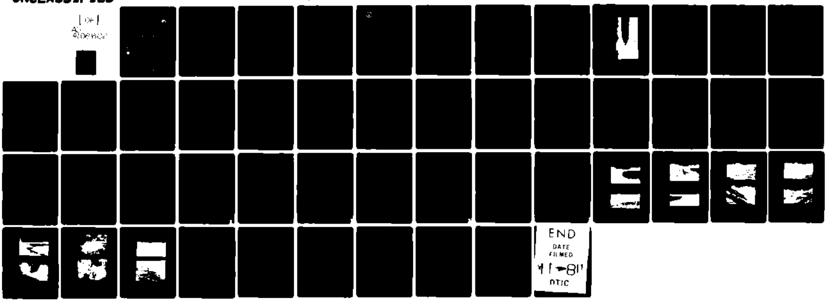
AD-A106 602 BLACK AND VEATCH KANSAS CITY MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. HAAKE LAKE DAM (MO 20379), MISSOUR--ETC(U)
MAR 79 P R ZAMAN, E R BURTON, H L CALLAHAN DACW43-79-C-0040

UNCLASSIFIED NL



LEVEL II

MISSOURI-KANSAS CITY BASIN

AD A106602

HAAKE LAKE DAM

CASS COUNTY, MISSOURI

MO 20379

DTIC
ELECTE
NOV 5 1981
D

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

DTIC FILE COPY

"Original contains color plates: All DT[illegible] [illegible]ions will be in black and white"

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

St. Louis District

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

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

FOR: STATE OF MISSOURI

MARCH 1979

81 11 02 062

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106602	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Haake Lake Dam (MO 20379) Cass County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Black & Veatch, Consulting Engineers		8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0040
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE March 1979
		13. NUMBER OF PAGES Approximately 40
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIB... from Report)

National Dam Safety Program. Haake Lake Dam (MO 20379), Missouri - Kansas City Basin, Cass County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Paul R. /Zaman Edwin R. /Burton
Harry L. /Callahan

19. KEY WORDS (Continue on reverse side if necessary and i...

Dam Safety, Lake, Dam Inspection, Private Dams

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

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

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

MISSOURI-KANSAS CITY BASIN

HAAKE LAKE DAM

CASS COUNTY, MISSOURI

MO 20379

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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

MARCH 1979

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

IN REPLY REFER TO

SUBJECT: Haake Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Haake Lake Dam:

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

SUBMITTED BY: SIGNED — Chief, Engineering Division — 8 AUG 1979 Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 8 AUG 1979 Date

By
Distribution/
A

HAAKE LAKE DAM

CASS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20379

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

MARCH 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Haake Lake Dam
State Located	Missouri
County Located	Cass County
Stream	Tributary to Big Creek
Date of Inspection	29 March 1979

Haake 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 a small 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 approximately four families downstream of the dam and would potentially cause appreciable damage to State Highway 7 within the estimated damage zone which extends approximately one mile downstream of the dam.

Our inspection and evaluation indicates the spillway does meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. The spillway will not pass the probable maximum flood without overtopping but will pass 50 percent of the probable maximum flood, which is greater than the estimated 100-year flood. Considering the small volume of water empounded by the dam and the down stream hazard, 50 percent of the probable maximum flood is the appropriate spillway design 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.

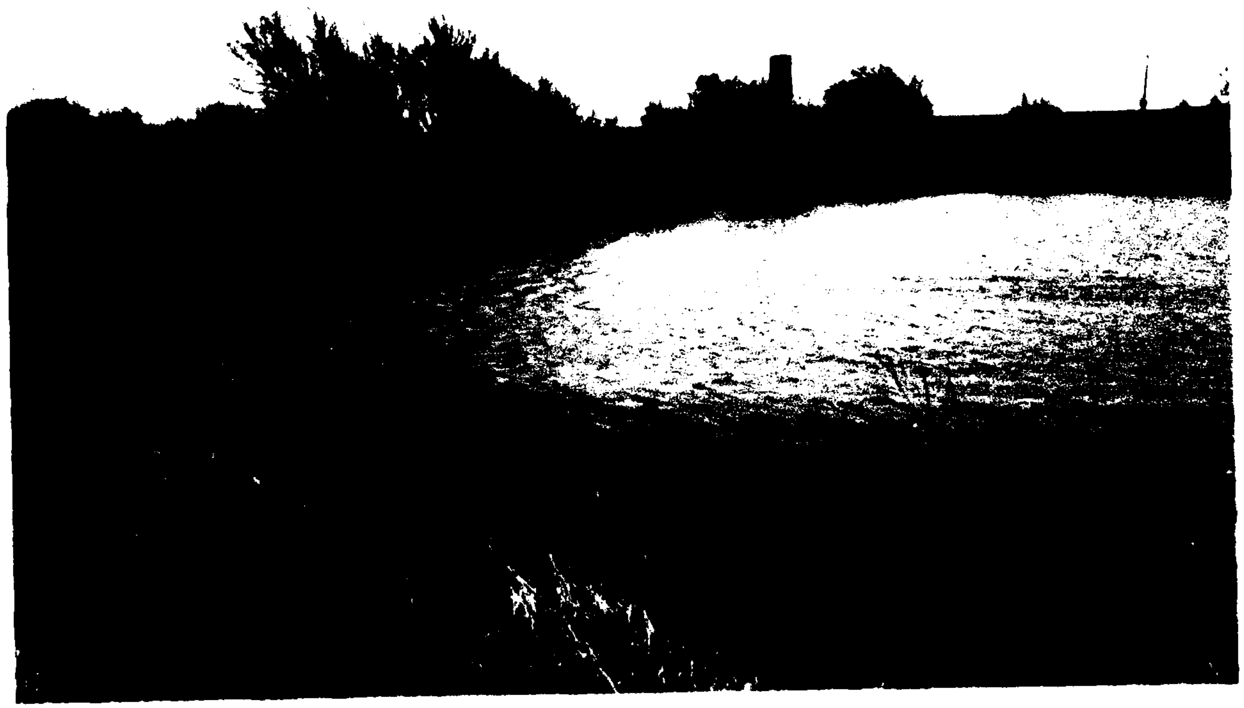
Deficiencies visually observed by the inspection team were seepage, animal burrows on the upstream face of the dam, and the presence of excessive brush and trees on the embankment slopes. Seepage and stability analyses required by the guidelines were not available.

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. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Paul R. Zaman, PE
Illinois 62-29261

Edwin R. Burton, PE
Missouri E-10137

Harry L. Callahan, Partner
Black & Veatch



OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
HAAKE LAKE DAM

TABLE OF CONTENTS

LIST OF PLATES

LIST OF PHOTOGRAPHS

APPENDIX

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 Haake 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) The dam is an earth structure located in the valley of an intermittent tributary to Big Creek in northeastern Cass County, Missouri (Plate 1). The dam is an earth fill embankment with a height of 20 feet. The dam has a top width of 10 feet and the slopes are covered with vegetation. It is approximately 450 feet long with an upstream slope of approximately 1.0 vertical on 2.7 horizontal and a downstream slope of approximately 1.0 vertical on 2.2 horizontal. Topography in the vicinity of the dam is shown on Plate 2.

(2) There are two spillways at this dam which shall be designated in this report as the principal spillway and the emergency spillway. The principal spillway is located at the right abutment and is constructed by excavation into the natural abutment. The discharge channel follows a roughly semicircular pattern around the right abutment of the dam. The channel is well protected from erosion. The left bank consists of earth covered with a good stand of grass, and the floor and right bank are formed in natural sandstone and shale. The discharge channel runs at a moderate slope perpendicular to the axis of the dam for approximately 125 feet downstream, to a rock overfall then drops vertically for 10 feet into the natural channel.

