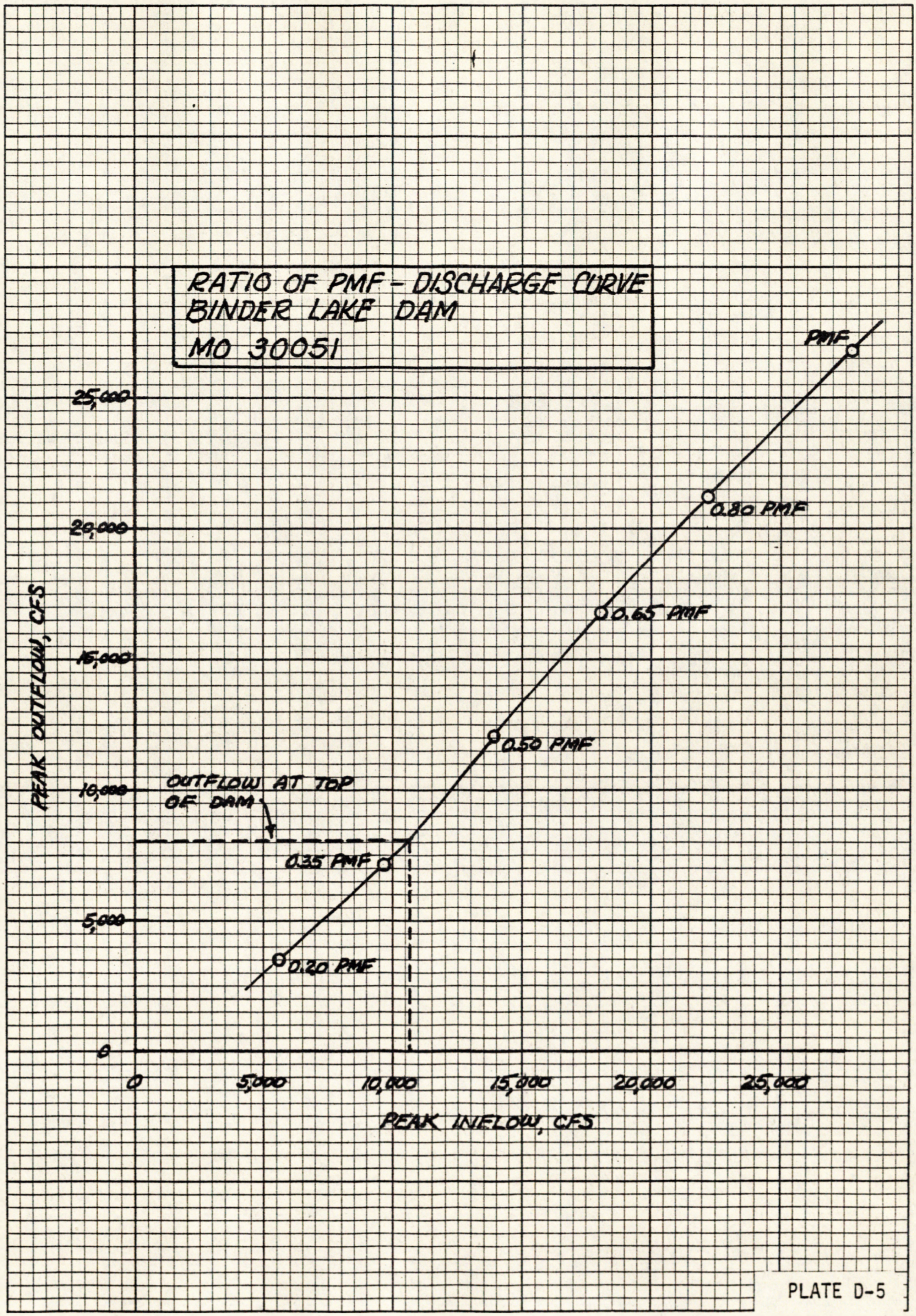

RATIO OF PMF - DISCHARGE CURVE
BINDER LAKE DAM
MO 30051
PEAK OUTFLOW, CFS
25,000
20,000
15,000
10,000
5,000
0
PMF
0.80 PMF
0.65 PMF
0.50 PMF
0.35 PMF
0.20 PMF
OUTFLOW AT TOP OF DAM
0
5,000
10,000
15,000
20,000
25,000
PEAK INFLOW, CFS

