

MISSOURI-KANSAS CITY BASIN

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LEVEL II

SPRING FORK LAKE DAM
PETTIS COUNTY, MISSOURI
MO 30152

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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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St. Louis District

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

FOR: STATE OF MISSOURI

AUGUST 1979

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PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY INSPECTION



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St. Louis District

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

FOR: STATE OF MISSOURI

AUGUST 1979



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

IN REPLY REFER TO

SUBJECT: Spring Fork Lake Dam Mo. ID No. 30152
Phase I Inspection Report

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

SUBMITTED BY:

Chief, Engineering Division

Date

APPROVED BY:

Colonel, CE, District Engineer

Date

SPRING FORK LAKE DAM
PETTIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30152

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF
ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR
GOVERNOR OF MISSOURI

August 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Spring Fork Lake Dam
State Located	Missouri
County Located	Pettis County
Stream	Cheese Creek
Date of Inspection	17 August 1979

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

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten the life and property of seven families downstream of the dam and would potentially cause damage to seven roads, the Sedalia water treatment plant and a park within the estimated damage zone which extends approximately eleven miles downstream of the dam.

Our inspection and evaluation indicates the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillways will pass 55 percent of the probable maximum flood, which is greater than the 100-year flood, without overtopping the dam. The spillway design flood recommended by the guidelines is the probable maximum flood. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Deficiencies visually observed by the inspection team were minor seepage through the spillway weir wall, erosion on the upstream embankment, minor deterioration of the concrete weir, separation of riprap, brush growth on both faces of the structure, and a slide area on the downstream face. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. A detailed report discussing each of these deficiencies is attached.

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OVERVIEW OF LAKE AND DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
SPRING FORK LAKE DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

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

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

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Spring Fork Lake Dam is an earthen structure built in 1925. It is located in southeast Pettis County about 8 miles directly south of Sedalia, Missouri on Cheese Creek, a tributary to Spring Fork Creek (from USGS Bahner, Missouri quadrangle map). The dam and appurtenances were designed by Burns & McDonnell Engineering Company, Kansas City, Missouri. The reservoir serves as a principal water supply source for the City of Sedalia.

Spring Fork Lake Dam is about 13 feet wide at the crest, 1,600 feet long, and about 42 feet high in the general vicinity of the original stream bed. The dam has both a concrete cut-off wall beneath its crest and a clay cut-off upstream of the dam's centerline.

The structure has a concrete principal spillway located at the right abutment and a grass-lined auxiliary spillway at the left abutment. The water supply intake structure is located about 90 feet upstream from the centerline of the dam about 215 feet west of the principal spillway.

Due to the heavy vegetal growth on both the upstream and downstream embankments, a detailed visual inspection was not possible. However, it was noted that the embankment is protected on the upstream face by hand-placed riprap in some locations and by what appears to be dumped

in-place riprap in other locations. The downstream slope does not appear to have any specific slope protection.

(2) A concrete side channel spillway with a 185 foot long gravity overflow section is located at the right abutment. The side channel trough consists of concrete bottom and walls and discharges toward the north into the existing creek channel.

(3) A grass-lined auxiliary spillway is located at the left abutment. It consists of a grass-lined approach channel and discharge channel. The spillway approach and discharge channels have trapezoidal cross-sections. The spillway is separated from the dam structure by the right bank of the discharge channel and a relatively flat, unobstructed area between the downstream embankment toe and the channel bank.

(4) A water supply intake structure is located about 215 feet west of the principal spillway. The structure is of concrete, circular in shape. Four sluice gates at varying levels allow water to flow into the structure. Water then passes through a hardware cloth screen before entering a 20-inch cast iron pipeline to the Sedalia water purification plant.

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

b. Location. The dam is located in southeast Pettis County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Bahner, Missouri in Sections 21 and 28 of T44N, R21W.

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

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Spring Fork Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial, and commercial facilities, and to important public utilities, main highways, or railroads. For the Spring Fork Lake Dam, the estimated flood damage zone extends downstream approximately eleven miles. Within the damage zone are seven dwellings, seven roads, the Sedalia water treatment plant, and a park.

e. Ownership. The dam is owned by the City of Sedalia, Missouri Water Department, 111 West Fourth Street, Sedalia, Missouri 65301.

f. Purpose of Dam. The dam forms a 128-acre water supply reservoir.

g. Design and Construction History. Engineering design drawings with as-built notations were made available by the City of Sedalia Water Department.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, capacity of the uncontrolled principal spillway, and flow through the water supply intake structure all combine to maintain a relatively stable water surface elevation.

i. Maintenance. The City of Sedalia Water Department is responsible for maintenance at this dam.

1.3 PERTINENT DATA

a. Drainage Area - 6,906 acres.

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through a controlled water intake structure.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 23,500 cfs (at probable maximum pool El. 898.8).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 896.5 \pm (see Plate 3)

(2) Water supply intake gate levels - 878.0, 870.2, 862.7, and 855.7 (from design drawings by Burns & McDonnell, Engineering Company)

(3) Principal spillway crest - 887.5 (from design drawings)

(4) Auxiliary spillway crest - 896.1

(5) Streambed at centerline of dam - 855.0 \pm (from design drawings)

(6) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 9,300 feet \pm

(2) Length of normal pool - 6,800 feet \pm

e. Storage (Acre-feet).

- (1) Top of dam - 3,104
- (2) Auxiliary spillway crest - 3,021
- (3) Principal spillway crest - 1,613
- (4) Design surcharge - Unknown.

f. Reservoir Surface (Acres).

- (1) Top of dam - 210
- (2) Auxiliary spillway crest - 206
- (3) Principal spillway crest - 128

g. Dam.

- (1) Type - Earth embankment
 - (2) Length - 1,600 feet
 - (3) Height - 42 feet \pm
 - (4) Top width - 13 feet
 - (5) Side slopes - upstream face varies from 1.0 V on 3.7 H to 1.0 V on 1.8 H, downstream face varies from 1.0 V on 3.1 H to 1.0 V on 2.0 H (see Plate 8)
 - (6) Zoning - None.
 - (7) Impervious core - None.
 - (8) Cut-offs - a) Reinforced concrete
b) Clay
 - (9) Grout curtain - None.
 - (10) Internal drainage system - Unknown.
- h. Diversion and Regulating Tunnel - None.

i. Auxiliary Spillway.

- (1) Type - Nonlevel, broad-crested weir.
- (2) Length of weir - 125 feet \pm .
- (3) Crest elevation - 896.1 feet m.s.l.
- (4) Gates - None.
- (5) Upstream channel - Not applicable.
- (6) Downstream channel - Grass-lined, channel and pasture near the toe of the downstream embankment slope.

j. Principal Spillway.

- (1) Type - Concrete gravity side channel.
- (2) Length of weir - 185 feet
- (3) Crest elevation - 887.5
- (4) Gates - None.
- (5) Upstream channel - None.
- (6) Downstream channel - Open channel comprised of a limestone floor with alluvial clay, silt, sand, and gravel of varying thickness.

k. Regulating Outlets - None. However, the water supply intake structure provides multilevel inlet capabilities. There are four gear-operated sluice gate inlets with screening apparatus and a single gear-operated sluice gate outlet installed within this structure. The raw water flows through a 20-inch cast iron pipe to the City of Sedalia water purification plant. A valve is provided immediately downstream of the dam which may serve to bypass flows through a ditch to the natural channel below the dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were available in the form of engineering design drawings with "as-built" notations, and pertinent excerpts from "Triennial Report Operations of the Sedalia Waterworks for the Period Ended March 31, 1978" provided by the City of Sedalia, Missouri, and Black & Veatch Consulting Engineers, Kansas City, Missouri, respectively.

2.2 CONSTRUCTION

The dam was constructed in 1925. Typical "period" construction methods were employed on this dam.

2.3 OPERATION

Documentation of past experiences of a serious nature was not available.

2.4 GEOLOGY

The dam is constructed across a broad shallow valley containing Cheese Creek. The soils of the reservoir area consist of the Hartwell-Creldon-Crider-Eldon soils associations which are characterized as deep, gently sloping to moderately sloping, well drained to somewhat poorly drained, formed in loess and residuum from cherty limestone. Beneath the soils are cherty dolomite of the Jefferson City, Cotter, Powell and Smithville formations of Ordovician age. The cherty dolomite is massive bedded with very few widely spaced closed vertical joints. The embankment is constructed of CL material as determined by visual classification of probe samples.