(3) The emergency spillway is located at the left abutment. The spillway is constructed exclusively in soil. The approach channel leads to the axis of the dam at an adverse slope. Near the axis of the dam the slope of the channel flattens. This area would be the control section and acts as a broad-crested weir. The discharge channel slopes steeply from this control section to the natural channel. A good stand of grass serves to protect the soil in the spillway from erosion. Some erosion has occurred in the discharge channel.

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

b. Location. The dam is located in northeastern Cass 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 Pleasant Hill, Missouri in Section 31 of T46N, R30W.

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 small size category.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Haake 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 Haake Lake Dam the estimated flood damage zone extends downstream for approximately one mile. Within the damage zone are four homes and State Highway 7.

e. Ownership. The dam is owned by Henry J. and Helen F. Haake, Route 1, Box 84, Pleasant Hill, Missouri 64080.

f. Purpose of Dam. The dam forms a 7-acre recreational lake.

g. Design and Construction History. Design history was not available. The dam was originally built in 1951 by a contractor named Jones. After a section of the dam washed out in 1961, the same contractor renovated the dam.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and outflow over the principal spillway all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 441 acres

b. Discharge at Damsite.

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

(2) Estimated experienced maximum flood at damsite - According to owner, the storm in 1961 was the largest flood at the dam site. Precipitation records show rainfall at Pleasant Hill on September 12 to 14, 1961 totaling 8.8 inches.

(3) Estimated ungated spillway capacity at maximum pool elevation is 1,990 cfs (top of Dam El.900.1).

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

(1) Top of dam - 900.1 ± (see Plate 4)

(2) Spillway crest - 894.8

(3) Streambed at toe of dam - 880.0 ±

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 2,700 feet ±

(2) Length of normal pool - 1,250 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 124

(2) Spillway crest - 47

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 21

(2) Spillway crest - 7

g. Dam.

(1) Type - Earth embankment

(2) Length - 500 feet

(3) Height - 20 feet ±

(4) Top width - 10 feet

(5) Side slopes - upstream face 1.0 V on 2.7 H, downstream face 1.0 V on 2.2 H (see Plate 4).

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Principal Spillway.

(1) Type - Open channel, earth, sandstone, and shale.

(2) Width of channel - 18 feet (see Plate 5).

(3) Crest elevation - 894.8 feet m.s.l.

(4) Gates - None.

(5) Upstream channel - Not applicable.

(6) Downstream channel - Open channel comprised of broken sandstone and shale.

j. Emergency Spillway.

(1) Type - Grass-lined open channel in soil.

(2) Width of spillway - 136 feet (see Plate 5).

(3) Crest elevation - 898.1 feet m.s.l.

(4) Gates - None

(5) Upstream channel - Grass

(6) Downstream channel - Grass-lined channel into natural streambed.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were unavailable.

2.2 CONSTRUCTION

Construction records were unavailable, however, the owners estimated that the dam was built in 1951. A portion of the dam washed out and was replaced in 1961. The emergency spillway appears to be of more recent construction than the dam.

2.3 OPERATION

The maximum recorded loading on the dam is unknown; however, according to the owner, the 1961 washout was the result of a large thunderstorm. The total rainfall measured at the Pleasant Hill rain gage was 8.8 inches on September 12 to 14, 1961.

2.4 GEOLOGY

The dam is located in a broad shallow valley that was formed in limestones, shales, and sandstones of the Pennsylvanian System, Missourian Series, Kansas City and Pleasanton Groups. The floor and side slopes of the valley are underlain by the Pleasanton Group which is divided stratigraphically into lower, middle, and upper unnamed formations. The Kansas City Group overlies the Pleasanton Group and forms the ridges on either side of the valley. The residual Summit Silt Loam soil series covers the bedrock except on the steepest slopes and along some stream valleys.

It is anticipated that the foundation for the dam consists of shale of the middle unnamed formation of the Pleasanton Group. It is not known whether the soil cover was removed or if a cutoff trench was constructed beneath the dam. The right abutment and spillway discharge channel consist of shale and sandstone of the upper unnamed formation of the Pleasanton Group. It is anticipated that the soils exposed on the left abutment overlie shale bedrock. The Summit Silt Loam soil series is present throughout the watershed. It is a residual soil developed from weathering of shales of Pennsylvanian age. It consists of sand, silt, clay, and organic matter with silt predominant nearer the surface and clay predominant at depth. For engineering purposes, the near-surface soil can be classified as clayey silt/silty clay (ML-CL) and the deeper soil as silty clay (CL). The silty clay soil is slower to drain and may tend to slow percolation, contributing to increased runoff during long periods of high precipitation. The soils are generally thinner on slopes and thicker on hill crests and valley floors.

2.5 EVALUATION

a. Availability. No engineering data could be obtained.

b. Adequacy. No engineering data were available upon which to make a detailed assessment of the design, construction, and operation. 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. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Haake Lake Dam was made on 29 March 1979. The inspection team included professional engineers with experience in dam design and construction, hydrology - hydraulic engineering, and geotechnical engineering. 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 the following items at the dam. No surface cracks or unusual movement of the embankment were found. A large animal burrow was found in the upstream face of the dam near the center. The depth of the burrow was unknown. There was no problem of sloughing or erosion of the embankment or abutment slopes. There was no riprap on the upstream face of the dam, but no problem of erosion was sighted. Growth of brush and trees was moderate to heavy on the downstream slope of the embankment. Two points of seepage were noticeable near the toe of the dam about 150 feet from the right abutment. These spots were wet, but there was no visible flow from them. Seepage was also detected in the left abutment downstream of the dam and right of the emergency spillway. Water was flowing from this spot at a rate of approximately two gallons per minute. The lake level at the time of the inspection was at full pool elevation. There was a small amount of flow over the principal spillway. The downstream embankment slope appears excessively steep and the stability criteria set forth in the guidelines probably will not be met.

c. Appurtenant Structures. The inspection team observed the following items pertaining to appurtenant structures. The earth and rock channel of the principal spillway appears to be in good condition with no evidence of erosion of either the bottom or side slopes of the channel. The bottom of the channel is partially formed by an intermittent layer of sandstone. This spillway discharges over a rock ledge to the natural channel downstream of the dam.

The emergency spillway channel was in good condition with no evidence of erosion of either the bottom or the side slopes of the channel. There was a good stand of grass in the channel to help prevent erosion.

d. Reservoir Area. Topography of the contributing watershed is characterized by gently rolling hills which should allow even runoff during periods of precipitation. The vegetation of the watershed is primarily composed of grassland and timber. No slides or excessive erosion due to wave action were observed along the shore of the reservoir, although a minor amount of siltation appears to have occurred at the upstream end of the reservoir.

e. Downstream Channel. Heavy vegetation along the banks and mild channel slopes typical of streams in the area characterize the downstream channel.

3.2 EVALUATION

The various minor deficiencies observed at the time of the inspection are not believed to represent any immediate safety hazard. They do, however, warrant repair and future monitoring and control.

(1) Further animal burrowing in the upstream face of the embankment should be prevented and the holes should be filled in with properly compacted material. Burrowing animals (muskrats and ground squirrels) have been responsible for piping failures in a number of small earth dams. If willows or other brush grow at the water line, muskrats will dig under them because the roots reinforce the opening of the hole and also hide its existence.

(2) Tree and brush growth on the embankment slopes should be controlled and consideration should be made for the removal of large trees and their root system. If large water seeking roots should someday rot and decay, then these roots could become channels for piping. Also large brush growth on the embankments prevents inspection of the slope and kills the smaller grasses whose roots are more effective in protecting the surface soil.

(3) The front and back embankment slopes are steeper than is generally considered acceptable for small earth fill dams and could lead to problems of embankment stability.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, and capacity of the uncontrolled principal spillway.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities are known to exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Existing animal burrows in the upstream face of the dam warrant repair. A maintenance program should be established to control the growth of brush and trees on the embankment. The grass cover on the embankment should be cut occasionally to discourage animal burrowing. The seep areas should be monitored periodically and, if flows increase significantly or if seepage flows become muddy, an engineer should be consulted.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Pleasant Hill and Harrisonville Quadrangle Maps. The spillway and dam layouts are from surveys made during the inspection.

c. Visual Observations.

