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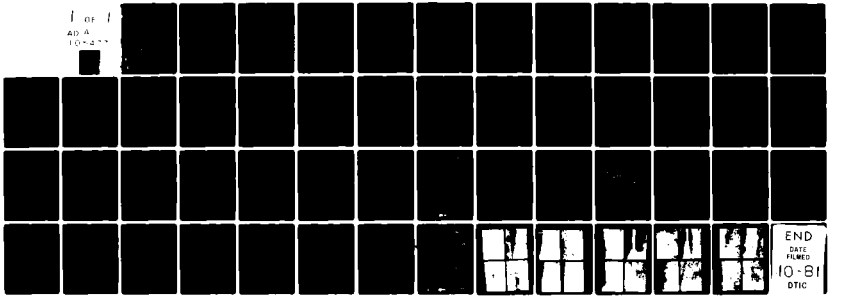

MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

AD A105 471

LAS BRISAS LAKE DAM
FRANKLIN COUNTY, MISSOURI
MO 30541

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

AUGUST 1979

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-A205 477 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Las Brisas Lake Dam (MO 30541) Franklin County, Missouri	5. TYPE OF REPORT & PERIOD COVERED (9) Final Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Anderson Engineering, Inc.	8. CONTRACT OR GRANT NUMBER(s) (15) DACW43-79-C-0070
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 (12) 341
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	(11) 12. REPORT DATE August 1979 13. NUMBER OF PAGES Approximately 40
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) (10) Steve /Brady Tom /Beckley Gene /Wertepny Dave /Daniels	15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Las Brisas Lake Dam (MO 30541), Mississippi - Kaskaskia - St. Louis Basin, Franklin County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

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

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

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UNCLASSIFIED 423554

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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

IN REPLY REFER TO

SUBJECT: Las Brisas Lake Dam Phase I Inspection Report

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

SUBMITTED BY: SIGNED
Chief, Engineering Division

29 AUG 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

29 AUG 1979
Date

LAS BRISAS LAKE DAM

FRANKLIN COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30541

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

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:	Las Brisas Lake Dam
State Located:	Missouri
County Located:	Franklin
Stream:	Tributary of Little Fox Creek
Date of Inspection:	May 9, 1979

Las Brisas Lake Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. 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 they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends approximately two miles downstream of the dam. Located within this zone are six dwellings and two buildings. The dam is in the intermediate size classification, since it is greater than 40 ft high but less than 100 ft high.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 58 percent of the Probable Maximum Flood without overtopping. 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 guidelines require that a dam of intermediate size with a high downstream hazard potential pass the PMF. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being exceeded in any given year.

Deficiencies visually observed by the inspection team were: (1) erosion of the upstream face at the normal pool level, the downstream face below the berm, and the downstream dam-abutment contacts below the berm; (2) wet areas on the downstream face just above the berm between Stations 1+00 and 2+00 and between approximate elevations 80 and 90; (3) heavy brush and small trees on the downstream face on the downslope of the berm; (4) brush in the outlet area of the primary spillway; and (5) brush and debris in the emergency spillway and close proximity of the emergency spillway channel to the dam. Another deficiency was the lack of seepage and stability analysis records. Although not indicated on the day of inspection, the owners have indicated that the primary spillway periodically becomes clogged.

It is recommended that the owners take the necessary action in the near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Steve Brady, P.E. (AEI)

Tom Beckley, P.E. (AEI)

Gene Wertepny, P.E. (HEI)

Dave Daniels, P.E. (HEI)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAS BRISAS LAKE DAM - ID No. 30541

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APPENDICES

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 St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Las Brisas Lake Dam in Franklin County, Missouri.

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 a 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, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." 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:

Las Brisas Lake Dam is a mixed earth and rock fill structure approximately 45.5 ft high and 430 ft long at the crest. The appurtenant works consist of a primary spillway located at Station 1+36 with an 18 in. diameter steel pipe drop inlet, a 12 in. diameter steel outlet pipe, and an earth emergency spillway located at the northwest abutment. Sheet 3 of Appendix A shows a plan profile and typical section of the embankment.

B. Location:

The dam is located in the northeast part of Franklin County, Missouri on a tributary of Little Fox Creek. The dam

and lake are within the Labadie, Missouri 7.5 minute quadrangle sheet (Section 3, T43N, R2E - latitude 38° 30.3'; longitude 90° 46.7'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 45.5 ft and a maximum storage capacity of approximately 173 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately two miles downstream of the dam. Located within this zone are six dwellings and two buildings.

E. Ownership:

The dam is owned by the Las Brisas Lake Trustees (in care of Mr. Mike Duvald' Adrian, Secretary). The owner's address is Rte. 2, No. 57, Las Brisas Lake 63069.

F. Purpose of Dam:

The dam was constructed primarily for recreational purposes.

G. Design and Construction History:

The dam was constructed in 1969 or 1970 by the Dollar Construction Company. Apparently, the Las Brisas Lake area was originally developed by American Triad of Crystal City, Missouri. Information from Brad Eisenbreis of American Triad indicates that a clay key was incorporated under the dam. No riprap was used on the upstream face. No plans or design information was available.

H. Normal Operating Procedures:

Normal flows are passed by an uncontrolled drop inlet spillway, whereas an earth emergency spillway comes into operation for major storms. The owner has indicated that the emergency spillway was last used in April 1979. The appearance of the emergency spillway indicates that it has

probably been used a number of times since the dam was built. The owner also has indicated that the primary spillway periodically becomes clogged and that a siphon has been used several times in the past when this has occurred (Photo No. 9 - note siphon pipe on dam).

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 77 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through uncontrolled spillways.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - Avg. El. 105.6): 432 cfs

(3) Estimated Capacity of Primary Spillway: 10 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: 87 cfs (El. 104)

(5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(7) Gated Spillway Capacity at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed elevation of 100.00 for the crest of the primary spillway at Station 1+36 (see Sheet 3, Appendix A).

(1) Top of Dam: 105.2 (low point); 106.3 (high point); 105.6 (average)

(2) Principal Spillway Crest: 100 (assumed)

(3) Emergency Spillway Crest: 103 (average)

(4) Principal Outlet Pipe Invert: 64.1

(5) Streambed at Centerline of Dam: 60.8

(6) Pool on Date of Inspection: 99.99

(7) Apparent High Water Mark: 104.0

(8) Maximum Tailwater: Unknown

(9) Upstream Portal Invert Diversion Tunnel: Not Applicable

(10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Principal Spillway Crest: 1150 ft

(2) At Emergency Spillway Crest: 1250 ft

E. Storage Capacities:

(1) At Principal Spillway Crest: 117 ac-ft

(2) At Top of Dam: 173 ac-ft

(3) At Emergency Spillway Crest: 145 ac-ft

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 9 acres

(2) At Top of Dam: 11 acres

(3) At Emergency Spillway Crest: 10 acres

G. Dam:

(1) Type: Mixed Earth and Rock Fill

(2) Length at Crest: 430 ft

(3) Height: 45.5 ft (maximum)

(4) Top Width: 10.5 ft

(5) Side Slopes: Upstream 3.3H: 1.0V; Downstream 2.6H:1V (average)

(6) Zoning: None (Homogeneous)

(7) Impervious Core: Unknown

(8) Cutoff: Clay key trench (depth and width unknown)

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: None

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

(1) Location: Station 1+36 (See Sheet 3 of Appendix A)

(2) Type: 18 in. Diameter Steel Pipe Drop Inlet with 12 in. Diameter Steel Pipe Through Dam

I.2 Emergency Spillway:

(1) Location: Northwest Abutment

(2) Type: Earth

J. Regulating Outlets:

There are no regulating outlets or permanent draindown facilities for this dam. A siphon has been used to lower high lake levels in the past when the primary spillway has clogged.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data exist for this dam. To our knowledge, no construction inspection records or documented maintenance and operation data exist.

A. Surveys:

To our knowledge, no detailed surveys have been made of the dam. The crest of the primary spillway was used as datum for our site survey (Assumed Elev. 100). It is estimated that this site datum approximately corresponds to mean sea level elevation 755.

B. Geology and Subsurface Materials:

The site is located at the northeastern edge of the Ozarks. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common rock types are dolomite, sandstone and chert. Information from the Missouri Geological Survey indicates that the St. Peter Formation is exposed on steeper slopes in nearby valleys. St. Peter is a massive, cross-bedded sandstone. The "Geologic Map of Missouri" indicates that the nearest known faults are approximately 10 miles southwest of the site. The Missouri Geological Survey has indicated that the faults in the area are generally considered to be inactive and have been for several hundred million years. The publication "Caves of Missouri" indicates that most of the known caves in Franklin County are in the south-central portion (20 to 25 miles from the site).

