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UPPER MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

STEEGER LAKE DAM

JEFFERSON COUNTY, MISSOURI

MO 11098

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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United States Army
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St. Louis District

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

FOR: STATE OF MISSOURI

NOVEMBER 1980

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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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STEEGER LAKE DAM

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

FOR: STATE OF MISSOURI

NOVEMBER 1980

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

REPLY TO
ATTENTION OF

SUBJECT: Steeger Lake Dam, MO 11098, Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Steeger Lake Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

The owner should initiate immediate action to provide an erosion-free spillway so that the full existing spillway capacity could be utilized. An erosion-free spillway will pass greater than 50 percent of the Probable Maximum Flood.

Non-implementation of this recommendation will result in an unsafe, non-emergency classification, due to degradation of the spillway crest which could cause dam failure by floods exceeding 15 percent of the Probable Maximum Flood.

SUBMITTED BY: SIGNED 23 MAR 1981
Chief, Engineering Division Date

APPROVED BY: SIGNED 24 MAR 1981
Colonel, CE, District Engineer Date

STEEGER LAKE DAM

MISSOURI INVENTORY NO. 11098

JEFFERSON COUNTY, MISSOURI

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
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FOR:

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

CORPS OF ENGINEERS

NOVEMBER 1980

HS-8011

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Steeger Lake Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary of Sugar Creek
Date of Inspection:	22 September 1980

The Steeger Lake Dam was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this 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 visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of these hydrologic/hydraulic investigations, the present general condition of the dam is considered to be somewhat less than satisfactory. The fact that the reservoir has experienced excessive leakage since completion of the dam does not, in the opinion of the inspection team, reflect adversely on the general condition of the dam. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. A small pond (about one-quarter acre) lies just downstream of the spillway for the Steeger Lake Dam. Spillway releases from Steeger Lake will be confined to an area between the main dam and the embankment for the pond through the exit section of the spillway outlet. According to the Owner, this area of the spillway outlet channel is to be protected by a concrete liner; however, at the time of the inspection, the spillway crest and the spillway outlet channel, except for some grass, was unprotected. Lack of a durable

form of spillway erosion protection will permit significant degradation of the spillway crest by lake outflow with erodible velocities. It will also allow spillway releases to impinge upon the dam which could result in loss of embankment material by high velocity spillway flows; a condition that could impair the structural stability of the dam.

2. Some minor surface erosion that appeared to be due to overland drainage has occurred across most of the grass covered upstream face of the dam beginning at a level about 10 feet below the top of the dam. (Ordinarily, this portion of the dam would be submerged and not subject to erosion by overland drainage, but would be subject to erosion by wave action and by fluctuations of the lake level that cannot be controlled by a vegetative type cover.) Erosion of the embankment by either overland drainage or by wave action and/or fluctuations of the lake level can impair the structural stability of the dam.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Steeger Lake Dam, which is classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood (PMF). Considering the fact that a relatively small volume of water is impounded by the dam, that the flood plain downstream of the dam is fairly broad, and that there are but three dwellings within the estimated flood damage zone, it is recommended that the spillway for this dam be designed for one-half the Probable Maximum Flood. The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

According to the Owner, since completion of the dam in 1976, the reservoir has experienced problems with excessive leakage, as indicated by the inability of the lake to reach the level of the spillway. At the time of the inspection, the lake level was about 15 feet below the spillway crest. Judging by a waterline mark across the upstream face of the dam, the lake had been for some period of time approximately one foot higher than the observed level. The Owner indicated that the highest lake level experienced to date was probably about three feet higher than the level at the time of the inspection. For the purpose of the hydrologic/hydraulic investigations performed for this dam, the level of the lake just prior to the beginning of the assumed antecedent storms for the Probable Maximum Flood and the one percent chance (100-year frequency) flood, was assumed to be the elevation of the observed waterline mark on the face of the dam, or about 13.8 feet below the spillway crest.

Results of a hydrologic/hydraulic analysis indicated that the spillway is inadequate to pass lake outflow resulting from a storm of one-half PMF magnitude without significant degradation by erosion of the spillway crest. However, the spillway is capable of safely passing lake outflow corresponding to about 15 percent of the PMF lake inflow. A similar analysis indicated that with the lake surface at the mean annual high water level (the observed waterline mark), the reservoir is capable of containing the runoff resulting from the one percent chance (100-year frequency) flood. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be three miles. Accordingly, within the possible damage zone are three dwellings and a warehouse.

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

It is recommended that the Owner take the necessary action sometime in the near future to correct or control the deficiencies and safety defects reported herein. Protection of the spillway in order to prevent erosion by lake outflow should be assign.J a high priority.

Harold B. Lockett

Harold B. Lockett
P. E. Missouri E-4189

Albert B. Becker, Jr.

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

OVERVIEW STEEGER LAKE DAM

PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

STEEGER LAKE DAM - MO 11098

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

STEEGER LAKE DAM - MO 11098

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, 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, directed that a safety inspection of the Steeger Lake Dam be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the above 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 Cuidelines for Safety Inspection of Dams", Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Steeger Lake Dam is an earthfill type embankment rising approximately 35 feet above the natural streambed at the downstream toe of the embankment. The embankment has an upstream slope (above the waterline) of approximately 1v on 3.4h that steepens to about 1v on 2.5h at an elevation nearly 10 feet below the top of the dam, a crest width of about 11 feet and a somewhat irregular downstream slope on the order of 1v on 2.4h. The length of the dam is approximately 385 feet and a road surfaced with gravel traverses the crest of the dam. A plan and profile of the dam is shown on Plate 3 and a cross-section of the dam at about the location of the original stream channel is presented on Plate 4. At spillway crest level, the reservoir impounded by the dam would occupy approximately 6 acres. At the present level of the lake, which is nearly 15 feet below the spillway crest, the reservoir occupies approximately 2 acres. The dam has no drawdown facility to unwater the lake. An overview photo of the Steeger Lake Dam is shown following the preface at the beginning of the report.

The spillway for the dam, an excavated earth trapezoidal section, is located at the right, or south, abutment. A small pond on the order of one-quarter of an acre is under construction just downstream of the spillway location. The spillway outlet channel, although not well defined through the area downstream of the dam, appears to join the original stream on which the embankment is constructed, at a point about 100 feet downstream of the toe of the dam. A profile and cross-section of the spillway channel are shown on Plate 5.

b. Location. The dam is located on an unnamed tributary of Sugar Creek, about 0.8 mile southeast of the intersection of Rock Creek Road and State Highway 30, and approximately 1.0 mile southeast of the Town of High Ridge, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located within Section 24, Township 43 North, Range 4 East, in Jefferson County.

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

d. Hazard Classification. The Steeger Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends three miles downstream of the dam. Within the possible damage zone are three dwellings and a warehouse. Those features lying within the downstream damage zone as reported by the St. Louis District, Corps of Engineers, were verified by the inspection team.

e. Ownership. The dam is owned by Mr. and Mrs. Oscar A. Steeger. Mr. and Mrs. Steeger's address is: 3456 Rock Creek Road, High Ridge, Missouri 63049. The Steeger residence is on the property where the dam is located.

f. Purpose of Dam. The original purpose of the dam was to impound water for commerical benefit, i.e., fee fishing. However, since the lake has not filled to the desired level, the reservoir has not, to date, been operated on a commercial basis.

g. Design and Construction History. The dam was constructed by the Owner. According to Mrs. Steeger, the dam required about two years to build and was completed in 1976. Mrs. Steeger also reported that Thomas J. Dean, a geologist with the Missouri Geological Survey, examined the proposed lake site prior to construction and made certain recommendations regarding the design and construction of the dam. A copy of Mr. Dean's report titled "Engineering Geologic Report on the Steeger Lake Site", dated April 17, 1975, reference Charts 2-1 through 2-3, is included herewith. An addendum to this report was also prepared by Mr. Dean following completion of the dam when it was found that the lake was experiencing excessive leakage. This report titled "Addendum to the Geologic Report of the Steeger Lake", dated May 18, 1979, is also included herewith, reference Charts 2-4 and 2-5. Mrs. Steeger also mentioned that some design assistance was provided in 1975 by the U. S. Department of Agriculture, Soil Conservation Service (SCS).

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacity of an excavated earth type spillway. However, according to the Owner, since completion of the dam, the level of the lake has never reached the spillway crest.

1.3 PERTINENT DATA

a. Drainage Area. With the exception of some residential type development along the ridge line of the watershed, the area tributary to the lake is essentially in a native state covered with timber. The watershed above the dam amounts to approximately 124 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at dam site ... None 1/

(2) Spillway capacity .... 89 cfs (W.S. Elev. 786.3)

c. Elevation (Ft. above MSL). Unless otherwise indicated, the following elevations were determined by survey and are based on topographic data shown on the 1954 House Springs, Missouri, Quadrangle Map, 7.5 Minute Series (photo-revised 1968 and 1974).

(1) Observed pool ... 770.2

(2) Normal pool ... Unknown

(3) Mean annual high water ... 771.2 (per high waterline mark)

(4) Spillway crest ... 785.0

(5) Maximum experienced pool ... 773.0 2/

(6) Top of dam ... 790.4 (Min.)

(7) Effective top of dam ... 786.3 3/

(8) Streambed at centerline of dam ... 758± (Est.)

(9) Maximum tailwater ... Unknown

(10) Observed tailwater ... None

d. Reservoir.

(1) Length of pool at spillway crest (Elev. 785.0) ... 1,000 ft.

(2) Length of pool at top of dam (Elev. 790.4) ... 1,200 ft.

1/ According to the Owner, the level of the lake has never reached the elevation of the spillway crest.

2/ Based on an estimate of lake level as observed by Owner.

3/ Elevation at which lake outflow exceeds permissable velocity.

e. Storage.

(1) Spillway crest ... 58 ac. ft.
(2) Top of dam (incremental) ... 39 ac. ft.

f. Reservoir Surface.

(1) Spillway crest ... 6 acres
(2) Top of dam (incremental) ... 2 acres

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier, to the top of the dam.

(1) Type .... Earthfill
(2) Length ... 385 ft.
(3) Height ... 35 ft.
(4) Top width ... 11 ft.
(5) Side slopes
    a. Upstream ... Varies; 1v on 2.5h to 1v on 3.4h
    b. Downstream ... 1v on 2.4h (irregular)
(6) Cutoff ... Core trench 1/
(7) Slope protection
    a. Upstream ... Grass
    b. Downstream ... Grass

h. Principal Spillway.

(1) Type ... Uncontrolled, excavated earth, trapezoidal section
(2) Location ... Right abutment
(3) Crest elevation ... 785.0
(4) Approach channel ... Lake
(5) Outlet channel ... Trapezoidal section through exit section, unconfined beyond exit section

1/ Per Owner

i. <u>Emergency Spillway</u>. ... None

j. <u>Lake Drawdown Facility</u>. ... None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

As previously stated, a geologic investigation of the proposed lake site, reference Charts 2-1 through 2-3, was made in 1975 by Thomas J. Dean, a geologist with the Missouri Geological Survey. In the report, which is dated April 17, 1975, Mr. Dean describes the underlying bedrock units and the surficial soils overlying the bedrock. Mr. Dean points out that both the limestone, which is present in the streambed near the east property line, and the sandstone, which is seen outcropping near the upper end of the proposed lake, are very permeable both vertically and horizontally and will transmit water rapidly. Mr. Dean states that a thick sequence of clayey soil is present on the lower valley slopes and valley bottom, and that the soil should prevent water from reaching the underlying permeable limestone. The report indicates that a test pit was excavated in the valley bottom near the streambed and that approximately 6 feet of sandy gravelly clay overlying a thin gravel bed bearing water was revealed; however, it was believed that the water in the gravel bed was perched on a clay layer of unknown thickness.

In summary, Mr. Dean reports that there appear to be sufficient amounts of clay present in the valley walls and bottom to mask the permeable bedrock, which would allow the site to be geologically feasible for a water impoundment.

In the Dean report, recommendations are made regarding construction of the core, excavation for borrow material, filling of the streambed upstream of the dam, and the design of the spillway. With regard to the spillway, Mr. Dean recommends that, because of the erodibility of the silty clay surface soil, a pipe type principal spillway be provided to handle the daily flow.

The Owner also reported that some design assistance was provided by the U. S. Department of Agriculture, Soil Conservation Service (SCS). According to information provided by Richard L. McMillen, SCS District Conservationist, St. Louis County (the Jefferson County records are maintained by the St. Louis County office at Manchester, Missouri), a preliminary design survey of the dam was made by Leonard Knoernschild, formerly SCS District Conservationist, St.

Louis County, in 1975; however, the design survey did not establish the spillway requirements or specify the embankment proportions. Mr. Knoernschild, now SCS District Conservationist, Franklin County, was contacted; however, no details of the design or the site could be recalled.

2.2 CONSTRUCTION

The dam was constructed by the Owner and required approximately two years to build, having been completed in 1976. According to Mrs. Steeger, a seepage cutoff trench approximately 5-to-8 feet deep and about 12 feet wide at the bottom, was excavated across the valley floor along the alignment of the dam. Mrs. Steeger reported that a seam of gravel was encountered during the excavation for the trench. Mrs. Steeger indicated that the trench was backfilled and the embankment constructed with gravelly clay that was obtained from the area to be occupied by the lake as well as the nearby hillsides, that the borrow material was hauled to the dam in trucks and spread by a tractor, and that compaction of the fill material was obtained by running the tractor, a John Deere 450, repeatedly over the fill. No tests were made to determine the degree of compaction obtained.

2.3 OPERATION

The lake level is uncontrolled and, under normal conditions, governed by the elevation of the crest of the excavated earth type spillway. However, since completion of contruction, the lake has experienced problems with excessive leakage, as indicated by the inability of the lake to reach the level of the spillway. There is no evidence of dam overtopping. According to Mrs. Steeger, the highest lake level experienced to date raised the lake surface about 3 feet higher than the observed level at the time of the inspection, or approximately 12 feet below the spillway crest.

According to Mrs. Steeger, in the spring of 1979 following a heavy rainfall, a hole approximately 5 feet deep and 8 feet in diameter, developed in the bottom of the reservoir just upstream from the lake at a point near the old streambed. Subsequently, at the request of the Owner, an investigation of the reservoir condition was made by Mr. Dean of the Missouri Department of

Natural Resources, Geology and Land Survey, formerly the Misouri Geological Survey, and a report was prepared. In the report which is titled "Addendum to the Geologic Report of the Steeger Lake", reference Charts 2-4 and 2-5, dated May 18, 1979, Mr. Dean states that the relatively thick plastic clays which are present in the lake bottom at the dam evidently have some weak spots in the upstream reaches of the lake, and that these weak points allow the lake to back up off its clay pad to the point where vertical water loss takes place into the underlying very permeable bedrock.