(1) The principal spillway is in good condition with no evidence of significant erosion or obstructions at the time of the inspection.

(2) The emergency spillway channel is in good condition with no evidence of erosion at the time of the inspection.

(3) There are no construction features incorporated in the dam for evacuating the pool. Evacuation could be accomplished only by lowering the channel of one of the spillways or by pumping.

(4) Spillway releases would not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will not pass the probable maximum flood without overtopping the dam. 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. The spillway will pass 50 percent of the probable maximum flood without overtopping the dam. This flood is greater than the 100-year flood estimated to be 720 cfs according to the methodology outlined by the USGS in "Technique for Estimating the Magnitude and Frequency of Missouri Floods". According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the small volume of water impounded by the dam and the downstream hazard, the appropriate spillway design flood should be 50 percent of the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 2,650 cfs of the total discharge from the reservoir of 5,010 cfs. The estimated duration of overtopping is 1.1 hours with a maximum height of 1.2 feet. Failure of upstream water impoundment shown on the 1954 USGS map would not have a significant impact on the hydrologic or hydraulic analysis.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately one mile downstream of the dam. There are four homes and State Highway 7 downstream of the dam which could be severely damaged and lives could be 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 and Construction Data. No design data relating to the structural stability of the dam were found. Detailed seepage and stability analysis should be performed as required by the guidelines.

c. Operating Records. No operational records exist.

d. Post Construction Changes. There is evidence to indicate that a portion of the dam was washed out and replaced in 1961. It appears that the section affected was about 50 feet from the right abutment of the dam. This section has the lowest crest elevation for the entire length of the dam and also has a slightly steeper downstream slope than the rest of the dam (1.0 V to 2.0 H, versus 1.0 V to 2.2 H for the rest of the dam). Some irregularities in the downstream embankment slope of this section which appear to be the result of difficult construction in a confined area were observed. No design data relating to the adequacy of the reconstructed section of the embankment were found.

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.

The seismic stability of an earth dam is dependent upon a number of factors: The important factors being embankment and foundation material classification and shear strengths; abutment materials, conditions, and strength; embankment zoning; and embankment geometry. 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. Animal burrows in the upstream face of the dam should be eliminated. Periodic inspections should be conducted to locate future burrows. Brush and trees on the downstream embankment slope pose no immediate hazard, but their growth should be controlled.

b. Adequacy of Information. Due to the lack of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. However, seepage and stability analyses are needed to satisfy the requirements of the guidelines.

c. Urgency. It is the opinion of the inspection team that a program should be developed to implement remedial measures recommended in paragraph 7.2b.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam or 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 was 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. No measures are recommended.

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

(1) A regular maintenance program should be implemented to control growth on the downstream and upstream slopes of the dam. An engineer experienced in the maintenance and design of dam should be retained to recommend procedures for the removal of trees and their root systems.

(2) The grass cover on the embankment should be cut periodically, and the animal burrows should be filled and compacted to the original design specifications.

(3) Check the downstream face of the dam periodically for seepage and stability problems. If increased seepage flows are observed or seepage flows become muddy, or sloughing on the embankment slope is noted, the dam should immediately be inspected and the condition evaluated by an engineer experienced in design and construction of earthen dams.

(4) To satisfy the guideline requirements seepage and stability analysis should be performed by a professional engineer experienced in the design and construction of dams. It should be noted that the embankment slopes are rather steep when compared to current design practices and could lead to a stability problem.

(5) A detailed inspection of the dam should be made periodically by an engineer experienced in design and construction of dams. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increases.