PLATE D-5

PLATE D-6

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF-
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF BINDER LAKE DAM 30051
A3       RATIOS OF PMF ROUTED - 0.20 0.35 0.50 0.65 0.80 AND 1.00
B 0001920000000000000015                          000000000000000000000003
B1000005
J       1        6        1
J1    .20      .35      .50      .65      .80      1.0
K       0        1                  2        0        1
K1       CALCULATION OF INFLOW HYDROGRAPH TO BINDER LAKE
M 000001000000020006.033         000000000000001.0                    00000001
P 000000000025.10000102.0000121.0000130.0000140.
T                                                  -1.      -85.
W2       00001.13
X        -.01    0000001.
K 00000100000002                  000000020000000000000001
K1       RESERVOIR ROUTING OF HYDROGRAPHS THRU BINDER LAKE DAM
Y                        0000000100000001
Y1      1                                          -640.          -1
Y400640.000640.50000641.000641.50000642.0000643.0000644.0000645.0000646.0000647.
Y400648.0000649.0000650.0000651.0000652.
Y500000.0000051.0000148.0000288.0000462.0000920.0001968.0003152.0004817.0006998.
Y509302.0012155.0015603.0019195.0022828.
$A00000.0000150.0000190.0000298.
$E00605.0000640.0000644.0000660.
$$00640.
$D0647.5000003.0000001.50001200.
K 000099
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/06/28.
     TIME= 19.34.13.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF BINDER LAKE DAM 30051
RATIOS OF PMF ROUTED - 0.20 0.35 0.50 0.65 0.80 AND 1.00

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
192	0	15	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1
RTIOS= .20 .35 .50 .65 .80 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO BINDER LAKE

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	6.03	0.00	6.03	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.10	102.00	121.00	130.00	140.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-85.00	0.00	0.00

CURVE NO = -85.00 WETNESS = -1.00 EFFECT CN = 85.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.13

RECESSION DATA
STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 25 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.13 VOL= 1.00

231.	716.	1523.	2153.	2323.	2168.	1823.	1319.	918.	660.
488.	348.	253.	183.	131.	95.	69.	50.	36.	26.
20.	15.	10.	5.	0.					

DVN

PLATE D-8

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5549.	3091.	1025.	531.	102015.
CMS	157.	88.	29.	15.	2889.
INCHES		4.77	6.32	6.55	6.55
MM		121.05	160.55	166.47	166.47
AC-FT		1533.	2033.	2108.	2108.
THOUS CU M		1891.	2507.	2600.	2600.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9710.	5409.	1793.	930.	178526.
CMS	275.	153.	51.	26.	5055.
INCHES		8.34	11.06	11.47	11.47
MM		211.85	280.97	291.33	291.33
AC-FT		2682.	3557.	3689.	3689.
THOUS CU M		3308.	4388.	4550.	4550.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	13872.	7727.	2562.	1328.	255038.
CMS	393.	219.	73.	38.	7222.
INCHES		11.91	15.80	16.39	16.39
MM		302.64	401.38	416.18	416.18
AC-FT		3832.	5082.	5269.	5269.
THOUS CU M		4726.	6268.	6500.	6500.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18033.	10046.	3331.	1727.	331549.
CMS	511.	284.	94.	49.	9388.
INCHES		15.49	20.54	21.30	21.30
MM		393.43	521.79	541.04	541.04
AC-FT		4981.	6607.	6850.	6850.
THOUS CU M		6144.	8149.	8450.	8450.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	22195.	12364.	4099.	2125.	408060.
CMS	628.	350.	116.	60.	11555.
INCHES		19.06	25.28	26.22	26.22
MM		484.22	642.21	665.89	665.89
AC-FT		6131.	8131.	8431.	8431.
THOUS CU M		7562.	10030.	10399.	10399.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	27744.	15455.	5124.	2657.	510075.
CMS	786.	438.	145.	75.	14444.
INCHES		23.83	31.60	32.77	32.77
MM		605.27	802.76	832.37	832.37
AC-FT		7663.	10164.	10539.	10539.
THOUS CU M		9453.	12537.	12999.	12999.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING OF HYDROGRAPHS THRU BINDER LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-640.	-1

