01 Jan 1980

Phase 1 Inspection Report: National Dam Safety Program. Mississippi - Kaskaskia - St. Louis Basin. Lac Benet Dam, St. Francois County, Missouri

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

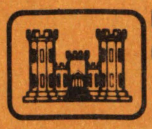
MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

LAC BENET DAM

ST. FRANCOIS COUNTY, MISSOURI

MO 30281

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
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St. Louis District

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

FOR: STATE OF MISSOURI

OCTOBER, 1980

LAC BENET DAM

ST. FRANCOIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. MO 30281

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

OCTOBER 1980

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

REPLY TO
ATTENTION OF

SUBJECT: Lac Benet Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lac Benet Dam (MO 30281).

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:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — 11 MAR 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 11 MAR 1981
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	Lac Benet Dam
State Located	Missouri
County Located	St. Francois County
Stream	Tributary to Big River
Date of Inspection	October 29, 1980

Lac Benet 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.

Lac Benet Dam has a height of thirty-five (35) feet and a storage capacity at the minimum top elevation of the dam of eighty-three (83) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Lac Benet Dam is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are three dwellings and a lake and dam.

Our inspection and evaluation indicates that the spillway does not meet criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream channel from the dam, one half of the Probable Maximum Flood is the appropriate spillway design flood. The spillway will pass the 100-year flood (1% probability flood - a flood having a one percent chance of being exceeded in any one year) without overtopping the dam. The spillway will pass 25% 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.

Design data were not available for this dam. Based on the observations made during the field inspection of the dam, the following remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams:

a. Alternatives.

(1) An emergency spillway should be constructed and/or the height of the dam should be increased in order to pass 50 percent of the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(2) Remedial measures should be taken to halt the scouring which is occurring under the outlet end of the spillway conduit.

(3) The few small saplings which have started growth on the downstream slope should be removed.

(4) The amount and character of seepage should be monitored at regular intervals.

(5) A trash rack should be mounted on the inlet end of the principal spillway pipe.

(6) The dam should be inspected at periodic intervals, and records of the inspections should be made a part of the project file on this dam.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

H. P. Hoskins

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

PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAC BENET DAM - MO 30281
ST. FRANCOIS 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 Lac Benet 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) Embankment. The dam is a small earthfill structure approximately 450 feet in length and 35 feet in height. The maximum water storage at the minimum top elevation of the dam is 83 acre-feet.

(2) Principal Spillway. The principal (and only) spillway is a 58-inch x 36-inch corrugated metal pipe-arch conduit. The spillway is 60 feet in length and is located in the right abutment of the dam. There is no inlet structure on the projecting open-end pipe. The inlet end is not equipped with a trash rack. The downstream end of the spillway conduit outlets into the right abutment trough. There is no stilling basin at the outlet end of the spillway.

(3) Low-Level Outlet. There is no low-level outlet.

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

b. Location. The dam is located in the northwest part of St. Francois County, Missouri as shown on Plate A-2. The dam is approximately three miles southwest of the City of Bonne Terre and is shown on Plate A-1 in the SW 1/4 Section 20, T37N, R4E. The lake formed behind the dam is in the same quarter section.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Lac Benet Dam has a height of 35 feet and a storage capacity of 83 acre-feet. This dam is classified as a small size dam. A small size dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to 50 acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size category.

d. Hazard Classification. Guidelines for determining hazard classification of dams and impoundments are presented in the guidelines as referenced in paragraph 1.1c above.

Aerial photographs of the downstream damage zone of this dam were taken in October, 1980. These photographs were used as reference in the field observations of the damage zone which were made during the inspection. Based on the field observations and on the referenced guidelines this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are three dwellings and a lake and dam. Photos 17, 18 and 19 show the downstream damage area.

e. Ownership. The dam is owned by the Terre Du Lac Property Owners' Association, P.O. Box 15, Bonne Terre, Missouri 63628.

f. Purpose of Dam. The dam impounds water for recreation purposes.

g. Design and Construction History. No design or construction information was available. According to Mrs. Fudge, receptionist for the Terre Du Lac Home Owners' Association, the dam was constructed in about 1970.

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. 51.2 acres (0.08 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through a 58" x 36" corrugated metal pipe-arch spillway.

(2) Estimated maximum flood at damsite -- unknown.

(3) The spillway capacity varies from 0 c.f.s. at elevation 900.7 feet to 50 c.f.s. at the minimum top of dam (elevation 903.5 feet).

(4) Total spillway capacity at the minimum top of dam is 50 c.f.s.±.

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

(1) Observed pool - 900.0

(2) Normal pool - 900.7

(3) Spillway crest - 900.7

(4) Maximum experienced pool - 901.7± (wash line)

(5) Top of dam (minimum) - 903.5

(6) Streambed - 868.2

(7) Maximum Tailwater - unknown

d. Reservoir. Length (feet) of pool

(1) At spillway crest - 850

(2) At top of dam (minimum) - 950

e. Storage (Acre-feet).

(1) Observed pool - 59±

(2) Normal pool - 64±

(3) Spillway crest - 64±

(4) Maximum experienced pool - 70±

(5) Top of dam (minimum) - 83±

f. Reservoir Surface (Acres).

(1) Observed pool - 6.2±

(2) Normal pool - 6.4±

(3) Spillway crest - 6.4±

(4) Maximum experienced pool - 6.8±

(5) Top of dam (minimum) - 7.4±

g. Dam.

(1) Type - Earthfill

(2) Length - 450 ft

(3) Height - 35 ft

(4) Top Width - 32 ft ±

(5) Side slopes

(a) Downstream - 1V on 2.1±H

(b) Upstream - 1V on 4.3±H

(6) Zoning - Unknown

(7) Impervious core - Unknown

(8) Cutoff - Unknown

(9) Grout Curtain - Unknown

(10) Wave protection - Vegetated with fescue, crown vetch, and other adapted grasses.

(11) Drains - Unknown

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Type - 58" x 36" corrugated metal pipe-arch conduit.

(2) Crest (invert) elevation - 900.7 ft

Outlet (invert) elevation - 899.7 ft

(3) Length - 60 feet.

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. The dam was constructed in about 1970.

2.3 OPERATION

No data were available on spillway operation. Wash lines on the upstream slope would indicate a depth of flow of approximately 1 foot has occurred in the spillway. There was no evidence to indicate that the dam has been overtopped.

2.4 EVALUATION

a. Availability. No data were available.

b. Adequacy. The field surveys and visual observations 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 the Lac Benet Dam was made on October 29, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were:

Rey S. Decker - Geotechnical
Garold G. Ulmer - Hydraulics and Hydrology
Gordon G. Jamison - Hydraulics and Hydrology

The owner, Terre Du Lac Home Owners' Association, was not represented during the inspection.

b. Dam.

(1) Geology and Soils (abutment and embankment). The embankment is situated in the Ozark Physiographic Province. The moderate to steep slopes of the upland setting are mantled by the Cantwell-Gasconade silty clays formed in limestone residuum. The bedrock is the Potosie Formation composed locally of dolomites. The significant structural features are the surrounding fault systems including the Simms Mountain, Big River and Palmer. The dam is located in Seismic Zone 2 which is indicative of moderate probability of earthquake activity. The groundwater movement under the embankment is controlled by seepage through the bedding planes of the bedrock.

The upland setting poses no significant hazard to the embankment. The abutments are dolomites and limestones (exposed in the right abutment trough) with massive bedding and no evidence of solution cavitation. Minor seepage, without flow, was detected at the bedding surface of the massive limestone beds. The ring of surrounding fault systems and the occurrence of numerous low intensity earthquakes within a 25 to 30 mile radius (Stover, Reagor and Algermissen, 1979) indicates a potential for seismic activity. The Modified Mercalli intensities of local earthquakes range from II to V without a record of high intensity quaking.

The embankment rests directly on the Potosie bedrock. No evidence of Karst topography exists at the site. The druse free dolomites are interbedded with stromatactis limestones.

The embankment consists of moderate to highly plastic clayey silts (MH or CH) with cherty gravels which are residual on the bedrock surface. Soil classification was done in the field from materials obtained by hand auger at depths of approximately 2 feet.

Groundwater moving under the embankment is ponding at the toe with a flow of less than 2 gpm. Phreatophytes, cattails and marshgrasses are evidence of the constancy of the seepage. The flow is "perched" on the bedrock.

(2) Upstream Slope. The upstream slope above the normal pool elevation is well vegetated with fescue, crown vetch, and native grasses. There is some minor erosion occurring at the water level, but it is not significant. There are no trees or shrubs and no indications of slumps, cracking, or rodent activity. Field measurements indicate the upstream slope to be approximately 1V on 4.3±H. The upstream slope appears quite flat for at least 10 feet out into the lake. Photo No. 4 shows the upstream slope.

(3) Crest. Measurements indicate the crest varies considerably in profile with the lowest elevations near the center of the dam. A well gravelled road traverses the top of the dam. No cracks, settlements or potholes were in evidence. Photo Nos. 3 and 11 show the crest.

(4) Downstream Slope. The downstream slope of the dam has an excellent vegetative cover of fescue, crown vetch, and native grasses. There are several small cottonwood saplings growing on the downstream slope. There is some minor erosion on the downstream slope. There are no indications of rodent activity or of cracks, slumps, or other deformations. There was no evidence of seepage on the slope but cattails and ponded seepage water occur outside the toe of the dam downstream from about Sta. 3+00 to 3+50. At least part of the ponded seepage results from flow through the bedrock exposed in the right abutment trough. All seepage was clear and total discharge was estimated to be about 2 gpm. The right abutment trough, which serves as the exit channel for the spillway, is eroded to bedrock. There is an approximate 4-foot vertical cut immediately below the spillway outlet, and some undercutting of the spillway conduit has occurred. Photos No. 8, 10 and 13 show the downstream slope. Photos 14, 15 and 16 show the seep areas. Photos 9, 10 and 13 show the right abutment trough.

c. Appurtenant Structures.

(1) Spillway.

(a) Inlet. The projecting open-end inlet is in good condition with no bends or tears to obstruct the entrance. There is no debris guard. Photo No. 11 shows the inlet end of the spillway.

(b) Conduit. The conduit appears to be straight and in good condition throughout.

(c) Stilling Basin. The conduit exits into the right abutment trough which has been eroded to bedrock. Photos 9, 10 and 13 shows the exit channel.

(2) Low-Level Outlet. There is no low-level outlet.

d. Reservoir Area. There is no significant erosion around the reservoir shoreline. The shoreline appears to be clear of trash and debris. There was no evidence of heavy siltation. Photo No. 6 shows a portion of the reservoir.

e. Downstream Channel. The outlet channel is on bedrock with a few trees and shrubs, which are not significant. The channel empties into a reservoir located approximately .3 mile downstream of the dam. Photo No. 7 shows the downstream channel. Photo No. 21 shows the point of entry of the downstream channel into the downstream reservoir.

3.2 EVALUATION

This structure appears to be in excellent condition. Seepage at the toe appears to result from flow through the bedrock abutments and foundation and does not have any apparent adverse affect on the stability of the dam. The excellent vegetative growth on the embankments, with minor exceptions, appears to provide adequate protection from wave action and erosion. The undercutting which is occurring under the outlet end of the spillway conduit should be halted, and the few small saplings growing on the downstream slope should be removed. The absence of a trash rack on the principal spillway inlet pipe could result in partial plugging of the pipe due to deposition of logs and debris within the pipe. Loss of spillway capacity would result.

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

Maintenance of the structure appears to be good. The saplings growing on the downstream slope should be eliminated.

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 dam is neat and clean in appearance which can be attributed to maintenance efforts.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available for this dam.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Bonne Terre, Missouri 7-1/2 minute topographic quadrangle map. 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. Hydrologic computations are included in this report as Appendix D.

c. Visual Observations.

(1) It would be advisable to add some protective material immediately below the spillway outlet in order to prevent undercutting of the spillway conduit.

d. Overtopping Potential. The spillway is too small to pass 50 percent of the probable maximum flood without overtopping the dam. The existing spillway will pass 25 percent of the probable maximum flood and the 1 percent probability flood without overtopping the dam.

The erosional damage to the dam that could be caused by overtopping is not known. However, overtopping would be dangerous because the flow of water over the crest could erode the downstream face of the dam and, if continued long enough, could breach the dam with sudden release of the impounded water onto the downstream floodplain.

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	*Maximum Depth Over Dam Feet	Duration Over Top Hours
1%	245	26	902.5	---	---
1/2 PMF	485	395	904.4	0.9	4-
PMF	965	870	904.8	1.3	6
0.25 PMF	245	50	903.5	---	---

* Minimum top of dam elevation - 903.5 ft.

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 potential rating and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillway.

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

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. This dam appears to be structurally stable. There is no evidence of slumps, cracks, slides, or abnormal deformations. Seepage downstream from the toe does not appear to impair 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. The inspection team is not aware of any post-construction changes.

e. Seismic Stability. This dam is located in Seismic Zone 2 as shown on Plate A-3. An earthquake of the magnitude predicted in this area could cause some structural damage to this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Based on visual observations and the measurements made during the inspection, this dam appears to be in excellent condition and structurally stable. There was no evidence of slumps, cracks, slides or abnormal deformations that would indicate structural stress. The vegetative growth on the embankments is excellent and appears, with minor exceptions, to provide adequate protection from wave action and erosion. Tree growth on the downstream slope is limited to several small cottonwood saplings which should be removed. There were no rodent holes in the dam. The seepage observed downstream from the toe appears to flow through the bedrock abutments and foundation of the dam and does not appear to have any adverse affect on the structural stability of the dam. It would be well, however, to monitor the amount and character of the seepage at regular intervals. 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 for dams in the high hazard potential classification.

The right abutment trough, which serves as the exit channel for the spillway, is stable having eroded to bedrock. Scour or undercutting is evident under the spillway conduit upstream from the outlet end. Protective measures should be taken to stop the scouring action.

The absence of a trash rack on the inlet end of the principal spillway pipe could result in partial plugging of the pipe due to deposition of logs and debris within the pipe. Loss of spillway capacity would result.

The approximate hydrologic analysis performed for this dam indicates the spillway is too small to pass 50 percent of the probable maximum flood without overtopping the dam. The 50 percent probable maximum flood would overtop this dam by nine-tenths of a foot for approximately 4 hours. The erosional damage to the dam that could be caused by such overtopping is not known. However, overtopping would be dangerous because the flow of water over the crest could erode the downstream face of the dam and, if continued long enough, could breach the dam with sudden release of all of the impounded water onto the downstream floodplain.

b. Adequacy of Information. The conclusions in this report are based on visual observations and a rather short (10 years) performance history. 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 remedial measures recommended in paragraph 7.2b should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Further Investigations. The additional analyses recommended in paragraph 7.2b should be accomplished by the owner in the near future.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of this magnitude could cause some structural damage to this dam. It is recommended that the prescribed seismic loading for Seismic Zone 2 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

a. Alternatives.