Design drawings for the dam provided information on the abutment and foundation materials along the centerline of the auxiliary spillway, earth embankment, and primary spillway. The auxiliary spillway is constructed at the left abutment in clay of either loessial or residual origin that is approximately 15 feet thick. The embankment foundation material (as determined from boring data) consists of 5 to 15 feet of topsoil over gumbo, over gray clay, clayey gravel or gravel, over cherty dolomite bedrock. A concrete cut-off wall begins approximately 200 feet from the auxiliary spillway and extends eastward the length of the earth embankment, the wing wall and primary spillway weir. This wall is keyed into gray clay for approximately 1,000 feet. Then it is keyed approximately two feet into the dolomite bedrock along the rest of the structure. A clay cut-off wall, beginning 200 feet from the auxiliary spillway, extends the length of the embankment on the upstream side. This clay cut-off wall is keyed into clay for approximately 700 feet and then

through the clay into the dolomite bedrock along the remainder of the embankment length. The principal spillway is constructed in dolomite bedrock and discharges into the natural stream below the dam.

2.5 EVALUATION

a. Availability. Engineering data were obtained as noted in Section 2.1.

b. Adequacy. The available engineering data provides an adequate description and classification of subsurface materials at the dam site, auxiliary spillway, and borrow areas.

The design slopes for Spring Fork Lake Dam are consistent with the recommended slopes for small (USBR definition) homogeneous earth fill dams on stable foundations as presented in Table 18 of the USBR "Design of Small Dams".

Engineering data were not available from which to make an assessment of construction of the facilities. Discussions with representatives of the Sedalia Water Department, and the caretaker of the facility provided information pertaining to the operation of the facility.

c. Validity. The available engineering data on the design and verbal information pertinent to the dam's operation were determined to be valid.

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 and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Spring Fork Lake Dam was made on 17 August 1979. The inspection team included professional engineers with experience in dam design and construction, hydrology, hydraulic engineering, and geotechnical engineering. The inspection team was accompanied by Sedalia, Missouri Water Department personnel; Mr. C. H. Taylor, General Manager; Mr. Gary Garoutte, Plant Superintendent; and Mr. Virgil Reed, Caretaker. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed that the dam is in generally good condition with the exception of the following items:

(1) A minor slide area was observed on the downstream slope about 720 feet west of the principal spillway. The slide area was about 10-15 feet wide and about 20-25 feet long. Vegetation covered the slide area.

(2) Several areas of erosion exist along the upstream face above the insitu riprap.

(3) Some areas on the upstream face are without adequate riprap protection.

(4) Excessive brush growth was observed on both slopes.

(5) Minor clear seepage was observed at some construction joints at the principal spillway of a magnitude less than 1 gpm.

(6) The concrete on the principal spillway and trough is deteriorating.

(7) Undercutting of the discharge trough floor has taken place at the downstream end.

(8) Two drain pipes located under the discharge trough floor are apparently nonfunctioning.

No animal burrows nor embankment cracking, settlement, sinkholes, potholes, or ruts were observed.

It is considered by the inspection team that the aforementioned visual observations are unlikely to cause major problems to the structure in the immediate future. Because of the density of brush and weed

growth on both slopes, the inspection team was unable to ascertain the presence or nonpresence of other possible exceptions relative to the dam's condition.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. A grass-lined auxiliary spillway which was constructed near the left abutment appears in good condition. The auxiliary spillway will act as a nonlevel, broad-crested weir. The right bank of the discharge channel protecting the main dam structure is intact. Minor drainage channels were observed in the spillway discharge channel.

The principal spillway consisting of a concrete gravity section and concrete trough appears to be in fair to good condition. The discharge trough is in generally good condition, although concrete deterioration was observed. The water intake structure and valve operators are in good condition. According to Mr. C. H. Taylor, Sedalia Water Department, the intake gates and the bypass valve downstream of the dam are in operable condition.

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

e. Downstream Channel. The principal spillway discharges into the natural stream channel. The floor and right side of the channel consist of cherty dolomite covered in places by either residual or alluvial soil. Some sand and gravel were present in the channel. The left bank consists of alluvial soil overlying bedrock. One minor healed fault in the bedrock was observed in the right wall of the channel just below the spillway. The channel was in good condition with only minor erosion. Some erosion of the bedrock has occurred beneath the lip of the spillway where it discharges into the stream (See Photo 18).

3.2 EVALUATION

During the inspection there were observed minor deficiencies which warrant attention. None of these deficiencies should be considered in an emergency category, although, in order to continue to maintain this dam in good condition they should be rectified.

a. A minor slide area has developed on the downstream slope midway between the dam crest and toe of slope. The area is about 720 feet from the left wall of the principal spillway. This particular area was densely covered with brush and weeds. No seepage or wet spots were noted which could conceivably be contributing factors. Attention should be focused on this area in future inspections or maintenance activities to assure that further deterioration of the slide area has not taken place. An engineer familiar with the design, construction, and repair of earth embankments should be consulted regarding repair to this area.

b. Wave induced bank erosion has occurred on the upstream slope of the embankment. The orientation of the reservoir pool in a general south to north direction allows the opportunity for wind induced wave erosion. Areas were observed along the upstream face above riprap protection where erosion has taken place. Steep slopes, nearly vertical in places, washouts of riprap, and areas void of vegetation have resulted from wave action. A program should be developed and initiated to repair the upstream slope and riprap protection. It is suggested that an engineer experienced in earth dam design and maintenance practices be retained to formulate necessary corrective measures and maintenance programs.

c. Brush, tree and weed control were evident for this structure. Brush and weed growth indicate recent cutting. Trees have been cut from both slopes. Roots and stumps were visible at numerous locations on both slopes. The potential exists for root decay and subsequent development of seepage routes into the interior of the dam. Continuous monitoring of exposed stumps and roots is in order. An engineer familiar with tree removal from earthen embankments should be consulted regarding this potential problem area.

d. Minor seepage sufficient to keep the concrete surface wet was observed coming from various construction joints in the gravity section of the principal spillway. Although not an immediate problem, attention should be given to reducing this seepage to insure stable conditions for this appurtenance. If left unattended, continual deterioration of the concrete surface can be expected.

e. There is evidence of concrete deterioration at various locations on the spillway and discharge trough. Spalling, cracks, and displacement were observed. Although of significant localized concern, these deficiencies are not considered significant enough to produce total failure of the structure. Repairs in the form of filling cracks with tar were observed to have been made. Repairs to this appurtenance are recommended as soon as practicable.

f. Undercutting of the discharge trough on the downstream end was observed. Remedial measures should be taken to repair this condition before it is allowed to jeopardize the floor slab.

g. Two drains, located under the discharge trough, were dry. From evidence of seepage through construction joints of the gravity section of the principal spillway, it is concluded that in all likelihood these drains are plugged. Efforts should be made to restore these drains to their original condition.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, transpiration, evaporation, the water supply demands of the City of Sedalia, and the capacity of the uncontrolled principal spillway.

4.2 MAINTENANCE OF DAM

Maintenance for Spring Fork Lake Dam is the responsibility of the City of Sedalia Water Department. The dam caretaker performs maintenance activities as directed by the water department.

Brush and tree control was observed to have taken place at an earlier date. Discussions held with the caretaker indicated brush and weed control was performed in the spring of 1979.

Repair work has been performed on the principal spillway as noted in Section 3.2.

4.3 MAINTENANCE OF OPERATING FACILITIES

Maintenance performed was unknown.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system for this dam.

4.5 EVALUATION

The existing maintenance program warrants increased efforts for a structure of this type. A concise maintenance program should be developed to repair erosion, washed out riprap and brush/tree control for this dam. Corrective measures as suggested elsewhere in this report should be implemented to keep this dam in its visibly good condition.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were not available. Independent calculations were performed for the report in accordance with the referenced guidelines.

b. Experience Data. The drainage area and lake surface area are developed from USGS Bahner, Ionia, Lincoln, and Cole Camp Quadrangle Maps. The spillway and dam layouts are from surveys made during the inspection and available design documents.

c. Visual Observations.

