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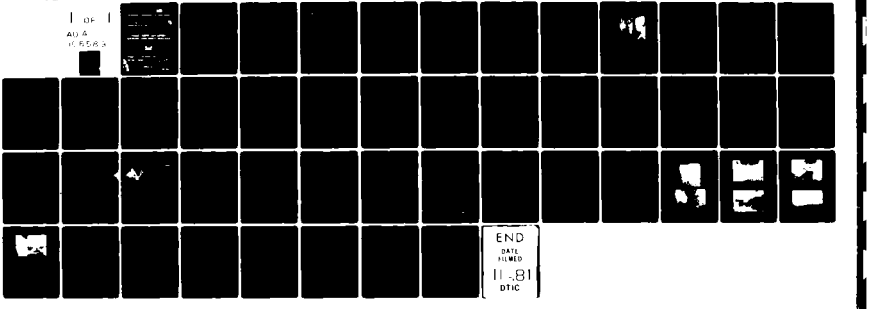

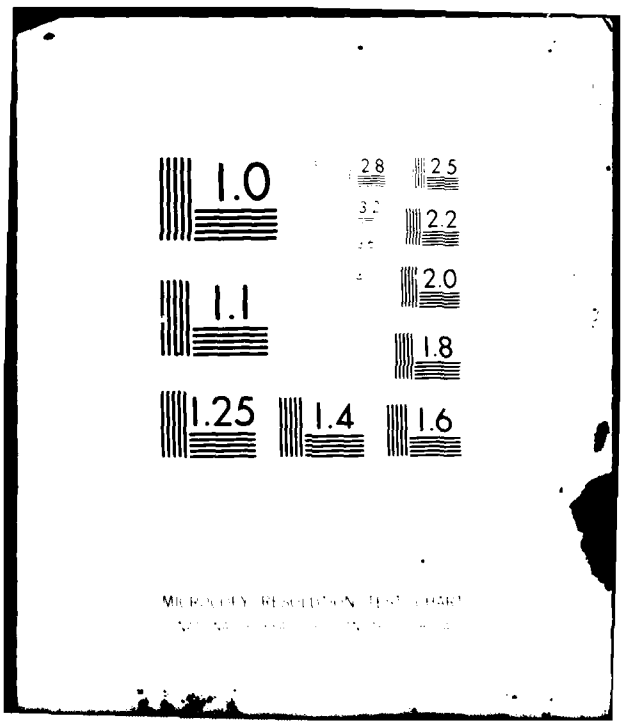
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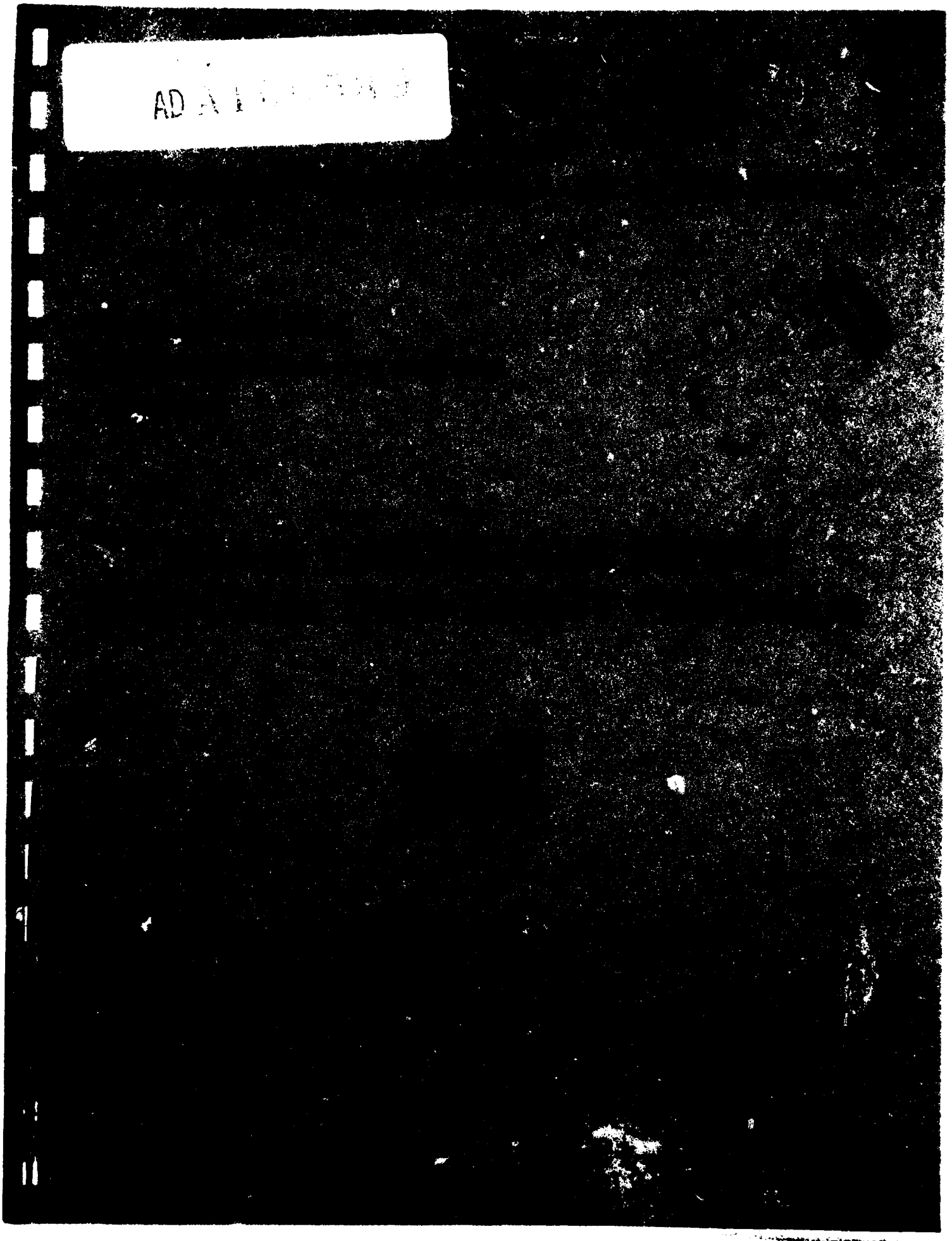

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Dam Safety, Lake, Dam Inspection, Private Dams

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

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

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

IN REPLY REFER TO

SUBJECT: Hornsey Lake Dam Phase I Inspection Report

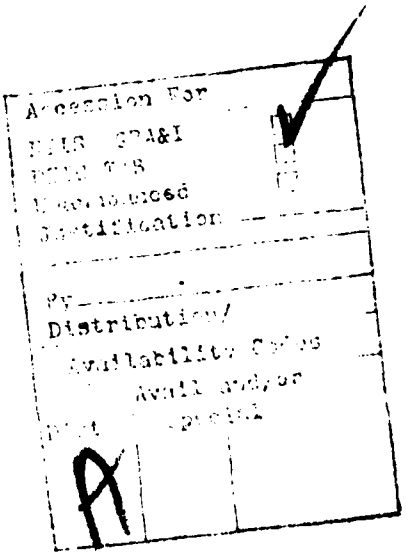
This report presents the results of a field inspection and an evaluation of the Hornsey Lake Dam.

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

The St. Louis District has classified this dam as unsafe, non-emergency because of the steep downstream embankment slope, lack of embankment stability analysis, unknown unique construction techniques of mine tailings dams, and lack of records.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 5 APR 1979
Date

APPROVED BY:
Colonel, CE, District Engineer — Date



HORNSEY LAKE DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30688

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

DECEMBER 1978

HS-7848-10

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Hornsey Lake Dam
State Located:	Missouri
County Located:	Washington
Stream:	Tributary Bates Creek
Date of Inspection:	23 August 1978

The Hornsey Lake Dam was visually inspected by engineering personnel of the office of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. The following deficiencies were noticed during the visual inspection and are considered to have an adverse effect on the overall safety and future operation of the dam and spillway:

1. A dense cover of small- to medium-size trees and brush that may conceal animal burrows exists on the upstream face of the dam. A few trees also exist on the downstream face along with patches of brush. Tree roots and animal burrows can provide a pathway for lake seepage that could develop into a piping condition and subsequent failure of the dam.

2. The upstream face of the dam is in an unkept state. The slope is protected from erosion by wave action by vegetation (grass, brush, trees, etc.). This form of protection is not considered adequate to protect the slope against erosion by wave action. Erosion of the slope will reduce the cross section of the dam and could result in instability and/or overtopping of the dam.

3. The crest width of the dam is non-uniform and varies from approximately 60 feet to more than 100 feet, The downstream embankment slope varies but is generally on the order of 1v on 1.4h. Steep slopes are considered detrimental due to the fact that the embankment may become statically unstable, particularly during an earthquake.

4. The course of the spillway outlet channel is not readily discernible due to the existence of dense brush and trees that begin at the end of the spillway control section. High spillway releases will probably result in indiscriminate flooding of the downstream face of the dam and erosion of the slope.

According to the criteria set forth in the recommended guidelines (see text) the minimum spillway design flood for this dam, which is classified as intermediate in size and of high hazard potential, is specified to be the Probable Maximum Flood (PMF). PMF is the flood that may be expected from the most severe combination of critical meteoroligic and hydrologic conditions that are reasonably possible in the region. Results of a hydrologic/hydraulic analysis indicated that the existing spillway is inadequate to pass the lake outflow resulting from a storm of PMF magnitude without overtopping the dam. It is capable of passing the lake outflow resulting from the 1 percent chance (100-year frequency) flood and the lake outflow corresponding to approximately 61 percent of the PMF without overtopping the dam. The length of the downstream damage zone, should failure of the dam occur, is estimated to be six miles.. There are eight to ten homes and associated buildings, two county roads, and two small dams within the first two miles downstream of the dam.

