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NATIONAL DAM SAFETY PROGRAM. FOUR RIDGE DAM (MO 30446), MISSISS--ETC(U)
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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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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

FOUR RIDGE DAM
JEFFERSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30446

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: ST. LOUIS DISTRICT CORPS OF ENGINEERS
FOR: GOVERNOR OF MISSOURI

SEPTEMBER 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Four Ridge Dam (30446)
State Located	Missouri
County Located	Jefferson County
Stream	Tributary to Rock Creek
Date of Inspection	8 September 1978

Four Ridge Dam was inspected by an interdisciplinary team of engineers from the St. Louis District, U. S. Army Corps of Engineers. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, to determine if the dam poses hazards to human life or property. The inspection and assessment were made using the "Recommended Guidelines for Safety Inspection of Dams" developed by the Chief of Engineers, U. S. Army, Washington, D. C., with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Based on the criteria in the guidelines, the dam is in the small-size classification because it is less than 40 feet high and impounds less than 1000 acre-foot of water and is in the high-hazard potential classification as failure of the dam would threaten the lives and property of one family living at the toe of the dam and one additional home approximately 1 mile downstream. Failure of the dam would also cause appreciable damage to various uninhabited buildings located downstream.

For its size and hazard potential category, this dam is required by the guidelines to pass from one-half the Probable Maximum Flood (PMF) to the full PMF without overtopping the dam. The PMF is defined as the flood discharge resulting from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway of this dam will pass only 15 percent of the PMF without overtopping the dam. Our evaluation also indicates that the spillway will not pass the 100-year flood, that is a flood having a 1 percent chance of exceedence in any given year, without overtopping the dam. Since the spillway for four Ridge Dam is not capable of passing a minimum of one-half (50 percent) of the PMF without overtopping the dam, the spillway is considered seriously inadequate and the dam is accordingly considered unsafe.

Other deficiencies visually observed by the inspection team were trees and heavy vegetation on the downstream slope, no erosion protection on the upstream slope and inadequate spillway erosion protection. The lack of seepage and stability analyses comparable to the requirements of the guidelines are also a deficiency which should be rectified.

It is recommended that the owner correct or control the deficiencies described above in accordance with the detail report submitted herewith.

Ken Alexander
KEN ALEXANDER
Soils Engineer

Frederick R Bader
FREDERICK BADER
Hydraulic Engineer

SUBMITTED BY: Jack R Clarin — Chief, Engineering Division — 16 Oct 78 — Date

APPROVED BY: Leon E. Mathy — Colonel, CE, District Engineer — 17 Oct 78 — Date

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
FOUR RIDGE DAM - ID NO. 30446

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
FOUR RIDGE DAM ID NO. 30446

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 the Four Ridge 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 is an earth structure built in a narrow valley which is tributary to Rock Creek. Topography adjacent to the narrow valley is hilly with narrow ridges as shown on PLATE 1.

(2) The spillway is grass-lined earth channel, located in the right (southeast) side of the earth embankment. As shown on PLATE 3, the spillway is approximately 200 feet long, of which approximately 80 feet are on the lake side of the dam. The spillway slopes approximately .6 foot per 100 feet and, as shown on PLATE 4, contains approximately 230 square feet in cross sectional area below the top of the dam. At the time of inspection, the grass in the channel had reached a height of 2 to 4 feet and flow was occurring through the spillway to a depth of 2 to 6 inches. There is a chain link fence across the spillway approximately 110 feet downstream of the axis of the dam. Just beyond this fence the spillway makes a sharp bend to the left and drops abruptly through a severely eroded area to the valley floor.

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

b. Location. The dam is located in the east-central portion of Jefferson County, Missouri, as shown on PLATE 2. The lake formed by the dam is shown on the Maxville, Missouri quadrangle sheet in Sections 9 and 10, T42N, R5E of the 5th principal meridian.

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 c above. Based on referenced guidelines, this dam is in the High Hazard Classification.

e. Ownership. This dam is owned by Mr. Joseph H. Schlummn, Rural Route, Otto, Missouri.

f. Purpose of Dam. The dam forms a 7.4-acre recreational lake.

g. Design and Construction History. The inspection team contacted Mr. Palmer Hahn, original owner of the dam. It was reported that the dam was built in 1962 by the Sutton Brothers, a construction firm from the area. Material for the embankment was excavated from the upstream fields and hillsides. A 16 to 20 foot wide core trench was placed on bed rock at a depth of approximately 15 feet below the natural valley elevation. No design data, stability analyses or construction information are available on this dam.

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 - 346 acres.

b. Discharge at Damsite.

(1) All discharge at the damsite is through an uncontrolled spillway.

(2) Maximum flood at damsite unknown. A recent flood was described as having caused the severe erosion in the lower end of the spillway. The inspection team was also informed that the dam had never been overtopped.

(3) Spillway capacity at top of dam - 688 cfs.

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

(1) Top of dam - 620.0 minimum (see PLATE 3).

(2) Spillway crest - 616.5.

(3) Streambed at centerline of dam - 588.±.

(4) Maximum tailwater - Unknown.

d. Reservoir. Length of maximum pool - 1000 feet ±.

e. Storage (Acre-feet).

(1) Maximum Pool - 138

(2) Top of Dam - 109

(3) Spillway Crest - 81

f. Reservoir Surface (Acres).

(1) Top of dam - 8.9.

(2) Spillway crest - 7.4.

g. Dam.

(1) Type - earth embankment.

(2) Length - 560 feet.

(3) Height - 35 feet maximum.

(4) Top width - 18 feet.

(5) Side Slopes.

(a) Downstream - 1V on 2.1H

(b) Upstream - 1V on 2H Upper (reported by owner)
1V on 3H Lower (reported by owner)

(6) Zoning - unknown.

(7) Impervious Core - unknown.

(8) Cutoff - unknown.

(9) Grout curtain - unknown.

h. Diversion and Regulating Tunnel. None.

i. Spillway.

(1) Type - Open channel, grass-lined earth. Top width of 55 feet and a maximum depth of 3.5 feet. Slope equals .6 ft/100 ft.

(2) Length of weir - None

(3) Crest elevation - 616.5 feet msl.

j. Gates. None

k. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. No design drawings or computations exist.

2.2 CONSTRUCTION. The dam was constructed in 1962 by a contractor from the area. The dam was reportedly constructed using borrow material from hillsides adjacent to the dam location. No additional construction data are available.

2.3 OPERATION. No operating records exist. At the dam, outflow passes over an uncontrolled spillway.

2.4 EVALUATION.

a. Availability. The only available engineering data is the personal recollections of the owner. It was reported that no engineering data was deveoped for construction of this dam.

b. Adequacy. The field surveys and visual inspections 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 Four Ridge Dam was made on 8 September 1978. Personnel making the inspection were employees of the St. Louis District, Corps of Engineers, and included a hydraulic engineer, soils engineer and a civil engineer. Specific observations are discussed below.

b. Project Geology.

(1) Four Ridge Dam and surrounding area are underlain by relatively undisturbed flat-lying Paleozoic rocks. The valley containing the impoundment is located in upper Ordivician limestones and shales, and the adjacent ridges are capped by lower Mississippian limestone. A thin layer of Devonian sandstone occurs in the higher slopes. Previous mapping has revealed no major structures or faulting in the immediate area.