(1) The auxiliary and principal spillways are in relatively good condition. Discharge channels for both spillways also appear in good condition.

(2) Facilities are available which could serve to draw down the pool.

(3) An auxiliary spillway with a grass-lined discharge channel is located near the left abutment. Discharges from this appurtenance are unlikely to endanger the integrity of this dam. The dam is protected from emergency discharges through the spillway and channel by the right bank of the discharge channel and a relatively flat, unobstructed area between the channel bank and the downstream embankment toe. Discharges reach Cheese Creek a short distance downstream from the dam and should not pose any threat to the structure.

(4) A principal spillway with a concrete discharge trough is located at the right abutment of the dam.

d. Overtopping Potential. The auxiliary and principal spillways discharging simultaneously will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillways will pass 55 percent of the probable maximum flood and the 100-year flood, estimated to be 4,700 cfs, without overtopping the dam. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of intermediate size should pass the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 6,200 cfs of the total discharge from the reservoir of 31,300 cfs. The estimated duration of overtopping is 5.0 hours with a maximum height of 2.3 feet. Failure

of the small farm pond type upstream water impoundments shown on the USGS maps would not have a significant impact on the hydrologic and hydraulic analyses. There is evidence the soils observed as characteristic of the embankment surfaces are susceptible to erosion. Although the inspection team found no evidence of overtopping of the embankment, it is thought that prolonged overtopping of the embankment would cause erosion which could lead to failure.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately eleven miles downstream of the dam.

Seven road crossings, the Sedalia water treatment plant, a park, and several homes and buildings could be severely damaged and lives lost should failure of the dam occur.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

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

b. Design Data. No design data relating to the structural stability of the dam were 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 and made a matter of record.

c. Operating Records. Operating records were not available.

d. Post Construction Changes. No known post construction changes.

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

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

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items noted during the visual inspection by the inspection team which should be monitored or controlled are seepage at the principal spillway, wave induced erosion, riprap washouts, concrete deterioration, brush - tree growth, and the slide area on the downstream slope.

b. Adequacy of Information. The conclusions in this report are based on performance history, visual conditions, and the available engineering design data. The inspection team considers that these data are sufficient to support the conclusions herein. 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. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue and lead to a potential of failure.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers that would require a Phase II investigation.

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

7.2 REMEDIAL MEASURES

a. Alternatives. The principal and auxiliary spillways, acting together, have the capacity to pass 55 percent of the probable maximum flood without overtopping the dam. In order to pass the probable maximum flood as required by the Recommended Guidelines, the spillway sizes and/or height of dam would need to be increased. It is recommended that the low portion of the embankment be raised to the original design elevation of 897.5 and that the crest of the auxiliary spillway be lowered 2-3 feet. A professional engineer experienced in the design and construction of earth embankments should be consulted to redesign the dam and/or appurtenances.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended:

(1) Measures should be implemented to eliminate seepage through construction joints in the gravity section of the principal spillway. Cracks, spalling, etc. of the concrete in this spillway should be repaired as directed by an engineer experienced in concrete design/maintenance.

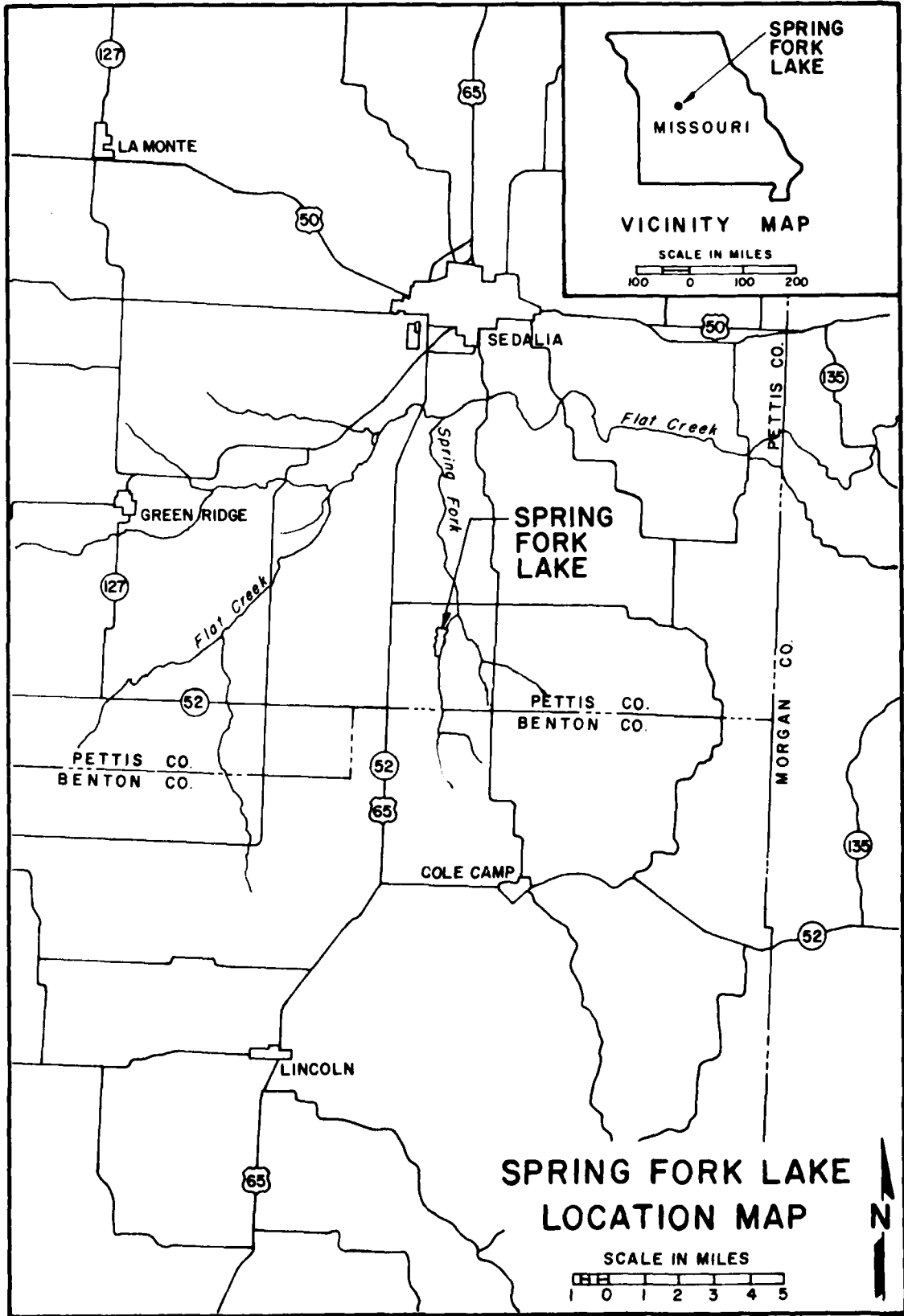
(2) Wave induced erosion of the upstream face of the dam above the insitu riprap should be corrected and measures adopted to eliminate future erosion damage.

