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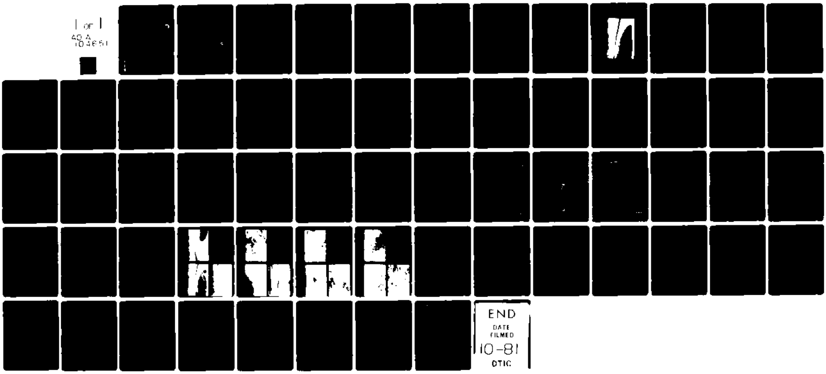

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AD A104651

MISSOURI - KANSAS CITY BASIN

ROGERS LAKE DAM

WARREN COUNTY, MISSOURI

MO 31772

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

St. Louis District

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

FOR: STATE OF MISSOURI

JUNE 1981

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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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MISSOURI - KANSAS CITY BASIN

ROGERS LAKE DAM

WARREN COUNTY, MISSOURI

MO 31772

PHASE 1 INSPECTION REPORT
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PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE 1981

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

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Rogers Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Rogers Lake Dam (MO 31772):

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

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

1) Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

2) Overtopping of the dam could result in failure of the dam.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: ED
Chief, Engineering Division

15 JUN 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

16 JUN 1981
Date

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ROGERS LAKE DAM

MISSOURI INVENTORY NO. 31772

WARREN COUNTY, MISSOURI

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

JUNE 1981

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Rogers Lake Dam
State Located:	Missouri
County Located:	Warren
Stream:	Sub-Tributary of Charrette Creek
Date of Inspection:	4 December 1980

The Rogers Lake Dam, which according to the St. Louis District, Corps of Engineers, is of high hazard potential, was visually inspected by enginering 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 an inordinate danger to human life or property. Evaluation of this dam was performed in accordance with the "Phase I" investigation procedures prescribed in "Recommended Guidelines for Safety Inspection of Dams", dated May 1975.

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 primarily on the results of the hydrologic/hydraulic investigations, as well as the visual inspection, the present general condition of the dam is considered to be less than satisfactory. Several items were noticed during the inspection which are considered to have an adverse effect on the overall safety and future operation of the dam. These items which are considered deficiencies include seepage, erosion of the area adjacent to the downstream toe of the dam, includng a 5-foot deep scour pool at the outlet end of the principal spillway, areas of dense undergrowth and numerous small trees on the downstream face of the dam, areas of very sparse turf cover on the crest and upstream face of the dam, and the lack of a durable form of protection, such as riprap, along the upstream face of the dam at the waterline in order to prevent erosion of the embankment by wave action or by fluctuations of the lake level.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Rogers Lake Dam, which, according to Table 1 of the guidelines, is classified as small in size, is specified, according to Table 3 of the guidelines for a dam of high hazard potential and small size, to be a minimum of one-half the Probable Maximum Flood (PMF). 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. Considering the fact that portions of the Innsbrook Subdivision development including numerous dwellings as well as a series of dams and reservoirs; the Lake Scheffborg Dam (No. 31442) and reservoir, the Lake Lucern Dam (No. 30519) and reservoir, and the Lake Innsbrook Dam (No. 11243) and reservoir, all of which are classified by the Corps of Engineers as being of high hazard potential, lie within the potential flood damage zone for this dam, and since failure of this dam by overtopping could result in successive failure of the three downstream dams which would endanger the lives of a number of people with dwellings about these lakes as well as those persons living within the potential flood damage zone for the downstream dam, it is recommended that the spillway for the Rogers Lake Dam be designed for the full PMF.

Results of a hydrologic/hydraulic analysis indicated that the spillways for this dam are inadequate to pass lake outflow resulting from a storm of PMF magnitude, one-half PMF magnitude, or the outflow resulting from the 1 percent (100-year frequency) flood without overtopping the dam. The spillways are capable of passing lake outflow corresponding to about 12 percent of the PMF lake inflow and the lake outflow resulting from the 10 percent chance (10-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 two miles. Within the potential damage zone are portions of the Innsbrook Subdivision development including numerous dwellings and the dams for Lake Scheffborg, Lake Lucern, and Lake Innsbrook. No determination was made whether or not failure of any of the downstream dams would occur so far as the flood events or conditions of overtopping investigated herein are concerned.

A review of available data did not diclose 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 within the near future to correct or control the deficiencies and safety defects reported herein. It is recommended, however, that a very high priority be given to increasing the spillway capacity, which is considered to be seriously inadequate.

Ralph E. Sauthoff
P.E. Missouri E-19090

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

OVERVIEW ROGERS LAKE DAM

PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

ROGERS LAKE DAM - MO 31772

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PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

ROGERS LAKE DAM - MO 31772

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 Rogers 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 dam with respect to safety and, based upon available data and this inspection, determine if the dam poses an inordinate danger to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in the "Recommended Guidelines 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 Rogers Lake Dam is an earthfill type embankment rising approximately 25 feet above the natural streambed at the downstream toe of the barrier. At the surveyed cross-section, which is considered to be representative of the entire dam, the embankment has an upstream slope (above the waterline) of approximately 1v on 3.5h, a crest width of about 17 feet, and a downstream slope on the order of 1v on 3.0h. The length of the dam is approximately 499 feet and the dam curves slightly away from the lake between the end abutments. A roadway, about 10 feet wide and surfaced with crushed limestone, traverses the dam crest. A plan and profile of the dam are shown on Plate 3 and a cross-section of the dam, at about the location of the original stream on which the dam was built, is shown on Plate 4. At normal pool elevation, the reservoir impounded by the dam occupies approximately 7 acres. There is no lake drawdown facility to dewater the lake. An overview photo of the Rogers Lake Dam is shown following the preface at the beginning of the report.

The dam has both a principal and an emergency spillway. The principal spillway, a 12-inch diameter steel pipe, passes through the dam at a point approximately 138 feet left, or north, of the right abutment. The normal level of the lake is governed by the invert elevation of the upstream end of this pipe. The downstream end of the 12-inch diameter pipe discharges lake outflow at a point near the toe of the dam, and pipe discharges have caused a scour pool approximately 5 feet deep and about 10 feet in diameter, to form in the original valley fill at the outlet end of the pipe. The principal spillway is shown in plan on Plate 3 and a profile of the 12-inch diameter pipe spillway is shown on Plate 5.

The emergency spillway, an 18-inch diameter corrugated metal pipe culvert, is located near the left end of the dam approximately 28 feet right, or south, of the left abutment. The crest of the emergency spillway pipe is about 0.9 foot higher than the crest of the principal spillway pipe and approximately 3.3 feet lower than the low point of the dam, which is located at the left, or north, end of the dam. The outlet channel for this spillway is unimproved, but appears to follow the same course as the overland drainage which is close to the toe of the dam. The drainage ditch joins the scour pool of the principal spillway, and the flow from both spillway outlets then continues in a trapezoidal earth channel parallel and adjacent to the dam for about 55 feet where it joins the original stream channel on which the dam was constructed. The emergency spillway and spillway outlet channels are shown in plan on Plate 3, and a profile of the 18-inch diameter pipe spillway is shown on Plate 5.

b. Location. The dam is located on an unnamed sub-tributary of Charrette Creek about 0.5 mile south and 0.25 mile west of the intersection of State Highways H and M; about 3.5 miles southwest of the community of Wright

City, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located within the northeast one-quarter of Section 31 of Township 47 North, Range 1 West, in Warren 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). A small size dam is classified, according to the guidelines, as having a height less than 40 feet, but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The Rogers 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 commerical 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 two miles downstream of the dam. Within the possible damage zone are portions of the Innsbrook Subdivision development including numerous dwellings and the dams for Lake Scheffborg, Lake Lucern, and Lake Innsbrook, all of which are classified as being of high hazard potential by the Corps of Engineers. 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 lake and dam are owned by Sharon L. and Elliot S. Rogers. Mr. & Mrs. Rogers' address is: 17 Trembley Lane, Wright City, Missouri 63390.

f. Purpose of Dam. The dam impounds water for recreational use.

g. Design and Construction History. According to Merlin Hutchison, owner of the property at the time the dam was built, the dam was constructed by the Hutchison & Schaper Excavating Company of Wright City, Missouri. Mr. Hutchison, who is one of the principals of Hutchison & Schaper, reported that the dam was constructed about 1972 and that the design of the dam was empirical having been derived from experience over a number of years of building dams of similar size in the same general area. According to the builder, drawings of the dam were not prepared. Mr. Hutchison stated that he sold the property on which the dam was constructed in about 1974 to Joseph and Dorothy Gmeiner, who in turn, sold the property to the present owners, Elliot and Sharon Rogers.

According to Mr. Hutchison, the dam was constructed with a 12-inch diameter pipe spillway and an emergency spillway which consisted of a low area in the dam crest at the left, or north, end of the structure. During the fall of 1980, the Owners, after having experienced a storm, a 6-inch rainfall in April of 1979 when the lake overflowed the emergency spillway by nearly 1 foot, and another storm, a 5-inch rainfall that occured early in 1980 when the lake level reached the crest of the emergency spillway, installed an 18-inch diameter corrugated metal pipe culvert at about the location of the original emergency spillway.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the combined capacities of two pipe spillways.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is about 40 percent woodland and 60 percent meadowland. The watershed above the dam amounts to approximately 178 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... No data available.*
(2) Spillway capacity ... 22 cfs (W.S. Elev. 764.2)

*No significant lake outflow since installation of new emergency spillway pipe in fall of 1980.

c. <u>Elevation (Ft. above MSL)</u>. Except where noted, the following elevations were determined by survey and are based on topographic data shown on the 1972 USGS Wright City, Missouri Quadrangle Map, 7.5 Minute Series.

(1) Observed pool ... 760.0

(2) Normal pool ... 760.0

(3) Spillway crest ... 760.0 (Principal); 760.9 (Emergency)

(4) Maximum experienced pool ... No data available*

(5) Top of dam ... 764.2 (Min.)

(6) Streambed at centerline of dam ... 742± (Est.)

(7) Maximum tailwater ... Unknown

(8) Observed tailwater ... None

d. <u>Reservoir</u>.

(1) Length at normal pool (Elev. 760.0) ... 1,000 Ft.

(2) Length of pool at top of dam (Elev. 764.2) ... 1,300 Ft.

e. <u>Storage</u>.

(1) Normal pool ... 39 Ac.Ft.

(2) Top of dam ... 82 Ac.Ft.

f. <u>Reservoir Surface Area</u>.

(1) Normal pool ... 7 Acres

(2) Top of dam ... 17 Acres

g. <u>Dam</u>. 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.

*No significant lake outflow since installation of new emergency spillway pipe in fall of 1980.

(1) Type ... Earthfill

(2) Length ... 499 Ft.

(3) Height ... 25 Ft.

(4) Top width ... 17 Ft.

(5) Side slopes

a. Upstream ... 1v on 3.5h (Above normal waterline)

b. Downstream ... 1v on 3.0h

(6) Cutoff ... Core trench

(7) Slope protection

a. Upstream ... Turf (Sparse)

b. Downstream ... Turf

h. Principal Spillway.

(1) Type ... Uncontrolled, 12-inch diameter steel pipe

(2) Location ... Station 0+00 (see Plan, Plate 3)

(3) Invert elevation ... 760.0 (upstream); 745.0 (downstream)

(4) Length ... 101 Ft.