In the report, Mr. Dean recommends that the most feasible method of preventing vertical water loss is to pad the bottom of the lake through the area not holding water. The report also recommends that a core be excavated to bedrock in the upper end of the lake to force water from the creek to the surface and onto the clay pad constructed in the lake bottom.

Mr. Dean also addresses a landslide problem that had developed along the northeastern side of the lake where a sandstone outcropping exists. The reason for the slide is presented and recommendations are made to remedy future slides in the area.

According to Mrs. Steeger, Mr. Dean's recommendations regarding the construction of a core across the upstream end of the lake and the padding of the reservoir bottom with approximately 2 feet of clay, were followed. However, in the year since completion of this work, no appreciable permanent increase in the level of the lake has been evident.

Mrs. Steeger also reported that an attempt was made to seal the lake bottom using bentonite. It was reported that approximately 2,000 pounds of bentonite were distributed by boat over the area of the lake; however, beneficial results of the bentonite operation were not conclusive.

2.4 EVALUATION

a. Availability. Detailed engineering data for assessing the design of the dam and spillway were unavailable.

b. Adequacy. Available data are inadequate. 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.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Steeger Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, H. B. Lockett, Hydrologist, and A. B. Becker, Jr., Civil and Soils Engineer, on 22 September 1980. An examination of the dam area was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the site geology. Also examined at the time of the inspection were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on pages A-1 and A-2 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. The topography at the dam site is moderately rugged, and relief between the valley bottom at the lake site and the surrounding drainage divide is about 150 feet. The area is included within the northeastern part of the Ozark Plateaus Physiographic Province; therefore, the regional dip of the bedrock is northeastward toward the Illinois Basin.

The lake site itself is located near the axis of the House Springs Anticline. Although the structure affects the dip of the strata in this area, the bedrock formations at the dam site still dip to the northeast. Several faults are associated with the anticlinal structure, although no faulting was observed at the site. The bedrock at the lake site consists of several Ordovician- and Mississippian-age limestone, shale, and sandstone formations. The limestone of the Kimmswick formation is the underlying bedrock at the dam site and valley bottom. This is overlain by the Maquoketa shale, Bushberg sandstone, and Fern Glen and Burlington limestones which make up the bedrock units of the valley walls and uplands.

The Kimmswick is a coarsely crystalline, light grey, massive- to medium-bedded limestone. It has a distinctive pitted weathering surface, and nodular chert is scattered in the upper portions of the formation. The Kimmswick has typically been extensively solution-weathered and commonly contains numerous sinks and solution-enlarged fractures. This weathering has made the limestone extremely permeable, and it will transmit water readily. The contact between the weathered bedrock surface and the overlying soils or residuum is usually irregular. The residual soil, when not modified by colluvium, is generally quite thin and typically is a reddish-brown, well-structured, plastic clay with a Unified Soil Classification of CH. Even though these clays are plastic, their natural permeabilities are higher than most clays, especially after drying.

Overlying the Kimmswick is the Maquoketa shale. No unaltered outcrops of shale were apparent at the site, but weathered shale and plastic clay soils were located up to about 5 feet above present reservoir level. The Maquoketa, when unweathered, is typically a thin-bedded, silty, calcareous shale. It weathers to a black, plastic soil, CH in the Unifed Soil Classification System, that is very impermeable and unstable on steep slopes. Because of its impermeable characteristics, seeps and springs are frequently found at the contact between the Maquoketa and the overlying Bushberg sandstone, and several were located around the reservoir perimeter.

The Bushberg sandstone outcrops on both sides of the reservoir above the Maquoketa and as far up as 15 feet above the top of the embankment. It is a massive, cross-bedded, brown, fine- to coarse-grained porous sandstone that transmits water readily. Soils derived from the Bushberg are sandy, but at the site include weathered components from the overlying Fern Glen limestone formation. These soils may be differentiated as light grey to buff, silty or sandy clays that are classified in the ML-CL range in the Unified Soil Classification System.

The principal bedrock formation underlying the valley sides and uplands is the Burlington limestone. This formation is a light grey, massively- to medium-bedded limestone with considerable amounts of nodular and bedded chert. The residual soils are light red to reddish-brown clays mixed with chert, stony CH. In general, the clay and chert residuum from the Burlington are a major component of the soils found on the valley sides and floor.

Steeger Lake has not been a successful impoundment and is currently filled to less than 25 percent of its design standing water level. Prior to construction, the stream was reported by the Missouri Geological Survey to be losing flow to the subsurface. Following construction, a small sink was located in the lake area and required sealing with compacted clay. Significant leakage apparently is occurring through the permeable Kimmswick limestone which underlies the reservoir. Some seepage effluent was noted downstream in the immediate vicinity of the embankment on both sides of the valley, but as this flow did not seem comparable to the inflow into the reservoir and since the stream bed below the embankment was dry, much of the seepage apparently is flowing through the bedrock to emerge further downstream or into adjacent drainage basins. In addition, considerable slumping has occurred in the Maquoketa shale residuum. Numerous small slump features comprised of plastic clays, sandstone, and chert residuum are apparent on the north bank of the reservoir. Some erosion has also developed around the reservoir, particularly in the sandy soils from the Bushberg sandstone, demonstrating the erodibility of these soils.

It is apparent that at the Steeger Lake site adverse geologic conditions are responsible for the lack of reservoir storage; however, these conditions do not appear to be affecting the stability of the dam embankment.

c. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1, 2 and 3) were examined and found to be in sound condition. No cracking of the dam surface, sloughing of the embankment slopes, or unusual settlement of the dam crest, was noted, although, according to survey data obtained during the inspection, the dam crest was somewhat lower, approximately 0.9 foot, left of the center of the structure than it was to the right of the center. Except for the top of the dam, which was mostly covered with gravel and small stones up to 6 inches in size for roadway surfacing, the slopes were, for the most part, covered by grass, a fescue, and other native types of grasses. However, along the upstream face beginning at a level about 10 feet below the dam crest, some minor surface erosion on the order of 6 inches deep and 1 foot wide was noticed across most of the embankment. There was no riprap slope protection on the upstream face of the dam. At the time of the inspection, the grass on the downstream face of the dam was up to 3 feet high; on the upstream face, the grass, except near the top of the dam, had been recently cut and was only several inches high. No significant erosion of the embankment was noticed at the junction of the dam with the abutments, and no seepage was observed at the abutments or the downstream area adjacent to the dam, or within the examined areas of the original stream channel for a distance of approximately 230 feet beyond the toe of the dam. Examination of a soil sample obtained from the downstream face of the embankment indicated the surficial material to be a stoney, yellow-brown, silty lean clay (CL) of low-to-medium plasticity.

The excavated earth spillway (see Photo 4) at the right, or south, abutment was examined and found to be in sound condition without evidence of significant erosion, although the outlet channel (see Photo 5), except for a portion of the exit section, was without a protective grass cover. The remains of a tree were present in the spillway channel at a point just downstream of the exit section.

A small pond (see Photo 6) on the order of one-quarter of an acre in surface area, that is impounded by an earthen dam approximately 9 feet high on the north side, lies just downstream of the spillway outlet. The pond is under construction, but the Owner mentioned that it is expected to be completed this year. According to the Owner, the pond is to be used for raising catfish. The Owner indicated that the exit section of the spillway outlet channel is to be lined with concrete in order to prevent erosion of the dam as well as the embankment of the pond; however, the extent of the protection had not yet been decided. The spillway channel downstream of the dam was indistinguishable, but probably will join the original stream channel at a point approximately 100 feet downstream of the toe of the dam.

d. Appurtenant Structures. No appurtenant structures were observed at this dam site.

e. Downstream Channel. Except at roadway crossing, the channel downstream of the dam within the estimated flood damage zone is unimproved. The section is irregular and for the most part lined with trees. The stream joins Sugar Creek approximately 0.4 mile downstream of the dam; Sugar Creek joins the Meramec River about 7.0 miles downstream of the dam.

f. Reservoir. Except for a roadway along the south side of the lake, and some cleared land at the upstream end of the lake, the area adjacent to the reservoir upstream of the dam is tree lined. The remnants of a slide were observed adjacent to the north side of the lake at a point approximately 400 feet from the dam. As previously reported, see Section 2, paragraph 2.3, the slide occurred at the location of a sandstone outcropping. With the exception of the slide area on the north side of the lake where it appeared that some material lies within the limits of the reservoir, no appreciable erosion of the lake banks was noticed. The amount of sediment within the lake could not be determined during the inspection; however, the actual amount is not expected to significantly affect the reservoir storage capacity. At the time of the inspection, the lake level was about 14.8 feet below the crest of the spillway.

3.2 EVALUATION

The deficiencies observed during the inspection and noted herein are not considered of significant importance to warrant immediate remedial action.

SECTION 4- OPERATIONAL PROCEDURES

4.1 PROCEDURES

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

4.2 MAINTENANCE OF DAM

The inspection team is of the opinion that the dam is reasonably well maintained. According to the Owner, the grass on the embankment is cut periodically through the growing season. However, the Owner stated that the grass on the downstream face has not been cut recently in order to allow the grass to re-seed itself. The Owner also reported that two trees were recently removed from the dam and that there have been no signs of muskrats about the dam.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilities requiring operation exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

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

4.5 EVALUATION

Measures should be taken to prevent further erosion by overland drainage of the upstream face of the dam and to prevent erosion of the spillway crest and outlet channel. It is recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5- HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data were not available.

b. Experience Data.

(1) The drainage area and lake surface area were determined from the 1954 House Springs, Missouri, Quadrangle Map (photorevised 1968 and 1974). The proportions and dimensions of the spillway and dam were developed from surveys made during the inspection. Records of rainfall, streamflow, or flood data for the watershed were not available.

(2) The corresponding elevation of the lake at which outflow velocities, approximately 5.5 feet per second, were assumed to cause significant degradation of the spillway crest was determined to be elevation 786.3. This lake level is referred to in the report as the efffective top of dam elevation.

(3) The lake level prior to the beginning of all antecedent storms was assumed to be at elevation 771.2 with storage equivalent to 5.97 acre-feet. This elevation was established during the inspection as the mean annual high lake level, as determined by a waterline mark on the upstream face of the dam. The Owner stated that the maximum lake level experienced to date was about 12 feet below the spillway crest, or approximately elevation 773.0.

In accordance with criteria established by the St. Louis District, Corps of Engineers, for the one percent chance (100-year frequency) storm, the 24-hour runoff from the rainfall distribution for the 24 hours preceding the maximum 24 hours was evaluated and found to be 0.40 inch, and the computed volume of runoff for the antecedent storm amounted to 4.15 acre-feet, resulting in accumulated storage equal to 10.12 acre-feet at elevation 773.4 at the beginning of the one percent chance (100-year frequency) storm.

In accordance with the hydrologic/hydraulic standards of the St. Louis District, Corps of Engineers, for the PMF ratio storms, an antecedent storm equal to one-half the PMF ratio event was assumed to precede the PMF ratio storm by four days. This PMF ratio antecedent storm was then routed through the reservoir. The antecedent storm, which, when combined with the PMF ratio storm, fills the reservoir to elevation 786.3, the effective top of dam elevation, corresponds to about 7.5 percent of the PMF lake inflow. As a result of this antecedent storm, the level of the lake at the beginning of the 15 percent PMF ratio storm was determined to be elevation 780.2.

For the 50 percent PMF storm, an antecedent storm of 25 percent PMF magnitude was assumed to precede the 50 percent PMF storm by four days. This storm was routed through the lake, and it was found that elevation 785.0, the spillway crest, was exceeded by about 1.5 feet, and that the lake level receded to the elevation of the spillway crest by the end of the second day. It is evident, therefore, that a similar analysis for the 100 percent PMF storm, using an antecedent storm of 50 percent PMF magnitude, would also result in the level of the lake exceeding the crest of the spillway with the lake level receding to the elevation of the spillway crest within two days. The lake surface at the beginning of the 50 percent and 100 percent PMF storms was therefore taken as the level of the spillway crest, elevation 785.0. Failure of the dam due to overtopping by the 25 percent or 50 percent PMF antecedent storms was not assumed to occur in these investigations of overtopping by the 50 percent PMF and 100 percent PMF events.

(4) According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends three miles downstream of the dam.

c. Visual Observations.

(1) The principal spillway, a broad-crested, trapezoidal excavated earth section, is located at the right abutment. The spillway crest and outlet channel have no durable form of protection to prevent erosion.

(2) There is no emergency spillway or lake drawdown facility.

(3) The observed level of the lake at the time of the inspection was approximately 14.8 feet below the elevation of the spillway crest. The maximum lake level was reported to be about 3 feet higher than the observed level.

d. Overtopping Potential. The spillway is inadequate to pass the probable maximum flood without overtopping the dam. The spillway is considered to be incapable of safely passing one-half the probable maximum flood, the recommended spillway design flood, without significant degradation of the spillway crest by lake outflow. As a result of antecedent storm conditions, the lake surface level was considered to be at the level of the spillway crest, elevation 785.0, prior to the beginning of the 50 percent and 100 percent probable maximum flood storms. Under the assumed antecedent conditions and with the level of the lake at elevation 773.4 at the beginning of the one percent chance storm, the reservoir is capable of containing the runoff from the one percent chance (100-year frequency) storm without flow occurring through the spillway.

(Note: The data appearing in the following table were extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Effective Top of Dam (Elev. 786.3)	Duration of Overtopping of Dam (Hours)
0.50	825	789.3	3.0	6.8
1.00	1,999	791.1	4.8	11.1
1% Chance Flood	0	785.0	0.0	0.0

Elevation 786.3 was considered to be the effective top of dam elevation, i.e., the level at which significant degradation of the spillway crest by high velocity lake outflow would occur. With the lake level at elevation 786.3, the maximum velocity within the spillway is 5.5 feet per second, which is considered acceptable. The maximum flow safely passing the spillway just prior to the lake level reaching the effective top of dam elevation, was

determined to be approximately 89 cfs, which is the routed outflow corresponding to about 15 percent of the probable maximum flood inflow. Due to the 7.5 percent PMF antecedent storm, the lake level was determined to be at elevation 780.2 at the beginning of the 15 percent PMF storm.

e. Evaluation. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam has shown evidence that under certain conditions, such as high velocity flow, the material can be very erodible. Such a condition exists during the PMF and one-half PMF events when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition, both the effective top of dam (elevation 786.3) and the actual top of dam (elevation 790.4) were found to be overtopped. For the one-half PMF condition, only the effective top of dam was found to be exceeded. Damage by erosion of the dam and/or spillway is expected during occurrence of the one-half PMF and PMF events. The extent of these damages is not predictable within the scope of these investigations; however, there is a possibility, particularly during the PMF, that they could result in failure of the dam.

f. Reference. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow passing the spillway and dam crest are presented on pages B-1 and B-2 of the Appendix. Listings of the HEC-1 (Dam Safety Version) input data for the 15 percent probable maximum flooo, the probable maximum flood, and the one percent chance (100-year frequency) flood are shown on pages B-3 through B-6. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-7 through B-10; tabulation of lake surface area, elevation and storage volume is shown on page B-11 and tabulations titled "Summary of Dam Safety Analysis" for the 15 percent PMF, the 50 and 100 percent PMF, and the one percent chance (100-year frequency) flood are shown on pages B-11 and B-12. Calculations for determination of spillway capacity are presented on pages B-13 through B-15.

