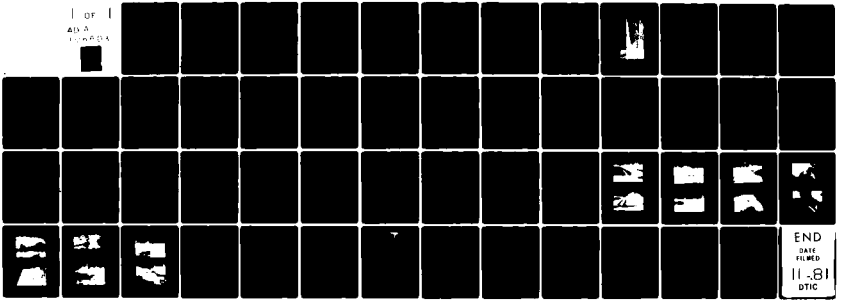
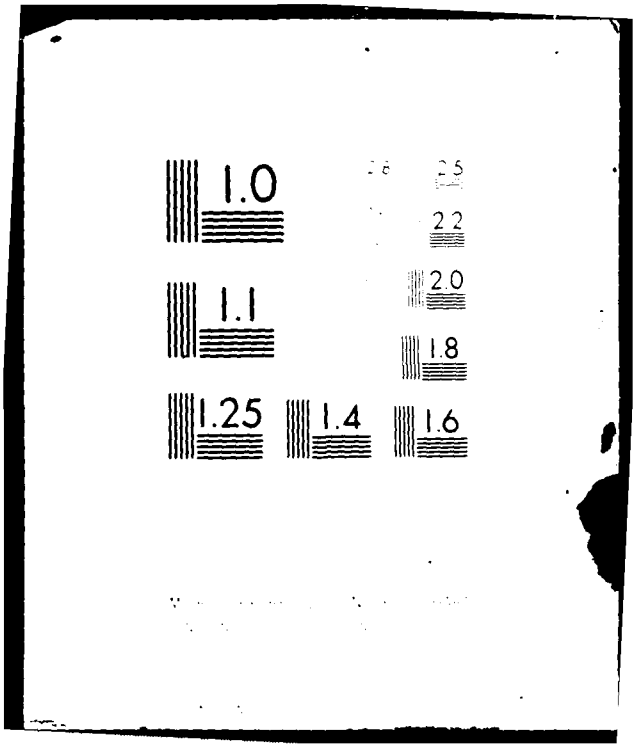
AD-A106 603 BLACK AND VEATCH .KANSAS CITY MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. NEFF LAKE DAM (MO 20376), MISSOURI--ETC(U)
MAR 79 P R ZAMAN, L K LAMPE, H L CALLAHAN DACW43-79-C-0040
UNCLASSIFIED NL



END
DATE FILMED
11-81
DTIC


1.0
1.1
1.25
1.4
1.6
2.0
1.8
2.2
2.5

LEVEL

MISSOURI-KANSAS CITY BASIN

NEFF LAKE DAM

CASS COUNTY, MISSOURI

MO 20376

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

"Original contains color plates: All DTIC reproductions will be in black and white"

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

St. Louis District

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

FOR: STATE OF MISSOURI

MARCH 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Neff Lake Dam (MO 20376) Cass County, Missouri		5. TYPE OF REPORT & PERIOD COVERED 9 Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Black & Veatch, Consulting Engineers		8. CONTRACT OR GRANT NUMBER(s) 15 DACW43-79-C-0040
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 12152
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101 11		12. REPORT DATE March 1979 13. NUMBER OF PAGES Approximately 35
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 10 Paul R. /Zaman Les K. /Lampe Harry L. /Callahan		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

6 National Dam Safety Program. Neff Lake Dam (MO 20376), Missouri - Kansas City Basin, Cass County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

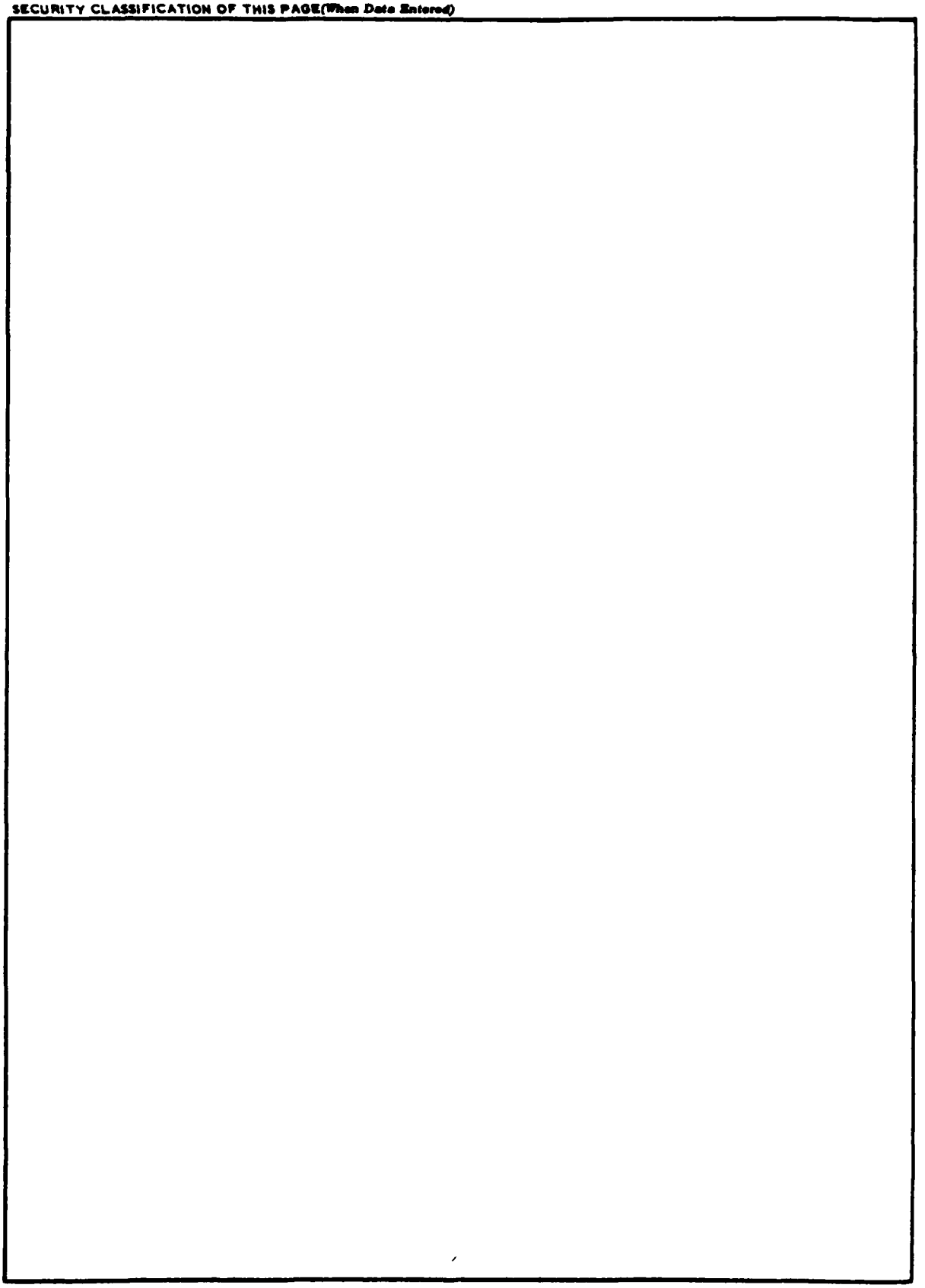
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 058550

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)



MISSOURI-KANSAS CITY BASIN

NEFF LAKE DAM

CASS COUNTY, MISSOURI

MO 20376

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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

St. Louis District

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

FOR: STATE OF MISSOURI

MARCH 1979

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

IN REPLY REFER TO

SUBJECT: Neff Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Neff Lake Dam:

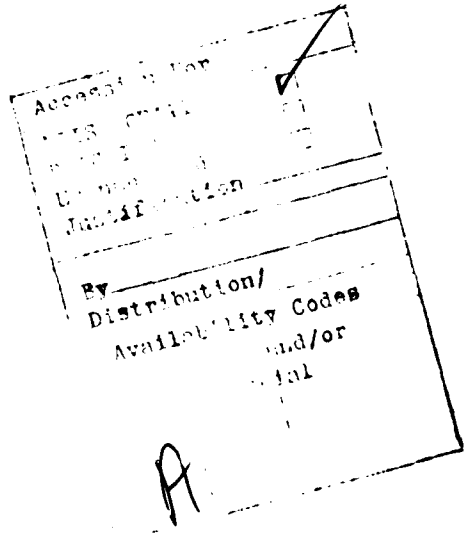
It was prepared under the National Program of Inspection of Non-Federal Dams.

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

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED
Chief, Engineering Division
22 AUG 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer
22 AUG 1979
Date



NEFF LAKE DAM

CASS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20376

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MARCH 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Neff Lake Dam
State Located	Missouri
County Located	Cass County
Stream	Tributary to the Little River
Date of Inspection	22 March 1979

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

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers failure would threaten the life and property of a trailer park, dwellings, and buildings 0.25 mile downstream of the dam and would potentially cause appreciable damage to U.S. Highway 71 and State Highway 150 within the estimated damage zone which extends 2.0 miles downstream of the dam.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass either the probable maximum flood or 50 percent of the probable maximum flood without overtopping but will pass 15 percent of the probable maximum flood, which is less than the estimated 100-year flood. The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded and the downstream hazard, 50 percent of the probable maximum flood is the appropriate spillway design flood. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Deficiencies visually observed by the inspection team were seepage at the toe of the embankment and right abutment, erosion of the discharge channel, undercutting of the concrete spillway chute, the presence of excessive brush and trees on the downstream embankment slope, and several animal burrows in the embankment. Seepage and stability analyses required by the guidelines were not available.

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

Paul R. Zaman

Paul R. Zaman, PE
Illinois 62-29261

Les K. Lampe

Les K. Lampe, PE
Kansas 7407

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NEFF LAKE DAM

TABLE OF CONTENTS

LIST OF PLATES

LIST OF PHOTOGRAPHS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

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

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

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam appears to be an earth structure located in the valley of an intermittent tributary to the Little Blue River in northwestern Cass County, Missouri (Plate 1). The upstream face of the embankment consists of a concrete capped vertical rock face, the top of which is several feet below the crest of the embankment. The remainder of the upstream face is covered with grass to the crest. A single-lane gravel road runs the length of the dam. The downstream face is covered with trees and brush. Topography of the contributing watershed is characterized by rolling hills. The watershed is primarily comprised of residential areas and farmland. Topography in the vicinity of the dam is shown on Plate 2.

(2) An 8-inch diameter drop inlet near the left abutment maintains the reservoir at normal pool elevation. When increased reservoir elevations and their associated discharges are encountered, a 2 feet by 3 feet box culvert and concrete chute handle discharges through the dam to the downstream discharge channel at the toe of the embankment. Additional discharge is handled over two emergency spillways located at the right and left abutments.

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

b. Location. The dam is located in northwestern Cass County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Belton, Missouri in Section 2 of T46N, R33W.