(1) An emergency spillway should be constructed and/or the height of the dam should be increased in order to pass 50 percent of the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(2) Remedial measures should be taken to halt the scouring which is occurring under the outlet end of the spillway conduit.

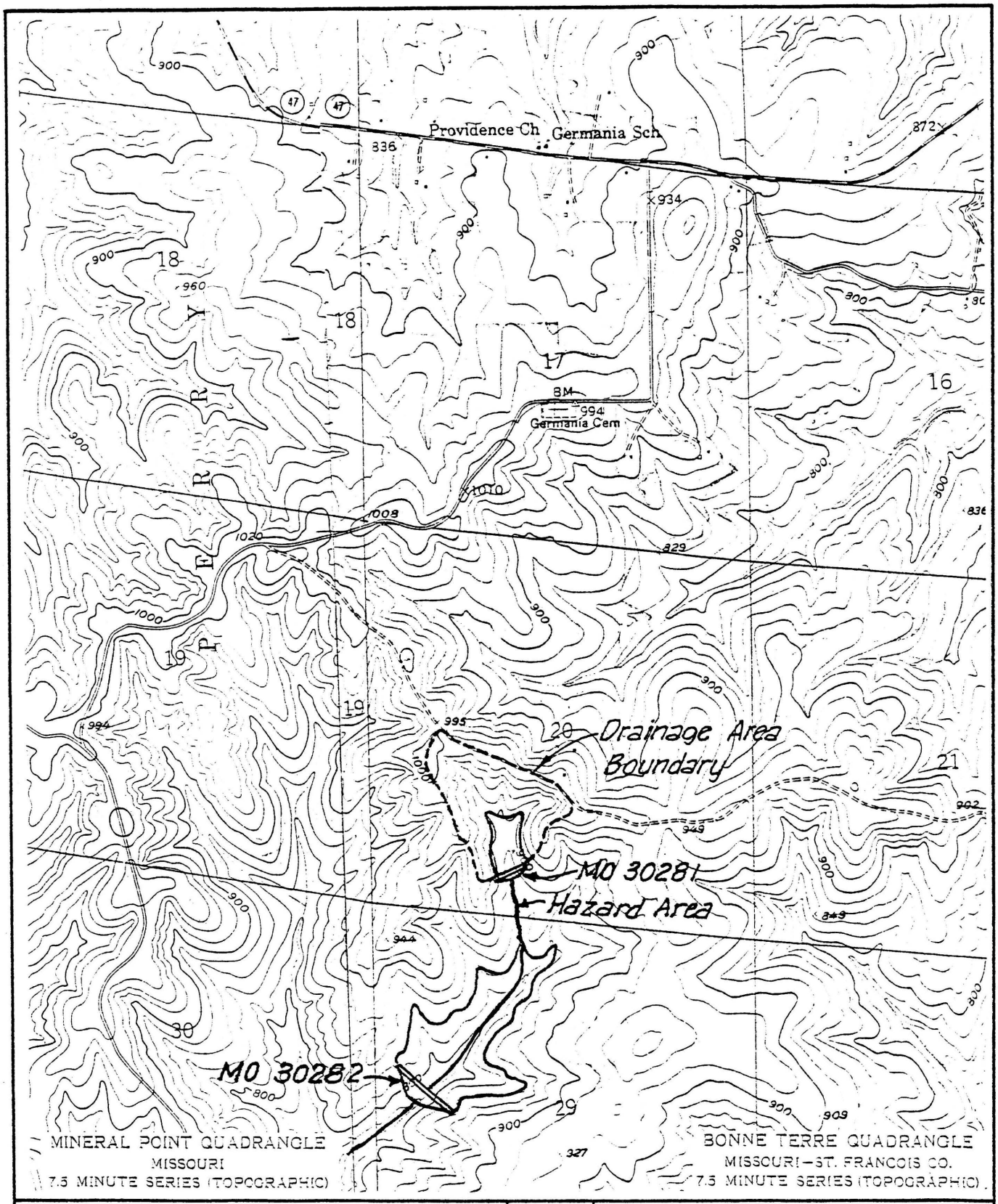
(3) The few small saplings which have started growth on the downstream slope should be removed.

(4) The amount and character of seepage should be monitored at regular intervals.

(5) A trash rack should be mounted on the inlet end of the principal spillway pipe.

(6) The dam should be inspected at periodic intervals, and records of the inspections should be made a part of the project file on this dam.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval – 20'

N

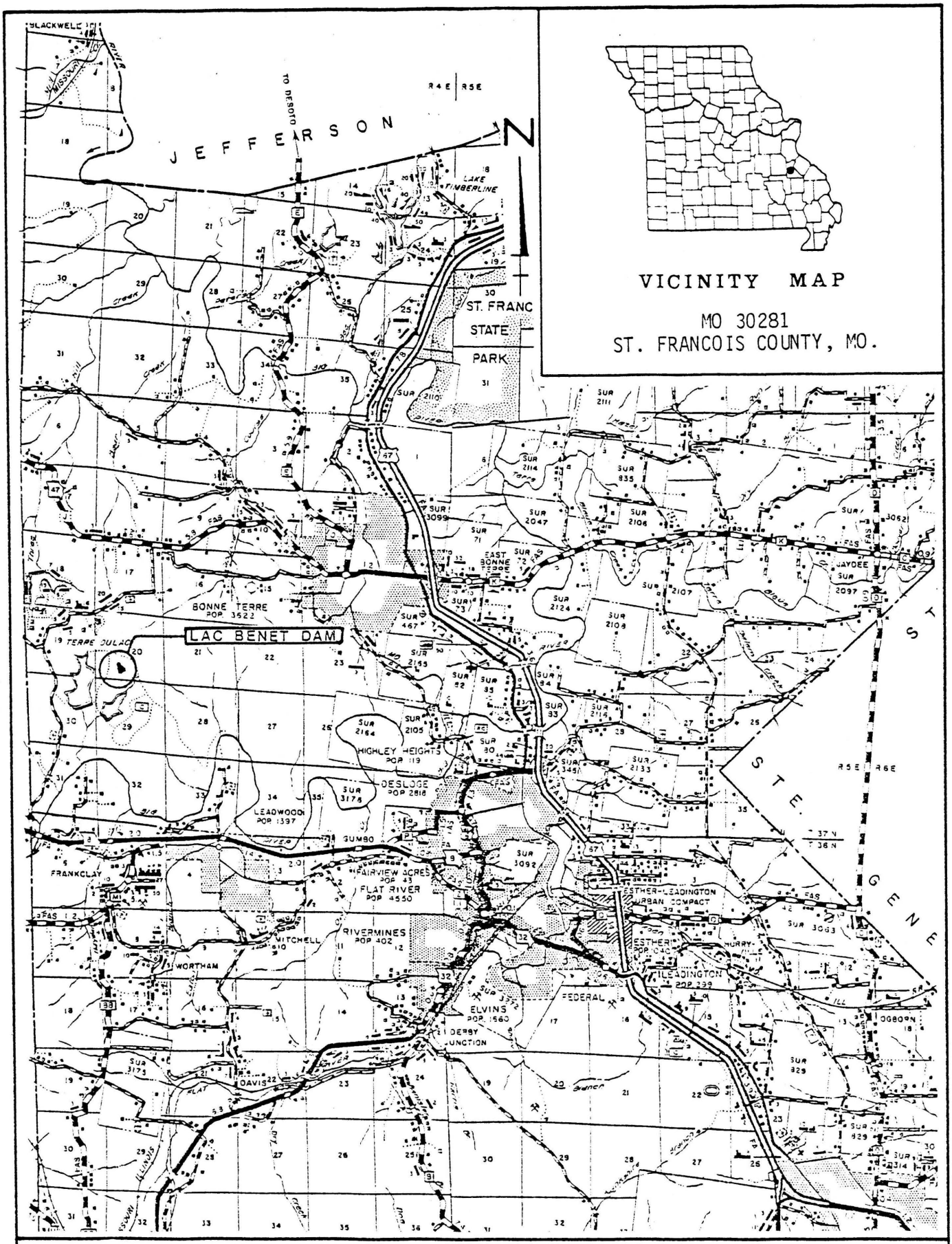
VICINITY TOPOGRAPHY

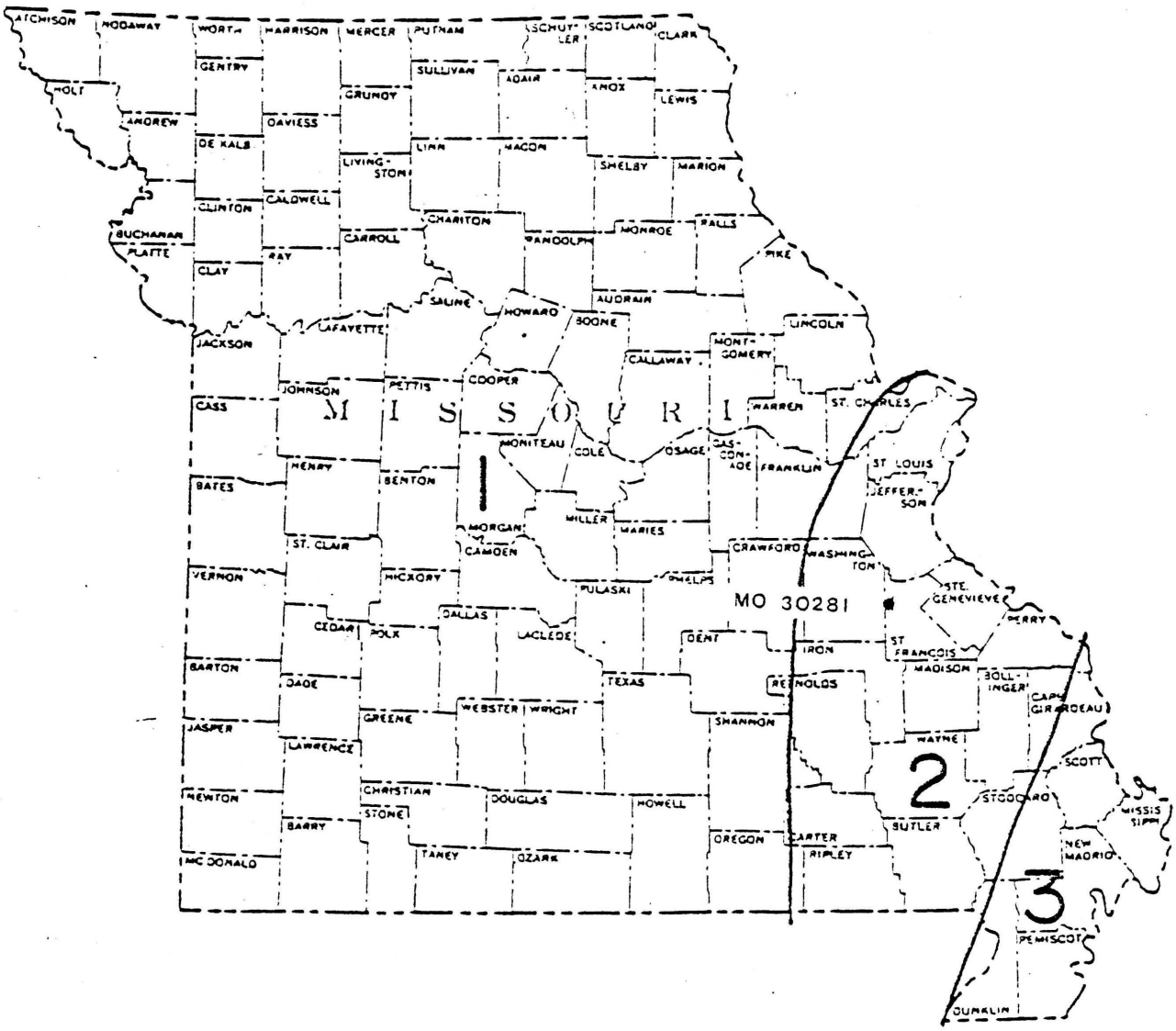
LAC BENET DAM

ST. FRANCOIS COUNTY, MISSOURI

MO 30281

PLATE A-1

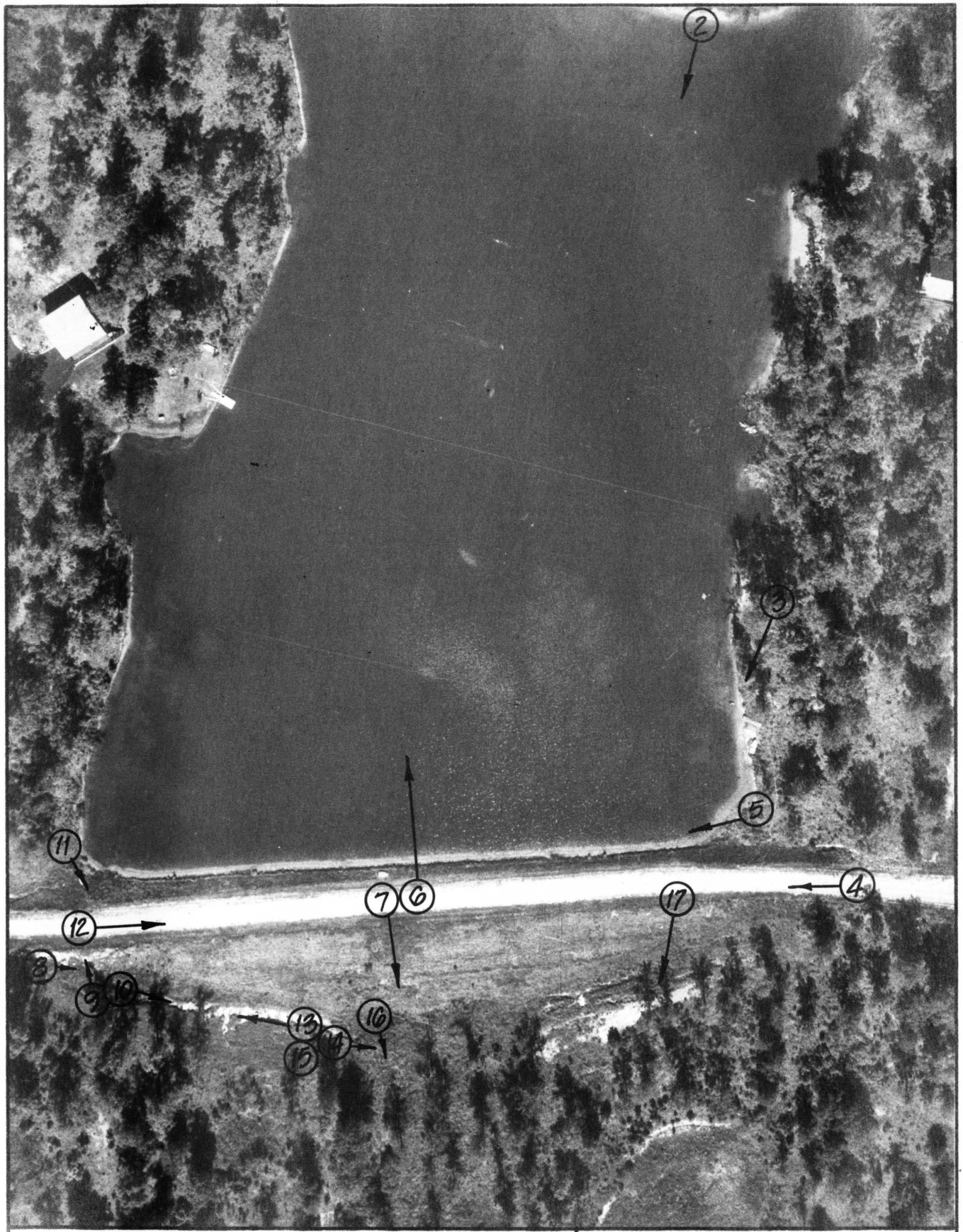

VICINITY MAP
MO 30281
ST. FRANCOIS COUNTY, MO.
JEFFERSON
N
R4E
R5E
TO DESOTO
LAKE TIMBERLINE
ST. FRANC
STATE
PARK
BONNE TERRE
POP 3622
LAC BENET DAM
HIGHLEY HEIGHTS
POP 119
DESLOGE
POP 2818
LEADWOOD
POP 1397
GUMBO
FAIRVIEW ACRES
POP 43
FLAT RIVER
POP 4550
FRANKCLAY
MITCHELL
RIVERMINES
POP 402
WORTHAM
ELVINS
POP 1560
DERBY
JUNCTION
DAVIS
FEDERAL
ESTHER-LEADINGTON
URBAN COMPACT
ESTHER
POP 1040
LEADINGTON
POP 339
HURRY
JAYDEE
EAST BONNE TERRE
R5E
R6E
37 N
36 N
STE. GENE
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2



