

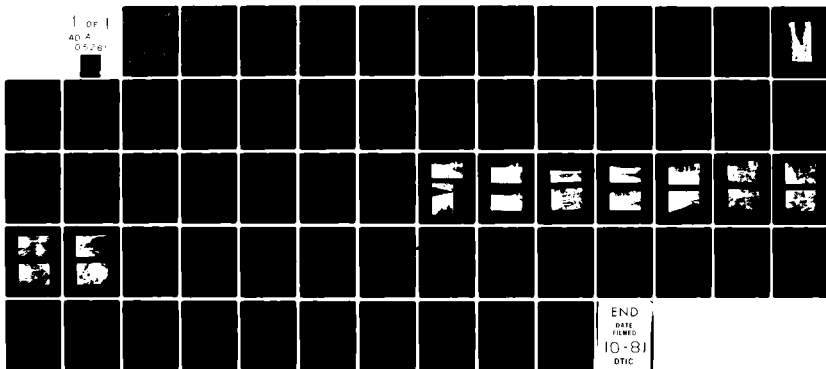
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NATIONAL DAM SAFETY PROGRAM, SAVANNAH CITY RESERVOIR DAM (MO 10--ETC(U)  
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**MISSOURI-NEMAHA-NODAWAY BASIN**

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SAVANNAH CITY RESERVOIR DAM  
ANDREW COUNTY, MISSOURI  
MO. 10038

**PHASE 1 INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM**

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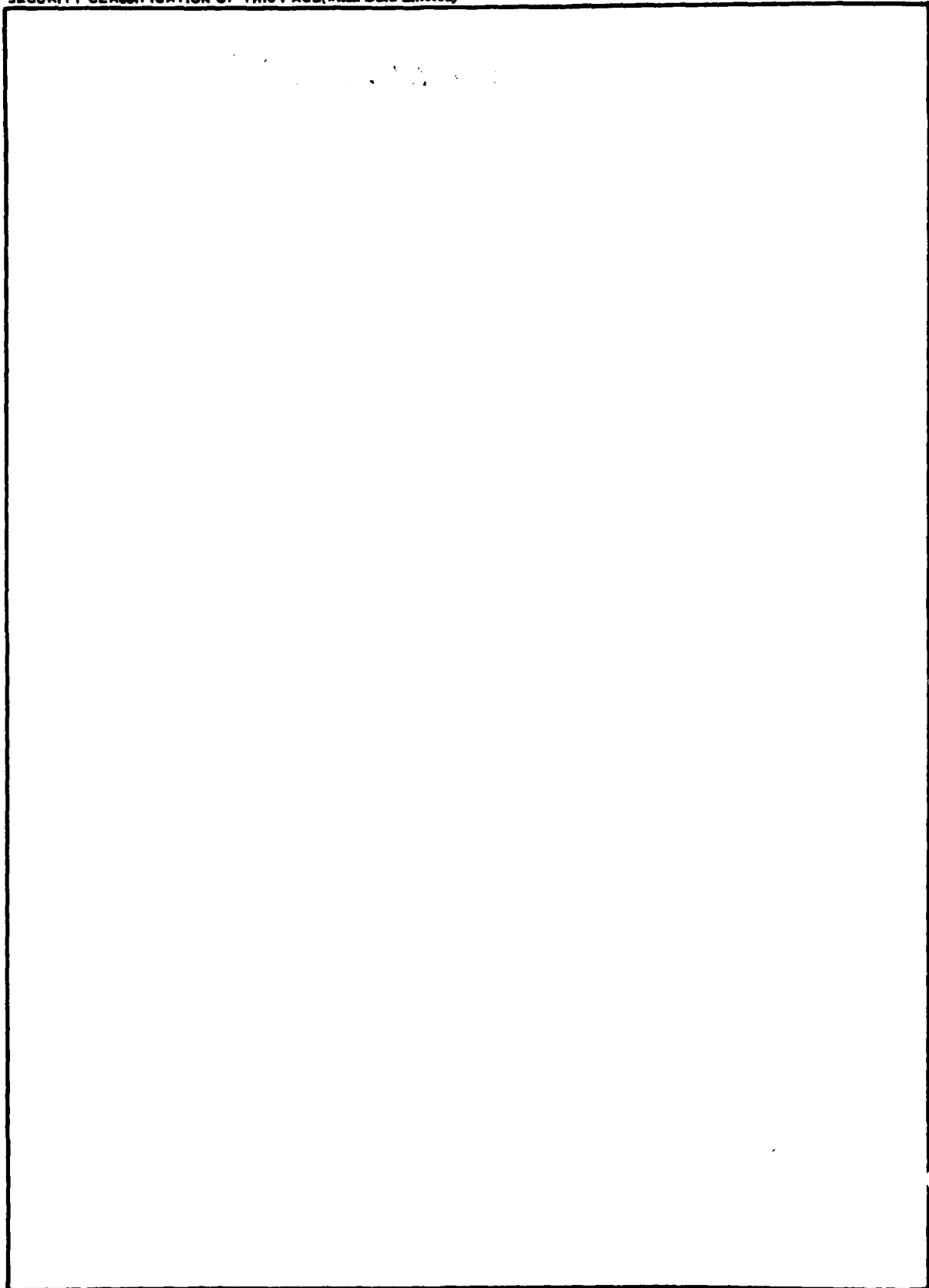
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A105 281	
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7. AUTHOR(s) Hoskins-Western-Sonderregger, Inc.		6. PERFORMING ORG. REPORT NUMBER
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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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SAVANNAH CITY RESERVOIR DAM  
ANDREW COUNTY, MISSOURI  
MO. 10038

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

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

UNDER DIRECTION OF  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR  
GOVERNOR OF MISSOURI  
MAY 1979

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

IN REPLY REFER TO

SUBJECT: Savannah City Reservoir Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Savannah City Reservoir 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.

**SIGNED**

SUBMITTED BY \_\_\_\_\_

Chief, Engineering Division

**25 SEP 1979**

Date

**25 SEP 1979**

**SIGNED**

APPROVED: \_\_\_\_\_

Colonel, CE, District Engineer

Date

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Savannah City Reservoir Dam
State Located	Missouri
County Located	Andrew County
Stream	Mace Creek
Date of Inspection	May 15, 1979

Savannah City Reservoir 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 engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately 0.5 mile downstream of the dam. Within the damage zone are the Savannah City water treatment plant, pumping station and appurtenant out buildings.

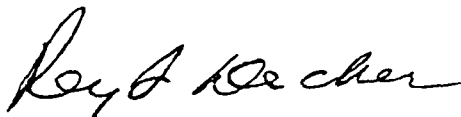
Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the volume of water impounded and the large floodplain downstream of the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 30% 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.

No design data were available for this 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. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

Other deficiencies observed during the inspection are: bulging of the downstream slope; considerable seepage along the downstream toe of the dam; a few small trees and shrubs growing along the waters edge; a few spalls and cracks in the upstream concrete wall; 18 to 20 feet of the left side of the concrete spillway weir is covered with soil sluff from the left abutment; many shrubs and several good sized trees growing in the earth spillway; badly spalled, cracked, and deteriorated concrete in the spillway exit chute; a number of holes in the exit chute concrete bottom and side walls; undermining around and under several of the holes, badly deteriorated and undermined condition of the outlet end of the concrete chute, seepage discharging under the right side wall and bottom of the chute, and small trees and shrubs growing in the cracks and holes in the concrete chute.

The serious deterioration of the concrete chute outlet for the spillway and the growth of trees and brush in the spillway channel indicate laxity in maintaining this dam.

Maintenance and repair items needed to be done by the owner are described in detail in the report.



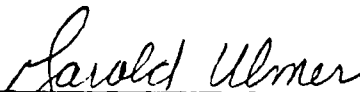
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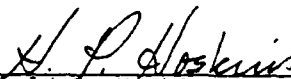
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Gordon Jamison



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Garold Uimer  
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Harold P. Hoskins  
Chairman of Board  
Hoskins-Western-Sonderegger, Inc.  
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PHOTO NO. 1 - OVERVIEW FROM RIGHT ABUTMENT.

PHASE 1 INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
SAVANNAH CITY RESERVOIR DAM - MO 10038  
ANDREW 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 Savannah City Reservoir 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 with a concrete core wall parallel with the axis of the dam and located near the upstream crest line. The dam is approximately 580 feet in length with a maximum height of about 34 feet.
  - (2) The spillway is uncontrolled and consists of a vegetated earth channel cut into the left abutment. At the upstream end of the spillway channel the inlet elevation is controlled by a concrete sill which is an extension of the dam core wall. At the downstream end of the spillway channel there is a concrete weir and trapezoidal chute control.

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

- b. Location. The dam is located in the west central portion of Andrew County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the NE $\frac{1}{4}$  of Section 7, T59N, R35W. The lake formed behind the dam is shown in the NE $\frac{1}{4}$  of Section 7, T59N, R35W, and the SE $\frac{1}{4}$  of Section 6, T59N, R35W.
- 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 small 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 one-half mile downstream of the dam. Within the damage zone are the Savannah City water treatment plant and pumping station and appurtenant out buildings.
- e. Ownership. The dam is owned by the City of Savannah, Missouri, 402 Court Street, Savannah, Missouri 64485. Attention: Dave Scantlin, City Administrator.
- f. Purpose of Dam. Water supply for the City of Savannah, Mo.
- g. Design and Construction History. The dam was constructed in 1926. One sheet of plans for the dam showing topography of the reservoir and a typical section of the dam, were provided by the Savannah City Administrator. This information is included in this report in Appendix C. It was reported by Mr. Otto Poland, an employee of the Savannah Water Department, that the dam was modified sometime between 1939 and 1951 in order to increase the impoundment behind the dam. A detailed description of the major changes made is covered in Section 6 of this report. No other information was available on design or construction of the dam.
- h. Normal Operating Procedure. The uncontrolled spillway discharges several times each year. It was reported by Randy Johnson, the plant operator, that maximum spillway flow is 2 to 3 inches over the outlet weir. The reservoir level is maintained at a relatively constant level by pumping from a downstream well.

### 1.3 PERTINENT DATA

a. Drainage Area. 0.91 sq. mi. (582.4 acres).

b. Discharge at Damsite.