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

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Neff Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Neff Lake Dam the flood damage zone extends downstream for 2.0 miles. Within the damage zone are several dwellings and buildings, a trailer park, State Highway 150, and U.S. Highway 71.

e. Ownership. The dam is owned by Bradshaw Bonding Company, Inc., P.O. Box 158, Belton, Missouri 64012.

f. Purpose of Dam. The dam forms a 7-acre recreational lake.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 280 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an uncontrolled drop inlet and box spillway.

(2) Estimated experienced maximum flood at damsite - A 6-inch, 24 hour rainfall was experienced in September 1977 resulting in overtopping of the embankment.

(3) Estimated ungated spillway capacity at maximum pool elevation 430 cfs (top of Dam El.1,035.3).

c. Elevation (Feet Above M.S.L.).

(1) Top of dam - Varies from 1035.3 to 1036.2 (see Plates 3 and 4)

(2) Drop inlet crest - 1,032.0

(3) Box spillway crest - 1,032.1

(4) Emergency spillway crests - 1,033.4 (west abutment), 1,033.7 (east abutment)

(5) Streambed at toe of dam - 1,015.0 ±

(6) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,000 feet ±

(2) Length of normal pool - 900 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 94

(2) Emergency spillway crest - 68

(3) Drop inlet crest - 49

(4) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 14

(2) Drop inlet and box spillway crest - 7

g. Dam.

(1) Type - Earth embankment

(2) Length - 600 feet

(3) Height - 20 feet ±

(4) Top width - 18 feet ±

(5) Side slopes - upstream face varies; downstream face varies from 1.0 V on 1.4 H to 1.0 V on 2.0 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

(10) Internal drainage system - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Spillway.

(1) Type - Drop inlet and concrete box.

(2) Drop inlet dimensions - 8 inch diameter corrugated metal pipe with steel reinforcing bar grating (see Photo 10).

(3) Box dimensions - 3.0 feet wide by 2.0 feet high with twelve 1/2-inch diameter steel reinforcing bars placed vertically on 2.8 inch centers in the inlet of the box (see Photo 6).

(4) Crest elevation - 1,032.0 feet m.s.l. (drop inlet), 1,032.1 (concrete box)

(5) Emergency spillways at the east and west abutments have elevations of 1,033.7 and 1,033.4, respectively. East emergency spillway is partially paved. West emergency spillway is grass-lined.

(6) Gates - None.

(7) Upstream channel - Not applicable.

(8) Downstream channel - Open channel comprised of clays and loess located near the toe of the downstream embankment slope.

j. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

Construction records were unavailable, however, the owners estimated that the dam was built in 1930.

2.3 OPERATION

The maximum recorded loading on the dam is unknown. However, the embankment was overtopped in September 1977 due to a 6-inch rainfall over the drainage basin in approximately 24 hours.

2.4 GEOLOGY

The dam is located in a broad shallow valley that was formed in limestones and shales of the Pennsylvanian System, Missourian Series, Kansas City Group, upper part - Zarah sub-group. Rock outcrops of limestone and shale were observed 800 feet right of the right abutment above the top of the dam.

The following information on soils has been taken from published reports and visual inspection in the area of the dam. No soils information was available from design drawings or field borings.

The soil at the site consists of the Summit Silt Loam soil series. It is a residual soil developed from weathering of shales of Pennsylvanian age, overlain by up to five feet of loess. It consists of sand, silt, clay, and organic matter with silt predominant nearer the surface and clay predominant at depth. For engineering purposes, the near-surface soil may be classified as clayey silt/silty clay (ML-CL) and the deeper soil as silty clay (CL or CH). The silty clay is slower draining and may tend to slow percolation contributing to increased runoff during long periods of high precipitation. The soils are generally thinner on slopes and thicker on hill crests and valley floors.

2.5 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data were available upon which to make a detailed assessment of the design, construction, and operation. Detailed seepage and stability analyses should be performed as required by the guidelines.

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

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Neff Lake Dam was made on 22 March 1979. The inspection team included professional engineers with experience in dam design and construction, hydrology - hydraulic engineering, and geotechnical engineering. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following items at the dam. Evidence of seepage was observed near the left and right abutments. An area of approximately 200 square feet located at the left third of the embankment toe contains ponding water. Another area of approximately 70 feet by 30 feet near the right abutment contained cattails. In both instances there was no running water or boils observed. The rock wall facing, capped with a concrete slab along the upstream slope of the dam, appeared in good condition. A few small animal burrows were observed in the downstream embankment material near the left abutment. Grass protection existed above the concrete capped rock wall on the upstream face. The downstream face is covered with a growth of trees, shrubs, and sparse grass cover with no additional slope protection. No sinkholes, cracking, slumping, crest settlement, road potholing, nor slides were apparent at the time of inspection. It was apparent that repairs had been made to the embankment at right of the drop inlet, to the drop inlet apron, and to the embankment/spillway interfaces.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. A concrete box spillway, constructed near the left abutment, discharges to a chute which has been undermined resulting in cracking and displacement of the lower portions of the chute. The box, however, appears in good condition. No seepage or piping was observed in the immediate vicinity of the cracked and displaced chute. The drop inlet located at normal pool elevation to the right of the box spillway was discharging at the time of inspection. The outlet for the drop inlet appeared damaged below the surface of the downstream slope. There are two emergency spillways. One located at the left abutment and one at the right abutment. The left abutment spillway is merely a low point in the abutment which is covered with vegetable growth. The spillway at the right abutment is also a low point near the abutment, but is lined with a 4-foot wide concrete slab. Erosion of the embankment downstream of the east emergency spillway and erosion near the box culvert chute were observed.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir. Siltation was observed in the upper end of the reservoir.

e. Downstream Channel. An open channel comprised of clay and loess is located near the toe of the downstream embankment slope.

3.2 EVALUATION

Slope protection along the upstream embankment face appears adequate.

Remedial action should be taken on the following reservoir conditions, or a serious potential for failure will develop.

(1) Undercutting of the discharge chute of the box spillway.

(2) Erosion on the downstream side of the embankment near the east emergency spillway and box spillway.

(3) Growth of trees and brush on the embankment prevents growth of good grass cover and provides habitat for small animals. The roots of large trees can cause deterioration of the embankment and develop piping problems.

(4) Apparent damage to the drop inlet discharge outlet may cause piping through the embankment and erosion of embankment material near the toe in the vicinity of the drop inlet discharge outlet.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

From visual inspection it appears that the drop inlet and outlet pipe have been reconstructed in recent years. In September 1977, a rainfall of approximately 6 inches in 24 hours was recorded over the drainage area of Neff Lake. On September 13, 1977, the City of Belton, Missouri made emergency repairs to the embankment through placement of 14.2 tons of minerun rock in a breach in the embankment near the drop inlet spillway. Trees and brush on the downstream slope have been periodically removed, however, adequate vegetal cover for embankment protection has been established.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities are known to exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Attention should be given to establishing maintenance procedures which will allow proper vegetation to protect the downstream embankment slope. Placement of the minerun rock near the drop inlet and box spillways appears to be adequate for precluding further erosion of the embankment, however, should fine material within the minerun be washed out, an additional potential piping failure would exist.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

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

b. Experience Data. The drainage area and lake surface area are developed from USGS Belton Quadrangle Map. The spillway and dam layouts are from surveys made during the inspection.

c. Visual Observations.

(1) The spillways are in fair condition. The discharge channels from the spillways need better slope protection immediately downstream of their respective crests. The concrete chute is being undermined.

(2) No facilities are available which could serve to draw down the pool.

(3) A drop inlet and box spillway with discharge chute are located near the west abutment. Emergency spillways are located at the east and west abutments. Spillway discharges may endanger the integrity of the dam due to the fact that overflow from the spillways has caused erosion of the embankment material.

d. Overtopping Potential. The drop inlet, box spillway, and emergency spillways will not pass the probable maximum flood, without overtopping the dam. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region. The spillways will pass 15 percent of the probable maximum flood without overtopping the dam but will not pass the 100-year flood. The runoff volume of 10 percent of the probable maximum flood is less than that of the 100-year flood. The principal spillway will pass the 10-year flood with a maximum reservoir elevation less than that resulting from 10 percent of the probable maximum flood. The difference in maximum reservoir elevation is attributed to the increased antecedent moisture condition and the rainfall distribution peculiar to 10 percent of the probable maximum flood. The result is a greater volume of runoff prior to the peak of the 10 percent probable maximum event than the volume of runoff prior to the peak of the 10-year event. Distributions for the 10-year and 100-year rainfalls were provided by the St. Louis District, Corps of Engineers. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded and the downstream hazard, 50 percent of the probable maximum

flood is the appropriate spillway design flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 3,400 cfs of the total discharge from the reservoir of 4,400 cfs. The estimated duration of overtopping is 5.8 hours with a maximum height of 1.5 feet. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 1,650 cfs of the total discharge of the reservoir of 1,700 cfs. The estimated duration of overtopping is 3.0 hours with a maximum height of 1.0 feet over the dam. It is highly probable that overtopping of the embankment would result in severe erosion of embankment material from the crest and downstream face. Overtopping of the embankment for a sustained period of time, such as during a probable maximum flood, could result in failure of the dam.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately 2.0 miles downstream of the dam. There are several dwellings and buildings, a trailer park, State Highway 150, and U.S. Highway 71 downstream of the dam which could be severely damaged and lives could be lost should failure of the dam occur.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Detailed seepage and stability analysis should be performed as required by the guidelines.

c. Operating Records. No operational records are known to exist.

d. Post Construction Changes. It appears that reconstruction of the drop inlet and surrounding apron has taken place in recent years. Minerun rock placed near the drop inlet in September 1977, was placed randomly as observed at the time of inspection. A concrete slab has been constructed upon existing limestone facing along the upstream face of the embankment.

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

Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items noted during the visual inspection by the inspection team which should be monitored or controlled are erosion of the downstream slope near the spillways, undercutting and cracking of the concrete chute, a stand of brush and trees on the downstream embankment slope, a seepage at the right and left abutments, animal burrows, and damage to the outlet of the drop inlet. It is anticipated that the embankment does not meet the stability requirements as per Appendix D of the guidelines. The downstream slope is steeper than the recommended slope as per the Bureau of Reclamation, "Design of Small Dams" referenced in Appendix A of this report.

b. Adequacy of Information. Due to the lack of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. However, seepage and stability analyses are needed to satisfy the requirements of the guidelines.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam or identify any serious dangers that would require a Phase II investigation.

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

7.2 REMEDIAL MEASURES

a. Alternatives. The present spillway has the capacity to pass 15 percent of the probable maximum flood without overtopping the dam. In order to pass 50 to 100 percent of the probable maximum flood as required by the Recommended Guidelines, the spillway size and/or height of dam would need to be increased.

b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

(1) Check the downstream face of the dam periodically for seepage and stability problems. If seepage flows are observed or sloughing on the downstream embankment slope is noted, the dam should immediately be inspected and the condition evaluated by an engineer experienced in design and construction of earthen dams.

(2) An engineer experienced in the maintenance and design of earthen dams should be retained to recommend procedures to control the growth of the trees and brush and establish proper slope protection.

(3) The spillway discharge channels at the east and west abutments should be protected from erosion especially near the dam embankment to prevent additional erosion of the dam embankment.

(4) An engineer experienced in the design and construction of earth dams should be retained to develop procedures to prevent further undermining of the discharge chute for the concrete box spillway. He should also assess the effectiveness and the necessity for the drop inlet, since the box spillway invert is 0.15 feet above the drop inlet invert. The drop inlet outlet requires attention be given to repair.