The publication "Soils of Missouri" indicates that soils in the area of the dam are of the Menfro-Winfield-Weldon association and are low plasticity silty clays and clayey silts developed from 18 ft to 20 ft of loessial deposits (modified loess). Some residual material would also be expected in the site area.

C. Foundation and Embankment Design:

Information from American Triad of Crystal City, Missouri indicates that the material for the dam probably came from the lake area. A clay key was incorporated under the dam. No riprap was used. It is not known whether anti-seep collars were incorporated for the outlet pipe through the dam.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design data were obtained. Our analyses of the PMF are presented in Appendix C. These analyses were based on our field survey and observations, and estimates of areas and volumes from the U.S.G.S. quad sheet. It was concluded that the structure will pass 58 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

The only appurtenant structure associated with this dam is the primary spillway which appears to be in good condition. The owners have indicated that the spillway periodically becomes clogged. It is not known whether anti-seep collars were used.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION AND MAINTENANCE:

To our knowledge, there are no operating records. The owner indicated that no maintenance procedures are used.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on May 9, 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

B. Dam:

The upstream slopes are fairly flat above the water level with an 8 ft to 10 ft wide berm just above the normal pool level. There is a 6 in. to 1 ft vertical erosion bank along the entire upstream face at the normal pool level. No erosion protection of the upstream face was noted.

The dam is fairly level across the crest, and no surface cracking or unusual movement was noted. Shallow auger probes into the dam near the top indicated a red-brown silty clay (residuum) mixed with rock fragments and some fairly large rock (some rock pieces as large as 6 in. to 1 ft in diameter). The lower part of the dam on the downstream side below the berm appears to be more of a silty clay to clayey silt (modified loess).

The downstream face of the dam below the berm level and the dam-abutment contacts below the berm level have erosion channels which are 1 ft to 3 ft deep and 2 ft to 3 ft wide (See Photos 8 and 11). The downstream face of the dam below the berm level is covered with heavy brush and small trees (See Photos 9 and 10).

Several apparent seepage areas were noted on the downstream face above the berm level between Stations 1+00 and 2+00 and between elevations 80 and 90. This seepage is manifested by wet, soft areas growing cattails and reeds (See Sheet 4 of Appendix A and Photo 7). No obvious flows were evident, so that an estimate of seepage quantity was not possible.

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Primary Spillway:

The primary spillway consists of an 18 in. diameter steel pipe drop inlet with a small trash rack (See Photo 13). The crest of the primary spillway was used as the datum for our site survey (Assumed El. 100). The outlet is a 12 in. diameter steel pipe through the dam with its upstream invert at elevation 89.3 and its downstream invert at elevation 64.0. The bottom of the plunge pool below the outlet pipe is at elevation 61.0 (See Photo 14).

The inlet and outlet pipes appear in good condition. The owners have indicated that the inlet periodically becomes clogged and that a siphon has been used in the past when this has occurred.

C.2. Emergency Spillway:

The emergency spillway is located in the northwest abutment. A berm has been constructed on the downstream side at the northwest abutment in an attempt to direct water away from the dam. However, the spillway channel is very near to the downstream abutment-dam contact, and some erosion has occurred at the abutment-dam contact near the lower berm level, due possibly to emergency spillway releases. The emergency spillway has apparently been used several times since the dam was built due to the low capacity of the primary spillway and its tendency to become clogged. There is some brush and tree growth in the upper portion of the emergency spillway and some wood debris in the spillway. Photographs 16 through 20 show the emergency spillway. The owners reported that the emergency spillway was used most recently in April 1979.

D. Reservoir:

The watershed is primarily wooded with some grassy areas. The slopes adjacent to the watershed are moderate, and no sloughing or serious erosion was noted. Residences are located around the lake, primarily on the west and south.

E. Downstream Channel:

The primary spillway outlet channel is overgrown with trees and brush. Rock outcrops in the outlet area indicate that the base of the plunge pool is probably very near to bedrock.

3.2 EVALUATION:

The erosional damage on the downstream face and at the abutment-dam contacts should be repaired and maintained. Trees and brush should be removed from the face of the dam on an annual basis. The seepage areas noted on the downstream face should be investigated by an engineer experienced in the design and construction of dams. Remedial measures may be required. As a minimum, these areas should be inspected periodically in an effort to detect an increase in the quantity of seepage or any indication that soil particles are being carried by the water. In this event, an engineer experienced in the design and construction of dams should be contacted immediately.

The primary spillway inlet should be inspected by a qualified engineer in an effort to devise a method to prevent future clogging of the spillway. A modification of the trash rack may be in order. The primary spillway outlet area should be cleared of trees and brush.

The emergency spillway should be cleared of trees, brush and debris. It would appear to be advisable to increase the length and the height of the berm at the northwest abutment to direct emergency spillway releases away from the downstream face of the dam.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam. The spillways are uncontrolled, so that the pool is normally controlled by rainfall, runoff and evaporation.

4.2 MAINTENANCE OF DAM:

The owner has indicated that no particular maintenance is performed for this dam.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities for this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Trees and brush should be cut annually. Animal holes should be filled, and erosional areas should be maintained. The emergency spillway and primary spillway outlet should be periodically cleared of wood debris and vegetation. The dam should be periodically inspected to detect possible seepage under or through the embankment.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field survey of spillway dimensions and embankment elevations, and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. No previous hydraulic or hydrologic studies were obtained. Our hydrologic and hydraulic analyses using U. S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

The outlet area for the primary spillway is overgrown with trees and brush. Rock outcrops in the outlet area indicate that the base of the plunge pool is probably very near to bedrock. The inlet and outlet pipes appear in good condition. The owners have indicated that the inlet becomes clogged periodically and that a siphon has been used in the past when this has occurred.

The emergency spillway channel is very near to the downstream abutment-dam contact, and some erosion has occurred at the abutment-dam contact near the lower berm level, due possibly to emergency spillway releases. The emergency spillway has apparently been used several times since the dam was built due to the low capacity of the primary spillway and its tendency to become clogged. There is some brush and tree growth in the upper portion of the emergency spillway and some wood debris in the spillway. The owners reported that the emergency spillway was used most recently in April 1979. They have no knowledge of the dam ever being overtopped.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the combined spillways will pass 58 percent of 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. The recommended guidelines from the

Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass the PMF, without overtopping. The structure will pass a 100-year frequency flood without overtopping.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by .75 ft at elevation 106.35. The duration of the overtopping will be .67 hours, and the maximum outflow will be 1389 cfs. The maximum discharge capacity of the spillways is 432 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. The modified loess materials below the berm on the dam are considered to be fairly erodible.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Physical factors observed which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Our site inspection indicates that the materials composing the dam are primarily silty clays and clayey silts mixed with rock. American Triad has indicated that a clay key was incorporated under the dam. It is not known whether internal drainage features were incorporated. No construction inspection records are available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The inspection team is not aware of any post-construction changes to the dam.

E. Seismic Stability:

The structure is located in seismic zone 2 near the boundary of zones 1 and 2. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) erosion of the upstream face at the normal pool level, the downstream face below the berm, and the downstream dam-abutment contacts below the berm; (2) seepage on the downstream face just above the berm between Stations 1+00 and 2+00 and between approximate elevations 80 and 90; (3) heavy brush and small trees on the downstream face on the downslope of the berm and light brush and a few trees above the berm; (4) brush in the outlet area of the primary spillway; and (5) brush and debris in the emergency spillway and close proximity of the emergency spillway channel to the dam. Although not indicated on the day of inspection, the owners have indicated that the primary spillway periodically becomes clogged.

The dam will be overtopped by flows in excess of 58 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. The residual silty clays are not generally considered to be particularly erodible; however, the modified loess materials below the berm are considered to be fairly erodible.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will continue to deteriorate and possibly could become serious in the future. Priority should be given to increasing the size of the spillway.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 2 near the boundary of zones 1 and 2. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

(1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the emergency spillway should be protected to prevent erosion. It should be noted that the overtopping depths are not the required or recommended increase in the height of the dam.

(2) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.

(3) The erosional damage on the downstream face and at the abutment-dam contacts should be repaired and maintained.

(4) Trees and brush should be removed from the face of the dam on an annual basis. The initial clearing should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.

(5) The seepage areas noted on the downstream face should be investigated by an engineer experienced in the design and construction of dams. Remedial measures may be required. As a minimum, these areas should be inspected periodically in an effort to detect an increase in the quantity of seepage or any indication that soil particles are being carried by the water. In this event, an engineer should be contacted immediately.