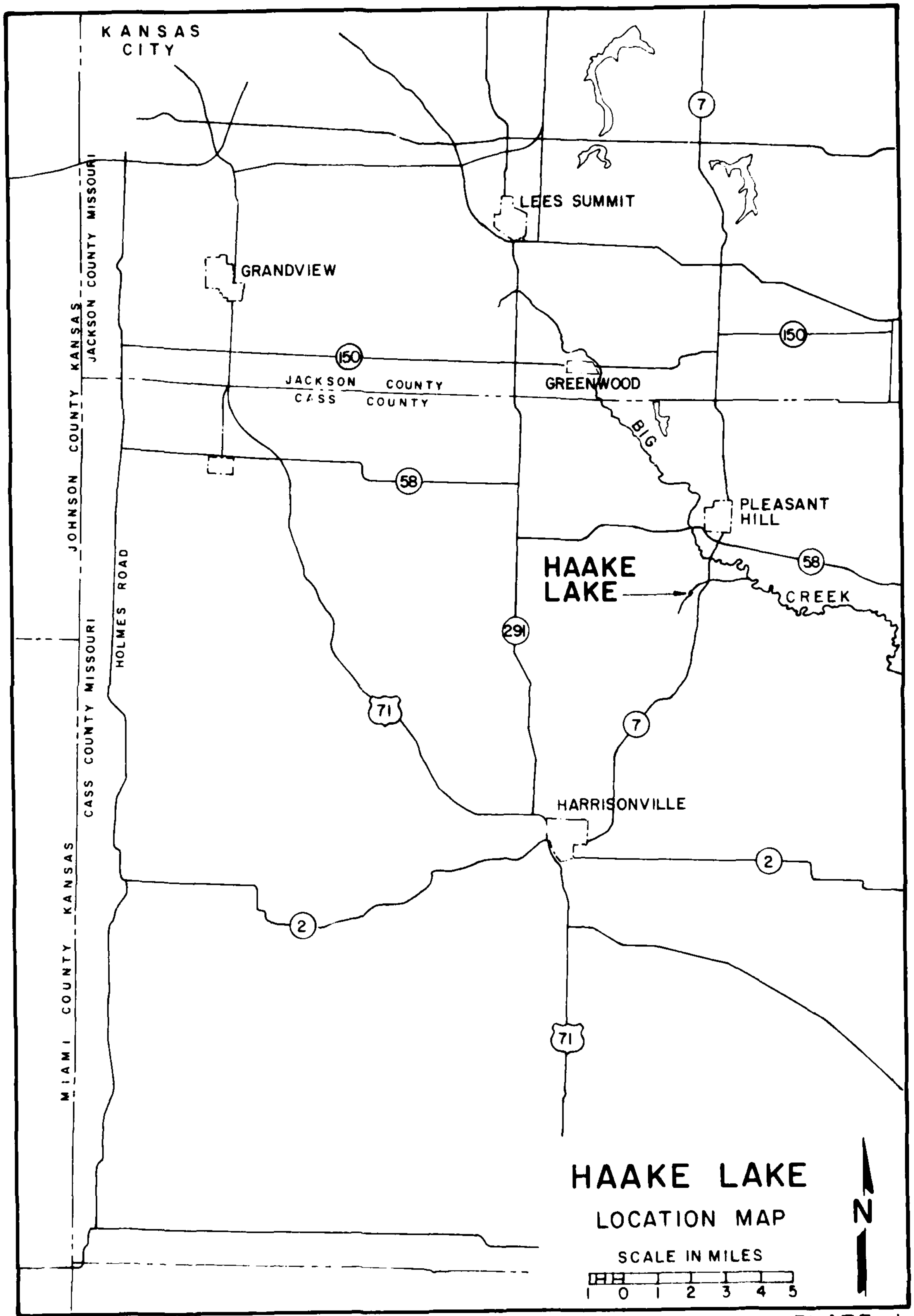
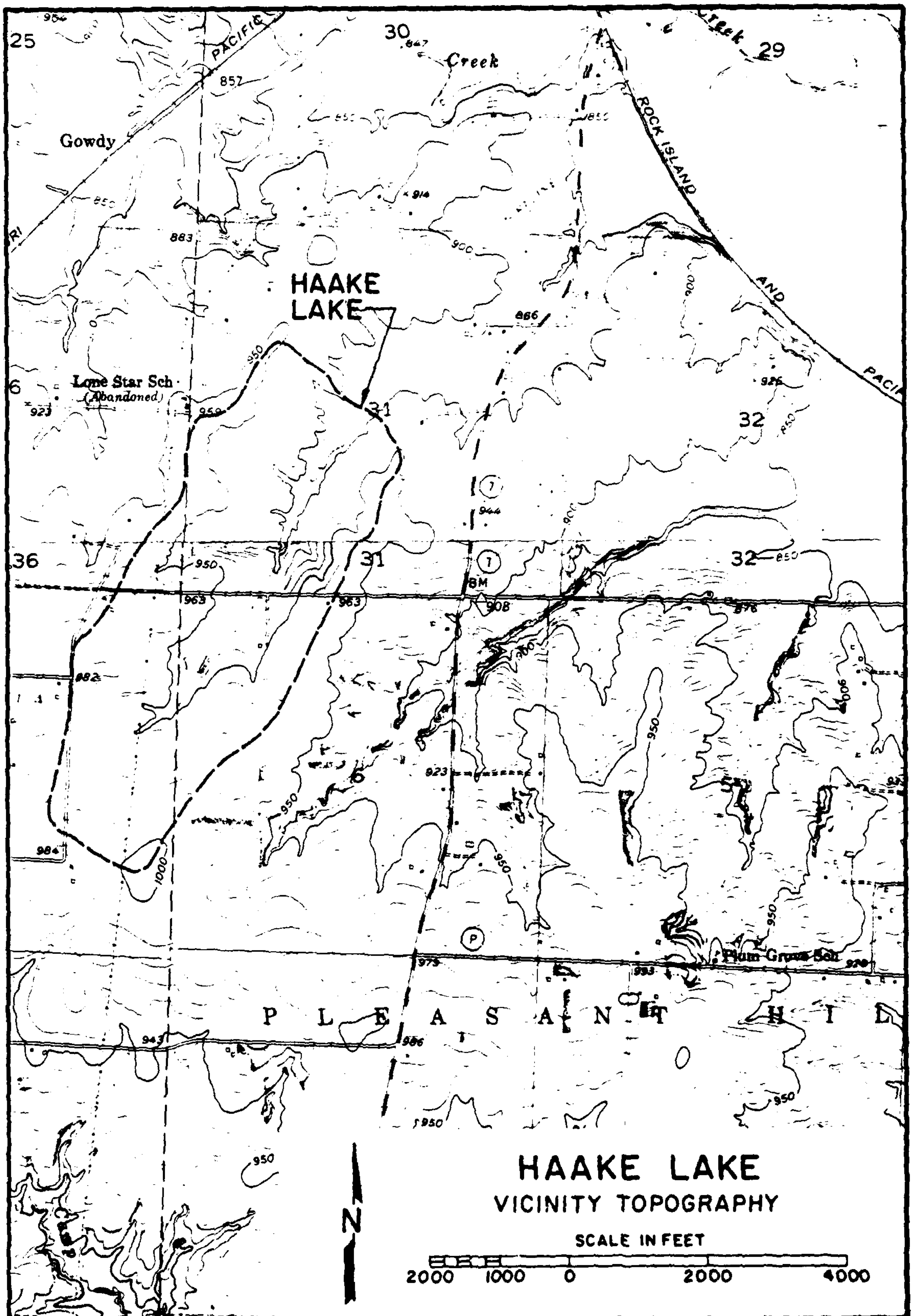
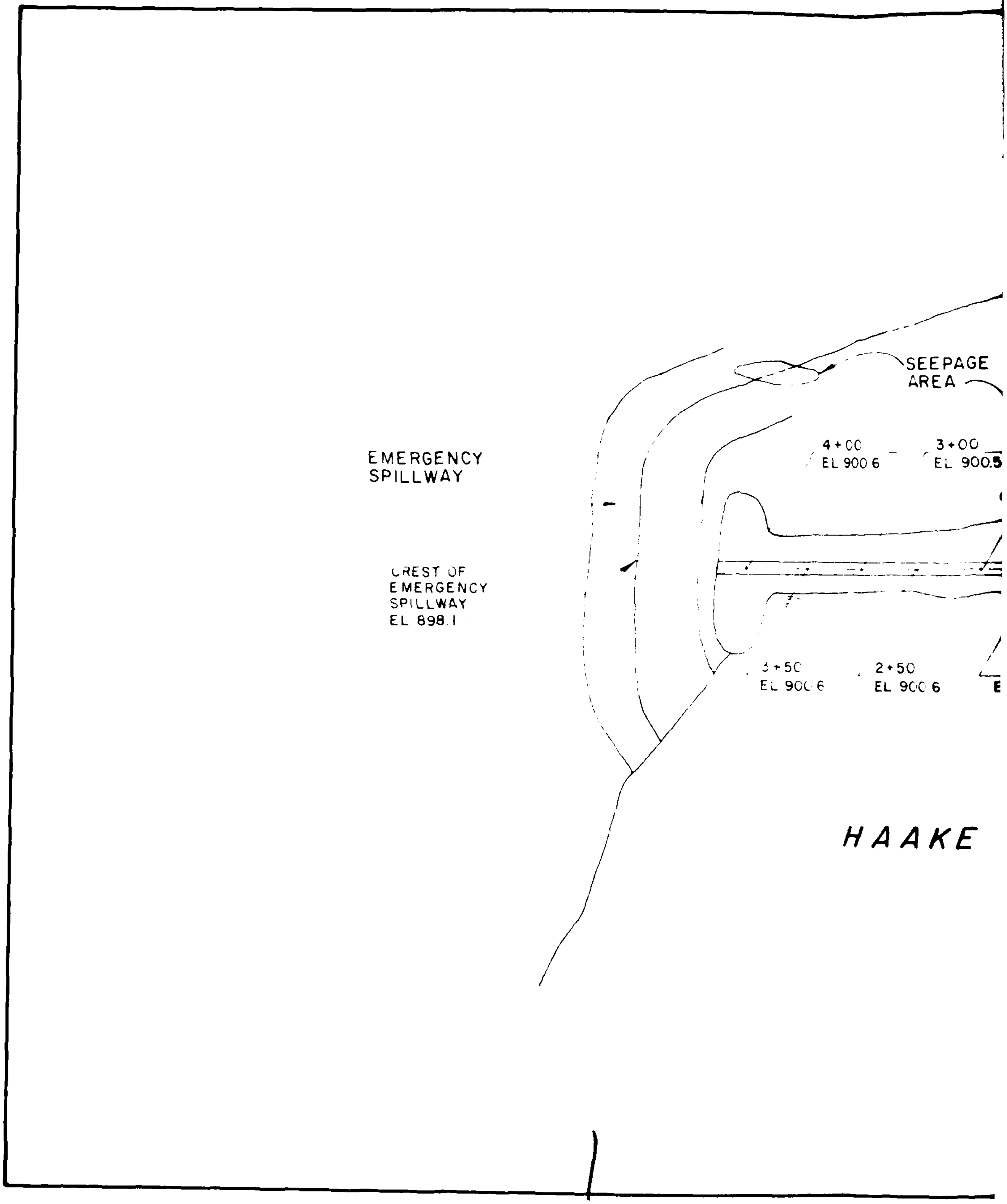

KANSAS CITY
LEES SUMMIT
GRANDVIEW
7
150
150
JACKSON COUNTY
CASS COUNTY
GREENWOOD
BIG
58
PLEASANT HILL
HAAKE LAKE
58
CREEK
JOHNSON COUNTY KANSAS
JACKSON COUNTY MISSOURI
CASS COUNTY MISSOURI
MIAMI COUNTY KANSAS
HOLMES ROAD
291
71
7
HARRISONVILLE
2
2
71
HAAKE LAKE
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4 5
N