A review of available data did not disclose that seepage and stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

Inquiries made of the builders of the dam did not disclose, in sufficient detail, the materials used or the methods employed in the construction of the

dam, nor the elevation to which it was originally built. Further, other than to state that the dam was raised after being overtopped in 1957 and that the fill material was placed hydraulically, the builders supplied little information regarding the type of material used except that it consisted of mine tailings.

It is recommended that the Owner take prompt action in the near future to correct or control the deficiencies and safety defects reported herein. In order to insure the safety of the dam, the Owner is advised to proceed without delay with the necessary investigations to determine the embankment materials and, utilizing this data, perform seepage and stability analyses for appropriate loading conditions, including earthquake loads.

Albert B. Becker, Jr.
P.E. Missouri E-9168

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HORNSEY LAKE DAM - ID NO. 30688

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

HORNSEY LAKE DAM - ID NO. 30688

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. National Dam Inspection Act, Public Law 92-367, dated 8 August 1972.

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

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Hornsey Lake Dam is an earthfill type embankment having a length of approximately 1,100 feet and rising approximately 66 feet above the original stream bed. The crest width is non-uniform and varies from about 60 feet to more than 100 feet. In general and at the location surveyed, the upstream face of the embankment has a slope of 1v on 2.1h from the crest of the dam to an elevation approximately 6.5 feet below the crest, at which point it continues to the waterline at a relatively flat slope of approximately 1v on 180h. (At the time of the inspection a heavy, dense cover of brush and trees was present on the upstream face of the dam. This cover limited the data that could reasonably be obtained by survey during the time allocated. It is recognized that other areas of the dam may

exist where the slope of the upstream face of the dam differs appreciably from that reported herein. Since the dam is about 66 feet high above the original stream bed, and since the slope of the upstream face as surveyed becomes near flat at a point only 6.5 feet below the dam crest, there is considerable doubt as to the actual slope of the upstream face below the lake surface and the extent to which the dam continues in the lake direction.) The downstream face of the embankment has a varying slope but is generally on the order of 1v on 1.4h. The downstream slope of the dam is, for the most part, covered with rock ranging in size from small gravel to large boulders. The lake level is governed by an uncontrolled spillway which has been cut into rock at the left abutment. The spillway channel is U-shaped and has a bottom width of approximately 40 feet. The improved section of the spillway outlet channel terminates approximately 135 feet downstream of the spillway crest where the channel meets the hillside at the left abutment. Spillway releases must continue down the hillside until the flow reaches the original stream immediately downstream of the dam. At normal pool elevation the lake surface occupies approximately 80 acres. There are no drawdown facilities to dewater the lake.

According to the 1958 Potosi, Missouri, Quadrangle Map, a second dam, with a lake about 3 acres in surface area and a drainage area of 150 acres, is located approximately 1,500 feet upstream. Since the maximum storage capacity of the lake is estimated to be only about 8 acre feet, this lake is considered too small to be of any consequence as far as safety of the dam is concerned.

b. Location. The dam and lake are located on an unnamed tributary of Bates Creek, approximately 1 mile southwest of Potosi, Missouri, in Washington County, as shown on the Regional Vicinity Map, Plate 1. The dam is located in Section 15, Township 37 North, Range 2 East, approximately 2 miles west of the intersection of State Route 8 and State Route 21.

c. Size Classification. The size classification, based on the height of the dam and/or storage capacity, is categorized as intermediate. (Per Table 1, Recommended Guidelines for Safety Inspection of Dams.)

d. Hazard Classification. According to the St. Louis District, Corps of Engineers, the Hornsey Lake Dam has a high hazard potential, meaning that the

dam is located where failure may cause loss of life, serious damage to homes, agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, has been determined by the St. Louis District to extend six miles downstream of the dam. There are eight to ten homes and associated buildings, two county roads, and two small dams within the first two miles downstream of the dam.

e. Ownership. The lake and dam are currently owned by RLC Investments, Inc., 612 West 47th Street, Kansas City, Missouri, 64112. Mr. Thomas Smith is president of the corporation.

f. Purpose of Dam. The dam was originally constructed to impound washwater for a barite mining operation, owned by NL Industries. The mining operation was discontinued and the property was abandoned in 1965. The lake, dam, and surrounding property was sold by NL Industries in late 1974 to RLC Investments, Inc., the parent company of United Farm Real Estate Agencies. The investment company purchased the property for speculation purposes and, at present, is offering the lake, dam, and 400 acres of land surrounding the lake for sale.

g. Design and Construction History. According to Mr. Mel Means, a local real estate agent for the United Farm Agency in Potosi, the dam was constructed in 1949 for NL Industries by the Hornsey Brothers Mining Company. The material used to construct the embankment consists of clay and rock stripped in the exploration of barite. The dam was breached in 1957 causing the level of the lake to drop approximately 15 to 20 feet. The eroded portion of the dam was repaired and the dam height increased by the mining company that same year. The material for the repairs and for raising the dam was placed hydraulically by pumping waste clay and rock from nearby tailing ponds. The relatively flat slope on the upstream side of the dam was a result of the method by which the material was placed to increase the height of the dam.

According to a representative of the Owner, no design data are available.

h. Normal Operational Procedures. The lake level is unregulated.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is, for the most part, undeveloped and in a natural state; i.e., covered with timber. The watershed above the dam amounts to approximately 655 acres. The watershed area is outlined on Plate 1.

b. Discharge at Damsite.

(1) Estimated maximum flood at damsite ... Unknown(1)

(2) Spillway capacity ... 2,340 cfs

c. Elevation (ft. above MSL). The top of the dam at a point adjacent to the right side of the rock spillway channel at the centerline of the dam crest was assumed to be elevation 970, the basis for this assumption being the elevation for the top of the dam shown on the 1958 Potosi, Missouri, Quadrangle Map, 7.5 minute series.

(1) Top of dam ... 968.1 (min.)

(2) Normal pool (spillway crest) ... 962.4

(3) Streambed at centerline of dam ... 902±

(4) Maximum tailwater ... Unknown

(5) Pool on date of inspection ... 962.0

d. Reservoir.

(1) Length of normal pool (elevation 962.4) ... 2,800 ft.

(2) Length of maximum pool (elevation 968.1) ... 3,400 ft.

e. Storage.

(1) Normal pool ... 1,250 ac.ft.(2)

(2) Top of dam (incremental) ... 500 ac.ft.

(1) According to a representative of the Owner, the dam was overtopped in 1957. However, no record of lake level or height of dam at that time is available.

(2) Storage volume at normal pool based on lake surface area considering upstream face of dam slopes uniformly from top of dam to bottom of lake.

f. Reservoir Surface.

(1) Top of dam ... 96 acres

(2) Normal pool ... 80 acres

g. Dam.

(1) Type ... Earthfill and mine tailings (per Owner)

(2) Length ... 1,100 ft.

(3) Height ... 66 ft.

(4) Top width ... 60 ft. min. (varies)

(5) Side slopes[1]

a. Upstream ... 1v on 2.1h (upper), 1v on 180h (lower)[2]

b. Downstream ... 1v on 1.4h

(6) Cutoff ... Unknown

(7) Slope protection

a. Upstream ... Trees and brush

b. Downstream ... Gravel, boulders

h. Spillway ... Rock cut, U-section, 40 foot bottom width.

i. Outlet for Lake Drawdown ... None provided.

(1) Per survey data for dam cross section at point approximately 340 feet from centerline of spillway.

(2) Change in slope occurs about 6.5 feet below top of dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No engineering data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

No formal records were kept during the construction of the dam. The material used to construct the embankment consists of overburden (clay, gravel and boulders) stripped in the exploration for barite.

According to a representative of the Owner, the dam was breached in 1957. The eroded area of the dam was repaired and the top of the dam raised in that same year. The material used to repair the dam and raise the dam consisted of waste material (tailings) from the barite mining operation. Mine waste was pumped from the tailing ponds and onto the dam. The tailings were allowed to flow down the upstream face of the dam, which decreased the slope of the embankment to something on the order of 1v on 180h at the location surveyed at the time of the inspection. Examination of the dam and lake overview photograph taken by the St. Louis Corps of Engineers apparently indicates the upstream face to be steeper in the area to the right of the dam center since the lake is nearer the top of the dam than it is in the area to the left of center.

An inspection of the lake and dam was made by the Missouri Geologic Survey in 1970 for the Missouri Conservation Commission. A copy of the resulting report (reference Chart 2-1), indicating the condition of the dam at that time, is presented herein.