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 3.1c.

b. Design and Construction Data. Design or construction data relating to the structural stability of the dam were not 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 for appropriate loading conditions (including earthquake loads) and made a matter of record.

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

d. Post Construction Changes. Mrs. Steeger indicated that no post construction changes have been made or have occurred which would affect the structural stability of the dam. A possible exception may be the existence of the small pond presently under construction just downstream of the spillway outlet. Confinement of the spillway outlet channel to a location where lake outflow could impinge upon the dam can, unless the structure is adequately protected, cause erosion damage by high velocity spillway flows which could be detrimental to the structural stability of the dam. However, Mrs. Steeger indicated that the channel will be protected sometime in the future by a concrete liner in order to prevent this condition from occurring. The padding of the reservoir bottom and the construction of a core across the upstream end of the lake floor are not believed to adversely affect the stability of the dam. The landslide that occurred along the northeastern side of the lake and which appears to have stabilized, at this time does not appear to pose a structural problem to the dam.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillway is capable of passing lake outflow of about 89 cfs without the level of the lake exceeding the effective top of dam level, elevation 786.3. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicated that for storm runoff of one-half the probable maximum flood magnitude, the recommended spillway design flood, the lake outflow would be on the order of 825 cfs, and that for the 1 percent chance (100-year frequency) flood, the reservoir would contain the runoff resulting from the 1 percent chance storm.

Seepage and stability analyses of the dam were not available for review and therefore no judgment could be made with respect to the structural stability of the dam.

Several items were noticed during the visual inspection that could adversely affect the safety of the dam. These items include minor erosion along the upstream face of the dam, the lack of protection to prevent erosion of the spillway and dam by spillway releases, and the lack of a suitable form of protection to prevent erosion of the embankment by wave action or by fluctuations of the lake level.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based largely on external conditions as determined during the visual inspection. The assessment of the hydrology of the watershed and 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 remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished sometime in the near future. Protection of the spillway in order to prevent erosion by lake outflow should be assigned a high priority.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located within a Zone II seismic probability area. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

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

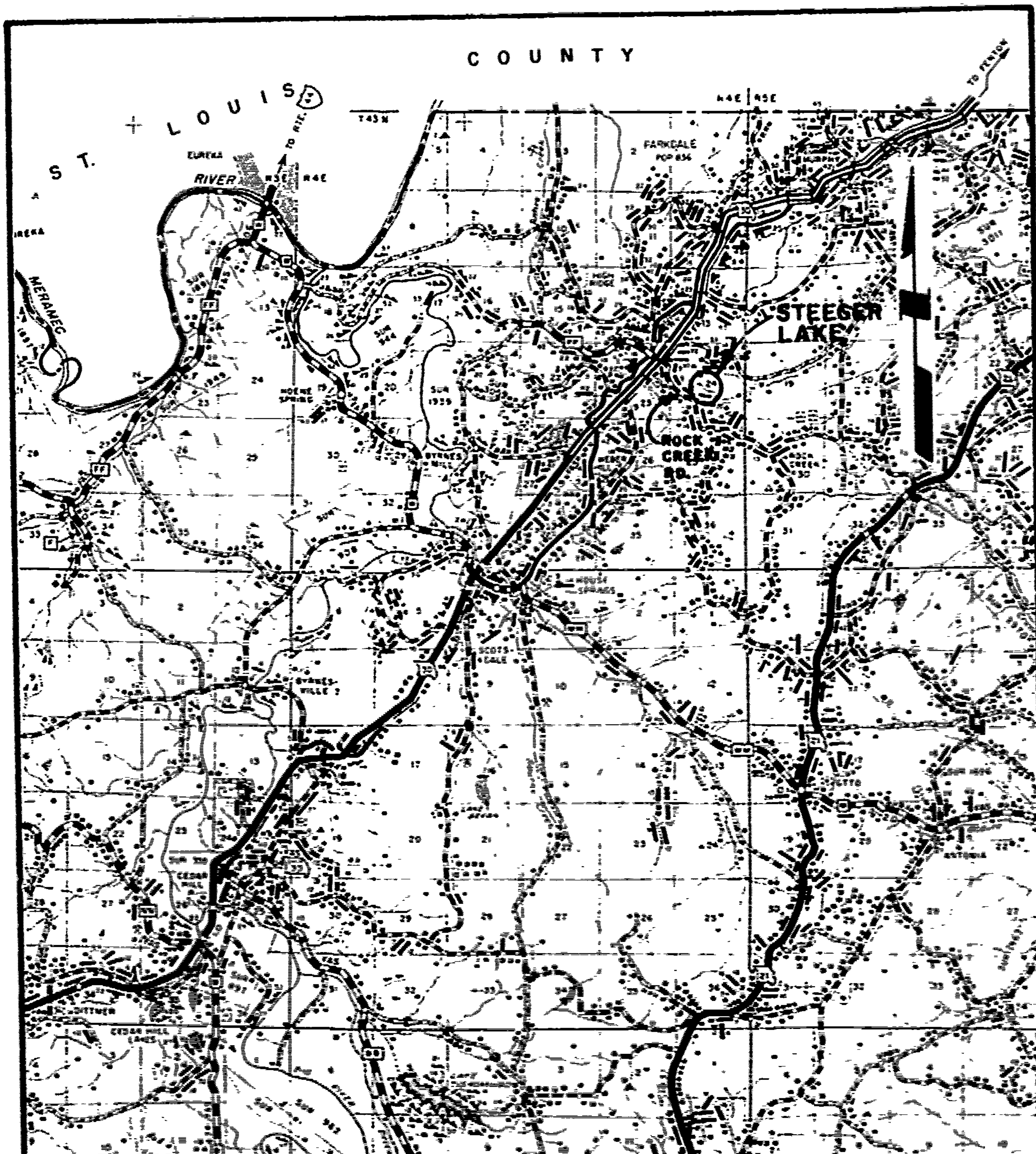
(2) Provide a suitable form of protection at the spillway in order to prevent erosion of the spillway and dam by lake outflow resulting from a storm of one-half probable maximum flood magnitude, the recommended spillway design flood.

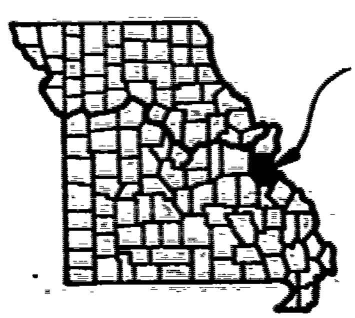
b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Restore the eroded areas along the upstream face of the dam. Although there appears to be no need for slope protection at the present level of the lake, if and when the lake level is established at or near the spillway elevation, a suitable form of protection should be provided to prevent erosion

of the embankment by wave action or by fluctuations of the lake level. Where interim protection is necessary to prevent erosion by overland drainage, a vegetative type of cover is acceptable. Loss of embankment material due to erosion can impair the structural stability of the dam.

(2) 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.