(2) The valley slopes and floor are well blanketed with residual soil, therefore, no outcrops are visible in the reservoir area, and jointing, fracturing, and weathering cannot be directly observed. The valley soil, a reddish- brown, silty, cherty clay, was reported to be 15 feet thick along the dam axis; however, road cuts indicated as much as 30 feet on the slopes.

(3) Examination of the residuum on the slopes confirms that the abutment and valley bedrock is composed of the middle and upper portions of the Ordovician Kimmswick formation - a massive, medium to coarse-grained fossiliferous limestone. The formation is approximately 110 feet thick in the reservoir area, and the base is at a depth of approximately 40 feet below the valley floor. The Kimmswick formation is underlain by 20 feet of thinly bedded shales and limestone of the Decorale formation, and 170 feet of dense, sublithographic Plattin Limestone.

(4) The Kimmswick formation is susceptible to solutioning along joints and bedding planes, and is noted for occasional cavern and sink development; however, no caves, sinks or springs were found in the reservoir area. The limestone exposed in the cutoff trench for the dam was reported to be in unweathered condition.

c Dam. No detrimental settlement, cracking or seepage was noted on or near the dam. Severe upstream erosion was observed above the waterline. This erosion has caused a 2-foot to 3-foot vertical scarp to develop across the entire upstream slope (see photograph 1). The upstream slope showed no signs of riprap protection. On the downstream slope vegetation was 2 feet to 3 feet

high with several trees up to 1-1/2 inches in diameter (see photograph 2). Surface soils on the dam were silty and quite erodiable as seen at localized areas of the upstream slope which were void of vegetation (see photograph 1).

d. Spillway. At the time of inspection, the earth spillway in the right (east) side of the embankment had a heavy growth of vegetation which had reached a height of 2 to 4 feet and flow was occurring to a depth of 2 to 6 inches (see photographs 3 and 4). There is a chain link fence across the spillway approximately 110 feet downstream from the centerline of the dam. Just beyond this fence the spillway turns sharply to the left. A short distance after the spillway turns, the edge and sides are eroded vertically up to 12 feet in depth (see photographs 5 and 6). This erosion, which apparently resulted from large spillway flows, was reported to have occurred within the last year. Some efforts to repair this erosion with concrete have failed.

e. Reservoir Area. Erosion similar to that on the upstream slope of the dam was observed around the perimeter of the lake. No slides have occurred on the relatively gentle slopes around the perimeter of the lake.

3.2 EVALUATION. Trees and brush on the downstream slope are a potential seepage hazard and should be removed. The trees and brush also provide animal habitat and encourage burrows. Any burrows found after clearing the embankment should be filled.

The upstream face of the dam is subject to erosion and should be protected with riprap.

The lower spillway is experiencing a serious erosion problem and should be repaired and protected with riprap.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. There are no controlled outlet works for this dam; therefore, no regulating procedures exist. The pool is controlled by rainfall, runoff, evaporation, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM. Based on the amount of brush and size of trees on the downstream slope, it has been several years since the vegetation on this slope has been cut.

4.3 MAINTENANCE OF OPERATING FACILITIES. No operating facilities exist at this dam.

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. If the uncontrolled vegetation on the downstream slope are allowed to continue, potential problems may develop.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES.

a. Design Data. No design data available.

b. Experience Data. All of the pertinent data furnished in this report are based on computations derived from the U. S. Geological Survey 7-1/2 minute, Maxville, Missouri, Quadrangle Sheet, photograph revised 1974, and measurements and surveys made during the field inspection. All surveyed elevations are based upon an assumed datum of 620.0 at the northwest end of the dam.

c. Visual Observations. The following deficiencies were noted by observation of the spillway.

1) Serious erosion approximately 110 feet south of the axis of the dam.

2) Excessively tall growth of grass in this spillway.

3) The presence of chain link fence across the flow area of the spillway.

d. Overtopping Potential. All floods in excess of 15 percent of the Probable Maximum Flood will overtop the dam. The Probable Maximum Flood is defined as the flood discharge which is expected from most severe combinations of critical, meteorologic, and hydrologic conditions that are reasonably possible in the region. The PMF will overtop the dam by 3 feet for a period of 5.7 hours with a peak outlfow of 6400 cubic feet per second. One-half of the PMF will overtop the dam by 1.8 feet for a period of 1.4 hours with peak outflow of 2900 cubic feet per second. Since the spillway for Four Ridge Dam is not capable of passing 50 percent of the PMF without overtopping and threatening the dam to failure, the spillway is considered to be serously inadequate. A flood with 1 percent chance of occurrence in any one year (once in 100-year) will also overtop the dam.

There is one inhabited home at the toe of the dam and one additional home approximately 1 mile downstream which could be severely damaged and lives of the inhabitants could be lost should failure of the dam occur. The effect from rupture of the dam could extend approximately 1 mile downstream of the dam.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY.

a. Visual Observations. No structural stability problems were observed on the downstream slope. The erosion on the upstream slope and heavy vegetation and trees discussed in Section 3, if not corrected and controlled, could lead development of potential problems.

b. Design and Construction Data. The only construction data available were the name of the contractor who built the dam (see Section 1.2g). No design or construction data relating to the structural stability of the dam were found. 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. Operating Records. There are no known operating procedures which would affect the structural stability of the dam.

d. Post Construction Changes. No post construction changes were reported by the owner or observed which will affect the structural stability of the dam.

e. Seismic Stability. Considering the seismic zone (2) in which this dam is located, an earthquake of this magnitude is not expected to cause a structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT.

a. Safety. Several items were noted during the visual inspection by the inspection team which if not corrected or controlled could lead to an unsafe condition. These items are:

(1) Heavy vegetation and trees on the downstream slope.

(2) Severe erosion above the waterline on the upstream slope.

(3) Severe erosion downstream of the spillway.

(4) Excessively high growth of grass within the spillway.

(5) Chain link fence located across the flow area of the spillway.

(6) Spillway capacity and height of dam is insufficient to pass the recommended spillway design flood without overtopping the dam.

b. Adequacy of Information. The lack of seepage or stability analysis is a deficiency which should be rectified.

c. Urgency. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. It is recommended that the remedial measures listed in Section 7.2 be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high-priority basis.

d. Necessity for Phase II. Based on the results of the Phase I inspection, no Phase II inspection is recommended.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of this magnitude is not expected to cause a structural failure of this dam.

7.2 REMEDIAL MEASURES.

a. Alternatives. Spillway size and/or height of dam should be increased to pass the Probable Maximum Flood without overtopping the dam. The overtopping depth stated elsewhere in the report should not be considered as the required increase in dam height to prevent overtopping. Any increase in dam height or spillway capacity should be based upon more detailed engineering studies beyond the scope of this investigation.

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

(1) Remove trees and heavy vegetation from the downstream slope. Care should be taken during removal not to destroy the existing condition of the downstream slope.

(2) Protect upstream slope with adequate riprap to prevent erosion.

(3) Repair lower spillway erosion with riprap.

(4) Remove the chain link fence constructed within the spillway.

(5) At least every five years a detailed inspection of the dam should be made by an engineer experienced in design and construction of dams.