2.3 OPERATION

The lake level is governed by an uncontrolled, excavated rock spillway. The dam was overtopped and breached in 1957 which effected the lake level to

drop approximately 20 feet. The elevation of the top of the dam at the time the dam was overtopped is unknown.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the earthfill dam and spillway were unavailable.

b. Adequacy. No data 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. These seepage and stability analyses should be performed by a qualified engineer for appropriate loading conditions and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the dam and spillway was made by Horner & Shifrin engineering personnel on 23 August 1978. Also inspected at this time was the area downstream from the dam, including the various downstream road crossings and homes for a distance of approximately six miles. Photographs of the dam and spillway taken at the time of the inspection are included on Pages A-1 thru A-4 of the Appendix.

b. Dam. The visible portions of the upstream and downstream slopes of the dam appeared to be in sound condition. A dense cover of brush and small- to medium-size trees exists on the upstream slope of the dam (see Photo 3). The material at the surface of the dam crest and upstream face of the dam appeared to be a clay type soil of low to medium plasticity that, in the flat area that lies below the point where the change in slope occurs (i.e., 6.5 feet below the top of the dam), was very soft and wet. At the time of the inspection and at the location surveyed, the lake surface was approximately 7.6 feet below the top of the dam, which corresponds to about 0.4 feet below the spillway crest. A few trees exist on the downstream slope (see Photos 1 and 2) along with patches of brush. The downstream slope also has a covering of rock which appeared to be waste material from the defunct mining operation. The rock material ranges in size from small gravel to boulders which were estimated to weigh about 200 pounds (see Photos 2 and 4). Fine grained material, where present, appeared to be a clay of low plasticity. The crest of the dam is non-uniform and varies in width from approximately 60 feet to more than 100 feet. A gravel road traverses the top of the dam and crosses the spillway crest (see Photo 5). The top of the dam was found to be 2.4 feet lower at a location near the right abutment than the top of the dam near the center. A profile of the dam crest centerline extending through the spillway section is shown on Plate 2.

c. Spillway. The spillway, consisting of a U-shaped, broad-crested section with a 40 foot bottom width, is cut in rock at the left abutment. A

dense growth of small- to medium-size trees exists at the lake approach (see Photo 6) to the spillway crest. The improved section of the spillway outlet channel terminates approximately 135 feet downstream of the spillway crest (see Photo 7) where the channel meets the hillside. Beyond this point the channel is not readily discernible but apparently continues down and along the hillside reaching the original stream immediately downstream of the dam. A profile of the spillway channel from the crest to the downstream end of the improved section is shown on Plate 2.

d. Downstream Channel. The downstream channel is unimproved. The stream joins Bates Creek approximately 2,000 feet downstream of the dam.

e. Reservoir. The area around the lake appeared to be in satisfactory condition. The banks were generally covered with dense brush and trees. No appreciable amount of sedimentation was observed in the readily accessible areas at the upstream end of the lake.

3.2 EVALUATION

The deficiencies observed during this inspection are not considered of major consequence to warrant immediate remedial action. The entire upstream face of the dam should be re-examined to determine its condition after removal of the heavy cover of trees and brush. A more thorough examination, by an engineer experienced in the design and construction of dams, should be made of the downstream slope after the trees and brush are removed. The removal work should be performed in a manner which will not disturb existing turf cover on the upstream slope of the dam. The rock cover existing on the downstream slope of the dam should be restored where disturbed by tree and brush removal.

Examination of the dam, to the extent possible during the inspection, did not reveal the elevation of the top of the dam prior to its being raised in 1957 by the previous owners.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The water surface level is governed by rainfall runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM AND SPILLWAY

Based on the dense cover of trees and brush on the upstream slope of the dam and the trees and brush on the downstream slope of the dam, it is apparent that the dam receives very little attention. According to a representative of the Owner, no maintenance work has been performed on the dam or spillway since the property was acquired.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet operating facilities exist at this dam, nor is there a drawdown pipe to dewater the lake.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam warning system.

4.5 EVALUATION

Lack of maintenance is considered detrimental to the safety of the dam. It is recommended that maintenance of all areas of the dam and spillway be undertaken on a regular basis.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were measured from the 1958 USGS Potosi Missouri Quadrangle Map. The proportions and dimensions of the spillway and dam were determined from surveys made during the inspection.

c. Visual Observations.

(1) The crest of the excavated rock spillway section is in good condition. A dense growth of small to medium-size trees is located in the approach to the spillway.

(2) Facilities to dewater the lake do not exist.

(3) The spillway and outlet channel are located in the left abutment of the dam. Spillway releases, within the capacity of the spillway section, will not endanger the integrity of the dam.

(4) The top of dam varies approximately 2.4 feet between low and high elevations.

d. Overtopping Potential. The spillway section is inadequate to pass the probable maximum flood. The spillway section will pass the lake outflow resulting from the 1/2 probable maximum flood and the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of a dam overtopping analysis are as follows:

Ratio of PMF	Q - Peak Outflow (cfs)	Max. Lake Water Surface Elev.	Max. Depth of Flow Over Dam (Elev. 968.1)	Duration of Overtopping of Dam (Hours)
0.50	1,770	967.4	0	0
0.61	2,340	968.1	0	0
1.0	6,250	970.0	1.9	2.7
100-Year Flood	455	965.8	0	0

The flow safely passing the spillway just prior to overtopping amounts to about 2,000 cfs, which is the outflow corresponding to about 61 percent of the probable maximum flood inflow and exceeds the outflow from the 1 percent chance (100-year frequency) flood.

Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow over the spillway and the dam crest are presented on Pages B-1 and B-2 of the Appendix. A listing of the HEC-1 (Dam Safety Version) input data is shown on Pages B-3 through B-6 of the Appendix. A copy of the computer output tables entitled "Summary of Dam Safety Analysis" is presented on Page B-7 of the Appendix.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to the Owner, no records have been kept of lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to a representative of the Owner, the only post construction change made that may affect the structural stability of the dam consisted of raising the dam after it was overtopped and breached in 1957.

e. Seismic Stability. Based on the steep downstream slope, lack of stability analysis, and unknown unique construction procedures of mine tailings dam, a judgment as to the effect of an earthquake on this dam cannot be made until completion of a Phase II investigation.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated the excavated rock spillway to be capable of passing lake outflow of about 2,340 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the runoff from the lake watershed area, as discussed in Section 5, indicated that for a storm runoff of probable maximum flood magnitude, the lake outflow would be on the order of 6,250 cfs, which would result in a 1.9 foot maximum depth of flow over the crest of the dam. For the 1 percent chance (100-year frequency) flood, the lake outflow would be about 455 cfs.

Several items were noticed during the visual inspection which adversely affect the safety of the dam. These items are the trees and dense brush which exist on the upstream and downstream slopes and the unusually steep (1v on 1.4h) downstream slope.

Investigations made during the inspection did not disclose that stability and seepage analyses of the dam had been performed.

b. Adequacy of Information. Due to the lack of engineering and construction data, the assessments reported herein were based largely on external conditions as determined during the visual inspection. Those recommendations with regard to the hydrology of the lake and the capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The items concerning the safety defects noted in paragraph 7.1a and the remedial measures recommended in paragraph 7.2 should be accomplished without delay.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is recommended.

e. Seismic Stability. Based on the steep downstream slope, lack of stability analysis, and unknown unique construction procedures of mine tailings dam, a judgment as to the effect of an earthquake on this dam cannot be made until completion of a Phase II investigation.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, alterations to the design of the dam should be made in order to pass lake outflow resulting from a storm of probable maximum flood magnitude by providing enlarged, erosion-resistant spillway and/or raising the dam's non-overflow section to provide additional freeboard.

(2) Obtain the necessary soil data and perform stability and seepage analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a competent professional engineer experienced in the design and construction of dams.

b. Operation and Maintenance (O & M) Procedures. The following O & M procedures are recommended:

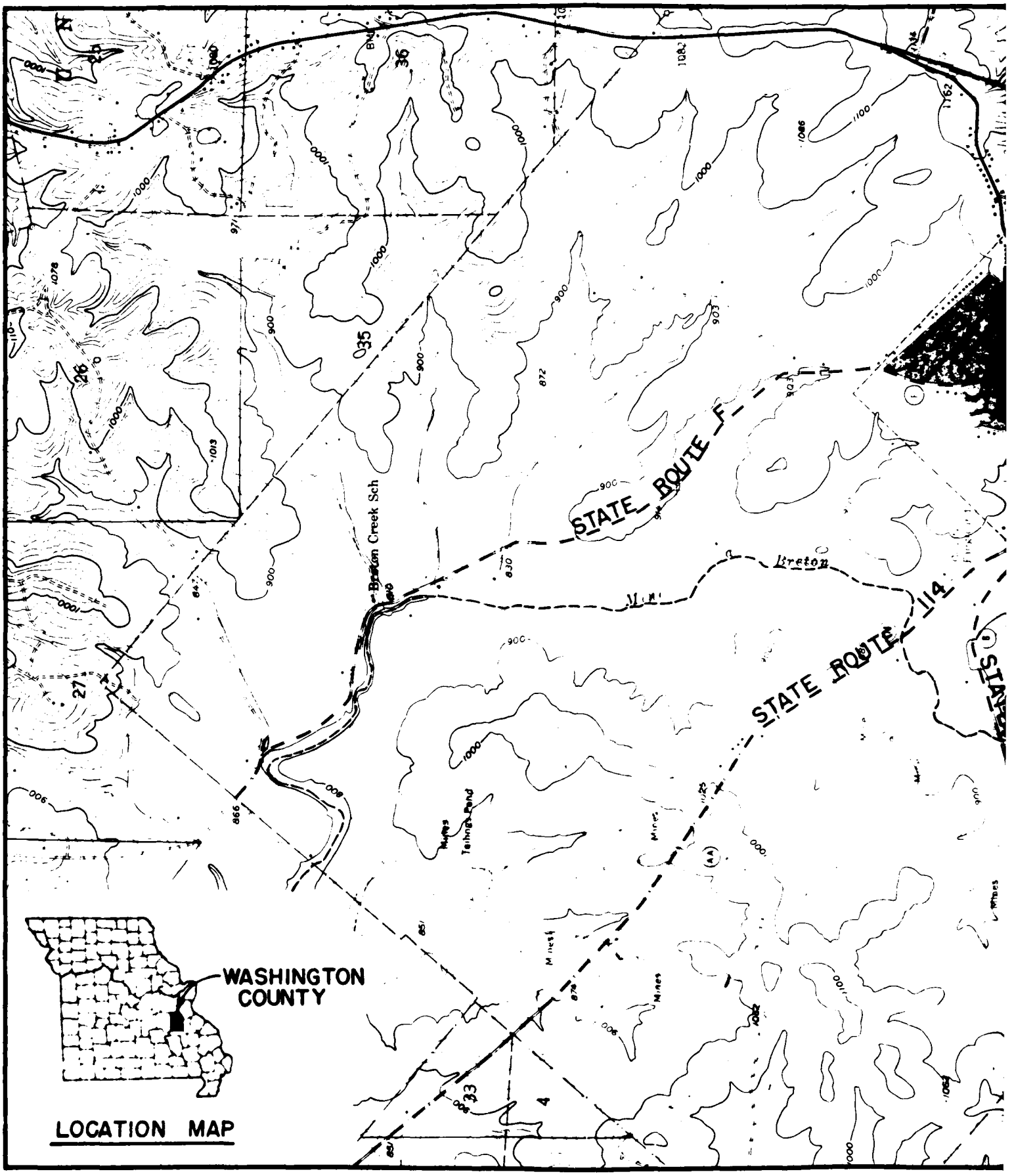
(1) Remove the trees and brush that may conceal animal burrows from the upstream and downstream slopes of the dam. Holes from tree roots and voids created by animal burrows provide a pathway for seepage that can lead to a piping condition and potential failure. The existing ground surface and turf or rock cover should be restored if destroyed or missing. Maintain the turf cover on the slope at a height that will not hinder inspection of the slopes or provide cover for burrowing animals.