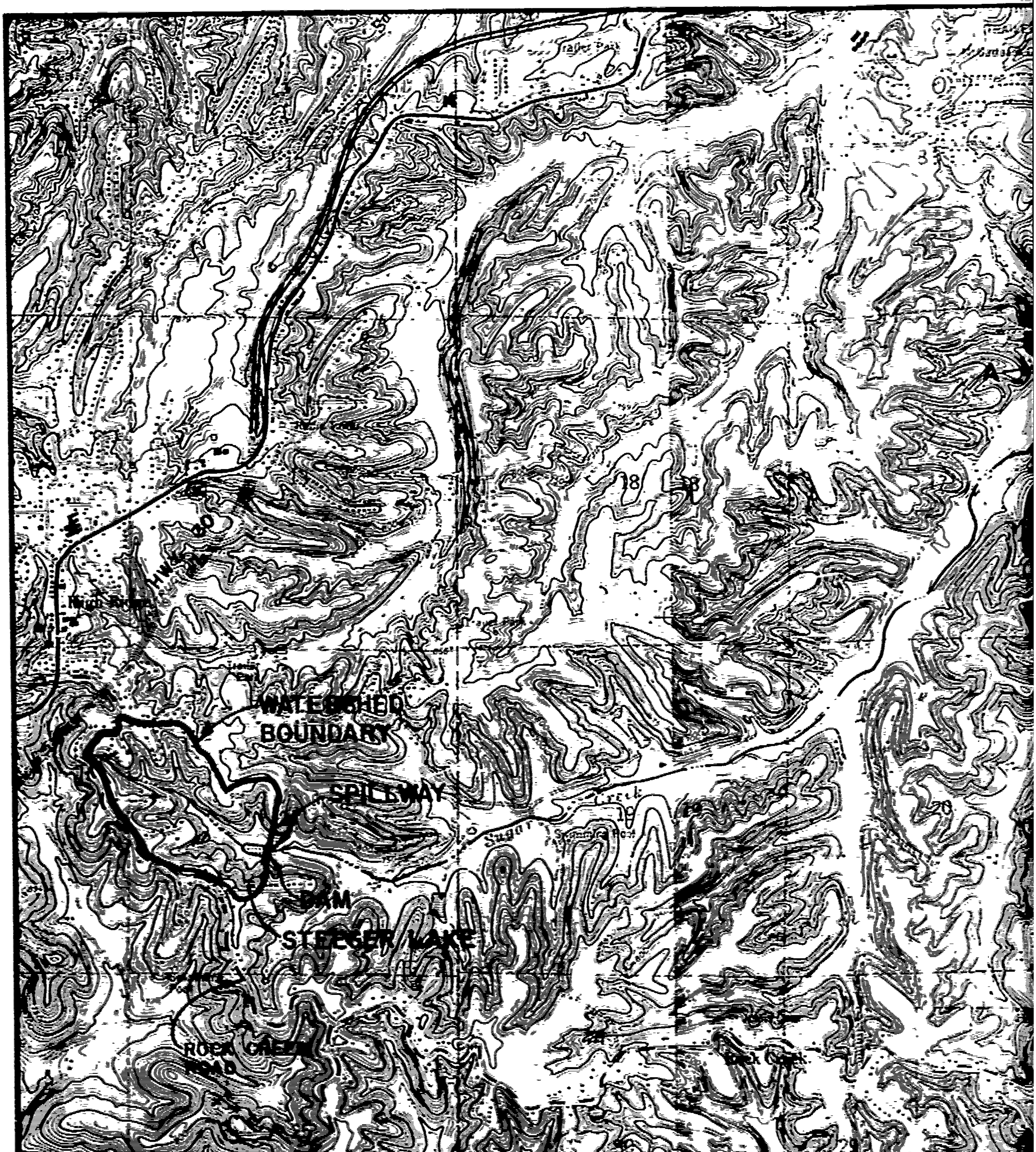


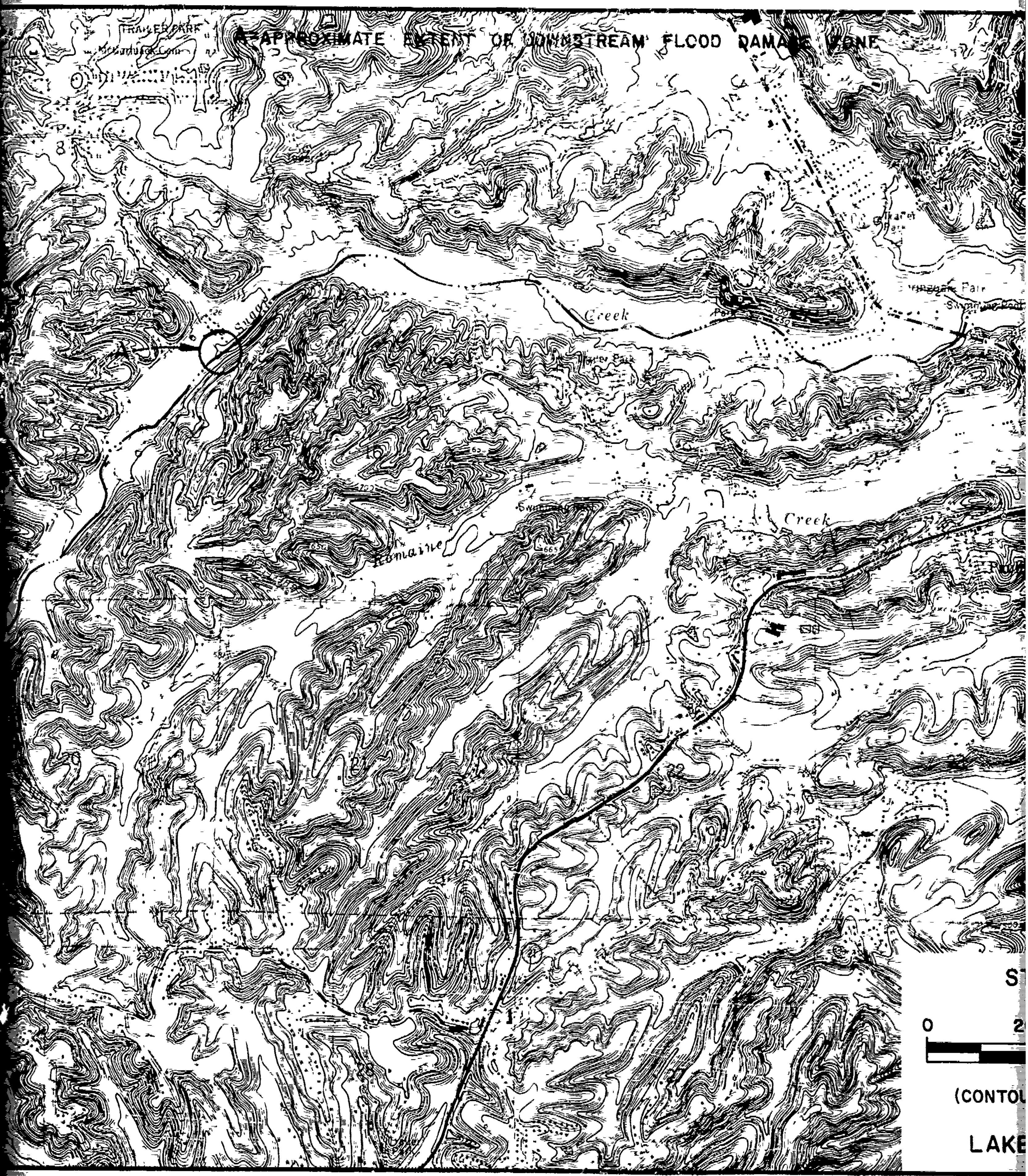
LOCATION MAP

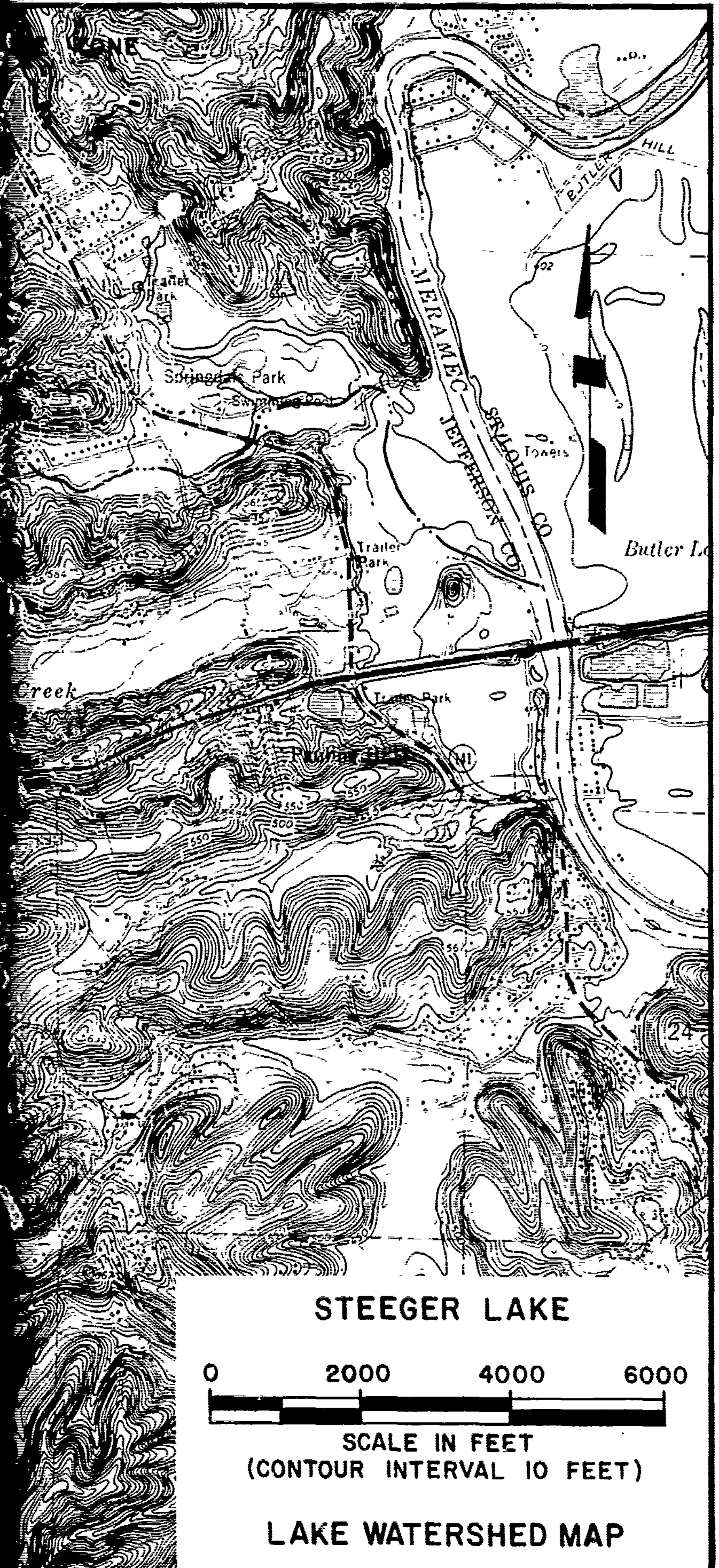
STEEGER LAKE

SCALE (MILES)

REGIONAL VICINITY MAP


BOUNDARY
SPILLWAY
DAM
STEEGER LAKE
Sugar Creek


APPROXIMATE EXTENT OF DOWNSTREAM FLOOD DAMAGE ZONE
TRAILER PARK
Creek
Romaine
Creek
ST
0
(CONTOU
LAKE



STEEGER LAKE

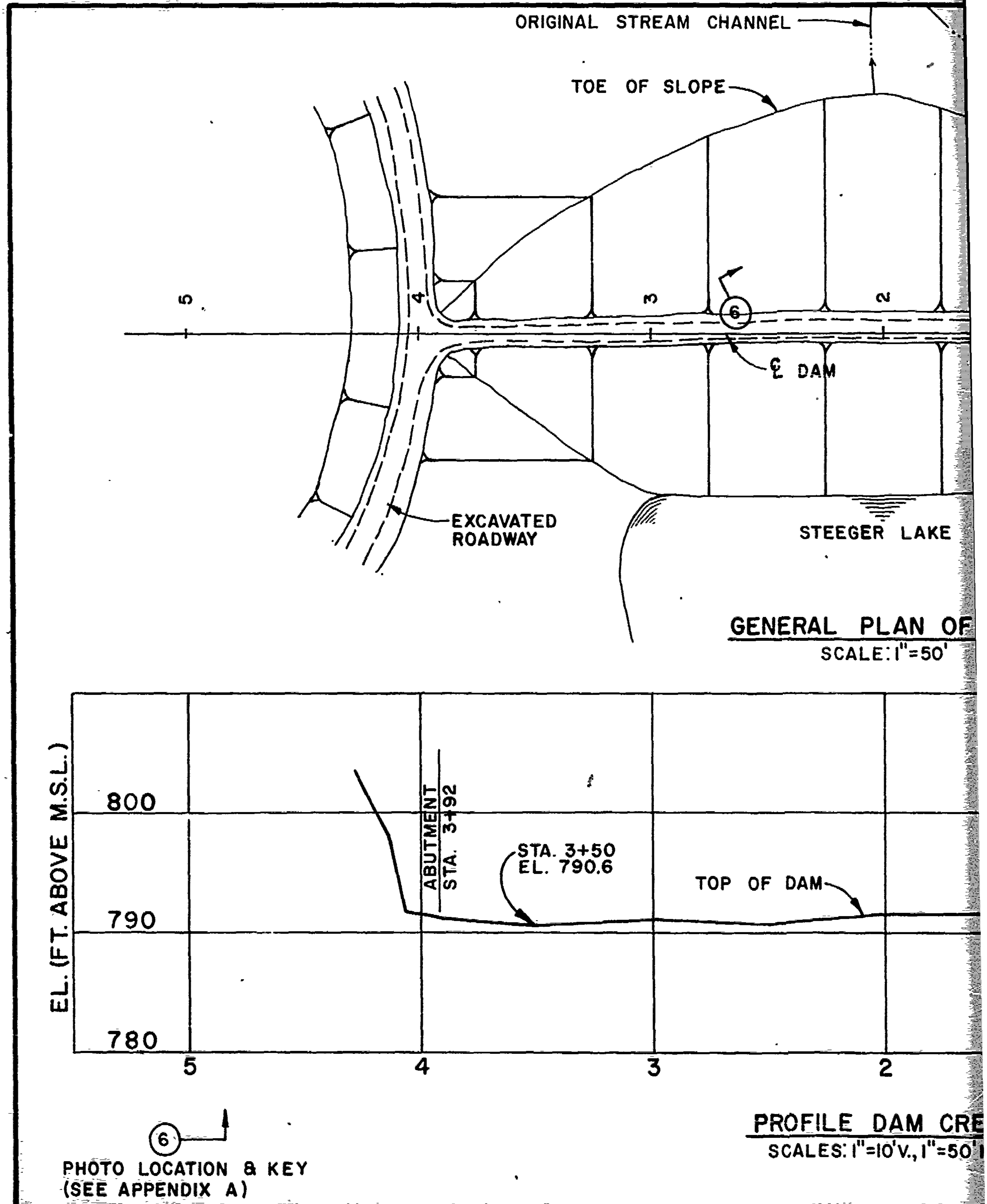
0 2000 4000 6000

SCALE IN FEET
(CONTOUR INTERVAL 10 FEET)

LAKE WATERSHED MAP

3

PLATE 2

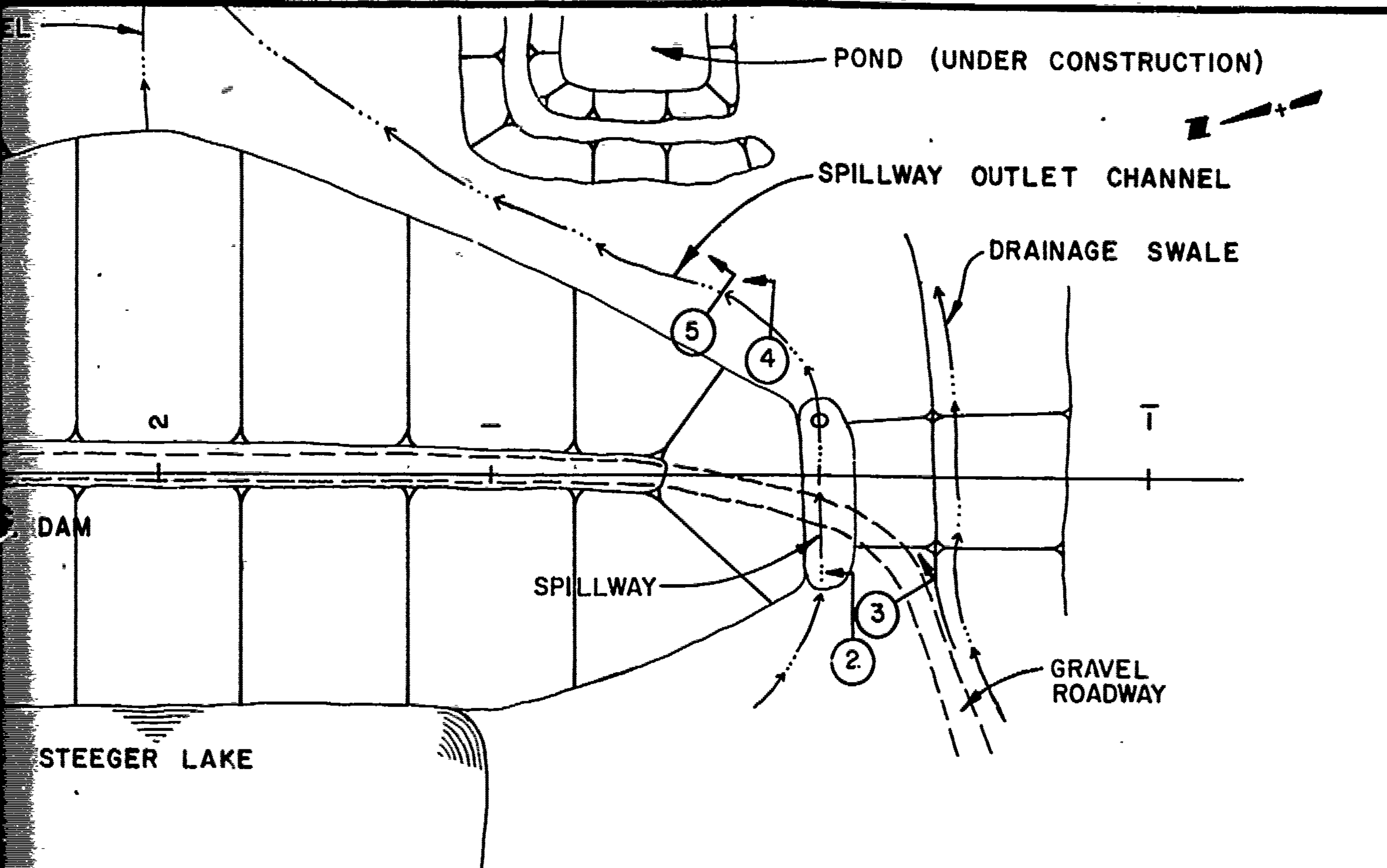


GENERAL PLAN OF

SCALE: 1"=50'

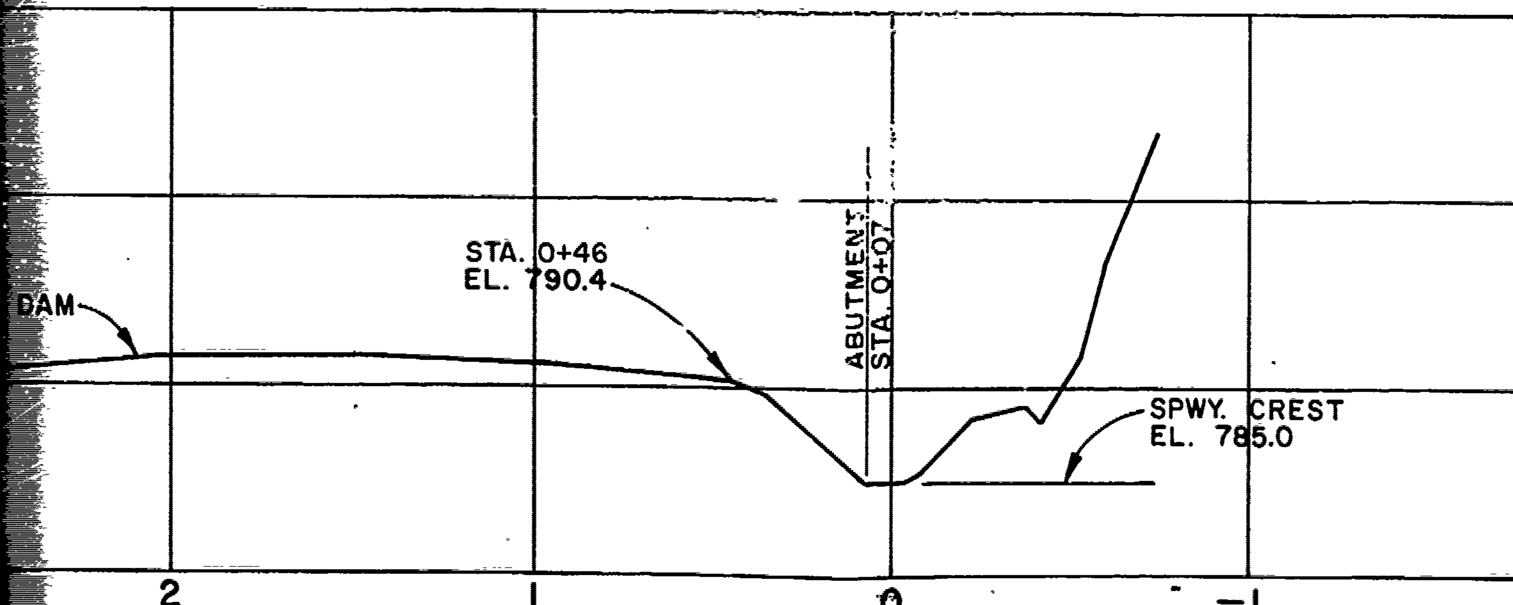
PROFILE DAM CRE

SCALES: 1"=10'V., 1"=50'