PLATE 1

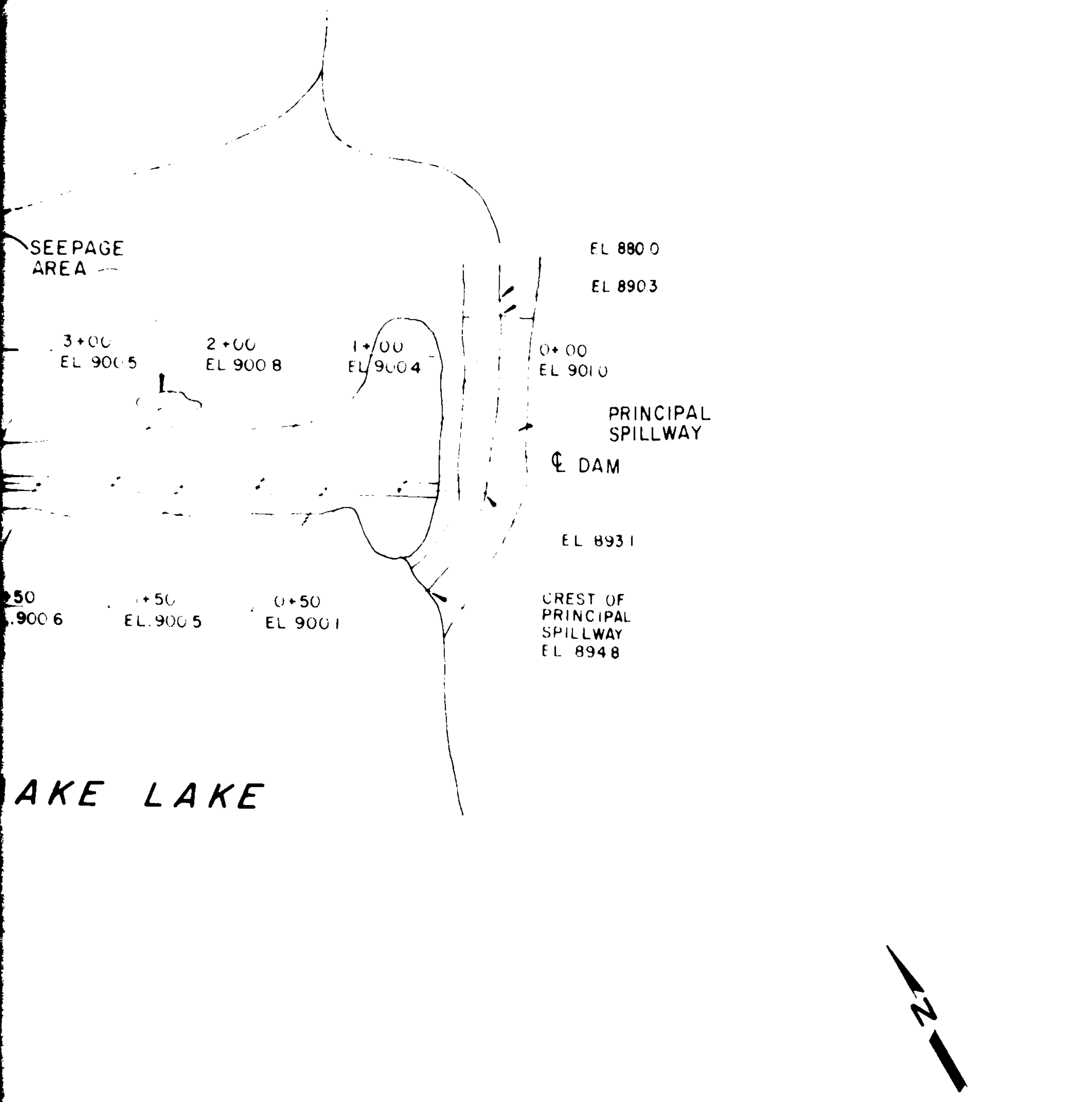


HAAKE LAKE
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N
HAAKE
LAKE
Gowdy
Lone Star Sch
(Abandoned)
Creek
ROCK ISLAND
AND
PACIFIC
Plum Grove Sch
P L E A S A N T H I L
BM
25
30
29
31
32
36
31
32

PLATE 2

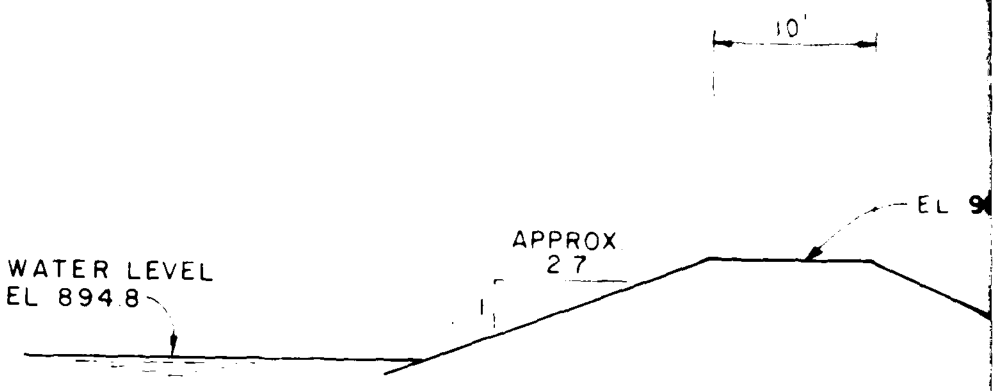


SEEPAGE AREA
EMERGENCY SPILLWAY
4+00
EL 900.6
3+00
EL 900.5
CREST OF EMERGENCY SPILLWAY EL 898.1
3+50
EL 900.6
2+50
EL 900.6
HAAKE