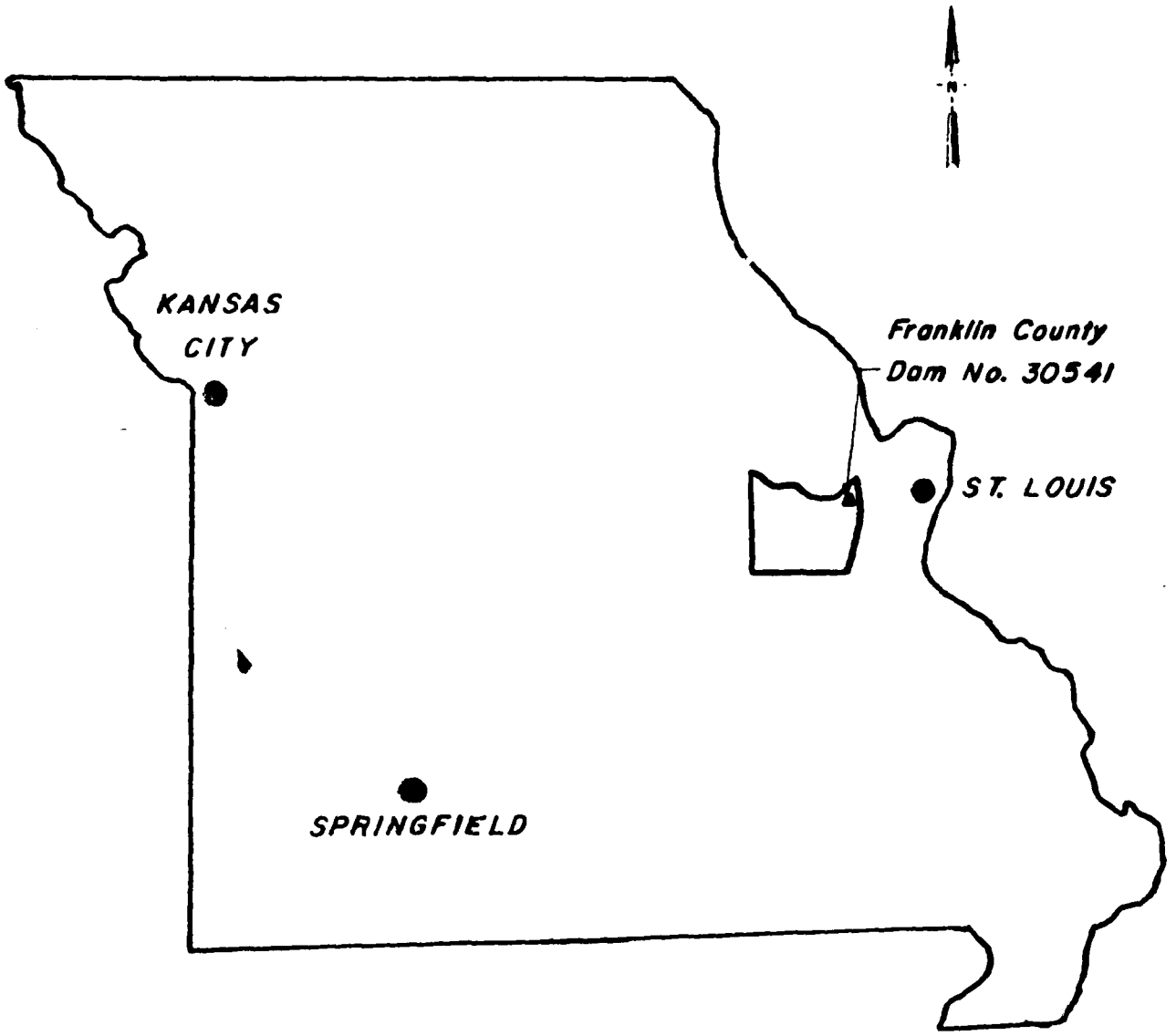
(6) The primary spillway inlet should be inspected by a qualified engineer in an effort to devise a method to prevent future clogging of the spillway. A modification of the trash rack may be in order. The primary spillway outlet area should be cleared of trees and brush.

(7) The emergency spillway should be cleared of trees, brush and debris. It would appear to be advisable to increase the length and the height of the berm at the northwest abutment to direct emergency spillway releases away from the downstream face of the dam.

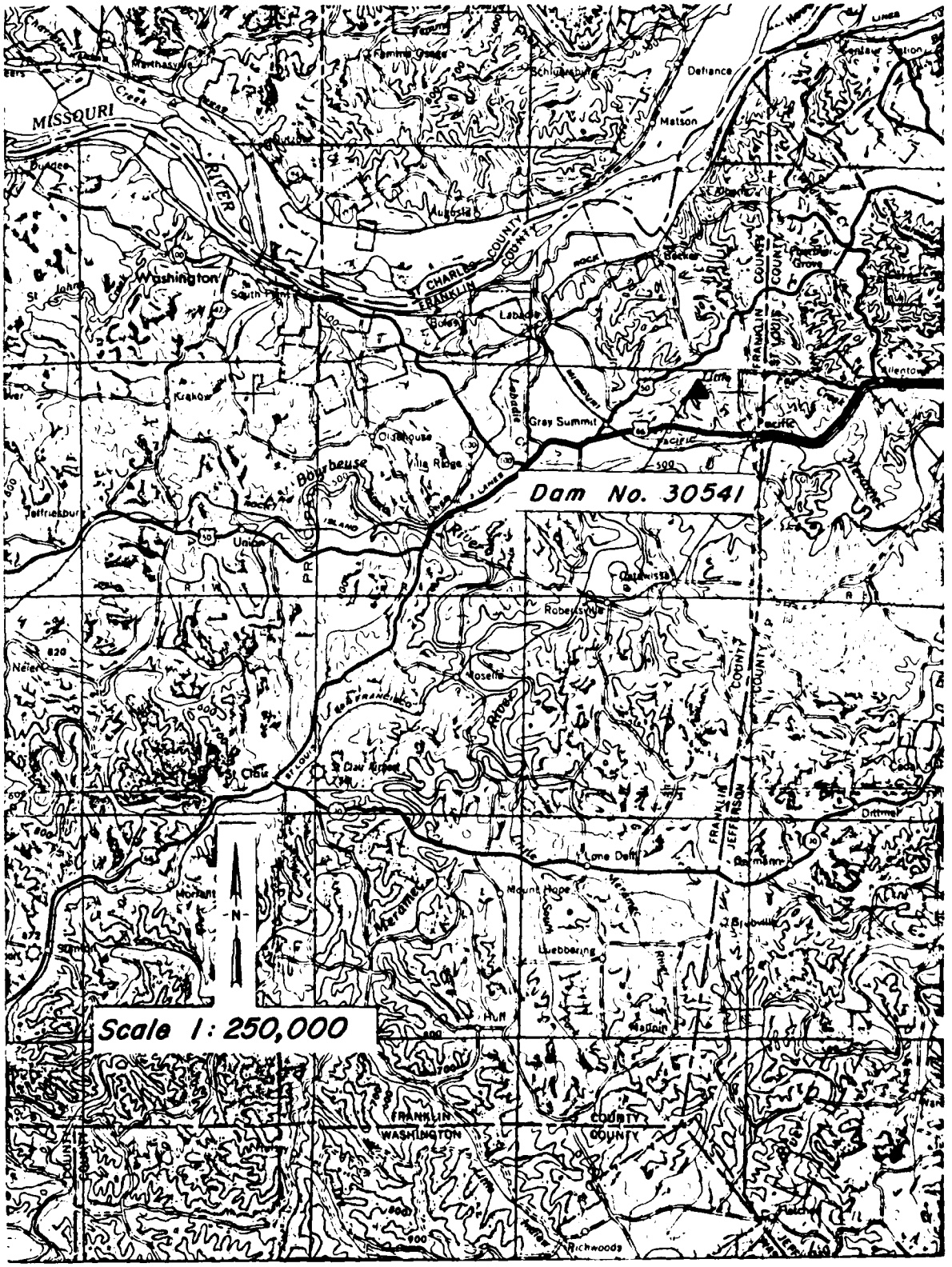
(8) Erosion protection should be provided for the upstream face of the dam.

