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NATIONAL DAM SAFETY PROGRAM. TRENTON UPPER LAKE DAM (MO 10365),--ETC(U)
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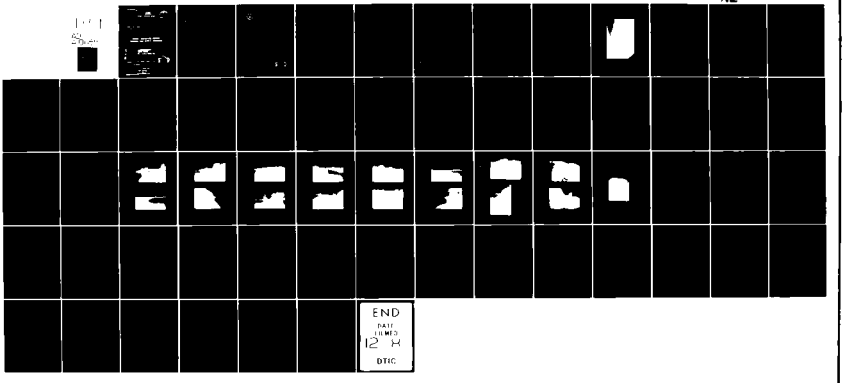

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TRENTON UPPER LAKE DAM

GRUNDY COUNTY, MISSOURI

MO. 10055

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD A106 511	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Trenton Upper Lake Dam (MO 10365) Grundy County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hoskins-Western-Sonderegger, Inc.	8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0046
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	12. REPORT DATE August 1979 13. NUMBER OF PAGES Approximately 45
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office) National Dam Safety Program. Trenton Upper Lake Dam (MO 10365), Grand - Chariton Basin, Grundy County, Missouri. Phase I Inspection Report.	15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for release; distribution unlimited.	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	
18. SUPPLEMENTARY NOTES	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams	
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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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Trenton Upper Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Trenton Upper 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 50 percent of 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 24 MAR 1980
Chief, Engineering Division Date

APPROVED BY SIGNED 24 MAR 1980
Colonel, CE, District Engineer Date

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TRENTON UPPER LAKE DAM
GRUNDY COUNTY, MISSOURI
MO. 10365

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

AUGUST, 1979

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Trenton Upper Lake Dam
State Located	Missouri
County Located	Grundy County
Stream	Tributary to Muddy Creek
Date of Inspection	August 14, 1979

Trenton Upper 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 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 developed with the help of several Federal and State agencies, professional and 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 three miles downstream of the dam. Within the damage zone are the 115 acre surface acre Trenton Lower Lake, 20 or more trailer homes, 2 or 3 business buildings, the Trenton Airport and Highway 65.

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 spillway will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillway will pass 37% 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.

Failure of this dam by overtopping or by structural instability would release the water from Trenton Upper Lake directly into Trenton Lower Lake and would undoubtedly cause overtopping of Trenton Lower Lake Dam and possibly failure of that dam.

It is recommended that the following be pursued on a high priority basis:

a. Increase the height of the dam and/or the size of the spillway in order to pass the probable maximum flood without overtopping the dam.

b. Conduct engineering studies to determine the cause and extent of the slide or deformation on the downstream slope of the dam and design protective measures if required.

c. Conduct seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" to be used in performing the work described in a. and b. above and also to be made a part of the record.

Maintenance has been lax as evidenced by the growth of trees on the slopes of the dam, erosion in areas along the upstream slope and severe erosion in the spillway outlet channel. Maintenance procedures concerned with the foregoing are recommended in Paragraph 7.2b of this report.

Rey S. Decker
E-3703

Garold Ulmer
E-4777

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

PHOTO NO. 1 OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
TRENTON UPPER LAKE DAM - MO 10365
GRUNDY 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 Trenton Upper 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 approximately 1300 feet in length and 31 feet in height located in the northern Missouri Loess-Till area. Soils in the area consist of loess (CL) over fine grained glacial till (CL or CH) on the rolling hill uplands with glacial till (CL-CH) exposed on the steeper valley slopes.

(2) The spillway consists of two corrugated metal pipes (CMP) located on the right (north) abutment which discharges into Trenton Lower Lake (MO. 10366).

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

b. Location. The dam is located in the central part of Grundy County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the SE¼ of Section 15, T61N, R24W. The lake formed behind the dam is shown in the SE¼ of Section 15, T61N, R24W and the W½ of Section 14, T61N, R24W.

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 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 three miles downstream from the dam. Within the damage zone are the 115 surface acre Trenton Lower Lake, 20 or more trailer homes, 2 or 3 business buildings, the Trenton Airport and Highway 65.

e. Ownership. The dam is owned by the Trenton Lake Association, c/o Mr. J. Martin, President, Martin Town and Country, Hwy 65, Trenton, Missouri 64683.

f. Purpose of Dam. The dam impounds a 63 acre lake for recreation and flood retardation.

g. Design and Construction History. It was reported by Mr. Blackburn, Trenton City Administrator, that the dam was constructed in 1963 by Fred Payne. No other design or construction history was available.

h. Normal Operating Procedure. There are no operating facilities for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillway.

1.3 PERTINENT DATA

a. Drainage Area. 577 acres (0.90 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through an uncontrolled spillway consisting of a 50"x 31" corrugated metal pipe arch culvert and a 21" corrugated metal pipe culvert laid approximately parallel with inverts at the same elevation.

(2) Estimated maximum flood at damsite - unknown.

(3) The spillway capacity varies from 0 c.f.s. at elevation 784.0 feet to 109 c.f.s. at the minimum top of dam (elevation 791.0 feet).

(4) Total spillway capacity at the minimum top of dam is 109 c.f.s. ±

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

(1) Top of dam (low point) - 791.0
(2) Spillway crest - 784.0
(3) Streambed at centerline - 760± (from U.S.G.S. Quad Sheet)
(4) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 3600±

e. Storage (Acre-feet).

(1) Top of dam - 1250±
(2) Spillway crest - 690±

f. Reservoir Surface (Acres).

(1) Top of dam - 90±
(2) Spillway crest - 63±

g. Dam.

(1) Type - earth fill
(2) Length - 1325 feet ±
(3) Height - 31 feet ±
(4) Top width - 24 foot asphaltic concrete surfaced roadway on 33 to 36 foot width.
(5) Side slopes.
    (a) Downstream - varies from 1.8H to 6.9H on 1V; overall = 2.8H on 1V (see Plate C-2)
    (b) Upstream - 1.4H on 1V on exposed section

(6) Zoning - unknown
(7) Impervious core - unknown
(8) Cutoff - unknown
(9) Grout curtain - unknown
(10) Wave protection - limestone riprap.
(11) Internal drainage - unknown

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal (and only)
(a) Type - Two uncontrolled CMP culverts, one 21-inch diameter, one 50"x 31" arch.
(b) Invert elevation - Both set at 784.0 feet
Outlet elevation - 21 in. = 776.8 feet
51 x 31 in. = 783.6 feet
(c) Length - 21 in. = 160 feet ±
51 x 31 in. = 60 feet.
(d) Upstream Channel - Direct from reservoir into spillway conduits.
(e) Downstream (exit) channel - Partially paved with rough concrete grout thence into eroded earth channel

j. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were available for this dam.

2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. Blackburn that the dam was constructed in 1963 by Mr. Fred Payne.

2.3 OPERATION

No data were available on spillway operation.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusions 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. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Trenton Upper Lake Dam was made on August 14, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: R. S. Decker, Geotechnical and Harold Ulmer, Hydrology. This inspection was conducted in the rain. No one representing the owner was present during the inspection.

b. Dam.

(1) Geology and Soils (Abutment and Embankment). Soils on the abutments consist of thin loess and loessial colluvium over fine grained glacial till (CH). Glacial till is exposed in the spillway exit channel on the right (north) abutment. Materials in the embankment appear to be plastic clay (CL or CH) probably borrowed from both abutments. No cracks, slumps or seepage were observed in the abutments.

Foundation materials consist of alluvium derived from loess and till underlain at some depth by limestone and/or shale of the Middle Pennsylvanian System.

(2) Upstream Slope. The upstream slope is adequately covered with durable limestone riprap up to 3 feet in size and waste concrete rubble. The riprap extends almost to the crest of the dam in some places and to elevations 2 or 3 feet below the crest in other locations. Some erosion was noted above the riprap in those areas where riprap did not extend to the crest (see Photo No. 5). Several trees, up to 4 inch diameter, are growing on the slope. Many smaller willows had been recently cut along the upstream side. No indications of cracks or deformations were observed. No rodent burrows were noted.

(3) Crest. The crest serves as a roadway with a 24 foot wide aspnaltic concrete surface. Longitudinal cracks were observed along the downstream crest line (in the roadway and shoulder) between stations 5+20 and 6+20

which appeared to result from sliding or slumping of the downstream section (see Photo No. 3).

The cracks were 0.5 to 0.75 inches in width and vertical displacement varied from about 1 to 2 inches.

The profile of the crest is quite uneven with a general slope from the left to the right abutment (south to north) with the right end of the dam some 5 to 6 feet lower than the left end.

d. Downstream Slope. The downstream slope, particularly on the left (south) one half, of the dam is heavily overgrown with brush and trees up to 8 inches in diameter. The open areas are well vegetated with adapted grasses and clover. The cross sectional profile of the downstream slope is quite irregular with approximately 2H on 1V slopes in the upper and basal sections and much flatter slopes (3H to 6H on 1V) in the central section, producing a berm like appearance when viewed longitudinally (see Photo No. 10). It appeared that most of the dam had been constructed with a berm about midway down the slope except in the area downstream from stations 5+00 to 6+00+ where some lateral deformations may have occurred. A seep area was noted downstream from Station 5+00 which extended from about Station 5+00 to 6+00 and outcropped at about elevation 775. (This is the possible slump area.) No seepage effluent was observed, but the area was covered with water-loving vegetation. The presence of seepage along the toe of the dam was difficult to detect since Trenton Lower Lake nearly encroaches upon the downstream toe of this dam. A few very small seeps were observed just above the Lower Lake level (elevation 753+) downstream from about Station 2+50 toward the left abutment. All seepage was clear, and the detectable seepage discharge was estimated at or less than 0.5 gpm. Borings on the slope showed gray, brown clay (CH) material to a depth of 2 feet or more.

c. Appurtenant Structures.

(1) The spillway is uncontrolled and consists of two corrugated metal culverts, one 21 inches in diameter, the other an arch 50 in. x 31 in., located on the right abutment of the dam. The spillway culverts exit into an excavated channel that is partially paved with rough concrete grout. All spillway discharges feed directly into Trenton Lower Lake. The earth channel (gully) downstream from the paved section is badly eroded. The arch culvert is open and in good shape. It was not possible to see through the smaller pipe from one end to the other. There was no evidence of recent discharges through the spillway. Neither culvert had a trash rack over the inlet; however, the short approach channel was clear of trash and brush.

(2) Drawdown Facilities. No drawdown facilities were observed for this dam.

d. Reservoir Area. The shoreline around the reservoir is well grassed and no significant erosion was observed.

e. Downstream Channel. Discharges from this reservoir flow directly into Trenton Lower Lake.

3.2 EVALUATION.

This structure appears to be in fairly good shape. Additional studies would be required to determine the nature, extent and potential hazard of the apparent deformation of the downstream slope between stations 5+00 and 6+00+. Tree growth on the slopes and erosion of the upstream slope above the riprap and in the spillway exit channel impose a potential of failure of this structure unless corrected. Installation of trash racks on the spillway culverts would assure more efficient operation.

The nature of materials in the dam, the paved roadway, and the dense vegetative cover indicate that overtopping by the PMF should not cause serious damage to the dam but could cause considerable damage in the right abutment trough (spillway exit).