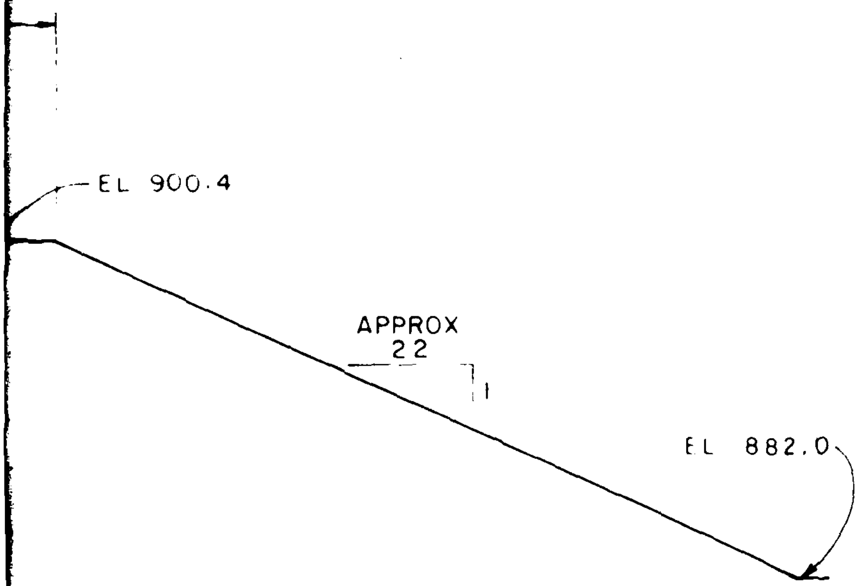


HAAKE LAKE
PLAN

PLATE 3

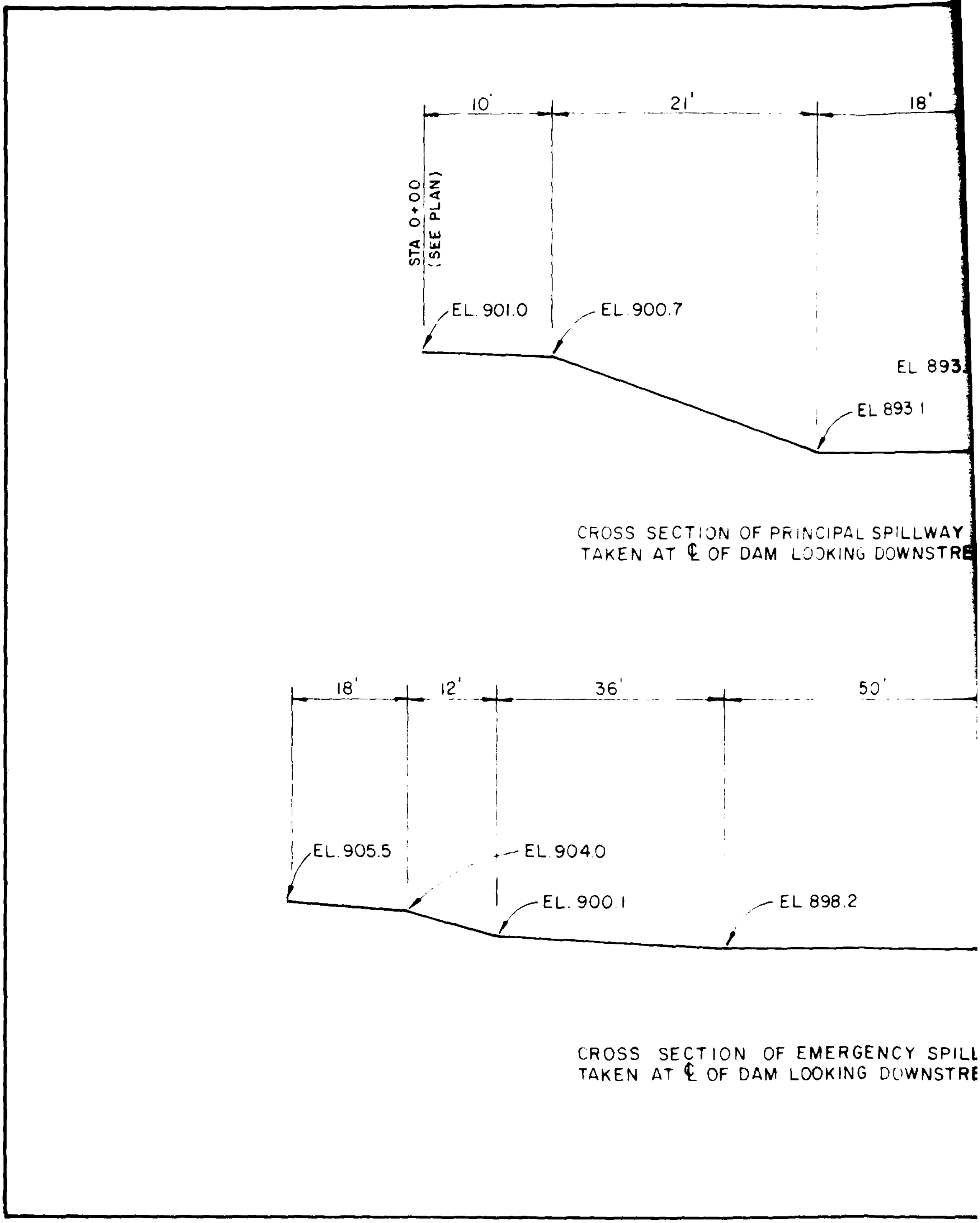


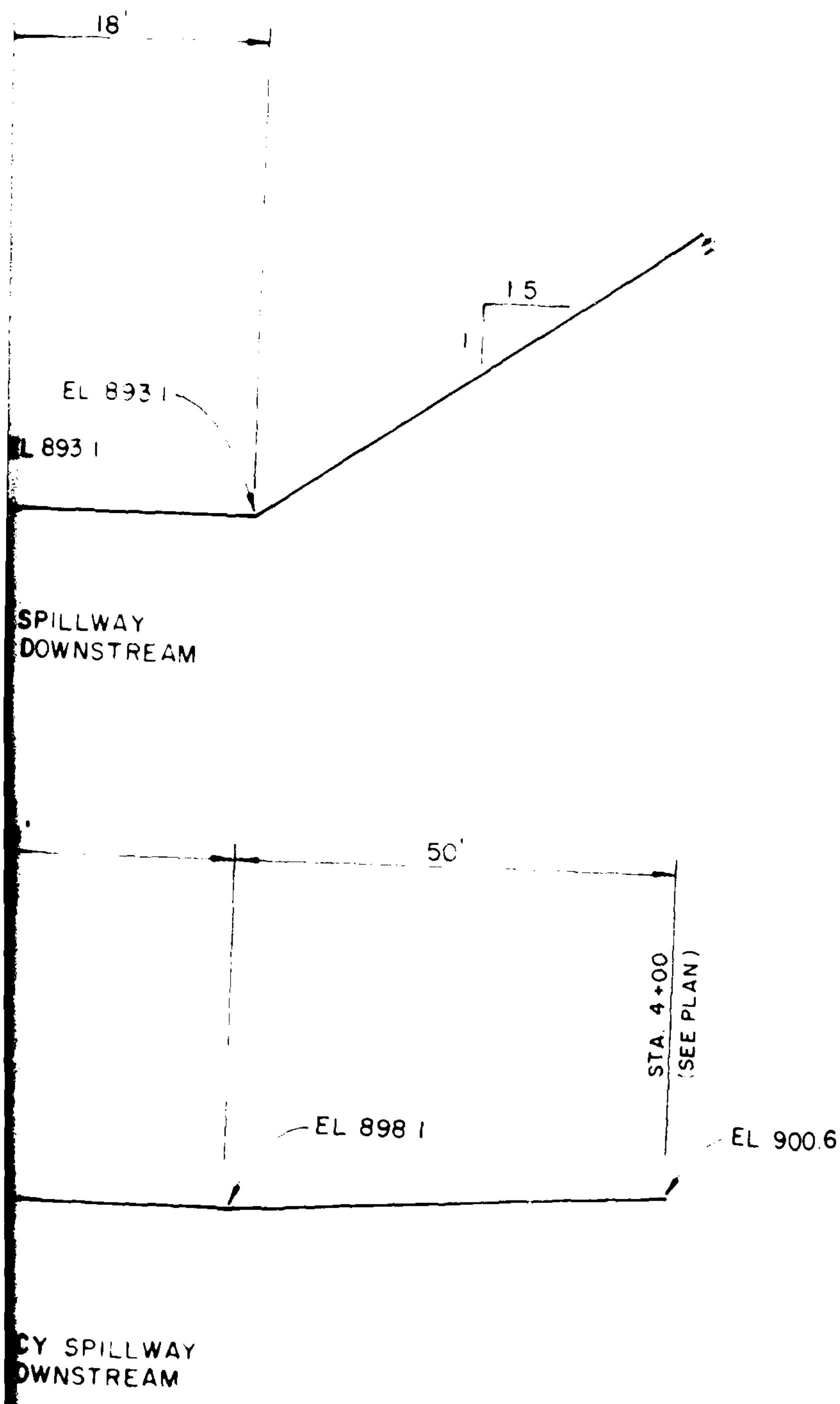
10'
EL 9
APPROX
2.7
1
WATER LEVEL
EL 894.8