(5) Approach channel ... Lake

(6) Outlet channel ... Earth, trapezoidal section

i. Emergency Spillway.

(1) Type ... Uncontrolled, 18-inch diameter corrugated metal pipe

(2) Location ... Left end of dam at Station 3+33

(3) Invert elevation ... 760.9 (upstream); 760.3 (downstream)

(4) Length ... 50 ft.

(5) Approach channel ... Lake

(6) Outlet channel ... Earth, irregular section

j. Lake Drawdown Facility ... None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

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

2.2 CONSTRUCTION

As previously indicated, the dam was constructed about 1972 by the Hutchison & Schaper Excavating Company, a local excavating contractor from Wright City, Missouri. Mr. Merlin Hutchison, one of the principals of the Hutchison & Schaper Company and owner of the property at the time the dam was built, reported that a core trench for seepage cutoff was excavated along the centerline of the dam. Mr. Hutchison stated that the trench was about 10 feet wide at the bottom and approximately 8 feet deep at its deepest point and that the trench was extended to clay. Mr. Hutchison also reported that the material used to backfill the trench and to construct the dam, a clay, was removed from the slopes of the area to be occupied by the lake using paddle-wheel scrapers, that the material was spread in layers by a bulldozer, and that compaction was achieved by running the scrapers over the fill layers. Mr. Hutchison indicated that the 12-inch diameter pipe spillway was installed with three steel diaphragms welded to the outside of the pipe in order to prevent seepage along the line of the pipe. According to the builder, the low area at the left end of the dam was intended to serve as an emergency spillway. Mr. Hutchison stated that no records of the construction of the dam were kept.

2.3 OPERATION

The level of the lake is uncontrolled. The lake level is governed by the combined capacities of a 12-inch diameter pipe principal spillway and an 18-inch diameter pipe emergency spillway. According to the Owner, the emergency spillway pipe was installed last fall (1980) in order to prevent lake outflow from spilling over the dam at the left end of the structure. As previously stated, prior to installation of the 18-inch pipe spillway, the Owner reported that the lake had overflowed to a depth of about 1 foot the left end of the dam at the location of the original emergency spillway. Since installation of the 18-inch diameter pipe outlet, there have been no significant rainfalls and, according to the Owner, the lake level has remained at about the crest of the 12-inch pipe spillway. Except for the lake overflowing the dam at the location of the original emergency spillway, the Owner reported that during their period of ownership, the dam has not been overtopped. No indication of the dam having been overtopped was observed during the inspection, although some erosion of the area just downstream of the low point at the left end of the dam, which could have been caused by lake outflow, was noticed.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillways 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 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 Rogers 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 4 December 1980. Neither the Owner nor a representative of the Owner was present during the inspection. An examination of the dam site was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the area 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 through A-4 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. The Rogers Lake Dam is located on the uplands, near the headwaters of an unnamed tributary of Charrette Creek. The topography is gently rolling, and there is only 50-75 feet of relief between the reservoir and the surrounding drainage divides.

The site is located in the southern portion of the Dissected Till Plains Section of the Central Lowlands Physiographic Province, near its border with the Ozark Plateaus Physiographic Province. No bedrock outcrops were observed at the site. Subsurface borings from adjacent projects indicate over 100 feet of glacial till and loessal deposits overlay limestone of the Ordovician-age Kimmswick formation. There is little bedrock structure. The sedimentary strata dip gently toward the north, and no faults are reported in the vicinity.

The Kimmswick formation is a light gray, coarsely crystalline, medium-bedded to massive limestone. Weathered exposures characteristically appear pitted. The limestones are susceptible to solution weathering and may have solution-enlarged joints and bedding planes, sinkholes, etc. Often, the karst features are filled with Pennsylvanian-age rubble.

The unconsolidated surficial materials consist of thick deposits of loess and glacial drift. The dam and reservoir are located on soils of the Keswick series. These soils are deep, moderately well-drained materials from glacial till with loess mixed in the upper layers. They are dark grayish-brown silts near the surface and become more clayey with depth. The soils are classified as CL or CL-ML materials (Unified Soil Classification System), are low in permeability, and are susceptible to erosion. The silty soils of the Hatton series cap the ridges above the reservoir. These soils formed from loess deposits and exhibit engineering properties similar to the Keswick soils. Glacial till overlaid with loess was noted in the stream channel immediately downstream from the dam and also upstream from the reservoir. The till consisted primarily of blocky clay with chert gravel and large glacial erratics.

There appear to be no significant geotechnical problems at the Rogers Dam site. It was reported by the Owner that the lake may be spring-fed and that there is a small sinkhole north of the site, but these karst features do not appear to affect dam or reservoir performance.

c. Dam. The visible portions of the upstream and downstream faces of the dam, as well as the dam crest (see Photos 1, 2 and 3) were examined and, except for some minor erosion (see Photo 12) near the downstream toe of the dam opposite about station 1+55, and some additional erosion just downstream of the dam crest at about station 3+70, appeared to be in sound condition. No undue settlement of the dam crest, sloughing or sliding of the embankment slopes, or cracking of the dam crest was noticed. No significant erosion of the unprotected (no riprap) upstream face of the dam was noted, although several areas with very sparse turf cover existed. A similar condition existed adjacent to the roadway on the crest of the dam. The downstream face was adequately covered. However, numerous small cedar trees including two 2-inch diameter trees at the toe of the dam opposite about station 1+25, as well as several patches of dense undergrowth, were found on the downstream slope of the dam. Examination of a soil sample obtained from the downstream face of the embankment near the location of the original stream on which the dam was constructed, indicated the surficial material of the dam to be a dark brown silty lean clay (CL) of low-to-medium plasticity.

The upstream and downstream ends of the 12-inch diameter steel pipe principal spillway (see Photos 4 and 5) were examined and, except for a light coating of rust as a result of corrosion of the metal, appeared to be in satisfactory condition. At the outlet end of the pipe, spillway discharges had created a scour pool (see Photo 8) approximately 5 feet deep and about 10 feet in diameter adjacent to the unprotected downstream toe of the dam.

An inspection of the 18-inch diameter corrugated metal pipe emergency spillway (see Photos 6 and 7) indicated the pipe to be galvanized and in good condition. However, both ends of the pipe projected beyond the dam and no protection of the embankment was provided at either end of the pipe to prevent erosion of the dam The outlet channel downstream of the 18-inch pipe appeared to be unimproved although a ditch section, on the order of 2 feet wide and 2 feet deep, existed between about station 1+55 and 2+35, and at the junction with the scour pool at the outlet end of the 12-inch pipe. Between the scour pool and the original stream channel, the spillway outlet channel was about 4 feet wide and 3 feet deep. Just downstream of the junction of the spillway channel and the original stream channel (see Photo 9), a tree trunk section about 15 inches in diameter and numerous small limbs about 6 inches in diameter were found lying within the stream channel.

Examination of the stream channel between the dam and a fence line roughly 150 feet downstream of the dam (see Photo 10), indicated the bottom of the channel to be covered with a rusty-colored residue and the water within the stream to have an oily film on the surface (see Photo 11). Both the rust colored residue and the oily film are believed to be a result of leaching of certain minerals within the soil by seepage from the lake. Since the lake was experiencing some outflow at the 12-inch pipe spillway at the time of the inspection, an estimate of the quantity of seepage could not be made, although it would appear to be minor, say on the order of 1-to-2 gpm.

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

e. Downstream Channel. Except at the three downstream lakes (Lake Scheffberg, Lake Lucern and Lake Innsbrook) and at roadway crossings, the channel downstream of the dam within the potential flood damage zone, a distance of approximately 2 miles, is unimproved. The unimproved channel section is irregular and for the most part, lined with trees. The stream joins the upstream end of Lake Scheffborg about 1,500 feet downstream of the dam.

f. Reservoir. Except for an area at the upstream end of the lake and a portion of the shoreline at the left side of the lake near the dam, the slopes adjacent to the reservoir are tree covered and in a natural state and in good condition. However, some slight erosion was observed about the shoreline. The amount of sediment within the lake attributable to this erosion and to other causes could not be determined. However, due to the fact that the drainage area is well covered with vegetation and since only some slight erosion of the lake shoreline was noticed, the actual amount of sediment within the lake relative to the total storage volume of the reservoir, is believed to be hydrologically insignificant. At the time of the inspection, the lake water was clear and the surface was at normal pool level.

3.2 EVALUATION

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

Due to the fact that the Owner resides adjacent to the lake and is observant of the pipe spillways and is aware of the necessity of maintaining the upstream ends clear of lake carried debris, a trash screen or rack is not considered necessary at either of the spillway pipe outlets.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillways are uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the combined capacities of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The Owner reported that willow trees on the upstream face of the dam are periodically cut and that muskrats in the vicinity of the dam are removed on a yearly basis by trapping. According to the Owner, no other routine maintenance of the dam is performed.

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 Owner, who resides adjacent to the lake in view of the dam, indicated that in the case of an emergency, such as the imminent failure of the dam due to overtopping or other causes, both the sheriff's office and the Innsbrook Subdivision office would be notified by telephone. The inspection did not reveal the existence of any other type of dam failure warning system.

4.5 EVALUATION

It is recommended that routine maintenance of the dam include such items as the removal of trees and undergrowth on the downstream face of the dam. Provision of appropriate forms of protection to prevent erosion of the embankment by wave action or by fuctuations of the lake level, as well as by overland drainage, is also recommended. Areas of the dam or foundation adjacent to the dam subject to erosion by spillway flows and storm water runoff should also be protected. It is also 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. The drainage area and lake surface area were developed from the 1972 USGS Wright City, Missouri, Quadrangle Map. The proportions and dimensions of the spillways and dam were developed from surveys made during the inspection. Records of rainfall, streamflow or flood data for the watershed were not available.

Due to the fact that the watershed for this reservoir is relatively small, and since there is no history of excessive reservoir leakage, the lake level was assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storms.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends two miles downstream of the dam. Within the potential flood damage zone are the Lake Scheffborg Dam (MO 31442), the Lake Lucern Dam (MO 30519), and the Lake Innsbrook Dam (MO 11243).

c. Visual Observations.

(1) The dam has both a principal and an emergency spillway, but no lake dewatering facility.

(2) The principal spillway consists of a 12-inch diameter steel pipe that passes through the embankment with its outlet end located at about the downstream toe of the dam. The principal spillway is located approximately 138 feet left, or north, of the right abutment within the main body of the dam.

(3) The emergency spillway consists of an 18-inch corrugated metal pipe culvert located near the left end of the dam.

(4) Spillway releases are directed along a course that follows close to the downstream toe of the dam. The spillway outlet channel joins the original stream channel on which the dam was constructed just downstream of the dam. The original stream channel abuts the dam.

d. Overtopping Potential. The spillways are inadequate to pass the probable maximum flood, 1/2 the probable maximum flood, or the 1 percent chance (100-year frequency) flood, without overtopping the dam. The spillways are adequate, however, to pass the lake outflow resulting from the 10 percent chance (10-year frequency) flood without overtopping the dam. The results of the dam overtopping analysis are as follows:

(Note: The data appearing in the following table have been 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 Dam (Elev. 764.2)	Duration of Overtopping of Dam (Hrs.)
0.50	1,334	766.3	2.1	10.8
1.00	2,863	766.9	2.7	13.4
1% Chance Flood	48	764.7	0.5	10.6
10% Chance Flood	21	763.4	0.0	0.0

Elevation 764.2, the low point of the dam crest at the left end of the dam, was considered to be the minimum elevation of the top of the dam. Lake levels higher than elevation 764.2 were considered as overtopping the dam. The flow safely passing the spillways just prior to overtopping was determined to be approximately 22 cfs, which is the routed outflow corresponding to about 12 percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 2.7 feet and overtopping will extend across the entire length of the dam, with the exception of about 25 feet at the south end of the structure.