ERAL PLAN OF DAM

SCALE: 1"=50'



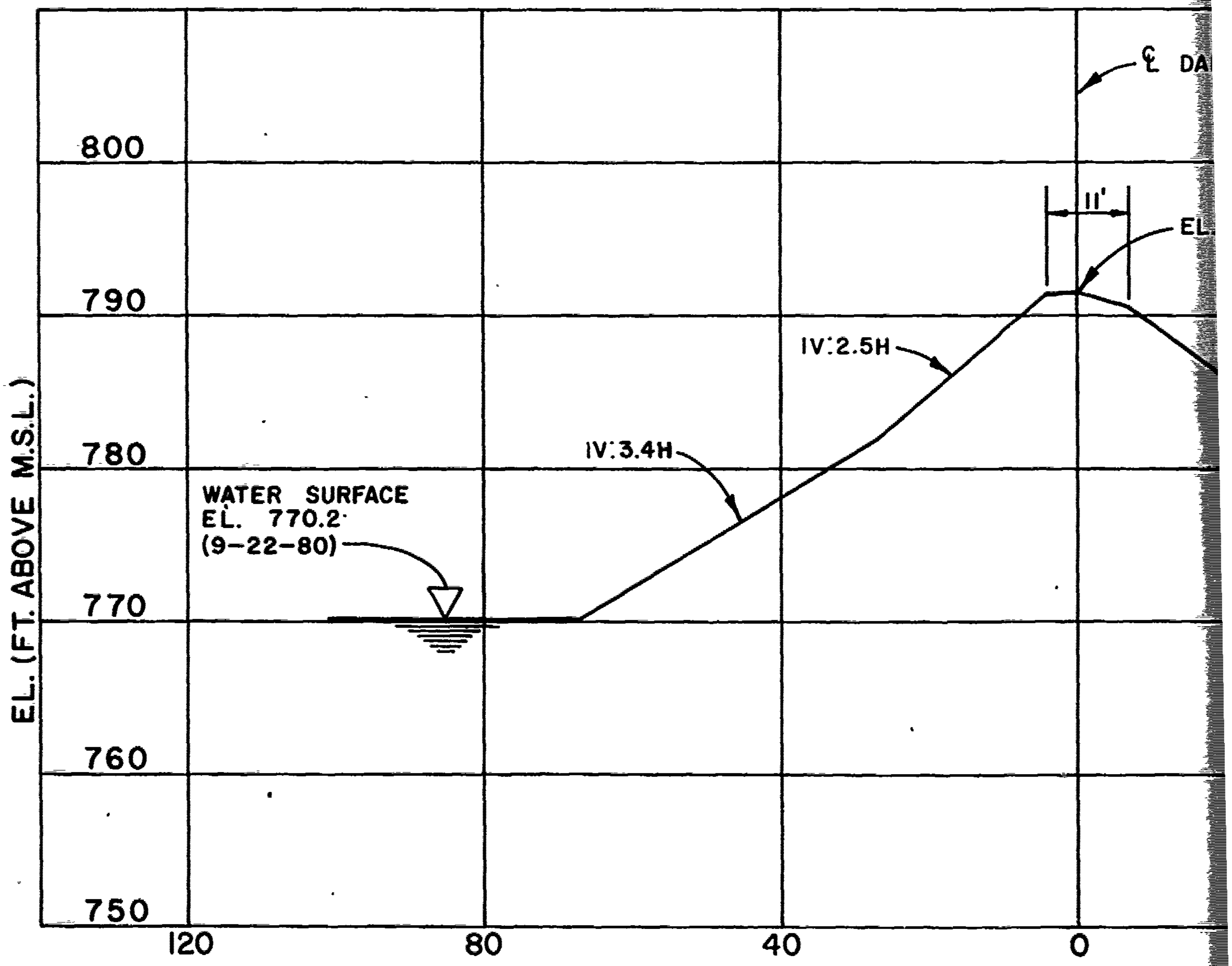
OFILE DAM CREST

ALES: 1"=10'V., 1"=50'H.

STEEGER LAKE
DAM PLAN & PROFILE

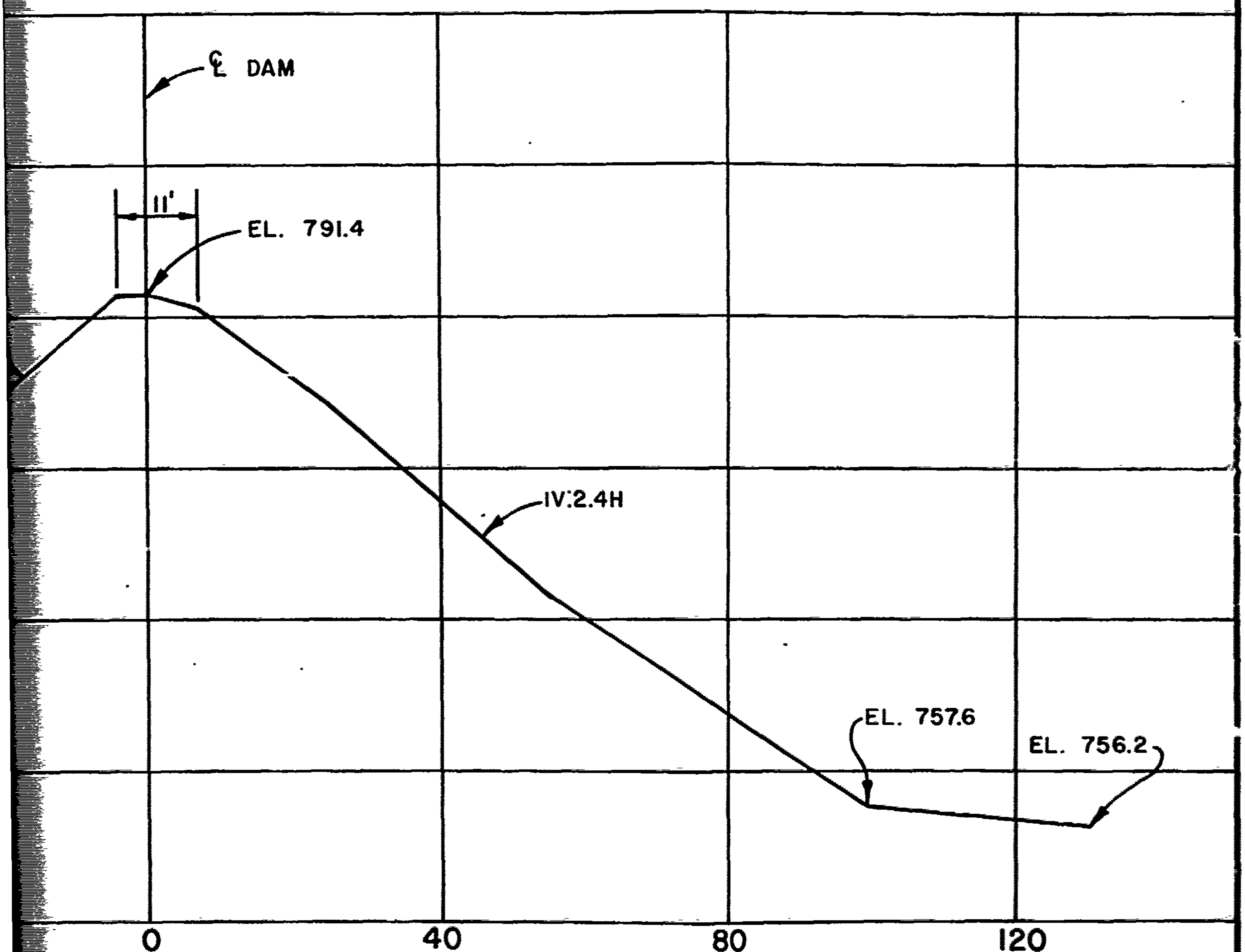
Horner & Shifrin, Inc. Oct. 1980

PLATE 3



DAM CROSS-SECTION STA

SCALES: 1"=10'V., 1"=20'H.



OSS-SECTION STA. 2+04

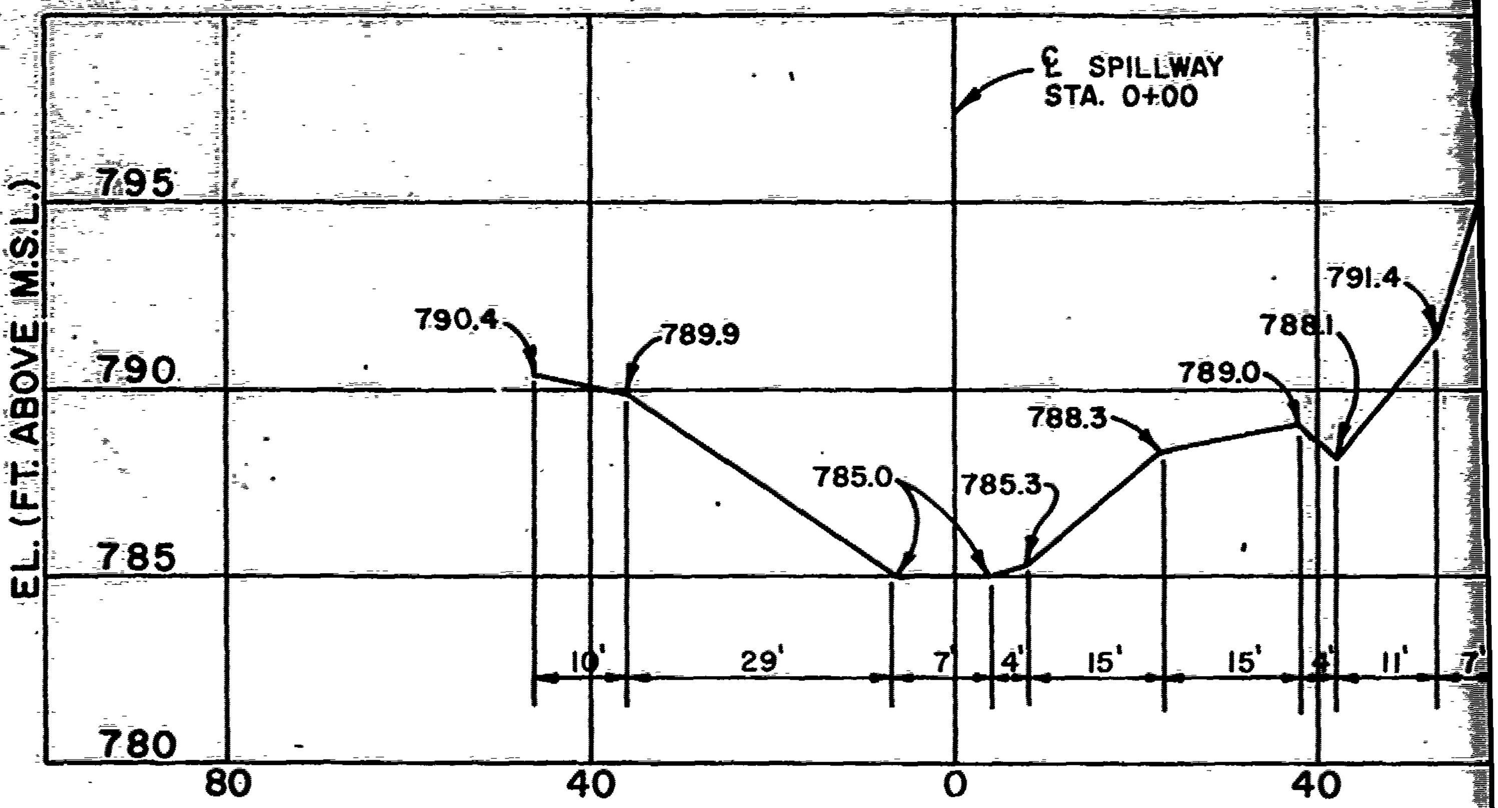
ALES: 1"=10'V., 1"=20'H.

STEEGER LAKE
DAM CROSS-SECTION

Horner & Shifrin, Inc. Oct. 1980

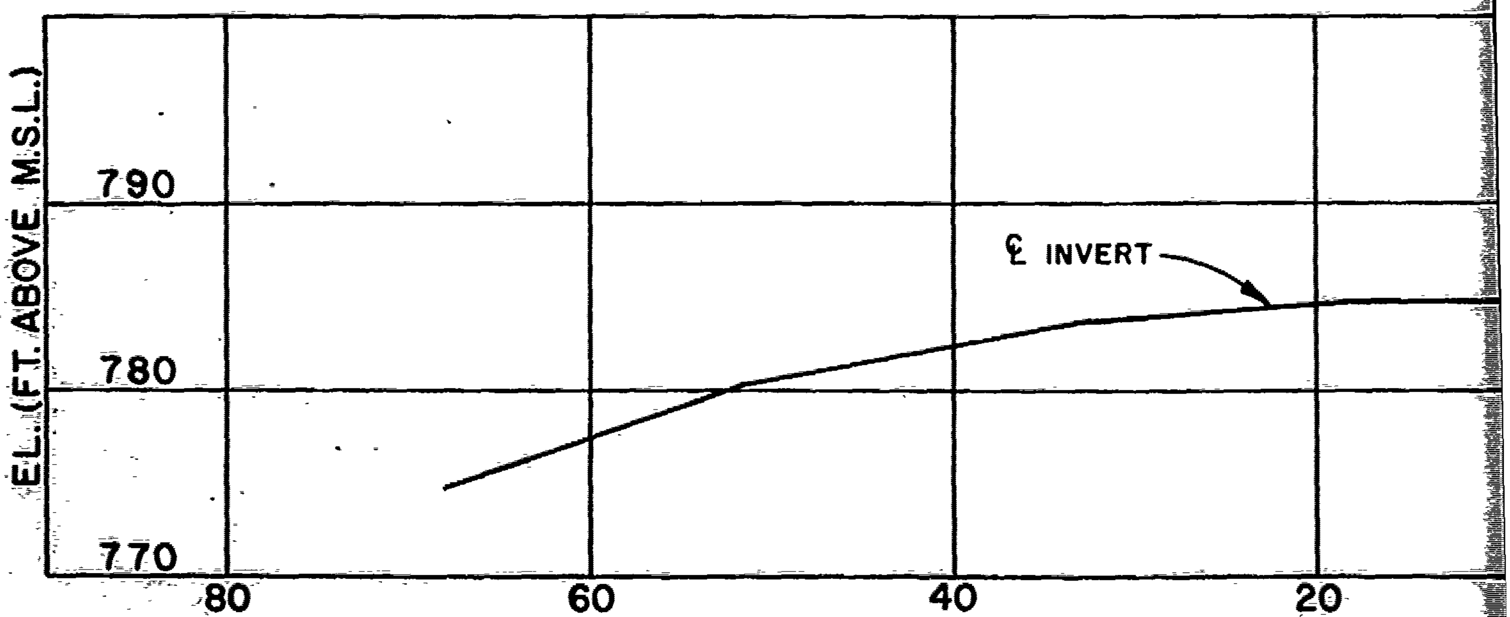
1 2

PLATE 4



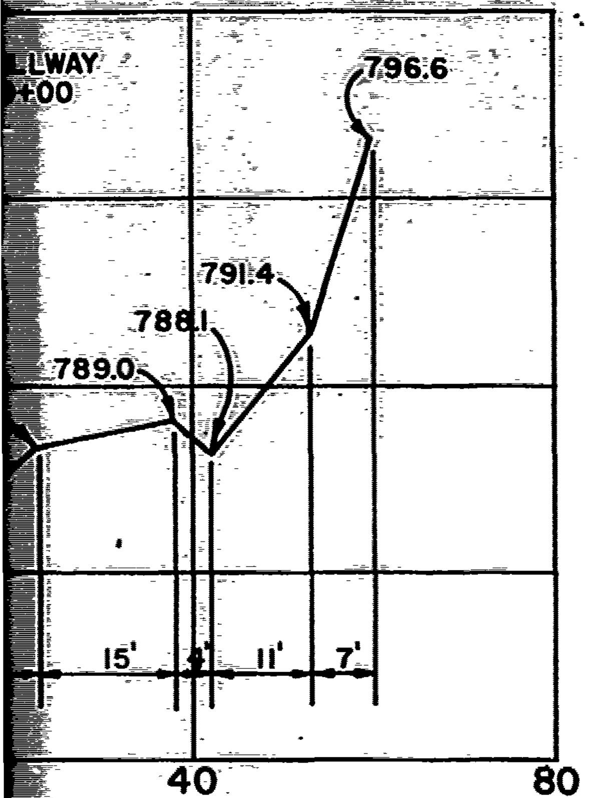
SPILLWAY CROSS-SECTION

SCALES: 1"=5'V., 1"=20'H.