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

APPENDIX

HYDROLOGIC COMPUTATIONS

HYDROLOGIC AND HYDRAULIC ANALYSIS

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation for those dams in the high hazard potential category is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the 24-hour rainfall depths distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed on PLATE 1A. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. The spillway rating curve was computed by backwater computations utilizing the computer program HEC-2, Water Surface Profiles, dated November 1976, as prepared by the Hydrologic

Engineering Center, Corps of Engineers, U. S. Army. For flows above the spillway, discharges were computed using the weir flow formula:

$$Q = CLH^{1.5}$$

The coefficient (C) used for flow over the top of dam was equal to 3.0. Due to the extreme variation in the elevations of the top of dam several horizontal segments were developed using the broad crested weir flow formula and combined for a composite rating curve. The input data and output data for the backwater portion of the spillway rating curve are attached as PLATE A-2.

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A    DAM  SAFETY PROGRAM U.S. CORPS OF  ENGINEERS
A      ED-ME        12 SEPT.78
A    MO.ID838448  4RIDGE  LAKE   JEFFERSON      CO.
B    888          0         5          0          0          0          0          -5         0
B1     5
J      1          7          1
J1   .10       .15       .80       .25       .30       .50      1.00
K      0          1                               3          1
K1    INFLOW  HYDROGRAPH  COMPUTED  BY  SCS  METHOD
M      1          2        .54                   1.0                                    1
P                 86.5      102       120       130
T                                                                -1        -88                .05
J8                .17
X    -1.0      -0.10      3.0
K      1          2                                            1
K1     RESERVOIR       ROUTING   BY  MODIFIED     PULS   RATING SPILL+DAM
V                                    1          1
Y1     1                                                  -616.5        -1
Y4  616.5     617.1     618.2     618.7     619.6     620.8     621.8     621.5     622.0     622.5
Y4  823.0     823.5     824.0     824.5
Y5     0        10       100       200       500      1064      1490      2500      3170      4490
Y5  6200      8200     10450     12900
SA     0       .29      2.01      4.59      8.90     12.91
SE  586.0     590.0     600.0     610.0     620.0     630.0
SS  616.5
SD  620.0
K      99
```

PLATE A-1 , PAGE 1

HYDROGRAPH DATA

IHYDQ	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.54	0.00	.54	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.50	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-86.00	0.00	.05

CURVE NO = -86.00 WETNESS = -1.00 EFFECT CN = 86.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .17