(1) All discharge at the dam is through an uncontrolled spillway. The spillway consists of an upstream concrete sill (8 inches wide) which is an extension of the core wall of the dam in tandem with a downstream broad crested weir with chute. The upstream and downstream weir are separated by a 280 ft. earthen irregular trapezoidal channel. The backwater effects of the channel and downstream weir drown out the control conditions of the upstream weir at approximately 1,032 ft. MSL.

(2) Estimated flood at damsite - unknown.

(3) The spillway capacity varies from 0 cfs at elevation 1030.0 ft. (upstream spillway crest) to 1,660 cfs at elevation 1033.3 ft. (nominal dam crest and maximum pool elevation).

c. Elevation (feet above MSL).

- (1) Top of dam - 1033.3 (nominal)
- (2) Normal pool & spillway crest - 1030.0
- (3) Stream bed at C of dam - 999±
- (4) Maximum tailwater - unknown

d. Reservoir. Length of maximum pool - 1,700 ft. ±

e. Storage (acre-feet).

- (1) Top of Dam - 332
- (2) Spillway crest - 264

f. Reservoir Surface (acres).

- (1) Top of Dam - 25±
- (2) Spillway Crest - 19±

g. Dam

- (1) Type - earthfill
- (2) Length - 580± feet
- (3) Height - 26±feet
- (4) Top width - 11 feet

(5) Side Slopes

- (a) Downstream - 2.6H on 1V± (measured)
- (b) Upstream - vertical concrete wall -  
(plans show 2.5H on 1V)

- (6) Zoning - unknown.
- (7) Impervious core - plans show concrete core wall.
- (8) Cutoff trench - plans show concrete core wall extending into the foundation.
- (9) Grout curtain - unknown.
- (10) Internal Drainage - unknown (none shown on plan).
- (11) Wave protection - vertical concrete wall and riprap.
- (12) Downstream slope protection - vegetation.

h. Diversion Channel and Regulating Tunnel - none.

i. Spillway.

- (1) Type - uncontrolled; concrete sill - vegetated earth channel - broadcrested weir, in tandem.
- (2) Location - left (east) abutment.
- (3) Crest elevation.
  - Upstream - 1030.0
  - Downstream - 1028.0
- (4) Control section - variable, upstream weir drowned out by downstream weir and trapezoidal channel.
- (5) Downstream channel - natural creek channel downstream from broadcrested weir and chute.

j. Regulating Outlets - 10 inch cast iron pipe from water supply intake tower. Seepage collars are not shown on the plan for the dam.

k. Regulating Inlet. A concrete box on left upstream abutment has a 8 inch steel pipe poured into the south wall. Randy Johnson, operator of the pumping station, reported that the 8 inch pipe was an inlet pipe from a pumped well line from a source some 6.8 miles distance, and is used to maintain the lake level at an essentially constant level.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

Design data available for this dam are shown in Appendix C.

### 2.2 CONSTRUCTION

No construction data were available. It was reported by Mr. Dave Scantlin, City Administrator, that the dam was constructed in 1926.

### 2.3 OPERATION

No data were available on spillway operation. It was reported that the spillway operates several times each year. It was also reported that the lake level is maintained by pumping from a well located in the valley downstream from the dam. The drawdown for city water is from the top port of the three ported raw water intake tower located at the upstream toe at Station 4+00±. The two gates for the lower level ports are probably rusted shut. The above information was obtained from Randy Johnson, the pump station operator.

### 2.4 EVALUATION

- a. Availability. The data shown in Appendix C were readily available from the city administrator.
- b. Adequacy. The available data, 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 the Savannah City Reservoir Dam was made on May 15, 1979. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were: R. S. Decker, Geotechnical; Gordon Jamison, Hydrology; Garold Ulmer, Civil Engineer.

b. Dam.

(1) Geology and Soils (abutment and embankment).

This dam is located in the northern Missouri loess-till physiographic area. The rolling hill uplands consist of 8 to 10 feet of CL-ML loess underlain by fine grained glacial till. The valley slopes (abutments) consist of weathered glacial till with or without a thin mantle of alluvial-colluvial material from the loess capping. Clay till with occasional gravel was observed in the right abutment some 20 feet in elevation above the reservoir level. Till was also exposed in the left bank of the spillway earthen channel. Materials in the dam appeared to be CL-CH soils probably borrowed from the valley slopes adjacent to the reservoir area.

(2) Upstream Slope.

The exposed upstream slope consists of a vertical concrete wall which is an extension of the core wall in the dam. The concrete wall is generally in good condition. A few small cracks (1/8 inch or less in width) and spalls were observed around Station 1+25. There is a distinct upstream bulge in the wall between stations 3+50 to 4+50±, as shown in Photo No. 4. A few small trees and shrubs are growing along the waters edge. Durable limestone riprap was observed extending into the reservoir for 6 to 8 feet where the upstream slope apparently breaks downward.

(3) Crest.

The crest of the dam is well vegetated with adapted grasses. In most places the downstream crestline is slightly higher than the crest of the concrete wall. The crest of the concrete wall is slightly irregular

in elevation with maximum variations of about 0.5 foot. No cracks, deformations or potholes were observed along the crest of the dam.

(4) Downstream slope.

The downstream slope is well vegetated with adapted grasses. No rodent holes or cracks were observed. There is an obvious bulge in the downstream slope located about 15 feet in elevation below the crest and extending from about Station 3+50 to 4+15. According to the plan shown in Appendix C (Plate C-2), the bulge is located approximately over the old stream channel section. No evidence of cracks or other signs of recent movement of the downstream slope was observed. The construction plan (Plate C-1) shows a downstream slope of 2H to 1V. The slope as measured is 2.6H to 1V. The difference is accounted for by the modification of the dam that was done sometime between 1939 and 1951 (See Section 6 and Plate C-3). The bulge occurred after the modification of the dam. Considerable seepage was observed along the downstream toe of the dam extending from the left abutment trough to about Station 3+50. All seepage was clear with no observable flow through the dense vegetative cover.

(5) Miscellaneous.

The apparent nature of materials on the crest and downstream slope and the excellent vegetative cover indicate that this dam could withstand considerable overtopping without serious damage.

c. Appurtenant Structures.

- (1) The spillway consists of a vegetated earth channel about 280 feet in length and 75 feet wide excavated into the left abutment with a concrete sill across the inlet channel at elevation 1030. The exit channel consists of a concrete weir 78 feet in width at elevation 1028 and a pyramidal concrete chute varying in width from 78 feet at the inlet to 30 feet at elevation 1010.5 and to 18 feet at elevation 1008.4

The concrete sill across the inlet appears to be in good condition, but the debris fence and posts on top of the sill have been flattened and bent (see Photos 12 and 13). The left (east) 18 to 20 feet of the sill is covered with colluvium and soil sluff from the left abutment. The

earth channel section is well vegetated with grasses, many shrubs and bushes and several good sized trees up to 15 inches in diameter. The concrete exit chute is badly spalled, cracked and deteriorated, particularly along the base of the right sidewall. A number of holes ranging in size up to about 2 to 5 feet were observed. The bottom and sidewalls are undermined to depths of 2-3 feet around and under several of these holes. The outlet end of the chute is badly deteriorated and undermined.

Seepage flows approximating 0.5 gallons or more are discharging under the right sidewall and bottom of the lower one-half of the chute. All seepage is clear.

Several small trees and shrubs are growing in the cracks and holes in the chute section of the spillway. Photos 16 through 19 show the deterioration of the spillway. Ponded water shown in Photo 19 is all from seepage along and under the spillway chute.

- (2) Drawdown facilities consist of a 10 inch diameter cast iron water supply line from the domestic water supply intake tower to the treatment plant. The valve house for this water line is located at the downstream toe of the dam opposite about Station 4+00. This structure was dry and in good shape. The valve is operable.

It was reported by Randy Johnson that all domestic water is withdrawn through the upper port of the water supply intake tower and that the gates for the lower ports are probably inoperable. Prior to modification of the dam the top of the intake tower projected above the normal pool level of the reservoir (Plate C-1). After modification the top of the intake tower is covered under normal pool level (Photo No. 8).

- d. Reservoir Area. The area surrounding and bounding the reservoir is well vegetated with grass and trees. No significant erosion was noted around the shoreline of the reservoir.
- e. Downstream Channel. The spillway channel discharge passes under a county road through a concrete box culvert 8.5 feet in height by 12 feet in width located some 25 to 30 feet downstream from the spillway outlet chute. The channel and culvert are clear and open. The channel downstream from the road culvert is choked with trees and brush.

### 3.2 EVALUATION

Additional studies would be required to evaluate the potential of failure due to inadequate shear strength (bulging) and to seepage through the left abutment and foundation. These deficiencies do not appear to pose any immediate hazard to the safety of the structure.

Deterioration of the concrete outlet for the spillway, tree and shrub growth in the spillway channel, and partial blocking of the spillway control sill are considered to be deficiencies that should be corrected. Hydrologic analyses presented in Section 5 indicate that the dam would be overtopped by the PMF for a period of 4 hours±. Such flows would undoubtedly remove the spillway chute in its present condition. However, considering the erosional resistance of the glacial till into which the spillway is excavated and the long length (280 ft.) of head cutting that would be required to breach the reservoir, it is doubtful that such flows would cause failure of the dam and/or reservoir.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

The reservoir serves as the water supply for the City of Savannah. Water is withdrawn as needed through the upper port of the intake tower and a 10 inch cast iron water line into the treatment plant and pumping station located just downstream from the dam. The pool level is maintained at a relatively constant level by pumping from a well in the valley downstream from the dam.