(9) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

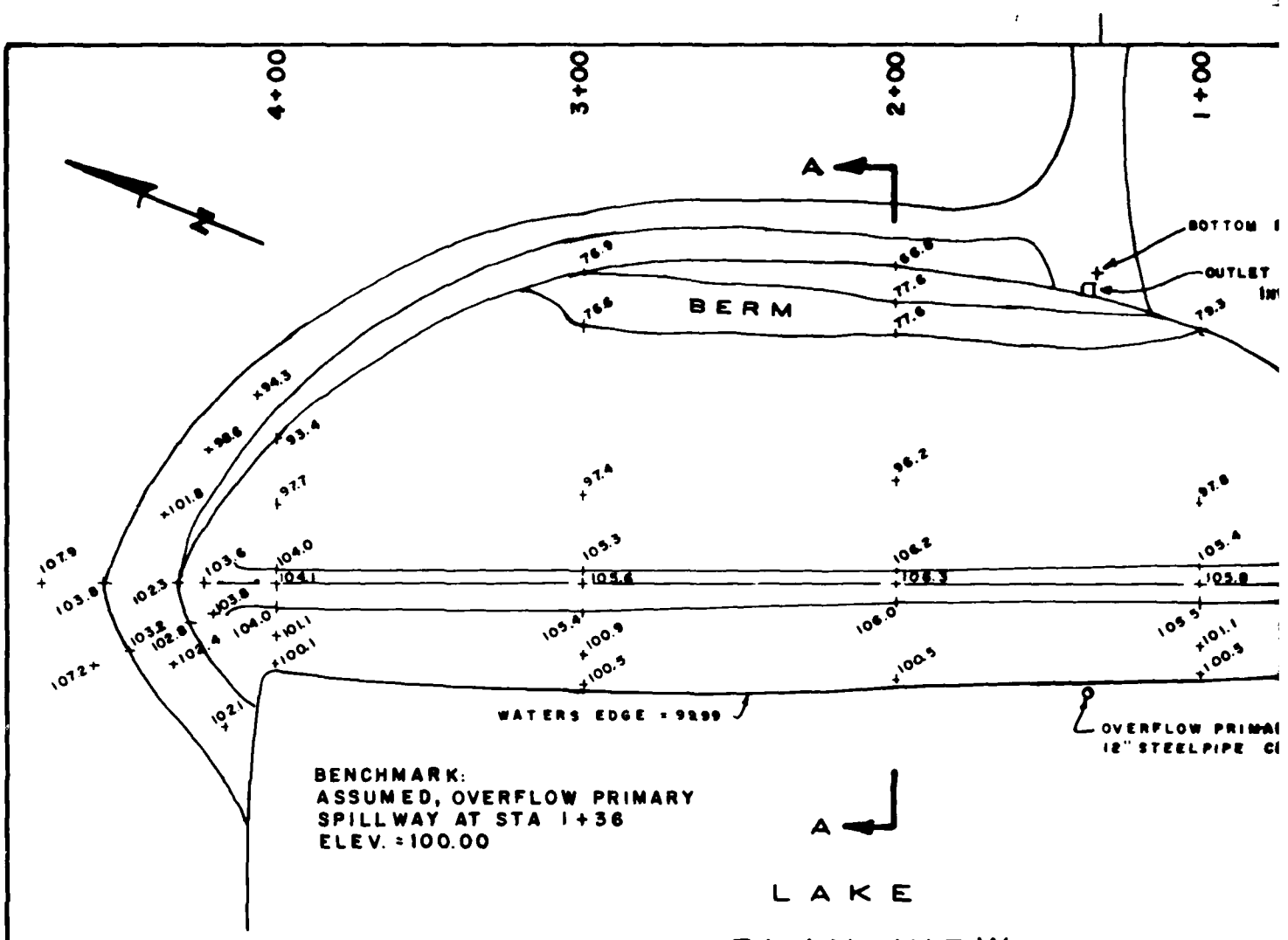


LOCATION MAP

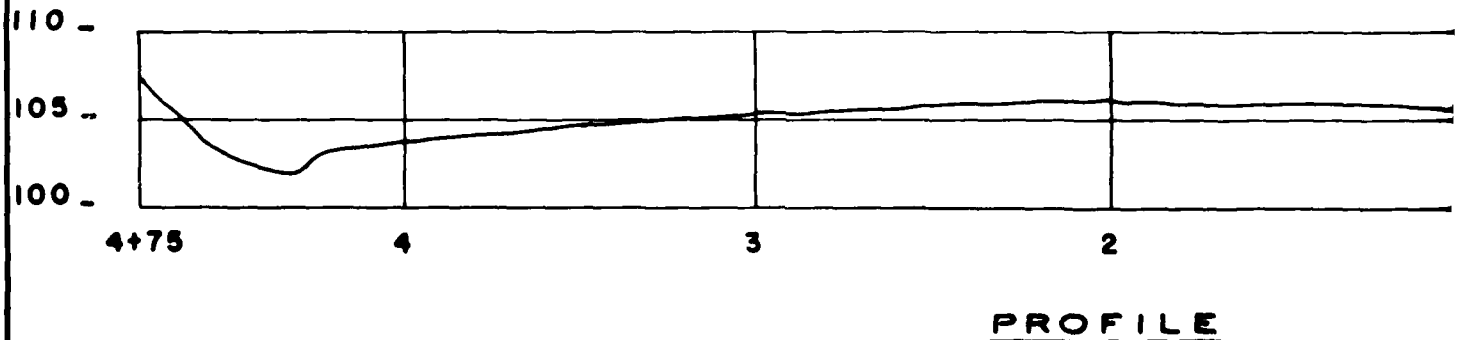


SITE VICINITY MAP

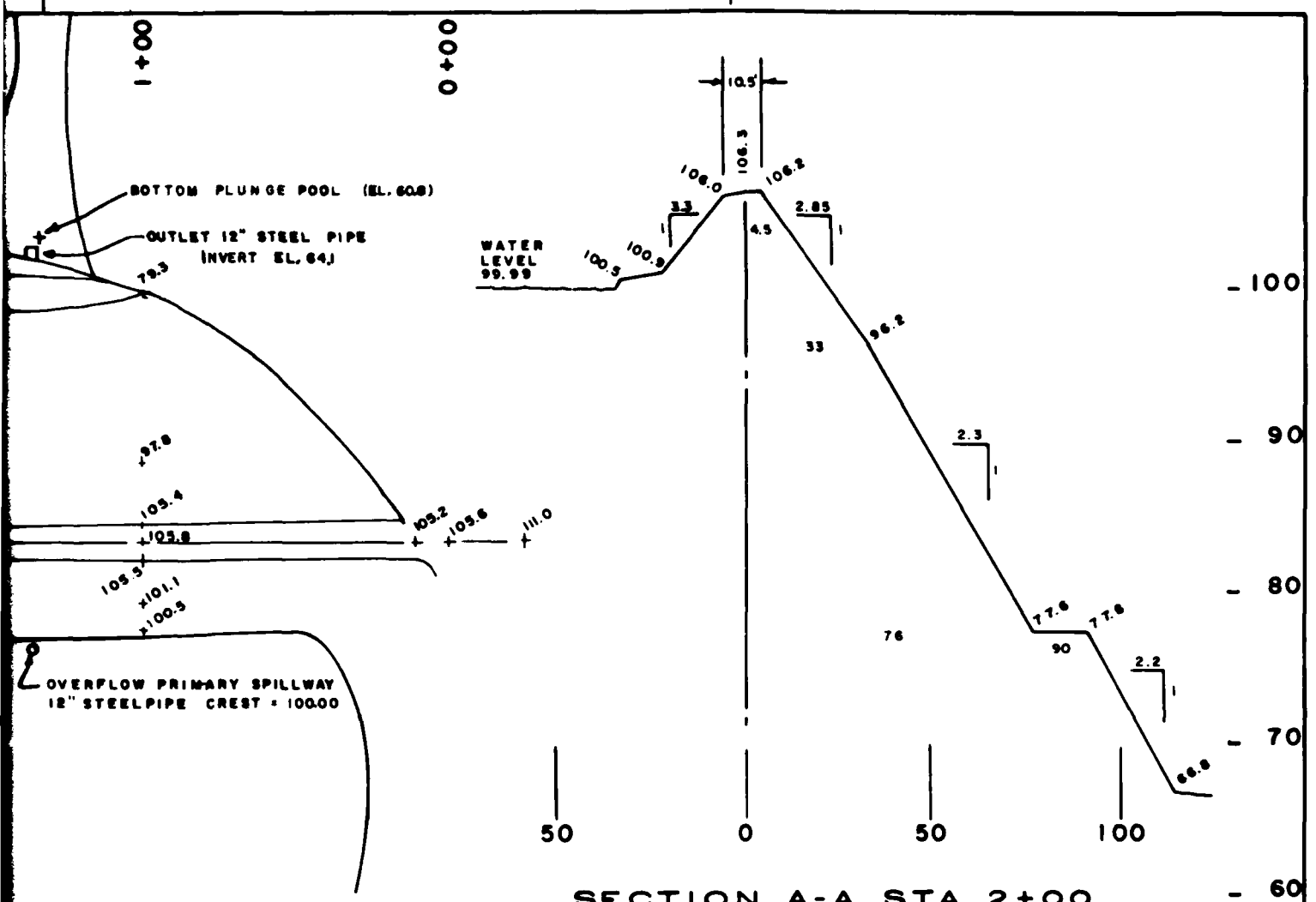
Sheet 2 Appendix A



PLAN VIEW
SCALE: 1" = 50'