SPILLWAY PROFILE

SCALES: 1"=10'V., 1"=10'H.



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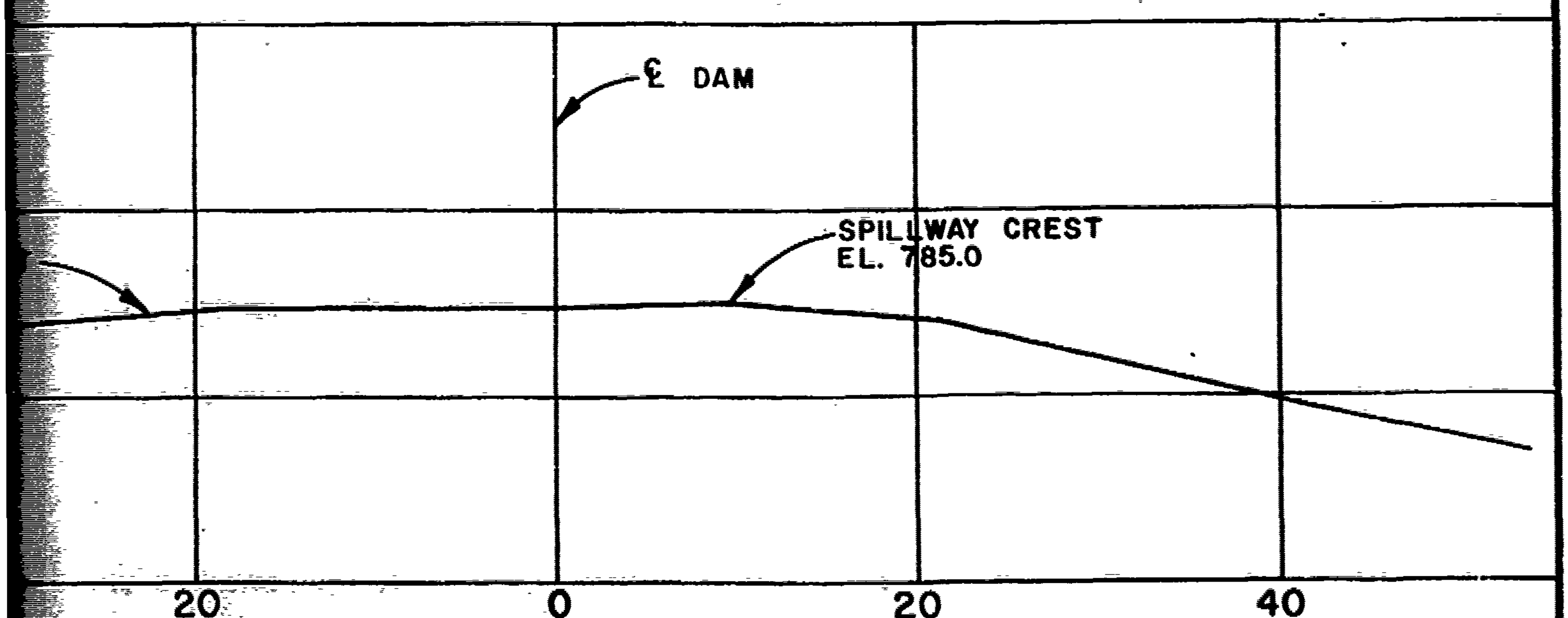


SPILLWAY PROFILE
SCALES: 1" = 10' V., 1" = 10' H.

STEEGER LAKE
SPILLWAY PROFILE &
CROSS-SECTION
Horner & Shifrin, Inc. Oct. 1980

ENGINEERING GEOLOGIC REPORT ON THE STEEGER LAKE SITE

Jefferson County, Mo.

LOCATION: In a tributary gully in the NE¼, NE¼, SW¼, Sec. 24, T. 43 N., R. 4 E., House Springs Quadrangle

The proposed lake site is in a east-west trending tributary to Sugar Creek. Limestone of the Kimswick Formation is the parent bedrock underlying the surface soils in the valley bottom. Shale, sandstone and limestone make up bedrock units in the valley walls and watershed area. The Kimswick limestone present in the streambed near the east property line is extremely permeable and will take and transmit water rapidly. The thin shale that is not exposed but probably is present behind the thick soil on the lower valley slope is water tight and as a result, numerous seeps and small springs appear on the lower valley slopes upstream and down stream of the dam site. The sandstone unit present just above the shale is seen outcropping near the upper end of the proposed lake on the shoreline of a small lake in that area. The sandstone is very permeable both vertically and horizontally and will transmit water rapidly. The limestone unit above the sandstone probably will not be involved in the project.

A thick sequence of clayey soil is present on the lower valley slopes and valley bottom. This soil unit appears to pinch-out approximately 20 to 25 feet above the valley bottom on both valley walls. This thick soil is probably the result of weathering on the shale unit with resultant landslides down the valley wall. The soil in the valley walls and valley bottom should prevent water from reaching the permeable limestone underneath. This soil will also make excellent borrow material both for the core and bulk material for the earthen dam.

The drainage area encompasses approximately 130 acres and would be on the high side for a 3 to 4 acre lake. Dam height to lake size cannot be computed on the scale of map used. A basin survey should be made if this information is desirable for spillway computation.

A test pit excavated in the valley bottom near the streambed reveals approximately 6 feet of sandy gravelly clay overlying a thin gravel bed bearing water. Penetration of this gravel bed into clay material indicates that the water is perched on a clay layer of unknown thickness.

SUMMARY:

In summary, sufficient amounts of clay appear to be present in the valley walls and valley bottom masking the permeable bedrock that would make water impoundment geologically feasible in this area.

RECOMMENDATIONS:

It is recommended that the core be extended to and into the clay layer that is present underneath the waterbearing gravel all the way across the valley bottom. As the core starts up the valley walls, seating the core in 3 to 4 feet of clay material would be sufficient. Unless sand and gravel lenses are present in the clay in the lower valley walls, coring all the way to bedrock is not necessary.

The core depth across the valley bottom may be uneven due to old channels that may be present in the fill material. As the core progresses across the valvey bottom, it should bottom out in the clay layer present underneath the gravel and clay for the core backfilled on clay material. It will be important to control water during the back-fill operation as the backfill should not be accomplished with water in the trench.

In the event that the clay layer under the water bearing gravel is thin (less than 2-3 feet), then the core should penetrate to bedrock across the valley bottom.

2). Spillway design will be somewhat critical due to the large and very steep watershed.

3). Bedrock should not be exposed in the lower valley walls below the waterline when excavating for borrow material. At least 4 to 5 or perhaps 6 feet of clay should be left masking the bedrock below the waterline. To repeat, the soil will make the lake hold water as the bedrock is very permeable.

4). As a precautionary measure, the streambed should be filled to general floodplain elevation upstream of the dam for several hundred feet. The streambed will be a weak point in the core area and filling of the streambed with borrow material will help alleviate this weak point.

5). Additional borrow material probably can be obtained in the upper end of the lake in the shallow water area.

6). Due to the erodability of the silty clay surface soil, a pipe primary spillway is recommended to handle the daily flow. A mechanical spillway will help cut down on constant maintance problems in the emergency spillway.

CONCLUSION:

Enough clay appears to be present in the lower valley walls and valley bottom to make this lake site geologically feasible for water impoundment.

Thomas J. Dean, Geologist
Applied Engineering & Urban Geology
Missouri Geological Survey
April 17, 1975

2 cpy: Mr. & Mrs. Stoeger
Rt. 3
Box 228
High Ridge, Mo. 63049

ADDENDUM TO THE GEOLOGIC REPORT OF THE STEEGER LAKE

JEFFERSON COUNTY, MISSOURI

LOCATION: NE¼, NE¼, SW¼, Sec. 24, T. 43 N., R. 4 E., House Springs Quadrangle.

The lake was constructed and the lake filled to a considerable depth and then drained down to a relatively stable water line according to the land owner.

The tributary stream feeding the lake is in a losing stream setting in the Kimmswick formation. The relatively thick plastic clays present in the lake bottom near the dam evidently have some weak spots in the upstream reaches of the lake. A small sink was reported by Mr. Steeger that was located during construction. Evidently, these weak points allow the lake to back up off of its clay pad to the point where vertical water loss takes place into the underlying very permeable bedrock. According to Mr. Steeger, the water does not reappear at a reasonable distance downstream of the dam. This is somewhat characteristic of the underlying limestone in that direction of travel of water in the rock does not coincide with the direction of the valley.

Padding of the upstream portion of the lake appears to be the only known feasible method of preventing vertical water loss through weak spots in the natural clay layer. A padding operation should start well onto the zone that does hold water with the pad extended upstream to the upper end of the excavated area in the valley bottom. It is thought at this time that only the bottom needs to be padded as the clay in the lower valley walls on the upper end of the lake appears to be of sufficient quality to pond water.

In addition to the padding of the lake bottom, it is recommended that a core be excavated to bedrock in the upper end of the lake to force water from the creek (that is presently going underground) to the surface and onto the clay pad constructed in the lake bottom. This, if successful, would give added quantities of water that would help overcome seepage and evaporation losses. It is not known whether the water coming down the creek that is now being lost is shallow enough to intercept with a core trench. It is thought at this time though that it would be worth the effort to make the attempt.

If sufficient clay is not available for a complete pad (18 inches to 2 feet in compacted thickness) then it would be well to scrape the bottom area a sufficient depth to locate the old collapses (that are probably now gravel filled) and repair them on an individual basis. It may well be that only one or two very small ancient collapse areas are present that are robbing the lake of water. If they cannot be located, however, then an entire pad would be necessary.

The severe landsliding problem on the northeastern side of the lake is caused by water moving out of the Bushberg sandstone. Loose sand that has accumulated on the slope in this area over many many years becomes saturated and slides when the toe of the natural slope has been removed such as for improvement of a lake shoreline. While this sliding action should not affect the lake from the water holding standpoint, it will tend to be unsightly where the slide material is present above the water line and of course tends to decrease the volume of the lake. The only known way to prevent further sliding would be to place a soil berm at the toe of the slide area to physically hold it in place. Additional benefits would be derived from cutting a trench across the slide area and placing a perforated drain pipe into the material so that water could drain out of the slide area into the lake rather than saturate the material at lower elevations.

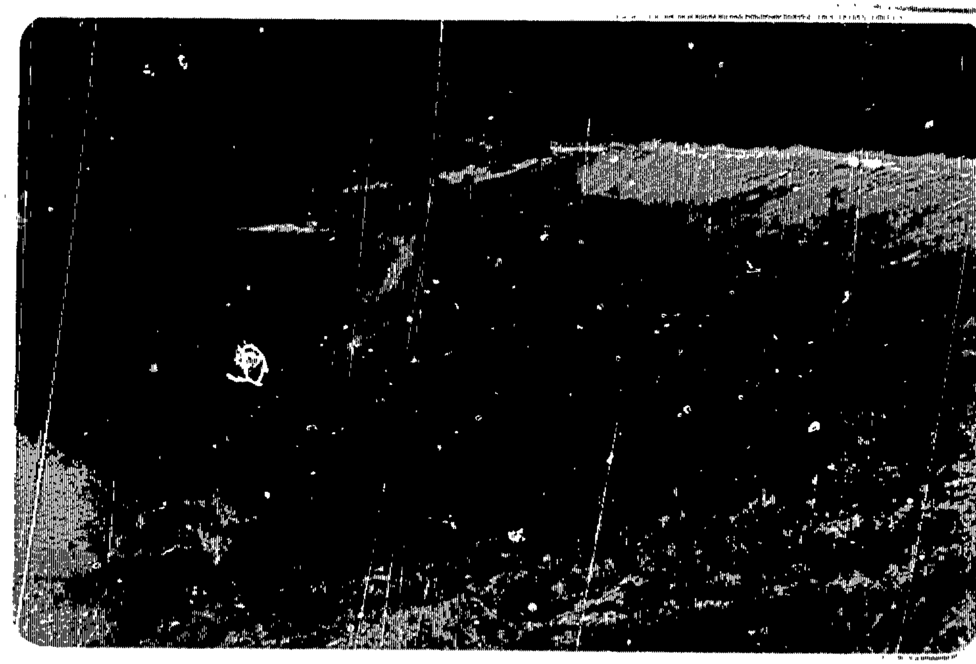
If a core is placed in the upstream portion of the lake, this office would be happy to help evaluate shallow subsurface conditions when the trench is opened up.