RECESSION DATA

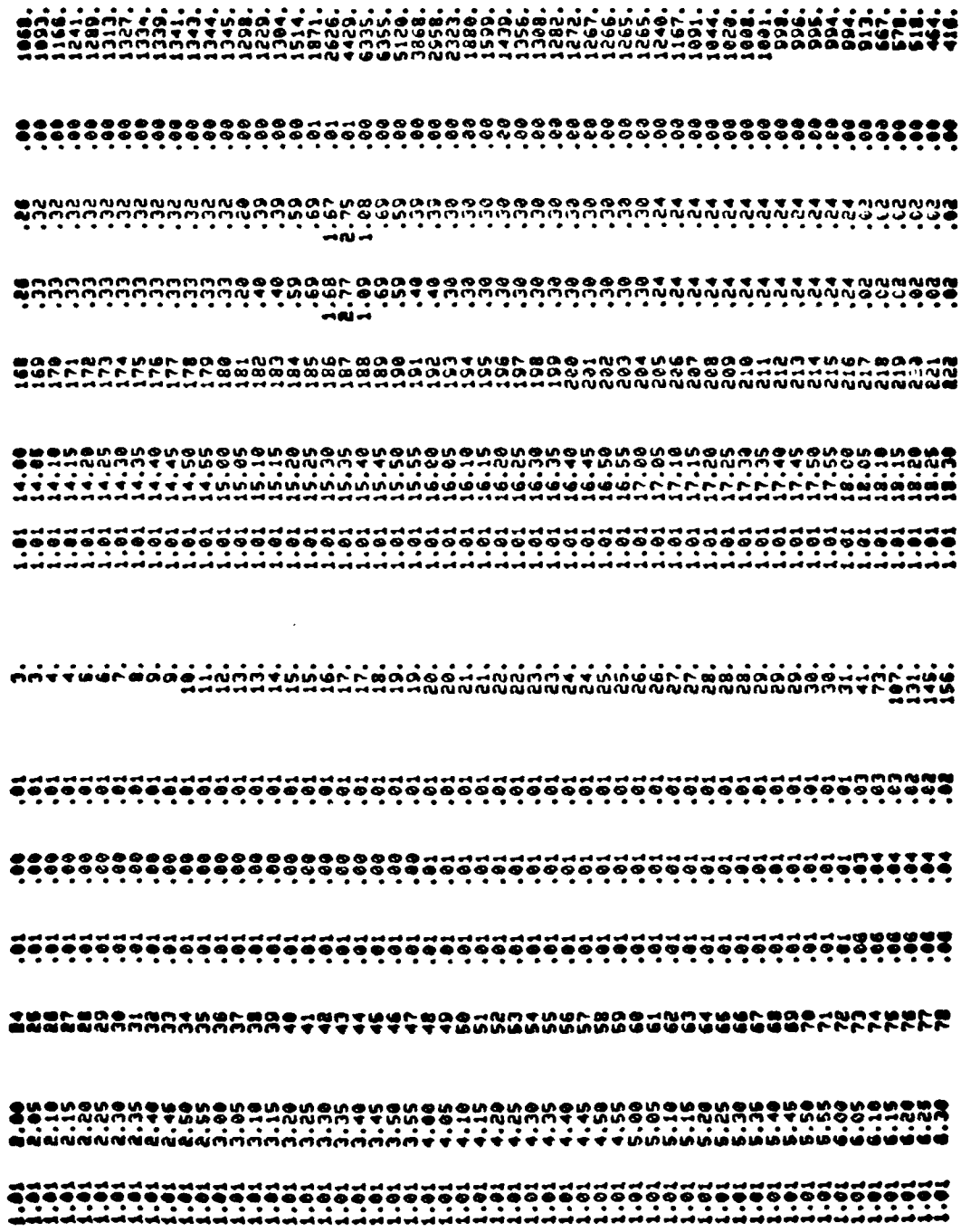
STRTQ= -1.00 QRCSN= -.10 RTIOR= 3.00

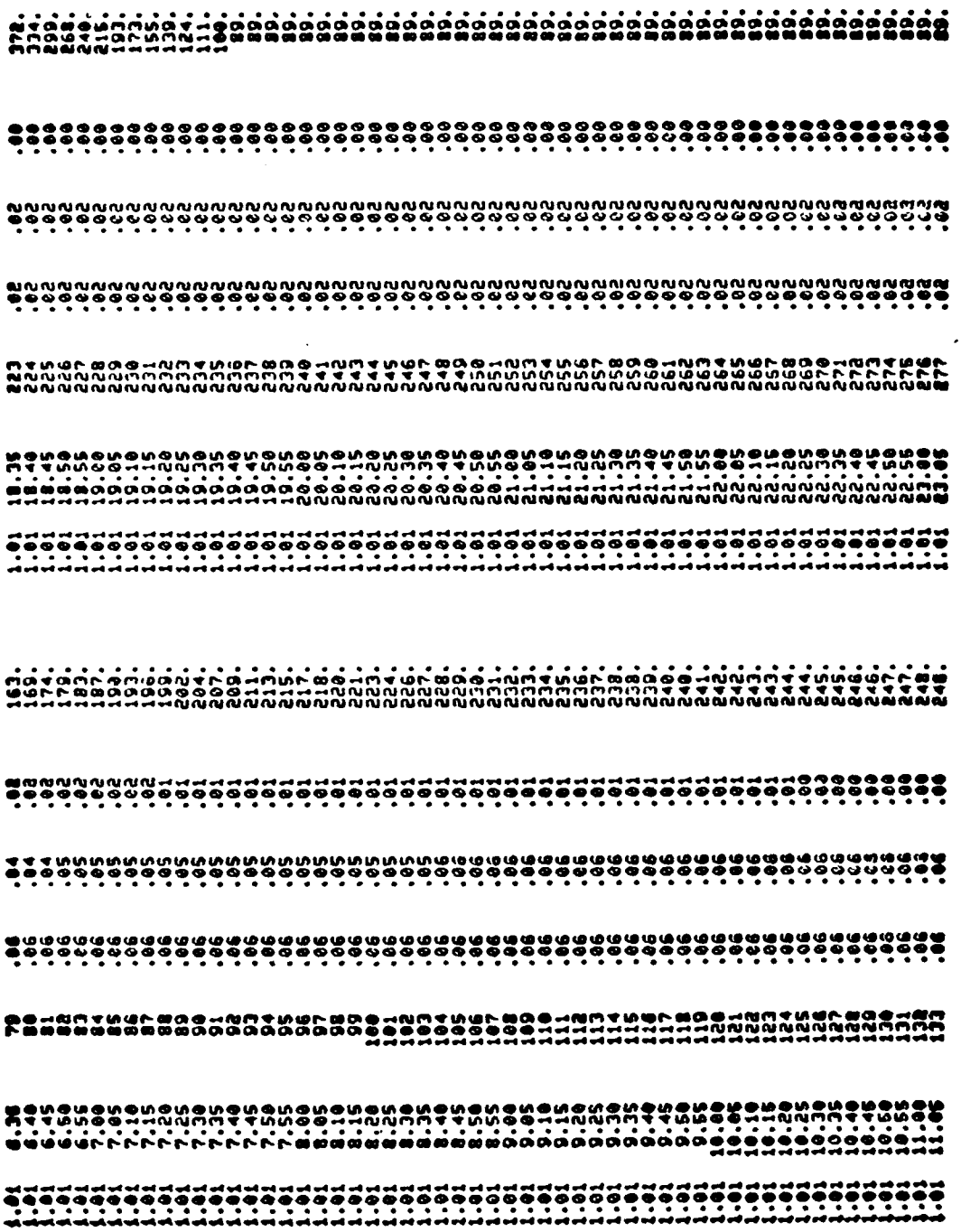
UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .17 VOL= 1.00

374. 1134. 1165. 731. 366. 196. 103. 54. 29. 15.
8. 3.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	1.	1.01	12.05	145	.22	.21	.01	306.
1.01	.10	2	.01	.00	.01	2.	1.01	12.10	146	.22	.21	.01	471.
1.01	.15	3	.01	.00	.01	2.	1.01	12.15	147	.22	.21	.01	642.
1.01	.20	4	.01	.00	.01	3.	1.01	12.20	148	.22	.21	.01	750.
1.01	.25	5	.01	.00	.01	3.	1.01	12.25	149	.22	.21	.01	805.
1.01	.30	6	.01	.00	.01	3.	1.01	12.30	150	.22	.21	.01	835.
1.01	.35	7	.01	.00	.01	3.	1.01	12.35	151	.22	.21	.01	853.
1.01	.40	8	.01	.00	.01	3.	1.01	12.40	152	.22	.21	.01	862.
1.01	.45	9	.01	.00	.01	3.	1.01	12.45	153	.22	.21	.01	868.
1.01	.50	10	.01	.00	.01	3.	1.01	12.50	154	.22	.21	.01	872.
1.01	.55	11	.01	.00	.01	3.	1.01	12.55	155	.22	.21	.01	875.
1.01	1.00	12	.01	.00	.01	3.	1.01	13.00	156	.22	.21	.01	877.
1.01	1.05	13	.01	.00	.01	3.	1.01	13.05	157	.26	.25	.01	894.
1.01	1.10	14	.01	.00	.01	3.	1.01	13.10	158	.26	.25	.01	943.
1.01	1.15	15	.01	.00	.01	3.	1.01	13.15	159	.26	.25	.01	994.
1.01	1.20	16	.01	.00	.01	3.	1.01	13.20	160	.26	.25	.01	1026.
1.01	1.25	17	.01	.00	.01	3.	1.01	13.25	161	.26	.25	.01	1043.
1.01	1.30	18	.01	.00	.01	3.	1.01	13.30	162	.26	.25	.01	1052.
1.01	1.35	19	.01	.00	.01	3.	1.01	13.35	163	.26	.25	.01	1058.
1.01	1.40	20	.01	.00	.01	3.	1.01	13.40	164	.26	.26	.00	1061.
1.01	1.45	21	.01	.00	.01	3.	1.01	13.45	165	.26	.26	.00	1064.
1.01	1.50	22	.01	.00	.01	3.	1.01	13.50	166	.26	.26	.00	1065.
1.01	1.55	23	.01	.00	.01	3.	1.01	13.55	167	.26	.26	.00	1067.





1.01	11.10	134	.06	.06	.00	248.	1.01	23.10	278	.02	.02	.00	89.
1.01	11.15	135	.06	.06	.00	249.	1.01	23.15	279	.02	.02	.00	89.
1.01	11.20	136	.06	.06	.00	249.	1.01	23.20	280	.02	.02	.00	89.
1.01	11.25	137	.06	.06	.00	249.	1.01	23.25	281	.02	.02	.00	89.
1.01	11.30	138	.06	.08	.00	250.	1.01	23.30	282	.02	.02	.00	89.
1.01	11.35	139	.06	.06	.00	250.	1.01	23.35	283	.02	.02	.00	89.
1.01	11.40	140	.06	.06	.00	250.	1.01	23.40	284	.02	.02	.00	89.
1.01	11.45	141	.06	.06	.00	251.	1.01	23.45	285	.02	.02	.00	89.
1.01	11.50	142	.06	.06	.00	251.	1.01	23.50	286	.02	.02	.00	89.
1.01	11.55	143	.06	.06	.00	251.	1.01	23.55	287	.02	.02	.00	89.
1.01	12.00	144	.06	.06	.00	252.	1.02	0.00	288	.02	.02	.00	89.
									SUM	33.15	31.37	1.78	133433.
										(842.)	(797.)	(45.)	(3778.40)

SUMMARY OF DAM SAFETY ANALYSIS

.....	ELEVATION STORAGE OUTFLOW	INITIAL VALUE 616.50 81. 0.	SPILLWAY CREST 616.50 81. 0.	TOP OF DAM 620.00 109. 688.

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	619.33	0.00	103.	411.	0.00	15.92	0.00
.16	619.95	0.03	109.	663.	0.00	15.92	0.00
.20	620.46	.46	113.	906.	.42	15.83	0.00
.25	620.91	.91	117.	1303.	.58	15.83	0.00
.30	621.10	1.10	119.	1698.	.67	15.83	0.00
.50	621.83	1.83	126.	2937.	1.42	15.75	0.00
1.00	623.06	3.06	138.	6439.	5.75	15.75	0.00