PROFILE



SHEET 3 APPENDIX A

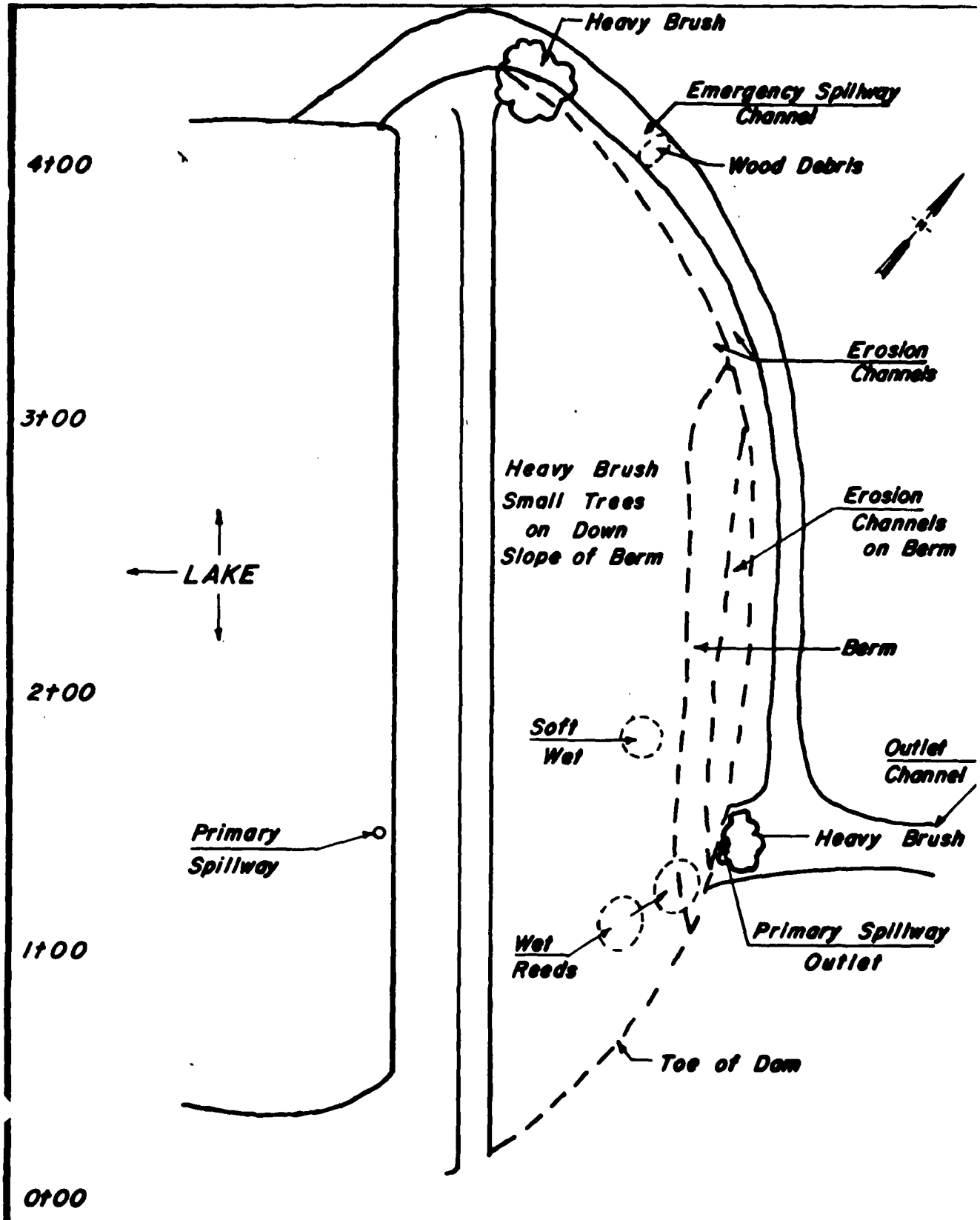
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

LAS BRISAS LAKE

MO. No. 30541

PLAN & PROFILE

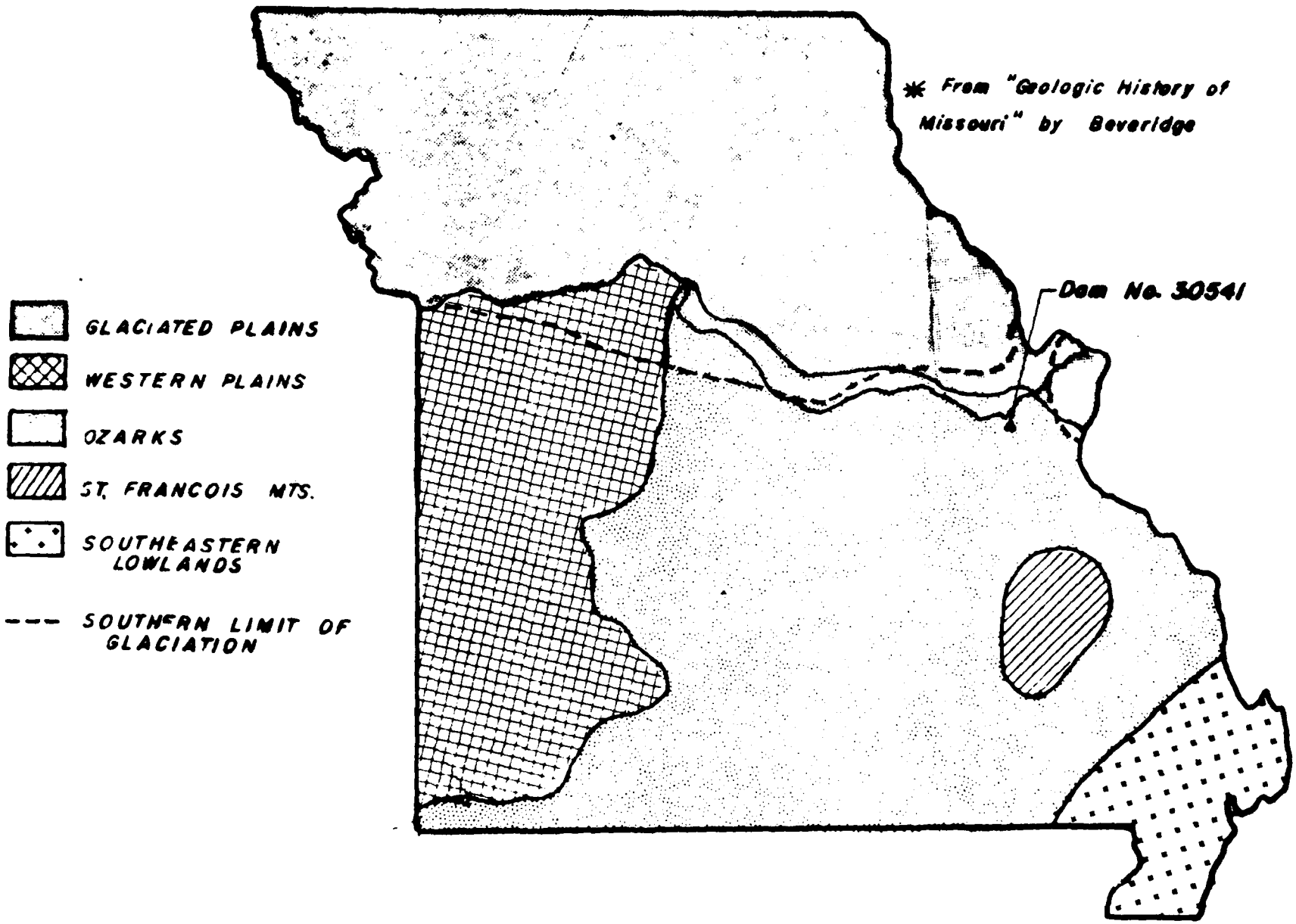
FRANKLIN COUNTY, MO.