MISSOURI
SEISMIC ZONE MAP

PLATE A-3

APPENDIX B
PHOTOGRAPHS



LAKE BENET DAM
ST. FRANCOIS COUNTY, MISSOURI
MO. 30281

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - OVERVIEW FROM UPSTREAM ENTRANCE CHANNEL

PHOTO NO. 3 - OVERVIEW FROM LEFT UPSTREAM BANK

PHOTO NO. 4 - CREST FROM THE LEFT END

PHOTO NO. 5 - UPSTREAM SLOPE FROM THE LEFT END

PHOTO NO. 6 - LOOKING UPSTREAM FROM STA. 3+00

PHOTO NO. 7 - LOOKING DOWNSTREAM FROM STA. 3+00

PHOTO NO. 8 - DOWNSTREAM SLOPE TAKEN FROM RIGHT END

PHOTO NO. 9 - OUTLET END OF PRINCIPAL SPILLWAY PIPE

PHOTO NO. 10 - VIEW LOOKING DOWN THE SPILLWAY EXIT CHANNEL (RIGHT TROUGH)

PHOTO NO. 11- INLET TO THE PRINCIPAL SPILLWAY PIPE

PHOTO NO. 12 - DAM CREST FROM RIGHT END

PHOTO NO. 13 - LOOKING UP SPILLWAY EXIT CHANNEL IN RIGHT ABUTMENT TROUGH

PHOTO NO. 14 - CATTAIL AREA AT TOE OF DAM
(STA. 3+00 to 3+50)

PHOTO NO. 15 - SEEPY AREA AT BASE OF RIGHT ABUTMENT TROUGH

PHOTO NO. 16 - WATER STANDING IN CATTAIL AREA (STA. 3+20)

PHOTO NO. 17 - LOOKING DOWNSTREAM AT LAKE AREA BELOW LAC BENET

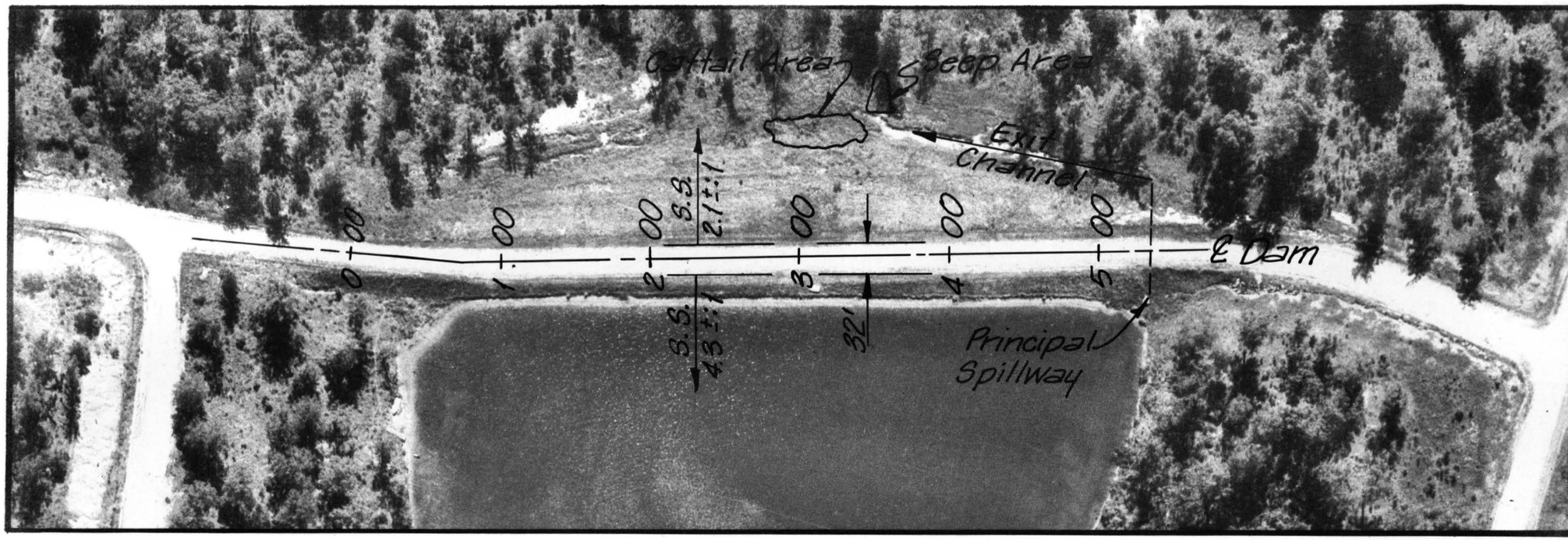
PHOTO NO. 18 - DOWNSTREAM HAZARD JUST ABOVE LOWER LAKE

PHOTO NO. 19 - ANOTHER DOWNSTREAM HAZARD AT UPSTREAM END OF LOWER LAKE

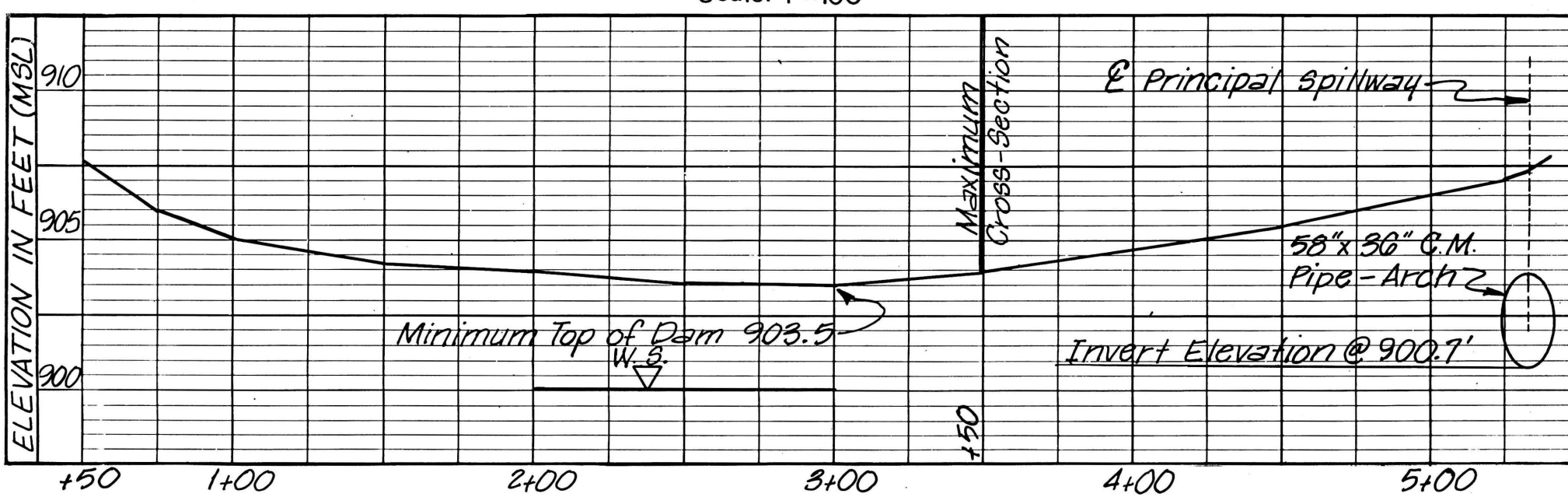
PHOTO NO. 20 - HOUSE JUST BELOW DAM ON RIGHT SIDE OF CHANNEL

PHOTO NO. 21 - LOOKING ACROSS ENTRANCE OF THE BENET CHANNEL INTO THE LOWER LAKE

APPENDIX C
PROJECT PLATES



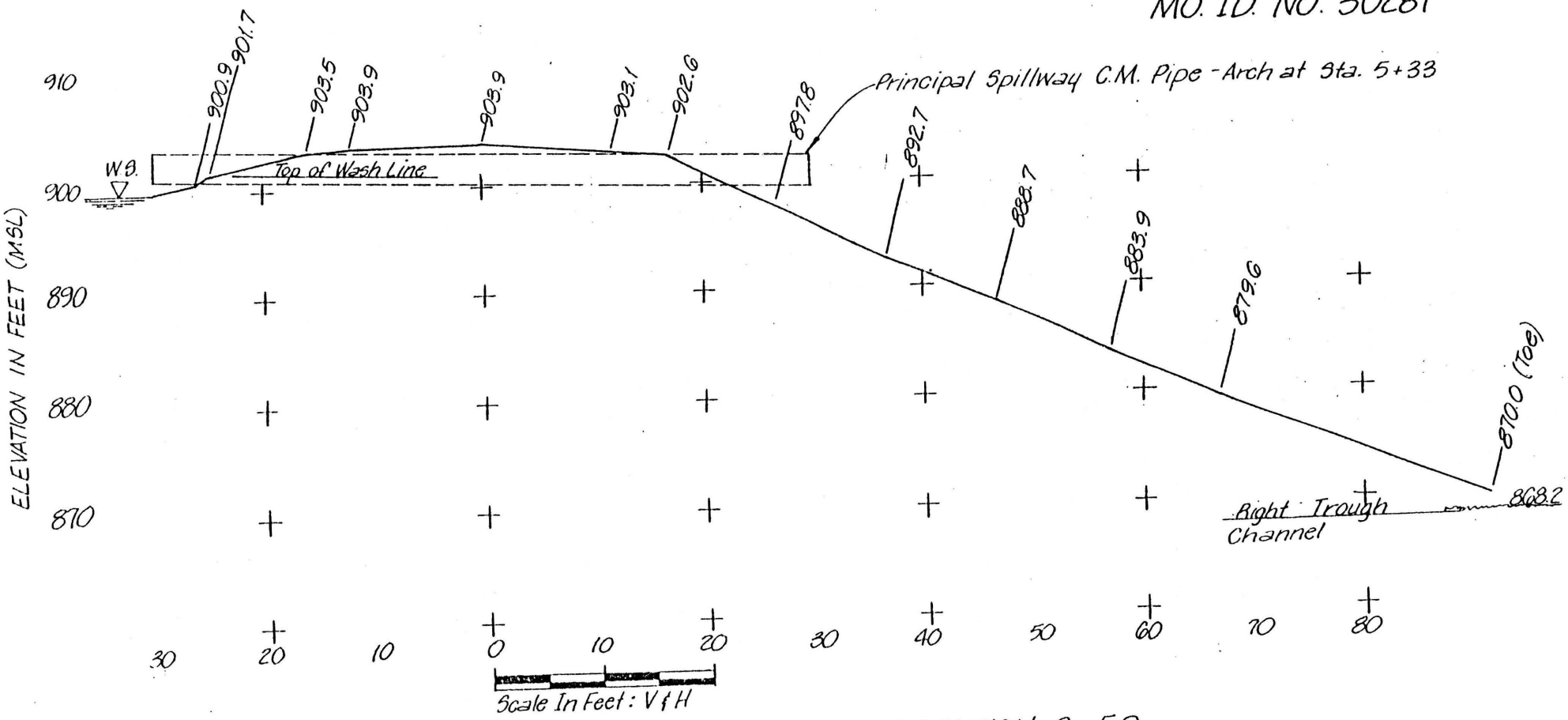
PLAN OF DAM
Scale: 1"=100'



CENTERLINE PROFILE OF DAM
Scale As Shown

PLATE C-

LAC BENET DAM
MO. ID. NO. 30281



MAXIMUM CROSS-SECTION OF DAM AT STATION 3+50

PLATE C-2

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 (See this Section).

   a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Sullivan, MO. 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 policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.08 square miles (51.2 acres).

   c. Time of concentration of runoff = 8 minutes (computed from the "Kirpich" formula and the California Department of Highways Culvert Practice 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 one percent probabilistic 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 invert of the spillway.

   e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 2.32 inches. The total losses for the PMF storm were 1.16 inches. These data are based on SCS runoff curve No. 80 and No. 91 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed primarily of SCS soil groups C & D (Peridge-Cantwell-Gasconade soils). The water shed is 85% wooded and the remainder is in home lots, roads, and water.

   f. Average soil loss rates = 0.05 inch per hour approximately (For PMF storm, AMC III).

2. The combined discharge rating consisted of two components: the flow through the spillway and the flow going over the top of the dam.

   a. The spillway rating was developed by using the culvert formulas and nomographs from BPR FHA HEC No. 5, Chart 6.

b. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.

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 and plotted hydrographs are attached in this Appendix.