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 spillway.

4.2 MAINTENANCE OF DAM

Some willow trees had been recently cut on the upstream slope. Other tree growth on both slopes and erosion on the upstream slope and in the spillway exit channel indicate considerable laxity in maintenance of this dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

The lack of regular inspection and maintenance of this structure could lead to serious potential of failure.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were found for this dam.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Trenton, Missouri 15 minute topographic quadrangle map, and the Trenton SE, Missouri 7.5 minute series orthophotoquad. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.

c. Visual Observations.

(1) The spillway releases directly into Trenton Lower Lake, and the lower reservoir water surface is at the toe of Trenton Upper Lake Dam.

(2) The inlets to both the spillway CMP culverts were clear of debris. However, it could not be determined if the smaller of the two pipes was free of obstructions throughout the full length of the tube.

(3) There was no evidence of overtopping of this structure.

d. Overtopping Potential. The spillway is too small to pass the probable maximum flood without overtopping. The spillway will pass 37% of the PMF and the 100-year flood without overtopping. This dam could probably withstand overtopping by the probable maximum storm without significant damage. The results of the routings through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	Freeboard Top of Dam Min. Elev. 791.0	Time Dam Overtopping Hr.
100 Yr.	2060	60	787.1	+3.9	-
0.5 PMF	3200	330	791.9	-0.9	7.0+
PMF	6400	4600 *	793.6	-2.6	9.0-
0.37 PMF	2400	110	791.0	0	-

* (Maximum discharge overtopping the dam = 4,470 cfs; maximum spillway discharge = 130 cfs.)

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and an intermediate size. Therefore, the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Longitudinal cracks along the downstream crest line, the very uneven surface profile of the downstream slope between Stations 5+00 and 6+00+ and the apparent presence of seepage would indicate possible lateral deformation in this area of the dam. The remainder of the dam appears to be structurally stable. Minor seepage at the toe of the dam toward the left end is probably following the old loess-till interface at the left abutment and does not appear to seriously endanger the stability of the structure.

b. Design and Construction Data. No design or construction data were 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.

d. Post Construction Changes. It would appear that the larger spillway culvert (50"x 31") was installed sometime after the smaller culvert. It is not known when this modification was made.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area would not ordinarily be expected to cause structural failure of this dam. However, the apparent instability of portions of the downstream slope could be accentuated by such seismic activity, and stability analyses should consider appropriate seismic forces.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The longitudinal cracks in the crest, and the apparent seepage and deformation in the downstream slope indicate that this dam may not be structurally stable under maximum loading conditions. A failure of this upper dam at maximum pool level would probably cause overtopping of Trenton Lower Lake Dam by several feet.

Using the approximate data available for analyses, this dam will be overtopped with a water depth of 2.6 feet for about 9 hours by the Probable Maximum Flood. The effects of such overtopping on erosional and structural stability are not known.

Deficiencies in maintenance, consisting of tree growth on embankment slopes and erosion on the upstream face and in the spillway exit, could lead to potential failure of the dam. 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 lack of engineering data, the conclusions in this report are based upon performance history and visual observations. 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. The analyses and remedial measures recommended in paragraph 7.2a. should be pursued on a high priority basis.

d. Necessity for Phase II. Phase II investigation is not considered necessary. The additional studies and analyses recommended in paragraph 7.2a. should be accomplished in the near future.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not ordinarily expected to be hazardous to a dam of this size and character. However seismic stresses should be considered in the stability analyses of this dam.

7.2 REMEDIAL MEASURES

a. Alternatives.

(1) Additional information should be obtained on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass the Probable Maximum Flood without overtopping the dam.

(2) Additional studies should be performed to determine the cause, extent and potential effects of the apparent slide or deformation of the downstream slope.

(3) The services of an engineer experienced in the design and construction of dams should be obtained to provide seepage and stability analyses (including seismic stresses) of the present dam and to perform and evaluate the aforementioned additional studies (7.2a.(1), (2)) and to design protective measures, if required.

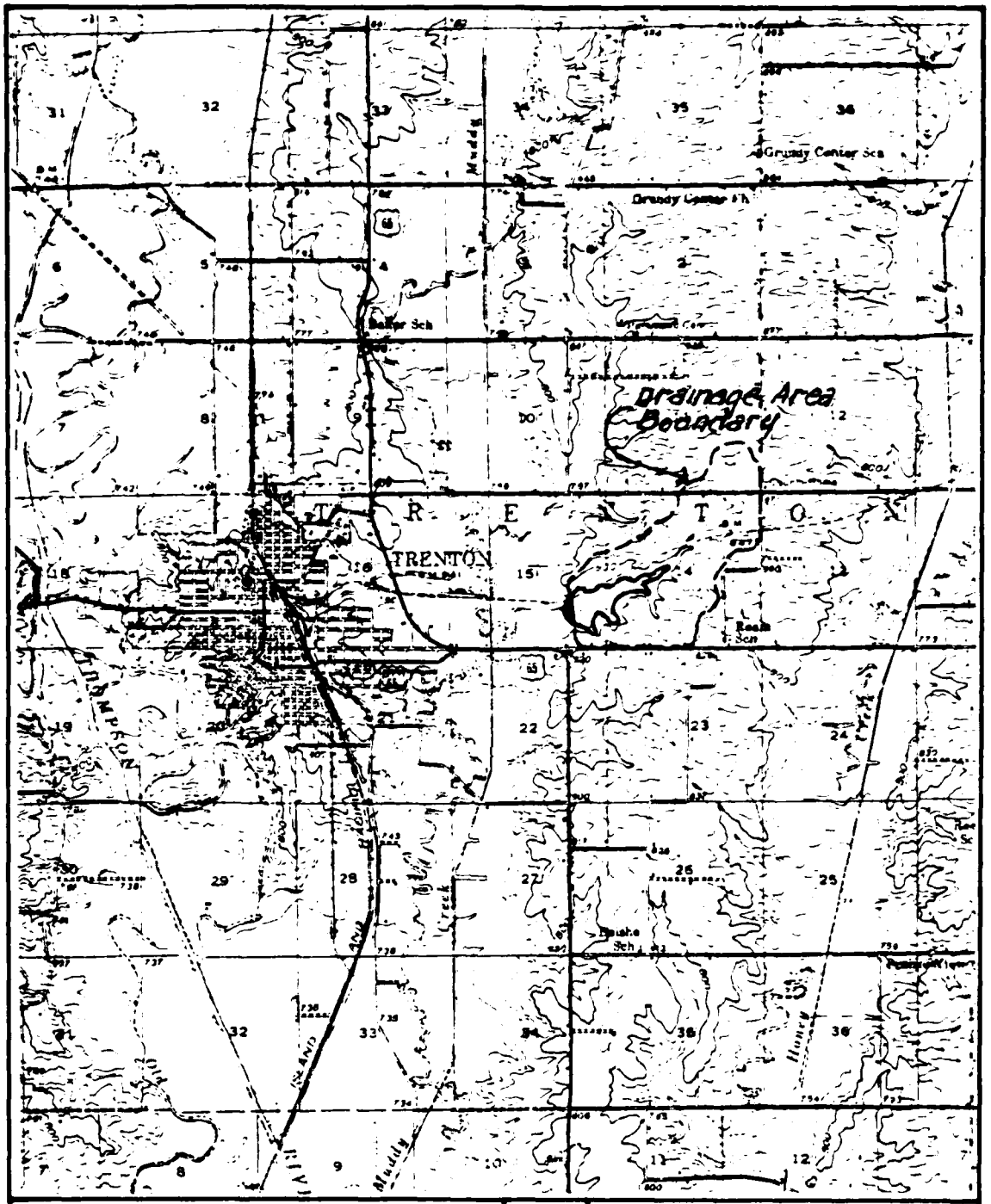
b. O and M Procedures.

(1) Trees should be removed from the slopes of the dam and measures initiated to prevent their recurrence. Removal of large trees should be done under the guidance of an engineer experienced in the design and construction of earthen dams.

(2) Erosion in the spillway exit channel and on the upstream slope of the dam should be corrected.

(3) A program of periodic inspection and maintenance of the structure should be initiated to control the above mentioned (or other) deficiencies.

APPENDIX A
MAPS



Scale in feet

5000 2500 0 5000 10,000

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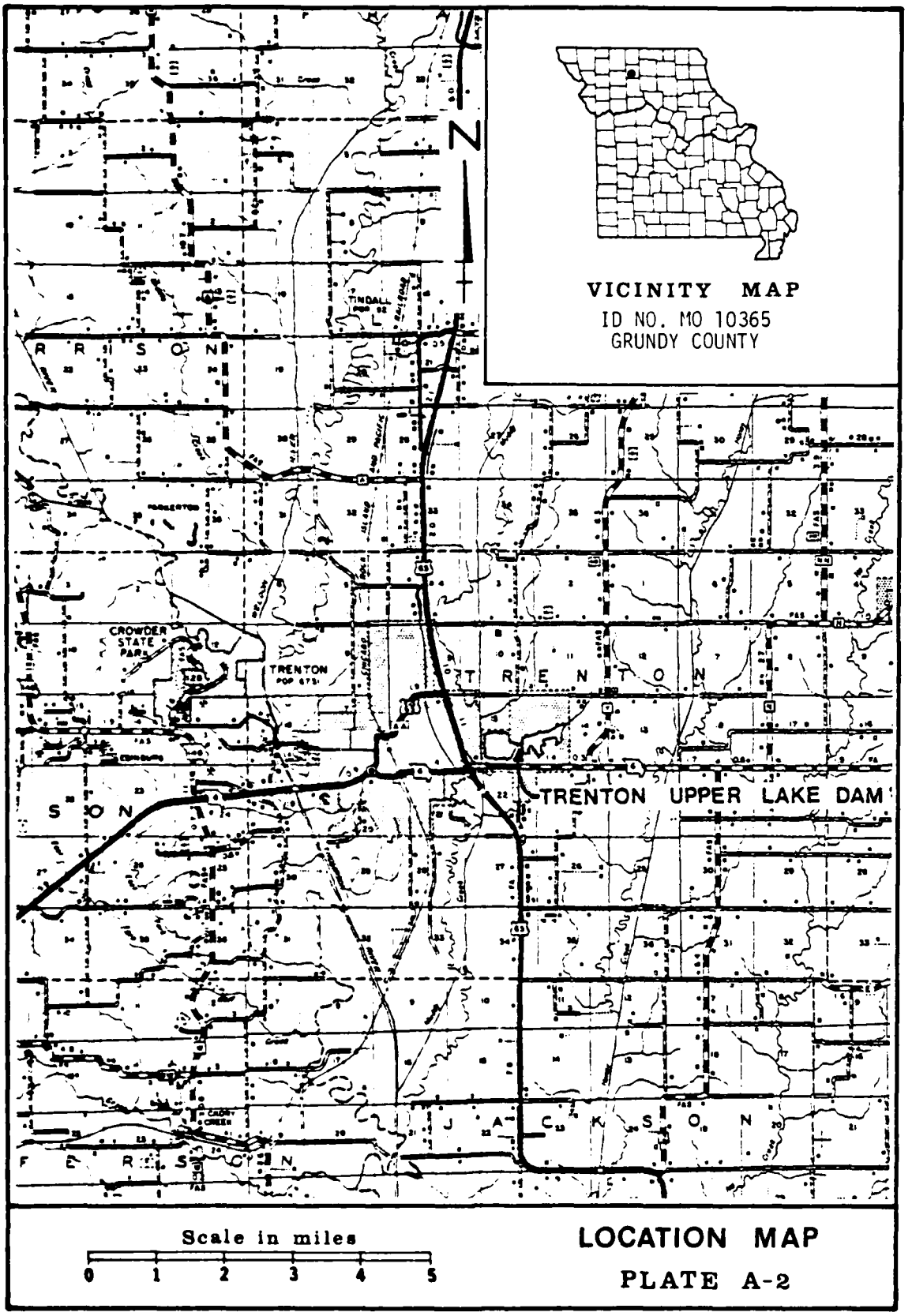
VICINITY TOPOGRAPHY