DRAWN DER CHECKED DED DATE 6-11-79 JOB NO. 79511	HANSON ENGINEERS SPRINGFIELD ILL. PEORIA ILL.	Plan Sketch Inspection Observations Sheet 4 Appendix A

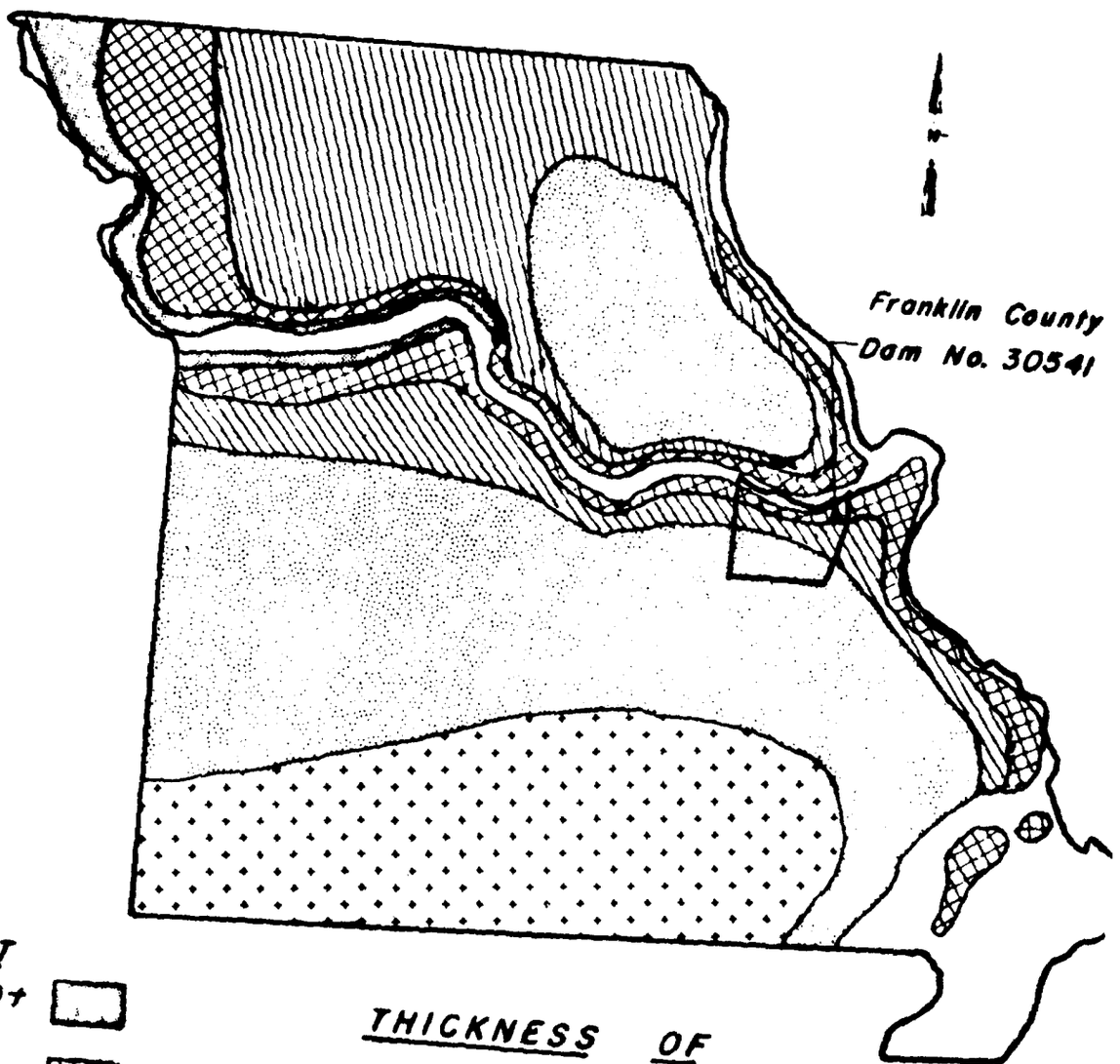
APPENDIX B

MAJOR GEOLOGIC REGIONS OF MISSOURI



SHEET 1 OF APPENDIX B

* From "Soils of Missouri"



FEET

20+

10-20

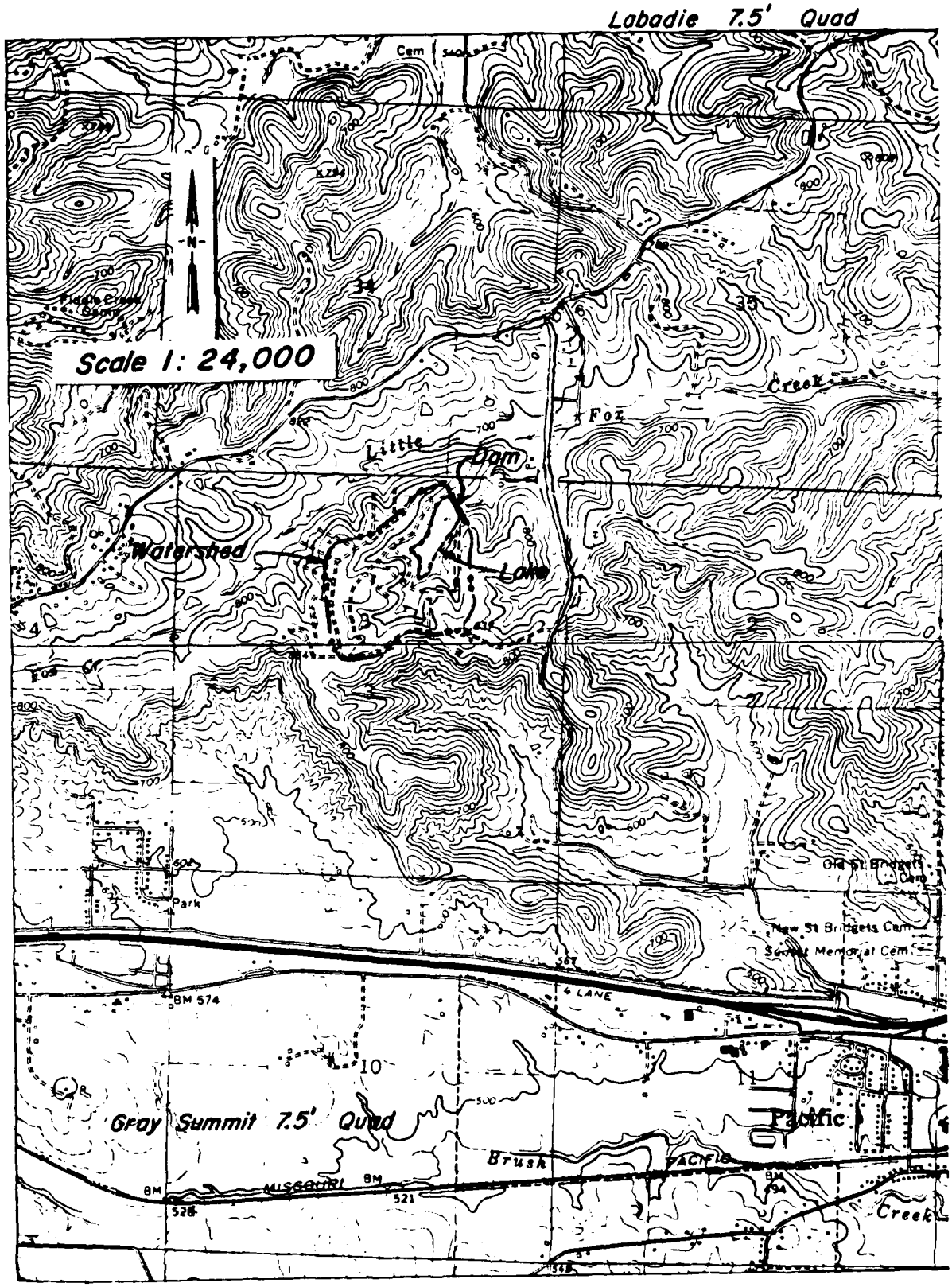
5-10

2.5-5

2.5-

THICKNESS OF LOESSIAL DEPOSITS

APPENDIX C



LAKE AND WATERSHED MAP

Sheet 1 Appendix C

HYDRAULIC AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. No previous hydraulic or hydrologic design data were available.

Visual Inspection: At the time of the inspection, the pool level was approximately .01 below normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by planimeter from the U.S.G.S. Labadie, Missouri 7.5 minute quadrangle map. The storage volume was developed from these data. A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 441 c.f.s. and a time to peak of 5 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 1872 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the combined spillways will pass 58 percent of the Probable Maximum Flood (PMF). 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 recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (intermediate size with high downstream hazard potential) pass the PMF, without overtopping.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 0.75 ft at elevation 106.35. The duration of the overtopping will be 0.67 hours, and the maximum outflow will be 1389 c.f.s. The maximum discharge capacity of the combined spillways is 432 c.f.s. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam.