```
C
C      3
C      1        CRITICAL DEPTH AT SIDE CHANNEL WASH DOWN HILLSIDE
C    100        AXIS OF THE DAM
C    120        CONTRACTION SECTIONS INTO THE LAKE
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       2        0        0       -1        0        0        0        0
J2     1                -1
J3    38       1        43       17       51       25       26
J5   -10
NC   .08     .08      .08       .5      1.0
QT     6      10       100      200      500     1000     1500
NV     4    .120       617     .080      618     .040      619     .025      630
X1     1       7         0       74        0        0        0        0     -.3
X3    10
GR 618.4       0    618.6        6    618.7       12    616.7       20    615.8       40
GR 617.7      64    620.8       74
X1    10                                10       10       10                .06
X1    20                                10       10       10                .06
X1    30                                10       10       10                .06
X1    40                                10       10       10                .06
X1    47                                07       07       07                .06
X1    60                                13       13       13                .06
X1    70                                10       10       10                .06
X1    80       5         0       60       10       10       10     1.11     -.19
GR 619.8       0    617.1       10    616.2       30    617.0       50    619.5       60
X1    90                                10       10       10     1.08      .06
X1   100                                10       10       10     1.04      .06
X1   110                                10       10       10
NC   .08     .08      .08       0.5      1.0
X1   120                 0       90       10       10       10     1.50
X1   130                 0      135       10       10       10     1.50     -2.0
EJ