### 4.2 MAINTENANCE OF DAM

The serious deterioration of the concrete chute outlet for the spillway, the growth of trees and brush in the spillway channel indicate extreme laxity in maintaining this structure.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

It was reported by Randy Johnson, the water-plant operator, that the gates for all intake ports of the water intake tower except the upper most port are probably inoperable. All other valves and controls necessary for near continuous operation of the water supply system are operable and in good condition.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

### 4.5 EVALUATION

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

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

- a. Design Data. No design data other than that presented in Plate C-1 were found for this dam.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Savannah, 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.
- c. Visual Observations.
  - (1) There is no pipe spillway through the dam. The only spillway is the combination concrete weir and earth channel spillway.
  - (2) The effect of the upstream weir is diminished due to the flattened woven-wire fence and bent steel posts at the weir crest.
  - (3) The downstream weir and chute are badly deteriorated on the floor and sides. There is considerable undermining.
  - (4) The upstream concrete dam face is out-of-line but appears to be in fair shape.
- d. Overtopping Potential. The spillway is too small to pass 50% of the probable maximum flood without overtopping. The spillway will pass 30% of the probable maximum flood without overtopping. The spillway will pass the 100-year frequency flood without overtopping the dam. The effect of overtopping on the structural or erosional stability of the dam is expected to be minimal. The results of the routings through the dam are tabulated in regards to the following conditions.

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 1033.3</u>	<u>Time Dam Overtopping Hr.</u>
100 Yr.	1750	1190	1032.6	+0.7	-
0.5 PMF	3610	3290	1034.0	-0.7	1
PMF	7220	6900	1035.0	-1.7	4
0.3 PMF	2150	1660	1033.3	0	-

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 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 1.2d in this report.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. The dam has significant seepage along the downstream toe. The dam has obviously spread horizontally both upstream and downstream in the maximum section as shown by the bulge in the downstream slope and by the upstream curvature in the core wall. There is no indication that the present dam is structurally unstable under normal loads. Additional studies would be necessary to determine the structural stability under maximum loading conditions. The outlet chute for the spillway would suffer major damage under maximum flow conditions. Additional studies would be required to determine the affects of overtopping on structural stability. However, it appears that the safety of the dam would not be seriously impaired by overtopping or head-cutting erosion in the spillway exit section.
- b. Design and Construction Data. The only available design data are shown in Appendix C - Plate C-1. No 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. The water supply for the City of Savannah is withdrawn from the reservoir as needed. The reservoir level is maintained by pumping from a well downstream from the dam. No records were available on operation of the spillway, but it was reported by the water plant operator that there is flow several times each year with a maximum flow depth of 2 to 3 inches over the lower weir.
- d. Post Construction Changes. Mr. Otto Poland, an employee of the Savannah Water Department since 1951, stated that the City ran out of water in 1936 and 1939. Sometime between 1939 and 1951 the original concrete core wall and the concrete spillway sill were raised approximately two feet (see Photo No. 3) in order to increase the amount of water impounded behind the dam. The raising of the core wall elevation occasioned the addition of embankment materials on the downstream slope of the dam. The downstream face slope averages 2.6H to 1V as compared to 2H to 1V as shown on the original plan. The source of the embankment material is not known. The field inspection revealed that durable limestone riprap extends 6 to 8 feet into the reservoir from the edge of the core wall where the upstream slope breaks downward.

Based upon the construction plan of the dam materials were also added to the upstream slope. The surveyed profile of the spillway indicates that the concrete weir and concrete chute in the spillway exit channel were constructed at the same time as the foregoing.

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

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

- a. Safety. The dam will be overtopped by one half the PMF. The effect of such overtopping on the structural or erosional stability of the dam is not known. It is felt that such overtopping would not seriously impair the safety of the dam. However, such overtopping would cause severe damage and probable reconstruction of the spillway chute. It seems doubtful that damage to the spillway would cause breaching of the reservoir. The safety of the dam against shear failures or excessive seepage pressures is not known. However, the dam has been in place for more than 50 years. The downstream slope is flatter than normally constructed for this height of dam and there are no signs of any recent instability of the structure. These factors would indicate that the dam is structurally stable.
- b. Adequacy of Information. Due to the minimum amount 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 guidelines were not available which is considered a deficiency.
- c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 2.7.a should be pursued on a high priority basis.
- d. Necessity for Phase II. Phase II investigation is not considered necessary.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

### 7.2 REMEDIAL MEASURES

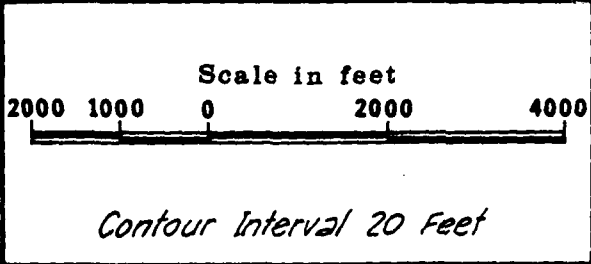
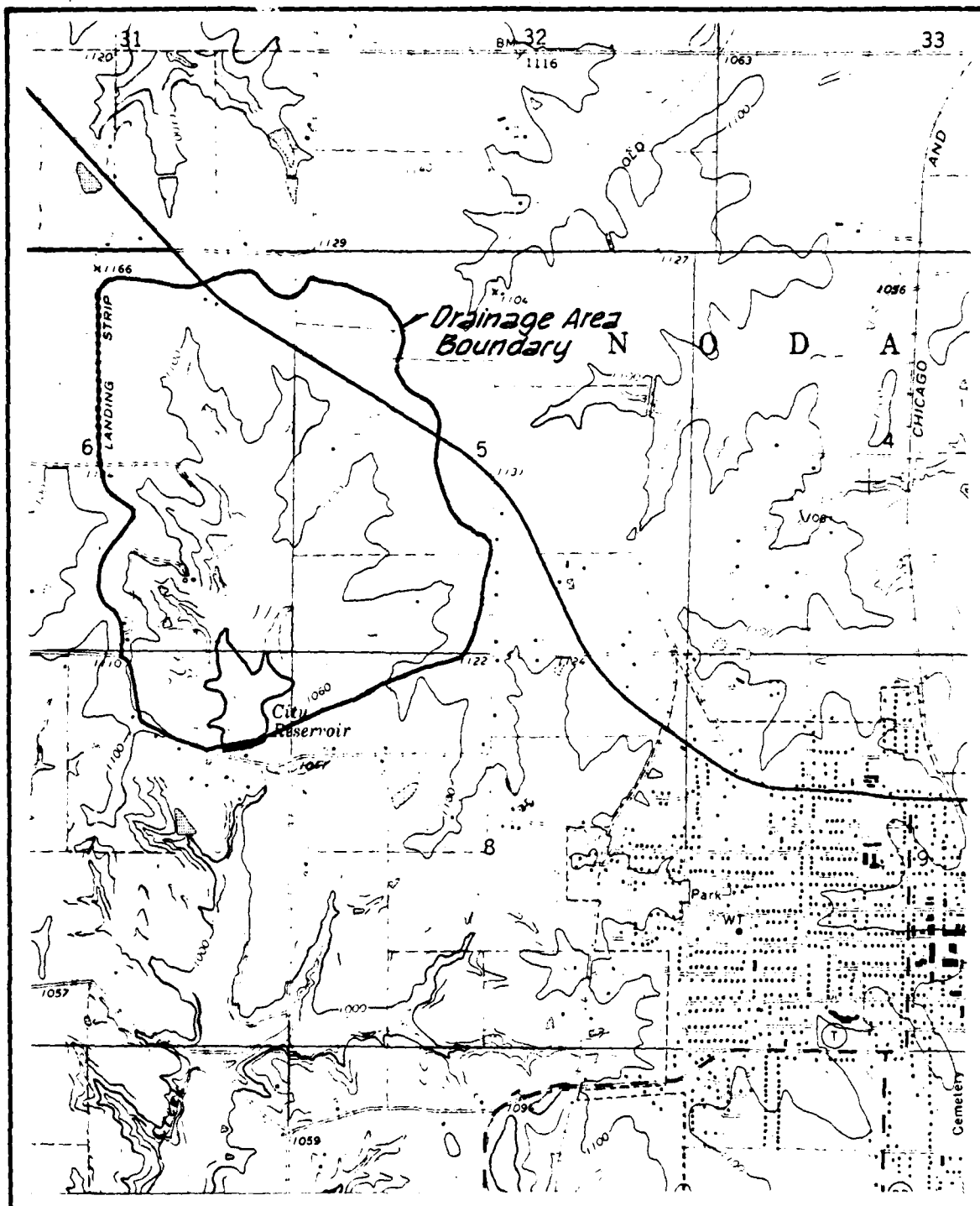
- a. Alternatives.
  - (1) Additional information should be obtained to determine the effects of overtopping and the increase in the

height of dam or the size of the spillway that is necessary to pass one half the probable maximum flood without overtopping the dam. The services of an engineer experienced in the design and construction of dams should be obtained to provide seepage and stability analyses of the present dam, and to design any requisite protective measures.