TRENTON UPPER LAKE DAM

GRUNDY COUNTY, MISSOURI

MO. 10365

PLATE A-1



LOCATION MAP

PLATE A-2

APPENDIX B
PHOTOGRAPHS

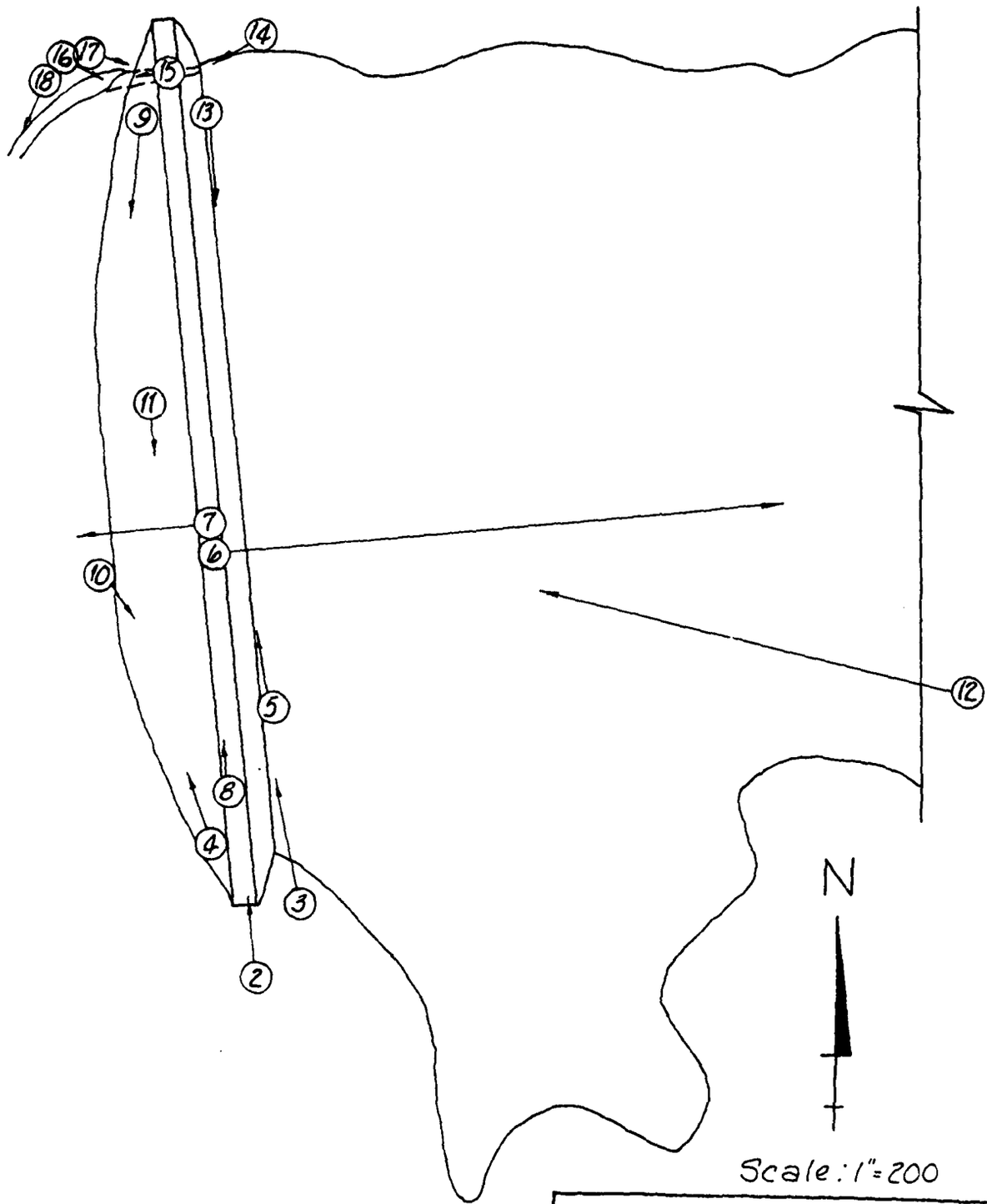


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PHOTO INDEX

TRENTON UPPER LAKE DAM

GRUNDY COUNTY, MISSOURI

MO. 10365 PLATE B-1

PHOTO NO. 2 - CREST FROM LEFT ABUTMENT

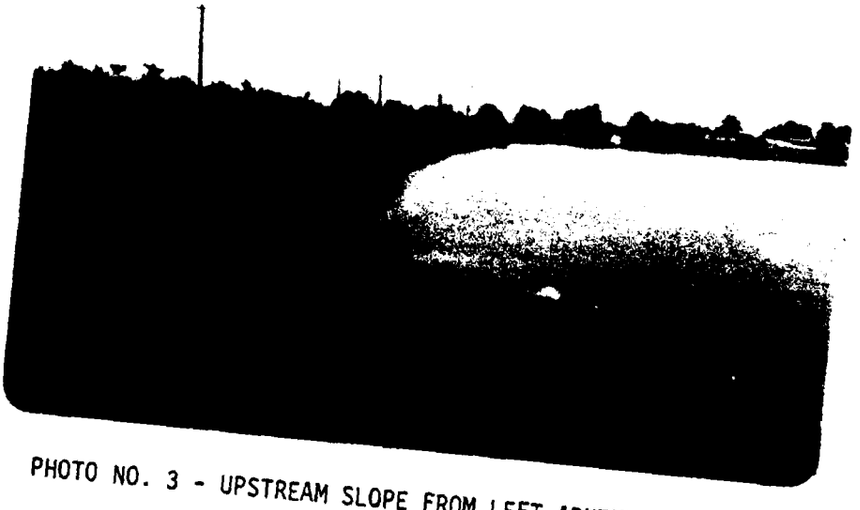


PHOTO NO. 3 - UPSTREAM SLOPE FROM LEFT ABUTMENT

PHOTO NO. 4 - DOWNSTREAM SLOPE FROM LEFT END

PHOTO NO. 5 - ERODED SECTION AT STA. 2 + 00±

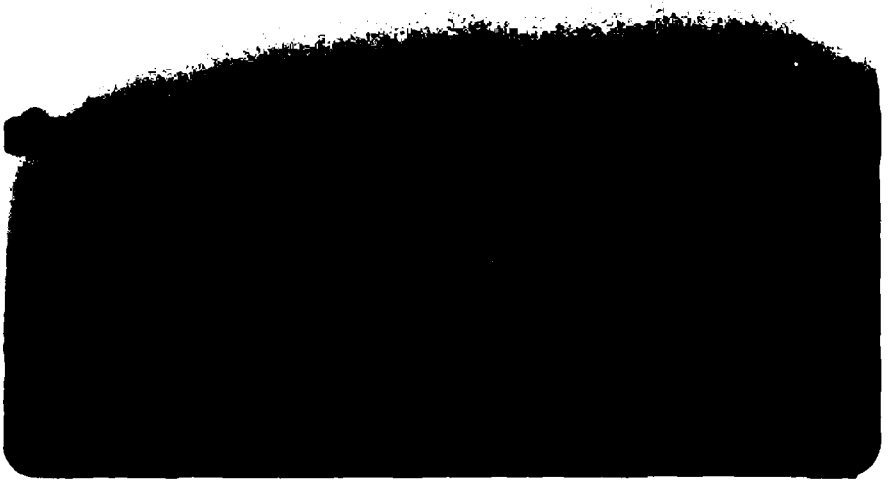


PHOTO NO. 6 - VIEW UPSTREAM FROM STA. 4 + 00

PHOTO NO. 7 - VIEW DOWNSTREAM FROM STA. 4 + 50
SHOWING TRENTON LOWER LAKE

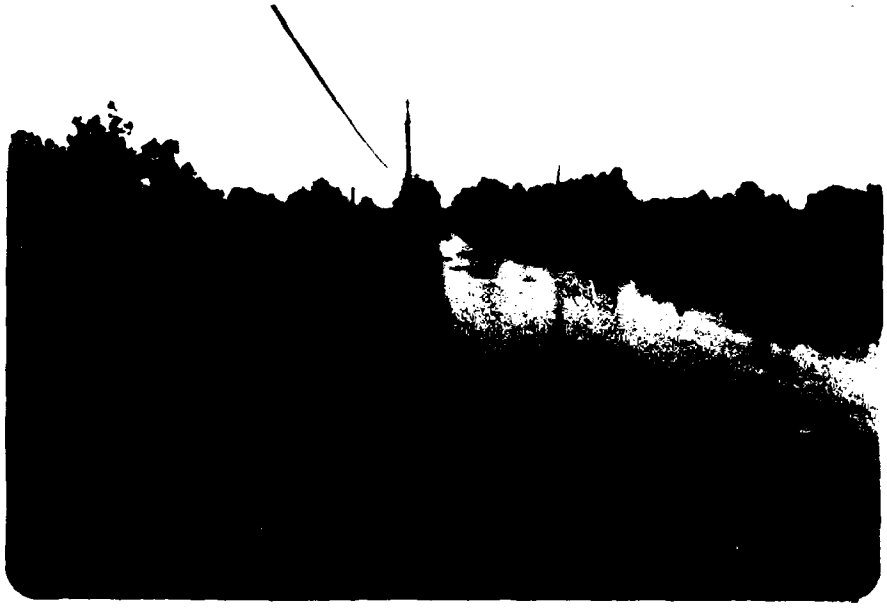


PHOTO NO. 8 - VIEW OF ROAD CROSSING DAM.
NOTE LONGITUDINAL CRACK.