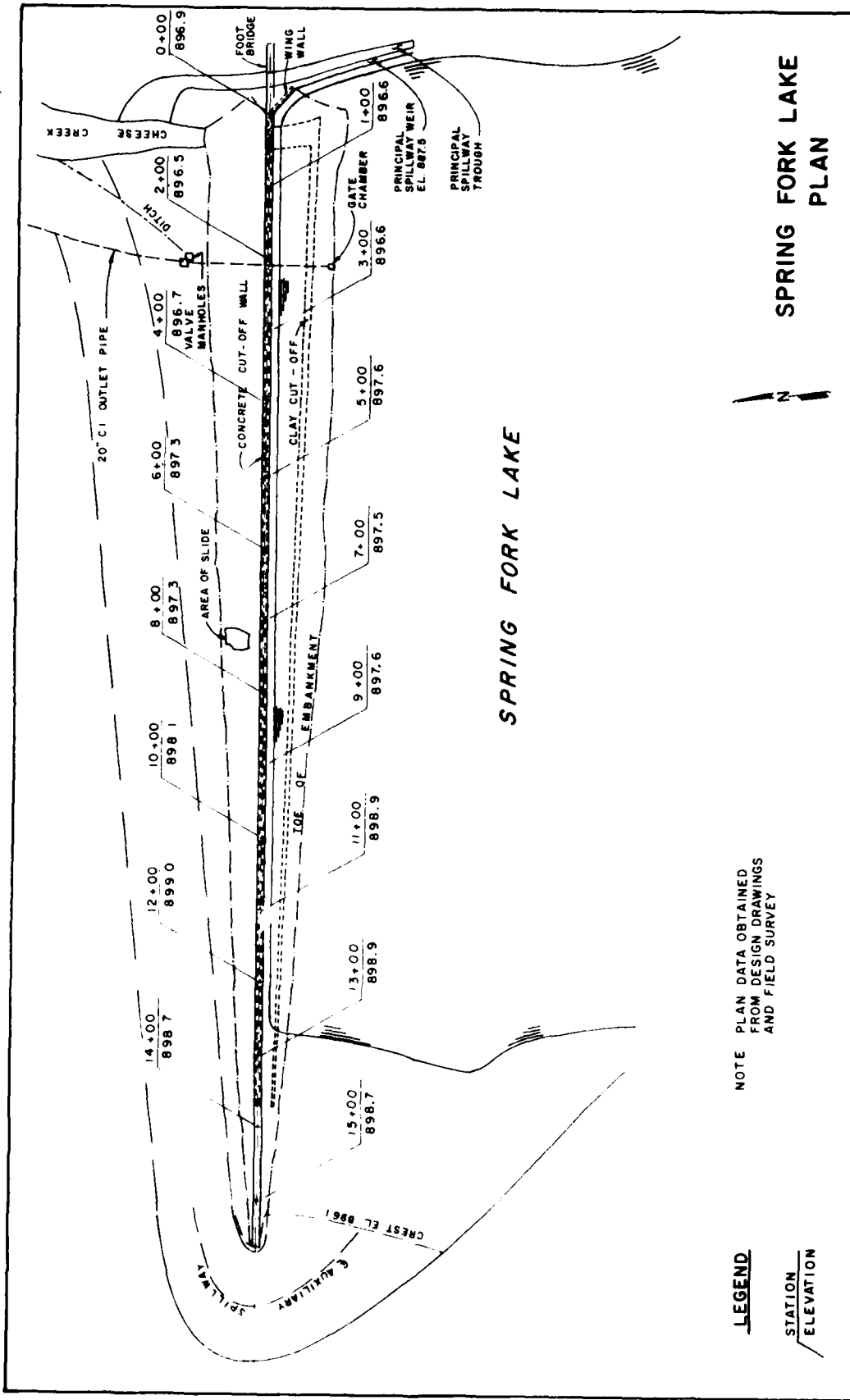
(3) In select areas, hand-placed riprap is in excellent condition and in other areas it has been damaged or washed out. Riprap slope protection should be replaced in those areas where it has been lost and repaired as needed elsewhere. Extension of the riprap higher on the slope than originally placed may be in order if a wind tide, wave height or wave run-up analysis so indicates.

(4) A program should be developed and implemented to control the growth of brush and trees on the dam. Past efforts have been made and have resulted in tree stumps and root systems left intact within the embankment material. A detailed control/removal program should be developed by an engineer experienced in earth dam design and maintenance.

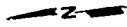
(5) Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

(6) A detailed inspection of the dam should be made periodically by an engineer experienced in design and construction of earthen dams. While the City of Sedalia Water Department has, on a triennial basis, had this dam inspected, more frequent inspections may be required if additional deficiencies are observed, or the severity of the reported deficiencies increases.