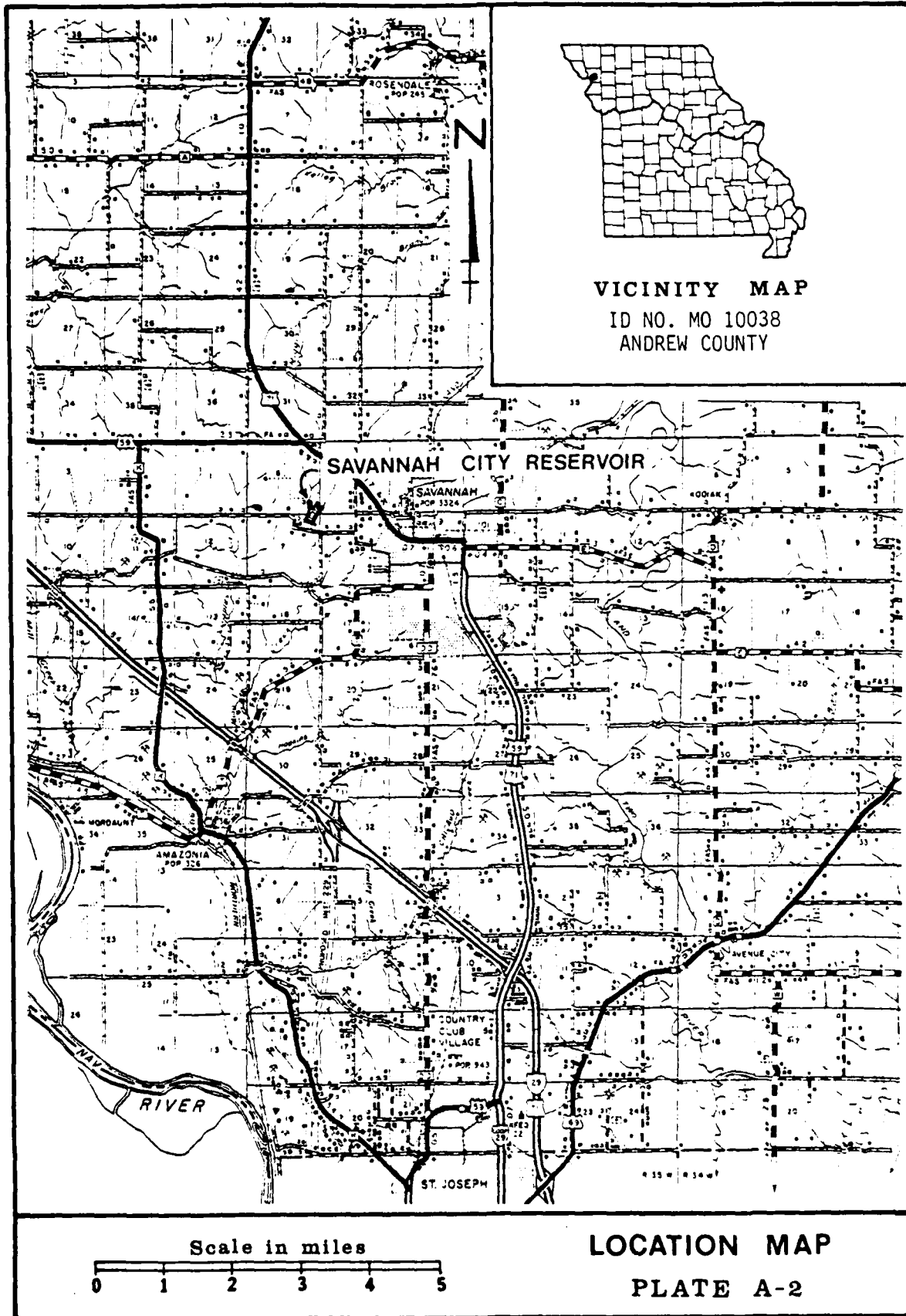
b. O & M Procedures.

- (1) The concrete chute section of the spillway should be repaired or replaced. Rehabilitation measures should include foundation and sidewall drains and replacement of deteriorated floor and sidewall sections as designed by an experienced and competent engineer.
- (2) Trees and shrubs should be removed from the spillway channel and from the upstream face of the dam and measures initiated to prevent their recurrence.
- (3) The buried section of the concrete sill controlling the inlet should be uncovered and the adjacent abutment slope should be stabilized, preferably under the supervision of a professional engineer. The fence on top of the concrete sill should be rehabilitated.
- (4) A program of regular inspection and repair should be initiated to insure the effective operation and integrity of the spillway.

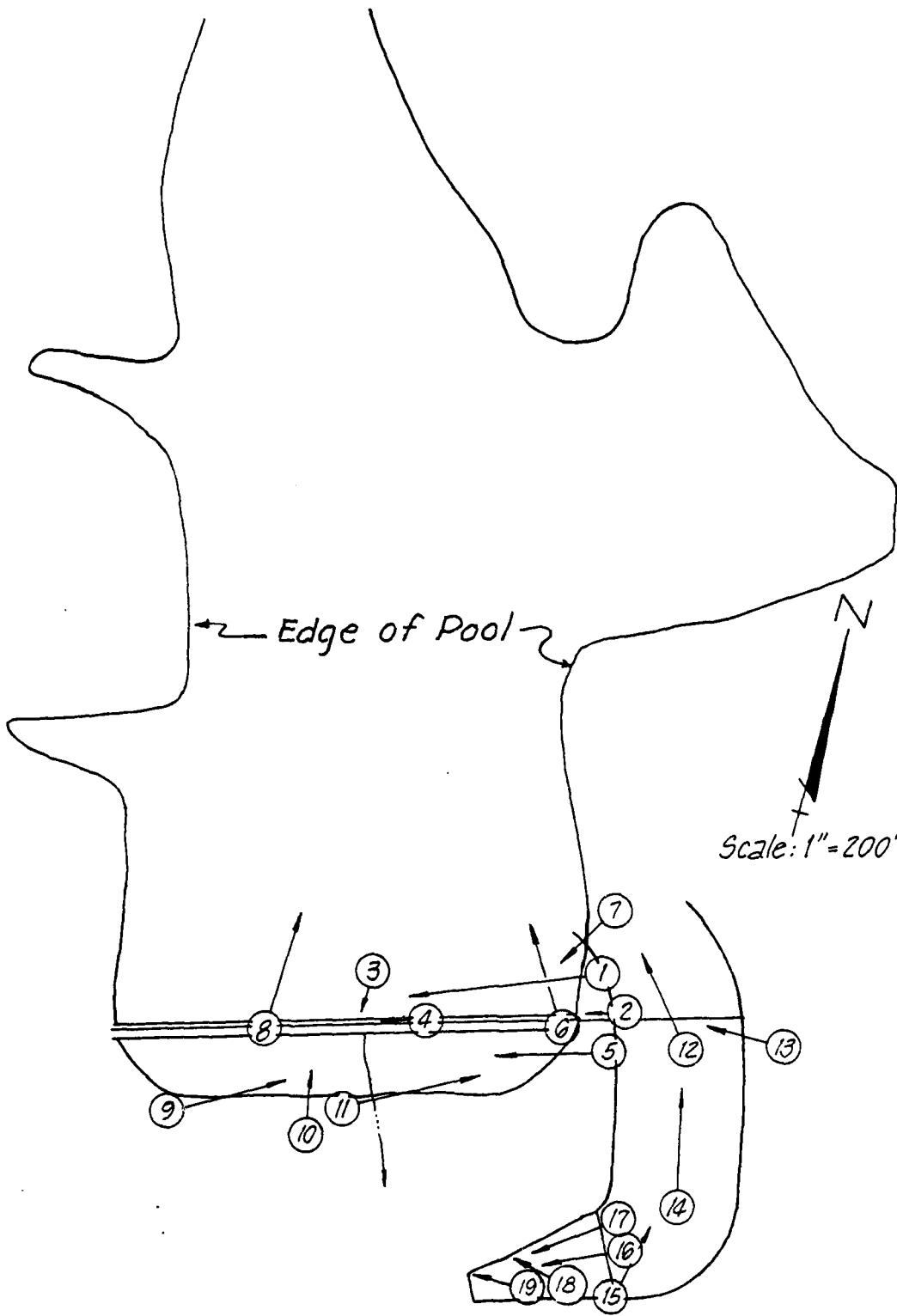
APPENDIX A  
MAPS



**VICINITY TOPOGRAPHY**  
 SAVANNAH CITY RESERVOIR  
 ANDREW COUNTY, MISSOURI  
 MO. 10038  
 PLATE A-1



APPENDIX B  
PHOTOGRAPHS



**PHOTO INDEX**

SAVANNAH CITY RESERVOIR DAM

ANDREW COUNTY, MISSOURI

MO. 10038

PLATE B-1



PHOTO NO. 2 - CREST AND UPSTREAM SLOPE FROM LEFT (EAST) END  
SHOWING EXTENSION OF ORIGINAL CONCRETE CORE WALL.



PHOTO NO. 3 -  
EXTENSION OF CONCRETE  
CORE WALL. NOTE  
JOINT JUST ABOVE  
WATER SURFACE.



PHOTO NO. 4 - EXTENSION OF ORIGINAL CONCRETE CORE WALL.  
NOTE BULGE IN WALL.

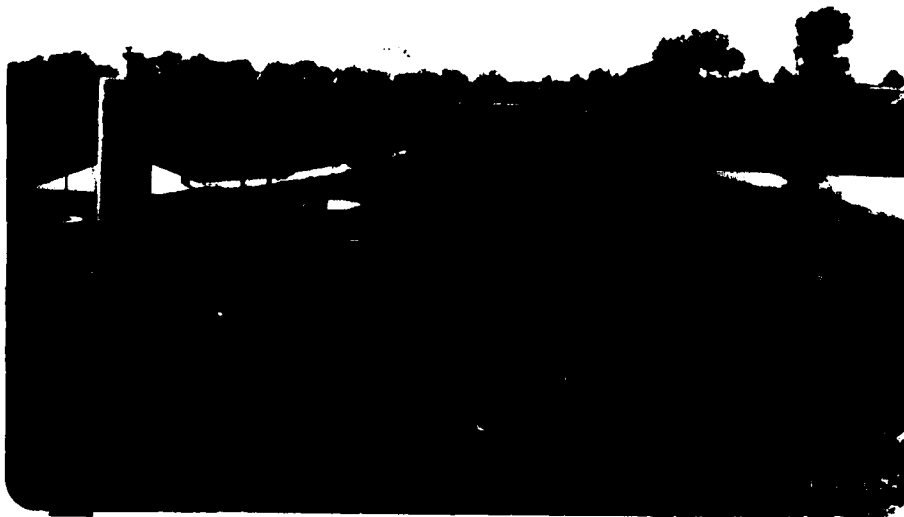


PHOTO NO. 5 - DOWNSTREAM SLOPE FROM LEFT (EAST) SIDE.



PHOTO NO. 6 - LOOKING UPSTREAM FROM LEFT END.