(2) Remove the trees and brush present in the upstream area at the approach to the spillway in order to allow flow to enter the spillway unrestricted.

(3) Provide some form of slope protection for the upstream face of the dam at and above the normal waterline in order to prevent eroison by wave action.

(4) Improve the spillway outlet channel in the area between the crest and the downstream channel in order to confine spillway releases to the channel and prevent indiscriminate flooding of the downstream face of the dam.

(5) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.


STATE ROUTE F
STATE ROUTE 114
Breton Creek Sch
Breton
Mines
Tailings Pond
WASHINGTON COUNTY
LOCATION MAP

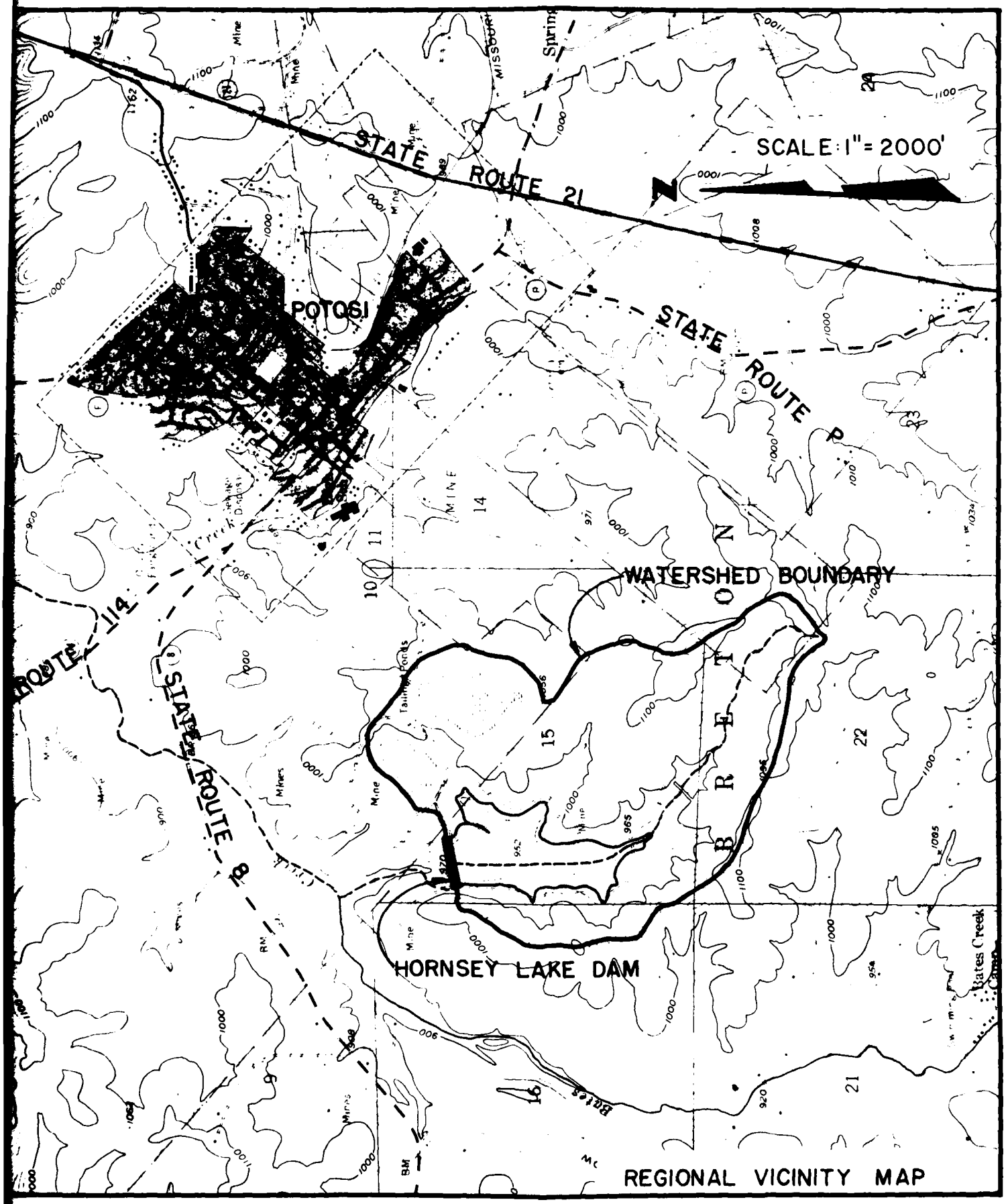
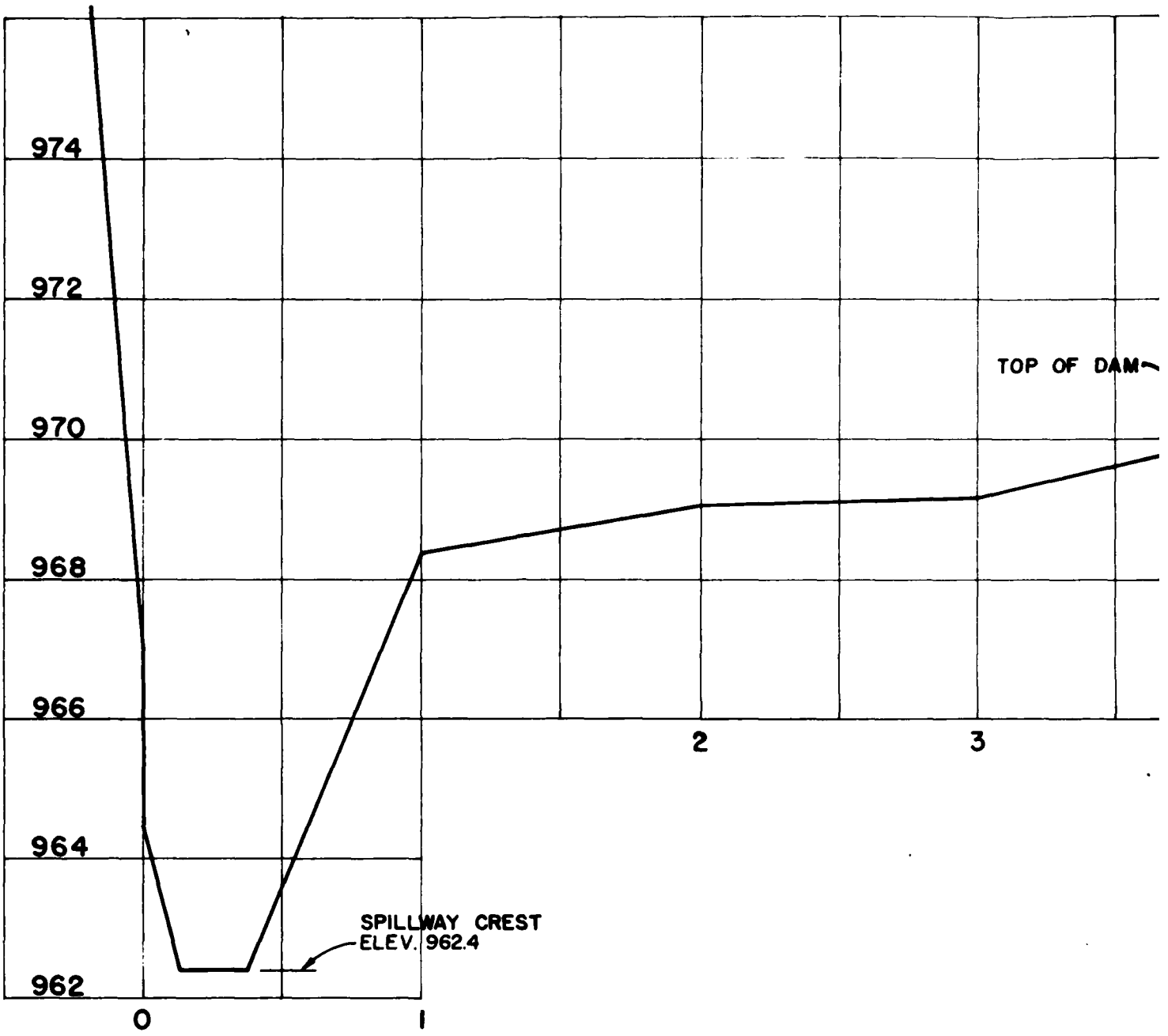
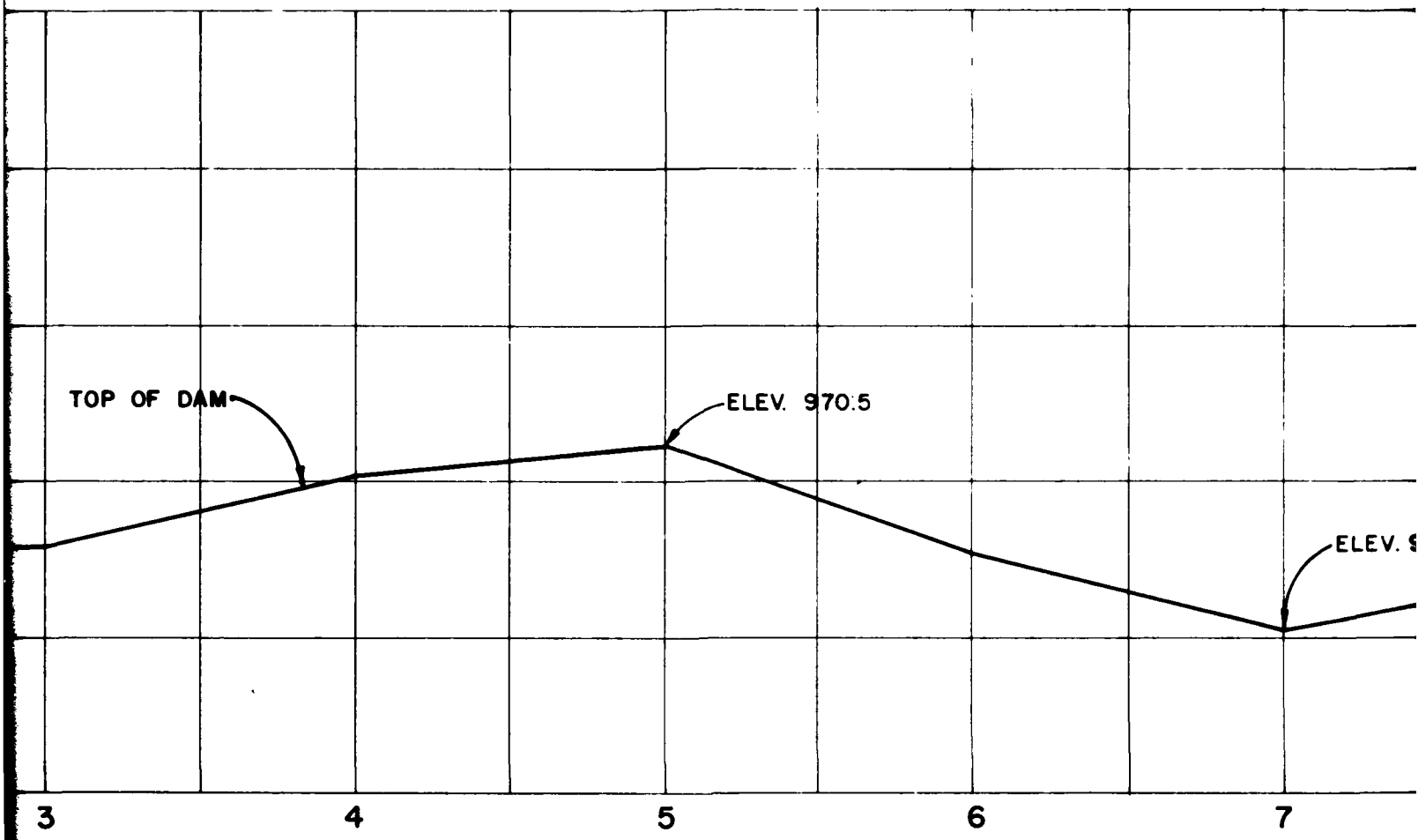
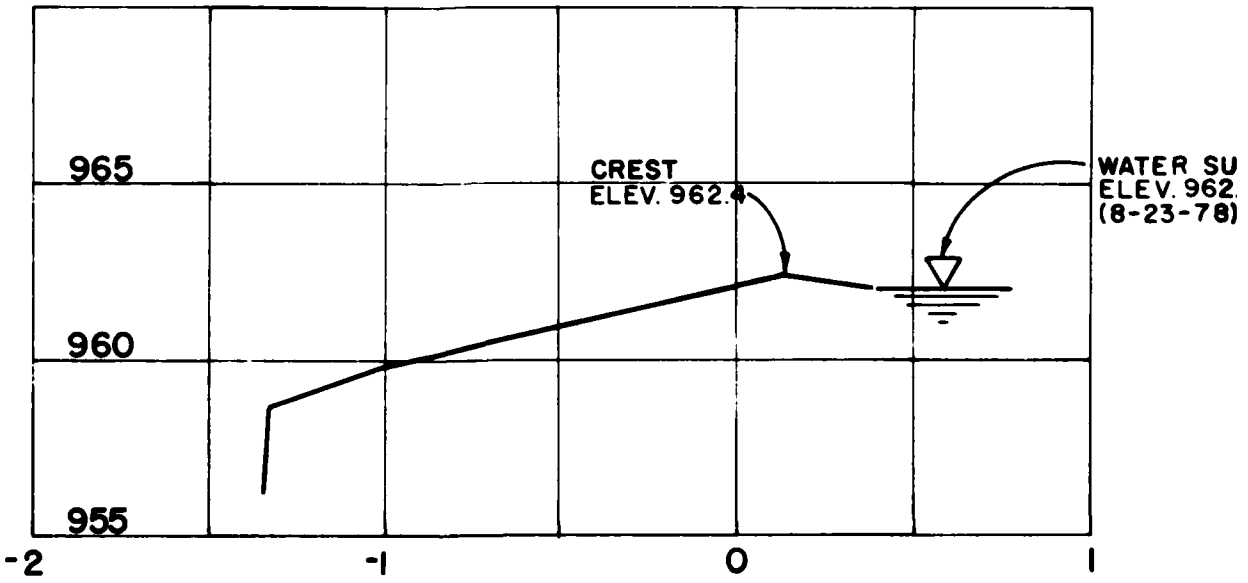