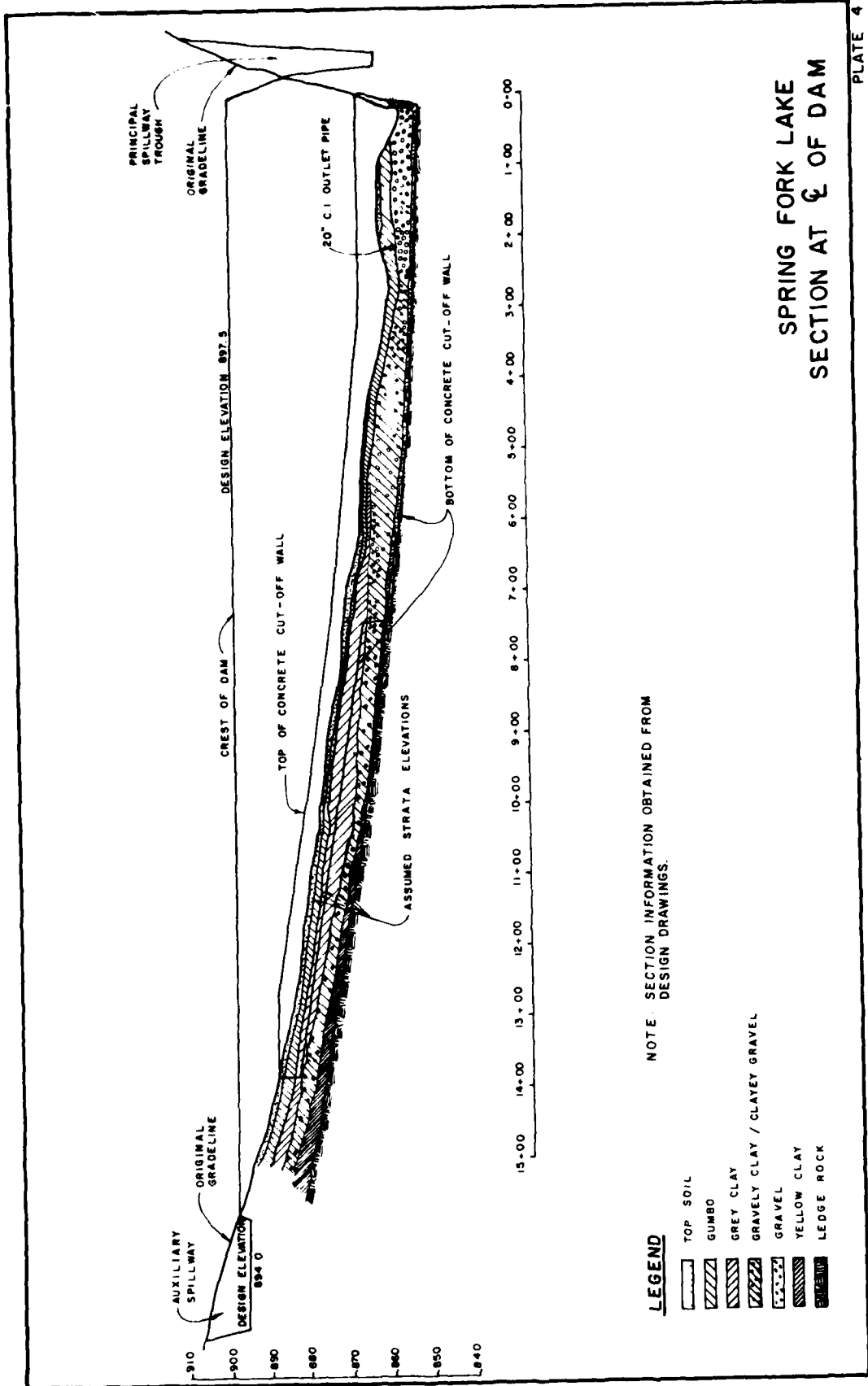
SPRING FORK LAKE



NOTE PLAN DATA OBTAINED FROM DESIGN DRAWINGS AND FIELD SURVEY

LEGEND
 STATION
 ELEVATION

SPRING FORK LAKE
 PLAN

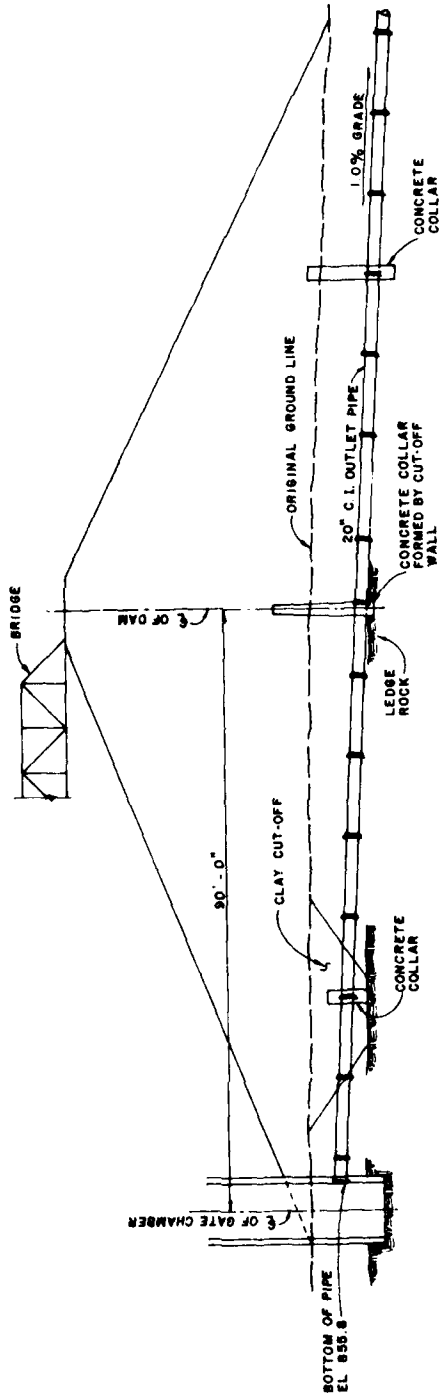


NOTE: SECTION INFORMATION OBTAINED FROM DESIGN DRAWINGS.

LEGEND

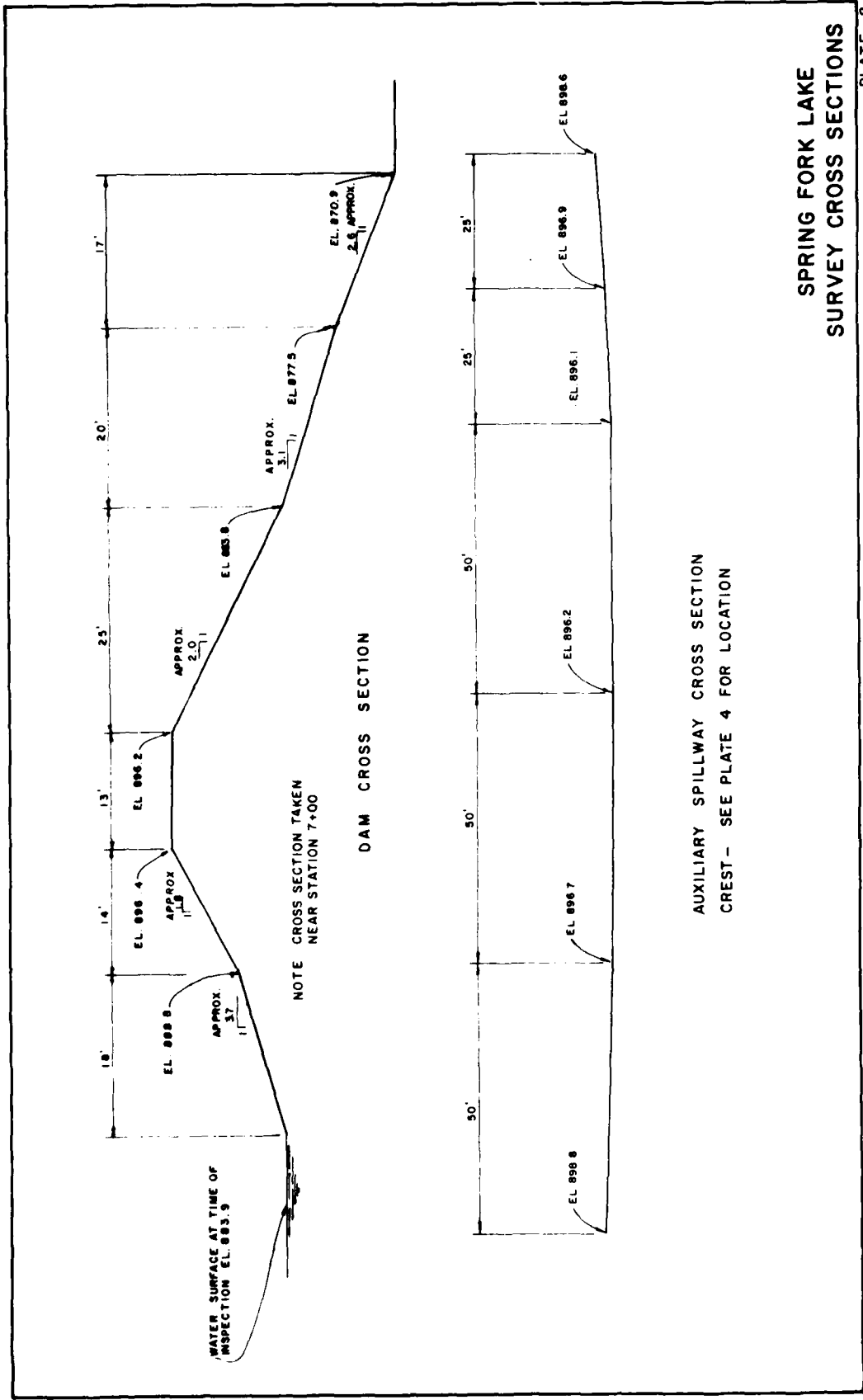
- TOP SOIL
- GUMBO
- GREY CLAY
- GRAVELLY CLAY / CLAYEY GRAVEL
- GRAVEL
- YELLOW CLAY
- LEDGE ROCK

**SPRING FORK LAKE
SECTION AT $\frac{1}{2}$ OF DAM**



NOTE: OUTLET PIPE DETAILS OBTAINED FROM DESIGN DRAWINGS.