Note: Overtopping depths are not the required or recommended increase in the height of dam.

OVERTOPPING ANALYSIS FOR LAS BRISAS LAKE DAM

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are As Follows:

   a. Twenty-four Hour Rainfall of 26.7 Inches For 200 Square Miles - All Season Envelope

   b. Drainage Area = 77 Acres; = .12 Sq. Miles

   c. Travel Time of Runoff 0.11 Hrs.; Lag Time 0.07 Hrs.

   d. Soil Conservation Service Soil Group C

   e. Soil Conservation Service Runoff Curve No. 86 (AMC III)

   f. Proportion of Drainage Basin Impervious 13%

2. Spillways

   a. Primary Spillway: Drop Inlet 18 in. Steel Pipe Riser
   12 in. Steel Pipe Outlet

   b. Emergency Spillway

   Length 24 Ft.; Side Slopes 4:1 ; C = 2.65

   c. Dam Overflow

   Length 410 Ft.; Side Slopes 0 ; C = 3.0

Note: Spillway and Dam Rating Curve Prepared by Hanson Engineers. Data Provided to Computer on Y4 and Y5 Cards.

Primary Spillway - Combination of weir flow and pipe flow
Emergency Spillway - Weir flow $Q = CLH^{3/2}$

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph

   a. Peak - 441 c.f.s.

   b. Time to Peak 5 Min.

2. Flood Routings Were Computed by the Modified Puls Method

   a. Peak Inflow

      50% PMF 936 c.f.s.; 100% PMF 1872 c.f.s.

   b. Peak Elevation

      50% PMF 105.24 100% PMF 106.35

   c. Portion of PMF That Will Reach Top of Dam

      58 %; Top of Dam Elev. 105.60 Ft.

Note: Time of Concentration From Equation $Tc = \left(\frac{11.9\ L^3}{H}\right).385$

California Culvert Practice, California Highways and Public Works, Sept. 1942.