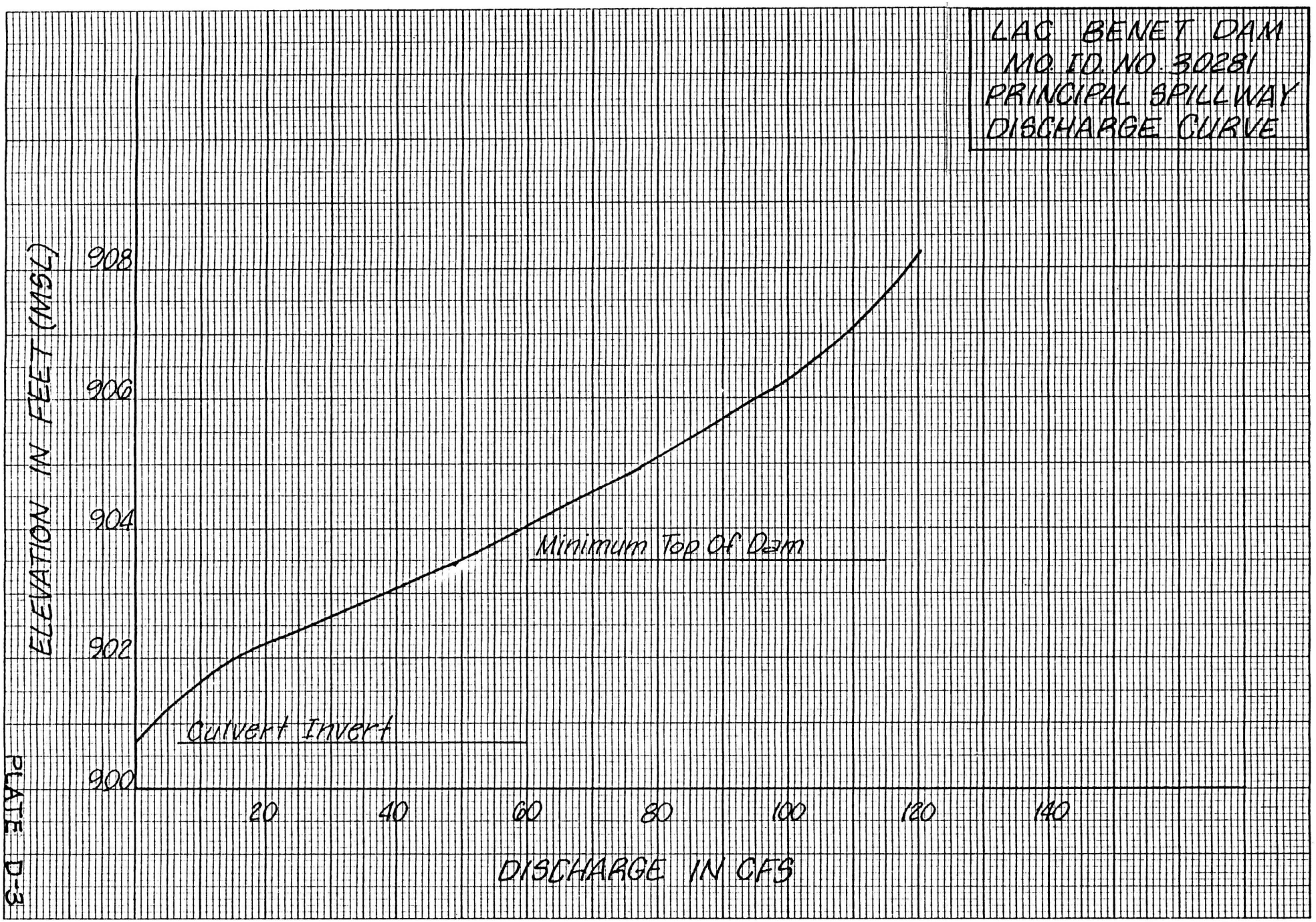


PLATE D-3

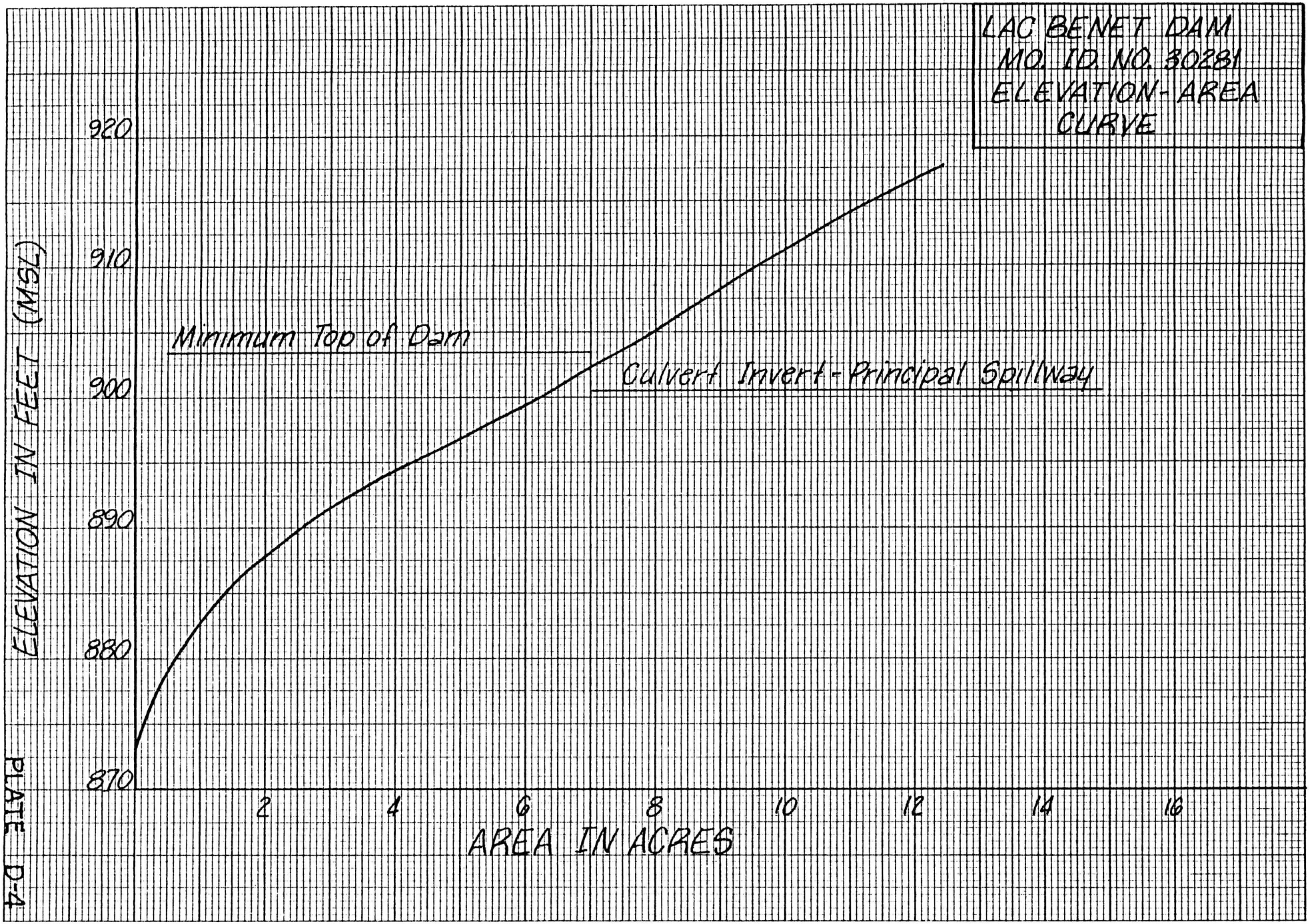


PLATE D-4

LAC BENET DAM
MO. ID. NO. 30281
PMF RATIO-DISCHARGE CURVES

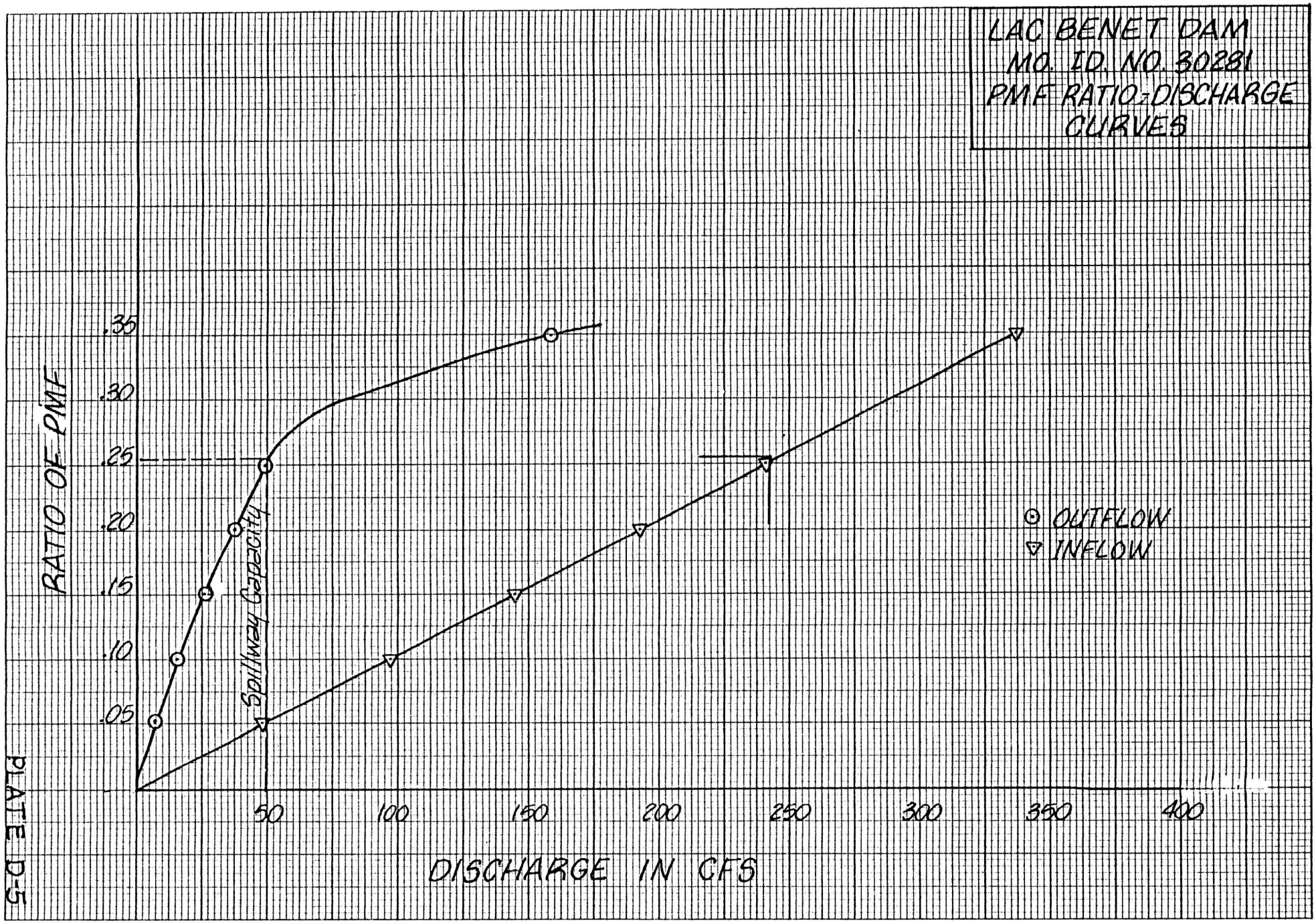


PLATE D-5

```
A1                          LAC BENET DAM / MO. ID. NO. 30281
A2       SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
A3                 H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR
B    2880000000000000005                                  00000000000000000000003
B1      5
J       100000008000000001
J1   .0500000.1000000.1500000.2000000.2500000.3500000.50000001.0
K       000000001                    000000000000000000000001
K1       CALCULATION OF INFLOW HYDRO TO LAC BENET
M       1000000020000.080          0000.080000001.000000000000000000000001
P       0000026.100000102000001210000130
T                                                              -1.0    -91.0
W2      00000.17
X       0     -.0100000001
K       100000002                    000000020000000000000001
K1       ROUTED FLOWS THRU LAC BENET DAM
Y                           00000001000000001
Y1      1                                                    -900.7       -1
Y4 900.7000901.3000901.7000902.0000902.2000902.7000903.1000903.5000904.0000905.1
Y4 906.3000908.2
Y5      000000005000000100000001500000020000000300000004000000050000000600000080
Y5   10000000120
$A      000000.650000014000002.5000004.3000006.2000007.9000009.5
$E   872000008800000088500000890000008950000090000009050000910
$$ 900.7
$D 903.5000002.8000001.500000500
$L      000000060000001500000021700000283000003180000036300000400000004300000046 5
$V 903.5000903.6000903.9000904.2000904.7000905.0000905.5000906.0000906.5000907.0
K       99
A
A
A
A
A
```