SCALE: 1" = 2000'
STATE ROUTE 21
STATE ROUTE P
STATE ROUTE 8
ROUTE 114
POTOSI
WATERSHED BOUNDARY
HORNSEY LAKE DAM
BRETZ RUN
REGIONAL VICINITY MAP

PLATE 1

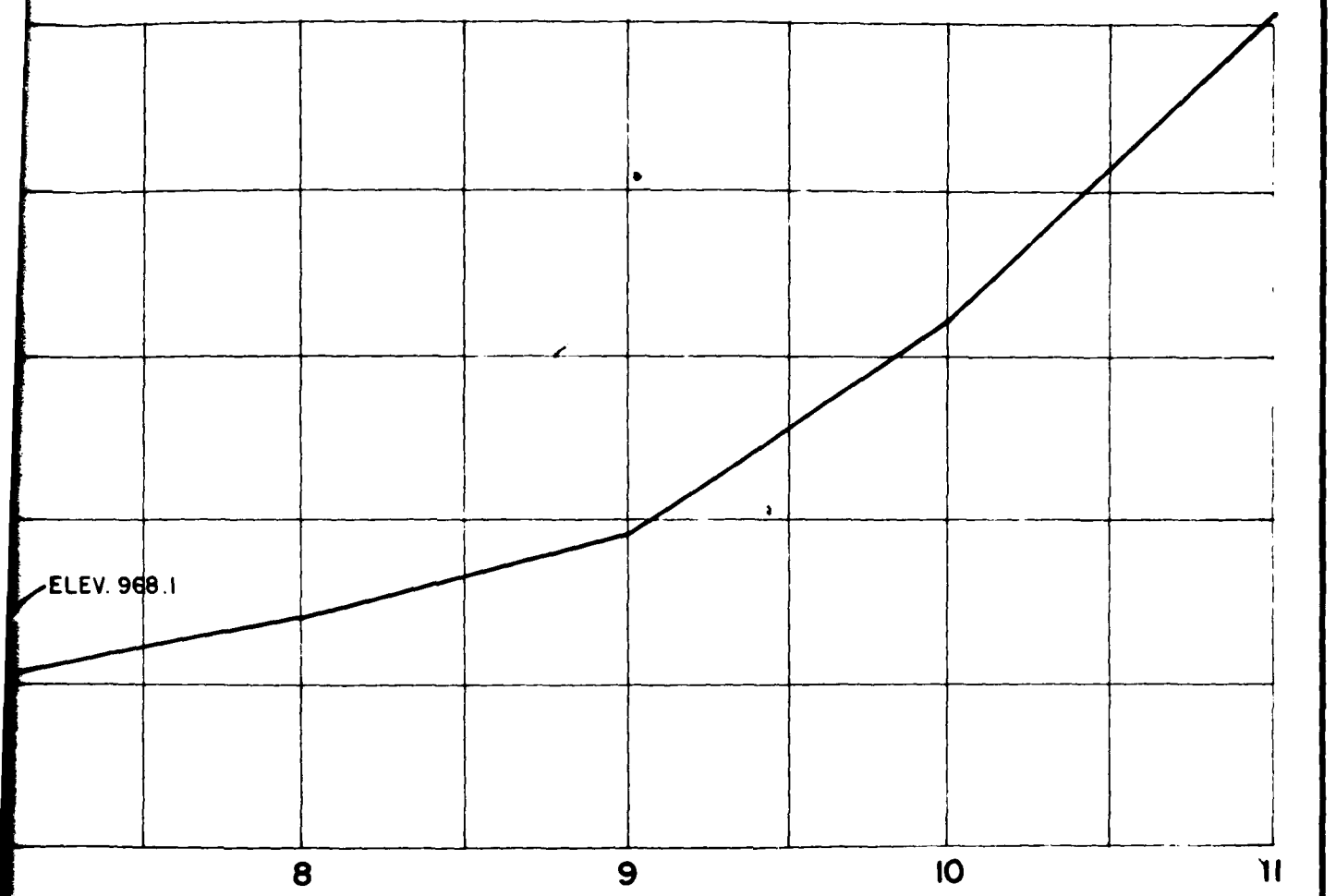

974
972
970
968
966
964
962
0
1
2
3
TOP OF DAM
SPILLWAY CREST
ELEV. 962.4



PROFILE DAM CREST
SCALES: 1" = 2' V., 1" = 50' H.



PROFILE SPILLWAY ℄
SCALES: 1" = 5' V., 1" = 50' H.



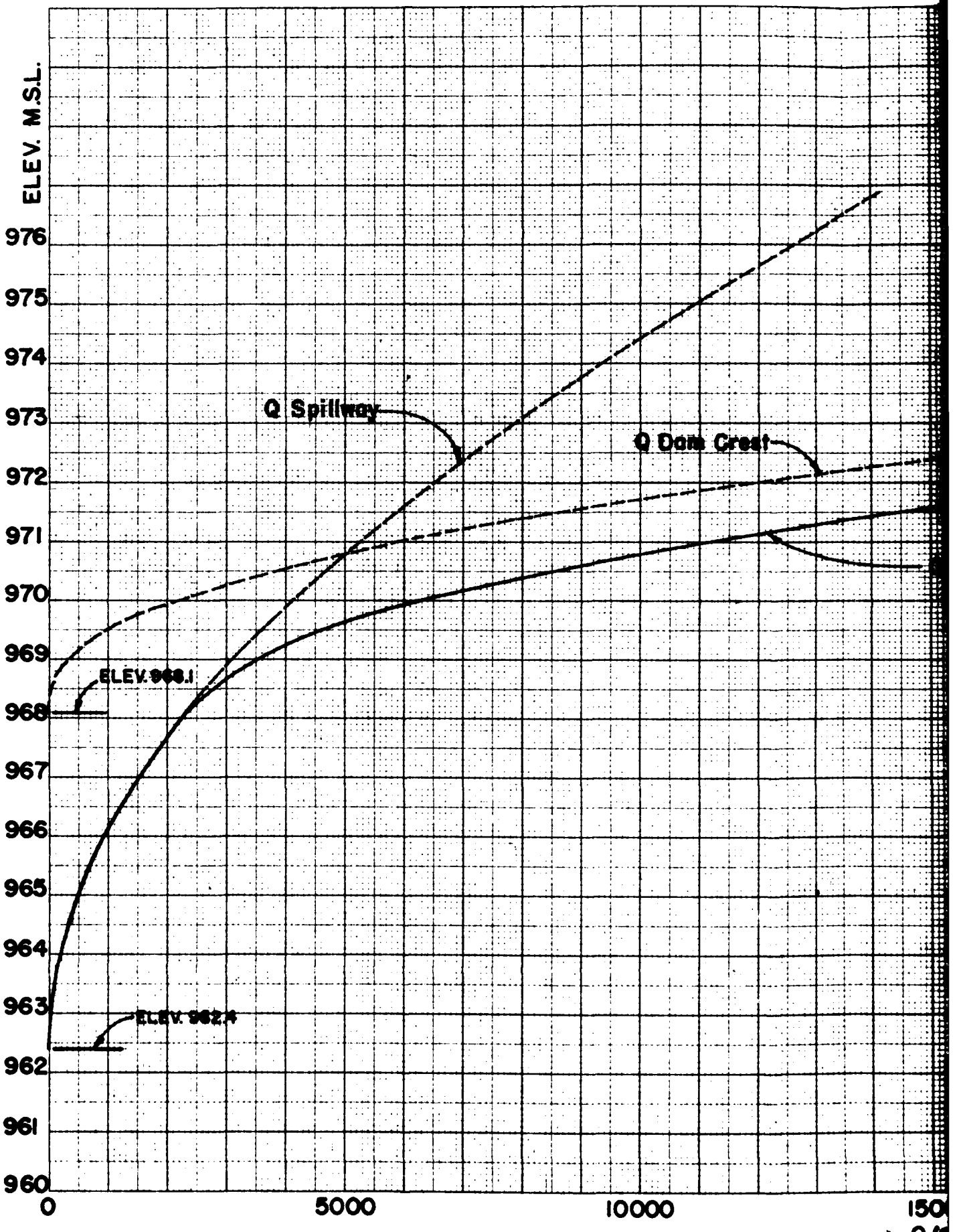
ATER SURFACE
LEV. 962.0
-23-78)

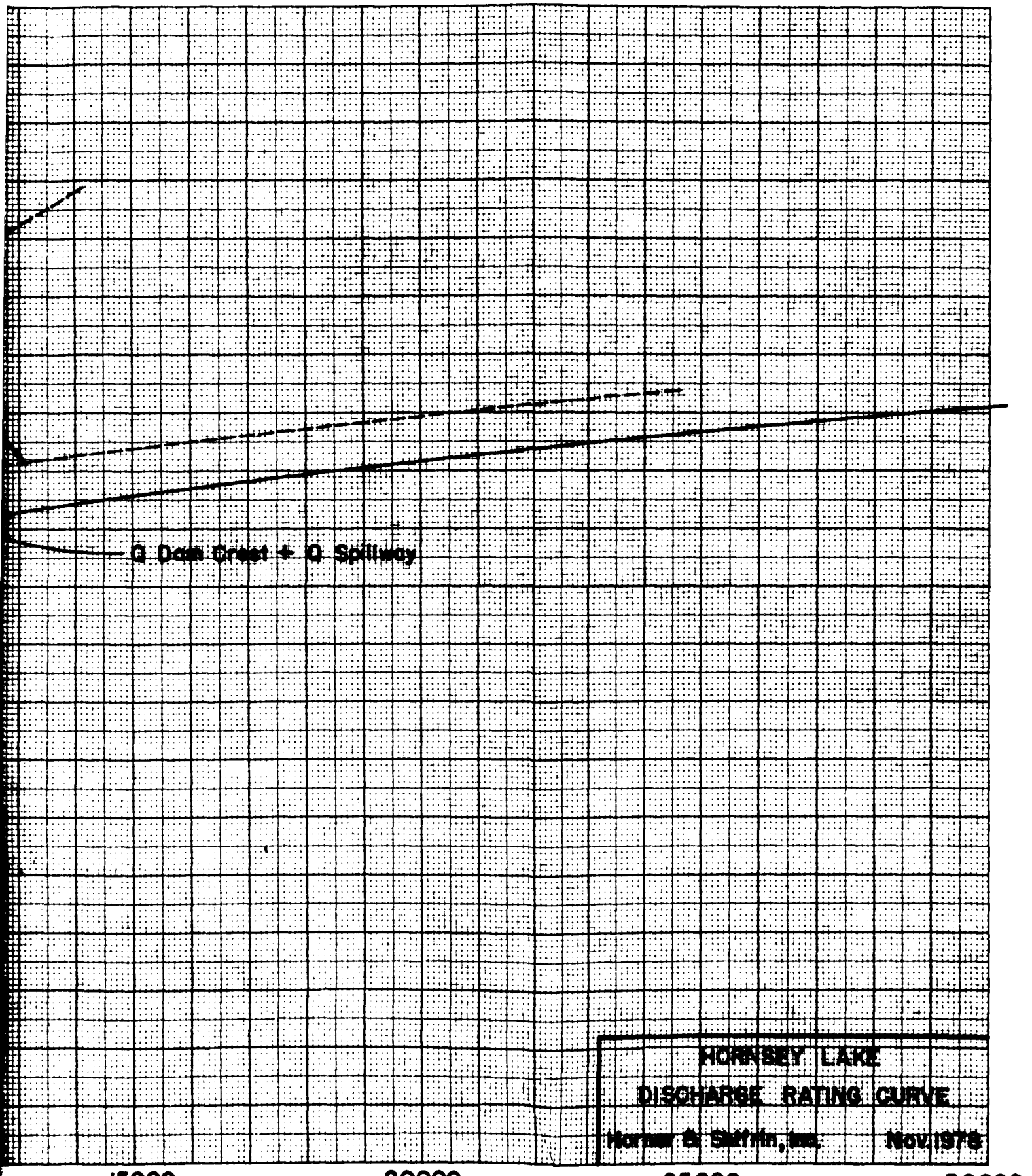
NOTE: DAM PROFILE LOOKING DOWNSTREAM.
DAM AXIS STRAIGHT.