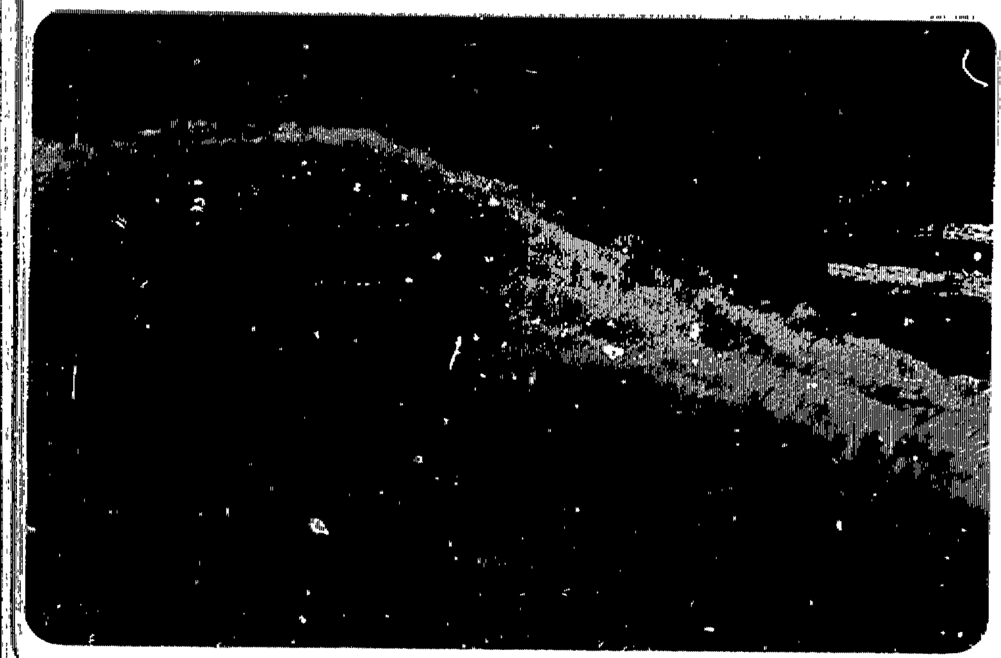
Thomas J. Dean, Geologist
Engineering Geology Section
Geology & Land Survey
May 18, 1979

orig: Mr. Steeger
Rt. 3, Box 228
High Ridge, MO 63049

APPENDIX A

INSPECTION PHOTOGRAPHS





1	2
3	X

PHOTO KEY

NO.	DESCRIPTION
1	DAM OVERVIEW
2	UPSTREAM FACE OF DAM
3	DOWNSTREAM FACE OF DAM

4	5
6	X

PHOTO KEY

NO.	DESCRIPTION
4	SPILLWAY CREST
5	SPILLWAY OUTLET CHANNEL
6	SMALL POND UNDER CONSTRUCTION JUST DOWNSTREAM OF SPILLWAY

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) 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 25.5 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent (100-year frequency) flood was provided by the St. Louis District, Corps of Engineers.

b. Drainage area = 0.194 square miles = 124 acres.

c. SCS parameters:

Time of Concentration (Tc) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.200 hours

Where: T_c = Travel time of water from hydraulically most distant point to point of interest, hours.

L = Length of longest watercourse = 0.578 miles.

H = Elevation difference = 151 feet.

The time of concentration (T_c) was obtained using Method C as described in Figure 30, "Design of Small Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Lag time = 0.120 hours (0.60 Tc)

Hydrologic soil group = D (100% Gasconade Series with steep wooded hillsides per SCS Missouri General Soil Map)

Soil type CN = 79 (AMC II, 100-yr flood condition)
= 91 (AMC III, PMF condition)

2. The trapezoidal spillway section consists of a broad-crested section for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

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

b. It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth was computed as

$Q_C = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference, "Handbook of Hydraulics", Fifth Edition, by King & Brater, page 8-7.

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

d. The spillway discharges and corresponding elevations were entered on the Y4 and Y5 cards. Calculations for determining the spillway capacity are presented on pages B-11 through B-13.

3. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The program assumes that flow over the dam crest section occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow over the spillway as entered on the Y4 and Y5 cards.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{{v_c}^2}{2g}$

```
A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF STEEGER LAKE DAM
A3      RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     208       0       5                                                    0
B1      5
J       1       1       1
J1   0.15
K       0   INFLOW                                      1
K1          INFLOW HYDROGRAPH
M       1       2   0.194                         1.0                        1
P       0    25.5     102     120     130
T                                                         -1      -.01
W2          0.120
X    -1.0    -.10     2.0
K       1     DAM                                       1
K1      RESERVOIR ROUTING BY MODIFIED PULS
                                      1       1
Y1      1                                             -780.20     -1
Y4  785.0  785.42  786.11  786.78  787.43  788.10  788.71  789.34  790.05  790.75
Y4791.31  791.88  792.63  793.35  794.13  794.86
Y5      0    11.6      62     145     244     410     617     860    1234    1696
Y5   2110    2600    3326    4110    4765    5667
$A      0     1.4     4.4     6.2     8.3    13.0    17.9
$E    760   771.2     780     785     790     800     810
$$  785.0
$D  786.3
$L      0      15      73     194     355     341     367     382
$V  790.4   790.6   790.8   791.0   791.5   791.8   798.0   803.6
K      99
```

```
1A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2        HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF STEEGER LAKE DAM
A3        RATIOS OF PMF ROUTED THROUGH RESERVOIR
B      288       0       5                                                         4
B1       5
J        1       8       1
J1    0.02    0.04    0.06    0.08    0.10    0.12    0.50    1.00
                                                          1
K        0   INFLOW
K1        INFLOW HYDROGRAPH                                                        1
M        1       2   0.194                          1.0
P        0    25.5     102     120     130
                                                         -1     -91
T
W2           0.120
X     -1.0    -.10     2.0
                                                          1
K        1     DAM
K1        RESERVOIR ROUTING BY MODIFIED PULS
                                 1       1
Y                                                     57.71      -1
Y1       1
Y4   785.0  785.42  786.11  786.78  787.43  788.10  788.71  78?.34  790.05  790.75
Y4  791.31  791.88  792.63  793.35  794.13  794.88
Y5       0    11.4      62     145     262     420     617  [illegible]  1234  1696
Y5    2110    2600    3326    4110    4965    5867
$A       0     1.6     4.4     6.2     8.3    13.0    17.9
$E     760   771.2     780     785     790     800     810
$$   785.0
$D   786.3
$L       0      15      73     194     355     361     367  [illegible]
$V   790.4   790.6   790.8   791.0   791.5   791.8   798.0  [illegible]
K       99
```

```
1A1       ANALYSIS OF DAM OVERTOPPING USING 1% CHANCE FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF STEEGER LAKE DAM
A3       1% CHANCE FLOOD ROUTED THROUGH RESERVOIR
B      288       0       5                                               4
B1       5
J        1       1       1
J1    1.00
K        0  INFLOW                                       1
K1       INFLOW HYDROGRAPH
M        0       2   6.194                   1.0                         1
O      288   6.974
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
O1    .007    .007    .012    .012    .012    .012    .012    .012    .012    .012
O1    .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
O1    .012    .012    .012    .012    .012    .012    .012    .012    .012    .012
O1    .012    .012    .012    .012    .012    .012    .012    .012    .023    .023
O1    .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
O1    .023    .023    .023    .023    .023    .023    .030    .030    .030    .030
O1    .030    .030    .048    .048    .048    .049    .049    .049    .134    .134
O1    .134    .255    .255    .546    .817    .380    .255    .134    .134    .134
O1    .049    .049    .049    .048    .048    .048    .030    .030    .030    .030
O1    .030    .030    .023    .023    .023    .023    .023    .023    .023    .023
O1    .023    .023    .023    .023    .023    .023    .023    .023    .023    .023
```

1% CHANCE FLOOD (cont'd)

01	.012	.012	.012	.012	.012	.012	.012	.012	.012	.012
01	.012	.012	.012	.012	.012	.012	.012	.012	.012	.012
01	.012	.012	.012	.012	.012	.012	.012	.012	.012	.012
01	.012	.012	.012	.012	.012	.012	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007	.007	.007
01	.007	.007	.007	.007	.007	.007	.007	.007		
1							-1	-79		
W2		0.120								
X	-1.0	-.10	2.0							
K	1	DAM					1			
K1	RESERVOIR ROUTING BY MODIFIED PULS									
Y				1	1					
Y1	1						-773.40	1		
Y4	785.0	785.42	786.11	786.78	787.43	788.10	788.71	789.34	790.05	790.75
Y4	791.21	791.88	792.63	793.35	794.13	794.88				
Y5	0	11.6	62	145	262	420	617	[illegible]	1234	1696
Y5	2110	2600	3326	4110	4965	5867				
$A	0	1.6	4.4	6.2	8.3	13.0	17.9			
$E	760	771.2	780	785	790	800	810			
$$	785.0									
$D	786.3									
$L	0	15	73	194	355	[illegible]	367	382		
$V	790.4	790.6	790.8	791.0	791.5	791.8	798.0	803.6		
K	99									

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF STEEGER LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= .15

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.19	0.00	.19	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	-91.00	0.00	0.00

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

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .12

RECESSION DATA

STRTQ= -1.00 QRCSN= -.10 RTIOR= 2.00

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 9 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .12 VOL= 1.00

292.	582.	365.	150.	65.	28.	12.	6.	2.

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	0.00	.01	0.	1.01	12.05	145	.22	.21	.01	137.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.21	.00	224.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.21	.00	279.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.21	.00	302.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.21	.00	312.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.21	.00	316.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.00	319.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.00	320.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.00	320.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.00	321.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.00	321.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.00	321.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.26	.00	334.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.26	.26	.00	359.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	.26	.00	375.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.26	.26	.00	381.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.26	.00	384.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.26	.00	386.
1.01	1.35	19	.01	.00	.01	2.	1.01	13.35	163	.26	.26	.00	387.
1.01	1.40	20	.01	.00	.01	2.	1.01	13.40	164	.26	.26	.00	387.
1.01	1.45	21	.01	.00	.01	3.	1.01	13.45	165	.26	.26	.00	387.
1.01	1.50	22	.01	.00	.01	3.	1.01	13.50	166	.26	.26	.00	387.
1.01	1.55	23	.01	.00	.01	4.	1.01	13.55	167	.26	.26	.00	388.
1.01	2.00	24	.01	.00	.01	4.	1.01	14.00	168	.26	.26	.00	388.
1.01	2.05	25	.01	.00	.01	5.	1.01	14.05	169	.33	.32	.00	407.
1.01	2.10	26	.01	.00	.01	5.	1.01	14.10	170	.33	.32	.00	444.
1.01	2.15	27	.01	.00	.01	5.	1.01	14.15	171	.33	.32	.00	468.
1.01	2.20	28	.01	.00	.01	6.	1.01	14.20	172	.33	.32	.00	478.
1.01	2.25	29	.01	.00	.01	6.	1.01	14.25	173	.33	.32	.00	482.
1.01	2.30	30	.01	.00	.01	7.	1.01	14.30	174	.33	.32	.00	484.
1.01	2.35	31	.01	.00	.01	7.	1.01	14.35	175	.33	.32	.00	485.
1.01	2.40	32	.01	.01	.01	7.	1.01	14.40	176	.33	.32	.00	486.
1.01	2.45	33	.01	.01	.01	8.	1.01	14.45	177	.33	.32	.00	486.
1.01	2.50	34	.01	.01	.01	8.	1.01	14.50	178	.33	.32	.00	486.
1.01	2.55	35	.01	.01	.01	8.	1.01	14.55	179	.33	.32	.00	486.
1.01	3.00	36	.01	.01	.01	8.	1.01	15.00	180	.33	.32	.00	485.
1.01	3.05	37	.01	.01	.01	9.	1.01	15.05	181	.20	.20	.00	449.
1.01	3.10	38	.01	.01	.01	9.	1.01	15.10	182	.40	.39	.00	433.
1.01	3.15	39	.01	.01	.01	9.	1.01	15.15	183	.40	.39	.00	501.
1.01	3.20	40	.01	.01	.01	9.	1.01	15.20	184	.59	.59	.00	611.
1.01	3.25	41	.01	.01	.01	10.	1.01	15.25	185	.69	.69	.00	776.
1.01	3.30	42	.01	.01	.01	10.	1.01	15.30	186	1.68	1.68	.00	1202.
1.01	3.35	43	.01	.01	.01	10.	1.01	15.35	187	2.77	2.76	.01	2163.
1.01	3.40	44	.01	.01	.01	10.	1.01	15.40	188	1.09	1.09	.00	2695.
1.01	3.45	45	.01	.01	.01	11.	1.01	15.45	189	.69	.69	.00	2161.
1.01	3.50	46	.01	.01	.01	11.	1.01	15.50	190	.59	.59	.00	1524.
1.01	3.55	47	.01	.01	.01	11.	1.01	15.55	191	.40	.39	.00	1114.
1.01	4.00	48	.01	.01	.01	11.	1.01	16.00	192	.40	.39	.00	833.
1.01	4.05	49	.01	.01	.01	11.	1.01	16.05	193	.30	.30	.00	671.