PLATE D-6

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

 RUN  DATE# 80/11/11.
      TIME# 17.20.20.
```

LAC BENET DAM / MO. ID. NO. 30281
SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	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= 8 LRTIO= 1

RTIOS=	.05	.10	.15	.20	.25	.35	.50	1.00

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

SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDRO TO LAC BENET

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.08	0.00	.08	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.10	102.00	121.00	130.00	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	-91.00	0.00	0.00

CURVE NO = -91.00 WETNESS = -1.00 EFFECT CN = 91.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .17

RECESSION DATA

STRTQ= 0.00 QRCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .17 VOL= 1.00

55.	168.	173.	108.	54.	29.	15.	8.	4.	2.
1.	1.								

0 END-OF-PERIOD FLOW

PLATE D-7

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.22	.00	50.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.22	.00	75.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.22	.00	101.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.22	.00	117.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.22	.00	126.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.22	.00	130.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.22	.00	133.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.22	.00	134.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.22	.00	135.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.22	.00	135.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.22	.00	135.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.22	.00	136.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.27	.26	.00	138.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.27	.26	.00	146.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.27	.26	.00	153.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.27	.26	.00	158.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.27	.26	.00	161.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.27	.26	.00	162.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.27	.26	.00	163.
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.27	.26	.00	163.
1.01	1.45	21	.01	.00	.01	1.	1.01	13.45	165	.27	.26	.00	163.
1.01	1.50	22	.01	.00	.01	1.	1.01	13.50	166	.27	.26	.00	163.
1.01	1.55	23	.01	.00	.01	1.	1.01	13.55	167	.27	.26	.00	164.
1.01	2.00	24	.01	.00	.01	1.	1.01	14.00	168	.27	.26	.00	164.
1.01	2.05	25	.01	.00	.01	1.	1.01	14.05	169	.33	.33	.00	167.
1.01	2.10	26	.01	.00	.01	1.	1.01	14.10	170	.33	.33	.00	179.
1.01	2.15	27	.01	.00	.01	2.	1.01	14.15	171	.33	.33	.00	190.
1.01	2.20	28	.01	.00	.01	2.	1.01	14.20	172	.33	.33	.00	197.
1.01	2.25	29	.01	.00	.01	2.	1.01	14.25	173	.33	.33	.00	201.
1.01	2.30	30	.01	.00	.01	2.	1.01	14.30	174	.33	.33	.00	203.
1.01	2.35	31	.01	.00	.01	2.	1.01	14.35	175	.33	.33	.00	204.
1.01	2.40	32	.01	.00	.01	2.	1.01	14.40	176	.33	.33	.00	205.
1.01	2.45	33	.01	.00	.01	2.	1.01	14.45	177	.33	.33	.00	205.
1.01	2.50	34	.01	.00	.01	3.	1.01	14.50	178	.33	.33	.00	205.
1.01	2.55	35	.01	.00	.01	3.	1.01	14.55	179	.33	.33	.00	205.
1.01	3.00	36	.01	.00	.01	3.	1.01	15.00	180	.33	.33	.00	205.
1.01	3.05	37	.01	.01	.01	3.	1.01	15.05	181	.20	.20	.00	198.
1.01	3.10	38	.01	.01	.01	3.	1.01	15.10	182	.40	.40	.00	187.
1.01	3.15	39	.01	.01	.01	3.	1.01	15.15	183	.40	.40	.00	199.
1.01	3.20	40	.01	.01	.01	3.	1.01	15.20	184	.61	.61	.00	231.
1.01	3.25	41	.01	.01	.01	3.	1.01	15.25	185	.71	.71	.00	205.
1.01	3.30	42	.01	.01	.01	3.	1.01	15.30	186	1.72	1.72	.00	400.
1.01	3.35	43	.01	.01	.01	4.	1.01	15.35	187	2.83	2.83	.01	674.
1.01	3.40	44	.01	.01	.01	4.	1.01	15.40	188	1.11	1.11	.00	964.
1.01	3.45	45	.01	.01	.01	4.	1.01	15.45	189	.71	.71	.00	967.
1.01	3.50	46	.01	.01	.01	4.	1.01	15.50	190	.61	.61	.00	779.
1.01	3.55	47	.01	.01	.01	4.	1.01	15.55	191	.40	.40	.00	588.
1.01	4.00	48	.01	.01	.01	4.	1.01	16.00	192	.40	.40	.00	450.
1.01	4.05	49	.01	.01	.01	4.	1.01	16.05	193	.31	.31	.00	353.
1.01	4.10	50	.01	.01	.01	4.	1.01	16.10	194	.31	.31	.00	286.
1.01	4.15	51	.01	.01	.01	4.	1.01	16.15	195	.31	.31	.00	243.
1.01	4.20	52	.01	.01	.01	4.	1.01	16.20	196	.31	.31	.00	219.
1.01	4.25	53	.01	.01	.01	4.	1.01	16.25	197	.31	.31	.00	206.
1.01	4.30	54	.01	.01	.01	4.	1.01	16.30	198	.31	.31	.00	199.
1.01	4.35	55	.01	.01	.01	4.	1.01	16.35	199	.31	.31	.00	195.
1.01	4.40	56	.01	.01	.01	4.	1.01	16.40	200	.31	.31	.00	193.
1.01	4.45	57	.01	.01	.01	5.	1.01	16.45	201	.31	.31	.00	193.
1.01	4.50	58	.01	.01	.01	5.	1.01	16.50	202	.31	.31	.00	192.
1.01	4.55	59	.01	.01	.01	5.	1.01	16.55	203	.31	.31	.00	192.
1.01	5.00	60	.01	.01	.01	5.	1.01	17.00	204	.31	.31	.00	192.

1.01	5.05	61	.01	.01	.01	5.	1.01	17.05	205	.24	.24	.00	180.
1.01	5.10	62	.01	.01	.01	5.	1.01	17.10	206	.24	.24	.00	177.
1.01	5.15	63	.01	.01	.00	5.	1.01	17.15	207	.24	.24	.00	166.
1.01	5.20	64	.01	.01	.00	5.	1.01	17.20	208	.24	.24	.00	159.
1.01	5.25	65	.01	.01	.00	5.	1.01	17.25	209	.24	.24	.00	155.
1.01	5.30	66	.01	.01	.00	5.	1.01	17.30	210	.24	.24	.00	153.
1.01	5.35	67	.01	.01	.00	5.	1.01	17.35	211	.24	.24	.00	152.
1.01	5.40	68	.01	.01	.00	5.	1.01	17.40	212	.24	.24	.00	152.
1.01	5.45	69	.01	.01	.00	5.	1.01	17.45	213	.24	.24	.00	151.
1.01	5.50	70	.01	.01	.00	5.	1.01	17.50	214	.24	.24	.00	151.
1.01	5.55	71	.01	.01	.00	5.	1.01	17.55	215	.24	.24	.00	151.
1.01	6.00	72	.01	.01	.00	5.	1.01	18.00	216	.24	.24	.00	151.
1.01	6.05	73	.07	.05	.02	7.	1.01	18.05	217	.02	.02	.00	139.
1.01	6.10	74	.07	.05	.02	14.	1.01	18.10	218	.02	.02	.00	101.
1.01	6.15	75	.07	.05	.02	21.	1.01	18.15	219	.02	.02	.00	62.
1.01	6.20	76	.07	.05	.02	26.	1.01	18.20	220	.02	.02	.00	38.
1.01	6.25	77	.07	.05	.02	29.	1.01	18.25	221	.02	.02	.00	26.
1.01	6.30	78	.07	.05	.02	30.	1.01	18.30	222	.02	.02	.00	19.