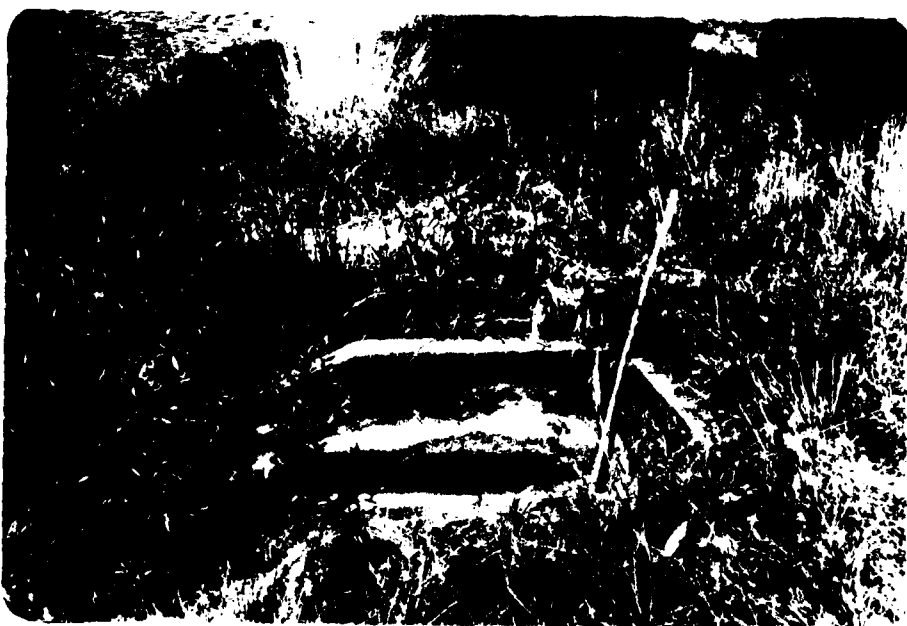


PHOTO NO. 7 - OUTLET BOX FOR SUPPLEMENTAL (PUMPED) WATER  
SUPPLY INTO THE RESERVOIR.



PHOTO NO. 8 - LOOKING UPSTREAM FROM  $\odot$  STA. 4+00  $\pm$ .  
SUBMERGED WATER SUPPLY INLET IN CENTER OF  
PICTURE.



PHOTO NO. 9 - LOOKING ACROSS BULGE IN DOWNSTREAM SLOPE AND  
SEEP ALONG TOE FROM DOWNSTREAM  $\odot$  STA. 5+00  $\pm$ .



PHOTO NO. 10 - LOOKING INTO BULGE AREA ON DOWNSTREAM SLOPE  
FROM RIGHT SIDE.

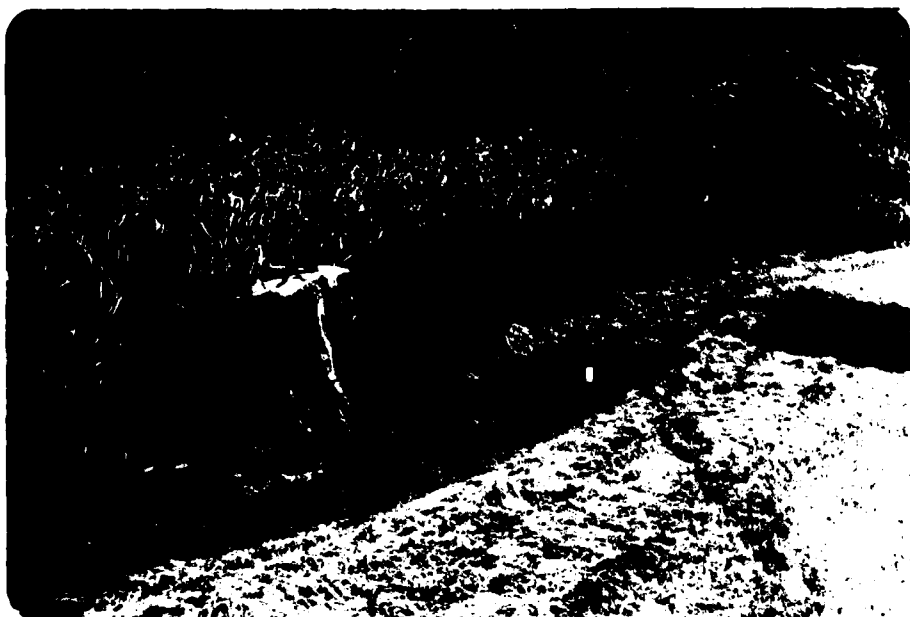


PHOTO NO. 11 - LOOKING INTO SEEP AREA ALONG TOE OF DAM,



PHOTO NO. 12 - LOOKING UPSTREAM INTO INLET SECTION OF  
SPILLWAY. FENCE POSTS SET IN CONCRETE SILL  
EXTENSION OF CONCRETE CORE WALL.



PHOTO NO. 13 - LOOKING ACROSS SPILLWAY INLET AND SILL  
CONTROL FROM LEFT ABUTMENT



PHOTO NO. 14 - LOOKING UPSTREAM IN SPILLWAY CHANNEL FROM ABOUT SPILLWAY STA. 1+00.



PHOTO NO. 15 - LOOKING UPSTREAM INTO ENTRANCE CHANNEL FOR LOWER WEIR AND CHUTE.



PHOTO NO. 16 - LOOKING DOWNSTREAM IN CHUTE SECTION FROM WEIR CREST.



PHOTO NO. 17 - LOOKING DOWNSTREAM IN CHUTE ALONG RIGHT (NORTH) SIDE OF CHUTE.

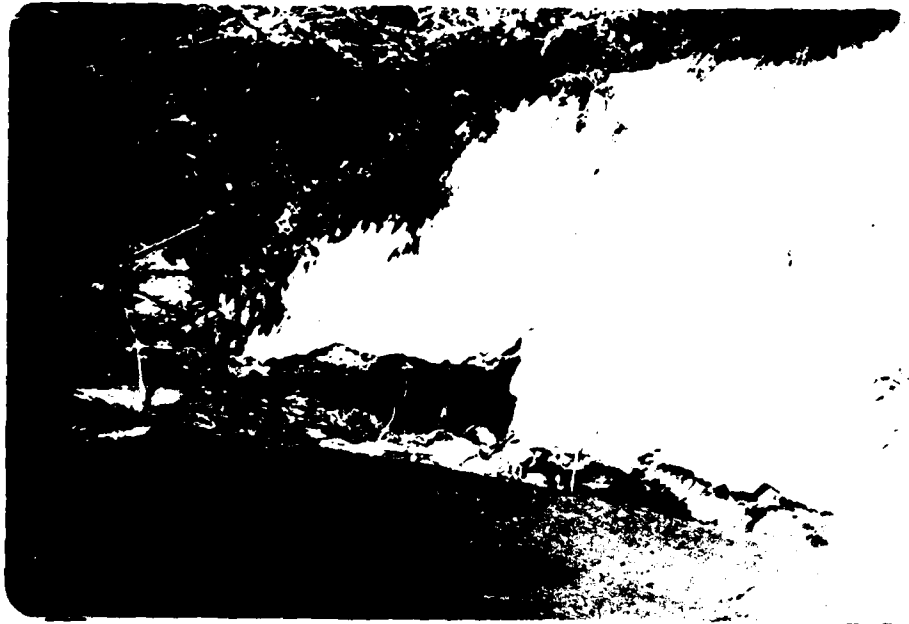


PHOTO NO. 18 - LOOKING INTO HOLES AND UNDERMINING OF RIGHT SIDE AND BOTTOM OF SPILLWAY (FROM UPSTREAM).

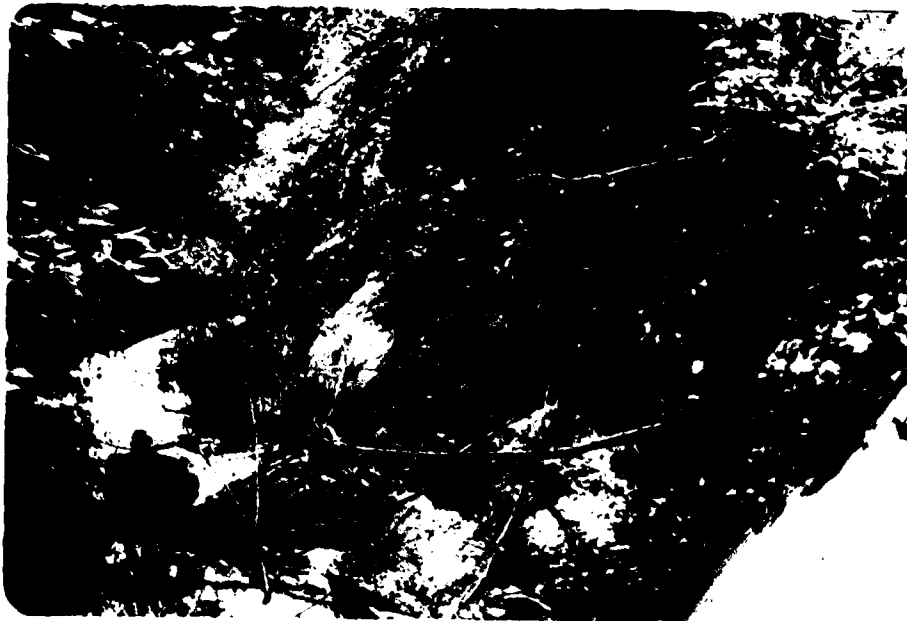


PHOTO NO. 19 - DETERIORATION AND UNDERMINING OF RIGHT SIDE OF OUTLET SECTION OF SPILLWAY CHUTE.