(5) Prevent introduction of animal burrows in the embankment as an additional erosion protection measure.

(6) Seepage and stability analysis should be performed by a professional engineer experienced in the design and construction of dams.

(7) A detailed inspection of the dam should be made periodically by an engineer experienced in design and construction of dams. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increases.

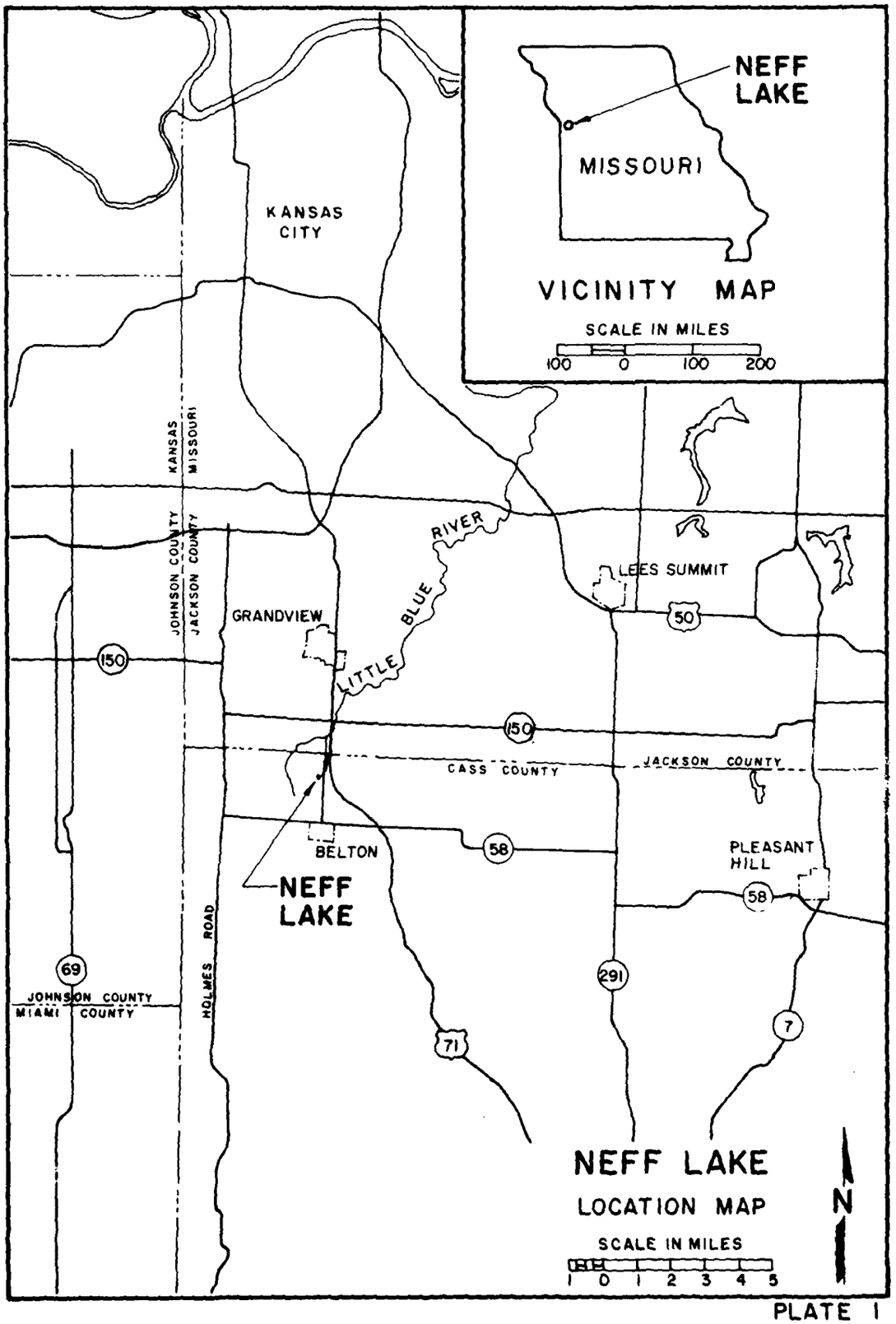
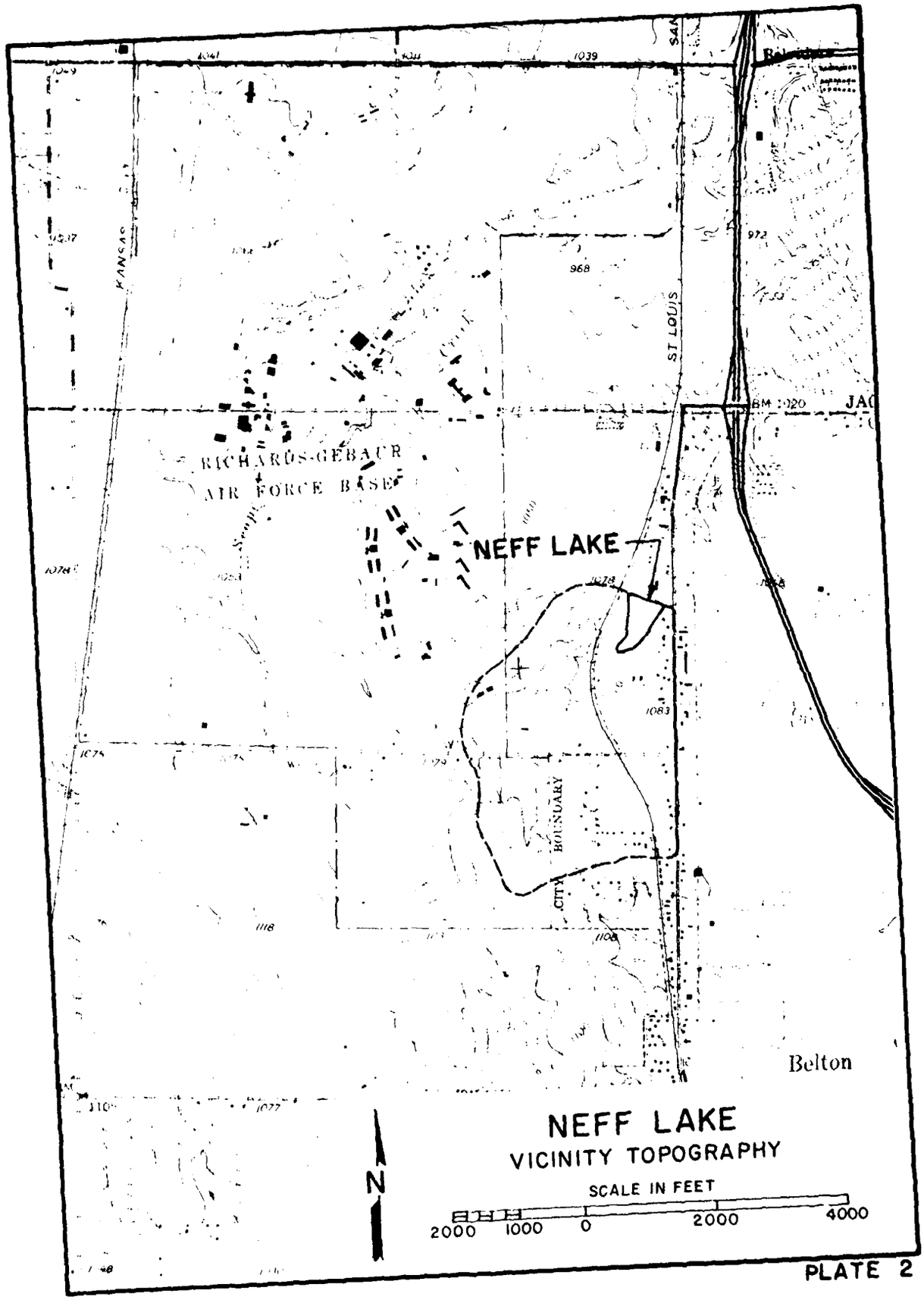
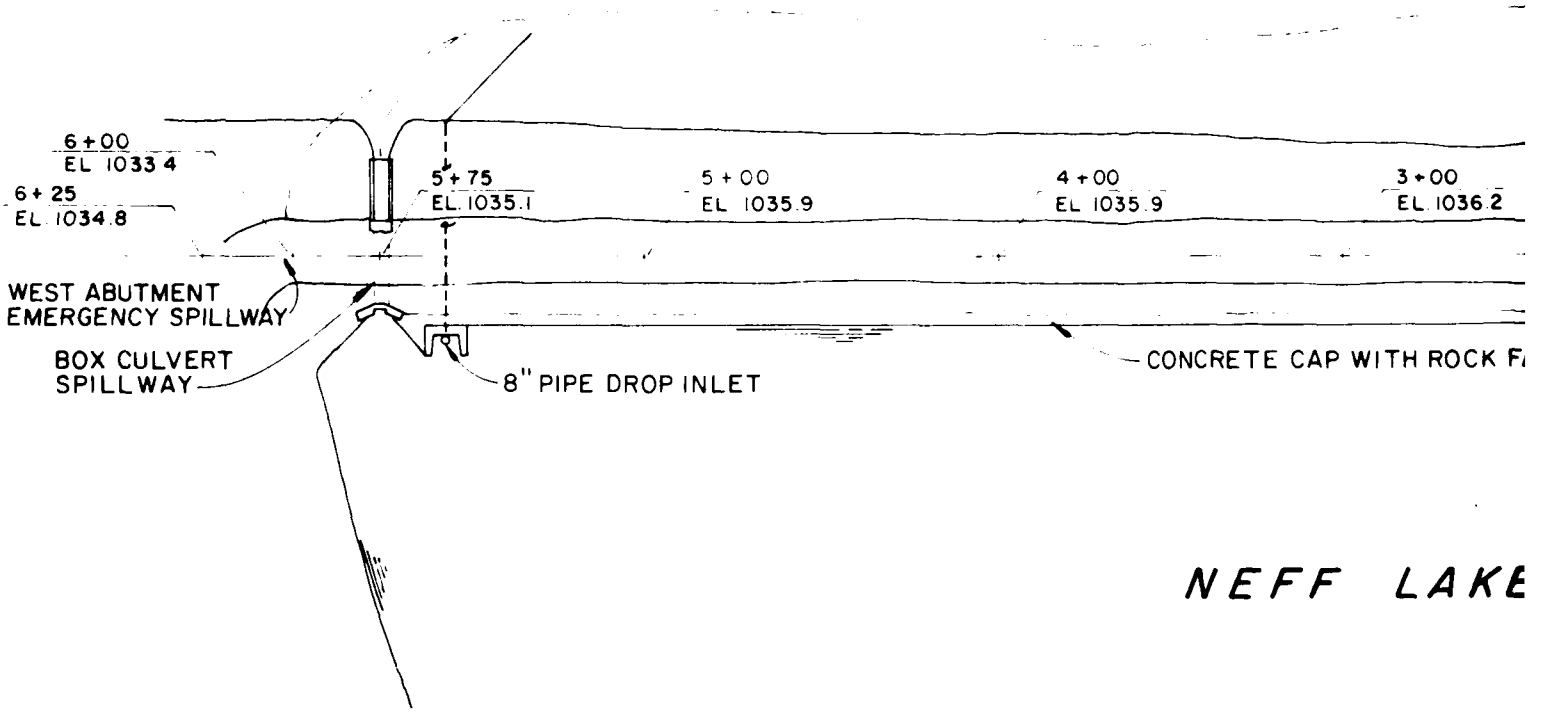
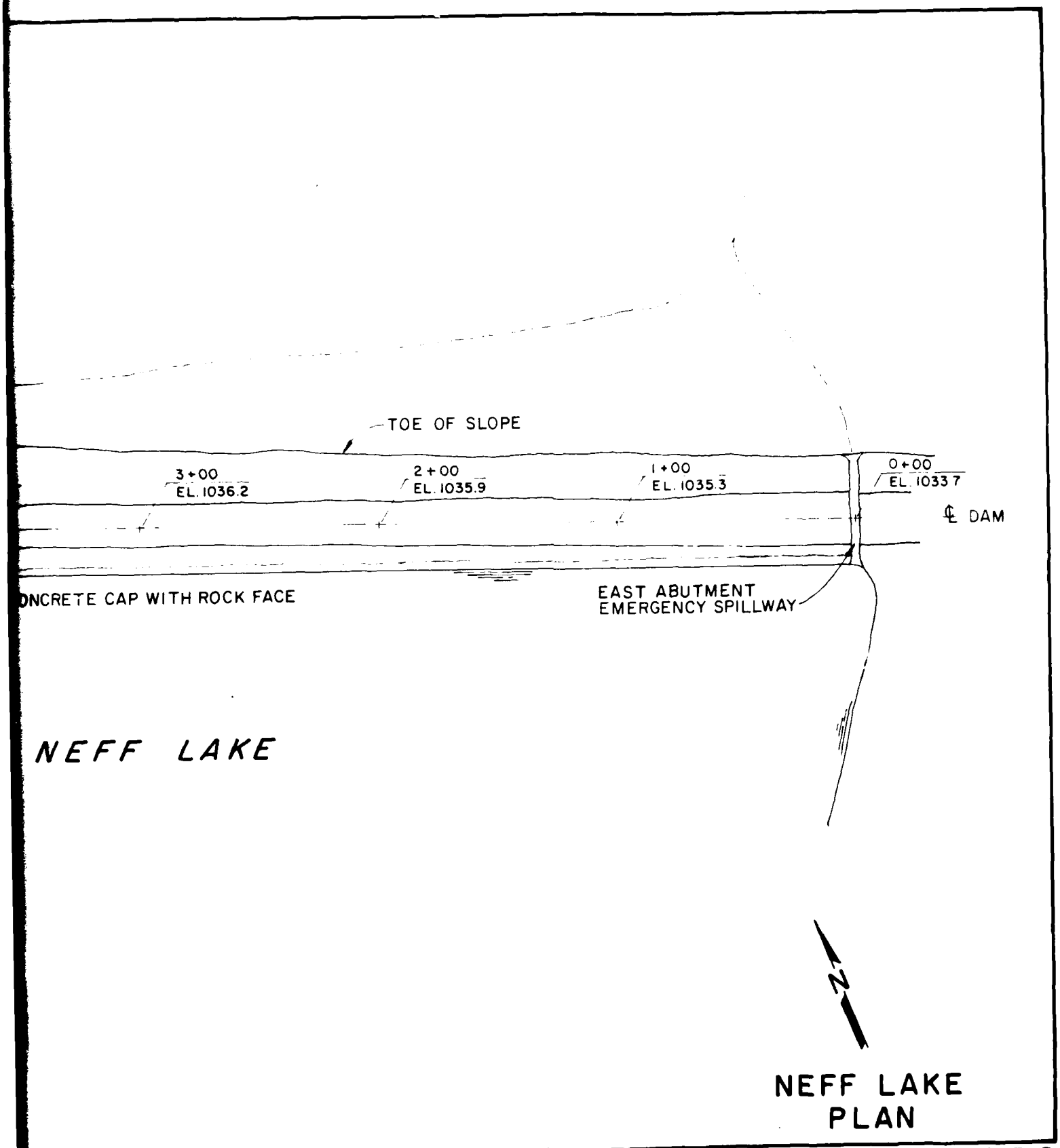