END-OF-PERIOD FLOW (Cont'd)

1.01	4.10	50	.01	.01	.01	12.	1.01	16.10	194	.30	.30	.00	558.
1.01	4.15	51	.01	.01	.01	12.	1.01	16.15	195	.30	.30	.00	497.
1.01	4.20	52	.01	.01	.01	12.	1.01	16.20	196	.30	.30	.00	471.
1.01	4.25	53	.01	.01	.01	12.	1.01	16.25	197	.30	.30	.00	461.
1.01	4.30	54	.01	.01	.01	12.	1.01	16.30	198	.30	.30	.00	457.
1.01	4.35	55	.01	.01	.01	13.	1.01	16.35	199	.30	.30	.00	456.
1.01	4.40	56	.01	.01	.01	13.	1.01	16.40	200	.30	.30	.00	455.
1.01	4.45	57	.01	.01	.01	13.	1.01	16.45	201	.30	.30	.00	455.
1.01	4.50	58	.01	.01	.01	13.	1.01	16.50	202	.30	.30	.00	455.
1.01	4.55	59	.01	.01	.01	13.	1.01	16.55	203	.30	.30	.00	455.
1.01	5.00	60	.01	.01	.01	13.	1.01	17.00	204	.30	.30	.00	455.
1.01	5.05	61	.01	.01	.01	13.	1.01	17.05	205	.24	.24	.00	436.
1.01	5.10	62	.01	.01	.01	14.	1.01	17.10	206	.24	.24	.00	398.
1.01	5.15	63	.01	.01	.00	14.	1.01	17.15	207	.24	.24	.00	375.
1.01	5.20	64	.01	.01	.00	14.	1.01	17.20	208	.24	.24	.00	365.
1.01	5.25	65	.01	.01	.00	14.	1.01	17.25	209	.24	.24	.00	361.
1.01	5.30	66	.01	.01	.00	14.	1.01	17.30	210	.24	.24	.00	359.
1.01	5.35	67	.01	.01	.00	14.	1.01	17.35	211	.24	.24	.00	358.
1.01	5.40	68	.01	.01	.00	14.	1.01	17.40	212	.24	.24	.00	358.
1.01	5.45	69	.01	.01	.00	14.	1.01	17.45	213	.24	.24	.00	358.
1.01	5.50	70	.01	.01	.00	15.	1.01	17.50	214	.24	.24	.00	358.
1.01	5.55	71	.01	.01	.00	15.	1.01	17.55	215	.24	.24	.00	358.
1.01	6.00	72	.01	.01	.00	15.	1.01	18.00	216	.24	.24	.00	358.
1.01	6.05	73	.06	.05	.02	25.	1.01	18.05	217	.02	.02	.00	294.
1.01	6.10	74	.06	.05	.02	46.	1.01	18.10	218	.02	.02	.00	255.
1.01	6.15	75	.06	.05	.02	60.	1.01	18.15	219	.02	.02	.00	238.
1.01	6.20	76	.06	.05	.02	67.	1.01	18.20	220	.02	.02	.00	222.
1.01	6.25	77	.06	.05	.01	71.	1.01	18.25	221	.02	.02	.00	207.
1.01	6.30	78	.06	.05	.01	73.	1.01	18.30	222	.02	.02	.00	193.
1.01	6.35	79	.06	.05	.01	75.	1.01	18.35	223	.02	.02	.00	180.
1.01	6.40	80	.06	.05	.01	76.	1.01	18.40	224	.02	.02	.00	168.
1.01	6.45	81	.06	.05	.01	77.	1.01	18.45	225	.02	.02	.00	157.
1.01	6.50	82	.06	.05	.01	78.	1.01	18.50	226	.02	.02	.00	146.
1.01	6.55	83	.06	.05	.01	79.	1.01	18.55	227	.02	.02	.00	137.
1.01	7.00	84	.06	.05	.01	80.	1.01	19.00	228	.02	.02	.00	127.
1.01	7.05	85	.06	.05	.01	81.	1.01	19.05	229	.02	.02	.00	119.
1.01	7.10	86	.06	.06	.01	82.	1.01	19.10	230	.02	.02	.00	111.
1.01	7.15	87	.06	.06	.01	82.	1.01	19.15	231	.02	.02	.00	104.
1.01	7.20	88	.06	.06	.01	83.	1.01	19.20	232	.02	.02	.00	97.
1.01	7.25	89	.06	.06	.01	83.	1.01	19.25	233	.02	.02	.00	90.
1.01	7.30	90	.06	.06	.01	84.	1.01	19.30	234	.02	.02	.00	84.
1.01	7.35	91	.06	.06	.01	85.	1.01	19.35	235	.02	.02	.00	78.
1.01	7.40	92	.06	.06	.01	85.	1.01	19.40	236	.02	.02	.00	73.
1.01	7.45	93	.06	.06	.01	85.	1.01	19.45	237	.02	.02	.00	68.
1.01	7.50	94	.06	.06	.01	86.	1.01	19.50	238	.02	.02	.00	64.
1.01	7.55	95	.06	.06	.01	86.	1.01	19.55	239	.02	.02	.00	59.
1.01	8.00	96	.06	.06	.01	87.	1.01	20.00	240	.02	.02	.00	55.
1.01	8.05	97	.06	.06	.01	87.	1.01	20.05	241	.02	.02	.00	52.
1.01	8.10	98	.06	.06	.01	87.	1.01	20.10	242	.02	.02	.00	48.
1.01	8.15	99	.06	.06	.01	88.	1.01	20.15	243	.02	.02	.00	45.
1.01	8.20	100	.06	.06	.00	88.	1.01	20.20	244	.02	.02	.00	42.
1.01	8.25	101	.06	.06	.00	88.	1.01	20.25	245	.02	.02	.00	39.

1.01	8.30	102	.06	.06	.00	88.	1.01	20.30	246	.02	.02	.00	37.
1.01	8.35	103	.06	.06	.00	89.	1.01	20.35	247	.02	.02	.00	32.
1.01	8.40	104	.06	.06	.00	89.	1.01	20.40	248	.02	.02	.00	32.
1.01	8.45	105	.06	.06	.00	89.	1.01	20.45	249	.02	.02	.00	32.
1.01	8.50	106	.06	.06	.00	89.	1.01	20.50	250	.02	.02	.00	32.
1.01	8.55	107	.06	.06	.00	90.	1.01	20.55	251	.02	.02	.00	32.
1.01	9.00	108	.06	.06	.00	90.	1.01	21.00	252	.02	.02	.00	32.
1.01	9.05	109	.06	.06	.00	90.	1.01	21.05	253	.02	.02	.00	32.
1.01	9.10	110	.06	.06	.00	90.	1.01	21.10	254	.02	.02	.00	32.
1.01	9.15	111	.06	.06	.00	90.	1.01	21.15	255	.02	.02	.00	32.
1.01	9.20	112	.06	.06	.00	90.	1.01	21.20	256	.02	.02	.00	32.
1.01	9.25	113	.06	.06	.00	91.	1.01	21.25	257	.02	.02	.00	32.
1.01	9.30	114	.06	.06	.00	91.	1.01	21.30	258	.02	.02	.00	32.
1.01	9.35	115	.06	.06	.00	91.	1.01	21.35	259	.02	.02	.00	32.
1.01	9.40	116	.06	.06	.00	91.	1.01	21.40	260	.02	.02	.00	32.
1.01	9.45	117	.06	.06	.00	91.	1.01	21.45	261	.02	.02	.00	32.
1.01	9.50	118	.06	.06	.00	91.	1.01	21.50	262	.02	.02	.00	32.
1.01	9.55	119	.06	.06	.00	91.	1.01	21.55	263	.02	.02	.00	32.
1.01	10.00	120	.06	.06	.00	92.	1.01	22.00	264	.02	.02	.00	32.
1.01	10.05	121	.06	.06	.00	92.	1.01	22.05	265	.02	.02	.00	32.
1.01	10.10	122	.06	.06	.00	92.	1.01	22.10	266	.02	.02	.00	32.
1.01	10.15	123	.06	.06	.00	92.	1.01	22.15	267	.02	.02	.00	32.
1.01	10.20	124	.06	.06	.00	92.	1.01	22.20	268	.02	.02	.00	32.
1.01	10.25	125	.06	.06	.00	92.	1.01	22.25	269	.02	.02	.00	32.
1.01	10.30	126	.06	.06	.00	92.	1.01	22.30	270	.02	.02	.00	32.
1.01	10.35	127	.06	.06	.00	92.	1.01	22.35	271	.02	.02	.00	32.
1.01	10.40	128	.06	.06	.00	92.	1.01	22.40	272	.02	.02	.00	32.
1.01	10.45	129	.06	.06	.00	92.	1.01	22.45	273	.02	.02	.00	32.
1.01	10.50	130	.06	.06	.00	92.	1.01	22.50	274	.02	.02	.00	32.
1.01	10.55	131	.06	.06	.00	93.	1.01	22.55	275	.02	.02	.00	32.
1.01	11.00	132	.06	.06	.00	93.	1.01	23.00	276	.02	.02	.00	32.
1.01	11.05	133	.06	.06	.00	93.	1.01	23.05	277	.02	.02	.00	32.
1.01	11.10	134	.06	.06	.00	93.	1.01	23.10	278	.02	.02	.00	32.
1.01	11.15	135	.06	.06	.00	93.	1.01	23.15	279	.02	.02	.00	32.
1.01	11.20	136	.06	.06	.00	93.	1.01	23.20	280	.02	.02	.00	32.
1.01	11.25	137	.06	.06	.00	93.	1.01	23.25	281	.02	.02	.00	32.
1.01	11.30	138	.06	.06	.00	93.	1.01	23.30	282	.02	.02	.00	32.
1.01	11.35	139	.06	.06	.00	93.	1.01	23.35	283	.02	.02	.00	32.
1.01	11.40	140	.06	.06	.00	93.	1.01	23.40	284	.02	.02	.00	32.
1.01	11.45	141	.06	.06	.00	93.	1.01	23.45	285	.02	.02	.00	32.
1.01	11.50	142	.06	.06	.00	93.	1.01	23.50	286	.02	.02	.00	32.
1.01	11.55	143	.06	.06	.00	93.	1.01	23.55	287	.02	.02	.00	32.
1.01	12.00	144	.06	.06	.00	93.	1.02	0.00	288	.02	.02	.00	32.

SUM	33.15	31.99	1.16	50131.
	(842.)(	813.)(	29.)(	1419.55)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2695.	537.	174.	174.	50117.
CMS	76.	15.	5.	5.	1419.
INCHES		25.73	33.38	33.38	33.38
MM		653.64	847.76	847.76	847.76
AC-FT		266.	345.	345.	345.
THOUS CU M		328.	426.	426.	426.

SURFACE AREA=	0.	2.	4.	6.	8.	13.	18.
CAPACITY=	0.	6.	31.	58.	94.	199.	353.
ELEVATION=	760.	771.	780.	785.	790.	800.	810.

SUMMARY OF DAM SAFETY ANALYSIS

0.15 PMF

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	78[illegible].20	785.00	786.30
STORAGE	32.	58.	66.
OUTFLOW	0.	0.	86.

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
.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUMMARY OF DAM SAFETY ANALYSIS

0.50 & 1.0 PMF

ELEVATION	785.00	785.00	786.30
STORAGE	58.	58.	[illegible]
OUTFLOW	0.	0.	86.

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	789.25	2.95	88.	825.	6.83	15.83	0.00
1.00	791.05	4.75	103.	1999.	11.08	15.75	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1% CHANCE FLOOD

....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATI'	773.40	785.00	786.30
	STORAGE	10.	58.	66.
	OUTFLOW	0.	0.	84.

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
1.00	784.[illegible]	0.00	58.	0.	0.00	0.00	0.00

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE. ST LOUIS, MO 63110

SHEET NO 1 OF ______ JOB NO 8014
SUBJECT FILE

TITLE: Steeger Lake

11098

BY HBL DATE 9/29/80 CHECKED ABB DATE 9/30/80

Spillway Capacity (1)

Elev.	d		ΔA	ΣΔA	T	A^3/T	Q	V	hv	d+hv	Elev
785.0	0			0	10.8		0			0	785.0
785.3	0.3	(10.8+16.6) 0.3/2	4.11	4.11	16.6	4.182	11.6	2.82	0.12	0.42	785.42
785.8	0.8	(16.6+22.1) 0.5/2	9.68	13.79	22.1	118.66	61.8	4.48	0.31	1.11	786.11
786.3	1.3	(22.1+27.5) 0.5/2	12.40	26.19	27.5	453.24	145.0	5.54	0.48	1.78	786.78
786.8	1.8	(27.5+33.0) 0.5/2	15.12	41.31	33.0	2136.25	262.3	6.35	0.63	2.43	787.43
787.3	2.3	(33.0+38.5) 0.5/2	17.88	59.19	38.5	5386.22	416.5	7.04	0.77	3.07	788.07
787.8	2.8	(38.5+44.0) 0.5/2	20.62	79.81	44.0	11553.65	609.9	7.64	0.91	3.71	788.71
788.3	3.3	(44.0+49.5) 0.5/2	23.38	103.19	49.5		845.4	8.19	1.04	4.34	789.34
788.6	3.6	(49.5+57.7) 0.3/2	16.08	119.27	57.7		973.1	8.16	1.03	4.63	789.63
789.0	4.0	(57.7+68.6) 0.4/2	25.26	144.53	68.6		1190.4	8.24	1.05	5.05	790.05
789.5	4.5	(68.6+71.6) 0.5/2	35.05	179.58	71.6		1613.8	8.99	1.25	5.75	790.75
789.9	4.9	(71.6+74.0) 0.4/2	29.12	208.70	74.0		1988.8	9.53	1.41	6.31	791.31
790.4	5.4	(74.0+84.0) 0.5/2	39.5	248.20	84.0		2421.0	9.75	1.48	6.88	791.88
790.9	5.9	(84.0) 0.5	42.0	290.2	84.0		3020.8	10.55	1.73	7.63	792.63
791.4	6.4		42.0	332.2	"		3748.8	11.28	1.98	8.38	793.35
791.9	6.9		42.0	374.2	"		4481.7	11.98	2.23	9.13	794.13
792.4	7.4		42.0	416.2	"		5257.0	12.63	2.48	9.88	794.88

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE. ST LOUIS, MO. 63110

SHEET NO 2 OF ___ JOB NO 8011
SUBJECT FILE
BY HFZL DATE 9/29/80 CHECKED ABB DATE 9/30/80

TITLE: Steeger Lake

11098

Elev	d		ΔA	ΣΔA	T	A³/T	Q	V	Hv	d+Hv	Elev.
788.1	0				0		0				788.1
789.0	0.9	$(7.0)\frac{0.9}{2}$	3.15	3.15	7.0		12.0	3.81	0.22	1.12	789.22
789.5	1.4	$(7.0+8.7)\frac{0.5}{2}$	3.92	7.07	8.7		36.2	5.12	0.41	1.81	789.91
790.0	1.9	$(8.7+10.3)\frac{0.5}{2}$	4.75	11.82	10.3		71.9	6.08	0.57	2.47	790.57
790.5	2.4	$(10.3+12.0)\frac{0.5}{2}$	5.58	17.40	12.0		118.9	6.83	0.72	3.12	791.22
791.0	2.9	$(12.0+13.7)\frac{0.5}{2}$	6.42	23.82	13.7		178.2	7.48	0.87	3.77	791.87
791.4	3.3	$(13.7+15.0)\frac{0.4}{2}$	5.74	29.56	15.0		235.5	7.97	0.99	4.29	792.39
791.9	3.8	$(15.0+15.7)\frac{0.5}{2}$	7.68	37.24	15.7		325.5	8.74	1.19	4.99	793.09
792.4	4.3	$(15.7+16.3)\frac{0.5}{2}$	8.0	45.24	16.3		427.7	9.45	1.39	5.69	793.79
792.9	4.8	$(16.3+17.0)\frac{0.5}{2}$	8.32	53.56	17.0		539.5	10.07	1.58	6.38	794.48
793.4	5.3	$(17.0+17.7)\frac{0.5}{2}$	8.68	62.24	17.7		662.3	10.64	1.76	7.06	795.16

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE. ST. LOUIS, MO. 63110

SHEET NO 3 OF ____ JOB NO 8011

SUBJECT FILE

TITLE: Steeger Lake 11098

BY HBL DATE 9/29/80 CHECKED ABB DATE 9/30/80

Spillway Capacity - Data for Y4/Y5 Cards

Elev	Q_1	Q_2	ΣQ
785.0	0	0	0
785.42	11.6	—	11.6
786.11	62	—	62
786.78	145	—	145
787.43	262	—	262
788.1	420	0	420
788.71	610	7	617
789.34	845	15	860
790.05	1190	44	1234
790.75	1614	82	1696
791.31	1989	121	2110
791.88	2421	179	2600
792.63	3061	265	3326
793.35	3749	361	4110
794.13	4482	483	4965
794.88	5257	610	5867