STAGE	640.00	640.50	641.00	641.50	642.00	643.00	644.00	645.00	646.00	647.00
	648.00	649.00	650.00	651.00	652.00					
FLOW	0.00	51.00	148.00	288.00	462.00	920.00	1968.00	3152.00	4817.00	6998.00
	9302.00.	12155.00	15603.00	19195.00	22828.00					
SURFACE AREA=	0.	150.	190.	298.						
CAPACITY=	0.	1750.	2428.	6300.						
ELEVATION=	605.	640.	644.	660.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
640.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
647.5	3.0	1.5	1200.

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	2.	2.	3.	4.
5.	6.	7.	9.	11.	14.	17.	21.	24.	27.
30.	32.	34.	35.	37.	38.	39.	39.	40.	40.
40.	40.	39.	39.	39.	39.	38.	38.	37.	37.

UVN

PLATE D-10 ✓

STATION 000002, PLAN 1, RATIO 6 (PMF)

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	2.	3.	4.	6.	8.	11.	15.	19.
23.	29.	35.	44.	59.	86.	116.	146.	185.	220.
249.	274.	296.	318.	335.	346.	353.	354.	352.	347.
340.	332.	323.	313.	304.	294.	285.	278.	270.	263.
256.	249.	242.	235.	229.	223.	217.	212.	208.	206.
206.	208.	212.	218.	224.	231.	238.	246.	253.	261.
268.	275.	282.	290.	298.	307.	315.	322.	330.	337.
344.	355.	371.	398.	437.	495.	573.	659.	749.	840.
942.	1137.	1314.	1476.	1622.	1755.	1874.	1985.	2094.	2192.
2280.	2358.	2428.	2490.	2552.	2631.	2758.	2963.	3299.	3814.
4403.	5100.	5925.	6724.	7526.	8387.	9816.	11264.	12872.	15197.
18691.	22898.	25877.	26816.	26004.	23977.	21468.	19168.	17313.	15640.
13957.	12191.	10427.	8927.	7894.	7101.	6317.	5562.	4862.	4358.
3902.	3486.	3123.	2882.	2660.	2458.	2277.	2114.	1967.	1851.
1746.	1651.								

STORAGE

1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.
1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.
1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.
1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.
1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.	1750.
1751.	1751.	1752.	1754.	1756.	1759.	1762.	1767.	1772.	1778.
1784.	1792.	1802.	1815.	1832.	1854.	1879.	1903.	1926.	1946.
1963.	1977.	1990.	2000.	2008.	2013.	2016.	2017.	2016.	2014.
2010.	2007.	2002.	1998.	1993.	1989.	1984.	1980.	1975.	1971.
1967.	1963.	1959.	1955.	1951.	1948.	1944.	1941.	1939.	1938.
1938.	1939.	1942.	1945.	1948.	1952.	1957.	1961.	1965.	1970.
1974.	1978.	1982.	1987.	1991.	1995.	1998.	2002.	2005.	2009.
2013.	2017.	2025.	2038.	2057.	2082.	2111.	2143.	2177.	2212.
2248.	2281.	2312.	2340.	2366.	2390.	2411.	2431.	2449.	2465.
2479.	2491.	2503.	2513.	2523.	2536.	2556.	2590.	2639.	2700.
2770.	2847.	2924.	3000.	3074.	3146.	3210.	3259.	3306.	3368.
3454.	3543.	3603.	3622.	3606.	3565.	3513.	3464.	3421.	3379.
3336.	3287.	3232.	3173.	3107.	3035.	2961.	2890.	2825.	2765.
2710.	2661.	2617.	2577.	2540.	2508.	2478.	2452.	2428.	2407.
2388.	2372.								