NEFF LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
KANSAS CITY
KANSAS
MISSOURI
JOHNSON COUNTY
JACKSON COUNTY
GRANDVIEW
LITTLE BLUE RIVER
LEES SUMMIT
50
150
150
CASS COUNTY
JACKSON COUNTY
BELTON
58
PLEASANT HILL
58
NEFF LAKE
HOLMES ROAD
69
JOHNSON COUNTY
MIAMI COUNTY
291
71
7
NEFF LAKE
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4 5
N

PLATE 1


NEFF LAKE
RICHARDS-GEBAUR
AIR FORCE BASE
ST LOUIS
KANSAS
CITY
BOUNDARY
Belton
N
NEFF LAKE
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
PLATE 2

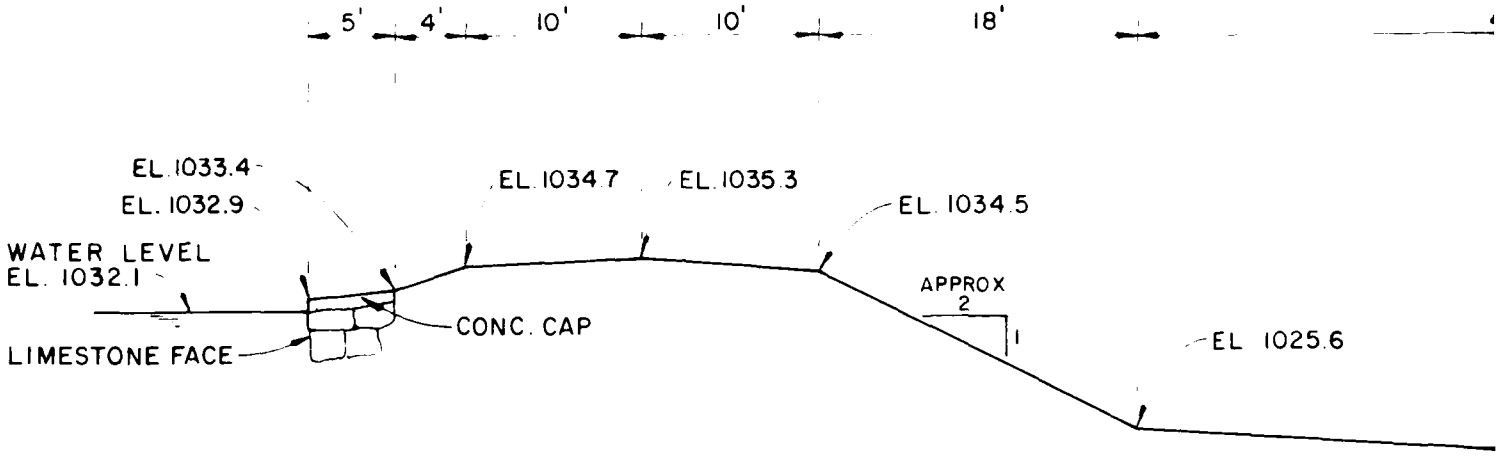

6+00
EL 1033.4
6+25
EL 1034.8
5+75
EL 1035.1
5+00
EL 1035.9
4+00
EL 1035.9
3+00
EL 1036.2
WEST ABUTMENT
EMERGENCY SPILLWAY
BOX CULVERT
SPILLWAY
8" PIPE DROP INLET
CONCRETE CAP WITH ROCK F