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       3        0        0       -1        0        0        0
J2     2                -1
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       4        0        0       -1        0        0        0
J2     3                -1
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       5        0        0       -1        0        0        0
J2     4                -1
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       6        0        0       -1        0        0        0
J2     5                -1
T1   DAM  SAFETY        - 4-RIDGE  #30446
T2JEFFERSON             CO
T3SPILLWAY       BACKWATER          9SEPT78
J1   -10       7        0        0       -1        0        0        0
J2    15                -1
```

SUMMARY PRINTOUT

	SECNO	CWSEL	Q	K*XNCH	DIFWSX	AREA	VCH
*	1.000	615.96	10.00	161.75	0.00	3.63	2.75
*	1.000	616.64	100.00	134.55	0.00	21.99	4.55
*	1.000	617.03	200.00	118.97	0.00	37.00	5.41
*	1.000	617.80	500.00	88.20	0.00	73.33	6.82
*	1.000	618.71	1000.00	51.47	0.00	128.14	7.80
*	1.000	619.30	1500.00	39.60	0.00	168.45	8.90
	10.000	616.48	10.00	140.79	.52	14.75	.68
	10.000	617.44	100.00	102.59	.81	52.62	1.90
	10.000	617.89	200.00	84.20	.87	75.36	2.65
	10.000	618.71	500.00	51.54	.92	123.92	4.03
	10.000	619.54	1000.00	39.27	.83	181.14	5.52
	10.000	620.29	1500.00	38.25	.99	235.03	6.38
	20.000	616.58	10.00	136.62	.10	16.17	.62
	20.000	617.58	100.00	96.70	.14	56.82	1.76
	20.000	618.02	200.00	78.66	.13	79.40	2.52
	20.000	618.81	500.00	47.35	.10	126.97	3.94
	20.000	619.62	1000.00	39.15	.08	182.91	5.47
	20.000	620.36	1500.00	38.15	.07	235.91	6.36
	30.000	616.65	10.00	133.47	.08	16.79	.60
	30.000	617.68	100.00	92.71	.10	58.74	1.70
	30.000	618.12	200.00	74.64	.10	81.50	2.45
	30.000	618.88	500.00	44.41	.07	127.88	3.91
	30.000	619.68	1000.00	39.07	.06	182.87	5.47
	30.000	620.42	1500.00	38.07	.06	235.83	6.36
	40.000	616.72	10.00	130.82	.07	16.99	.59