STAGE

640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0	640.0
640.0	640.0	640.0	640.0	640.0	640.1	640.1	640.1	640.1	640.2
640.2	640.3	640.3	640.4	640.5	640.7	640.8	641.0	641.1	641.3
641.4	641.4	641.5	641.6	641.6	641.7	641.7	641.7	641.7	641.7
641.6	641.6	641.6	641.6	641.5	641.5	641.5	641.5	641.4	641.4
641.4	641.4	641.3	641.3	641.3	641.3	641.2	641.2	641.2	641.2
641.2	641.2	641.2	641.2	641.3	641.3	641.3	641.3	641.4	641.4

641.4	641.5	641.5	641.5	641.5	641.6	641.6	641.6	641.6	641.6
641.7	641.7	641.7	641.8	641.9	642.1	642.2	642.4	642.6	642.8
643.0	643.2	643.4	643.5	643.7	643.8	643.9	644.0	644.1	644.2
644.3	644.3	644.4	644.4	644.5	644.6	644.7	644.8	645.1	645.4
645.8	646.1	646.5	646.9	647.2	647.6	647.9	648.1	648.3	648.6
649.0	649.4	649.7	649.7	649.7	649.5	649.3	649.0	648.8	648.7
648.5	648.2	648.0	647.7	647.4	647.0	646.7	646.3	646.0	645.7
645.5	645.2	645.0	644.8	644.6	644.4	644.3	644.1	644.0	643.9
643.8	643.7								

PEAK OUTFLOW IS 26816. AT TIME 41.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	26816.	14844.	4911.	2500.	479973.
CMS	759.	420.	139.	71.	13591.
INCHES		22.89	30.29	30.84	30.84
MM		581.35	769.28	783.24	783.24
AC-FT		7361.	9740.	9917.	9917.
THOUS CU M		9079.	12014.	12232.	12232.