APPENDIX C  
PROJECT PLATES

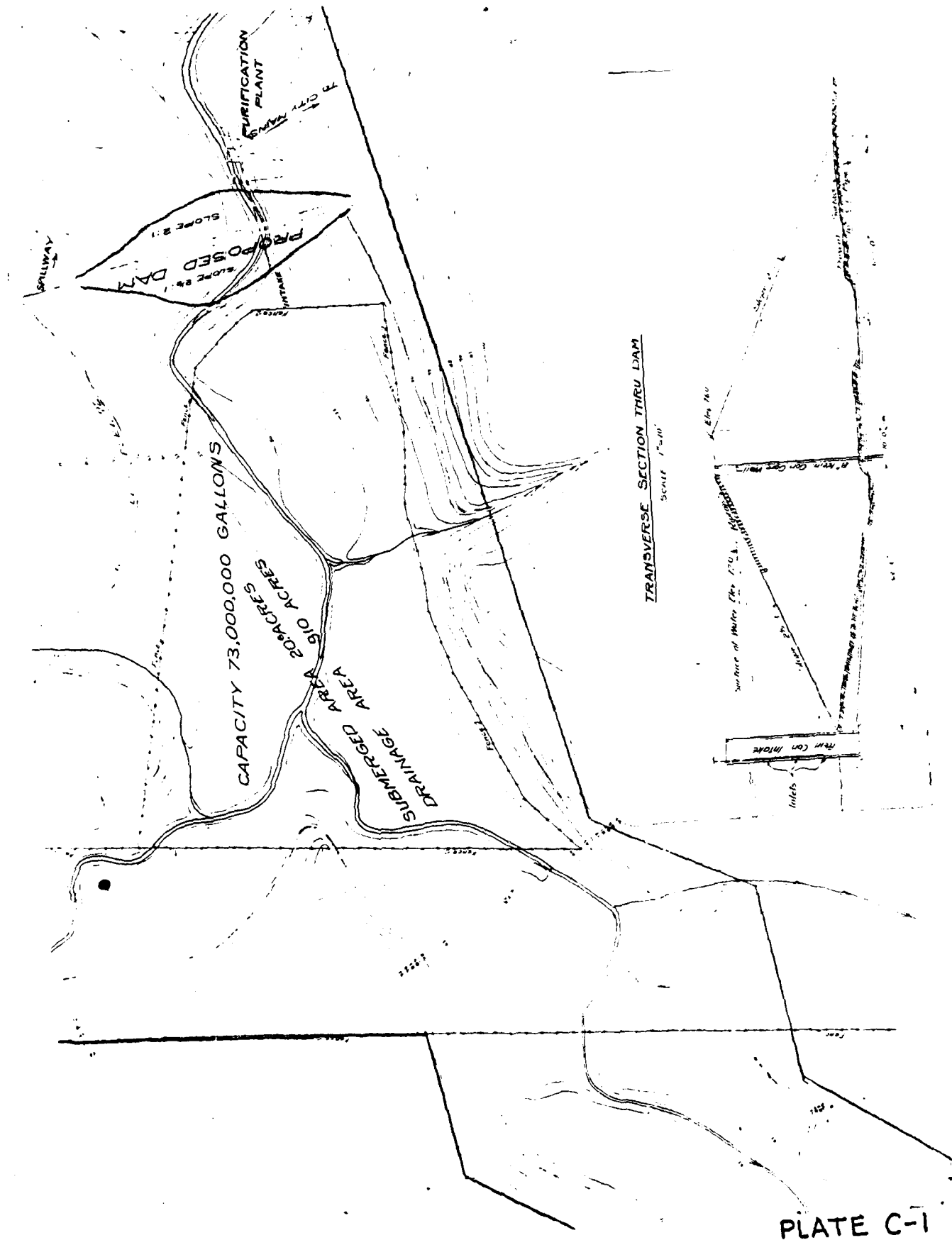
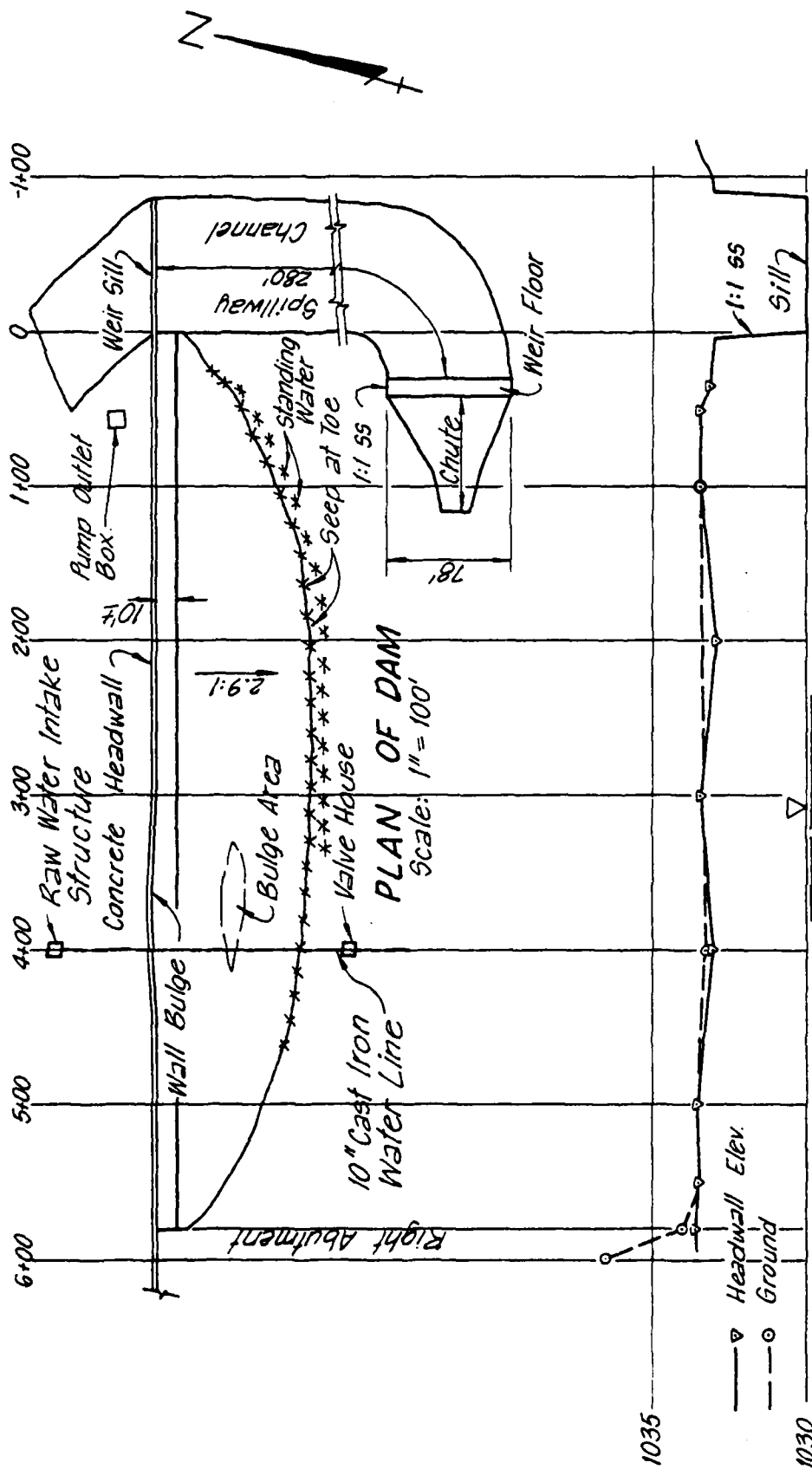
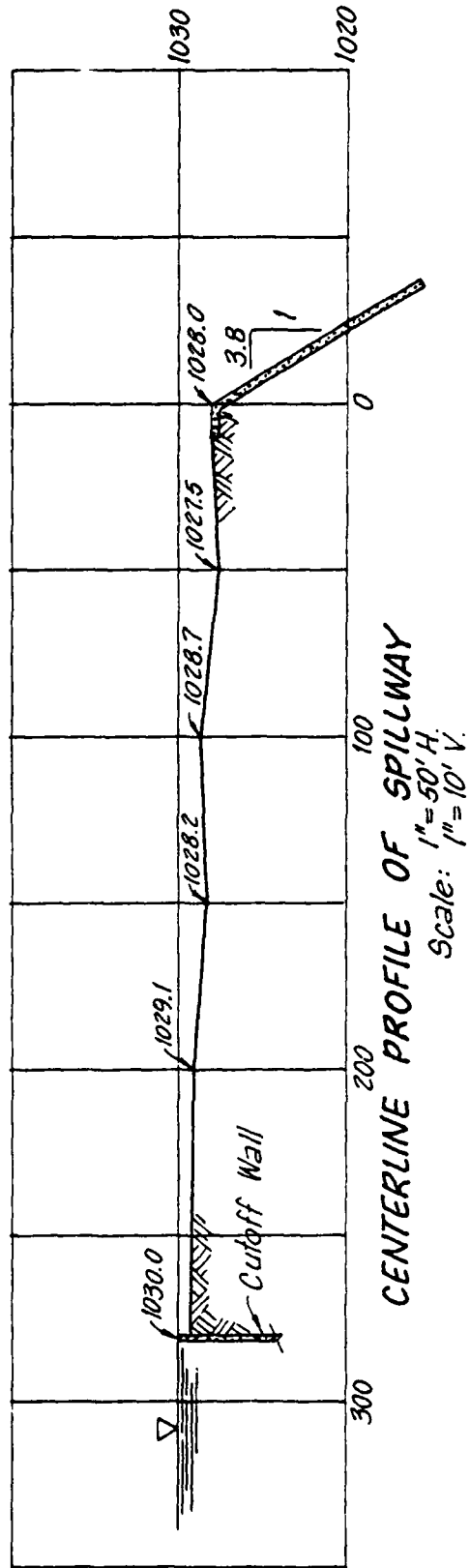
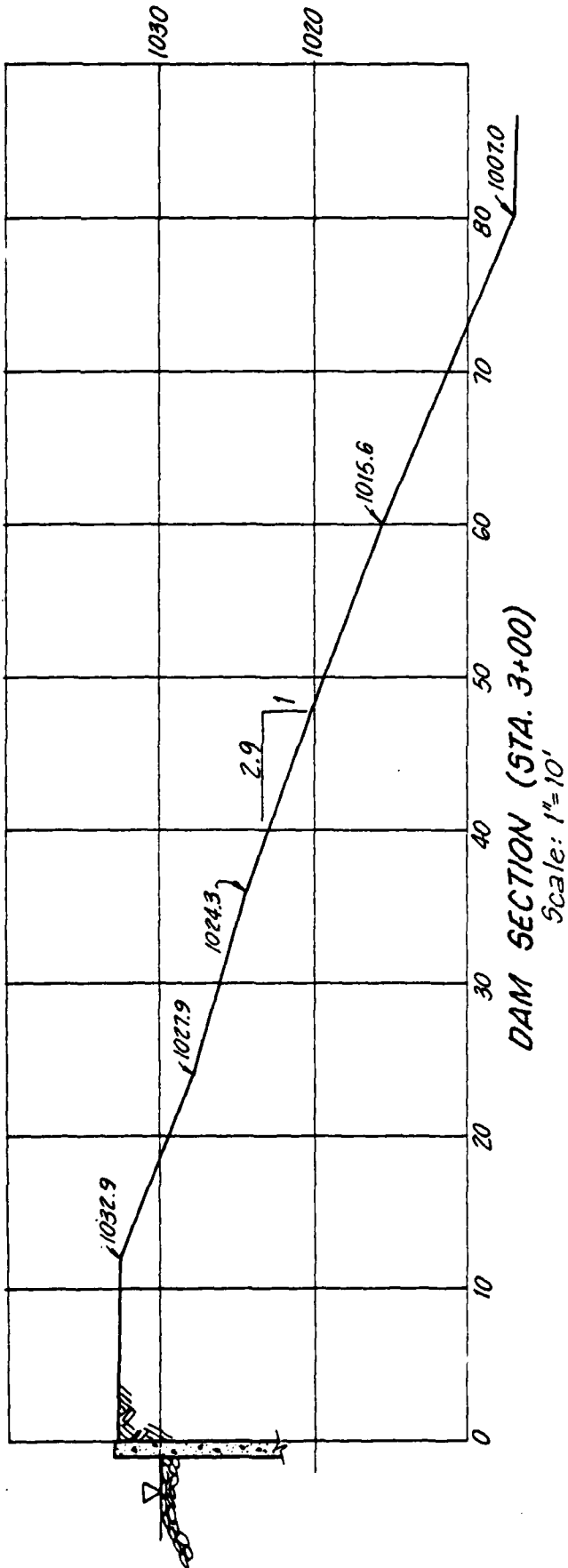