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 have shown evidence that the material under certain conditions, such as high velocity flow, can be very erodible. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition where the depth of flow over the dam crest, a maximum of 2.7 feet, and the duration of flow over the dam, 13.4 hours, are substantial, damage by erosion to the crest and downstream face of the dam is expected. The extent of these damages is not predictable within the scope of this investigation; however, there is a possibility that they could result in failure by erosion of the dam. A similar, and almost as severe, condition also exists during occurrence of the one-half PMF event.

f. Reference. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, the 10-year frequency flood, and the discharge rating curve for flow passing the spillways and dam crest are presented on pages B-1 and B-2 of Appendix B. Listings of the HEC-1 (Dam Safety Version) input data for the probable maximum flood, the 100-year frequency flood, and the 10-year frequency flood are shown on pages B-3 through B-7. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-8 through B-11; tabulation of lake surface area, elevation and storage volume and tabulation titled "Summary of Dam Safety Analysis" for the PMF is shown on page B-12; "Summary of Dam Safety Analysis" for the 1 percent chance (100-year frequency) flood and the 10 percent chance (10-year frequency) flood are shown on page B-13. Values for the spillway rating curve used in the overtopping analyses are shown in the table on page B-14.

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. No design or construction data relating to the structural stability of the dam are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inpsection 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 the Owner, no records of lake level, spillway discharge, dam settlement, or lake seepage have been kept.

d. Post Construction Changes. With the exception of provision of an 18-inch diameter pipe emergency spillway which replaced the original emergency spillway (a low area of the dam crest at the left end of the dam), the Owner reported that to their knowledge, no other changes have been made or have occurred which would affect the structural stability of the dam. The description of the dam as constructed provided by Melvin Hutchison, builder of the dam, confirms the Owner's conclusion that no prior post construction changes to the dam were made.

e. Seismic Stability. The dam is located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen 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 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 spillways are capable of passing lake outflow of about 22 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of probable maximum flood magnitude, the lake outflow would be about 2,863 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 48 cfs. A similar analysis indicated that for the 10 percent chance (10-year frequency) flood, the lake outflow would be on the order of 21 cfs. Since the existing spillways are inadequate to pass lake outflow resulting from a storm of probable maximum flood magnitude (the recommended spillway design flood for this dam) without overtopping the dam, the possibility exists that overtopping could result in failure by erosion of the dam during this flood event. A description of the features within the potential flood damage zone should failure of the dam occur is presented in Section 1, paragraph 1.2d.

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

Several items were noticed during the inspection that could adversely affect the safety of the dam. These items include seepage, erosion of the area adjacent to the downstream toe of the dam, including a 5-foot deep scour pool at the outlet end of the principal spillway, areas of dense undergrowth and numerous small trees on the downstream face of the dam, areas of very sparse turf cover on the crest and upstream face of the dam, and the lack of a durable form of protection, such as riprap, along the upstream face of the dam at the waterline in order 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 on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacities of the spillways were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "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 within the near future. The provision of additional spillway capacity should be pursued on a very high priority basis, since the existing spillways are considered to be seriously inadequate.

d. Necesssity 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 in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earthen 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 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of probable maximum flood magnitude, the recommended spillway design flood for this dam. In any event, all spillways shall be protected to prevent erosion by lake outflow.

(2) 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 earthen dams.

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

(1) Provide some means of controlling seepage evident in the downstream channel adjacent to the toe of the dam. Although the amount of dam underseepage presently being experienced is relatively minor, the possibility exists that uncontrolled seepage can lead to a piping condition (progressive internal erosion) which could result in failure of the dam.

(2) Restore the eroded areas adjacent to the dam and provide some form of protection in order to prevent future erosion of these areas by overland drainage or by spillway flows. Loss of embankment material or foundation material adjacent to the embankment can impair the structural stability of the dam.

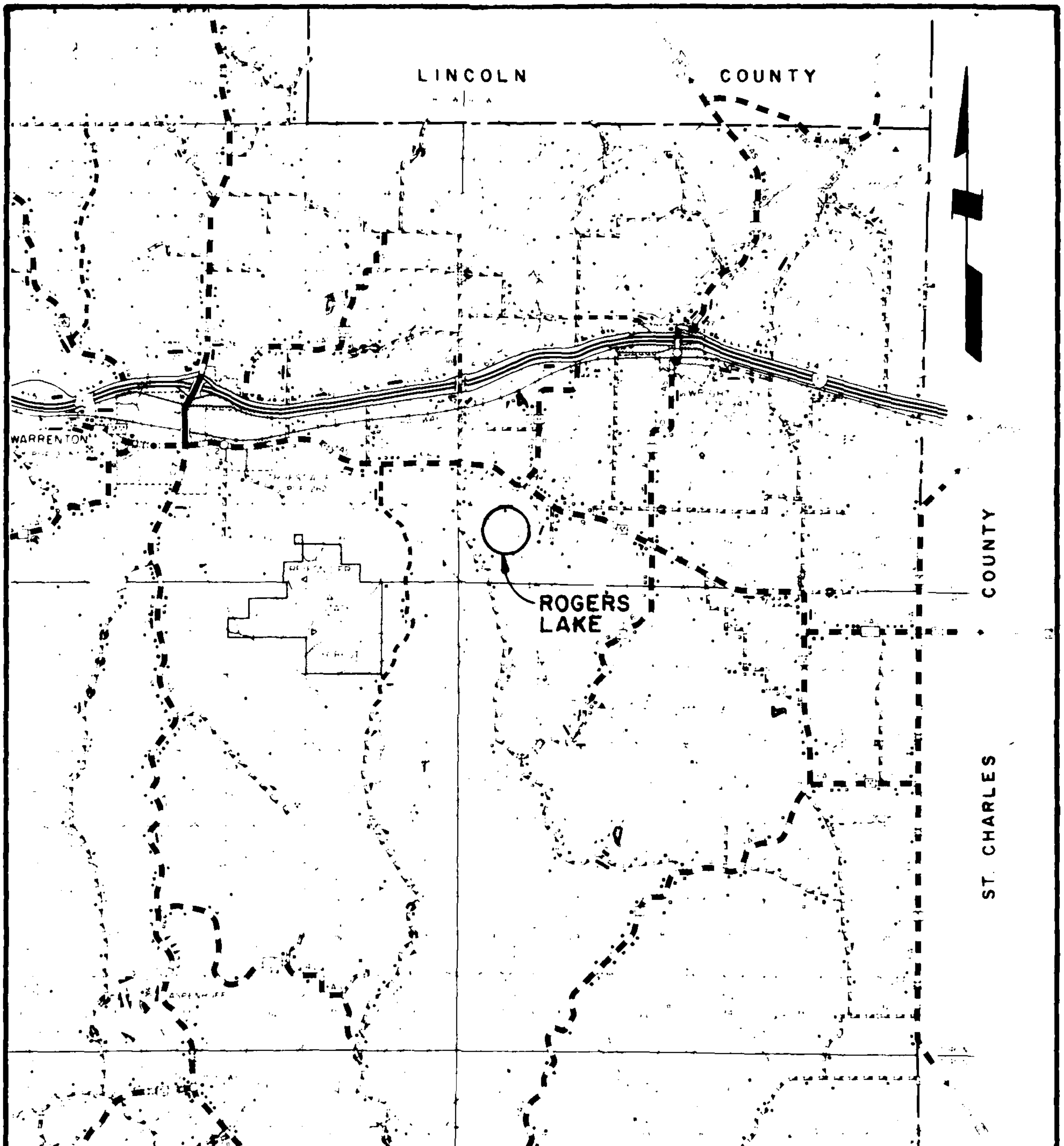
(3) Remove the trees and areas of dense undergrowth that may conceal animal burrows from the downstream face of the dam. Tree roots and animal burrows can provide passageways for lake seepage that can result in a piping condition which, as previously stated, can lead to failure of the dam.

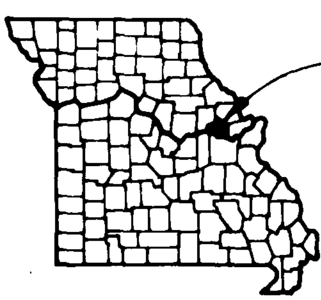
(4) Provide some form of protection other than grass for the upstream face of the dam at and above the normal waterline in order to prevent erosion by wave action or by a fluctuating lake level. A grass covered slope is not considered adequate protection to prevent erosion by wave action or by a fluctuating lake level. Erosion of the embankment can impair the structural stability of the dam.

(5) The existing turf cover on the dam, except where otherwise indicated for the upstream face of the embankment, should be restored where missing in order to prevent erosion by overland drainage. The turf cover should be maintained at a height that will not provide cover for burrowing animals or hinder inspection of the dam.

(6) Provide maintenance of all areas of the dam and spillways on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(7) 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.