1.01	6.35	79	.07	.05	.01	32.	1.01	18.35	223	.02	.02	.00	16.
1.01	6.40	80	.07	.06	.01	33.	1.01	18.40	224	.02	.02	.00	14.
1.01	6.45	81	.07	.06	.01	33.	1.01	18.45	225	.02	.02	.00	13.
1.01	6.50	82	.07	.06	.01	34.	1.01	18.50	226	.02	.02	.00	13.
1.01	6.55	83	.07	.06	.01	35.	1.01	18.55	227	.02	.02	.00	12.
1.01	7.00	84	.07	.06	.01	35.	1.01	19.00	228	.02	.02	.00	12.
1.01	7.05	85	.07	.06	.01	36.	1.01	19.05	229	.02	.02	.00	12.
1.01	7.10	86	.07	.06	.01	36.	1.01	19.10	230	.02	.02	.00	12.
1.01	7.15	87	.07	.06	.01	36.	1.01	19.15	231	.02	.02	.00	12.
1.01	7.20	88	.07	.06	.01	37.	1.01	19.20	232	.02	.02	.00	12.
1.01	7.25	89	.07	.06	.01	37.	1.01	19.25	233	.02	.02	.00	12.
1.01	7.30	90	.07	.06	.01	37.	1.01	19.30	234	.02	.02	.00	12.
1.01	7.35	91	.07	.06	.01	37.	1.01	19.35	235	.02	.02	.00	12.
1.01	7.40	92	.07	.06	.01	38.	1.01	19.40	236	.02	.02	.00	12.
1.01	7.45	93	.07	.06	.01	38.	1.01	19.45	237	.02	.02	.00	12.
1.01	7.50	94	.07	.06	.01	38.	1.01	19.50	238	.02	.02	.00	12.
1.01	7.55	95	.07	.06	.01	38.	1.01	19.55	239	.02	.02	.00	12.
1.01	8.00	96	.07	.06	.01	39.	1.01	20.00	240	.02	.02	.00	12.
1.01	8.05	97	.07	.06	.01	39.	1.01	20.05	241	.02	.02	.00	12.
1.01	8.10	98	.07	.06	.01	39.	1.01	20.10	242	.02	.02	.00	12.
1.01	8.15	99	.07	.06	.01	39.	1.01	20.15	243	.02	.02	.00	12.
1.01	8.20	100	.07	.06	.01	39.	1.01	20.20	244	.02	.02	.00	12.
1.01	8.25	101	.07	.06	.00	39.	1.01	20.25	245	.02	.02	.00	12.
1.01	8.30	102	.07	.06	.00	39.	1.01	20.30	246	.02	.02	.00	12.
1.01	8.35	103	.07	.06	.00	40.	1.01	20.35	247	.02	.02	.00	12.
1.01	8.40	104	.07	.06	.00	40.	1.01	20.40	248	.02	.02	.00	12.
1.01	8.45	105	.07	.06	.00	40.	1.01	20.45	249	.02	.02	.00	12.
1.01	8.50	106	.07	.06	.00	40.	1.01	20.50	250	.02	.02	.00	12.
1.01	8.55	107	.07	.06	.00	40.	1.01	20.55	251	.02	.02	.00	12.
1.01	9.00	108	.07	.07	.00	40.	1.01	21.00	252	.02	.02	.00	12.
1.01	9.05	109	.07	.07	.00	40.	1.01	21.05	253	.02	.02	.00	12.
1.01	9.10	110	.07	.07	.00	40.	1.01	21.10	254	.02	.02	.00	12.
1.01	9.15	111	.07	.07	.00	40.	1.01	21.15	255	.02	.02	.00	12.
1.01	9.20	112	.07	.07	.00	40.	1.01	21.20	256	.02	.02	.00	12.
1.01	9.25	113	.07	.07	.00	40.	1.01	21.25	257	.02	.02	.00	12.
1.01	9.30	114	.07	.07	.00	41.	1.01	21.30	258	.02	.02	.00	12.
1.01	9.35	115	.07	.07	.00	41.	1.01	21.35	259	.02	.02	.00	12.
1.01	9.40	116	.07	.07	.00	41.	1.01	21.40	260	.02	.02	.00	12.
1.01	9.45	117	.07	.07	.00	41.	1.01	21.45	261	.02	.02	.00	12.
1.01	9.50	118	.07	.07	.00	41.	1.01	21.50	262	.02	.02	.00	12.
1.01	9.55	119	.07	.07	.00	41.	1.01	21.55	263	.02	.02	.00	12.
1.01	10.00	120	.07	.07	.00	41.	1.01	22.00	264	.02	.02	.00	12.
1.01	10.05	121	.07	.07	.00	41.	1.01	22.05	265	.02	.02	.00	12.
1.01	10.10	122	.07	.07	.00	41.	1.01	22.10	266	.02	.02	.00	12.

PLATE D-9

1.01	10.15	123	.07	.07	.00	41.	1.01	22.15	267	.02	.02	.00	12.
1.01	10.20	124	.07	.07	.00	41.	1.01	22.20	268	.02	.02	.00	12.
1.01	10.25	125	.07	.07	.00	41.	1.01	22.25	269	.02	.02	.00	12.
1.01	10.30	126	.07	.07	.00	41.	1.01	22.30	270	.02	.02	.00	12.
1.01	10.35	127	.07	.07	.00	41.	1.01	22.35	271	.02	.02	.00	12.
1.01	10.40	128	.07	.07	.00	41.	1.01	22.40	272	.02	.02	.00	12.
1.01	10.45	129	.07	.07	.00	41.	1.01	22.45	273	.02	.02	.00	12.
1.01	10.50	130	.07	.07	.00	41.	1.01	22.50	274	.02	.02	.00	12.
1.01	10.55	131	.07	.07	.00	41.	1.01	22.55	275	.02	.02	.00	12.
1.01	11.00	132	.07	.07	.00	41.	1.01	23.00	276	.02	.02	.00	12.
1.01	11.05	133	.07	.07	.00	41.	1.01	23.05	277	.02	.02	.00	12.
1.01	11.10	134	.07	.07	.00	41.	1.01	23.10	278	.02	.02	.00	12.
1.01	11.15	135	.07	.07	.00	41.	1.01	23.15	279	.02	.02	.00	12.
1.01	11.20	136	.07	.07	.00	41.	1.01	23.20	280	.02	.02	.00	12.
1.01	11.25	137	.07	.07	.00	41.	1.01	23.25	281	.02	.02	.00	12.
1.01	11.30	138	.07	.07	.00	42.	1.01	23.30	282	.02	.02	.00	12.
1.01	11.35	139	.07	.07	.00	42.	1.01	23.35	283	.02	.02	.00	12.
1.01	11.40	140	.07	.07	.00	42.	1.01	23.40	284	.02	.02	.00	12.
1.01	11.45	141	.07	.07	.00	42.	1.01	23.45	285	.02	.02	.00	12.
1.01	11.50	142	.07	.07	.00	42.	1.01	23.50	286	.02	.02	.00	12.
1.01	11.55	143	.07	.07	.00	42.	1.01	23.55	287	.02	.02	.00	12.
1.01	12.00	144	.07	.07	.00	42.	1.02	0.00	288	.02	.02	.00	12.
									SUM	33.93	32.77	1.16	20258.
										(862.)	(832.)	(29.)	(573.64)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	967.	226.	70.	70.	20250.
CMS	27.	6.	2.	2.	574.
INCHES		26.26	32.72	32.72	32.72
MM		667.10	831.00	831.00	831.00
AC-FT		112.	140.	140.	140.
THOUS CU M		138.	172.	172.	172.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	48.	11.	4.	4.	1013.
CMS	1.	0.	0.	0.	29.
INCHES		1.31	1.64	1.64	1.64
MM		33.36	41.55	41.55	41.55
AC-FT		6.	7.	7.	7.
THOUS CU M		7.	9.	9.	9.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	97.	23.	7.	7.	2026.
CMS	3.	1.	0.	0.	57.
INCHES		2.63	3.27	3.27	3.27
MM		66.71	83.10	83.10	83.10
AC-FT		11.	14.	14.	14.
THOUS CU M		14.	17.	17.	17.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	145.	34.	11.	11.	3039.
CMS	4.	1.	0.	0.	86.
INCHES		3.94	4.91	4.91	4.91
MM		100.07	124.65	124.65	124.65
AC-FT		17.	21.	21.	21.
THOUS CU M		21.	26.	26.	26.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	193.	45.	14.	14.	4052.
CMS	5.	1.	0.	0.	115.
INCHES		5.25	6.54	6.54	6.54
MM		133.42	166.20	166.20	166.20
AC-FT		22.	28.	28.	28.
THOUS CU M		28.	34.	34.	34.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	242.	56.	18.	18.	5065.
CMS	7.	2.	0.	0.	143.
INCHES		6.57	8.18	8.18	8.18
MM		166.78	207.75	207.75	207.75
AC-FT		28.	35.	35.	35.
THOUS CU M		35.	43.	43.	43.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	338.	79.	25.	25.	7090.
CMS	10.	2.	1.	1.	201.
INCHES		9.19	11.45	11.45	11.45
MM		233.49	290.85	290.85	290.85
AC-FT		39.	49.	49.	49.
THOUS CU M		48.	60.	60.	60.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7 [1/2 PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	483.	113.	35.	35.	10129.
CMS	14.	3.	1.	1.	287.
INCHES		13.13	16.36	16.36	16.36