PHOTO NO. 9 - DOWNSTREAM SLOPE FROM RIGHT END

PHOTO NO. 10 - DOWNSTREAM SLOPE SHOWING BERM OR DEFORMATION

PHOTO NO. 11 - SEEP AREA AT STA. 5 + 00

PHOTO NO. 12 - OVERVIEW FROM LEFT SIDE UPSTREAM

PHOTO NO. 13 - UPSTREAM SLOPE FROM RIGHT SIDE

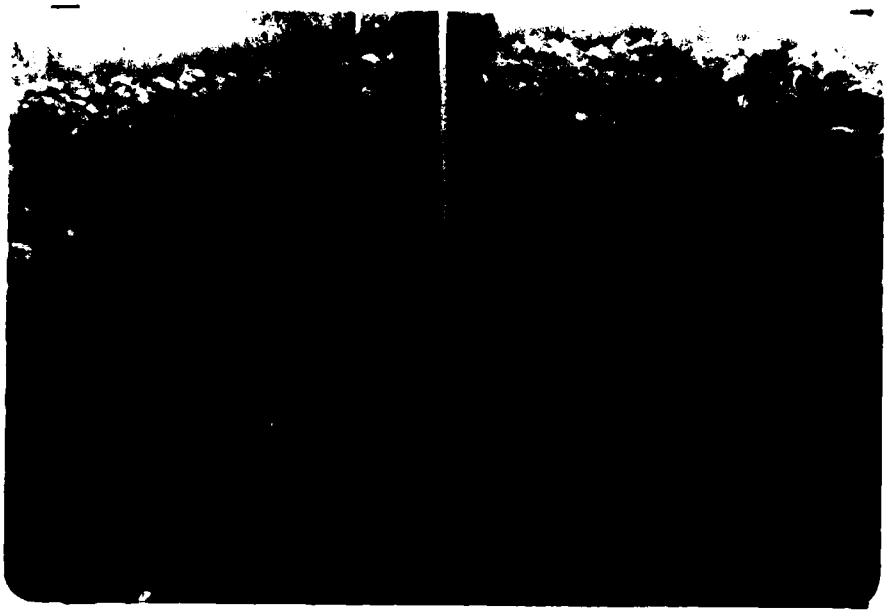


PHOTO NO. 14 - SPILLWAY ENTRANCE

PHOTO NO. 15 -
VIEW DOWNSTREAM IN
SPILLWAY OUTLET FOR
50" x 31" PIPE ARCH

PHOTO NO. 16 - OUTLET CHANNEL FOR SPILLWAY. ROD IN CHANNEL FROM 50" x 31" PIPE ARCH. 21" PIPE IN FOREGROUND

PHOTO NO. 17 - VIEW UPSTREAM IN OUTLET CHANNEL FROM 50" x 31" PIPE ARCH

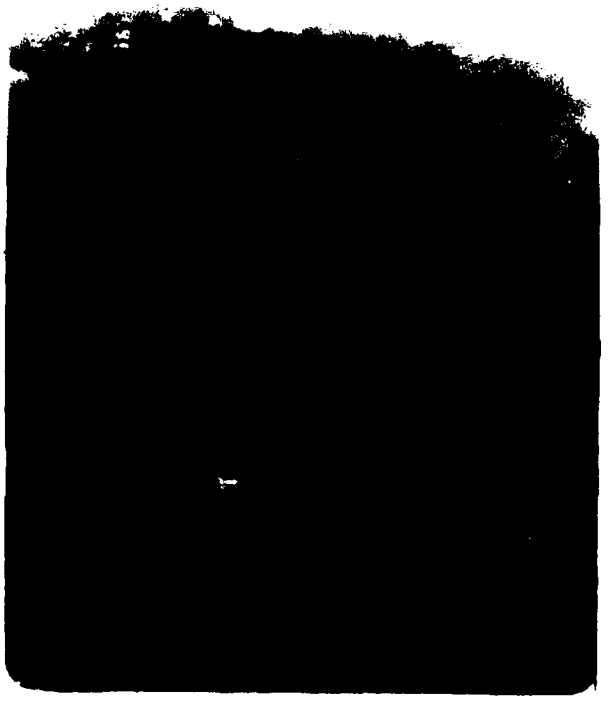
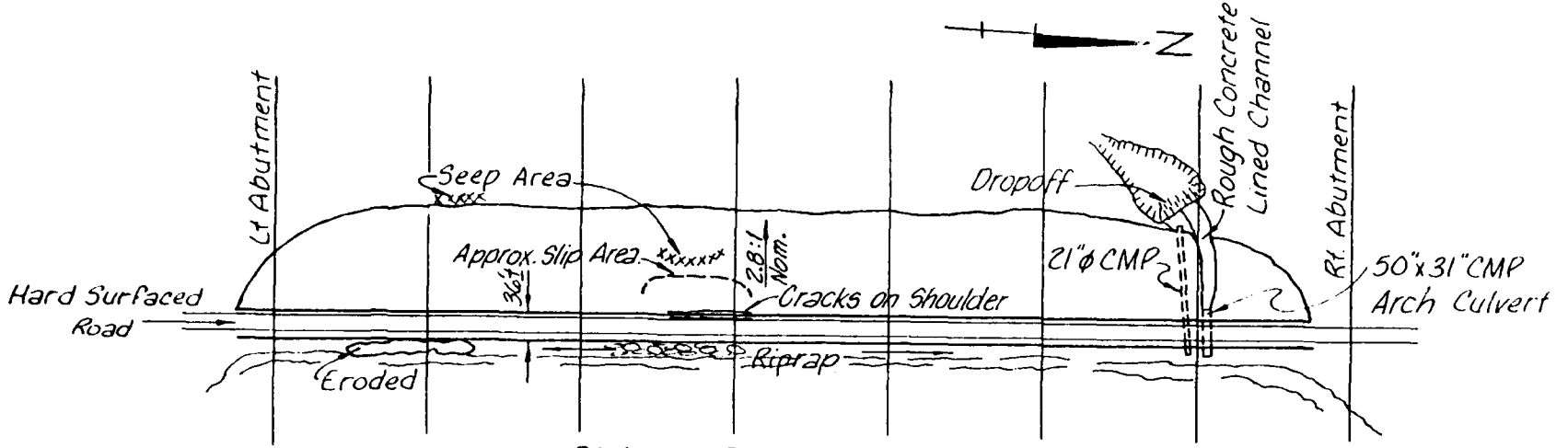


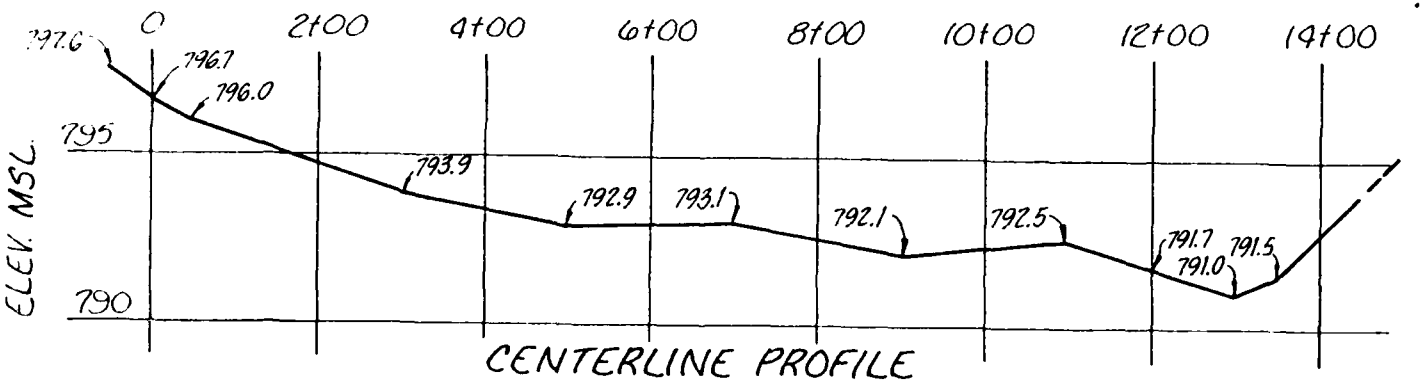
PHOTO NO. 18 -

OUTLET CHANNEL DROPS INTO GULLY

APPENDIX C
PROJECT PLATES

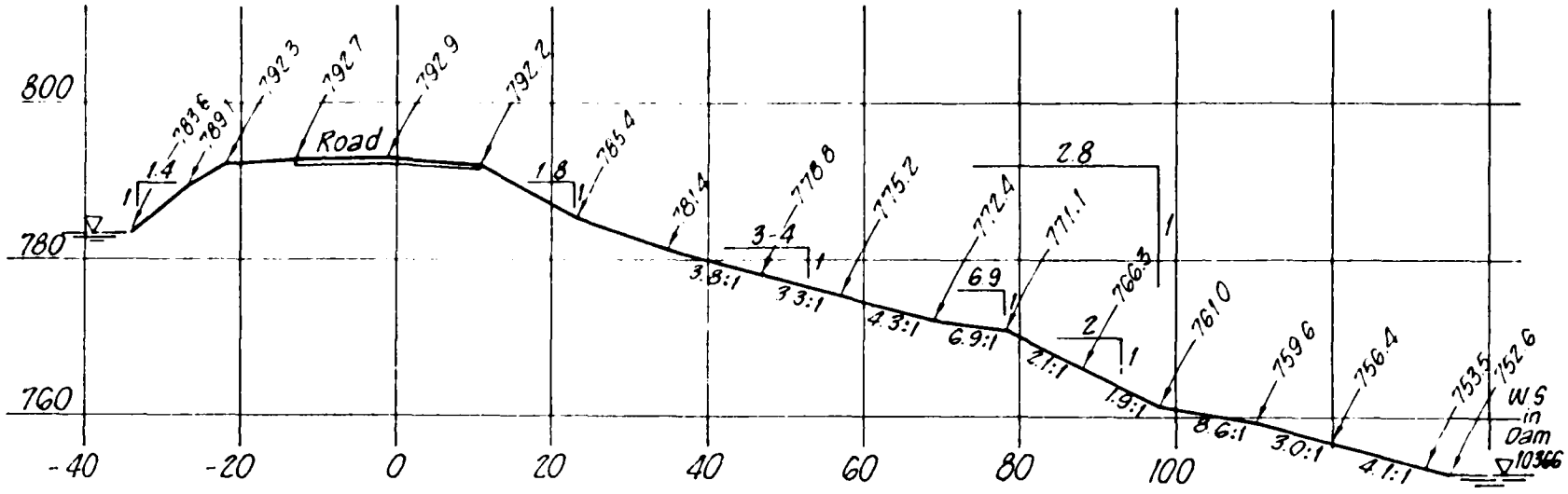


PLAN OF DAM
Scale: 1" = 200'



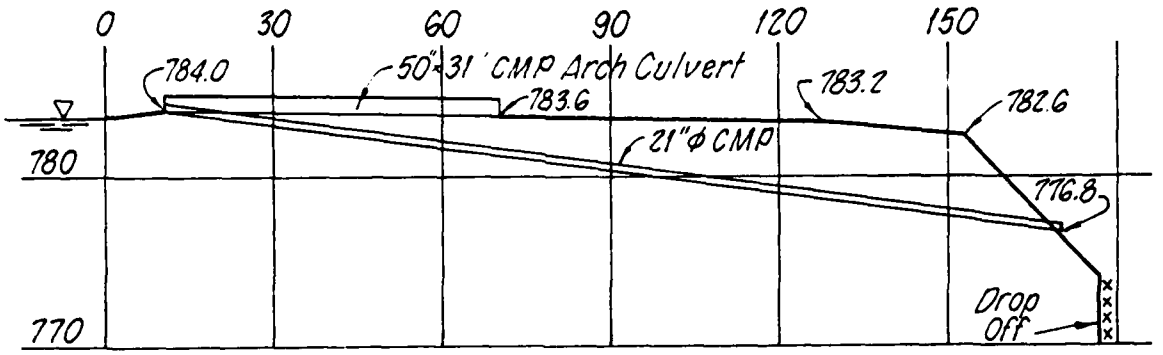
CENTERLINE PROFILE
Scale: 1" = 200' H.
1" = 5' V.

PLATE C-1



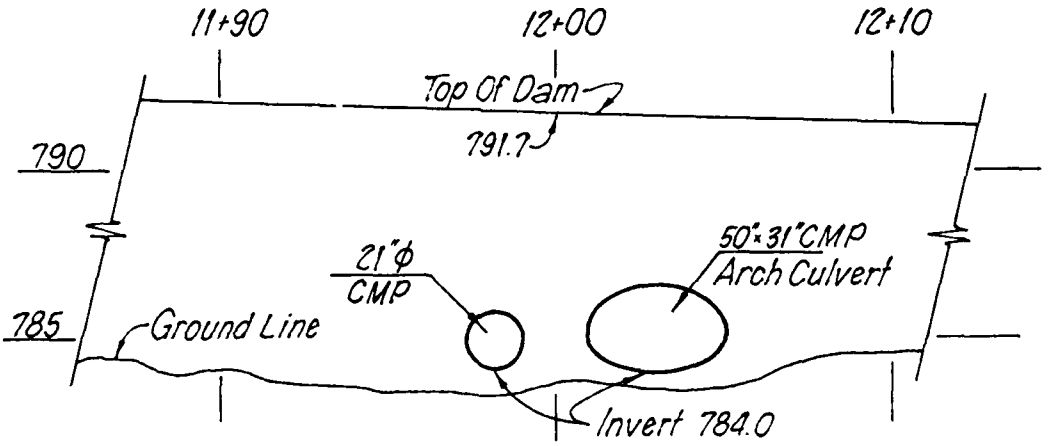
DAM SECTION AT STA. 5+00

PLATE C-2



PROFILE OF SPILLWAY

Scale: 1"= 3.0' H.
1"= 5.0' V.