PLATE C-1





APPENDIX D  
HYDRAULIC AND HYDROLOGIC DATA

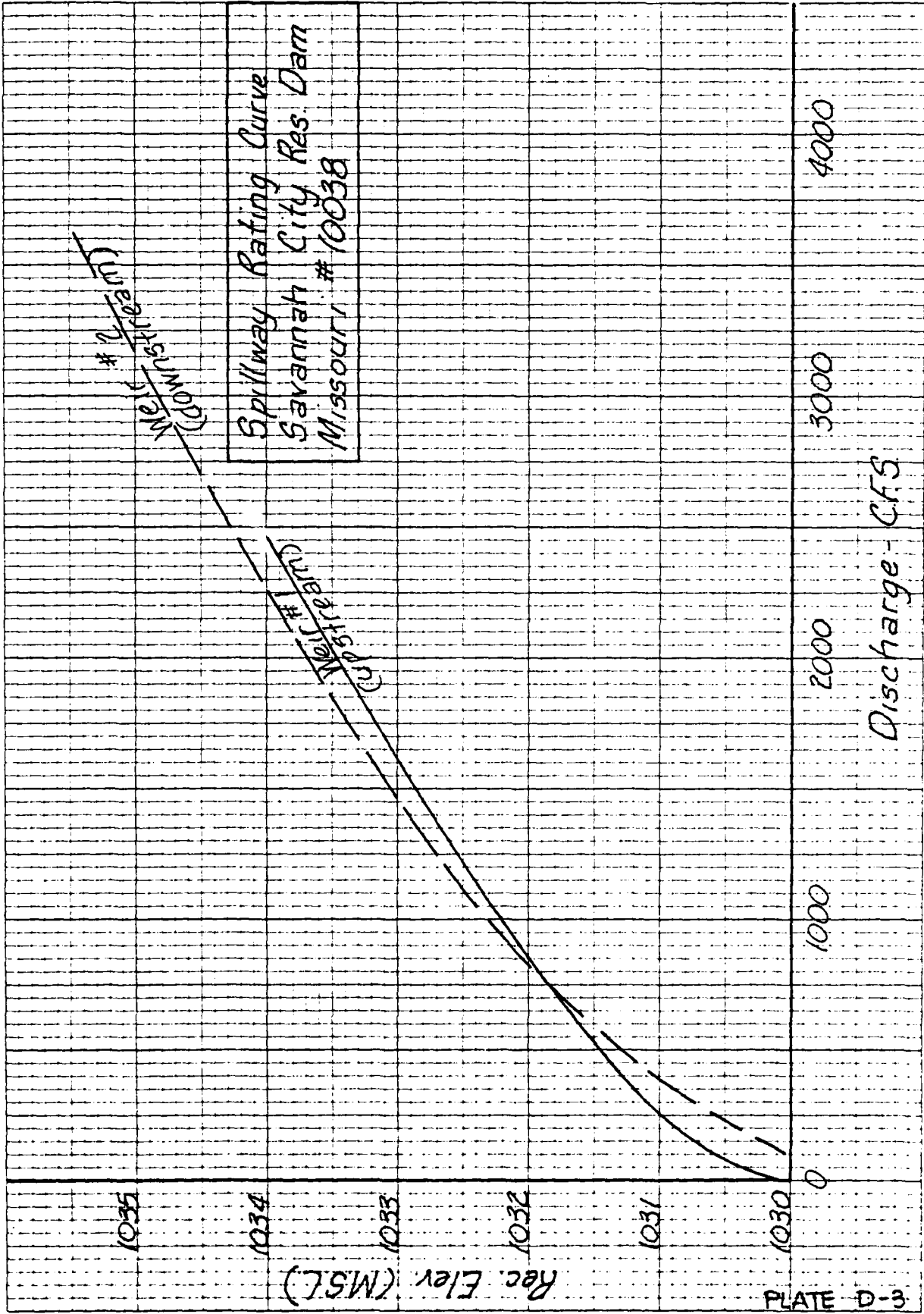
## HYDROLOGIC COMPUTATIONS

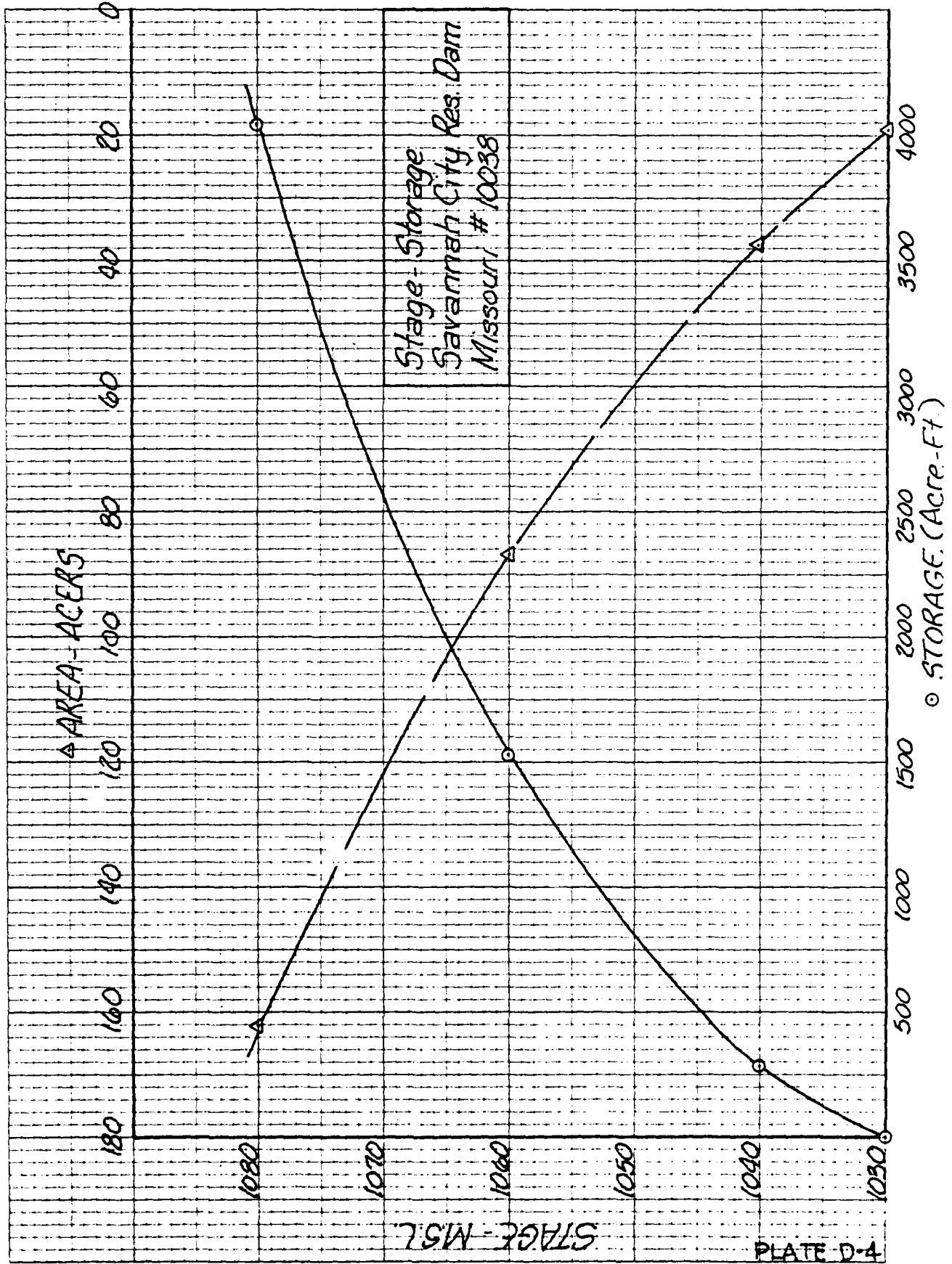
1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See Appendix D).
  - a. Twenty-four hour, 100-year 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 policy and guidance for hydraulics and hydrology.
  - b. Drainage area = 0.91 square miles (582.4 acres).
  - c. Time of concentration of runoff = 38 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 spillway crest.
  - e. The total twenty-four hour storm duration losses for the 100-year storm were 3.08 inches. The total losses for the PMF storm were 1.72 inches. These data are based on SCS runoff curve No. 87 and No. 73 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group B (Marshall-Logoda-Gara soils) and consists approximately of 75% alfalfa and grass and 25% cropland.
  - f. Average soil loss rates = 0.05 inch per hour approximately.
2. The discharge rating for the upstream spillway weir was developed using equations for weir flow, as follows:

Weir flow equation ( $Q_w = CLH^{3/2}$ )  
where C = weir coefficient = 2.6 to 3.0  
L = length of weir, ft. = 88 ft.  
H = total head, ft.