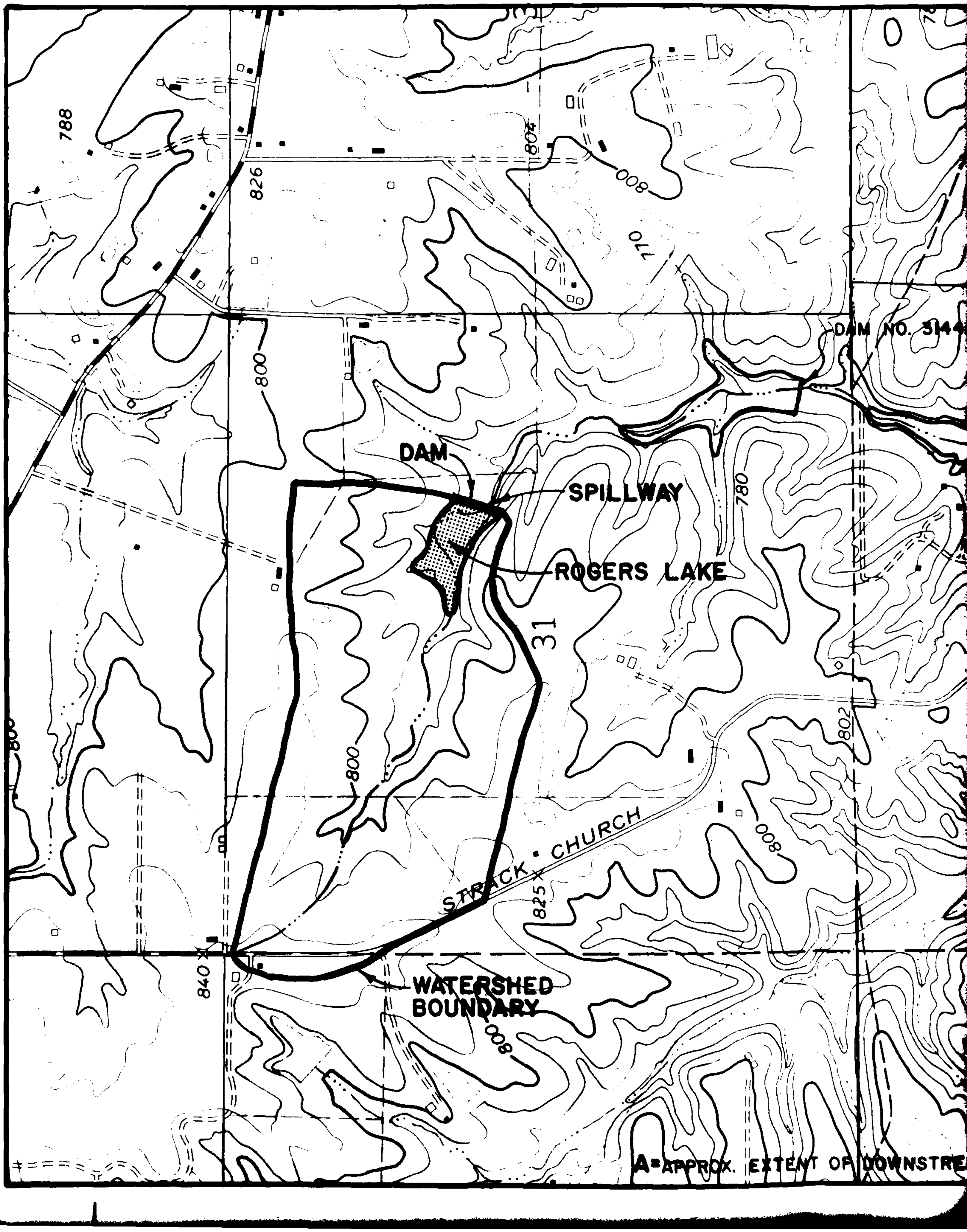


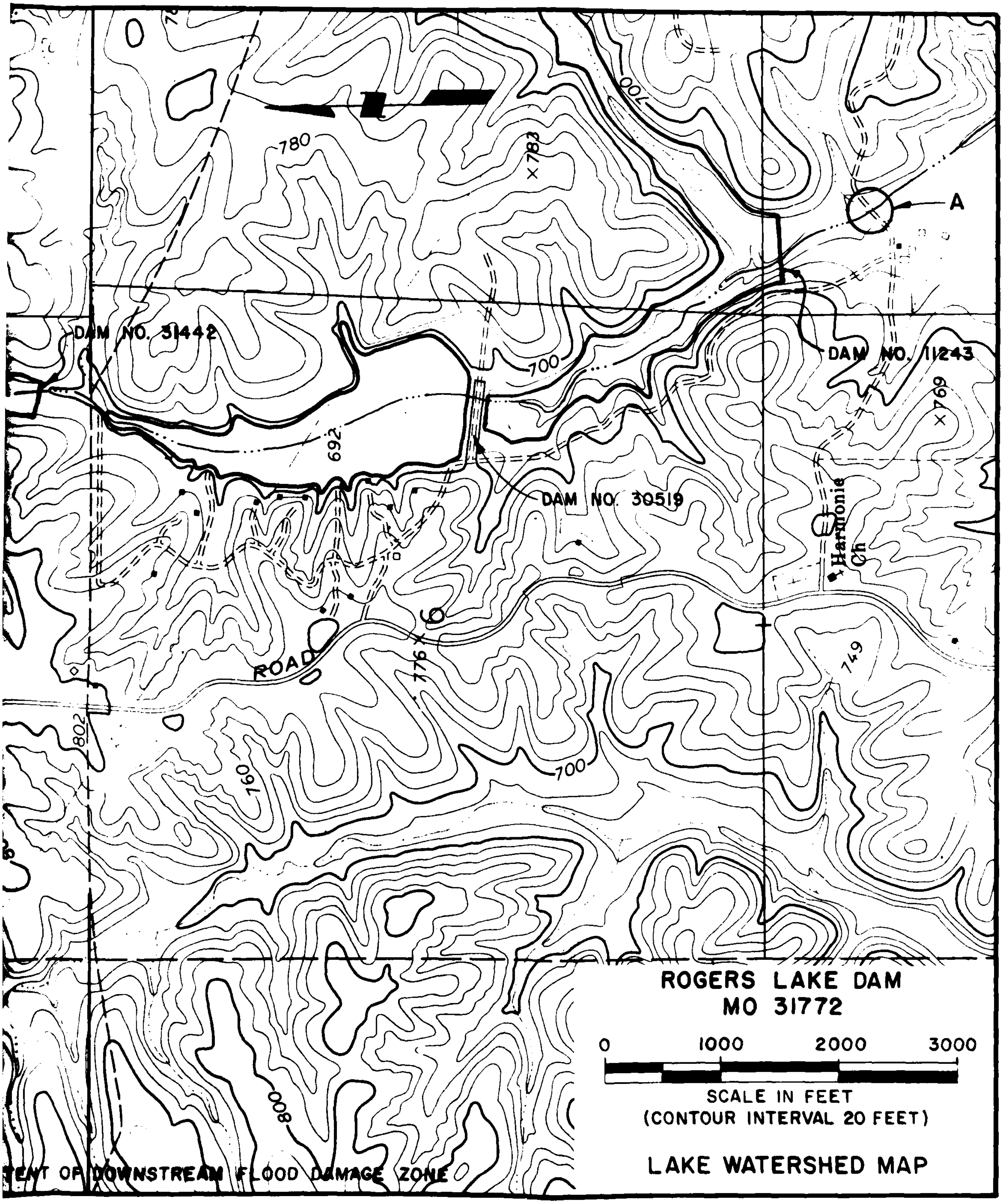
LOCATION MAP

ROGERS LAKE DAM
MO 31772

0 1 2 3 4
SCALE (MILES)

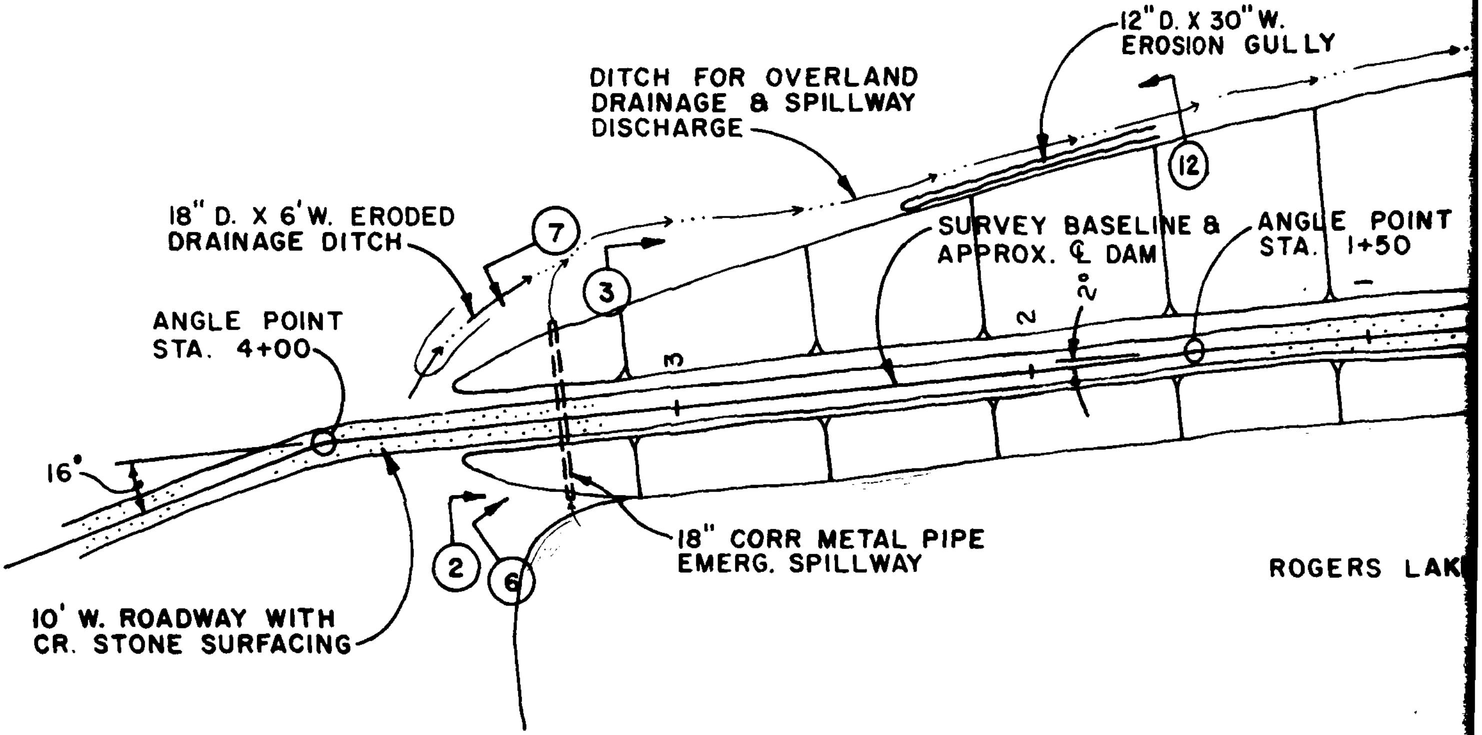
REGIONAL VICINITY MAP


788
826
804
800
770
DAM NO. 3144
800
DAM
SPILLWAY
ROGERS LAKE
780
31
800
802
800
STRACK CHURCH
825
840
WATERSHED
BOUNDARY
800
A=APPROX. EXTENT OF DOWNSTRE



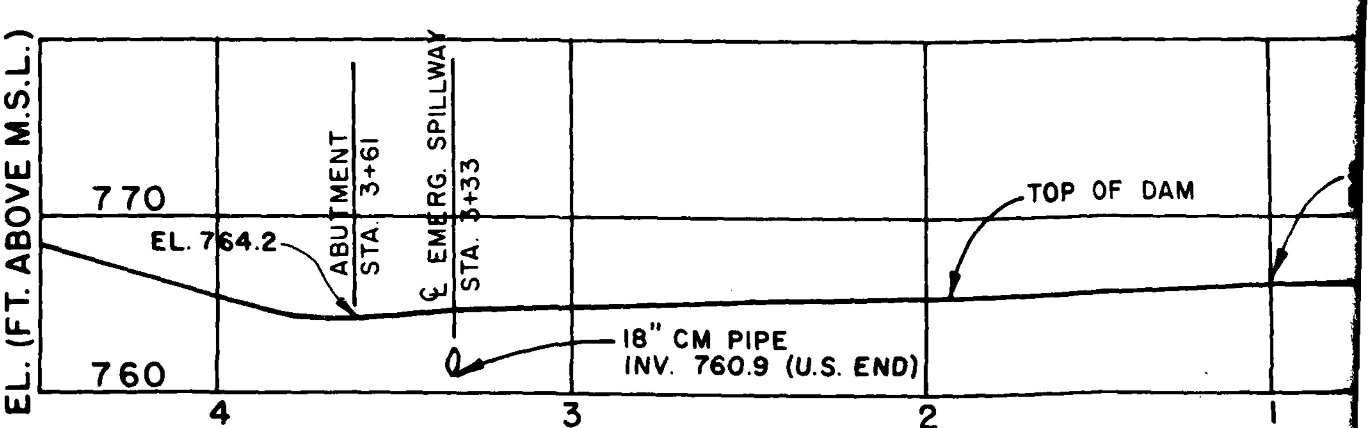
DAM NO. 31442
780
x783
700
A
692
DAM NO. 30519
DAM NO. 11243
x769
Harmonie Ch
ROAD
776
749
802
760
700
800
TENT OF DOWNSTREAM FLOOD DAMAGE ZONE
ROGERS LAKE DAM
MO 31772
0 1000 2000 3000
SCALE IN FEET
(CONTOUR INTERVAL 20 FEET)
LAKE WATERSHED MAP