SPILLWAY ELEVATION

Scale: 1"-5'

PLATE C-3

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. Twenty-four hour, 100-year rainfall for the dam location was taken from the data for the rainfall station at Maryville, Missouri as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis District policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.90 square miles (577 acres).

   c. Time of concentration of runoff = 47 minutes (computed from "Kirpich" formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on 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 crest of the spillway.

   e. The total twenty-four hour storm duration losses for the 100-year storm were 1.64 inches. The total losses for the PMF storm were 0.75 inches. These data are based on SCS runoff curve No. 94 and No. 86 for antecedent moisture conditions SCS AMC III and AMC II, respectively. The watershed is composed of primarily SCS soil groups C & D and consists of the following approximate percentages of land use, 10% reservoir area, 20% urban, 10% woodland, 60% cropland.

   f. Average soil loss rates = 0.05 inch per hour, approximately.

2. The discharge ratings for the spillway were developed using nomographs from HEC No. 5, Highway Culverts, FHwA, assuming inlet control with projecting entrance conditions, and specified size and shape.

The flows over the dam crest were developed using the HEC-1 (Dam Safety Version) program with a discharge coefficient of 2.9 and a value of 1.5 for the exponent of head.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input-output for several ratios of the PMF and the plotted hydrograph for the PMF are shown in this Appendix.

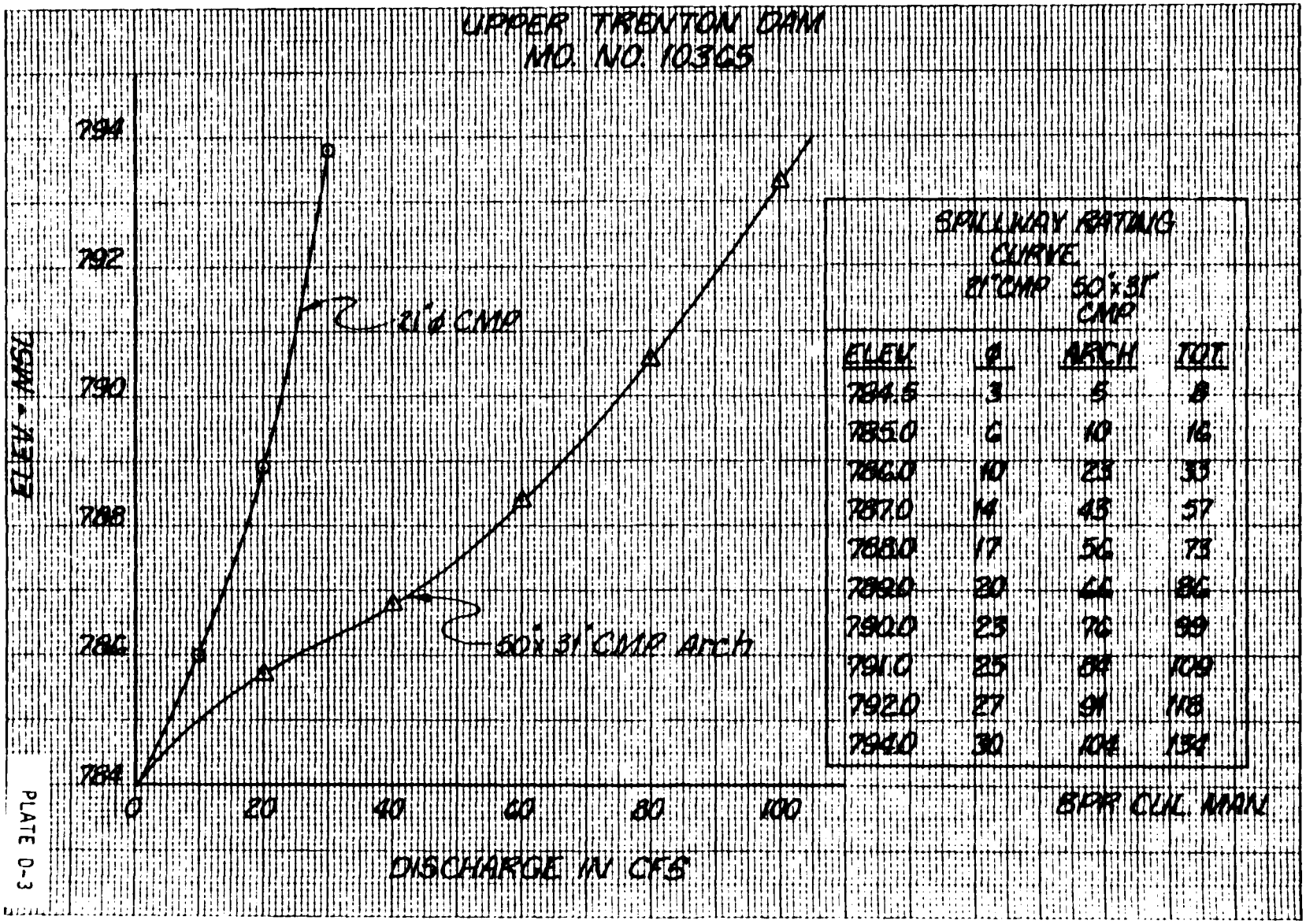

UPPER TRENTON DAM
NID NO. 10365
794
792
790
788
786
784
0
20
40
60
80
100
21"ø CMP
50"x31" CMP Arch
DISCHARGE IN CFS
POOL ELEV. MSL
SPILLWAY RATING CURVE
21" CMP 50"x31" CMP
ELEV. | 21" | ARCH | TOT.
784.5 | 3 | 5 | 8
785.0 | 6 | 10 | 16
786.0 | 10 | 23 | 33
787.0 | 14 | 43 | 57
788.0 | 17 | 56 | 73
789.0 | 20 | 66 | 86
790.0 | 23 | 76 | 99
791.0 | 25 | 84 | 109
792.0 | 27 | 91 | 118
794.0 | 30 | 104 | 134
BPR CUL. MAIN

PLATE D-3

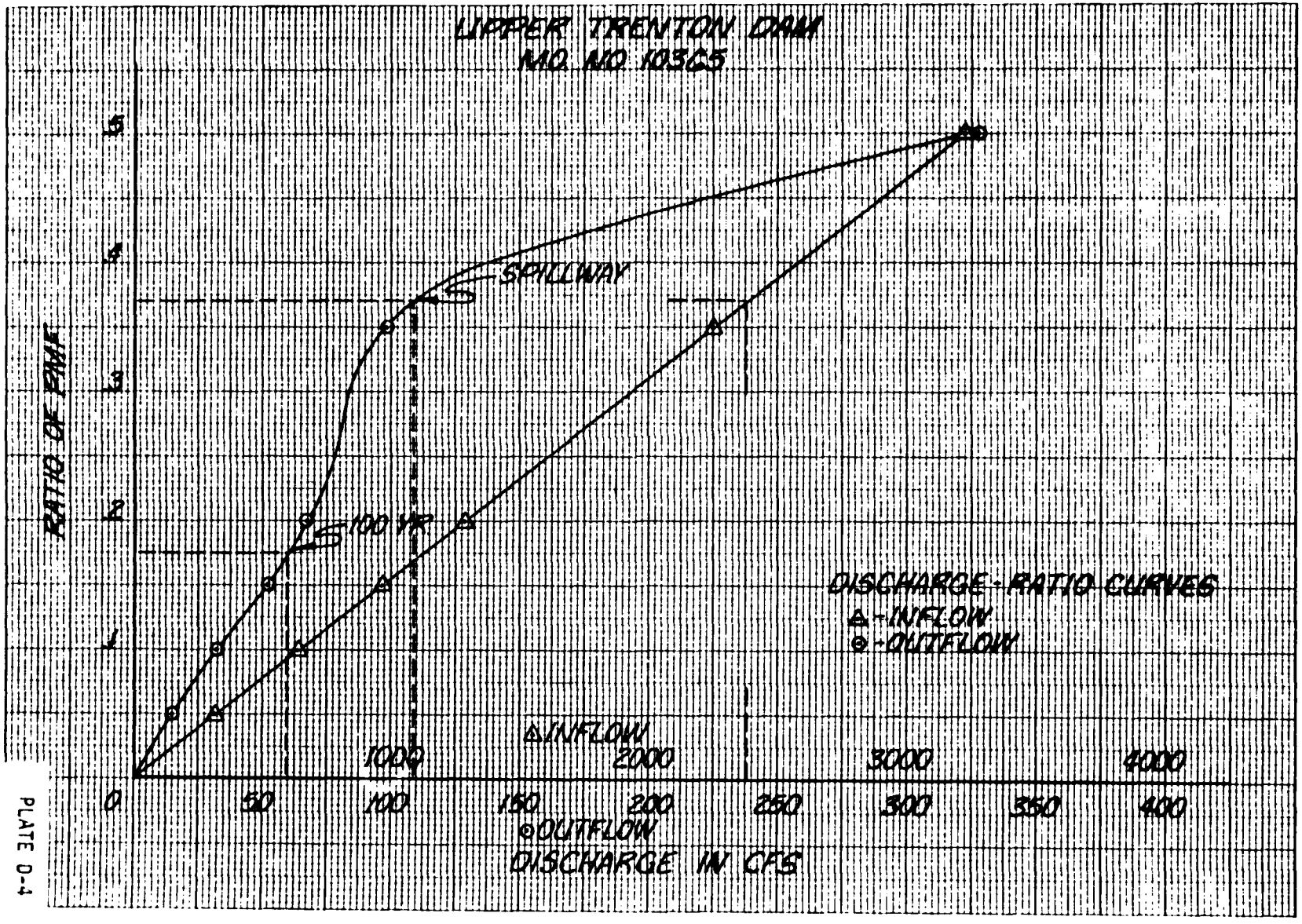

UPPER TRENTON DAM
MO. MO 10365
RATIO OF PMF
5
4
3
2
1
0
SPILLWAY
100 YR
DISCHARGE - RATIO CURVES
△ - INFLOW
⊙ - OUTFLOW
△INFLOW
1000
2000
3000
4000
50
100
150
200
250
300
350
400
⊙OUTFLOW
DISCHARGE IN CFS