HAAKE LAKE
TYPICAL SECTION

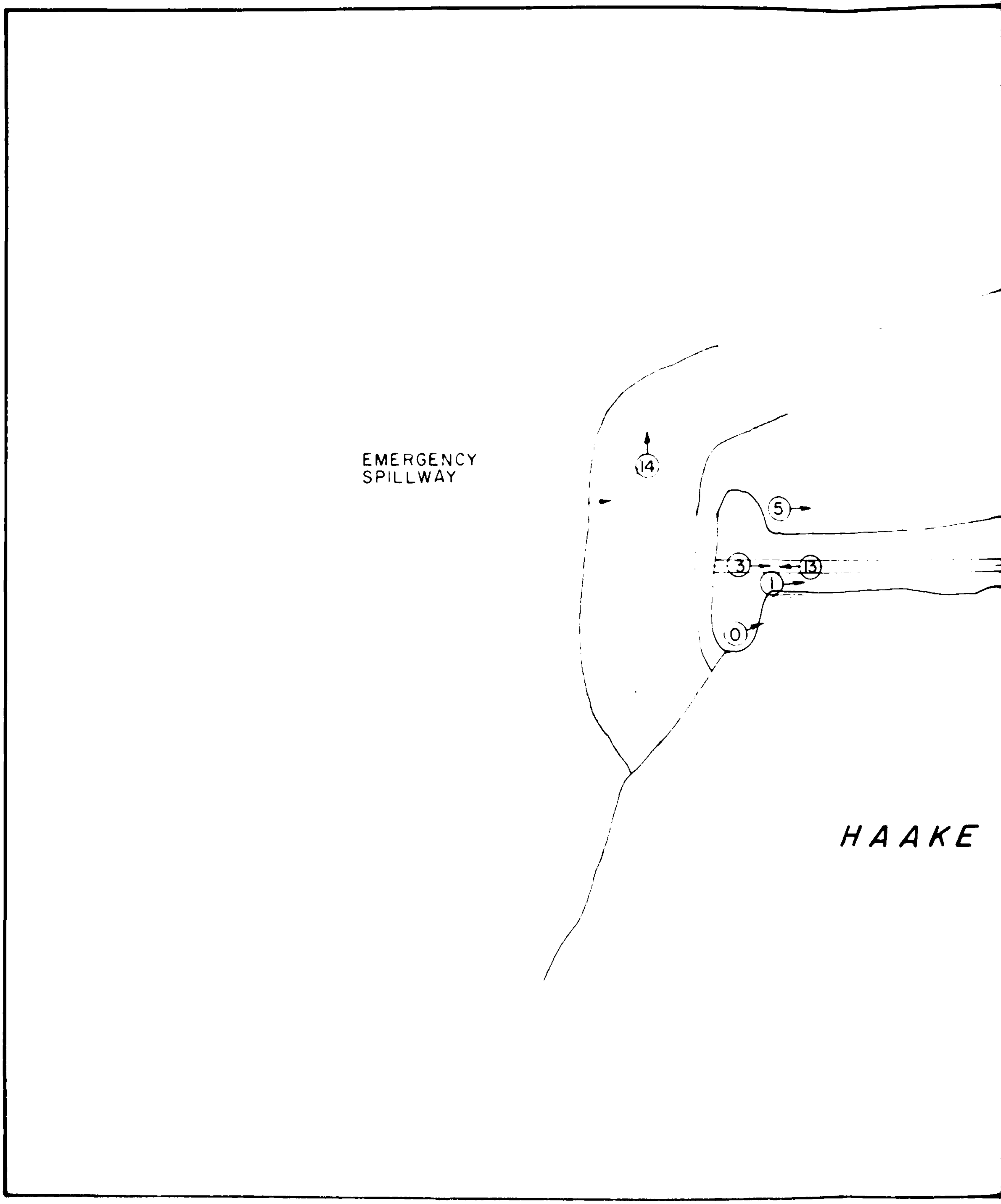
PLATE 4

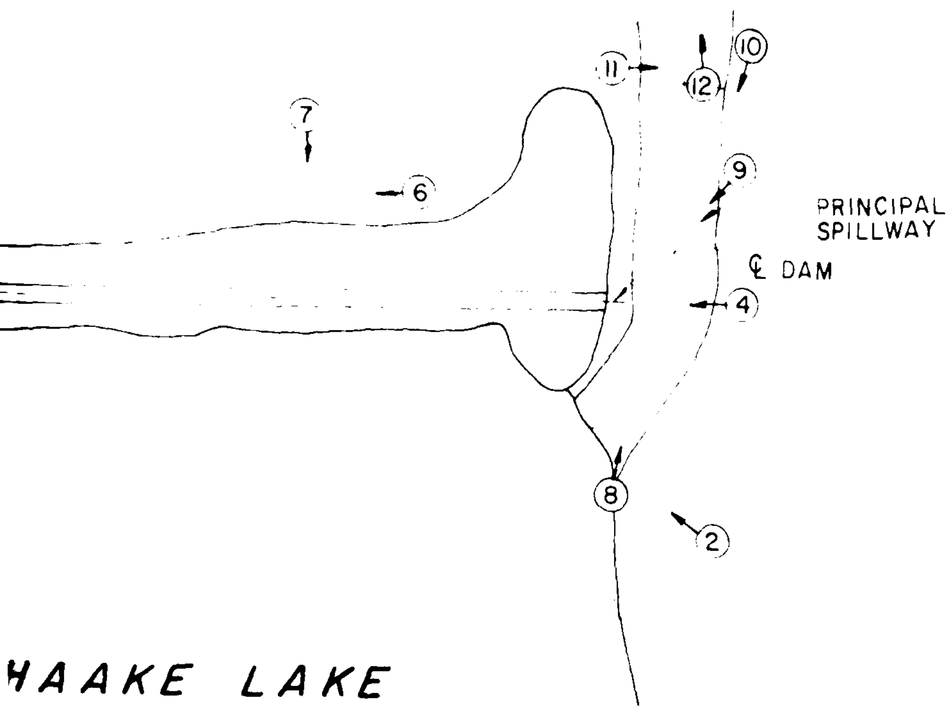

10'
21'
18'
STA 0+00
(SEE PLAN)
EL. 901.0
EL. 900.7
EL 893
EL 893.1
CROSS SECTION OF PRINCIPAL SPILLWAY
TAKEN AT ℄ OF DAM LOOKING DOWNSTRE
18'
12'
36'
50'
EL. 905.5
EL. 904.0
EL. 900.1
EL 898.2
CROSS SECTION OF EMERGENCY SPILL
TAKEN AT ℄ OF DAM LOOKING DOWNSTRE



HAAKE LAKE
SPILLWAY SECTIONS

PLATE 5


EMERGENCY
SPILLWAY
14
5
3
13
1
0
HAAKE



LEGEND

PHOTO LOCATION AND DIRECTION

N

HAAKE LAKE
PHOTO INDEX

PLATE 6

PHOTO 1: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 2: UPSTREAM FACE OF DAM