NEFF LAKE

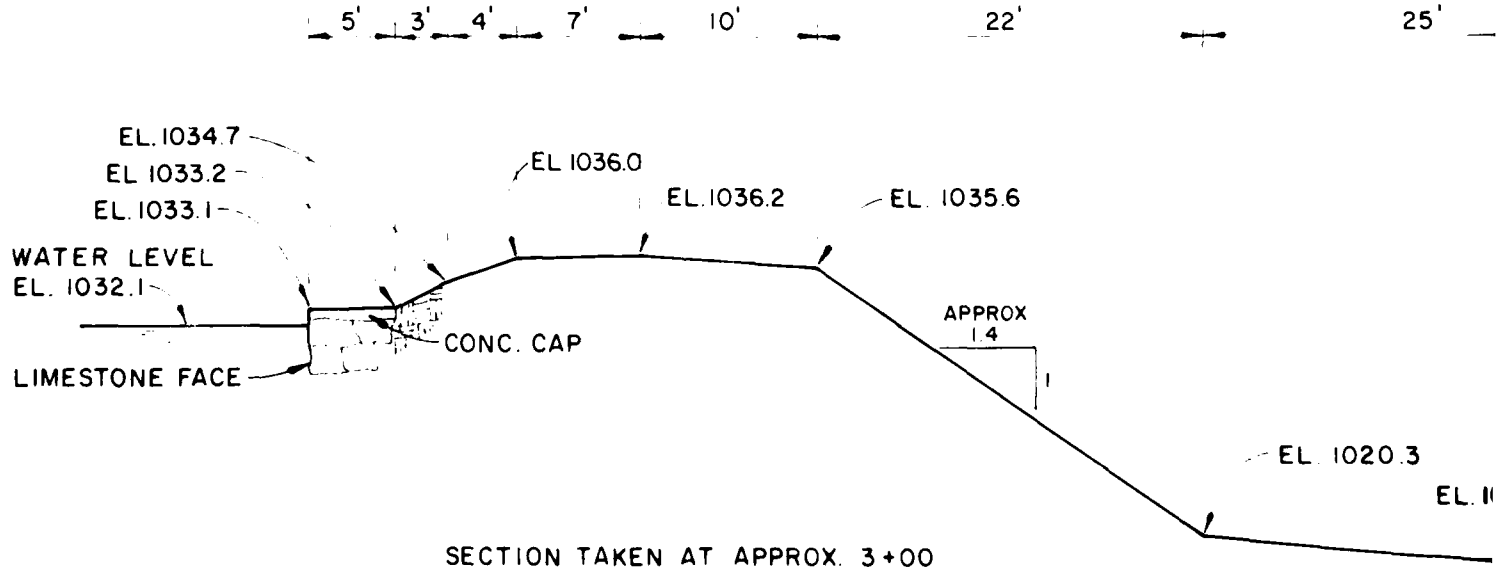


NEFF LAKE
PLAN

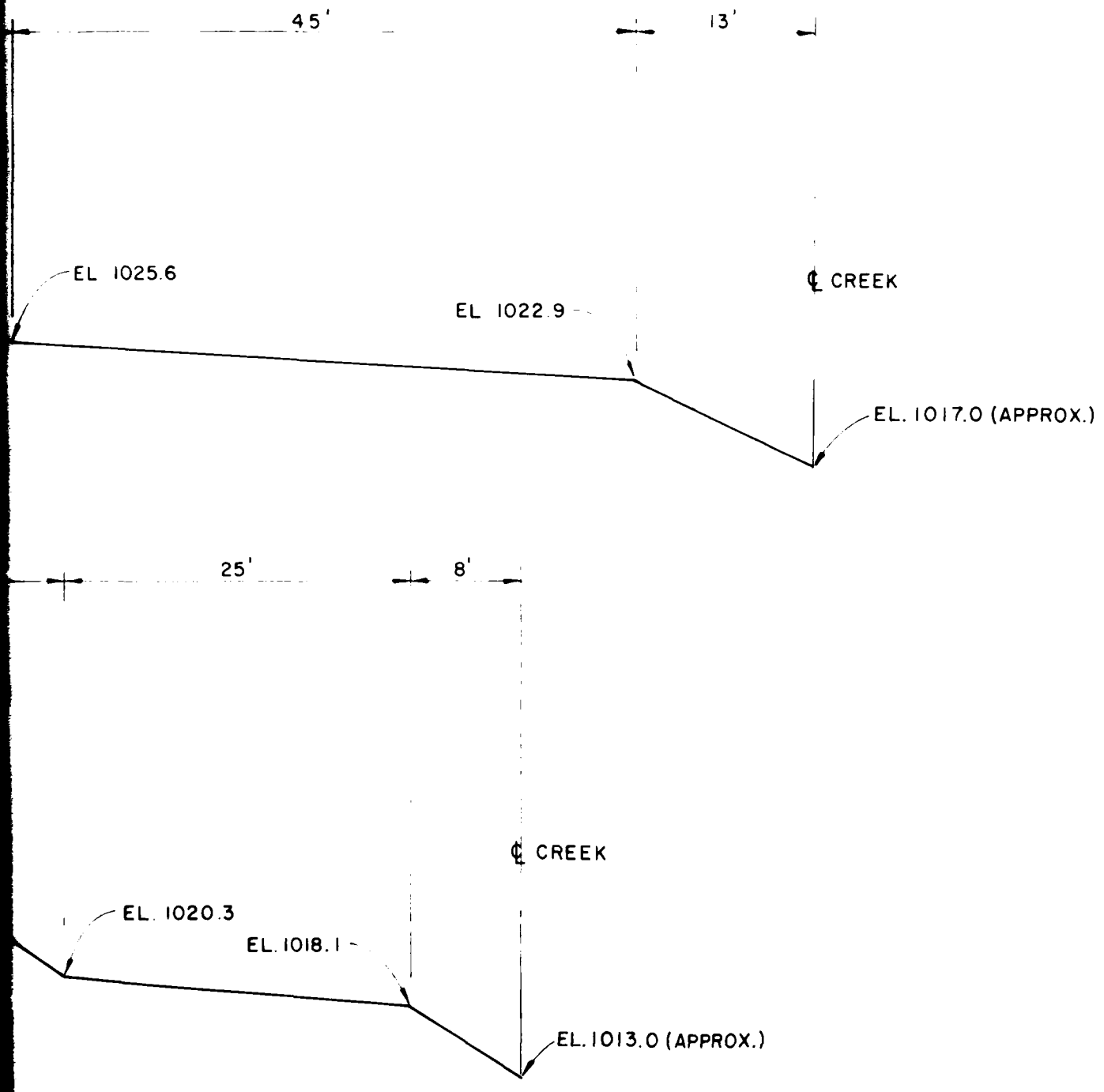
PLATE 3



SECTION TAKEN AT APPROX 1+00

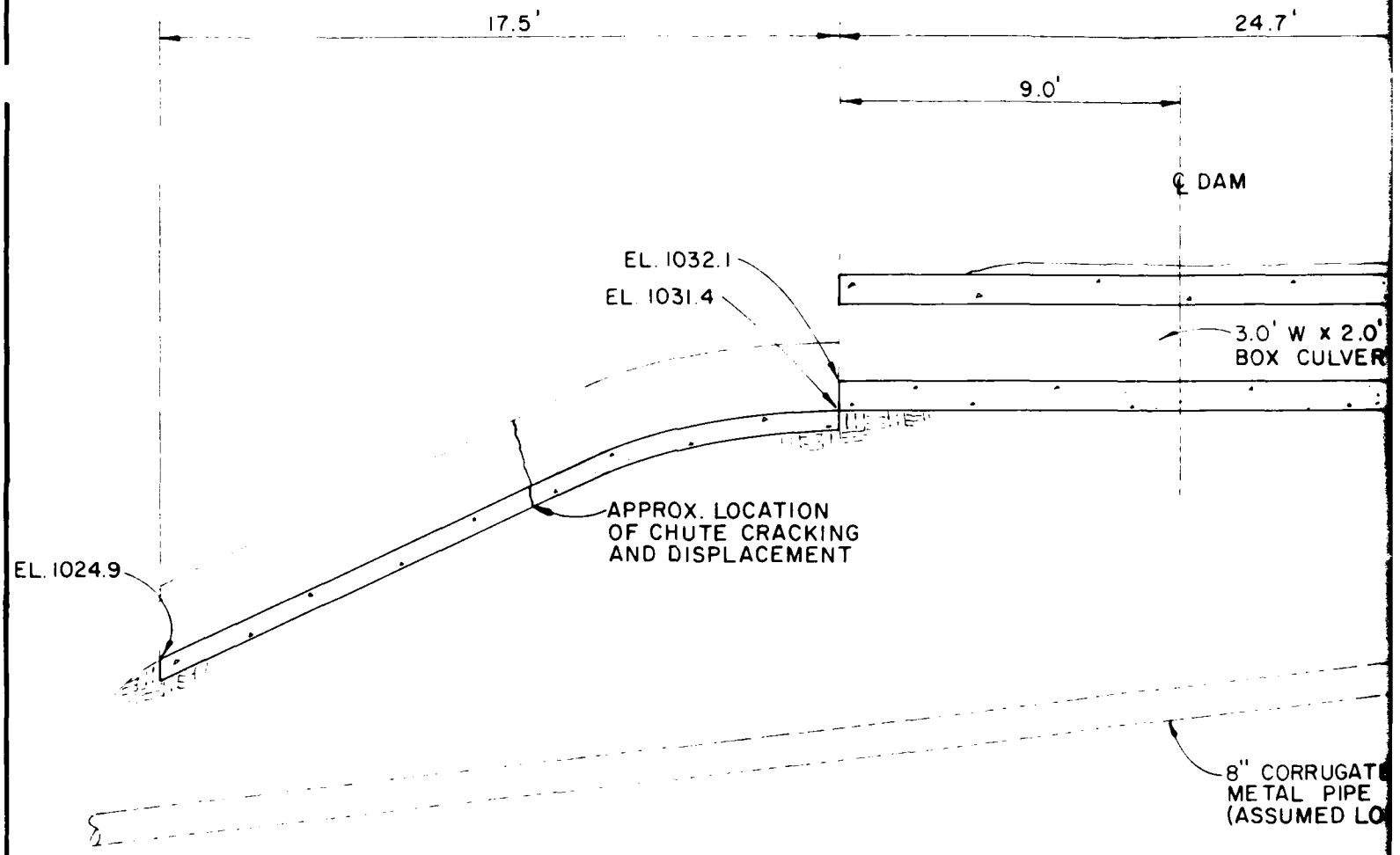


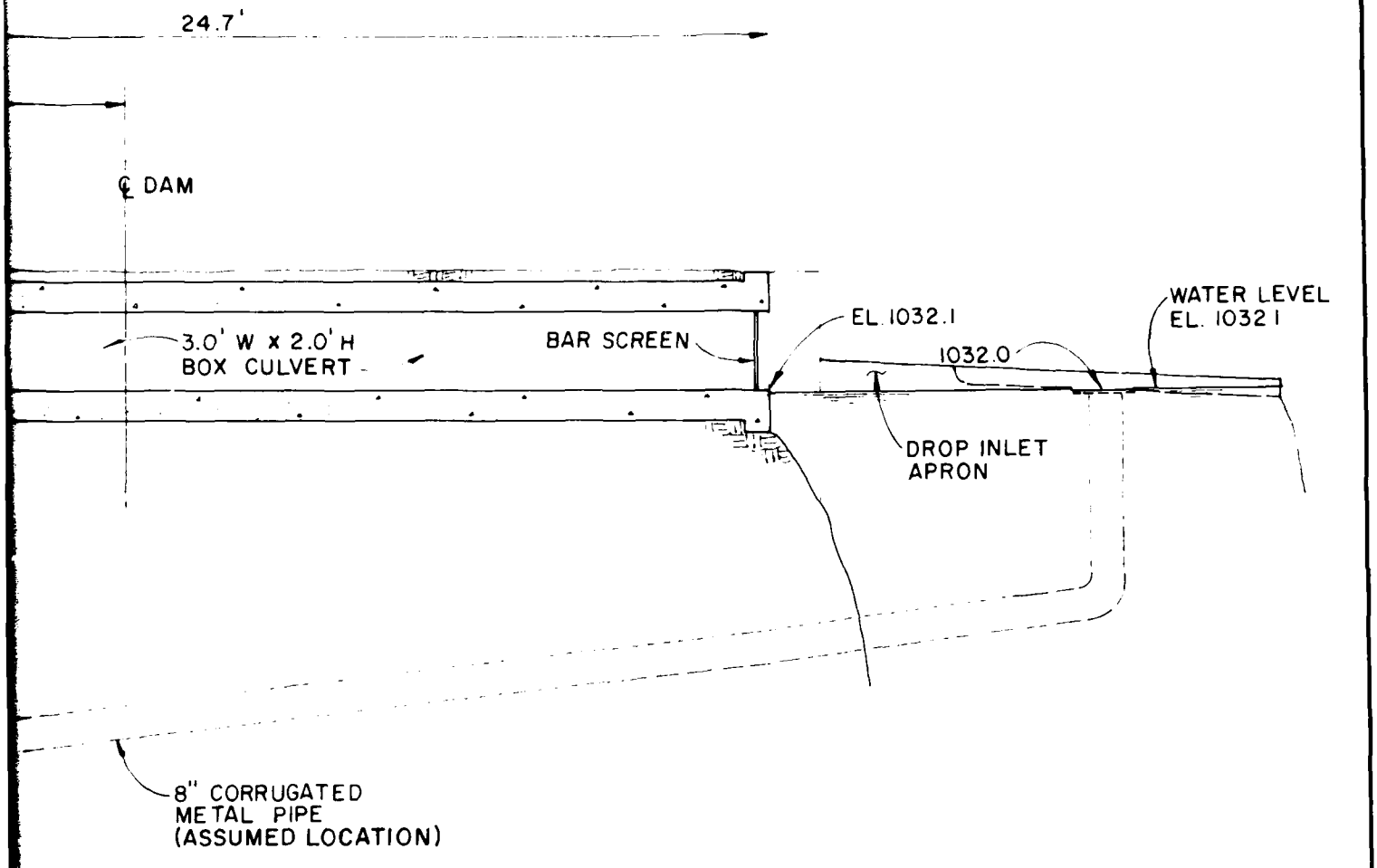
SECTION TAKEN AT APPROX. 3+00



NEFF LAKE SECTIONS

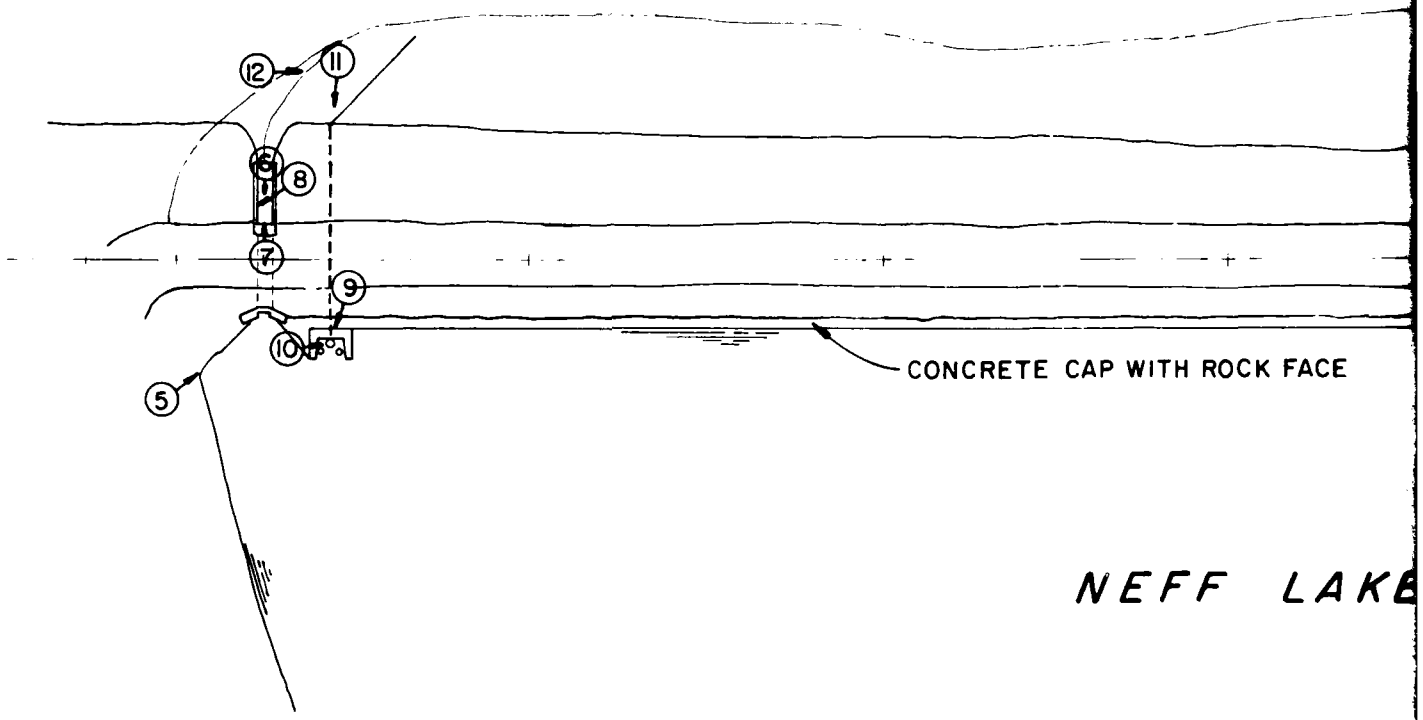
PLATE 4


17.5'
24.7'
9.0'
℄ DAM
EL. 1032.1
EL. 1031.4
3.0' W x 2.0'
BOX CULVER
APPROX. LOCATION
OF CHUTE CRACKING
AND DISPLACEMENT
EL. 1024.9
8" CORRUGATE
METAL PIPE
(ASSUMED LO