HORNSEY LAKE
DAM & SPILLWAY PROFILES
Horner & Shifrin, Inc. Nov. 1978

12

PLATE 2


ELEV. M.S.L.
976
975
974
973
972
971
970
969
968
967
966
965
964
963
962
961
960
Q Spillway
Q Dam Crest
ELEV. 968.1
ELEV. 962.4
0
5000
10000
150



HORNSEY LAKE

DISCHARGE RATING CURVE

Harmer & Saffrin, Inc. Nov. 1978

PLATE 3

HORNSEY LAKE

PMF INFLOW & OUTFLOW

HYDROGRAPHS

Horner & Shifrin, Inc. Nov. 1978

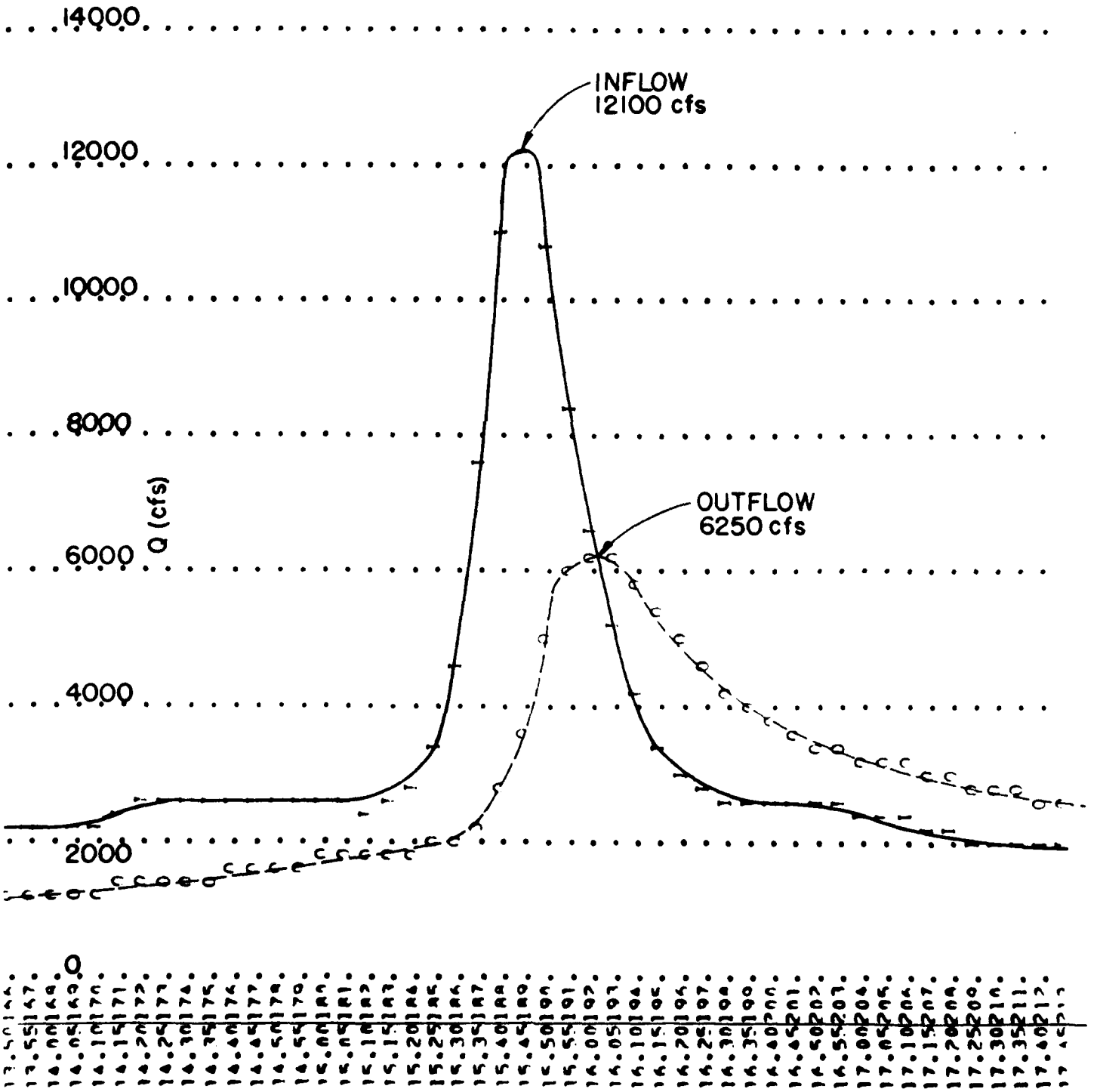


PLATE 4

For File Only

Suggested CONSERVATION COMMISSION (POTOSI) LAKE SITE, WASHINGTON COUNTY

LOCATION: C W½ sec. 15, T. 37 N., R. 2 E. (Potosi Quadrangle)

GEOLOGIC SETTING:

The bedrock in the region is Eminence Dolomite. It is overlain by stony residuum consisting of red clay mixed with chert and barite.

STATUS:

The existing lake was constructed by National Lead Co. as a water supply in use with barite mining. The dam consists of overburden stripped in the exploration of barite; thus, the dam is made up of clay mixed with gravel and boulders. Height of the dam is 60 feet at the steepest portion, however, much of the dam is no higher than 30 feet because of the valley profile. The downstream slope is 1½:1 (40%). The crest width of the dam is 60 feet at the most narrow point. This is the approximate angle of repose of the gravels and boulders dumped over the edge of the dam. Upstream slopes appear to be much more gentle because of the method in which material was dumped during the construction of the lake.

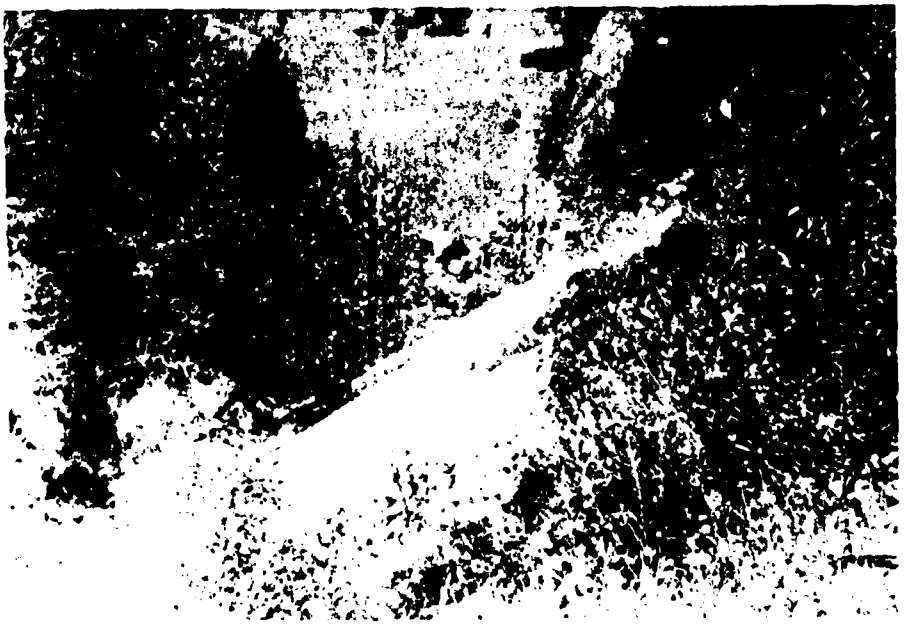
There is no evidence of slope instability apparently the material being well compacted and consisting of a large percentage of boulders and gravels. There is no evidence of leakage either through seepage in fill of the dam or through bedrock of the Eminence Formation. There appears to be no structural instability from a geological aspect that would affect the future existence of this dam. The type of material used for the dam and the width of the fill have increased the stability of the fill.

James H. Williams
Geologist and Chief
Engineering Geology
Missouri Geological Survey
29 June 1970

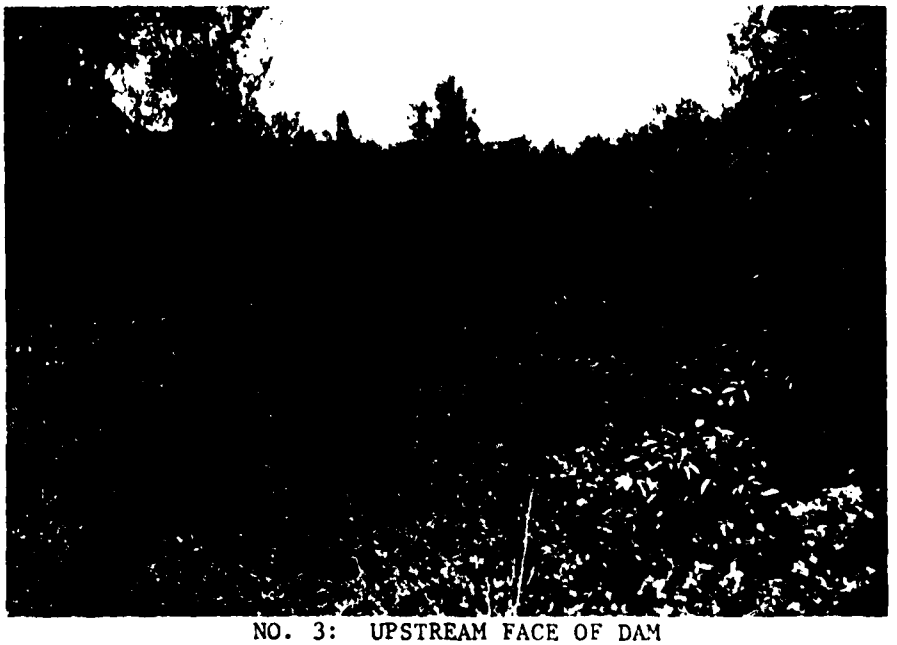
Chart 2-1

APPENDIX

NO. 1: DOWNSTREAM FACE OF DAM



NO. 2: DOWNSTREAM FACE OF DAM



NO. 3: UPSTREAM FACE OF DAM

NO. 4: RIPRAP ON DOWNSTREAM FACE OF DAM

NO. 5: ROAD CROSSING SPILLWAY CREST

NO. 6: LAKE APPROACH TO SPILLWAY CREST

NO. 7: END OF IMPROVED SPILLWAY CHANNEL

HYDROLOGIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 26.6 inches) from Hydrometeorological Report No. 33. One hundred year frequency (point precipitation, 24-hour value equals 7.21 inches) from U. S. Weather Bureau Technical Paper No. 40.