PHOTO 3: CREST OF DAM LOOKING EAST

PHOTO 4: CREST OF DAM LOOKING WEST

PHOTO 5: DOWNSTREAM SLOPE OF DAM FROM WEST END

PHOTO 6: DOWNSTREAM SLOPE OF DAM AT EAST END

PHOTO 7: SEEPAGE AREA AT TOE OF DAM

PHOTO 8: PRINCIPAL SPILLWAY LOOKING DOWNSTREAM FROM LAKE

PHOTO 9: PRINCIPAL SPILLWAY LOOKING UPSTREAM

PHOTO 10: PRINCIPAL SPILLWAY CHANNEL AND FALLS LOOKING UPSTREAM

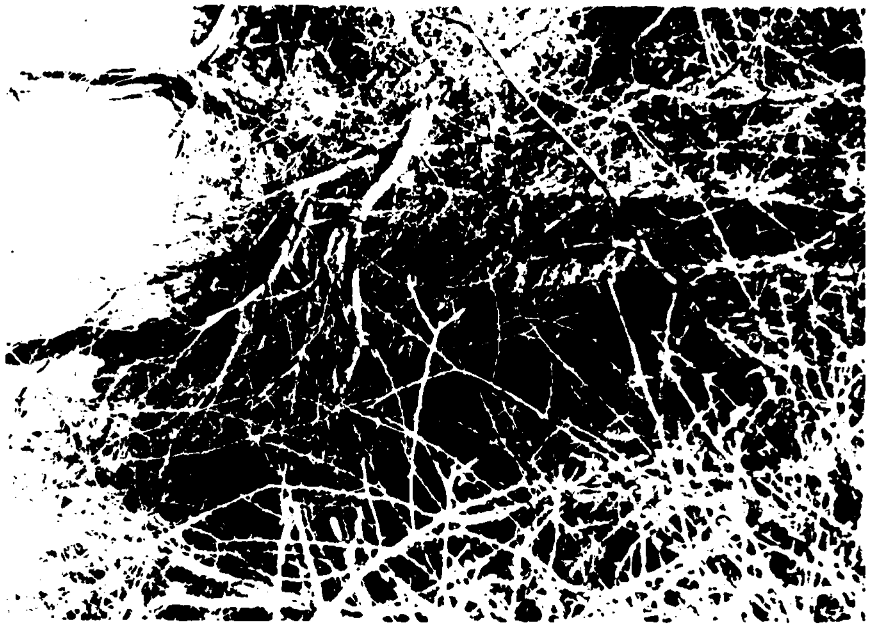


PHOTO 11: FALLS IN PRINCIPAL SPILLWAY CHANNEL

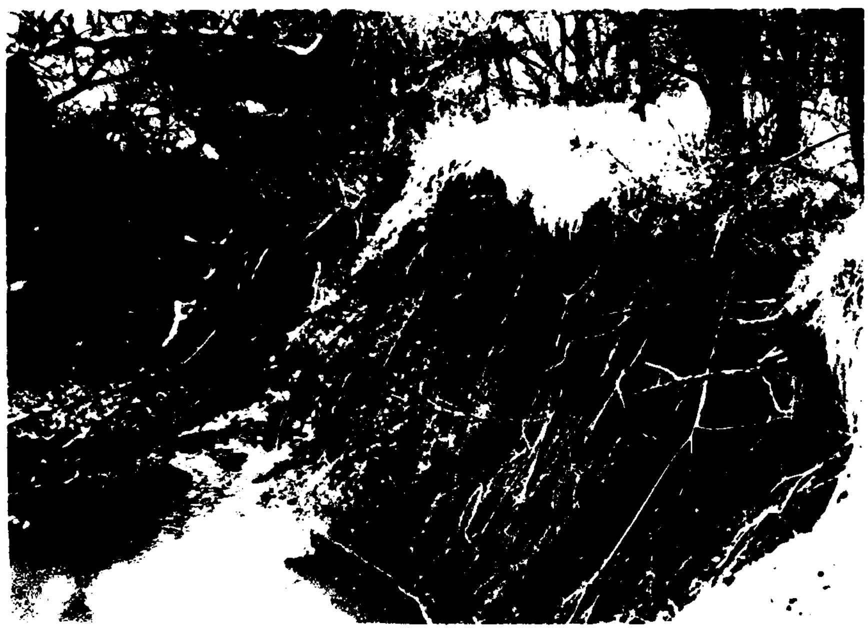


PHOTO 12: CHANNEL DOWNSTREAM FROM FALLS

PHOTO 13: EMERGENCY SPILLWAY AT LEFT ABUTMENT

PHOTO 14: CHANNEL BELOW EMERGENCY SPILLWAY

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph (1) and HEC-1 (2) were used to develop the inflow hydrographs and hydrologic inputs are as follows:

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

200 square mile, 24 hour rainfall inches	- 24.9
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%

b. Drainage area = 441 acres.

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385} = 0.64$ hours = 38 minutes (L = length of longest watercourse in miles, H = elevation difference in feet) (3)

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 84 and antecedent moisture condition III. The Soil Associations in this watershed were Grundy and Polo-Sogn (4). The hydrologic soil groups in the basin were B, C, and D.

2. Principal spillway release rates are based on critical depth flow in trapezoidal cross section:

$Q = c_1 \, b \, Dc^{1.5}$ (c_1 = 5.79 to 8.65, b = bottom width of channel = 18 feet, and Dc = critical depth in feet above the channel bottom) (5).

Spillway release rates through the emergency spillway are based on the broad-crested weir equation for weirs not level:

$$Q = \frac{2 \, C \, b}{5h_b - h_a} (h_b^{2.5} - h_a^{2.5})$$ (C = 2.54 to 3.05,

L = length of flow normal to weir = 0.5 to 142 feet, h_a is the lead on the high end of the weir in feet, and h_b is the head on the low end of the weir) (6).

Discharge rates over the top of the dam are also based on the broad-crested weir equation for weirs not level:

$$Q = \frac{2\ C\ b}{5(h_b - h_a)}(h_b^{2.5} - h_a^{2.5})\ (C = 2.50 \text{ to } 2.92, \text{ and}$$

b = 6 to 400 feet).

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

4. Floods are routed through the spillway using HEC-1, modified Puls to determine the capability of the spillway.

(1) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(2) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(3) U.S. Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1974, Washington, D.C.

(4) Mid-America Regional Council, Regional Soils Guide, March 1976.

(5) Horace W. King and Ernest F. Brater, Handbook of Hydraulics, Sixth Edition, McGraw Hill Book Company, 1976.

(6) U.S. Department of the Interior, Geological Survey, Techniques of Water-Resources Investigations, Book 3, Chapter A5, Measurement of Peak Discharge at Dams by Indirect Method, by Harry Hulsing, 1967.

```
********************************
FLOOD HYDROGRAPH    PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
********************************
A1***** HAAKE DAM I.D.#20379  - MISSOURI DAM INSPECTION STUDY *****
A2ROUTING COMPUTATION FOR HAAKE RESERVOIR USING REVIEWER'S RATING CURVE
A3DRAINAGE AREA = 441 ACRES = 0.689 SQ.MI.
B    288       0       5       0       0       0       0       0       0       0
B1     5
J      1       9       1
J1    .4     .45      .5     .55      .6      .7      .8      .9      1.
K      0       1                               3       1
K1 HAAKE DAM         (24HR. PROBABLE MAXIMUM RUNOFF)
M      1       2   0.689                       1
P           24.9     101     120     130
T                                                     -1     -84
W2          0.38
X                      1
K      1       2                                       1
K1 ROUTING THROUGH HAAKE RESERVOIR
Y                                      1       1
Y1     1                                              -1      -1
Y4 894.8895.1   895.5   896.1   897.1   898.1   898.9   899.2   899.7   900.1
Y4900.3 900.6   900.9   901.3   901.5   901.7   901.9
Y5 0.   20.     60.     160.    410.    750.    1200.   1440.   1910.   2360.
Y52610. 3060.   3720.   4860.   5520.   6260.   7040.
$S 0.   73.8    410.3
$E894.8 900.    910.
$$ 896.8
$D 900.1      0.     1.5      0.
K     99
```

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

OPERATION	STATION	AREA	PLAN	RATIO 1 .40	RATIO 2 .45	RATIO 3 .50	RATIO 4 .55	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
				RATIOS APPLIED TO FLOWS								
HYDROGRAPH AT	1	.69	1	2241.	2521.	2801.	3061.	3362.	3922.	4482.	5042.	5603.
	(	1.78)	(	63.46)(	71.39)(	79.32)(	87.26)(	95.19)(	111.05)(	126.92)(	142.78)(	158.65)
ROUTED TO	2	.69	1	1896.	2202.	2377.	2563.	2776.	3282.	3850.	4443.	5008.
	(	1.78)	(	53.69)(	62.34)(	67.31)(	72.58)(	78.61)(	92.94)(	109.02)(	125.82)(	141.81)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	894.80	894.80	900.10
STORAGE	0.	0.	77.
OUTFLOW	0.	0.	2360.

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
.40	899.60	0.00	69.	1896.	0.00	16.08	0.00
.45	899.96	0.00	73.	2202.	0.00	16.08	0.00
.50	900.11	.01	73.	2377.	.17	16.08	0.00
.55	900.26	.16	83.	2563.	.33	16.08	0.00
.60	900.41	.31	88.	2776.	.50	16.08	0.00
.70	900.70	.60	97.	3282.	.75	16.08	0.00
.80	900.95	.85	106.	3850.	.83	16.08	0.00
.90	901.15	1.05	113.	4443.	1.00	16.08	0.00
1.00	901.34	1.24	119.	5008.	1.08	16.08	0.00

LMED

8