SPRING FORK LAKE
OUTLET PIPE DETAIL



SPRING FORK LAKE
SURVEY CROSS SECTIONS

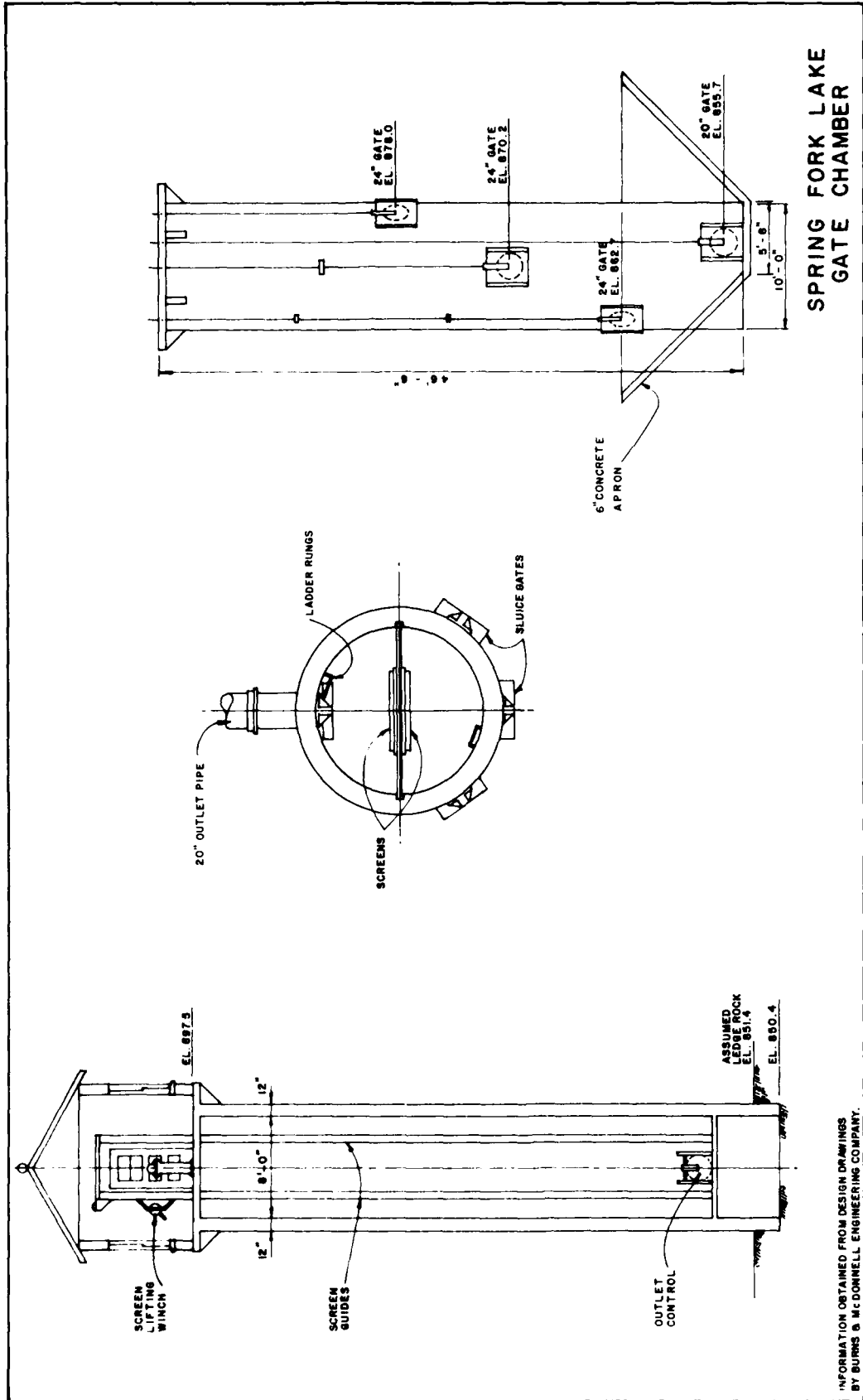
PLATE 8

AUXILIARY SPILLWAY CROSS SECTION
CREST - SEE PLATE 4 FOR LOCATION

WATER SURFACE AT TIME OF
INSPECTION EL. 883.9

NOTE CROSS SECTION TAKEN
NEAR STATION 7+00

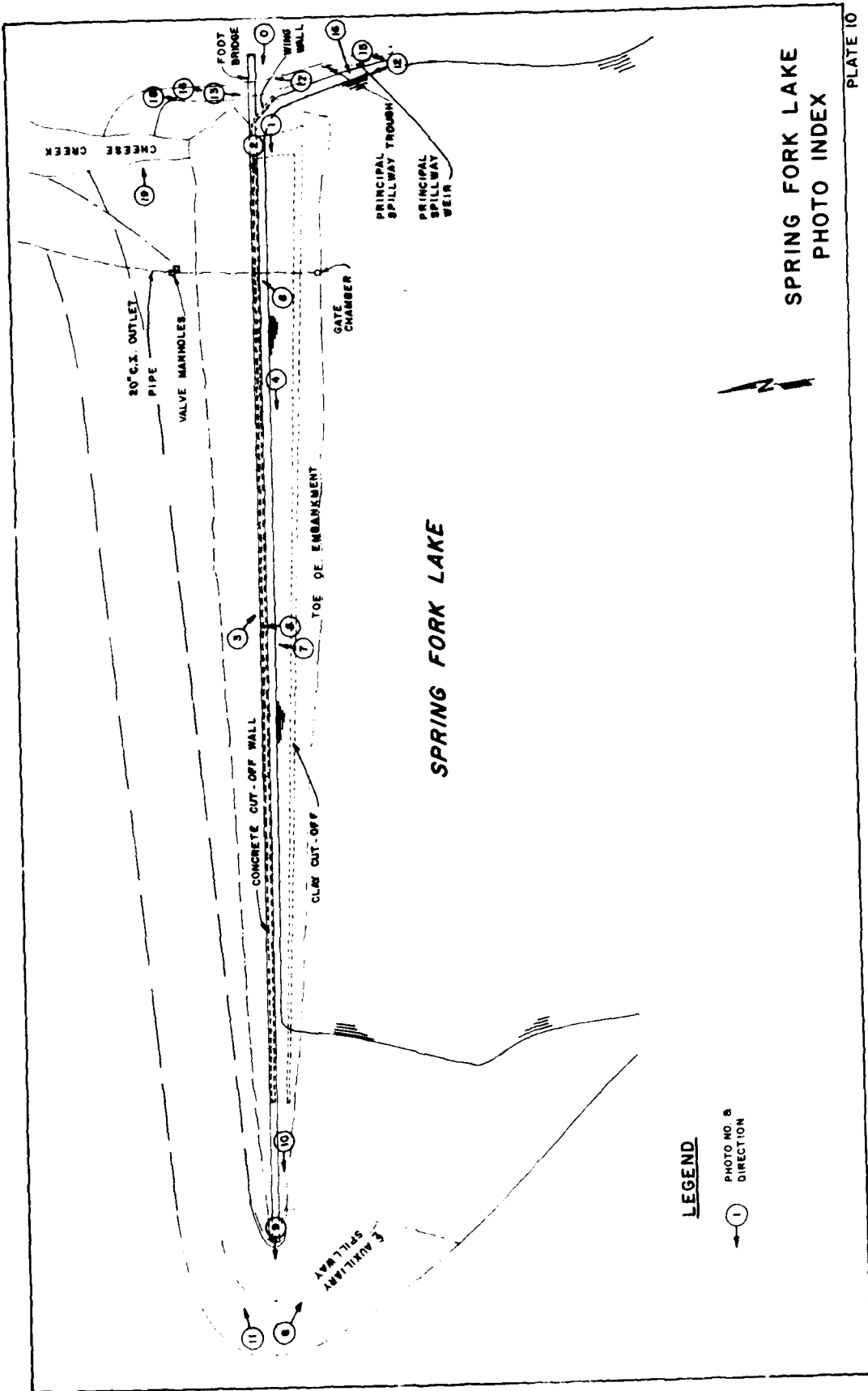
DAM CROSS SECTION



**SPRING FORK LAKE
GATE CHAMBER**

PLATE 9

INFORMATION OBTAINED FROM DESIGN DRAWINGS
BY BURNS & MCDONNELL ENGINEERING COMPANY.



SPRING FORK LAKE
PHOTO INDEX



PHOTO 1: UPSTREAM EMBANKMENT FACE (LOOKING WEST FROM NEAR THE PRINCIPAL SPILLWAY)

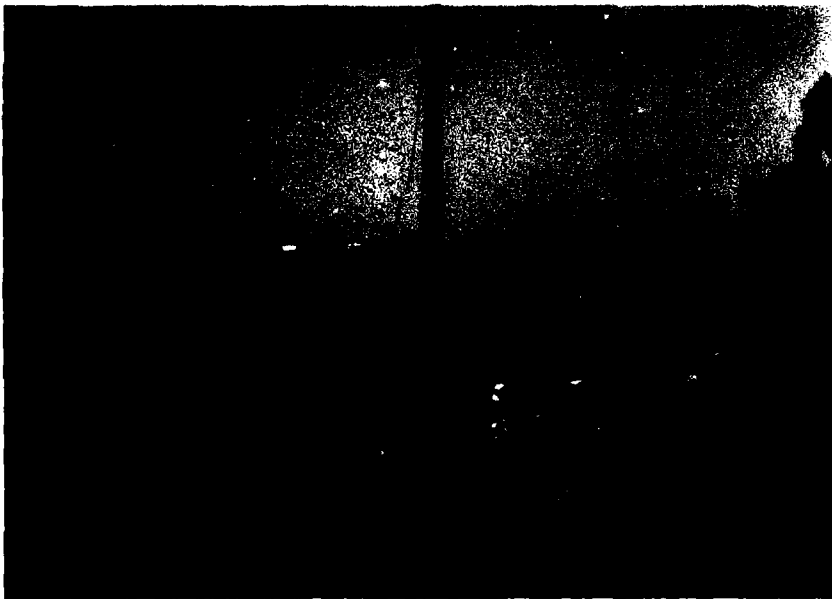


PHOTO 2: EMBANKMENT CREST (LOOKING WEST FROM NEAR THE PRINCIPAL SPILLWAY)