PLATE D-4

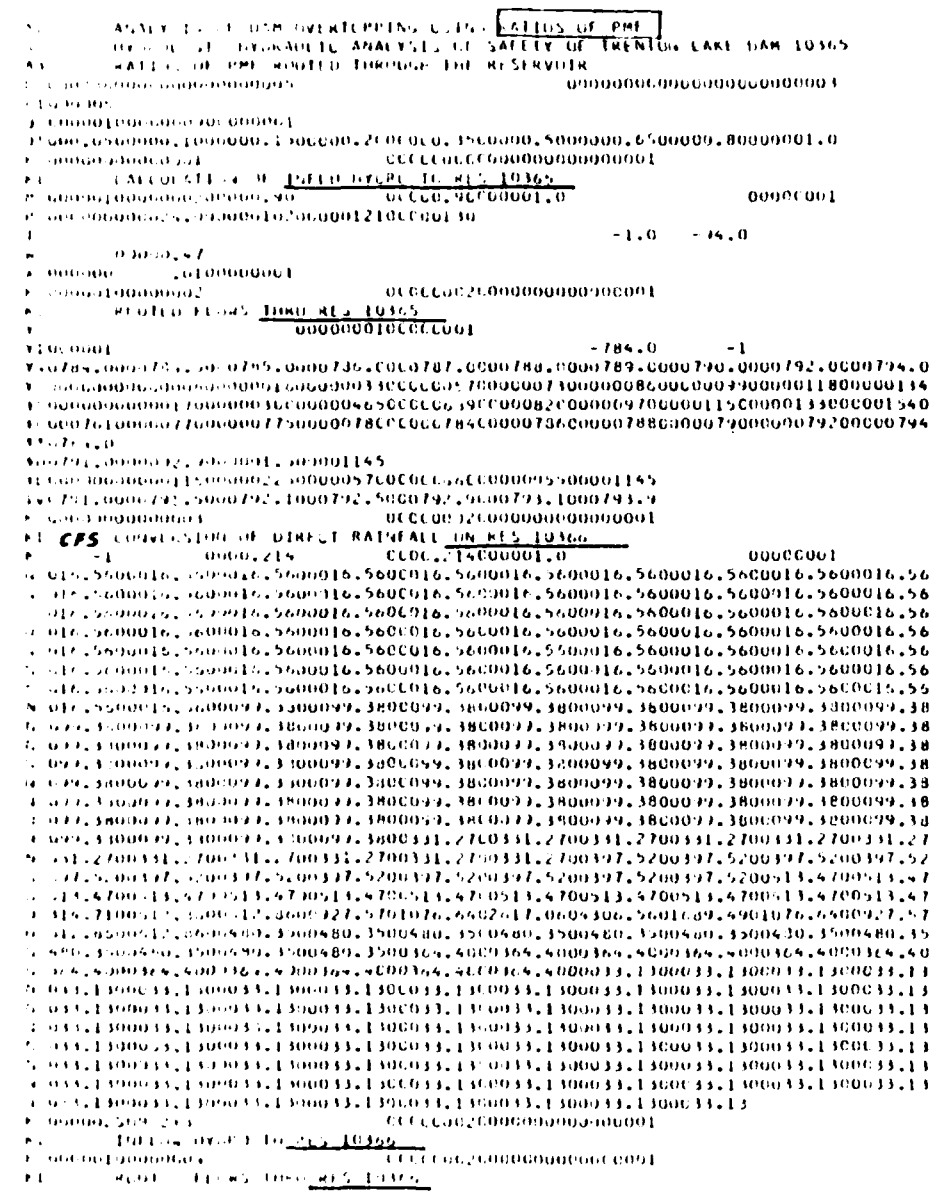


PLATE D-5

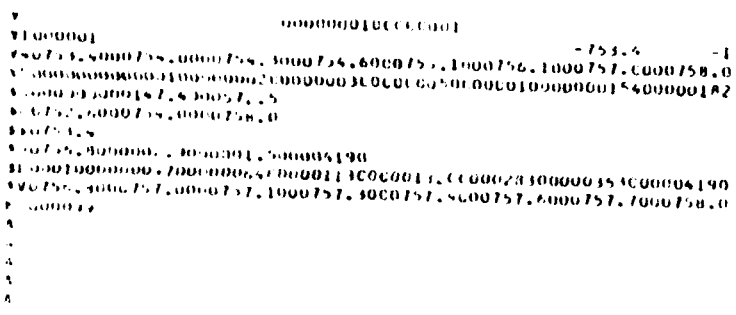


PLATE D-6

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	000001
ROUTE HYDROGRAPH TO	000002
RUNOFF HYDROGRAPH AT	000003
COMBINE 2 HYDROGRAPHS AT M 2+3	
ROUTE HYDROGRAPH TO	000004
END OF NETWORK	

PLATE D-7

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

 RUN DATE = 77/07/26.
 TIME = 11.00.45.
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF TRENTON LAKE DAM 10365
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
299	0	5	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= .05 .10 .15 .20 .35 .50 .65 .80 1.00

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

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLO HYDRO TO RES 10365

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.90	0.00	.90	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	102.00	121.00	140.00	0.00	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	-94.00	0.00	0.00

CURVE NO = -94.00 RETNESS = -1.00 EFFECT OF = 94.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .47

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

UNIT HYDROGRAPH 30 END-OF-PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .47 VOL= 1.00

93.	188.	384.	631.	787.	849.	821.	729.	607.	451.
311.	257.	206.	159.	119.	90.	67.	53.	41.	31.
23.	19.	14.	11.	9.	7.	5.	4.	2.	1.

PLATE D-8

CFS	5157.	1850.	587.	587.	168929.
CMS	146.	52.	17.	17.	4784.
INCHES		19.12	24.25	24.25	24.25
MM		485.71	615.96	615.96	615.96
AC-FT		917.	1163.	1163.	1163.
THOUS CU M		1132.	1435.	1435.	1435.

HYDROGRAPH AT STA0G0001 FOR PLAN 1, RTIO 9 PMF

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6446.	2313.	733.	733.	211161.
CMS	183.	65.	21.	21.	5979.
INCHES		23.90	30.31	30.31	30.31
MM		607.14	769.95	769.95	769.95
AC-FT		1147.	1454.	1454.	1454.
THOUS CU M		1415.	1794.	1794.	1794.

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

HYDROGRAPH ROUTING

ROUTED FLOWS INDU RES 10365

ISTAG	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	ISTR
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	-784.	-1

STAGE	784.00	784.50	785.00	786.00	787.00	788.00	789.00	790.00	792.00	794.00
FLOW	0.00	8.00	16.00	33.00	57.00	73.00	86.00	99.00	118.00	134.00
CAPACITY=	0.	170.	300.	465.	689.	820.	970.	1150.	1330.	1540.
ELEVATION=	761.	770.	775.	780.	784.	786.	788.	790.	792.	794.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
784.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
791.0	2.9	1.5	1145.

CREST LENGTH	0.	115.	225.	570.	660.	955.	1145.
AT OR BELOW ELEVATION	791.0	791.5	792.1	792.5	792.9	793.1	793.9

STATION 000002, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

PLATE D-9

STATION 0CC002, PLAN 1, RATIO 9 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.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	2.	2.	2.	2.	2.	2.	2.	2.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
4.	4.	4.	4.	4.	4.	4.	5.	5.	5.
6.	6.	7.	7.	8.	9.	9.	10.	10.	11.
12.	12.	13.	14.	14.	15.	16.	16.	17.	18.
18.	19.	20.	21.	21.	22.	23.	23.	24.	25.
26.	26.	27.	28.	28.	29.	30.	31.	31.	32.
33.	33.	34.	35.	36.	37.	38.	39.	40.	40.
41.	42.	43.	44.	45.	46.	46.	47.	48.	49.
50.	51.	51.	52.	53.	54.	55.	56.	57.	58.
60.	61.	63.	64.	66.	68.	69.	71.	73.	74.
76.	77.	79.	80.	82.	83.	85.	86.	88.	89.
91.	93.	94.	96.	98.	100.	101.	102.	104.	105.
107.	108.	110.	119.	140.	177.	246.	363.	540.	888.
1504.	2302.	3202.	3953.	4425.	4602.	4551.	4366.	4120.	3857.
3601.	3365.	3156.	2975.	2819.	2684.	2567.	2463.	2368.	2280.
2199.	2123.	2054.	1991.	1935.	1885.	1840.	1797.	1750.	1694.
1629.	1560.	1446.	1345.	1244.	1146.	1054.	973.	900.	836.
780.	730.	686.	647.	612.	582.	554.	530.	508.	488.
470.	454.	439.	424.	411.	398.	387.	375.	363.	352.
343.	333.	324.	316.	308.	301.	294.	288.	282.	276.
270.	265.	260.	256.	251.	247.	243.	239.	235.	232.
229.	225.	222.	219.	217.	214.	211.	209.	207.	204.
202.	200.	198.	196.	194.	192.	191.	189.		

STORAGE

689.	689.	689.	689.	689.	689.	689.	689.	689.	689.
689.	689.	689.	689.	689.	689.	689.	689.	689.	689.
689.	689.	689.	689.	690.	690.	690.	690.	690.	690.
691.	691.	691.	691.	691.	692.	692.	692.	692.	693.
693.	694.	694.	694.	694.	694.	695.	695.	695.	696.
696.	696.	697.	697.	698.	698.	698.	699.	699.	699.
700.	700.	701.	701.	701.	702.	702.	702.	703.	703.
704.	704.	705.	705.	706.	706.	707.	708.	710.	711.
713.	715.	717.	719.	722.	724.	727.	729.	732.	734.
737.	740.	742.	745.	748.	750.	753.	756.	759.	761.
764.	767.	769.	772.	775.	778.	780.	783.	786.	789.
791.	794.	797.	800.	802.	805.	808.	810.	813.	816.
819.	821.	824.	827.	829.	832.	835.	838.	840.	843.
846.	848.	851.	854.	856.	859.	862.	865.	867.	870.
873.	875.	878.	880.	883.	886.	889.	892.	897.	902.
907.	914.	921.	929.	937.	945.	954.	962.	971.	980.
990.	999.	1009.	1020.	1030.	1041.	1051.	1062.	1073.	1084.
1095.	1106.	1118.	1130.	1143.	1155.	1168.	1182.	1195.	1208.
1222.	1236.	1249.	1263.	1276.	1291.	1307.	1327.	1351.	1381.
1412.	1443.	1468.	1480.	1490.	1500.	1499.	1495.	1489.	1484.
1478.	1472.	1467.	1462.	1458.	1454.	1451.	1448.	1445.	1442.
1439.	1437.	1434.	1432.	1430.	1428.	1426.	1425.	1423.	1421.
1418.	1414.	1410.	1405.	1400.	1395.	1391.	1386.	1381.	1377.
1373.	1369.	1366.	1362.	1359.	1356.	1353.	1350.	1347.	1345.

PLATE D-10

1342.	1340.	1338.	1336.	1334.	1332.	1330.	1328.	1327.	1325.
1324.	1322.	1321.	1320.	1318.	1317.	1316.	1315.	1314.	1313.
1312.	1311.	1310.	1309.	1308.	1307.	1307.	1306.	1305.	1304.
1304.	1303.	1302.	1302.	1301.	1300.	1300.	1299.	1299.	1298.
1297.	1297.	1296.	1296.	1295.	1295.	1295.	1294.		