PLATE 2



GENERAL PLAN

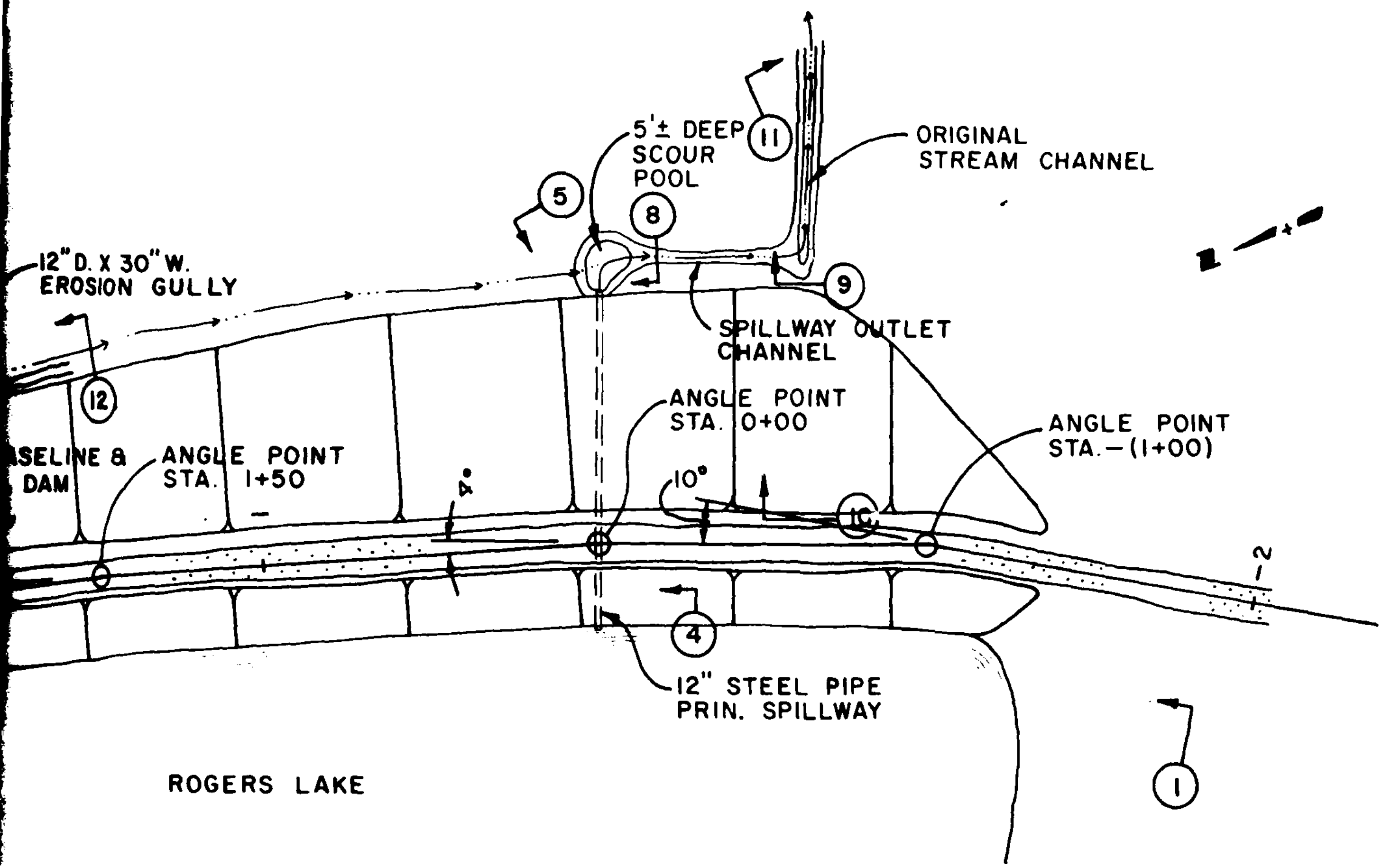
SCALE: 1"=50



PROFILE DAM

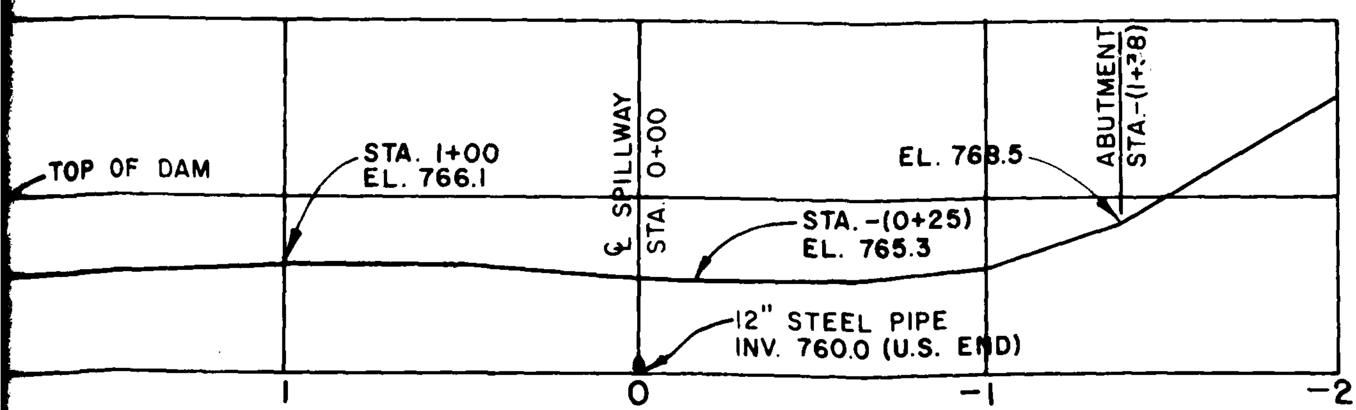
SCALES: 1"=10'V.,

(6) PHOTO LOCATION & KEY (SEE APPENDIX A)



GENERAL PLAN OF DAM

SCALE: 1"=50'