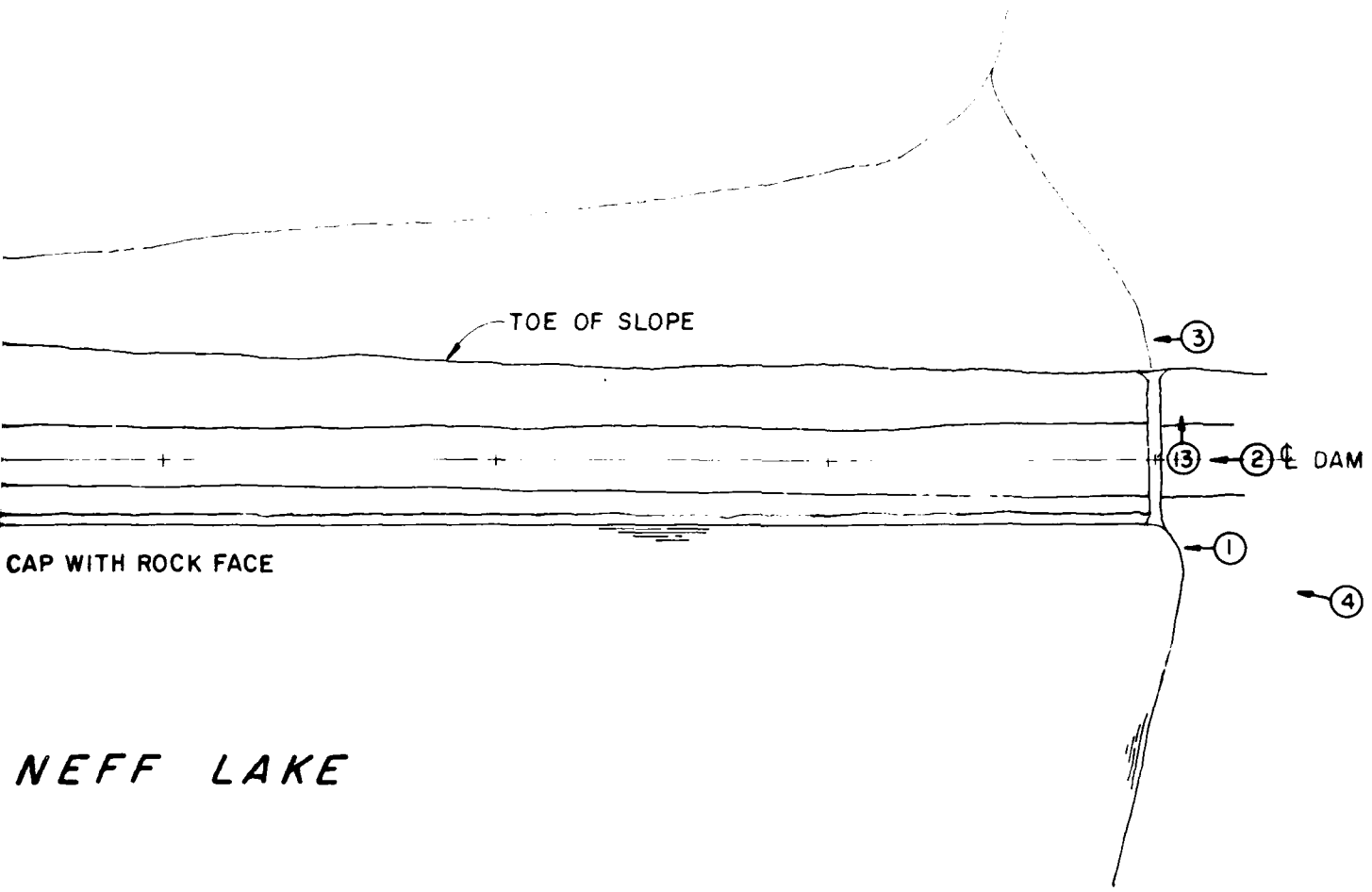
NEFF LAKE
SPILLWAY SECTION

PLATE 5



NEFF LAKE

1



LEGEND

① PHOTO LOCATION AND DIRECTION

N

NEFF LAKE PHOTO INDEX

PLATE 6

1 2

PHOTO 1: UPSTREAM FACE OF DAM FROM EAST END

PHOTO 2: CREST OF DAM FROM EAST END

PHOTO 3: DOWNSTREAM SLOPE OF DAM FROM EAST END

PHOTO 4: UPSTREAM OVERVIEW OF DAM FROM EAST END

PHOTO 5: OVERVIEW OF SPILLWAYS

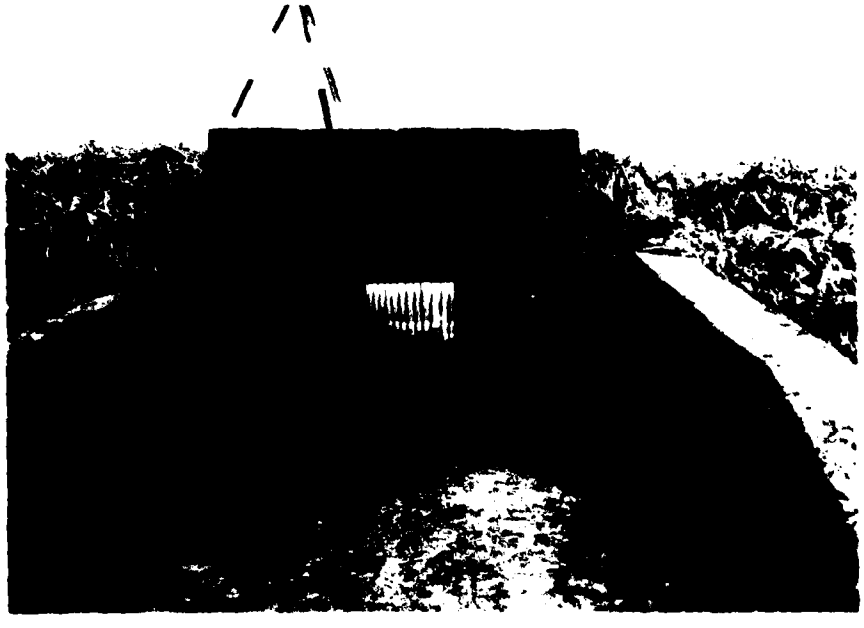


PHOTO 6: BOX SPILLWAY FROM DOWNSTREAM END

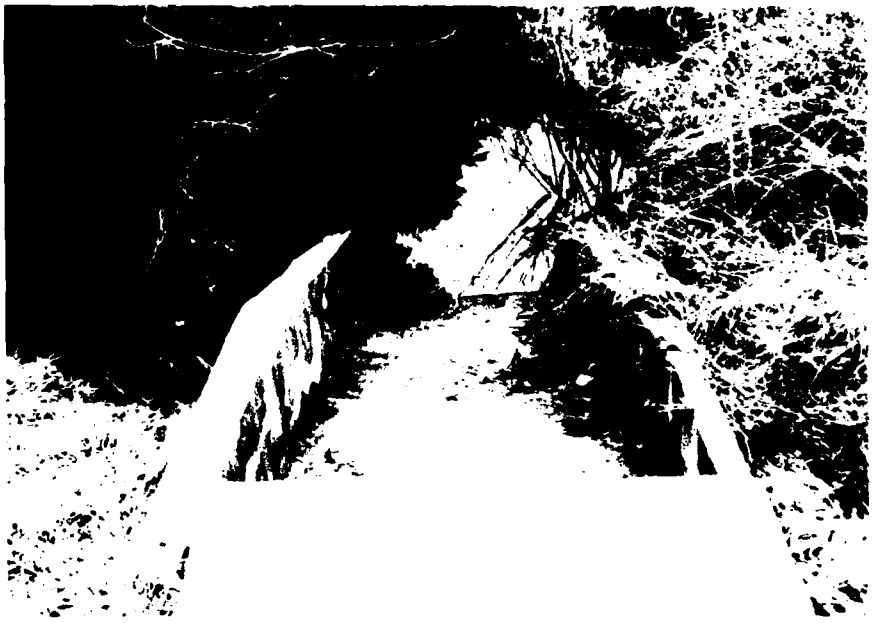


PHOTO 7: BOX SPILLWAY CHUTE LOOKING DOWNSTREAM

PHOTO 8; DISPLACEMENT OF BOX SPILLWAY CHUTE

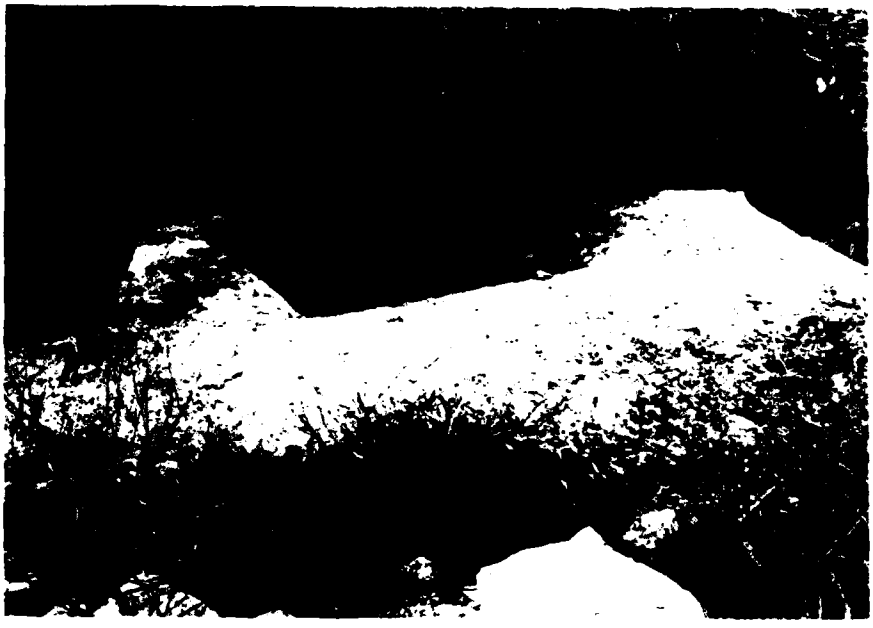


PHOTO 9: DROP INLET SPILLWAY

PHOTO 10: DROP INLET SPILLWAY PIPE

PHOTO 11: DROP INLET SPILLWAY CONDUIT AT DOWNSTREAM TOE

PHOTO 12: CHANNEL BELOW SPILLWAYS

PHOTO 13: BUILDINGS IMMEDIATELY BELOW DAM

PHOTO 14: PIPES THROUGH RAILROAD INFLOW TO LAKE

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrographs (see Plates A-1, A-2, A-3 and A-4), and hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33.

200 square mile, 24 hour rainfall inches	- 24.8
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile, rainfall	- 130%

b. Drainage area = 282 acres.