STAGE

784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0
784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0
784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0
784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.0	784.1	784.1
784.1	784.1	784.1	784.1	784.1	784.1	784.1	784.1	784.1	784.1
784.1	784.1	784.1	784.1	784.1	784.1	784.1	784.1	784.2	784.2
784.2	784.2	784.2	784.2	784.2	784.2	784.2	784.2	784.2	784.2
784.2	784.2	784.2	784.2	784.3	784.3	784.3	784.3	784.3	784.3
784.4	784.4	784.4	784.5	784.5	784.5	784.6	784.6	784.7	784.7
784.7	784.8	784.8	784.9	784.9	784.9	785.0	785.0	785.1	785.1
785.1	785.2	785.2	785.3	785.3	785.4	785.4	785.4	785.5	785.5
785.6	785.6	785.6	785.7	785.7	785.8	785.8	785.9	785.9	786.0
786.0	786.0	786.1	786.1	786.1	786.2	786.2	786.2	786.3	786.3
786.3	786.4	786.4	786.5	786.5	786.5	786.6	786.6	786.6	786.7
786.7	786.7	786.8	786.8	786.8	786.9	786.9	787.0	787.0	787.1
787.2	787.3	787.3	787.4	787.6	787.7	787.8	787.9	788.0	788.1
788.2	788.3	788.4	788.6	788.7	788.8	788.9	789.0	789.1	789.3
789.4	789.5	789.6	789.8	789.9	790.1	790.2	790.4	790.5	790.6
790.8	791.0	791.1	791.3	791.4	791.6	791.7	792.0	792.2	792.5
792.9	793.1	793.3	793.5	793.6	793.6	793.6	793.6	793.5	793.5
793.4	793.4	793.3	793.3	793.2	793.2	793.2	793.1	793.1	793.1
793.0	793.0	793.0	793.0	793.0	792.9	792.9	792.9	792.9	792.9
792.8	792.8	792.8	792.7	792.7	792.6	792.6	792.5	792.5	792.4
792.4	792.4	792.3	792.3	792.3	792.2	792.2	792.2	792.2	792.1
792.1	792.1	792.1	792.1	792.0	792.0	792.0	792.0	792.0	791.9
791.9	791.9	791.9	791.9	791.9	791.9	791.8	791.8	791.8	791.8
791.8	791.8	791.8	791.8	791.8	791.7	791.7	791.7	791.7	791.7
791.7	791.7	791.7	791.7	791.7	791.7	791.7	791.7	791.7	791.6
791.6	791.6	791.6	791.6	791.6	791.6	791.6	791.6		

PEAK OUTFLOW IS 4602. AT TIME 16.33 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4602.	1546.	428.	428.	123192.
CMS	130.	44.	12.	12.	3474.
INCHES		15.98	17.71	17.71	17.71
MM		405.77	449.92	449.92	449.92
AC-FT		766.	850.	850.	850.
THOUS CU M		945.	1048.	1048.	1048.

PLATE D-11

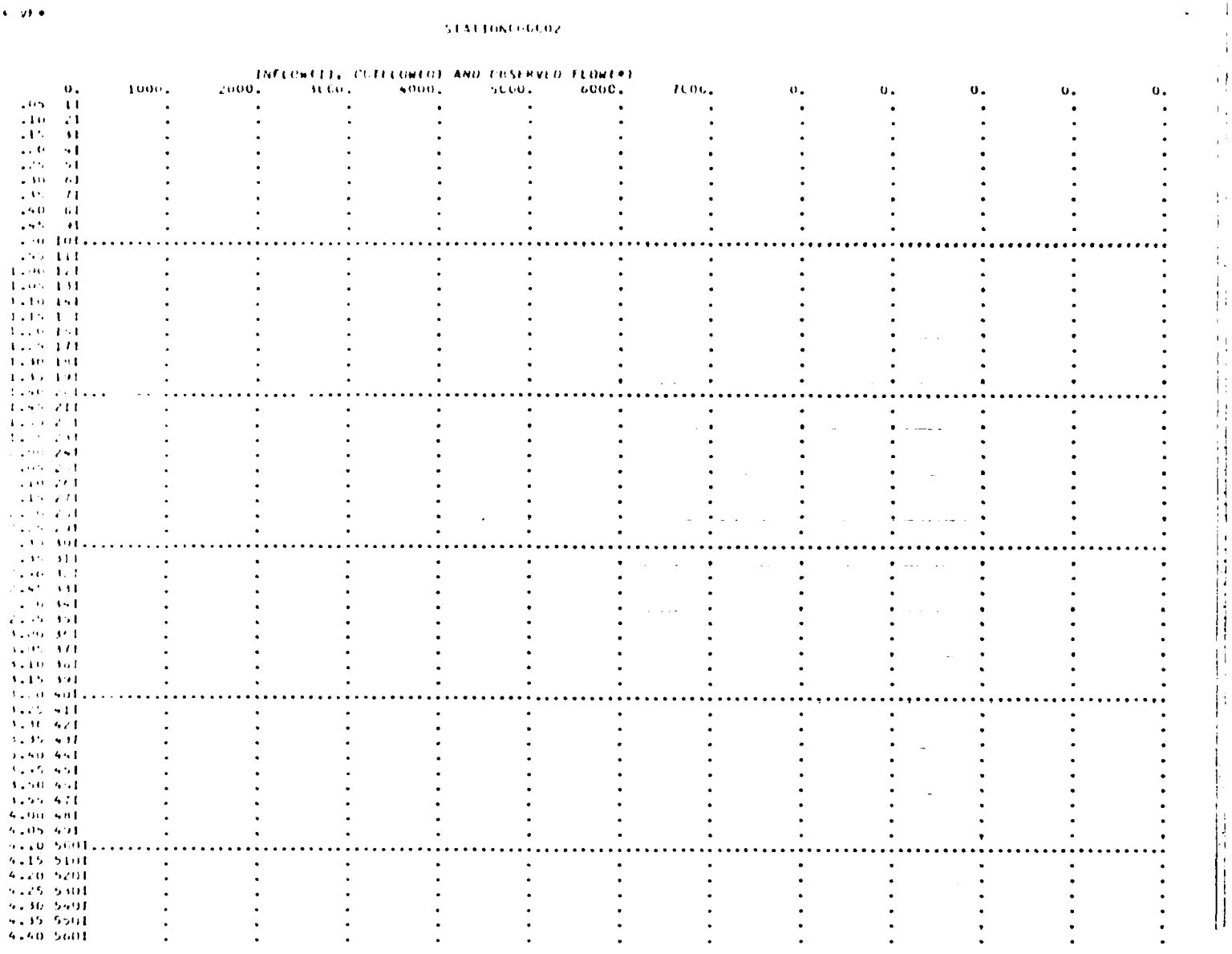

STATION=GG02
INFLOW(I), OUTFLOW(O) AND RESERVED FLOW(*)
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.