MM		333.55	415.50	415.50	415.50
AC-FT		56.	70.	70.	70.
THOUS CU M		69.	86.	86.	86.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8 [PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	967.	226.	70.	70.	20258.

CMS	27.	6.	2.	2.	574.
INCHES		26.26	32.72	32.72	32.72
MM		667.10	831.00	831.00	831.00
AC-FT		112.	140.	140.	140.
THOUS CU M		138.	172.	172.	172.

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

HYDROGRAPH ROUTING

ROUTED FLOWS THRU LAC BENET 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	-901.	-1

STAGE	900.70	901.30	901.70	902.00	902.20	902.70	903.10	903.50	904.00	905.10
	906.30	908.20								
FLOW	0.00	5.00	10.00	15.00	20.00	30.00	40.00	50.00	60.00	80.00
	100.00	120.00								

SURFACE AREA=	0.	1.	1.	3.	4.	6.	8.	10.
CAPACITY=	0.	2.	7.	16.	33.	59.	94.	138.
ELEVATION=	872.	880.	885.	890.	895.	900.	905.	910.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
900.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
903.5	2.8	1.5	500.

CREST LENGTH	0.	60.	150.	217.	283.	318.	363.	400.	430.	465.
AT OR BELOW ELEVATION	903.5	903.6	903.9	904.2	904.7	905.0	905.5	906.0	906.5	907.0

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.	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.

OVN

STATION 000002, PLAN 1, RATIO 7 ½ 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.
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.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	3.	3.	3.
3.	3.	3.	3.	3.	4.	4.	4.	4.	4.
4.	4.	5.	5.	5.	5.	5.	5.	5.	6.
6.	6.	6.	6.	7.	7.	7.	7.	7.	7.
8.	8.	8.	8.	8.	8.	9.	9.	9.	9.
9.	9.	9.	10.	10.	10.	10.	10.	10.	11.
11.	11.	11.	11.	11.	12.	12.	13.	14.	15.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
26.	27.	28.	30.	31.	32.	33.	34.	35.	37.
38.	39.	41.	42.	43.	45.	46.	47.	49.	50.
51.	53.	56.	62.	71.	89.	134.	235.	351.	396.
368.	313.	261.	218.	184.	160.	142.	130.	121.	115.
110.	107.	104.	102.	101.	99.	96.	93.	90.	87.
85.	83.	82.	81.	80.	79.	78.	75.	70.	64.
58.	54.	52.	50.	49.	48.	48.	47.	46.	45.
44.	43.	42.	41.	40.	40.	39.	38.	37.	37.
36.	35.	34.	34.	33.	33.	32.	31.	31.	30.
30.	29.	29.	28.	28.	27.	27.	27.	26.	26.
25.	25.	25.	24.	24.	24.	23.	23.	23.	22.
22.	22.	21.	21.	21.	20.	20.	20.	20.	19.
19.	19.	18.	18.	18.	17.	17.	17.		

STORAGE

64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
64.	64.	64.	64.	64.	64.	64.	65.	65.	65.
65.	65.	65.	65.	65.	65.	66.	66.	66.	66.
66.	66.	66.	66.	66.	66.	67.	67.	67.	67.
67.	67.	67.	67.	67.	68.	68.	68.	68.	68.
68.	68.	68.	68.	68.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	70.	70.	70.
70.	70.	70.	70.	70.	70.	70.	70.	70.	70.
71.	71.	71.	71.	71.	71.	71.	71.	72.	72.
73.	73.	73.	74.	74.	74.	75.	75.	75.	76.
76.	76.	77.	77.	77.	78.	78.	78.	79.	79.
79.	80.	80.	81.	81.	81.	82.	82.	83.	83.
83.	84.	84.	84.	85.	85.	86.	88.	89.	90.
89.	89.	88.	88.	87.	87.	87.	86.	86.	86.
86.	86.	86.	86.	86.	86.	86.	85.	85.	85.
85.	85.	85.	85.	85.	85.	85.	85.	85.	84.
84.	84.	83.	83.	83.	83.	82.	82.	82.	81.
81.	81.	81.	80.	80.	80.	80.	80.	79.	79.

PLATE D-13

79.	79.	78.	78.	78.	78.	78.	78.	77.	77.
77.	77.	77.	77.	76.	76.	76.	76.	76.	76.
76.	75.	75.	75.	75.	75.	75.	75.	75.	74.
74.	74.	74.	74.	74.	74.	74.	74.	74.	73.
73.	73.	73.	73.	73.	73.	73.	73.		

STAGE

900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.7	900.7	900.7	900.8	900.8	900.8	900.8
900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8
900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.9	900.9
900.9	900.9	900.9	900.9	901.0	901.0	901.0	901.0	901.0	901.0
901.1	901.1	901.1	901.1	901.1	901.1	901.1	901.2	901.2	901.2
901.2	901.2	901.2	901.3	901.3	901.3	901.3	901.3	901.3	901.4
901.4	901.4	901.4	901.4	901.4	901.4	901.5	901.5	901.5	901.5
901.5	901.5	901.5	901.5	901.6	901.6	901.6	901.6	901.6	901.6
901.6	901.6	901.7	901.7	901.7	901.7	901.7	901.7	901.7	901.7
901.7	901.8	901.8	901.8	901.8	901.8	901.8	901.9	901.9	902.0
902.0	902.1	902.1	902.2	902.2	902.3	902.3	902.4	902.4	902.5
902.5	902.6	902.6	902.7	902.7	902.8	902.8	902.9	902.9	903.0
903.0	903.1	903.1	903.2	903.2	903.3	903.3	903.4	903.4	903.5
903.5	903.6	903.6	903.7	903.7	903.8	904.0	904.2	904.3	904.4
904.4	904.3	904.2	904.1	904.1	904.0	904.0	903.9	903.9	903.9
903.9	903.9	903.9	903.9	903.9	903.9	903.8	903.8	903.8	903.8
903.8	903.8	903.8	903.8	903.8	903.8	903.8	903.8	903.7	903.7
903.6	903.6	903.6	903.5	903.5	903.4	903.4	903.4	903.3	903.3
903.3	903.2	903.2	903.2	903.1	903.1	903.1	903.0	903.0	903.0
902.9	902.9	902.9	902.9	902.8	902.8	902.8	902.8	902.7	902.7
902.7	902.7	902.6	902.6	902.6	902.6	902.5	902.5	902.5	902.5
902.5	902.5	902.4	902.4	902.4	902.4	902.4	902.3	902.3	902.3
902.3	902.3	902.3	902.3	902.2	902.2	902.2	902.2	902.2	902.2
902.2	902.1	902.1	902.1	902.1	902.1	902.1	902.1		

PEAK OUTFLOW IS 396. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	396.	93.	31.	31.	8818.
CMS	11.	3.	1.	1.	250.
INCHES		10.80	14.24	14.24	14.24
MM		274.35	361.74	361.74	361.74
AC-FT		46.	61.	61.	61.
THOUS CU M		57.	75.	75.	75.

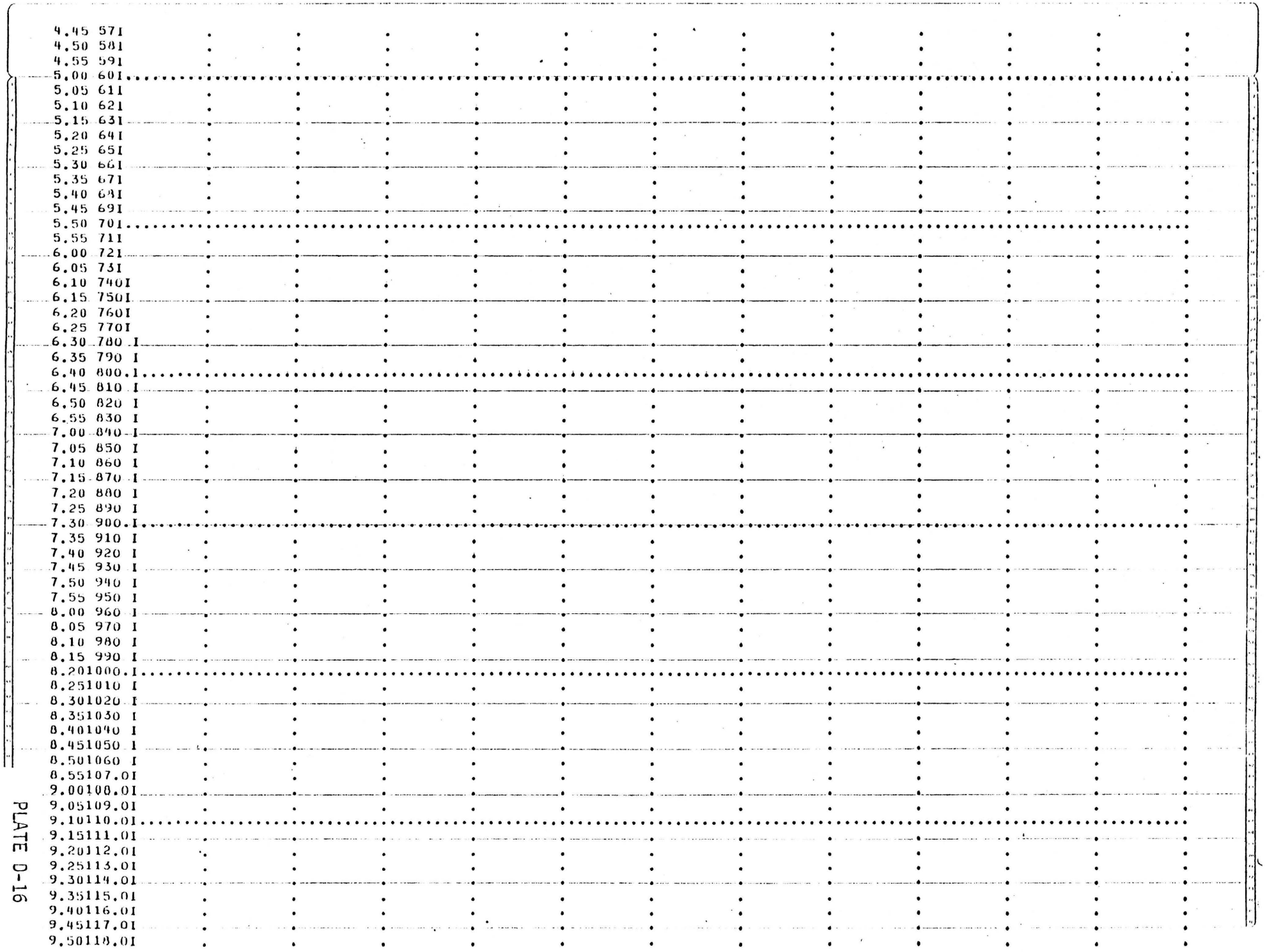
OVF

STATION000002

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

	0.	100.	200.	300.	400.	500.	0.	0.	0.	0.	0.	0.	0.
.05	11												
.10	21												
.15	31												
.20	41												
.25	51												
.30	61												
.35	71												
.40	81												
.45	91												
.50	101												
.55	111												
1.00	121												
1.05	131												
1.10	141												
1.15	151												
1.20	161												
1.25	171												
1.30	181												
1.35	191												
1.40	201												
1.45	211												
1.50	221												
1.55	231												
2.00	241												
2.05	251												
2.10	261												
2.15	271												
2.20	281												
2.25	291												
2.30	301												
2.35	311												
2.40	321												
2.45	331												
2.50	341												
2.55	351												