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385}$ = 0.31 hours = 19 minutes (L = length of longest watercourse in miles, H = elevation difference in feet) (2)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 91 and antecedent moisture condition III. The hydrologic soil group in the basin was B.

e. Inflows for the 100-year flood were determined from the twenty-four hour, 100-year rainfall distribution for drainage areas less than one square mile provided by the St. Louis District, Corps of Engineers. Losses for the 100-year event were determined in accordance with SCS methods for determining runoff using a curve number of 80 and antecedent moisture condition II.

2. Spillway release rates are based on the broad-crested weir equation and nomographs for box and pipe culverts with inlet control (2).

Broad-crested weir equation:

$Q = CLH^{1.5}$ (C = 2.6, L = length of weir in feet, H is the head on weir).

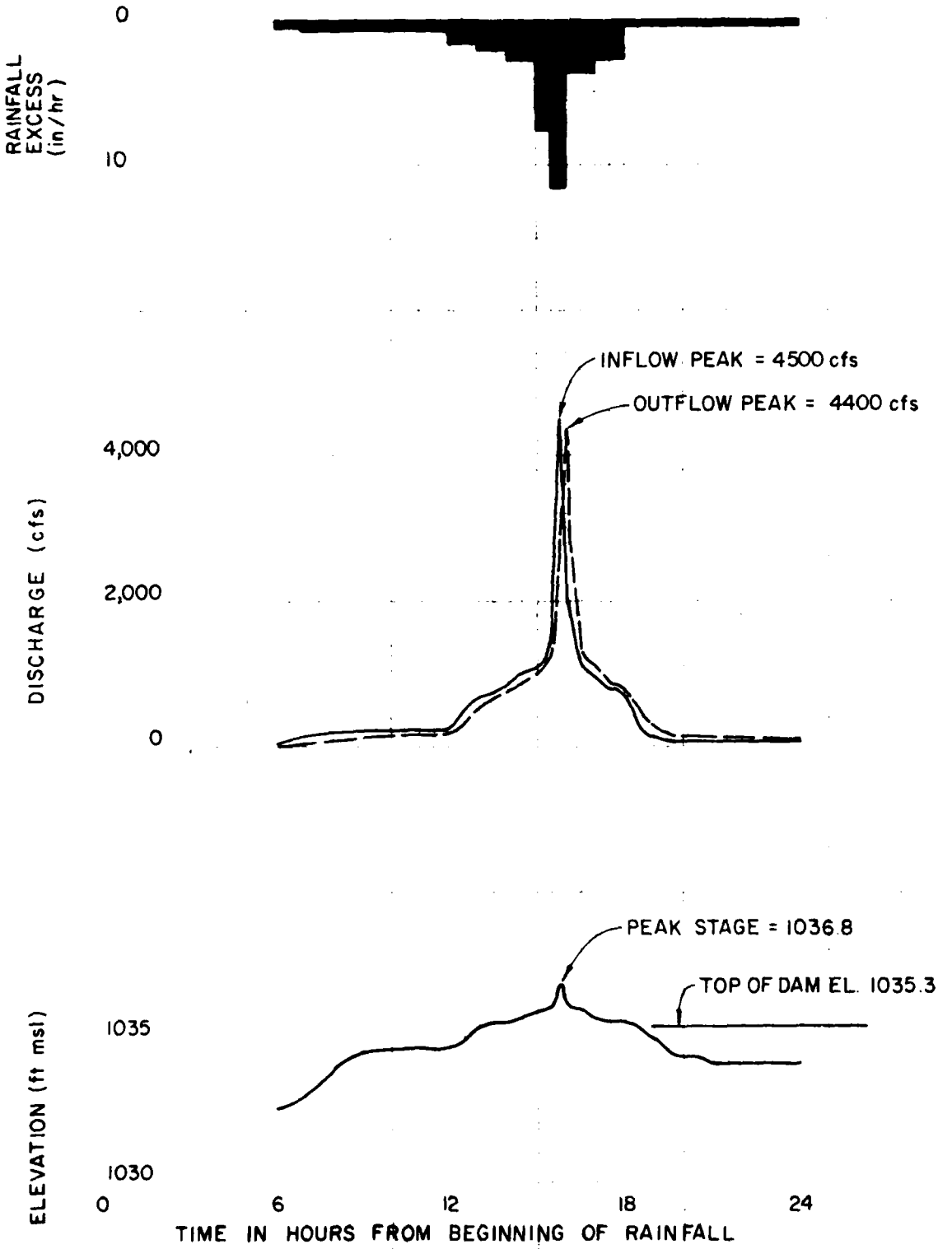
Discharge rates over the top of the dam are also based on the broad-crested weir equation.

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway. Inflow and outflow hydrographs are shown on Plates A-1, A-2, A-3, and A-4.

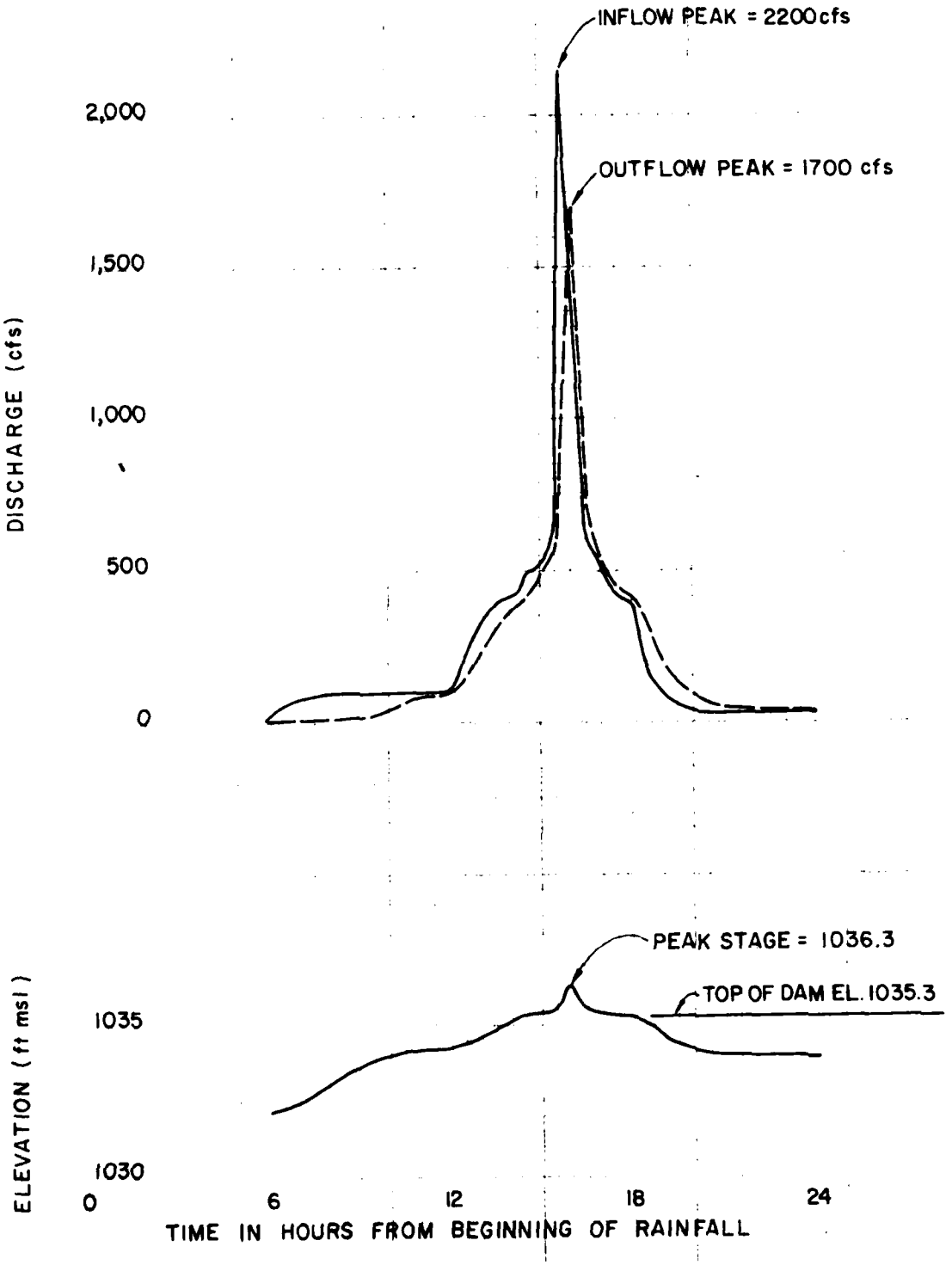
(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