PLATE D-12

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

	0.	4000.	8000.	12000.	16000.	20000.	24000.	28000.	0.	0.	0.	0.	0.
.15	1I	.	.	.	.	.	.	.	.	.	.	.	.
.30	2I	.	.	.	.	.	.	.	.	.	.	.	.
.45	3I	.	.	.	.	.	.	.	.	.	.	.	.
1.00	4I	.	.	.	.	.	.	.	.	.	.	.	.
1.15	5I	.	.	.	.	.	.	.	.	.	.	.	.
1.30	6I	.	.	.	.	.	.	.	.	.	.	.	.
1.45	7I	.	.	.	.	.	.	.	.	.	.	.	.
2.00	8I	.	.	.	.	.	.	.	.	.	.	.	.
2.15	9I	.	.	.	.	.	.	.	.	.	.	.	.
2.30	10I	.	.	.	.	.	.	.	.	.	.	.	.
2.45	11I	.	.	.	.	.	.	.	.	.	.	.	.
3.00	12I	.	.	.	.	.	.	.	.	.	.	.	.
3.15	13I	.	.	.	.	.	.	.	.	.	.	.	.
3.30	14I	.	.	.	.	.	.	.	.	.	.	.	.
3.45	15I	.	.	.	.	.	.	.	.	.	.	.	.
4.00	16I	.	.	.	.	.	.	.	.	.	.	.	.
4.15	17I	.	.	.	.	.	.	.	.	.	.	.	.
4.30	18I	.	.	.	.	.	.	.	.	.	.	.	.
4.45	19I	.	.	.	.	.	.	.	.	.	.	.	.
5.00	20I	.	.	.	.	.	.	.	.	.	.	.	.
5.15	21I	.	.	.	.	.	.	.	.	.	.	.	.
5.30	22I	.	.	.	.	.	.	.	.	.	.	.	.
5.45	23I	.	.	.	.	.	.	.	.	.	.	.	.
6.00	24I	.	.	.	.	.	.	.	.	.	.	.	.
6.15	25I	.	.	.	.	.	.	.	.	.	.	.	.
6.30	26I	.	.	.	.	.	.	.	.	.	.	.	.
6.45	27I	.	.	.	.	.	.	.	.	.	.	.	.
7.00	28I	.	.	.	.	.	.	.	.	.	.	.	.
7.15	29I	.	.	.	.	.	.	.	.	.	.	.	.
7.30	30I	.	.	.	.	.	.	.	.	.	.	.	.
7.45	31I	.	.	.	.	.	.	.	.	.	.	.	.
8.00	32I	.	.	.	.	.	.	.	.	.	.	.	.
8.15	33I	.	.	.	.	.	.	.	.	.	.	.	.
8.30	34I	.	.	.	.	.	.	.	.	.	.	.	.
8.45	35I	.	.	.	.	.	.	.	.	.	.	.	.
9.00	36I	.	.	.	.	.	.	.	.	.	.	.	.
9.15	37I	.	.	.	.	.	.	.	.	.	.	.	.
9.30	38I	.	.	.	.	.	.	.	.	.	.	.	.
9.45	39I	.	.	.	.	.	.	.	.	.	.	.	.
10.00	40I	.	.	.	.	.	.	.	.	.	.	.	.
10.15	41I	.	.	.	.	.	.	.	.	.	.	.	.
10.30	42I	.	.	.	.	.	.	.	.	.	.	.	.
10.45	43I	.	.	.	.	.	.	.	.	.	.	.	.
11.00	44I	.	.	.	.	.	.	.	.	.	.	.	.
11.15	45I	.	.	.	.	.	.	.	.	.	.	.	.
11.30	46I	.	.	.	.	.	.	.	.	.	.	.	.
11.45	47I	.	.	.	.	.	.	.	.	.	.	.	.
12.00	48I	.	.	.	.	.	.	.	.	.	.	.	.
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12.30	50I	.	.	.	.	.	.	.	.	.	.	.	.
12.45	51I	.	.	.	.	.	.	.	.	.	.	.	.
13.00	52I	.	.	.	.	.	.	.	.	.	.	.	.
13.15	53I	.	.	.	.	.	.	.	.	.	.	.	.
13.30	54I	.	.	.	.	.	.	.	.	.	.	.	.
13.45	55I	.	.	.	.	.	.	.	.	.	.	.	.
14.00	56I	.	.	.	.	.	.	.	.	.	.	.	.