3.00	361												
3.05	371												
3.10	381												
3.15	391												
3.20	401												
3.25	411												
3.30	421												
3.35	431												
3.40	441												
3.45	451												
3.50	461												
3.55	471												
4.00	481												
4.05	491												
4.10	501												
4.15	511												
4.20	521												
4.25	531												
4.30	541												
4.35	551												
4.40	561												

PLATE D-15


4.45 571
4.50 581
4.55 591
5.00 601
5.05 611
5.10 621
5.15 631
5.20 641
5.25 651
5.30 661
5.35 671
5.40 681
5.45 691
5.50 701
5.55 711
6.00 721
6.05 731
6.10 740I
6.15 750I
6.20 760I
6.25 770I
6.30 780 I
6.35 790 I
6.40 800.I
6.45 810 I
6.50 820 I
6.55 830 I
7.00 840 I
7.05 850 I
7.10 860 I
7.15 870 I
7.20 880 I
7.25 890 I
7.30 900.I
7.35 910 I
7.40 920 I
7.45 930 I
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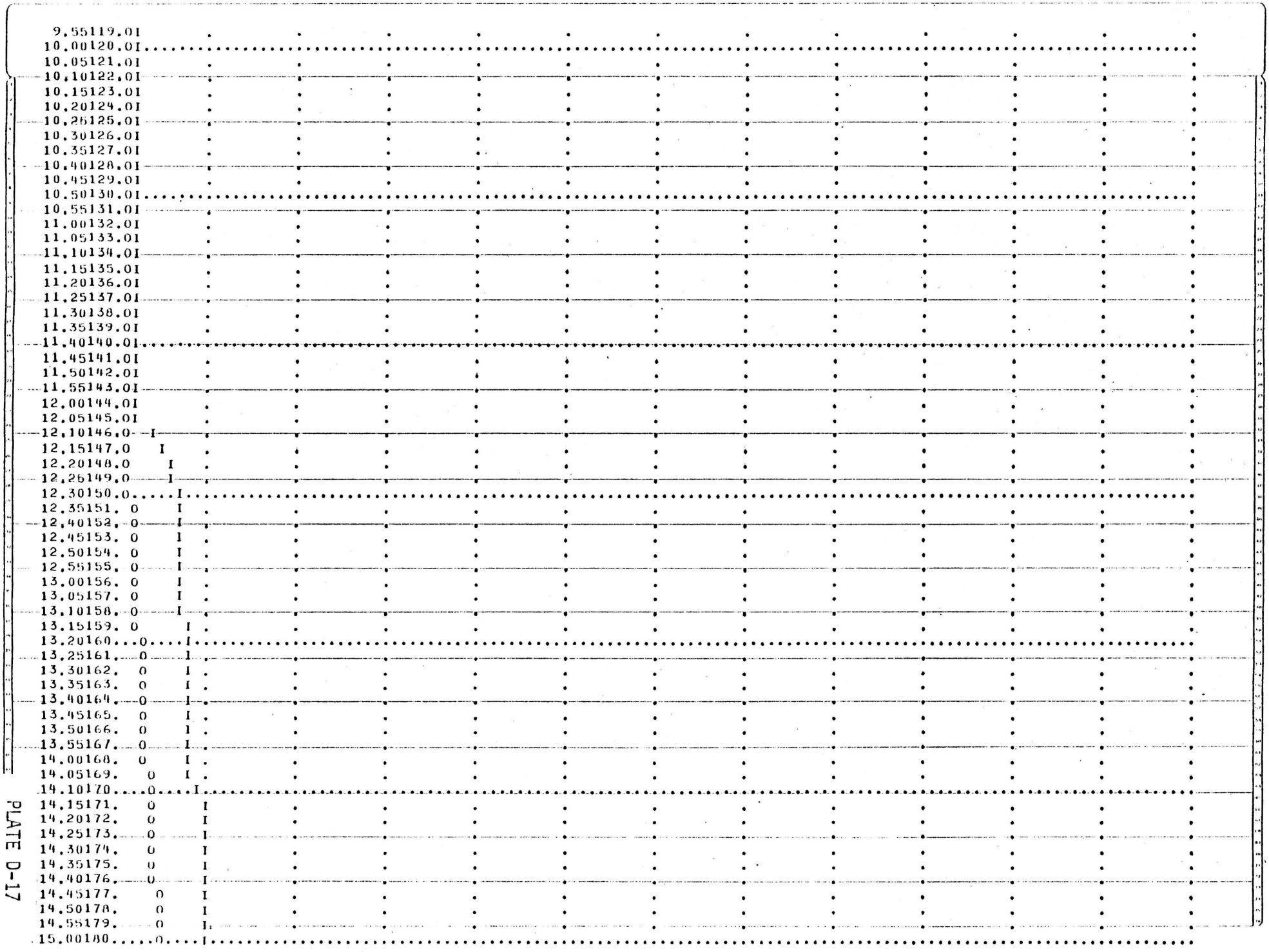
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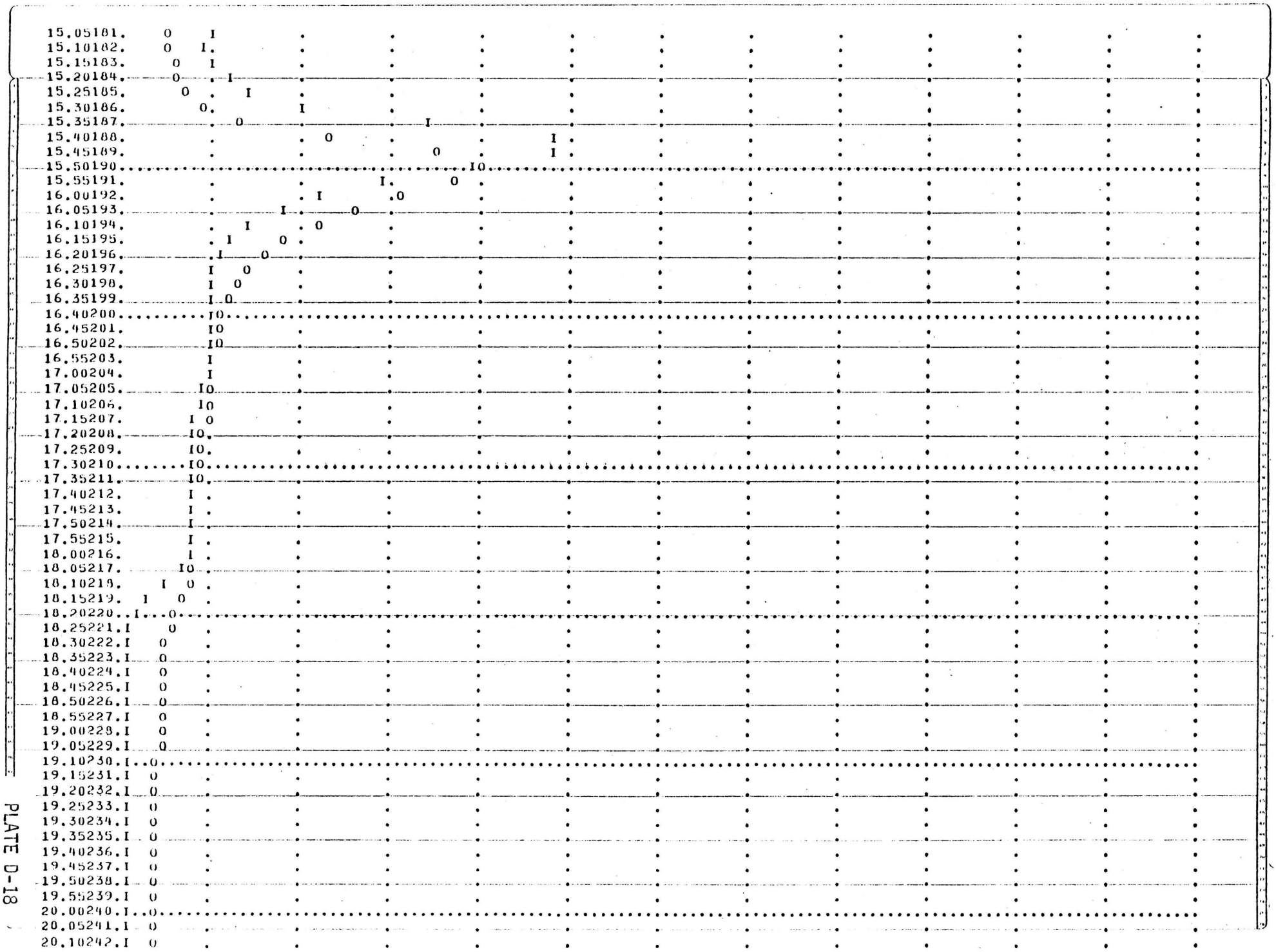
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PLATE D-18

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PLATE D-19

OVN

STATION 000002, PLAN 1, RATIO 8 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

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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.	1.	1.
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1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	2.	2.	2.	2.	3.	3.
3.	3.	4.	4.	4.	4.	5.	5.	5.	6.
6.	7.	7.	7.	8.	8.	9.	9.	9.	10.
10.	11.	11.	12.	12.	12.	13.	13.	14.	14.
15.	15.	16.	16.	17.	18.	18.	19.	19.	20.
20.	21.	21.	21.	22.	22.	23.	23.	23.	24.
24.	24.	25.	25.	25.	26.	26.	26.	27.	27.
27.	27.	28.	28.	28.	29.	30.	32.	34.	36.
39.	41.	43.	45.	47.	49.	52.	57.	68.	83.
99.	114.	127.	138.	146.	151.	155.	158.	160.	165.
171.	179.	186.	192.	196.	199.	201.	203.	204.	204.
203.	199.	197.	204.	226.	277.	408.	653.	865.	870.
741.	597.	480.	391.	325.	280.	250.	230.	217.	208.
202.	198.	196.	195.	193.	189.	183.	176.	169.	164.
160.	157.	155.	154.	153.	152.	150.	140.	123.	104.
88.	76.	67.	60.	56.	53.	51.	50.	49.	48.
48.	47.	46.	45.	45.	44.	43.	42.	42.	41.
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27.	26.	26.	26.	25.	25.	25.	25.	24.	24.
24.	24.	23.	23.	23.	23.	23.	22.		

STORAGE

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64.	64.	64.	64.	64.	64.	64.	64.	64.	64.
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65.	65.	65.	65.	65.	65.	65.	65.	66.	66.
66.	66.	66.	67.	67.	67.	67.	68.	68.	68.
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76.	76.	76.	76.	77.	77.	77.	78.	78.	79.
80.	80.	81.	82.	82.	83.	83.	84.	85.	85.
86.	86.	86.	86.	87.	87.	87.	87.	87.	87.
87.	87.	87.	87.	87.	87.	87.	88.	88.	88.
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92.	91.	90.	90.	89.	88.	88.	88.	88.	88.
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PLATE D-20

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77.	77.	77.	77.	77.	76.	76.	76.	76.	76.
76.	76.	76.	76.	76.	75.	75.	75.	75.	75.
75.	75.	75.	75.	75.	75.	75.	75.		

STAGE

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900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7	900.7
900.7	900.7	900.7	900.8	900.8	900.8	900.8	900.8	900.8	900.8
900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8
900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.8	900.9	900.9
900.9	900.9	900.9	900.9	900.9	900.9	900.9	901.0	901.0	901.0
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902.0	902.0	902.0	902.1	902.1	902.1	902.1	902.1	902.2	902.2
902.2	902.2	902.3	902.3	902.3	902.3	902.3	902.3	902.4	902.4
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903.8	903.8	903.7	903.7	903.6	903.6	903.5	903.5	903.5	903.4
903.4	903.4	903.3	903.3	903.3	903.3	903.2	903.2	903.2	903.1
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902.7	902.7	902.6	902.6	902.6	902.6	902.6	902.6	902.6	902.5
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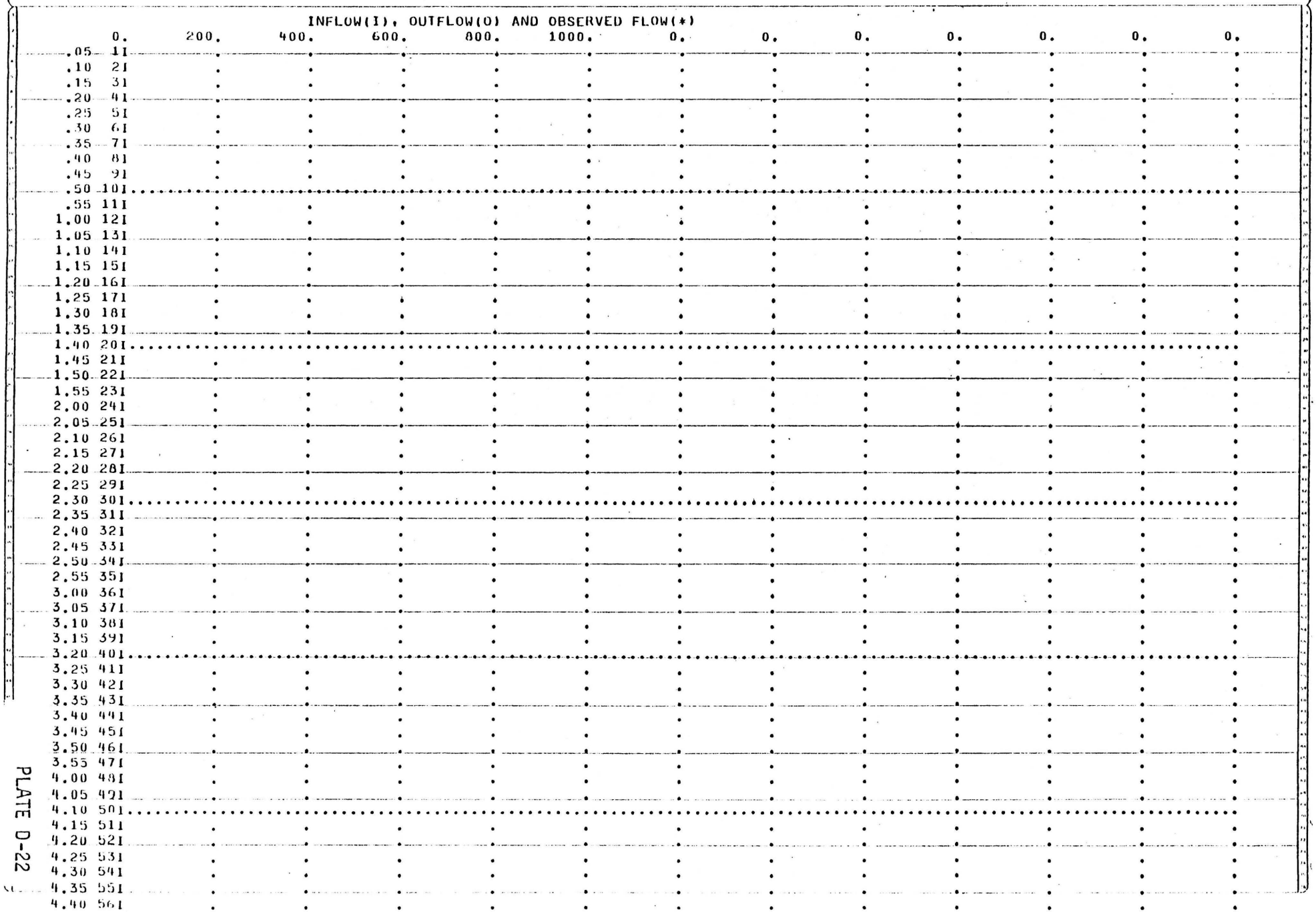
902.4	902.4	902.4	902.4	902.4	902.3	902.3	902.3		

PEAK OUTFLOW IS 870. AT TIME 15.83 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	870.	212.	65.	65.	18691.
CMS	25.	6.	2.	2.	529.
INCHES		24.62	30.19	30.19	30.19
MM		625.31	766.72	766.72	766.72
AC-FT		105.	129.	129.	129.
THOUS CU M		129.	159.	159.	159.

OVF

STATION000002



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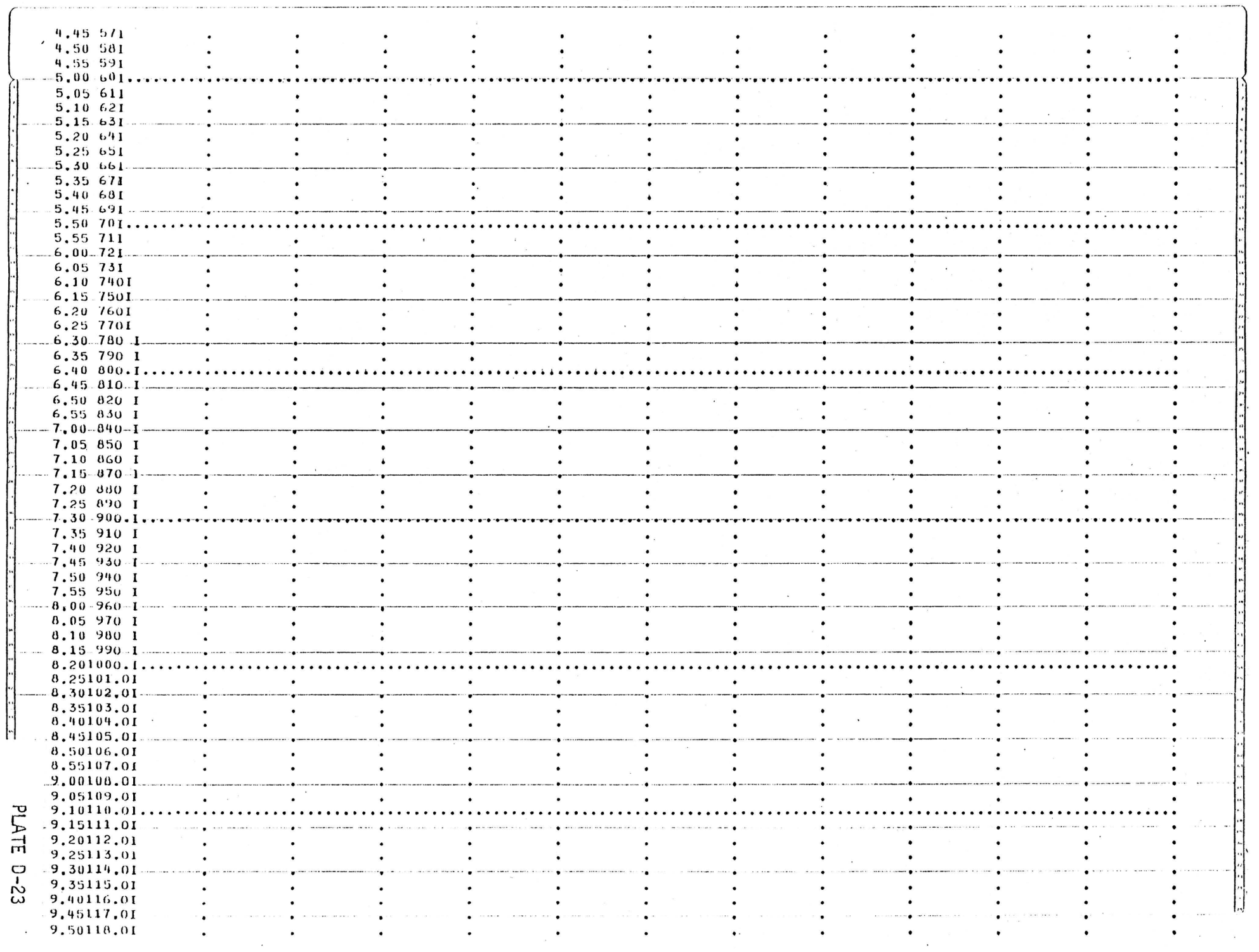
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7.45 930 I
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8.00 960 I
8.05 970 I
8.10 980 I
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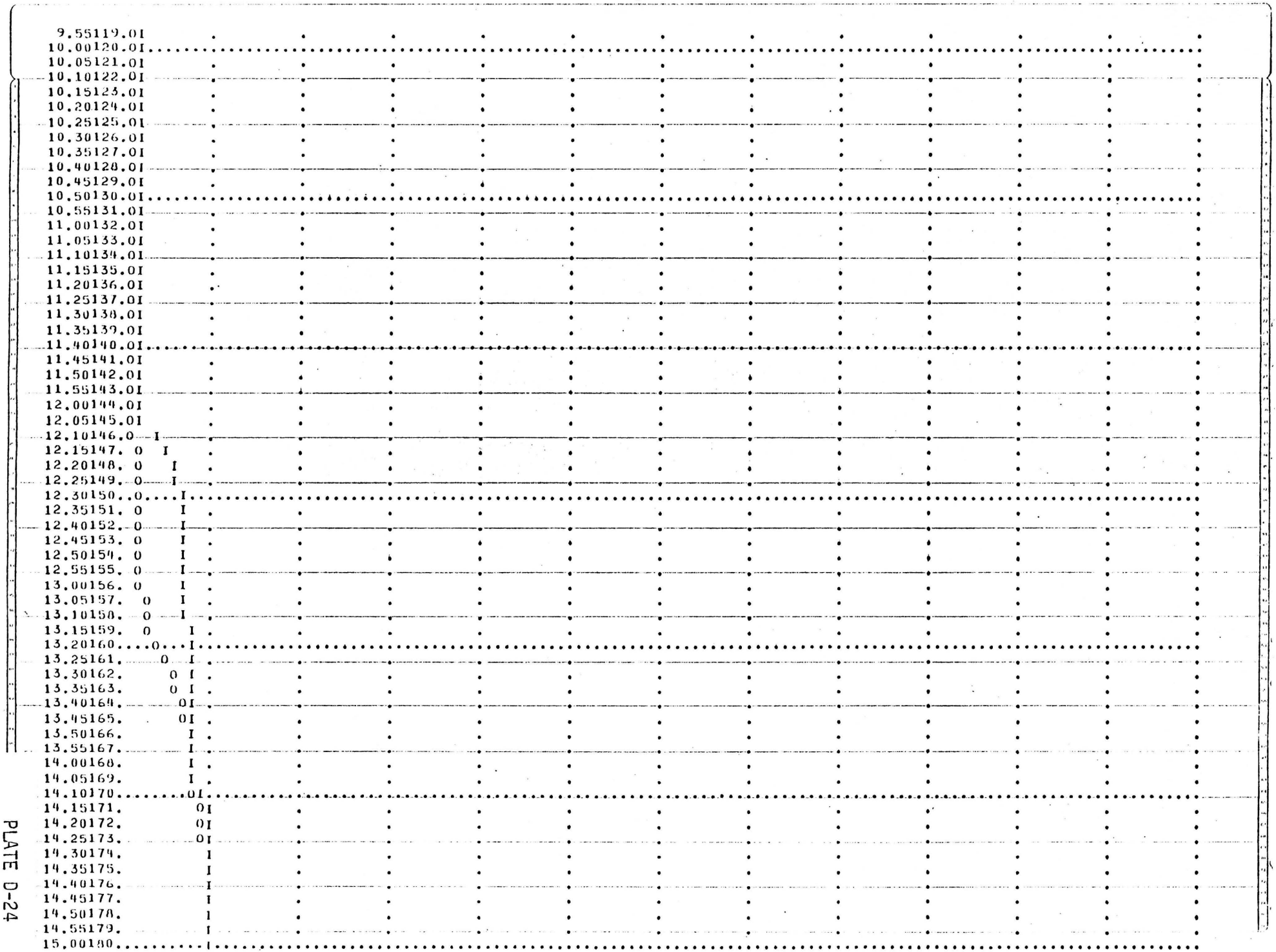
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PLATE D-24

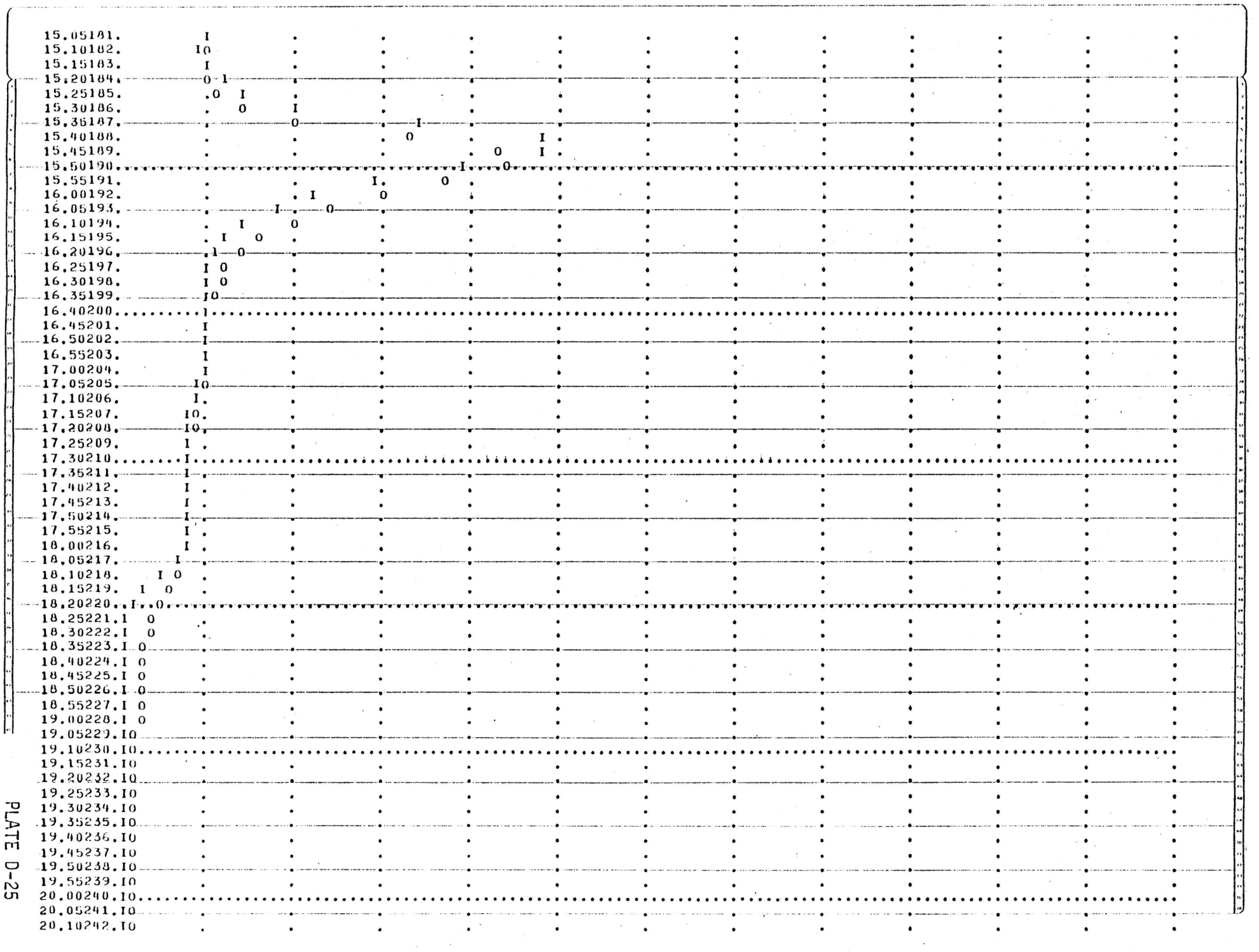
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PLATE D-25

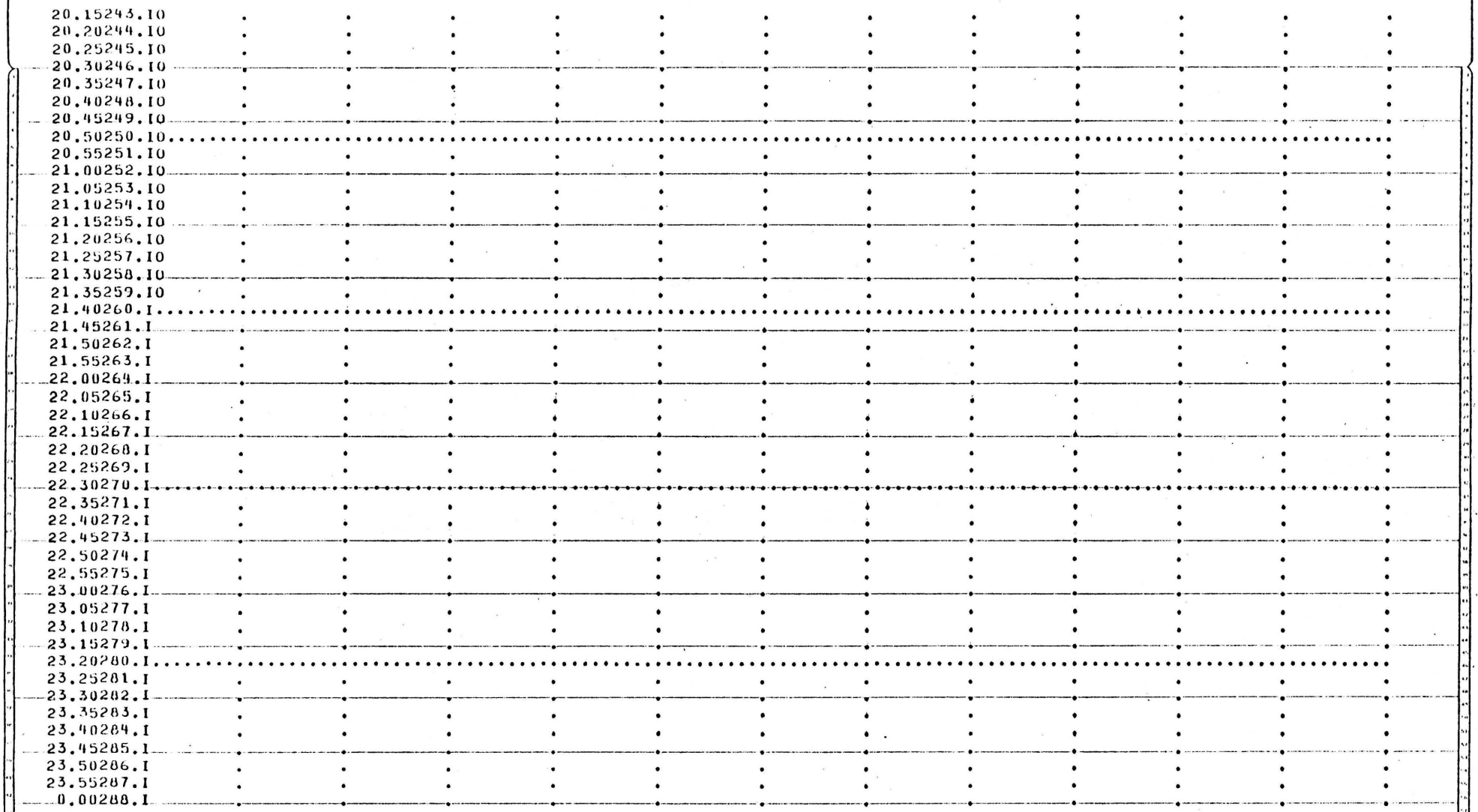
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PLATE D-26

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 .25	RATIO 6 .35	RATIO 7 .50	RATIO 8 1.00
HYDROGRAPH AT	000001	.08	1	48.	97.	145.	193.	242.	338.	483.	967.
		(.21)		(1.37)(	2.74)(	4.11)(	5.48)(	6.84)(	9.58)(	13.69)(	27.38)(
ROUTED TO	000002	.08	1	6.	15.	26.	37.	49.	159.	396.	870.
		(.21)		(.18)(	.42)(	.74)(	1.05)(	1.38)(	4.49)(	11.21)(	24.65)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	900.70	900.70	903.50
STORAGE	64.	64.	83.
OUTFLOW	0.	0.	50.

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	901.40	0.00	68.	6.	0.00	18.08	0.00
.10	901.99	0.00	72.	15.	0.00	18.00	0.00
.15	902.51	0.00	76.	26.	0.00	17.17	0.00
.20	902.99	0.00	79.	37.	0.00	17.08	0.00
.25	903.44	0.00	83.	49.	0.00	16.50	0.00
.35	904.02	.52	87.	169.	2.75	16.00	0.00
.50	904.39	.89	90.	396.	3.67	15.83	0.00
1.00	904.85	1.35	93.	870.	6.00	15.83	0.00

PLATE D-28