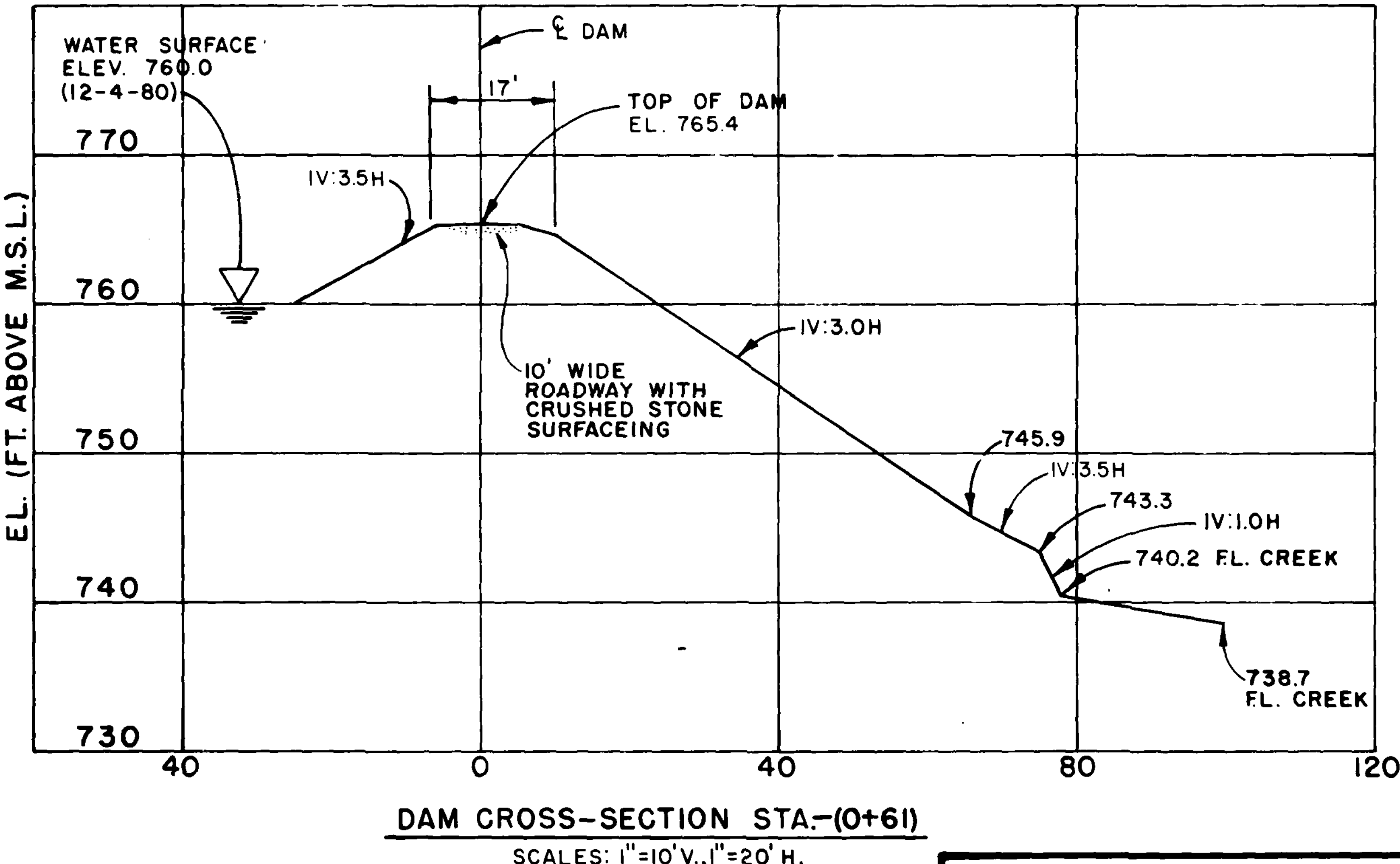
PROFILE DAM CREST

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

ROGERS LAKE DAM-MO 31772
DAM PLAN & PROFILE

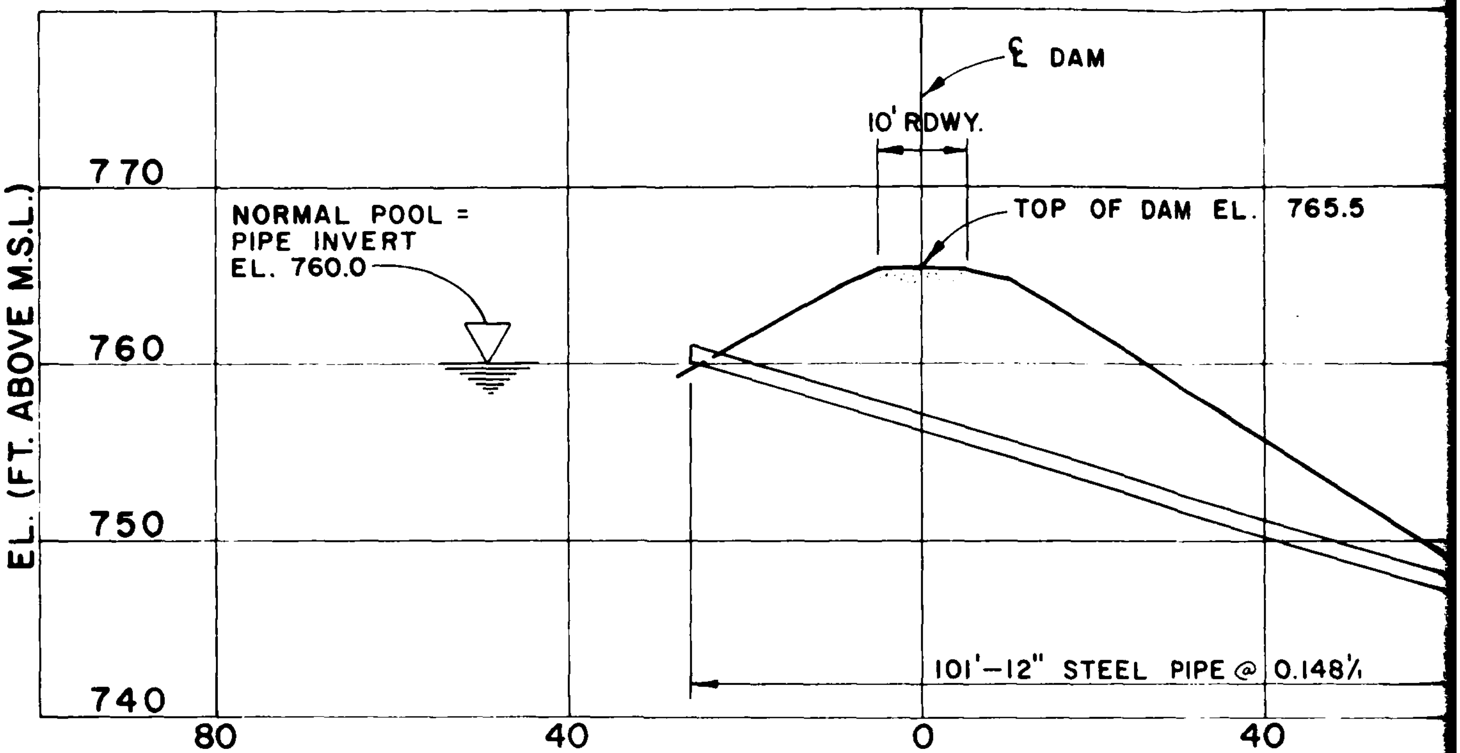
Horner & Shifrin, Inc. March 1981

PLATE 3



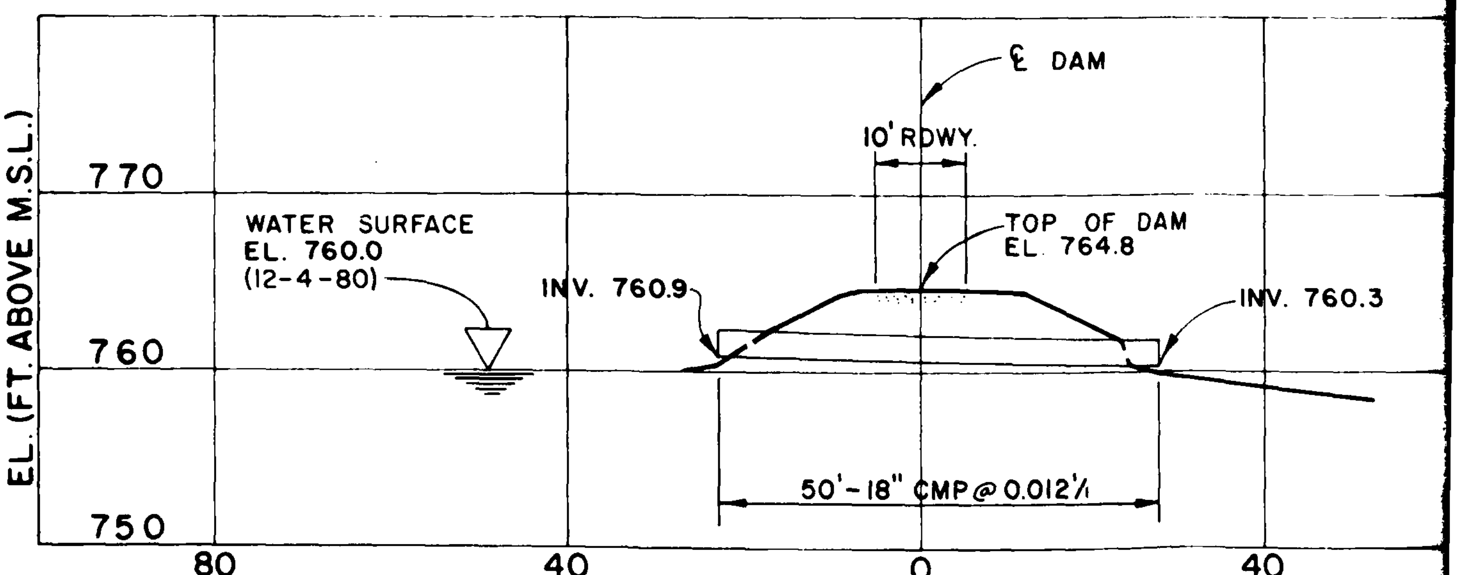
ROGERS LAKE DAM-MO 31772
DAM CROSS-SECTION

Horner & Shifrin, Inc. March 1981



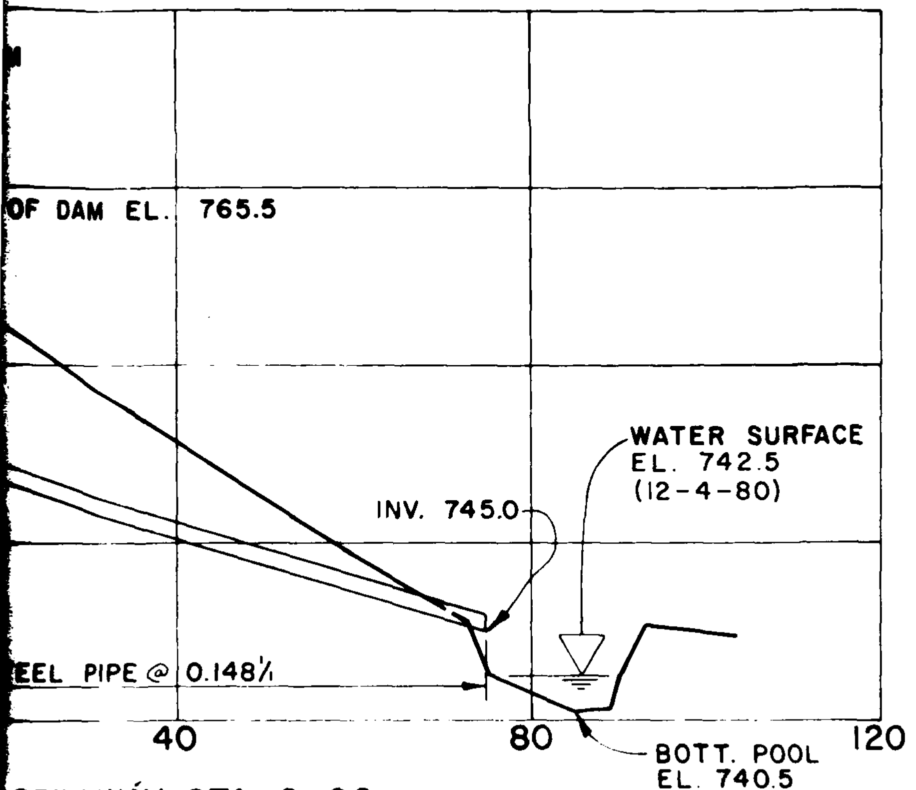
PROFILE PRINCIPAL SPILLWAY STA. 0+0

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



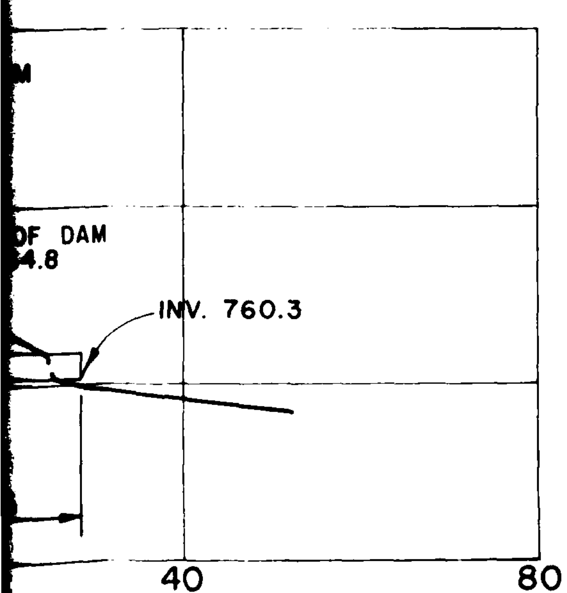
PROFILE EMERGENCY SPILLWAY STA. 3+33

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



SPILLWAY STA. 0+00

0'V., 1"=20' H.



Y STA. 3+33

ROGERS LAKE DAM-MO 31772
PRINCIPAL & EMERGENCY
SPILLWAY PROFILES

Horner & Shifrin, Inc. March 1981

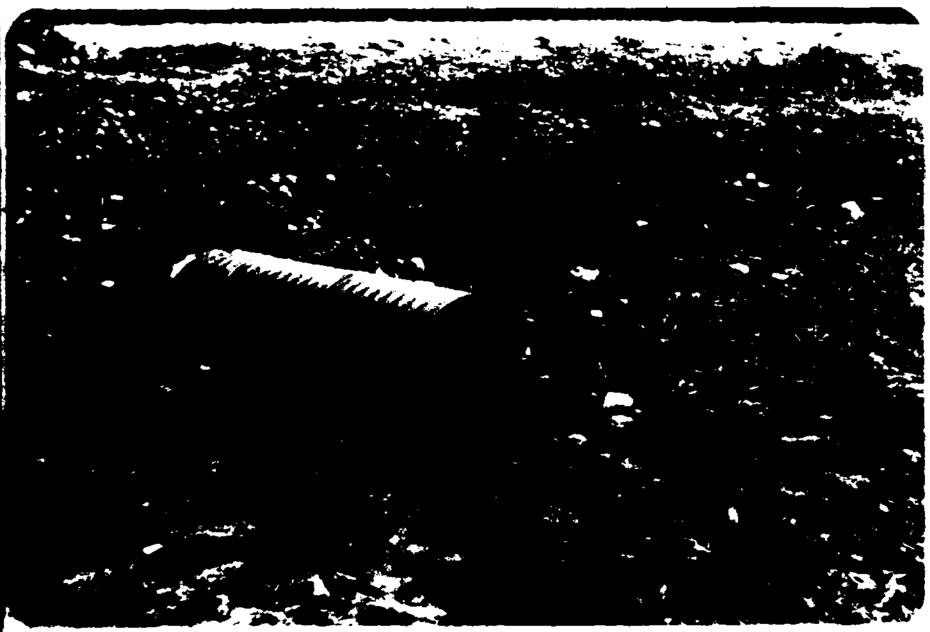
APPENDIX A

INSPECTION PHOTOGRAPHS

PHOTO KEY

1	2
3	X

NO.	DESCRIPTION
1	Dam Overview
2	Upstream Face of Dam
3	Downstream Face of Dam



4	5
6	X

PHOTO KEY

NO.	DESCRIPTION
4	Upstream End of 12" Prin. Spillway Pipe
5	Downstream End of 12" Prin. Spillway Pipe
6	Upstream End of 18" Emerg. Spillway Pipe

7	8
9	X

PHOTO KEY

NO.	DESCRIPTION
7	Downstream End of 18" Emerg. Spillway
8	Jct. of Spillway Channel & Scour Pool
9	Jct. of Spillway Channel & Orig. Stream Channel

10	11
12	☒

PHOTO KEY

NO.	DESCRIPTION
10	Overview of Downstream Channel
11	Evidence of Seepage in Stream
12	Erosion Gully Opposite Sta. 1+55

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 25.0 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent (100-year flood) and the 10 percent (10-year flood) were provided by the St. Louis District, Corps of Engineers.

b. Storm duration = 24 hours; Unit hydrograph duration = 5 minutes.

c. Drainage area = 0.279 square miles = 178 acres.

d. SCS parameters:

Time of Concentration (Tc) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.299 hours

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

L = Length of longest watercourse = 0.663 miles.

H = Elevation difference = 80 feet.

The time of concentration (Tc) was obtained using method C as described in Fig. 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 = 0.179 hours (0.60 Tc)

Hydrologic Soil Group = 11% C (Dockery & Hatton Series) and 89% D (Keswick & Calwoods Series) per SCS County Soil Report

Soil type CN = 83 (AMC II, 10-yr & 100-yr flood condition)
= 93 (AMC III, PMF condition)

2. The principal spillway section consists of a 12-inch diameter steel pipe and the emergency spillway consists of an 18-inch diameter corrugated metal pipe. Profiles of these spillway pipes are shown on Plate 5.

Flow passing the 12-inch diameter steel pipe spillway was determined using Bernoulli's equation for flow in pipes. A pipe friction factor (n) of 0.013 was used. Losses, including entrance, pipe and exit losses, totaled 4.31 velocity heads. Flow passing the 18-inch diameter corrugated metal pipe was determined in a similar manner. A friction factor (n) of 0.024 was used. Losses, including entrance, pipe and exit losses, totaled 5.00 velocity heads. Reference "Handbook of Hydraulics", Fifth Edition, King and Brater, pages 8-5 and 8-6.

Discharge quantities, determined by the methods described herein, were plotted versus corresponding lake surface elevations to determine the discharge rating curve for the combined, principal plus emergency, spillways.