PHOTO 3: SLIDE AREA ON DOWNSTREAM FACE ABOUT 720 FEET WEST OF BRIDGE OVER PRINCIPAL SPILLWAY TROUGH



PHOTO 4: UPSTREAM EMBANKMENT FACE (LOOKING WEST, NOTE HAND-PLACED RIPRAP)



PHOTO 5: WAVE EROSION ON UPSTREAM FACE NEAR MIDPOINT OF DAM



PHOTO 6: UPSTREAM FACE RIPRAP NEAR THE WATER INTAKE STRUCTURE
(LOOKING NORTHEAST)



PHOTO 7: WASHOUT BENEATH TREE ROOT AND TRUNK ON UPSTREAM FACE
NEAR MIDPOINT OF DAM NEAR WATER EDGE



PHOTO 8: AUXILIARY SPILLWAY APPROACH (LOOKING SOUTHEAST)

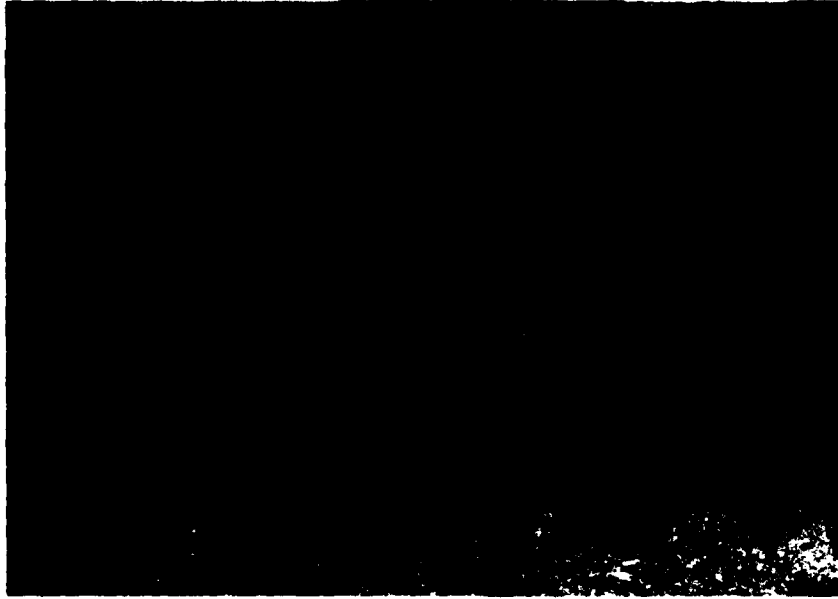


PHOTO 9: AUXILIARY SPILLWAY IN LINE WITH EMBANKMENT CREST CENTERLINE (LOOKING WEST)



PHOTO 10: AUXILIARY SPILLWAY APPROACH AND UPSTREAM EMBANKMENT FACE (LOOKING WEST)

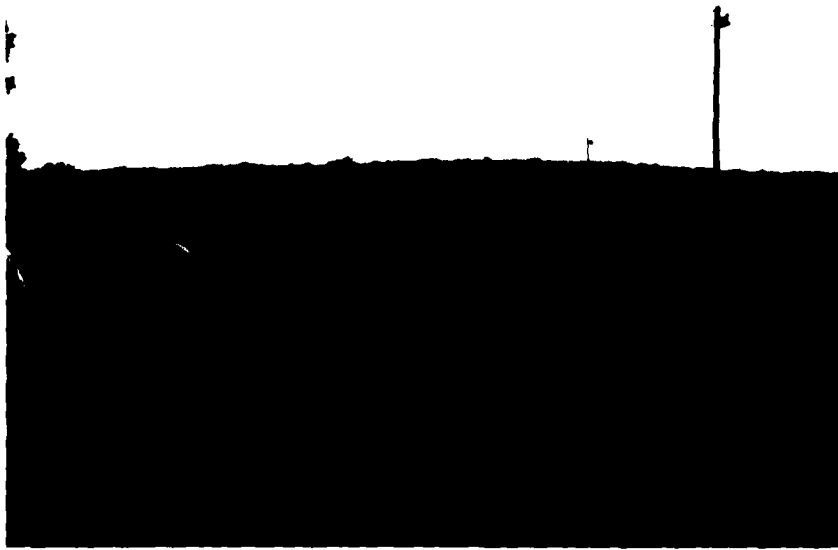


PHOTO 11: AUXILIARY SPILLWAY DISCHARGE CHANNEL (FROM NEAR LEFT ABUTMENT LOOKING EAST)

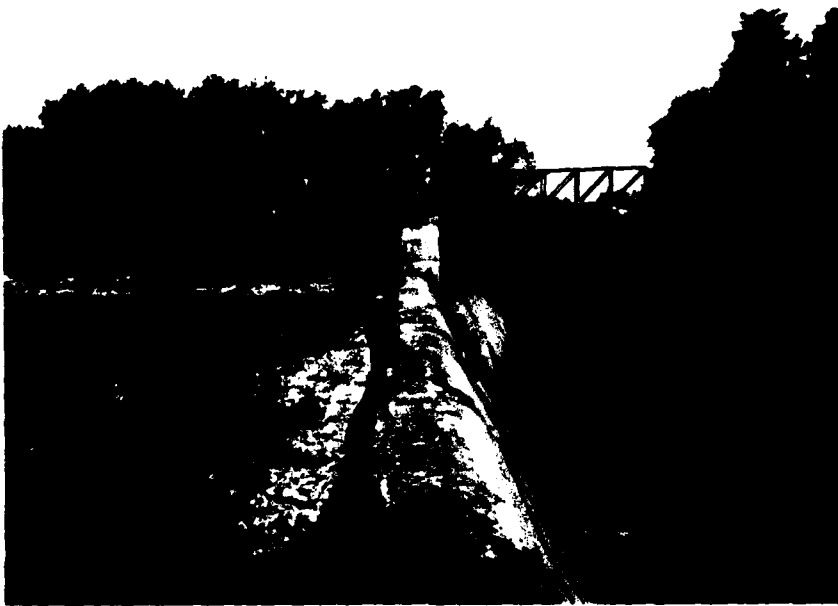


PHOTO 12: PRINCIPAL SPILLWAY CREST (LOOKING NORTH TOWARD DAM)

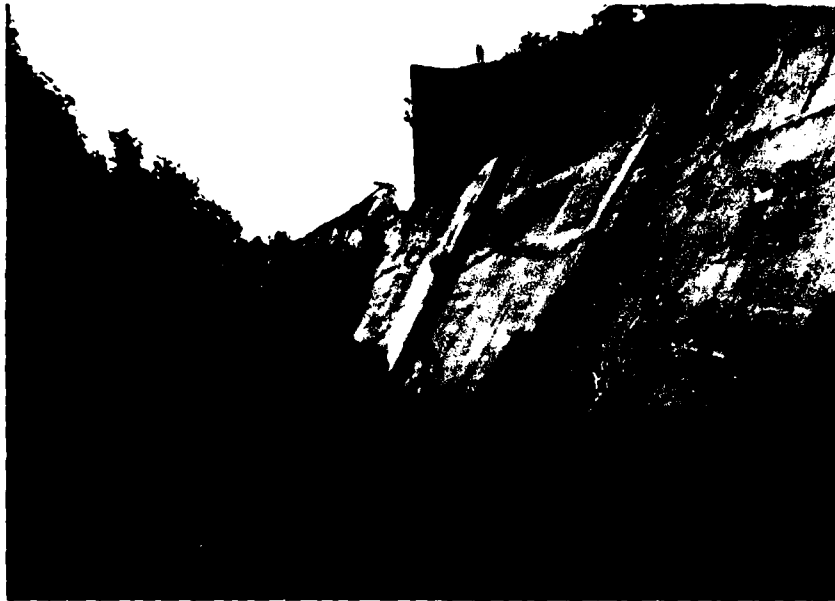


PHOTO 13: PRINCIPAL SPILLWAY TROUGH (LOOKING SOUTH, NOTE SEEPAGE AND BRUSH GROWTH)



PHOTO 14: PRINCIPAL SPILLWAY TROUGH (LOOKING SOUTH, NOTE CRACKING AND SEEPAGE)