	40.000	617.77	100.00	89.06	.08	60.27	1.66
	40.000	618.21	200.00	71.52	.08	82.44	2.43
	40.000	618.94	500.00	42.20	.06	127.57	3.92
	40.000	619.74	1000.00	38.99	.06	182.83	5.47
	40.000	620.47	1500.00	37.99	.06	235.70	6.36

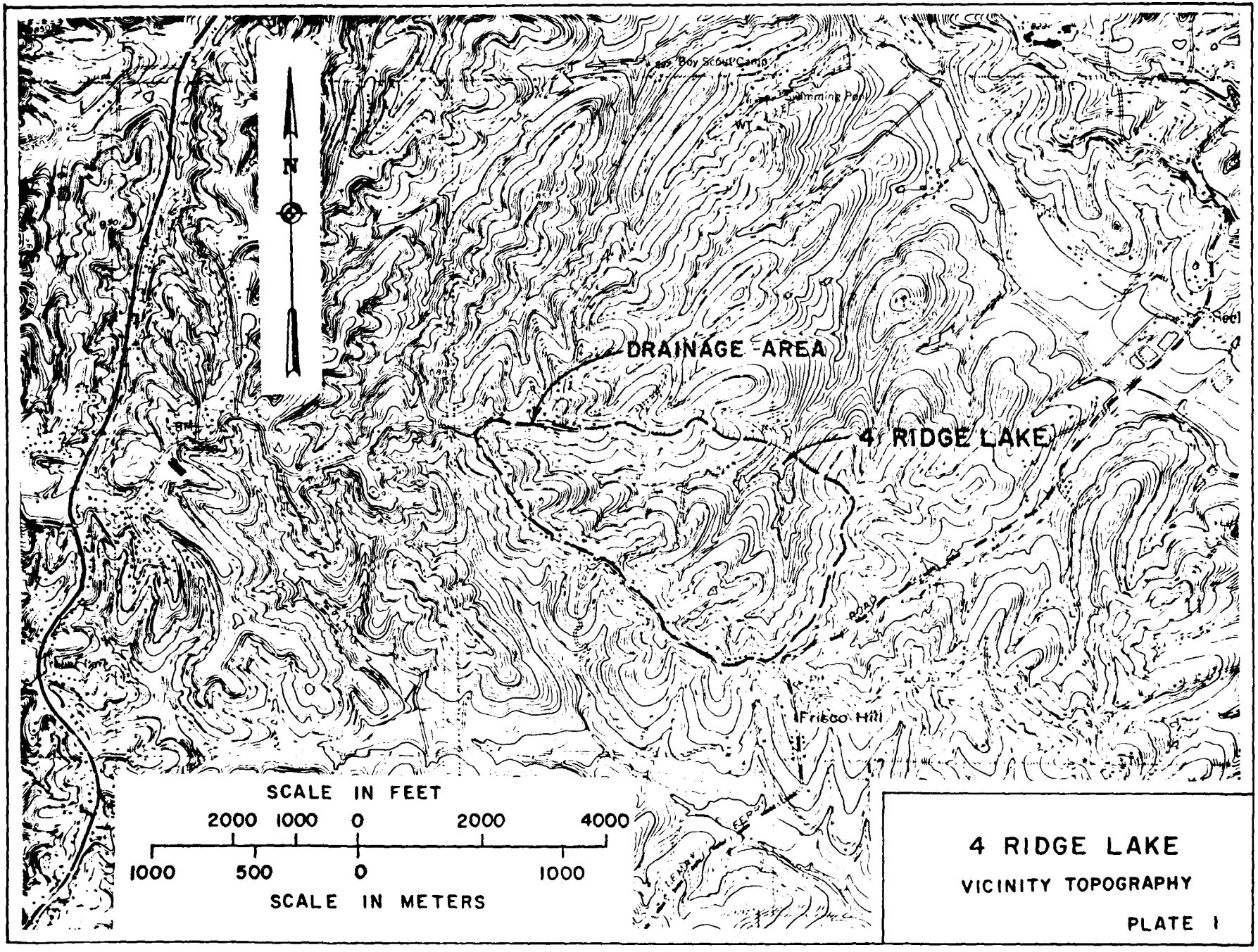
1

	SECNO	CWSEL	Q	K*XNCH	DIFWSX	AREA	VCH
	47.000	616.77	10.00	129.27	.05	16.30	.61
	47.000	617.82	100.00	87.02	.05	59.84	1.67
	47.000	618.26	200.00	69.50	.05	81.94	2.44
	47.000	618.98	500.00	40.89	.04	125.71	3.98
	47.000	619.78	1000.00	38.93	.04	181.57	5.51
	47.000	620.52	1500.00	37.93	.04	234.30	6.40
	60.000	616.85	10.00	125.70	.08	17.26	.58
	60.000	617.91	100.00	83.35	.09	61.39	1.63
	60.000	618.35	200.00	65.87	.09	83.55	2.39
	60.000	619.05	500.00	39.94	.07	126.30	3.96
	60.000	619.87	1000.00	38.82	.09	183.31	5.46
	60.000	620.60	1500.00	37.83	.09	235.54	6.37

	70.000	616.91	10.00	123.31	.06	17.24	.58
	70.000	617.97	100.00	80.85	.06	61.51	1.63
	70.000	618.41	200.00	63.38	.06	83.67	2.39
	70.000	619.10	500.00	39.86	.05	125.83	3.97
	70.000	619.94	1000.00	38.72	.06	183.88	5.44
	70.000	620.67	1500.00	37.73	.06	236.18	6.35
	80.000	616.95	10.00	121.67	.04	23.28	.43
	80.000	618.03	100.00	78.73	.06	76.79	1.30
	80.000	618.49	200.00	60.29	.08	102.79	1.95
	80.000	619.24	500.00	39.67	.14	148.79	3.36
	80.000	620.13	1000.00	38.45	.20	208.21	4.80
	80.000	620.85	1500.00	37.47	.19	256.04	5.86
	90.000	616.98	10.00	120.46	.03	23.70	.42
	90.000	618.07	100.00	77.09	.03	81.83	1.22
	90.000	618.53	200.00	58.58	.04	109.93	1.82
	90.000	619.30	500.00	39.59	.06	160.83	3.11
	90.000	620.26	1000.00	38.28	.13	229.51	4.36
	90.000	621.04	1500.00	37.21	.19	286.02	5.24
	100.000	617.02	10.00	119.48	.03	22.86	.44
	100.000	618.09	100.00	76.19	.03	82.81	1.21
	100.000	618.56	200.00	57.69	.03	111.87	1.79
	100.000	619.33	500.00	39.55	.03	164.71	3.04
	100.000	620.32	1000.00	38.20	.06	238.65	4.19
	100.000	621.13	1500.00	37.10	.08	298.99	5.02
€	110.000	617.05	10.00	118.08	.03	24.63	.41
	110.000	618.12	100.00	75.23	.03	84.27	1.19