The discharge rating for the spillway channel below the upstream weir was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program assuming critical flow at the downstream weir and using dimensions measured in the field. The flows over the dam crest were developed using the HEC-1 (Dam Safety Version) program with a discharge coefficient of 3.0 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, and plotted hydrographs are attached in Appendix D.





Ratio-Discharge Curves  
Savannah City Res. Dam  
Missouri #10038

▲ INFLOW  
○ OUTFLOW

1.0

0.8

0.6

0.4

0.2

0

Ratio of PMF

4000

3000

2000

1000

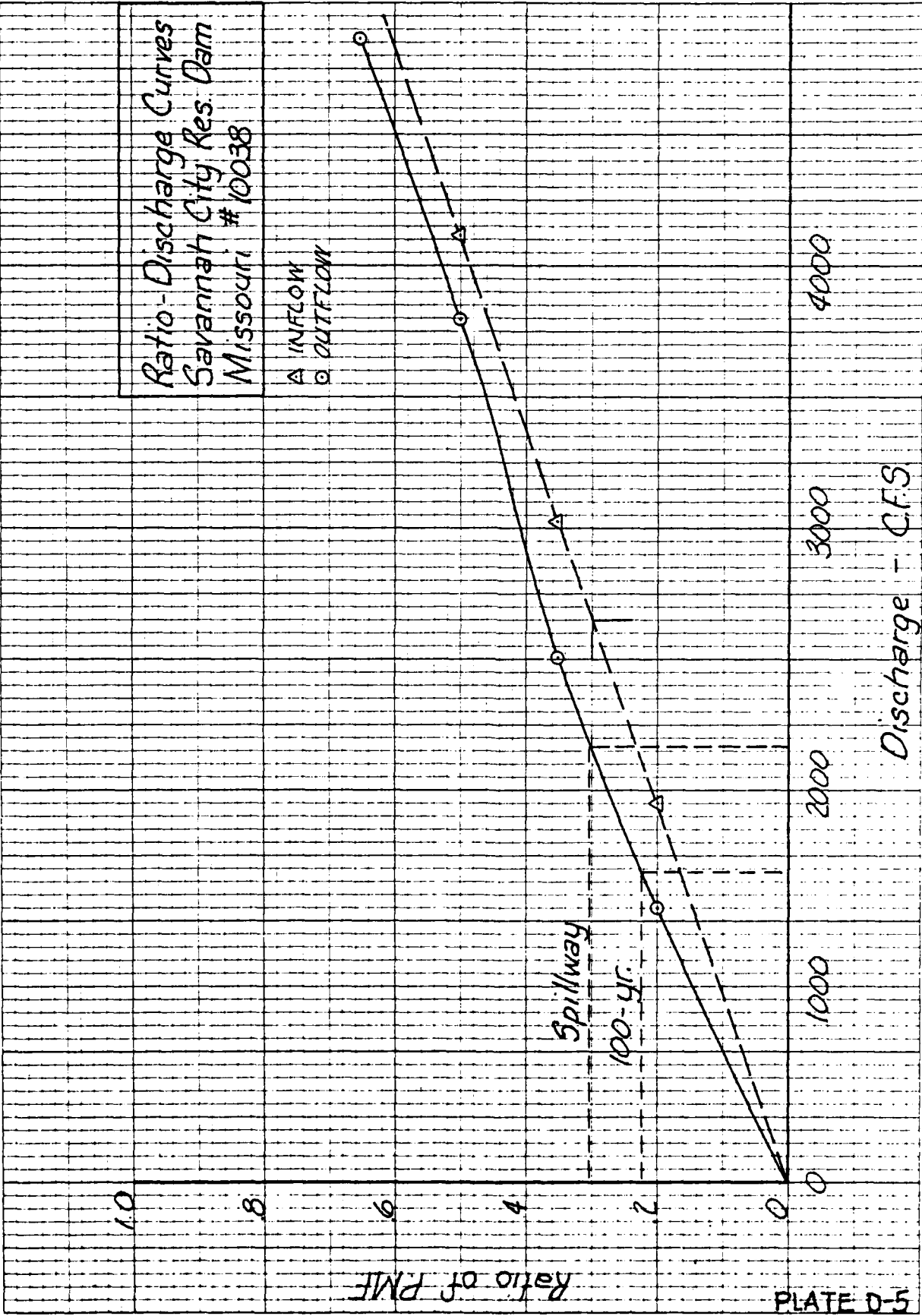
0

Discharge - CFS

Spillway

100-yr.

5-PLATE D-5





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

RUN DATE 79/06/21.  
 TIME 19.42.17.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF  
 HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SAVANNAH CITY DAM 10038  
 RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

NO	MHR	MMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	INSTAN
288	0	5	0	0	0	0	0	3	0
			JOPER	NHT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

RTIOS= .20 .35 .50 .65 .80 1.00  
 NPLAN= 1 NRTIO= 6 LRTIO= 1

\*\*\*\*\* SUB-AREA RUNOFF COMPUTATION \*\*\*\*\*

CALCULATION OF INFLOW HYDROGRAPH TO RES 10038

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRY	INAME	ISTAGE	IAUTO
000001	0	0	0	2	0	1	0	0

HYDROGRAPH DATA

IHYDC	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.91	0.00	.91	1.00	0.000	0	1	0

PRECIP DATA

SPEE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.00	102.00	121.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOI	FRAIN	STHKS	RTIOK	STRIL	CNSIL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 WEIKNSS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .38

STRIO= 0.00 ORCSN= -.01 RTIOP= 1.00

UNIT HYDROGRAPH 25 END OF PERIOD OPTIMATES, TC= 0.00 HOURS, IAG= .38 VOL= 1.00  
 103. 317. 674. 959. 1042. 979. R27. 608. 74. 422. 104.  
 226. 162. 118. 85. 61. 45. 31. 74. 17. 12.  
 10. 7. 5. 3.

HYDROGRAPH AT STA00001 FOR PLAN 1, RTID 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7223.	2227.	718.	710.	206896.
CMS	205.	66.	20.	20.	5857.
INCHES	23.79	29.37	29.37	29.37	745.93
MM	604.21	745.53	745.53	745.53	1625.
AG-FT	1154.	1425.	1425.	1425.	1757.
THOUS CU M	1423.	1757.	1757.	1757.	1757.

\*\*\*\*\*

HYDROGRAPH ROUTING

ROUTED FLOWS THRU RES 10038

STAGE	1030.00	1030.10	1030.20	1030.50	1031.00	1031.50	1032.00	1032.50	1033.00	1033.50	1034.00	1034.50	1035.00	1040.00
FLOW	0.00	7.00	21.00	83.00	260.00	530.00	820.00	1110.00	1440.00	1810.00				
CAPACITY=	0.	20.	40.	60.	85.	115.	283.							
ELEVATION=	1030.	1031.	1032.	1033.	1034.	1035.	1040.							

LOSS	CLASS	AVG	IRIS	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

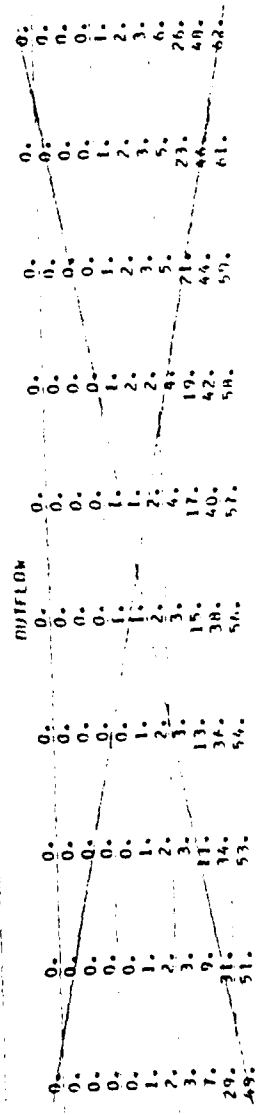
MSTPS	NSTDL	LAG	ANSSK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1030.	-1

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1033.3	3.0	1.5	580.

STATION 000002 PLAN 1

END OF PERIOD HYDROGRAPH ORDINATES







0NVE\*

STATION000002

	0.	500.	1000.	1500.	2000.	2500.	3000.	3500.	4000.	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													

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  
6.10 741  
6.15 7501  
6.20 7601  
6.25 7701  
6.30 7801  
6.35 7901  
6.40 8001  
6.45 8101  
6.50 8201  
6.55 8301  
7.00 8401  
7.05 8501  
7.10 8601  
7.15 8701  
7.20 8801  
7.25 8901  
7.30 9001  
7.35 9101  
7.40 9201  
7.45 9301  
7.50 9401  
7.55 9501  
8.00 9601  
8.05 9701  
8.10 9801  
8.15 9901  
8.2010001  
8.2510101  
8.3010201  
8.3510301  
8.4010401  
8.4510501  
8.5010601  
8.5510701  
9.0010801  
9.0510901  
9.1011001  
9.1511101  
9.2011201  
9.2511301  
9.3011401  
9.3511501  
9.4011601  
9.4511701  
9.5011801





20.15243.10  
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 23.40284.1  
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 23.50286.1  
 23.55287.1  
 0.00288.1

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

OPERATION	STATION	AREA	PLAN	RATIO	1	RATIO	2	RATIO	3	RATIO	4	RATIO	5	RATIO	6
					.20		.35		.50		.65		.80		1.00
HYDROGRAPH AT	00001	.91 ( 2.36)	1	1445.	2528.	3611.	4695.	5778.	7223.						
ROUTED TO	00002	.91 ( 2.36)	1	1091.	2005.	3294.	4364.	5465.	6903.						
				29.76	56.77	93.26	123.57	154.76	195.47						

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		ELEVATION STORAGE	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
		OUTFLOW	1030.00	1030.00	1033.30
			0.	0.	68.
			0.	0.	1662.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FY	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1032.40	0.00	48.	1051.	0.00	16.17	0.00
.35	1033.52	.22	73.	2005.	.42	16.17	0.00
.50	1034.01	.71	85.	3294.	.83	16.08	0.00
.65	1034.33	1.03	95.	4364.	1.25	16.08	0.00
.80	1034.63	1.33	104.	5465.	1.92	16.00	0.00
1.00	1034.98	1.68	114.	6903.	3.67	16.00	0.00