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



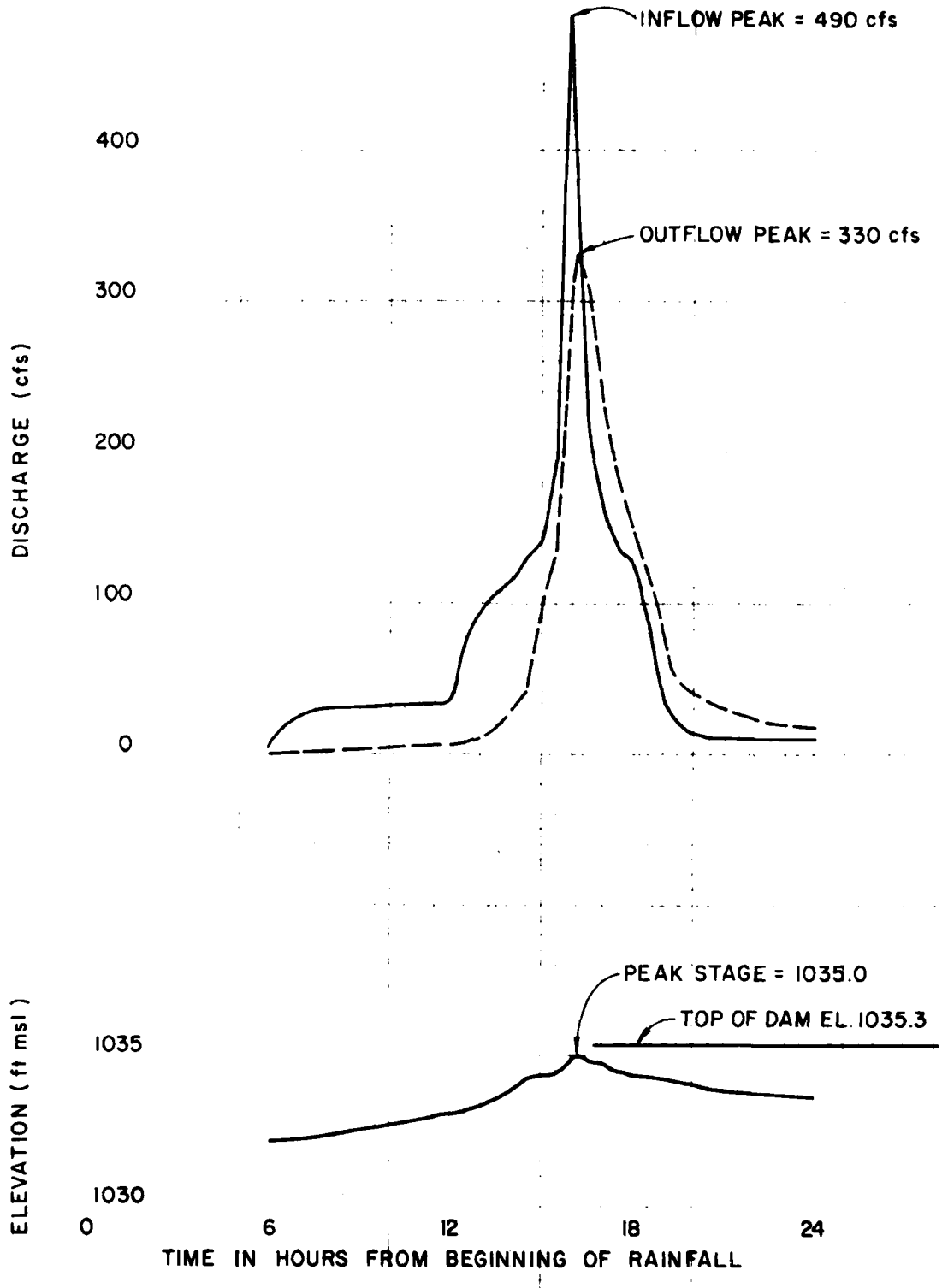
NEFF LAKE
PROBABLE MAXIMUM FLOOD
HYETOGRAPH, HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-1



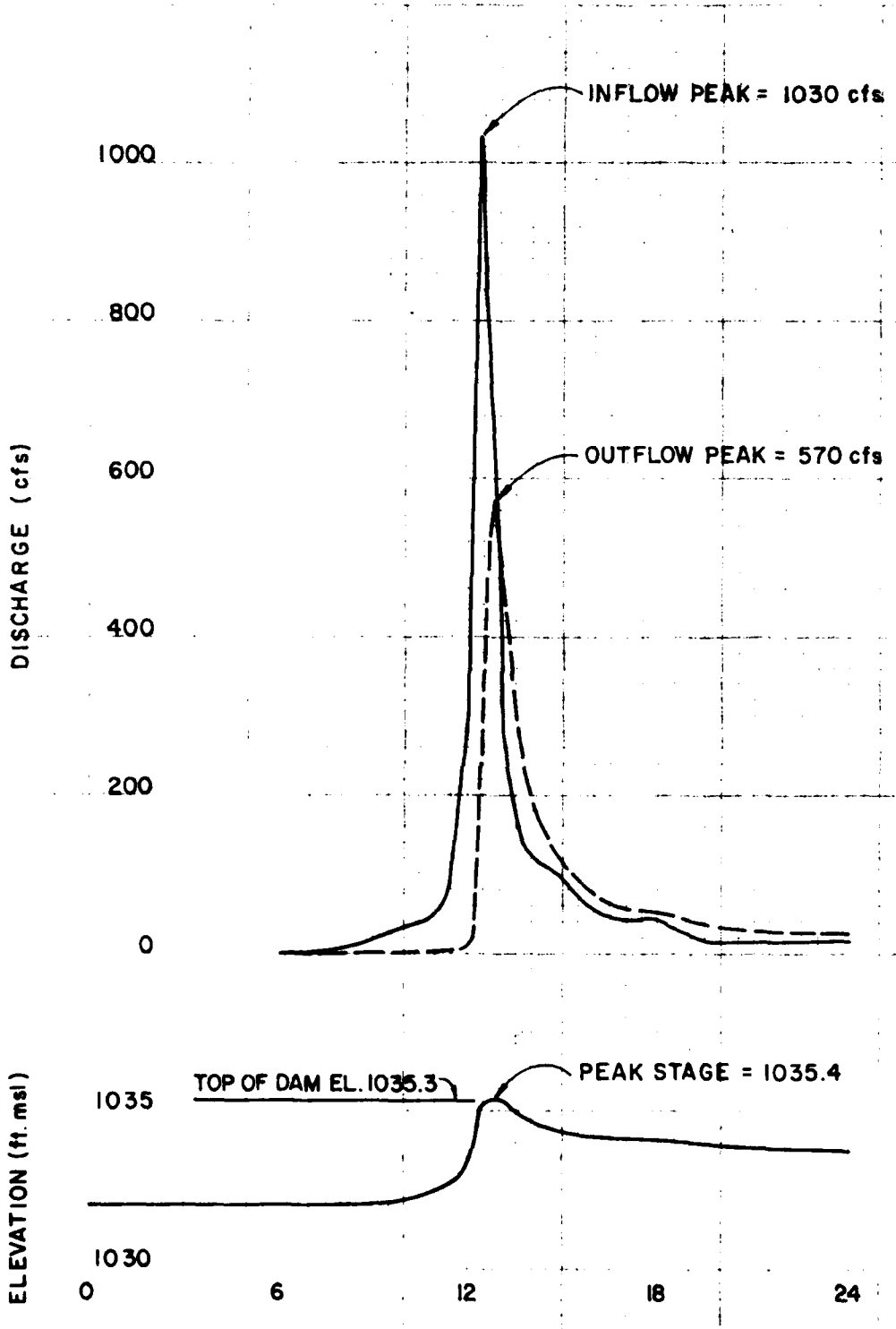
NEFF LAKE
50% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-2



NEFF LAKE
15% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-3



NEFF LAKE
100-YEAR FLOOD
HYDROGRAPHS AND STAGE - TIME CURVE

PLATE A-4

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
    1               A1MISSOURI DAM INSPECTION PROGRAM
    2               A2ST LOUIS DISTRICT  US ARMY CORPS OF ENGINEERS
    3               A3NEFF LAKE  NO.20376
    4               B    288       0       5       0       0       0       0       0       0       0
    5               B1     5
    6               J      1       9       1
    7               J1   .10     .15     .20     .25     .30     .35     .40      .5      1.
    8               K      0       1                               3       1
    9               K1   24 HR PMF INFLOW ABOVE RAILROAD
   10               M      1       2     .31                       1
   11               P              24.8     101     120     130
   12               I                                                       -1      -91
   13               W2             .21
   14               X                      1
   15               K      1       2                                       1
   16               K1   ROUTE THROUGH RAILROAD CULVERT
   17               Y                                      1       1
   18               Y1     1                                               -1      -1
   19               Y41040.61041.65 1042.3  1044.4  1046.05 1047.15 1048.8  1049.36 1052.36 1054.36
   20               Y50.0    66.     104.    184.    320.    400.    500.    550.    1775.   4654.
   21               $SQ.    18.8
   22               $E1040.61050.
   23               $S1046.8
   24               $D1050.
   25               K      0       3                               3       1
   26               K1   24 HR PMF INFLOW BELOW RAILROAD
   27               M      1       2     .12                       1
   28               P              24.8     101     120     130
   29               I                                                       -1      -91
   30               W2             .18
   31               X                      1
   32               K      2       4                                       1
   33               K1   COMBINE HYDROGRAPHS
   34               K      1       5                                       1
   35               K1   ROUTE THROUGH NEFF LAKE DAM
   36               Y                                      1       1
   37               Y1     1                                               -1      -1
   38               Y41032.01032.14 1033.09 1033.39 1033.7  1034.09 1035.3  1036.3  1038.3
   39               Y5     0.00.4    7.4     11.2    20.1    47.8    423.7   1688.   8259.
   40               $SC.0    10C.4   352.4
   41               $E1032.01040.0  1050.
   42               $S1033.4
   43               $D1035.3
   44               K      99
```

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 .10	RATIO 2 .15	RATIO 3 .20	RATIO 4 .25	RATIO 5 .30	RATIO 6 .35	RATIO 7 .40	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	1	.31	1	334.	501.	667.	834.	1001.	1168.	1335.	1668.	3337.
		(.80)	(	9.45)(	14.17)(	18.90)(	23.62)(	28.35)(	33.07)(	37.79)(	47.24)(	94.49)
ROUTED TO	2	.31	1	198.	338.	443.	567.	818.	1054.	1241.	1572.	3193.
		(.80)	(	5.61)(	9.58)(	12.55)(	16.06)(	23.17)(	29.85)(	35.15)(	44.52)(	90.41)
HYDROGRAPH AT	3	.12	1	136.	203.	271.	339.	407.	474.	542.	678.	1356.
		(.31)	(	3.84)(	5.76)(	7.68)(	9.60)(	11.52)(	13.43)(	15.35)(	19.19)(	38.38)
2 COMBINED	4	.43	1	280.	487.	645.	792.	1144.	1450.	1694.	2147.	4515.
		(1.11)	(	7.94)(	13.78)(	18.27)(	22.42)(	32.39)(	41.06)(	47.96)(	60.80)(	127.84)
ROUTED TO	5	.43	1	183.	331.	491.	667.	957.	1207.	1448.	1687.	4398.
		(1.11)	(	5.18)(	9.39)(	13.90)(	19.46)(	27.09)(	34.17)(	41.02)(	47.78)(	124.52)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1032.00	1033.40	1035.30
STORAGE	0.	19.	65.
OUTFLOW	0.	11.	424.

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
.10	1034.53	0.00	34.	183.	0.00	16.33	0.00
.15	1035.00	0.00	41.	331.	0.00	16.25	0.00
.20	1035.35	.05	45.	491.	.33	16.17	0.00
.25	1035.51	.21	42.	687.	.75	16.00	0.00
.30	1035.72	.42	50.	957.	1.00	16.00	0.00
.35	1035.92	.62	53.	1207.	1.25	15.92	0.00
.40	1036.11	.81	56.	1448.	1.67	15.92	0.00
.50	1036.30	1.00	58.	1687.	3.08	15.83	0.00
1.00	1036.82	1.52	65.	4398.	5.75	15.83	0.00


DATE
ILME