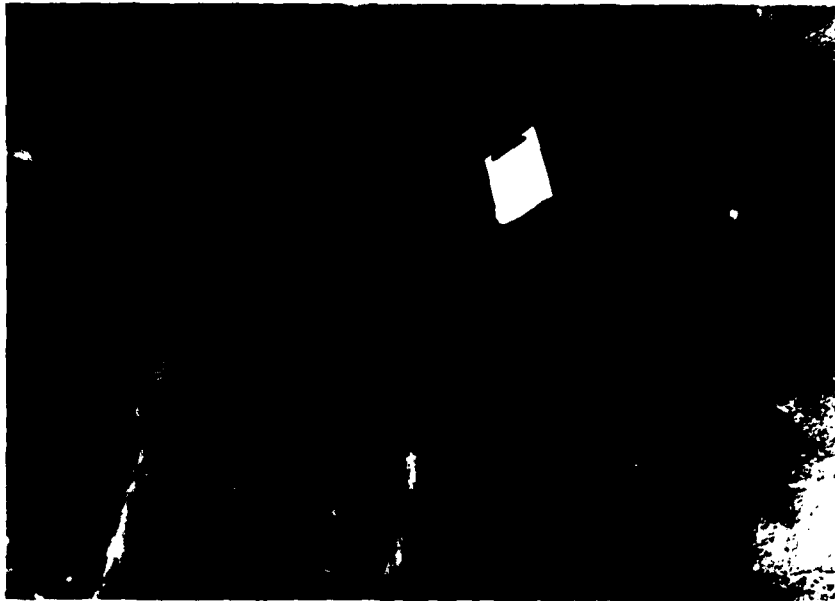


PHOTO 15: DETERIORATION AND REPAIR OF CONCRETE AT SOUTHWEST TROUGH CORNER



PHOTO 16: CONCRETE DETERIORATION OF WEST TROUGH WALL

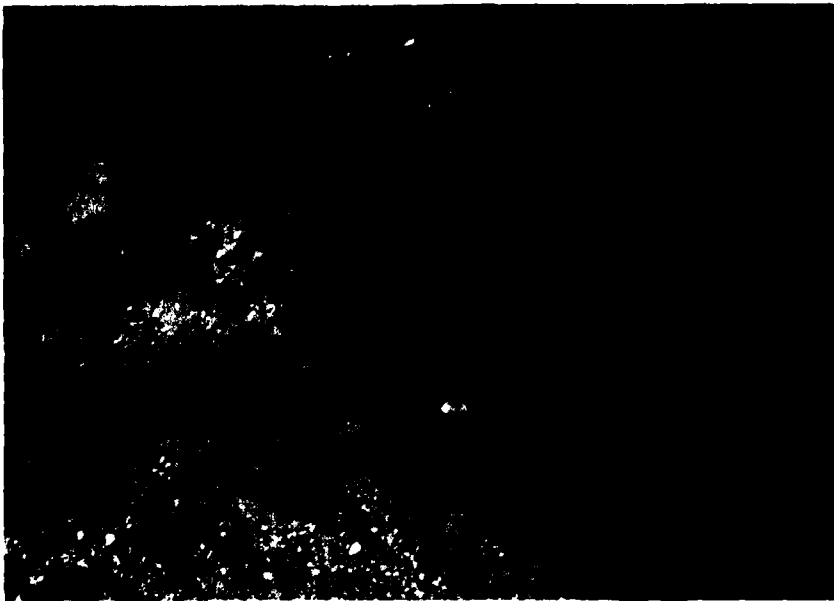


PHOTO 17: HOLE WASHOUT AT BOTTOM OF TROUGH WALL



PHOTO 18: UNDERCUTTING OF DISCHARGE END OF PRINCIPAL SPILLWAY
TROUGH (LOOKING SOUTH)



PHOTO 19: DISCHARGE CHANNEL DOWNSTREAM OF PRINCIPAL SPILLWAY
TROUGH (LOOKING EAST)

APPENDIX A
HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

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

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

200 square mile, 24 hour rainfall inches	- 25.2
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%
10 square mile, 48 hour percent of 24 hour 200 square mile rainfall	- 140%

b. Drainage area = 6,906 acres.

c. Time of concentration:

$$\text{Lag} = C_t (L_c)^n / s^{0.5}$$

Lag = lag in hours

L = length of watershed in miles

L_c = length along main channel to a point opposite the watershed centroid in miles

s = slope

n = 0.38

C_t = coefficient for basin characteristics = 0.35 for valleys

$$T_c = \frac{\text{Lag}}{0.6} = 4.8 \text{ hours (2)}$$

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

e. The soil associations in this watershed are mainly Hartwell, Creldon, Crider and Eldon (3).

2. Principal spillway release rates are based on the weir flow equation.

Weir equation:

$$Q = CLH^{1.5} \quad (C = \text{varies from } 2.69 \text{ to } 3.32, L = 185 \text{ feet, } H \text{ is the head on weir}).$$

Discharges over the auxiliary spillway and dam are based upon calculations using the nonlevel weir equation.

Nonlevel weir equation:

$$Q = \frac{2Cb}{5(h_b - h_a)} (h_b^{2.5} - h_a^{2.5})$$

(C = 2.6, b = length of weir normal to flow, h_a = head referred to high end of weir in feet, h_b = head referred to low end of weir in feet) (4)

3. The elevation-storage relationship above normal pool elevation was constructed by planimetry the area enclosed within each contour above normal pool. Storage at various elevations was computed utilizing the conic method for computation of reservoir volume provided in HEC-1(1).

- (1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.
- (2) R. K. Linsley, M. A. Kohler, J. L. H. Paulus; Hydrology for Engineers; McGraw-Hill, Inc.; 1975.
- (3) U.S. Department of Agriculture, Report on the Water and Related Land Resources, Blackwater - Lamine River Basin, Missouri, 1977.
- (4) Techniques of Water-Resources Investigations of the United States Geological Survey, Measurement of Peak Discharge at Dams by Indirect Methods, by Harry Hulsing, United States GPO, Washington, D.C., 1967.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC FEET PER SECOND)
 AREA IN SQUARE FEET (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS										
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9		
HYDROGRAPH AT														
	1	10.80 (27.97)		.50	15809.	17390.	18971.	20552.	22133.	23714.	25295.	26876.	28456.	31619.
				.55	(447.67)	(492.43)	(537.20)	(581.97)	(626.73)	(671.50)	(716.27)	(761.04)	(805.80)	(850.57)
ROUTED TO														
	2	10.80 (27.97)		.60	16735.	18217.	19700.	21182.	22664.	24146.	25628.	27110.	28592.	31298.
				.65	(477.12)	(505.23)	(533.33)	(561.43)	(589.53)	(617.63)	(645.73)	(673.83)	(701.93)	(730.03)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

RATIO OF PPF	ELEVATION		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM		DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	RESERVOIR STORAGE OUTFLOW	U.S. ELEV	887.50 1013. 0.	887.50 1013. 0.	887.50 1013. 0.	887.50 1013. 0.	896.53 3104. 16618.	896.53 3104. 16618.			
	MAXIMUM RESERVOIR STORAGE U.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS							
.50	805.91	0.00	2793.	14231.	0.00	0.00	43.50	0.00	0.00	0.00	0.00
.55	806.34	0.00	1073.	16217.	0.00	0.00	43.50	0.00	0.00	0.00	0.00
.60	806.84	.34	1174.	17843.	1.50	1.50	43.50	0.00	0.00	0.00	0.00
.65	807.20	.70	1250.	19551.	2.50	2.50	43.50	0.00	0.00	0.00	0.00
.70	807.57	1.03	1320.	21769.	3.00	3.00	43.00	0.00	0.00	0.00	0.00
.75	807.83	1.33	1386.	23066.	3.50	3.50	43.00	0.00	0.00	0.00	0.00
.80	808.09	1.59	1445.	24870.	4.00	4.00	43.00	0.00	0.00	0.00	0.00
.85	808.48	1.98	1532.	28162.	4.50	4.50	43.00	0.00	0.00	0.00	0.00
.90	808.84	2.34	1618.	31293.	5.00	5.00	43.00	0.00	0.00	0.00	0.00

END

DATE
FILMED

11-81

DTIC