3. The discharges for the principal and emergency spillways for equal elevations were summated for entry on the Y4 and Y5 cards.

4. 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 the $V cards. The program assumes that flow over the dam crest occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

```
A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF ROGERS LAKE DAM
A3      RATIOS OF PMF ROUTED THROUGH RESERVOIR
B    288       0       5                                               0
B1     5
J      1       4       1
J1   .12     .13     .50     1.0
K      0  INFLOW                                       1
K1      INFLOW HYDROGRAPH
M      1       2   0.279                     1.0                       1
P      0    25.0     102     120     130
T                                             -1     -93
W2             0.179
X   -1.0    -.10     2.0
K      1     DAM                                       1
K1      RESERVOIR ROUTING BY MODIFIED PULS
Y                              1       1
Y1     1                                    -760.     -1
Y4   760     761   761.4     762     763     764     766     768
Y5     0    10.8      14    16.7    19.7    21.8    25.4    28.4
$A     0     6.8    30.1    64.5
$E   743     760     770     780
$$ 760.0
$D 764.2
$L     0      30      50     145     155     200     210     460     510     590
$V 764.2   764.4   764.8   765.3   765.3   765.4   765.4   766.1   766.1   768.4
K     99
```

```
A1       ANALYSIS OF DAM OVERTOPPING USING 1% CHANCE FLOOD
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF ROGERS LAKE DAM
A3       1% CHANCE FLOOD ROUTED THROUGH RESERVOIR
B     288       0       5                                       4
B1      5
J       1       1       1
J1     1.
K       0  INFLOW                               1
K1       INFLOW HYDROGRAPH
M       0       2   0.279               1.0                     1
O     288   7.094
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .006    .006    .006    .006    .006    .006    .006    .006
01   .006    .006    .014    .014    .014    .014    .014    .014    .014    .014
01   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
01   .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
01   .014    .014    .014    .014    .014    .014    .014    .014    .024    .024
01   .024    .024    .024    .024    .024    .024    .024    .024    .024    .024
01   .024    .024    .024    .024    .024    .024    .029    .029    .029    .029
01   .029    .029    .060    .060    .060    .060    .060    .060    .129    .129
01   .130    .247    .247    .546    .826    .380    .247    .130    .130    .129
01   .060    .060    .060    .060    .060    .060    .029    .029    .029    .029
01   .029    .029    .024    .024    .024    .024    .024    .024    .024    .024
```

1% CHANCE FLOOD DATA (Cont'd)

O1	.024	.024	.024	.024	.024	.024	.024	.024	.024	.024
O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
O1	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
O1	.014	.014	.014	.014	.014	.014	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006
O1	.006	.006	.006	.006	.006	.006	.006	.006		
T							-1	-83		
W2		0.179								
X	-1.0	-.10	2.0							
K	1	DAM					1			
K1	RESERVOIR ROUTING BY MODIFIED PULS									
Y				1	1					
Y1	1						-760.	-1		
Y4	760	761	761.4	762	763	764	766	768		
Y5	0	10.8	14	16.7	19.7	21.8	25.4	28.4		
$A	0	6.8	30.1	64.5						
$E	743	760	770	780						
$$	760.0									
$D	764.2									
$L	0	30	50	145	155	200	210	460	510	590
$V	764.2	764.4	764.8	765.3	765.3	765.4	765.4	766.1	766.1	768.4
K	99									

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A1      ANALYSIS OF DAM OVERTOPPING USING 10% CHANCE FLOOD
A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF ROGERS LAKE DAM
A3      10% CHANCE FLOOD ROUTED THROUGH RESERVOIR
B      288       0       5                                               4
B1       5
J        1       1       1
J1      1.
K        0   INFLOW                                      1
K1      INFLOW HYDROGRAPH
M        0       2   0.279                       1.0                     1
O      288   5.045
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .005    .005    .005    .005    .005    .005    .005    .005
01    .005    .005    .010    .010    .010    .010    .010    .010    .010    .010
01    .010    .010    .010    .010    .010    .010    .010    .010    .010    .010
01    .010    .010    .010    .010    .010    .010    .010    .010    .010    .010
01    .010    .010    .010    .010    .010    .010    .010    .010    .015    .015
01    .015    .015    .015    .015    .015    .015    .015    .015    .015    .015
01    .015    .015    .015    .015    .015    .015    .031    .031    .031    .031
01    .031    .031    .048    .048    .048    .048    .048    .048    .083    .083
01    .083    .159    .159    .373    .587    .259    .159    .083    .083    .083
01    .048    .048    .048    .048    .048    .048    .031    .031    .031    .031
01    .031    .031    .015    .015    .015    .015    .015    .015    .015    .015
```

10% CHANCE FLOOD DATA (Cont'd)

```
01  .015   .015   .015   .015   .015   .015   .015   .015   .015   .015
01  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
01  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
01  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
01  .010   .010   .010   .010   .010   .010   .010   .010   .010   .010
01  .005   .005   .005   .005   .005   .010   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
01  .005   .005   .005   .005   .005   .005   .005   .005
T                                                  -1     -83
WS         0.179
X   -1.0   -.10    2.0
K      1   DAM                                      1
K1      RESERVOIR ROUTING BY MODIFIED PULS
Y                                1      1
Y1     1                                         -760.    -1
Y4   760    761  761.4    762    763    764    766    768
Y5     0   10.8     14   16.7   19.7   21.8   25.4   28.4
$A     0    6.8   30.1   64.5
$E   743    760    770    780
$$ 760.0
$D 764.2
$L     0     30     50    145    155    200    210    460    510    590
$V 764.2  764.4  764.8  765.3  765.3  765.4  765.4  766.1  766.1  768.4
K     99
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF ROGERS 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= 4 LRTIO= 1
RTIOS= .12 .13 .50 1.00

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.28	0.00	.28	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.00	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	-93.00	0.00	0.00

CURVE NO = -93.00 WETNESS = -1.00 EFFECT CN = 93.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .18

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

UNIT HYDROGRAPH 13 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .18 VOL= 1.00

173.	537.	592.	407.	206.	114.	61.	33.	18.	10.
6.	3.	1.							

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP O	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.21	.21	.00	158.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.21	.21	.00	238.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.21	.21	.00	326.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.21	.21	.00	386.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.21	.21	.00	417.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.21	.21	.00	434.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.21	.21	.00	443.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.00	443.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.00	451.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	453.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.21	.00	454.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.21	.00	455.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.26	.25	.00	462.
1.01	1.10	14	.01	.00	.01	1.	1.01	13.10	158	.26	.25	.00	485.
1.01	1.15	15	.01	.00	.01	2.	1.01	13.15	159	.26	.25	.00	510.
1.01	1.20	16	.01	.00	.01	3.	1.01	13.20	160	.26	.25	.00	528.
1.01	1.25	17	.01	.00	.01	3.	1.01	13.25	161	.26	.25	.00	537.
1.01	1.30	18	.01	.00	.01	4.	1.01	13.30	162	.26	.25	.00	542.
1.01	1.35	19	.01	.00	.01	5.	1.01	13.35	163	.26	.25	.00	544.
1.01	1.40	20	.01	.00	.01	6.	1.01	13.40	164	.26	.25	.00	546.
1.01	1.45	21	.01	.00	.01	7.	1.01	13.45	165	.26	.25	.00	547.
1.01	1.50	22	.01	.00	.01	7.	1.01	13.50	166	.26	.25	.00	547.
1.01	1.55	23	.01	.00	.01	8.	1.01	13.55	167	.26	.25	.00	548.
1.01	2.00	24	.01	.00	.01	9.	1.01	14.00	168	.26	.25	.00	548.
1.01	2.05	25	.01	.01	.01	9.	1.01	14.05	169	.32	.32	.00	559.
1.01	2.10	26	.01	.01	.01	10.	1.01	14.10	170	.32	.32	.00	593.
1.01	2.15	27	.01	.01	.01	11.	1.01	14.15	171	.32	.32	.00	631.
1.01	2.20	28	.01	.01	.01	11.	1.01	14.20	172	.32	.32	.00	657.
1.01	2.25	29	.01	.01	.01	12.	1.01	14.25	173	.32	.32	.00	670.
1.01	2.30	30	.01	.01	.01	12.	1.01	14.30	174	.32	.32	.00	678.
1.01	2.35	31	.01	.01	.01	13.	1.01	14.35	175	.32	.32	.00	682.
1.01	2.40	32	.01	.01	.01	13.	1.01	14.40	176	.32	.32	.00	684.
1.01	2.45	33	.01	.01	.01	14.	1.01	14.45	177	.32	.32	.00	685.
1.01	2.50	34	.01	.01	.01	14.	1.01	14.50	178	.32	.32	.00	686.
1.01	2.55	35	.01	.01	.01	15.	1.01	14.55	179	.32	.32	.00	686.
1.01	3.00	36	.01	.01	.01	15.	1.01	15.00	180	.32	.32	.00	686.
1.01	3.05	37	.01	.01	.01	15.	1.01	15.05	181	.19	.19	.00	665.
1.01	3.10	38	.01	.01	.01	16.	1.01	15.10	182	.39	.39	.00	632.
1.01	3.15	39	.01	.01	.01	16.	1.01	15.15	183	.39	.39	.00	662.
1.01	3.20	40	.01	.01	.01	16.	1.01	15.20	184	.58	.58	.00	759.
1.01	3.25	41	.01	.01	.01	17.	1.01	15.25	185	.68	.68	.00	933.
1.01	3.30	42	.01	.01	.01	17.	1.01	15.30	186	1.65	1.64	.00	1292.
1.01	3.35	43	.01	.01	.01	17.	1.01	15.35	187	2.71	2.71	.00	2147.
1.01	3.40	44	.01	.01	.01	18.	1.01	15.40	188	1.07	1.06	.00	3094.
1.01	3.45	45	.01	.01	.01	18.	1.01	15.45	189	.68	.68	.00	3214.
1.01	3.50	46	.01	.01	.01	18.	1.01	15.50	190	.58	.58	.00	2673.
1.01	3.55	47	.01	.01	.01	18.	1.01	15.55	191	.39	.39	.00	2032.
1.01	4.00	48	.01	.01	.00	19.	1.01	16.00	192	.39	.39	.00	1563.
1.01	4.05	49	.01	.01	.00	19.	1.01	16.05	193	.30	.30	.00	1227.
1.01	4.10	50	.01	.01	.00	19.	1.01	16.10	194	.30	.30	.00	989.
1.01	4.15	51	.01	.01	.00	19.	1.01	16.15	195	.30	.30	.00	836.