	110.000	618.58	200.00	56.74	.02	113.42	1.76
	110.000	619.36	500.00	39.51	.03	166.93	3.00
DAM	110.000	620.35	1000.00	38.16	.03	240.64	4.16
	110.000	621.16	1500.00	37.06	.03	301.06	4.98
	120.000	617.06	10.00	80.00	.01	38.45	.26
	120.000	618.15	100.00	80.00	.03	128.64	.78
	120.000	618.64	200.00	80.00	.06	176.27	1.13
	120.000	619.52	500.00	80.00	.15	267.83	1.87
	120.000	620.63	1000.00	80.00	.28	393.29	2.54
	120.000	621.56	1500.00	80.00	.40	497.18	3.02

1

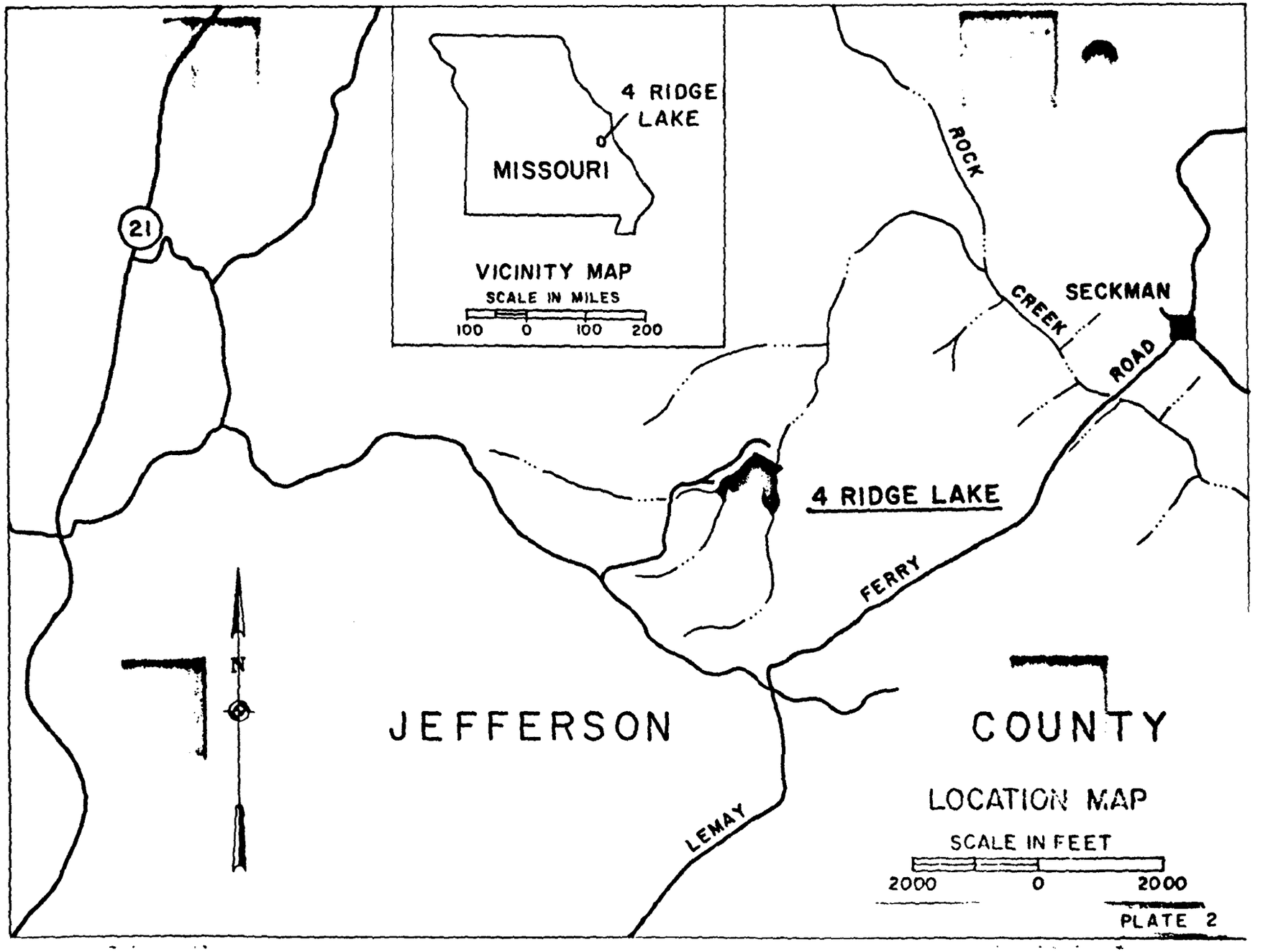
	SECNO	CWSEL	Q	K*XNCH	DIFWSX	AREA	VCH
IN	130.000	617.06	10.00	80.00	.00	329.10	.03
	130.000	618.17	100.00	80.00	.01	511.81	.20
LAKE	130.000	618.67	200.00	80.00	.03	594.72	.34
	130.000	619.59	500.00	80.00	.08	750.77	.67
	130.000	620.77	1000.00	80.00	.13	948.62	1.05
	130.000	621.74	1500.00	80.00	.18	1112.12	1.35

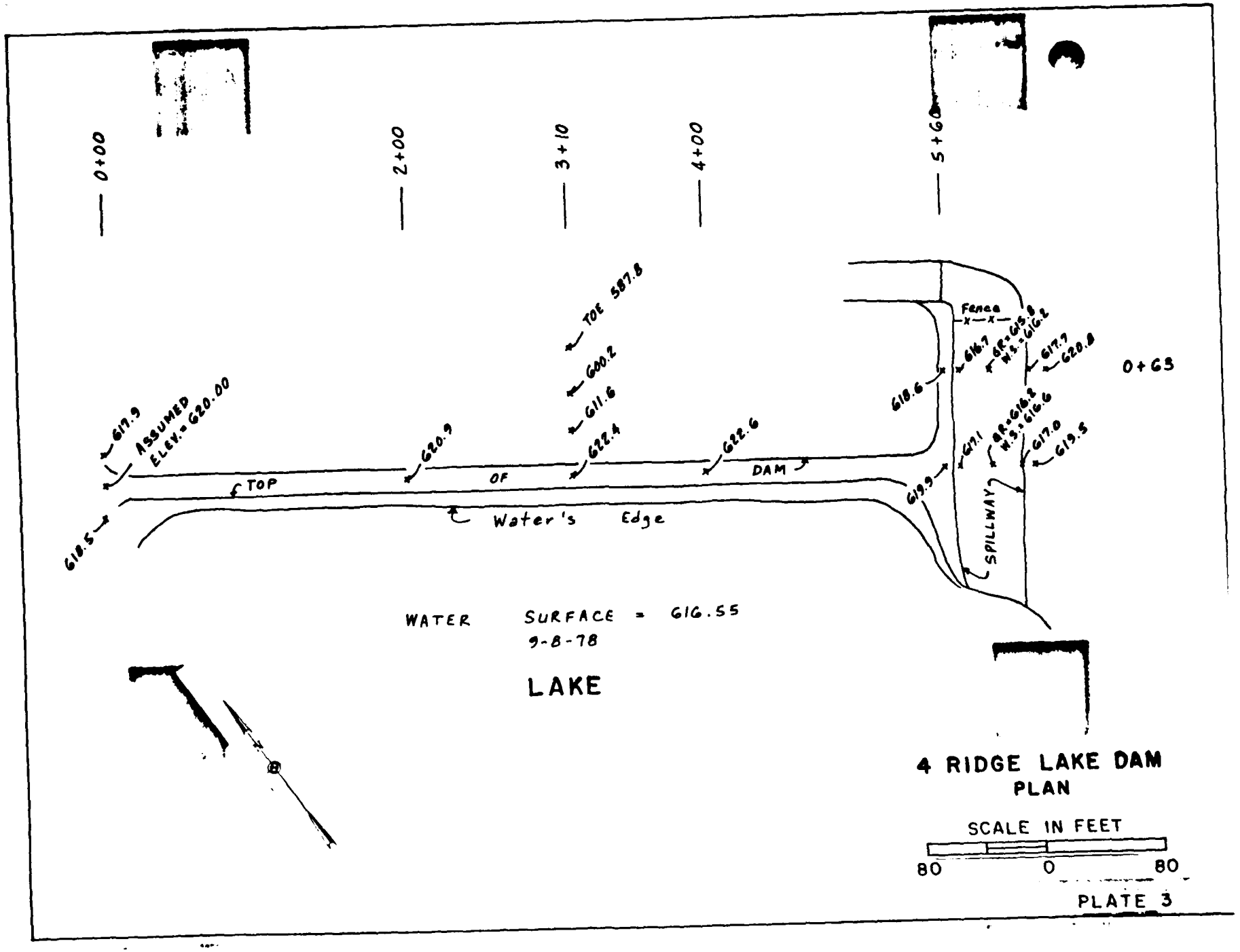


4 RIDGE LAKE

VICINITY TOPOGRAPHY

PLATE 1


4 RIDGE LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
21
ROCK
CREEK
SECKMAN
ROAD
4 RIDGE LAKE
FERRY
N
JEFFERSON
COUNTY
LEMAY
LOCATION MAP
SCALE IN FEET
2000 0 2000
PLATE 2


0+00
2+00
3+10
4+00
5+60
TOE 587.8
600.2
611.6
622.4
622.6
617.9
ASSUMED ELEV. = 620.00
620.9
618.5
℄ TOP OF DAM
℄ Water's Edge
618.6
Fence
616.7
617.7
620.8
0+65
617.1
617.0
619.5
619.9
SPILLWAY
WATER SURFACE = 616.55
9-8-78
LAKE
4 RIDGE LAKE DAM
PLAN
SCALE IN FEET
80
0
80
PLATE 3

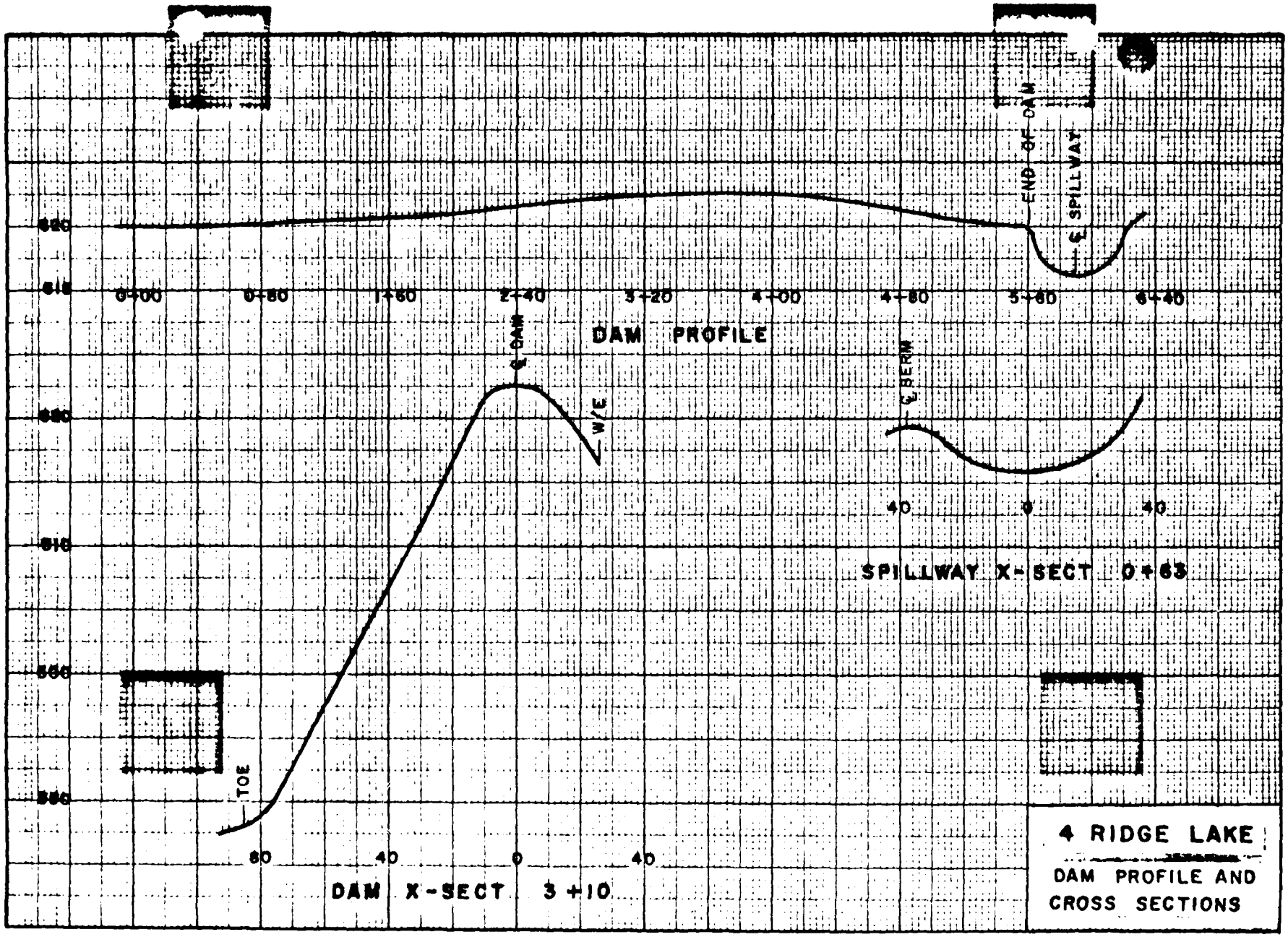

620
615
610
605
600
595
0+00
0+80
1+60
2+40
3+20
4+00
4+80
5+60
6+40
℄ DAM
W/E
DAM PROFILE
℄ BERM
℄ SPILLWAY
END OF DAM
40
0
40
SPILLWAY X-SECT 0+63
TOE
80
40
0
40
DAM X-SECT 3+10
4 RIDGE LAKE
DAM PROFILE AND
CROSS SECTIONS
PLATE 4

PHOTO 1: Upstream Slope Erosion

PHOTO 2: Downstream Slope Vegetation

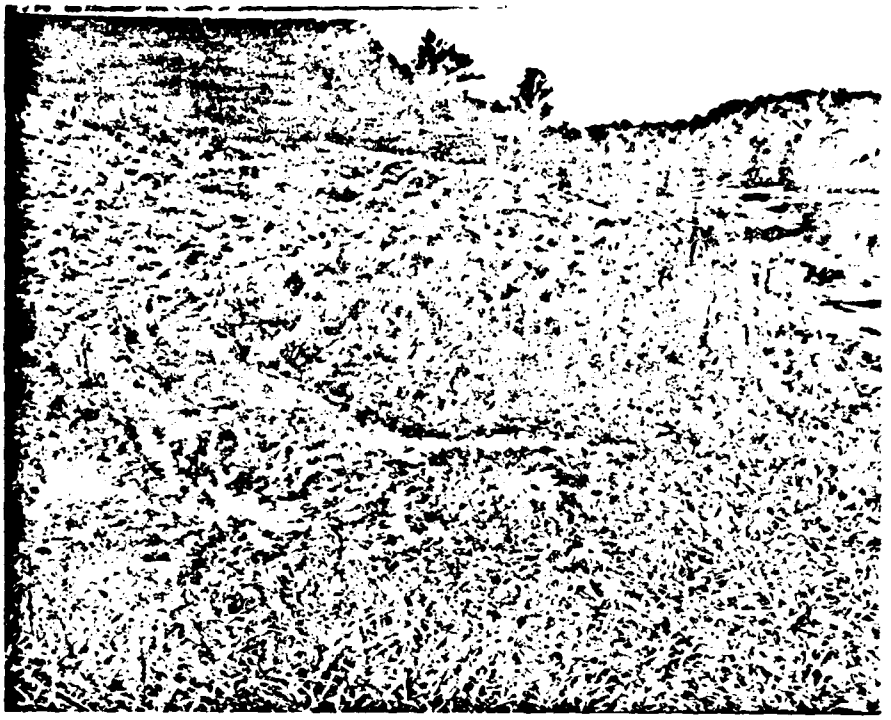


PHOTO 3: Spillway Vegetation (Upstream)

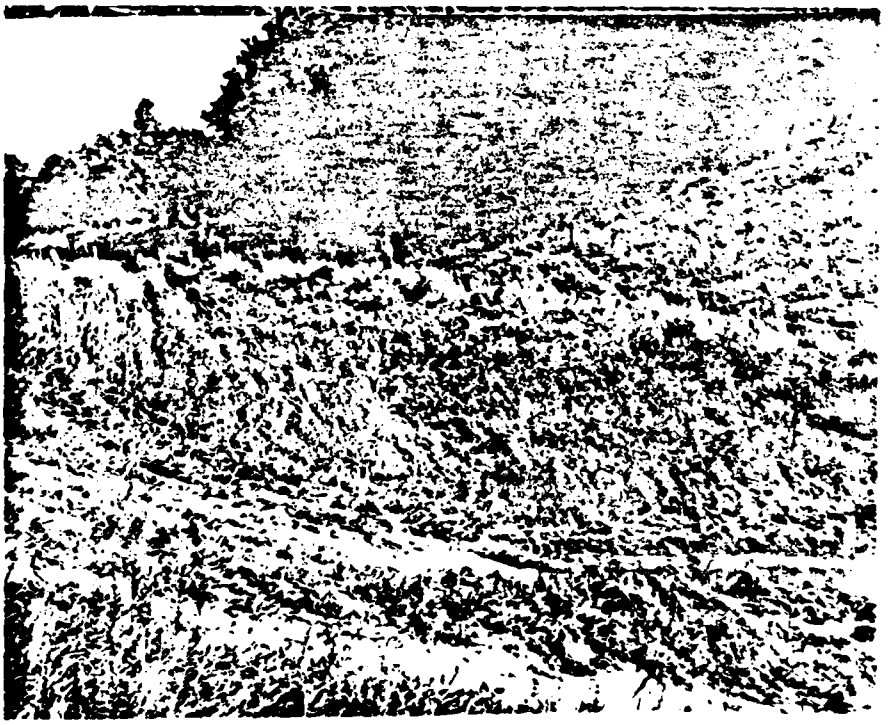


PHOTO 4: Spillway Vegetation (Downstream)

PHOTO 5: Spillway Erosion

PHOTO 6: Spillway Erosion