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14.45 590I
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15.30 620I
15.45 630I
16.00 640 I
16.15 650  I
16.30 660  I
16.45 670  I
17.00 680  I
17.15 690  I
17.30 70.0.I
17.45 71.0 I
18.00 72.0I
18.15 73.0I
18.30 74.0I
18.45 75.0I
19.00 76.I
19.15 77.I
19.30 78.I
19.45 79.I
20.00 80.I
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22.00 8810
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5.30118.I
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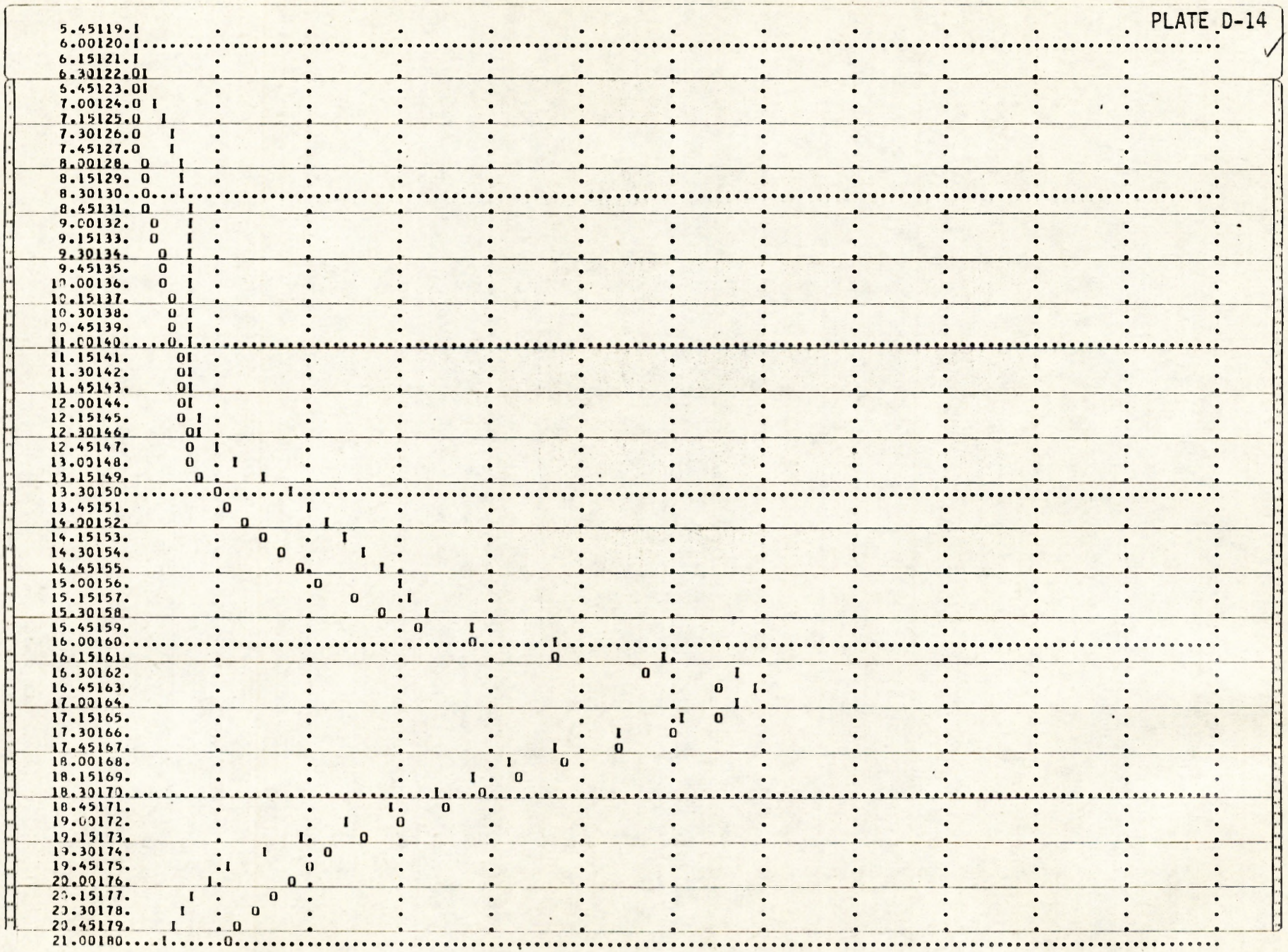
PLATE D-14



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23.15189.  I  0
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 0.00192.  I 0
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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	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
				.20	.35	.50	.65	.80	1.00
HYDROGRAPH AT	1	6.03	1	5549.	9710.	13872.	18033.	22195.	27744.
		(15.63)		(157.12)(	274.97)(	392.81)(	510.65)(	628.49)(	785.61)(
ROUTED TO	000002	6.03	1	3530.	7164.	12095.	16779.	21251.	26816.
		(15.63)		(99.97)(	202.87)(	342.48)(	475.12)(	601.75)(	759.34)(

PLATE D-17

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	640.00	640.00	647.50
STORAGE	1750.	1750.	3131.
OUTFLOW	0.	0.	8150.

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
.20	645.23	0.00	2666.	3530.	0.00	42.00	0.00
.35	647.07	0.00	3041.	7164.	0.00	41.50	0.00
.50	648.22	.72	3284.	12095.	2.00	41.25	0.00
.65	648.78	1.28	3408.	16779.	3.00	41.00	0.00
.80	649.24	1.74	3509.	21251.	3.75	41.00	0.00
1.00	649.74	2.24	3622.	26816.	4.75	41.00	0.00