END-OF-PERIOD FLOW (Cont'd)

1.01	4.20	52	.01	.01	.00	20.	1.01	16.20	196	.30	.30	.00	746.
1.01	4.25	53	.01	.01	.00	20.	1.01	16.25	197	.30	.30	.00	699.
1.01	4.30	54	.01	.01	.00	20.	1.01	16.30	198	.30	.30	.00	671.
1.01	4.35	55	.01	.01	.00	20.	1.01	16.35	199	.30	.30	.00	655.
1.01	4.40	56	.01	.01	.00	21.	1.01	16.40	200	.30	.30	.00	647.
1.01	4.45	57	.01	.01	.00	21.	1.01	16.45	201	.30	.30	.00	644.
1.01	4.50	58	.01	.01	.00	21.	1.01	16.50	202	.30	.30	.00	643.
1.01	4.55	59	.01	.01	.00	21.	1.01	16.55	203	.30	.30	.00	642.
1.01	5.00	60	.01	.01	.00	21.	1.01	17.00	204	.30	.30	.00	642.
1.01	5.05	61	.01	.01	.00	21.	1.01	17.05	205	.23	.23	.00	631.
1.01	5.10	62	.01	.01	.00	22.	1.01	17.10	206	.23	.23	.00	597.
1.01	5.15	63	.01	.01	.00	22.	1.01	17.15	207	.23	.23	.00	559.
1.01	5.20	64	.01	.01	.00	22.	1.01	17.20	208	.23	.23	.00	533.
1.01	5.25	65	.01	.01	.00	22.	1.01	17.25	209	.23	.23	.00	520.
1.01	5.30	66	.01	.01	.00	22.	1.01	17.30	210	.23	.23	.00	513.
1.01	5.35	67	.01	.01	.00	22.	1.01	17.35	211	.23	.23	.00	509.
1.01	5.40	68	.01	.01	.00	22.	1.01	17.40	212	.23	.23	.00	507.
1.01	5.45	69	.01	.01	.00	23.	1.01	17.45	213	.23	.23	.00	506.
1.01	5.50	70	.01	.01	.00	23.	1.01	17.50	214	.23	.23	.00	505.
1.01	5.55	71	.01	.01	.00	23.	1.01	17.55	215	.23	.23	.00	505.
1.01	6.00	72	.01	.01	.00	23.	1.01	18.00	216	.23	.23	.00	505.
1.01	6.05	73	.06	.05	.01	30.	1.01	18.05	217	.02	.02	.00	463.
1.01	6.10	74	.06	.05	.01	51.	1.01	18.10	218	.02	.02	.00	353.
1.01	6.15	75	.06	.05	.01	74.	1.01	18.15	219	.02	.02	.00	305.
1.01	6.20	76	.06	.05	.01	91.	1.01	18.20	220	.02	.02	.00	285.
1.01	6.25	77	.06	.05	.01	100.	1.01	18.25	221	.02	.02	.00	266.
1.01	6.30	78	.06	.05	.01	106.	1.01	18.30	222	.02	.02	.00	248.
1.01	6.35	79	.06	.05	.01	110.	1.01	18.35	223	.02	.02	.00	231.
1.01	6.40	80	.06	.05	.01	113.	1.01	18.40	224	.02	.02	.00	216.
1.01	6.45	81	.06	.05	.01	115.	1.01	18.45	225	.02	.02	.00	201.
1.01	6.50	82	.06	.06	.01	116.	1.01	18.50	226	.02	.02	.00	18[illegible].
1.01	6.55	83	.06	.06	.01	117.	1.01	18.55	227	.02	.02	.00	175.
1.01	7.00	84	.06	.06	.01	119.	1.01	19.00	228	.02	.02	.00	164.
1.01	7.05	85	.06	.06	.01	119.	1.01	19.05	229	.02	.02	.00	153.
1.01	7.10	86	.06	.06	.01	120.	1.01	19.10	230	.02	.02	.00	142.
1.01	7.15	87	.06	.06	.01	121.	1.01	19.15	231	.02	.02	.00	133.
1.01	7.20	88	.06	.06	.01	122.	1.01	19.20	232	.02	.02	.00	124.
1.01	7.25	89	.06	.06	.01	122.	1.01	19.25	233	.02	.02	.00	116.
1.01	7.30	90	.06	.06	.00	123.	1.01	19.30	234	.02	.02	.00	108.
1.01	7.35	91	.06	.06	.00	124.	1.01	19.35	235	.02	.02	.00	101.
1.01	7.40	92	.06	.06	.00	124.	1.01	19.40	236	.02	.02	.00	94.
1.01	7.45	93	.06	.06	.00	125.	1.01	19.45	237	.02	.02	.00	88.
1.01	7.50	94	.06	.06	.00	125.	1.01	19.50	238	.02	.02	.00	82.
1.01	7.55	95	.06	.06	.00	126.	1.01	19.55	239	.02	.02	.00	76.
1.01	8.00	96	.06	.06	.00	126.	1.01	20.00	240	.02	.02	.00	71.
1.01	8.05	97	.06	.06	.00	126.	1.01	20.05	241	.02	.02	.00	66.
1.01	8.10	98	.06	.06	.00	127.	1.01	20.10	242	.02	.02	.00	62.
1.01	8.15	99	.06	.06	.00	127.	1.01	20.15	243	.02	.02	.00	58.
1.01	8.20	100	.06	.06	.00	127.	1.01	20.20	244	.02	.02	.00	54.
1.01	8.25	101	.06	.06	.00	128.	1.01	20.25	245	.02	.02	.00	50.
1.01	8.30	102	.06	.06	.00	128.	1.01	20.30	246	.02	.02	.00	47.
1.01	8.35	103	.06	.06	.00	128.	1.01	20.35	247	.02	.02	.00	45.

END-OF-PERIOD FLOW (Cont'd)

1.01	8.40	104	.06	.06	.00	128.	1.01	20.40	248	.02	.02	.00	45.
1.01	8.45	105	.06	.06	.00	129.	1.01	20.45	249	.02	.02	.00	45.
1.01	8.50	106	.06	.06	.00	129.	1.01	20.50	250	.02	.02	.00	45.
1.01	8.55	107	.06	.06	.00	129.	1.01	20.55	251	.02	.02	.00	45.
1.01	9.00	108	.06	.06	.00	129.	1.01	21.00	252	.02	.02	.00	45.
1.01	9.05	109	.06	.06	.00	129.	1.01	21.05	253	.02	.02	.00	45.
1.01	9.10	110	.06	.06	.00	130.	1.01	21.10	254	.02	.02	.00	45.
1.01	9.15	111	.06	.06	.00	130.	1.01	21.15	255	.02	.02	.00	45.
1.01	9.20	112	.06	.06	.00	130.	1.01	21.20	256	.02	.02	.00	45.
1.01	9.25	113	.06	.06	.00	130.	1.01	21.25	257	.02	.02	.00	45.
1.01	9.30	114	.06	.06	.00	130.	1.01	21.30	258	.02	.02	.00	45.
1.01	9.35	115	.06	.06	.00	130.	1.01	21.35	259	.02	.02	.00	45.
1.01	9.40	116	.06	.06	.00	131.	1.01	21.40	260	.02	.02	.00	45.
1.01	9.45	117	.06	.06	.00	131.	1.01	21.45	261	.02	.02	.00	45.
1.01	9.50	118	.06	.06	.00	131.	1.01	21.50	262	.02	.02	.00	45.
1.01	9.55	119	.06	.06	.00	131.	1.01	21.55	263	.02	.02	.00	45.
1.01	10.00	120	.06	.06	.00	131.	1.01	22.00	264	.02	.02	.00	45.
1.01	10.05	121	.06	.06	.00	131.	1.01	22.05	265	.02	.02	.00	45.
1.01	10.10	122	.06	.06	.00	131.	1.01	22.10	266	.02	.02	.00	45.
1.01	10.15	123	.06	.06	.00	131.	1.01	22.15	267	.02	.02	.00	45.
1.01	10.20	124	.06	.06	.00	131.	1.01	22.20	268	.02	.02	.00	45.
1.01	10.25	125	.06	.06	.00	132.	1.01	22.25	269	.02	.02	.00	45.
1.01	10.30	126	.06	.06	.00	132.	1.01	22.30	270	.02	.02	.00	45.
1.01	10.35	127	.06	.06	.00	132.	1.01	22.35	271	.02	.02	.00	45.
1.01	10.40	128	.06	.06	.00	132.	1.01	22.40	272	.02	.02	.00	45.
1.01	10.45	129	.06	.06	.00	132.	1.01	22.45	273	.02	.02	.00	45.
1.01	10.50	130	.06	.06	.00	132.	1.01	22.50	274	.02	.02	.00	45.
1.01	10.55	131	.06	.06	.00	132.	1.01	22.55	275	.02	.02	.00	45.
1.01	11.00	132	.06	.06	.00	132.	1.01	23.00	276	.02	.02	.00	45.
1.01	11.05	133	.06	.06	.00	132.	1.01	23.05	277	.02	.02	.00	45.
1.01	11.10	134	.06	.06	.00	132.	1.01	23.10	278	.02	.02	.00	45.
1.01	11.15	135	.06	.06	.00	132.	1.01	23.15	279	.02	.02	.00	45.
1.01	11.20	136	.06	.06	.00	132.	1.01	23.20	280	.02	.02	.00	45.
1.01	11.25	137	.06	.06	.00	132.	1.01	23.25	281	.02	.02	.00	45.
1.01	11.30	138	.06	.06	.00	132.	1.01	23.30	282	.02	.02	.00	45.
1.01	11.35	139	.06	.06	.00	133.	1.01	23.35	283	.02	.02	.00	45.
1.01	11.40	140	.06	.06	.00	133.	1.01	23.40	284	.02	.02	.00	45.
1.01	11.45	141	.06	.06	.00	133.	1.01	23.45	285	.02	.02	.00	45.
1.01	11.50	142	.06	.06	.00	133.	1.01	23.50	286	.02	.02	.00	45.
1.01	11.55	143	.06	.06	.00	133.	1.01	23.55	287	.02	.02	.00	45.
1.01	12.00	144	.06	.06	.00	133.	1.02	0.00	288	.02	.02	.00	45.
								SUM	32.50	31.61	.89	70422.	
									(825.)	(803.)	(23.)	(1994.13)	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3214.	756.	244.	244.	70400.
CMS	91.	21.	7.	7.	1993.
INCHES		25.20	32.60	32.60	32.60
MM		640.04	828.06	828.06	828.06
AC-FT		375.	485.	485.	485.
THOUS CU M		462.	598.	598.	598.

SURFACE AREA=	0.	7.	30.	65.
CAPACITY=	0.	39.	209.	671.
ELEVATION=	743.	760.	770.	780.

SUMMARY OF DAM SAFETY ANALYSIS
PMF

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	760.00	760.00	764.20
STORAGE	39.	39.	82.
OUTFLOW	0.	0.	22.

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
.12	764.11	0.00	81.	22.	0.00	18.83	0.00
.13	764.37	.17	85.	25.	3.75	18.83	0.00
.50	766.29	2.09	118.	1334.	10.83	15.83	0.00
1.00	766.91	2.71	130.	2863.	13.42	15.83	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1% CHANCE FLOOD

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	760.00	760.00	764.20
STORAGE	39.	39.	82.
OUTFLOW	0.	0.	22.

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	764.69	.49	90.	48.	10.58	15.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

10% CHANCE FLOOD

....	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	760.00	760.00	764.20
STORAGE	39.	39.	82.
OUTFLOW	0.	0.	22.

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	763.39	0.00	71.	21.	0.00	15.42	0.00

5200 OAKLAND AVE. ST. LOUIS, MO. 63110

SHEET NO 6-12 OF ___ JOB NO 2028

TITLE:- Rogers Lake Dam-MO 31772
Spillway Rating Curve Values

SUBJECT FILE Hydraulics

BY JBB DATE 2-25-81 CHECKED ___ DATE ___

PRIN. SPILLWAY (12"φ STL. P.)				EMERG. SPILLWAY (18"φ CMP)				Total
Elev.	H (ft.)	V (ft/sec.)	Q (cfs)	Elev.	H (ft.)	V (ft./sec.)	Q (cfs)	Q (cfs)
760.5	0	0	0	761.65	0	0	0	0
761.0	0.5	13.71	10.8	761.0	—	—	0	10.2
762.0	1.5	14.15	11.1	762.0	0.35	3.19	5.6	16.7
762.5	2.0	14.36	11.3	762.5	0.85	3.95	7.0	18.3
763.0	3.0	14.78	11.6	763.0	1.35	4.57	8.1	19.7
764.0	4.0	15.18	11.9	764.0	2.35	5.63	9.9	21.8
765.0	5.0	15.57	12.2	765.0	3.35	6.51	11.5	23.7
766.0	6.0	15.96	12.5	766.0	4.35	7.29	12.9	25.4
767.0	7.0	16.33	12.8	767.0	5.35	7.99	14.1	26.9
768.0	8.0	16.70	13.1	768.0	6.35	8.64	15.3	28.4

Where: $V = \frac{Q}{A}$.