b. Drainage area = 1.02 square miles
= 650 acres

c. SCS parameters
Lag time = 0.20 hours
Soil type CN = 91 (Soil Type C, AMC III)

2. The spillway section consists of a broad-crested, approximately U-shaped rock section for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

(1) Spillway crest section properties (area, a and top width, t) were computed for various depths, d.

(2) It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth (Q_c) was computed as $Q_c = (\frac{a^3}{t} g)^{0.5}$ for the various depth, d.

Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.

(3) Static lake levels corresponding to the various Q_c values passing over the spillway were computed as critical depths plus critical velocity head ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

3. The profile of the dam crest is irregular and flow over the dam crest cannot be determined by conventional weir formulas. Flow quantities overtopping the dam crest were computed as described in the preceding paragraph and corresponding flow over the dam and spillway for given elevations were added to obtain the combined outflow rating curve for the dam and spillway. This rating curve is shown on Plate 3. The inflow-outflow hydrographs for the PMF are shown on Plate 4.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION                JULY 1978
  LAST MODIFICATION:  3 AUG 78
**********
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF HORNSEY LAKE DAM
    3                 A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4                 B     300         0         5        -0        -0        -0        -0        -0        -0        -0
    5                 B1      5
    6                 I       1         3         1
    7                 II   1.50      0.69      1.00
    8                 K       0  INFLOW                                 3         1
    9                 K1       INFLOW HYDROGRAPH
   10                 M       1         2      1.02                             1.0                                   1
   11                 O       0      26.6       102       120       130
   12                 T                                                                -1       -91
   13                 P2                0.20
   14                 R    -1.0      -.10       2.0
   15                 K       1       DAM                                2         3         1
   16                 K1       RESERVOIR ROUTING BY MODIFIED PULS
   17                 K                                      1         1
   18                 K1      1                                                    1250        -1
   19                 K4  962.4     963.3     964.6     965.2     967.3     968.1     969.6      969     969.5      970
   20                 K5  970.5       971       972       973     973.3
   21                 K6      1        70       370       600      1710      2320      2810      3420      4570      4290
   22                 K5   3550     11190     18410     29150     31650
   23                 K8      0      79.9     134.5     192.8
   24                 KE  915.1     942.4       980      1000
   25                 K8  962.4
   26                 K0  968.1
   27                 K      99
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF HORNSEY LAKE DAM
    3                 A3       RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4                 R     200        0        5       -0       -0       -0       -0       -0       -0       -0
    5                 R1      5
    6                 J       1        1        1
    7                 J1   0.61
    8                 K       0  INFLOW                                  3        1
    9                 K1       INFLOW HYDROGRAPH
   10                 M       1        2     1.02                       1.0                        1
   11                 P       0     26.6      102      120      130
   12                 T                                                          -1      -91
   13                 W2            0.20
   14                 X    -1.0     -.10      2.0
   15                 K       1     DAM                                2        3        1
   16                 K1       RESERVOIR ROUTING BY MODIFIED PULS
   17                 Y                                        1        1
   18                 Y1      1                                                1259       -1
   19                 Y4  962.4    963.3    964.6    965.2    967.3    968.1    968.6      969    969.5      970
   20                 Y4  970.5      971      972      973    973.3
   21                 Y5      0       70      370      600     1710     2320     2810     3420     4570     6290
   22                 Y5   8550    11190    18410    28150    31650
   23                 $A      0     79.9    134.5    192.8
   24                 $E  915.1    962.4      980     1000
   25                 $$  962.4
   26                 $D  968.1
   27                 K      99
```

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
**********************************
    1                 A1       ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD
    2                 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF HORNSEY LAKE DAM
    3                 A3       100 YR FLOOD ROUTED THROUGH RESERVOIR
    4                 B    288         0         5        -0        -0        -0        -0        -0        -0        -0
    5                 B1     5
    6                 J      1         1         1
    7                 J1   1.0
    8                 K      0  INFLOW                                  3         1
    9                 K1       INFLOW HYDROGRAPH
   10                 M      0         2     1.02                      1.0                             1
   11                 C    288
   12                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   13                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   14                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   15                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   16                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   17                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   18                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   19                 01  .007     .007      .014      .014      .014      .014      .014      .014      .014      .014
   20                 01  .014     .014      .014      .014      .014      .014      .014      .014      .014      .014
   21                 01  .014     .014      .014      .014      .014      .014      .014      .014      .014      .014
   22                 01  .014     .014      .014      .014      .014      .014      .014      .014      .022      .022
   23                 01  .022     .022      .022      .022      .022      .022      .022      .022      .022      .022
   24                 01  .022     .022      .022      .022      .022      .022      .031      .031      .031      .031
   25                 01  .031     .031      .061      .061      .061      .061      .061      .061      .132      .132
   26                 01  .133     .251      .251      .550      .823      .382      .251      .133      .132      .132
   27                 01  .061     .061      .061      .061      .061      .061      .031      .031      .031      .031
   28                 01  .031     .031      .022      .022      .022      .022      .022      .022      .022      .022
   29                 01  .022     .022      .022      .022      .022      .022      .022      .022      .022      .022
   30                 01  .014     .014      .014      .014      .014      .014      .014      .014      .014      .014
   31                 01  .014     .014      .014      .014      .014      .014      .014      .014      .014      .014
   32                 01  .014     .014      .014      .014      .014      .014      .014      .014      .014      .014
   33                 01  .014     .014      .014      .014      .014      .014      .007      .007      .007      .007
   34                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   35                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   36                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   37                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   38                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   39                 01  .007     .007      .007      .007      .007      .007      .007      .007      .007      .007
   40                 01  .007     .007      .007      .007      .007      .007      .007      .007
   41                 T                                                              -1        -91
   42                 W2             0.20
   43                 X   -1.0      -.10       2.0
```

```
38   O1   .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
39   O1   .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
40   O1   .007   .007   .007   .007   .007   .007   .007   .007
41   T                                                  -1     -91
42   W2          0.20
43   X    -1.0   -.10   2.0
44   K     1     DAM                        2     3     1
45   K1         RESERVOIR ROUTING BY MODIFIED PULS
46   Y                                  1     1
47   Y1    1                                          1259   -1
48   Y4  962.4   963.3  964.6  965.2  967.3  968.1  968.6  969   969.5  970
49   Y4  970.5   971    972    973    973.3
50   Y5    0     70     370    600    1710   2320   2810   3420  4570   6290
```



```
51   Y5  9550   11190  18410  28150  31650
52   $A    0    79.9   134.5  192.8
53   $E  915.1  962.4  980    1000
54   $S  962.4
55   $D  968.1
56   K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	962.37	962.40	968.10
STORAGE	1257.	1260.	1760.
OUTFLOW	0.	0.	2320.

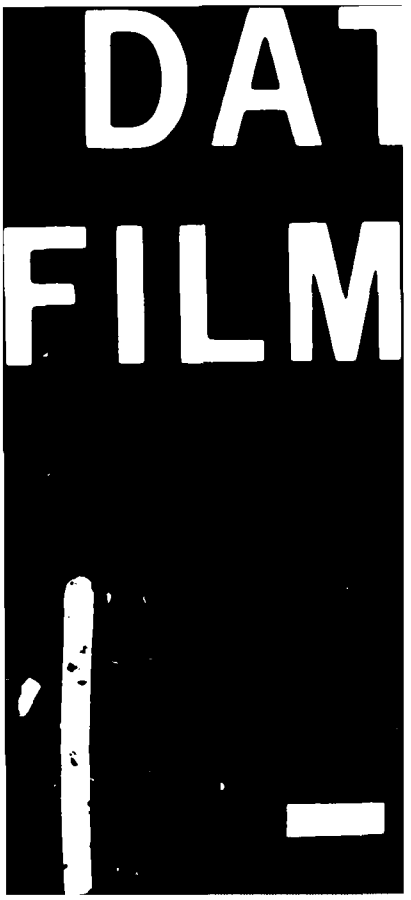
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	967.38	0.00	1692.	1773.	0.00	16.25	0.00
.69	968.61	.51	1810.	2924.	1.17	16.17	0.00
1.00	969.99	1.89	1947.	6249.	2.67	16.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	962.37	962.40	968.10
STORAGE	1257.	1260.	1760.
OUTFLOW	0.	0.	2320.

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
.61	968.12	.02	1762.	2335.	.17	16.25	0.00


DAT
FILM