PLATE D-12

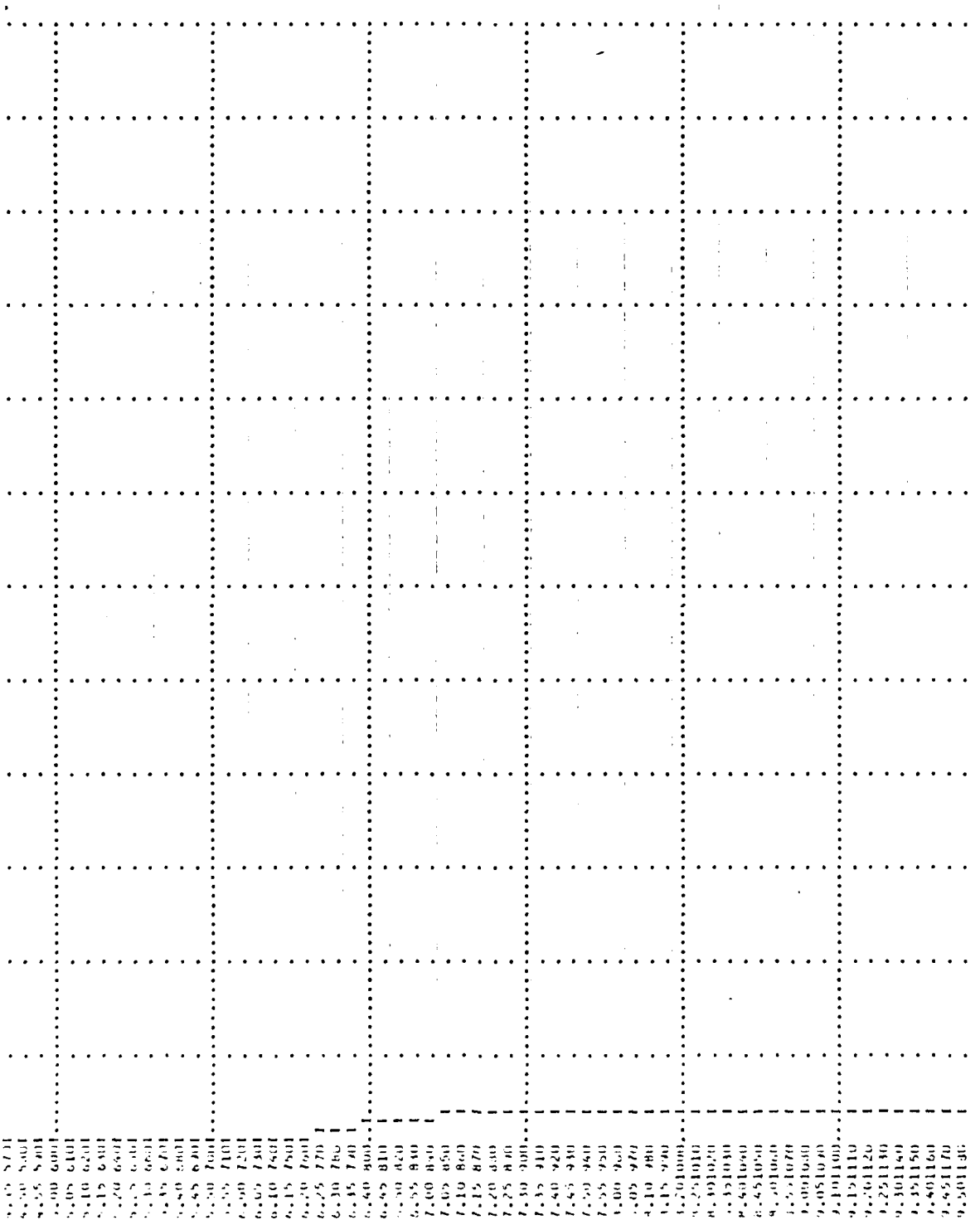


PLATE D-13

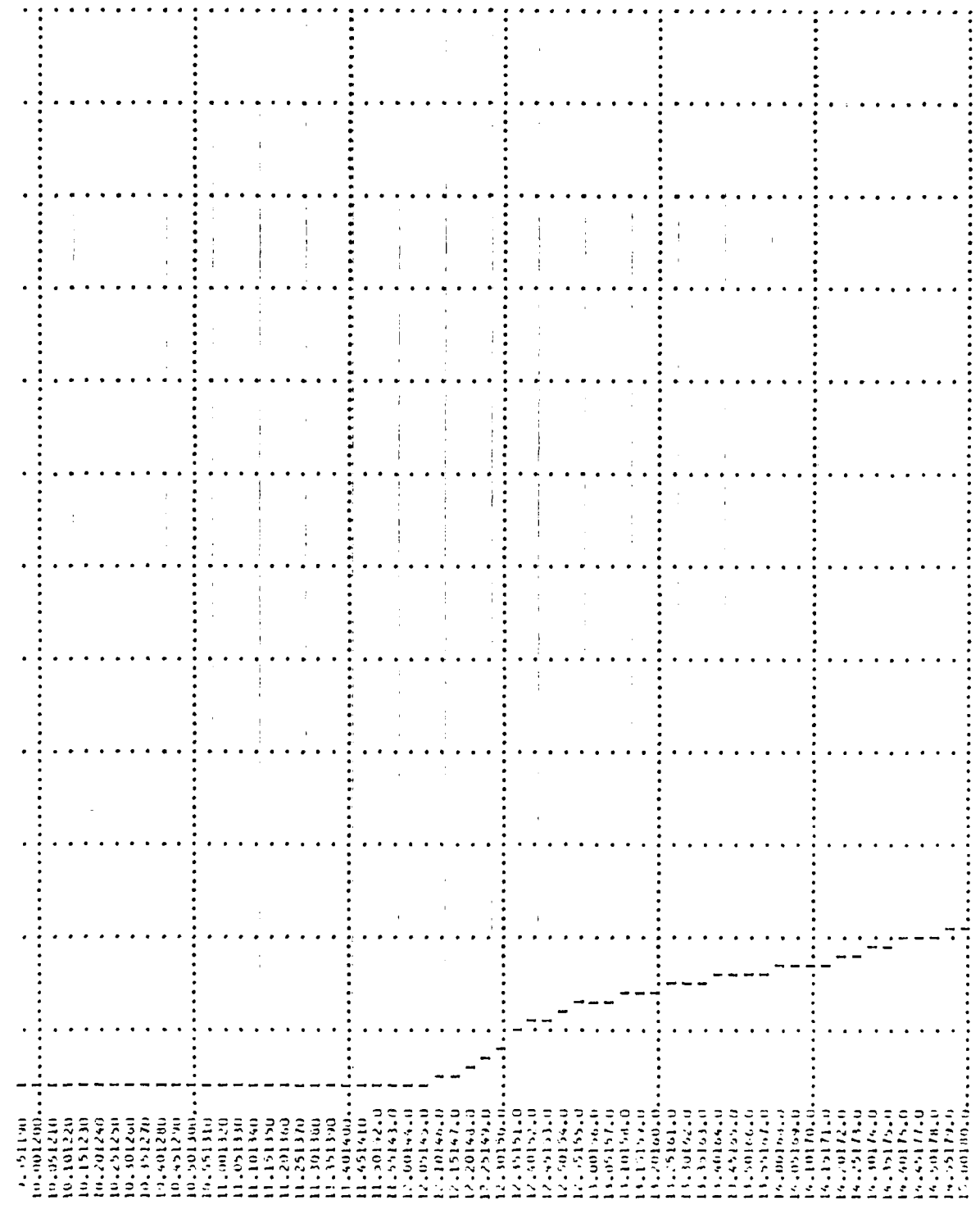


PLATE D-14

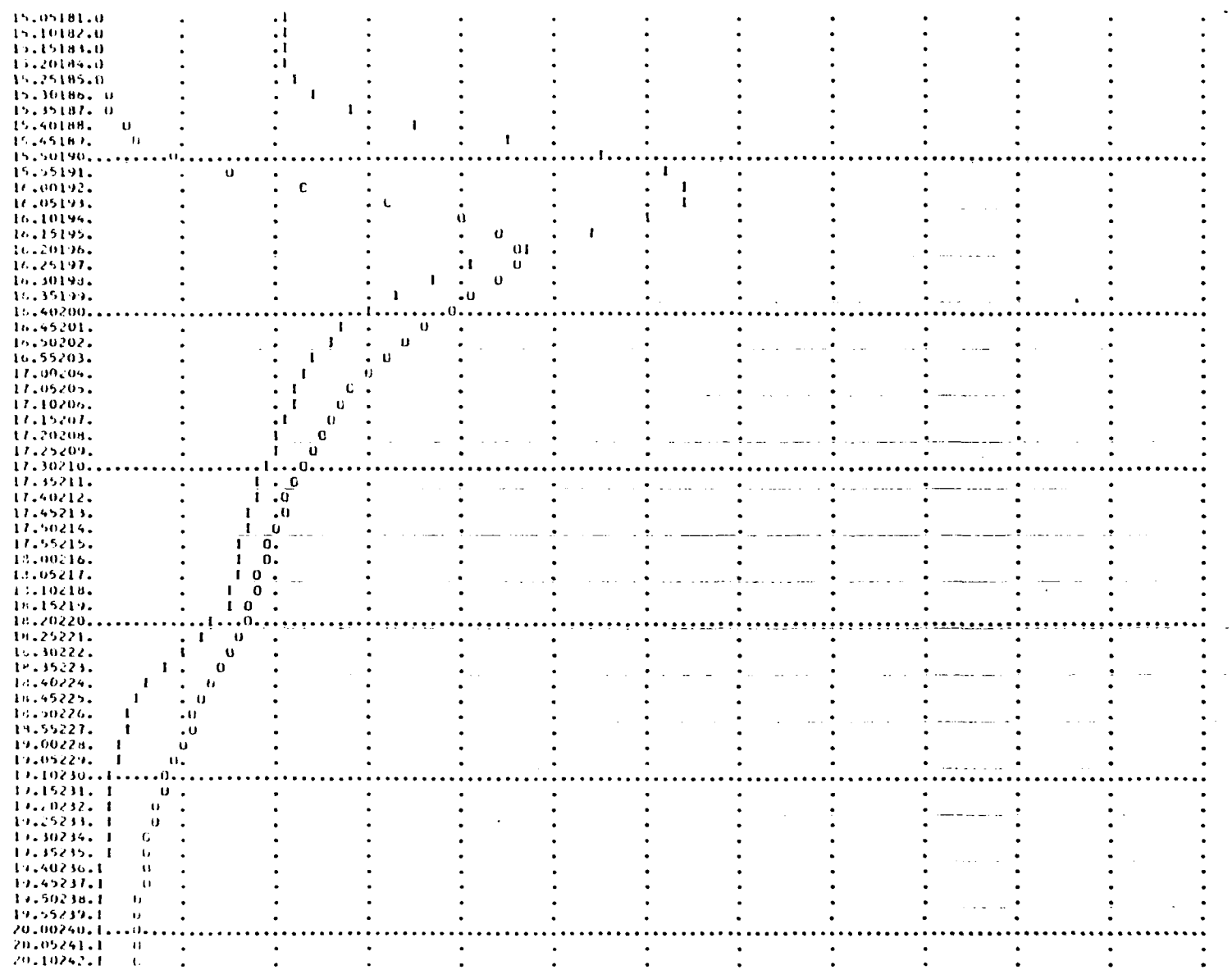


PLATE D-15

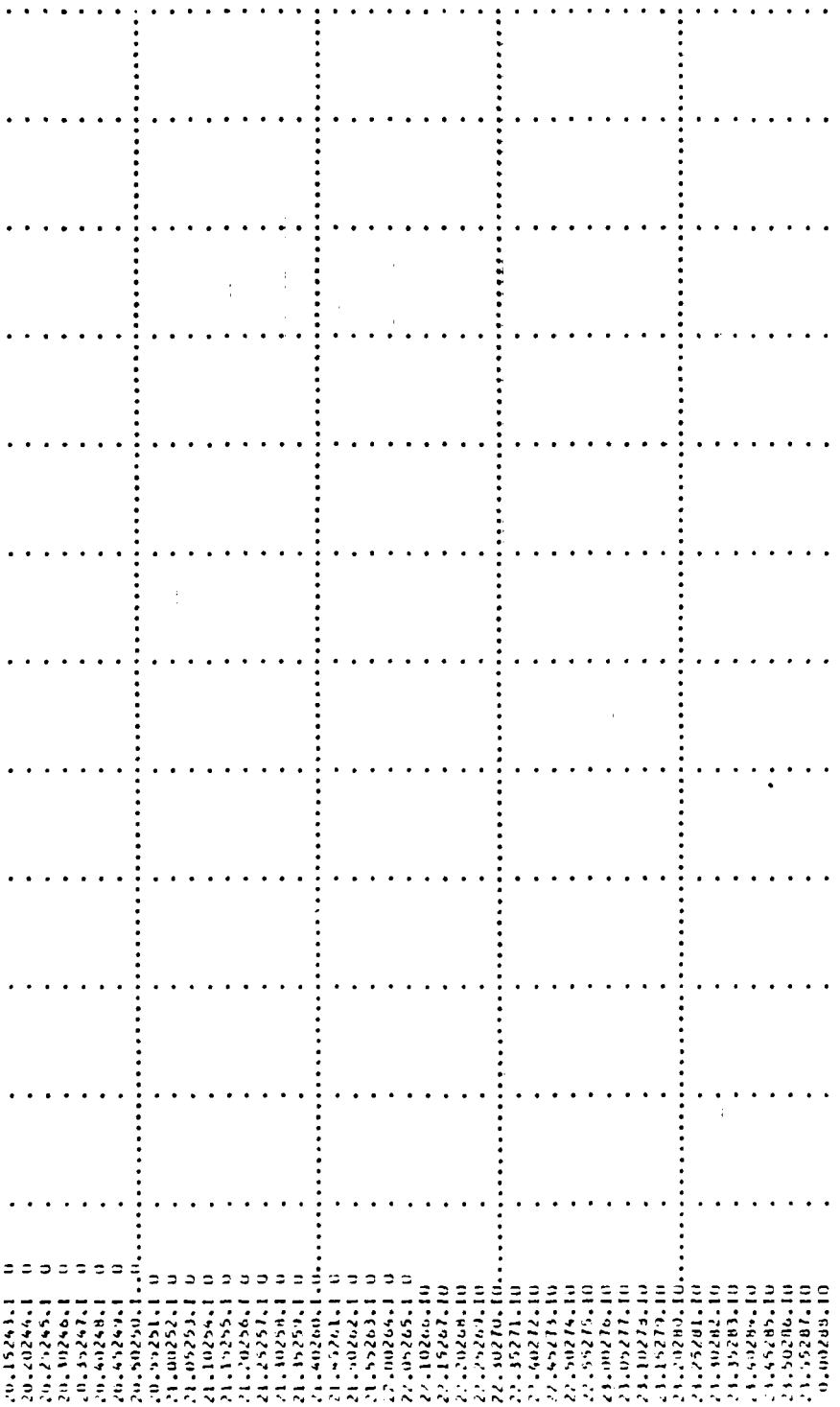


PLATE D-16

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 .05	RATIO 2 .10	RATIO 3 .15	RATIO 4 .20	RATIO 5 .35	RATIO 6 .50	RATIO 7 .65	RATIO 8 .80	RATIO 9 1.00
HYDROGRAPH AT	000001	.90	1	322.	645.	967.	1289.	2256.	3223.	4190.	5157.	6446.
		(2.33)	(	9.13)	18.25)	27.38)	36.51)	63.89)	91.27)	118.65)	146.03)	182.54)
ROUTED TO	000002	.90	1	16.	32.	52.	67.	98.	327.	1128.	2294.	4602.
		(2.33)	(	.44)	.91)	1.48)	1.91)	2.76)	9.25)	31.95)	64.95)	130.31)
HYDROGRAPH AT	000003	.21	1	215.	431.	646.	861.	1507.	2153.	2799.	3445.	4307.
		(.55)	(	6.10)	12.19)	18.29)	24.39)	42.68)	60.97)	79.27)	97.56)	121.95)
2 COMBINED	M 003	1.11	1	223.	446.	669.	892.	1566.	2230.	2890.	3548.	5082.
		(2.89)	(	6.31)	12.62)	18.95)	25.27)	44.35)	63.15)	81.82)	100.46)	143.91)
ROUTED TO	000004	1.11	1	4.	9.	16.	24.	47.	91.	553.	1974.	4305.
		(2.89)	(	.12)	.24)	.45)	.68)	1.33)	2.58)	15.65)	55.83)	121.89)

PLATE D-17

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .RES..10345

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	784.00	784.00	791.00
STORAGE	689.	689.	1240.
OUTFLOW	0.	0.	109.

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
.05	784.91	0.00	753.	16.	0.00	19.00	0.00
.10	785.95	0.00	817.	32.	0.00	19.00	0.00
.15	786.81	0.00	881.	52.	0.00	18.92	0.00
.20	787.65	0.00	944.	67.	0.00	18.92	0.00
.35	789.88	0.00	1140.	98.	0.00	19.08	0.00
.50	791.90	.90	1321.	327.	7.00	18.67	0.00
.65	792.61	1.61	1395.	1128.	7.92	17.67	0.00
.80	793.07	2.07	1443.	2294.	8.25	16.67	0.00
1.00	793.62	2.62	1500.	4602.	8.83	16.33	0.00

PLATE D-18


DATE
ILME