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A       OVERTOPPING ANALYSIS FOR DAM #23 LAS BRISAS LAKE
A       CO CODE #071 FRANKLIN CO MON 30541 OWNER LAS BRISAS LAKE TRUSTEES
A       HANSON ENGINEERS INC DAM SAFETY INSPECTION JOB #79511
B    300              5
B1     5
J      1       6       1
J1   0.2     0.3     0.4     0.5     0.6     1.0
K      0       1                               3       1
K1      INFLOW HYDROGRAPH COMPUTATION
N      1       2    0.12            0.12       1                       1
P      0    25.3     102     120     130
T                                                       -1      -86             0.13
U2  0.11    0.07
X      0     0.1       2
K      1       2                       2       4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT LAS BRISAS LAKE
Y                               1       1
Y1     1                                               117      -1
Y4   100     101     103     104   104.6   105.6   106.5
Y5     0       9      10      87     182     432     711
$A     0       9      11
$E    61     100   105.6
$$   100
$D 105.6     3.0     1.5     410
K     99
```

PMF INPUT DATA
SHEET 5 , APPENDIX C

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

1

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	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
				0.20	0.30	0.40	0.50	0.60	1.00
HYDROGRAPH AT	1	0.12	1	374.	562.	749.	936.	1123.	1872.
		(0.31)		(10.60)(	15.90)(	21.20)(	26.50)(	31.80)(	53.01)(
ROUTED TO	2	0.12	1	29.	81.	231.	354.	482.	1389.
		(0.31)		(0.83)(	2.29)(	6.55)(	10.03)(	13.65)(	39.33)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

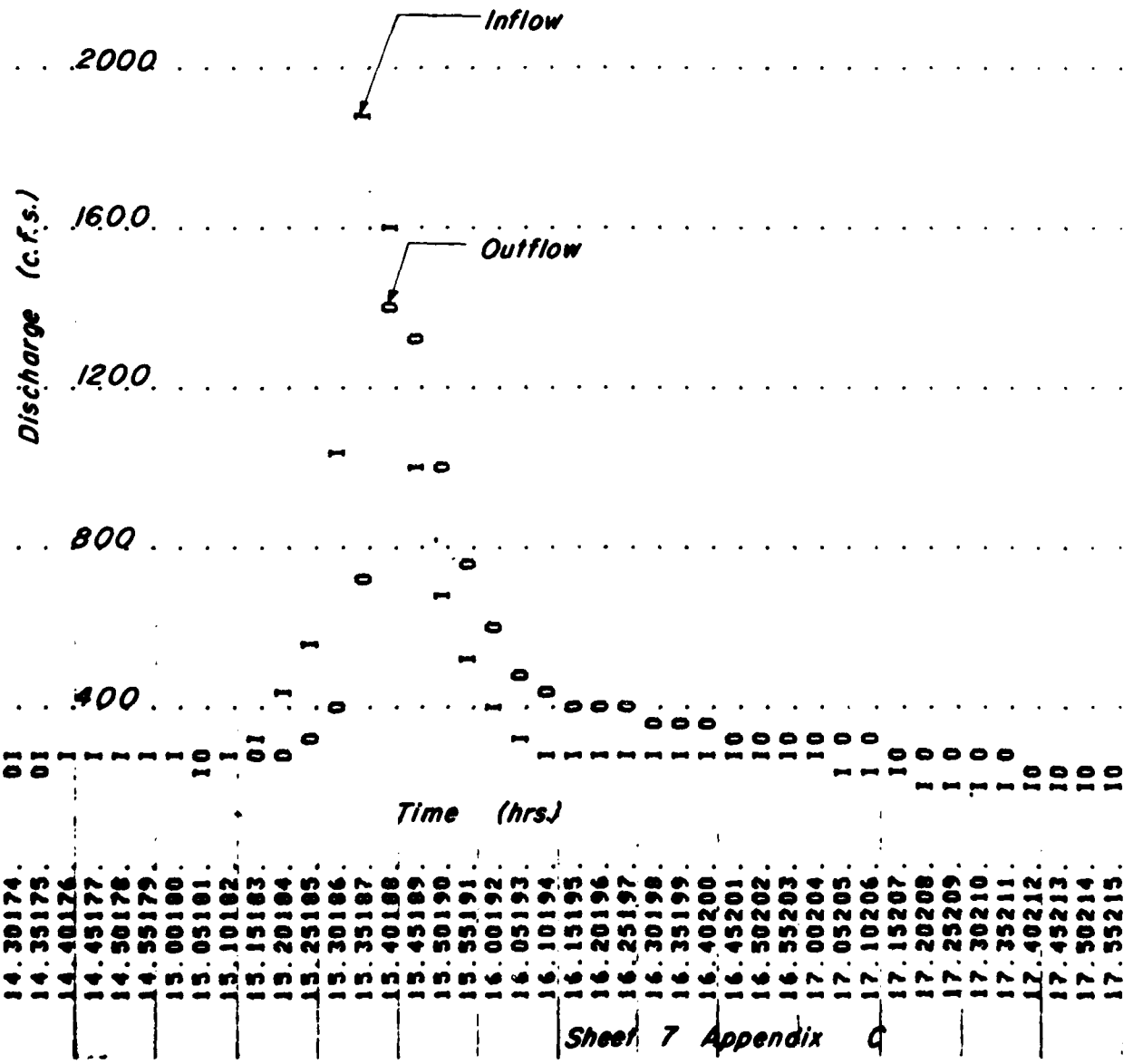
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	100.00	100.00	105.60
STORAGE	117.	117.	173.
OUTFLOW	0.	0.	432.

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
0.20	103.25	0.00	148.	29.	0.00	18.08	0.00
0.30	103.92	0.00	155.	81.	0.00	17.00	0.00
0.40	104.67	0.00	163.	231.	0.00	15.92	0.00
0.50	105.24	0.00	169.	354.	0.00	15.83	0.00
0.60	105.69	0.09	174.	482.	0.25	15.83	0.00
1.00	106.35	0.75	181.	1389.	0.67	15.67	0.00

P.M.F. HYDROGRAPHS

Max.. Inflow = 1,872 c.f.s.

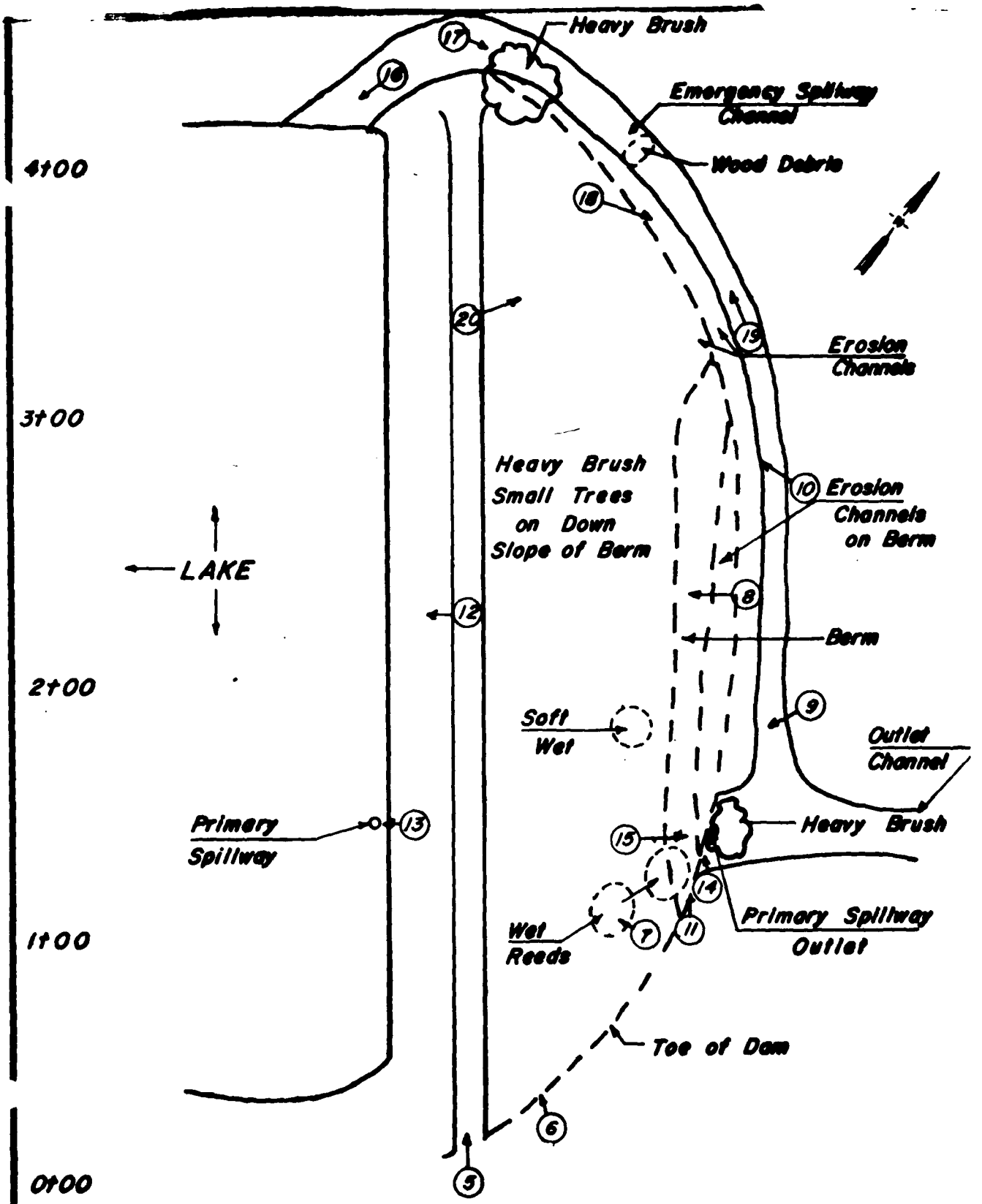
Max. Outflow = 1,389 c.f.s.



APPENDIX D

LIST OF PHOTOGRAPHS

Photo No.	Description
1.	Aerial - Looking West at Dam, Lake and Watershed
2.	Aerial - Looking West at Dam and Lake
3.	Aerial - Looking Northwest at Dam
4.	Upstream Face of Dam- Looking North
5.	Crest of Dam - Looking Northwest
6.	Downstream Face - Looking Northwest
7.	Seepage Area on Downstream Face - Note Cattails
8.	Erosion Gully on Downslope of Berm
9.	Downstream Face - Looking Toward Southeast Abutment from Toe
10.	Downstream Face - Looking Toward Northwest Abutment from Toe
11.	Erosion Gully at Southeast Abutment-Dam Contact Below Berm
12.	Lake Area - Looking West from Crest
13.	Primary Spillway Inlet
14.	Primary Spillway Outlet
15.	Outlet Channel - Looking Downstream
16.	Approach Area of Emergency Spillway - Looking Upstream
17.	Emergency Spillway - Looking Downstream from Crest
18.	Emergency Spillway - Looking Downstream
19.	Emergency Spillway - Looking Upstream, Note Debris
20.	Emergency Spillway from Crest of Dam



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DATE	6-11-79
JOB NO.	79611

HANSON ENGINEERS
SPRINGFIELD ILL. PEORIA ILL.

Plan Sketch
Key To Photographs

Sheet 2 Appendix D


1


2


3


4


5


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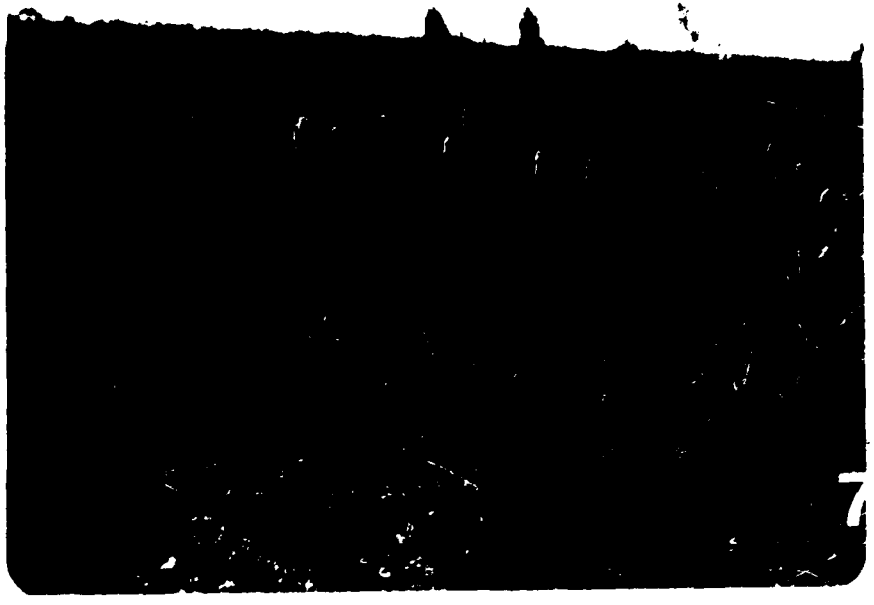
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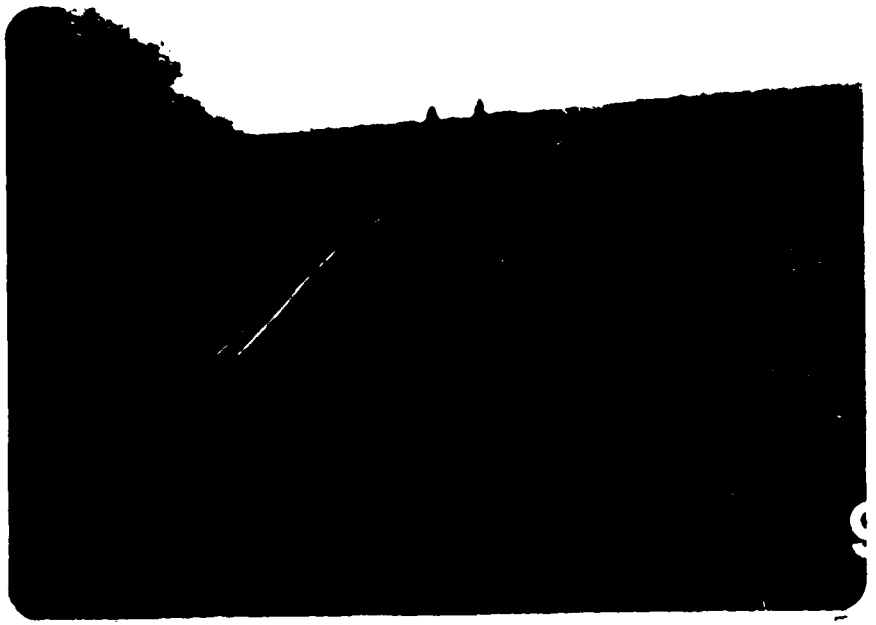


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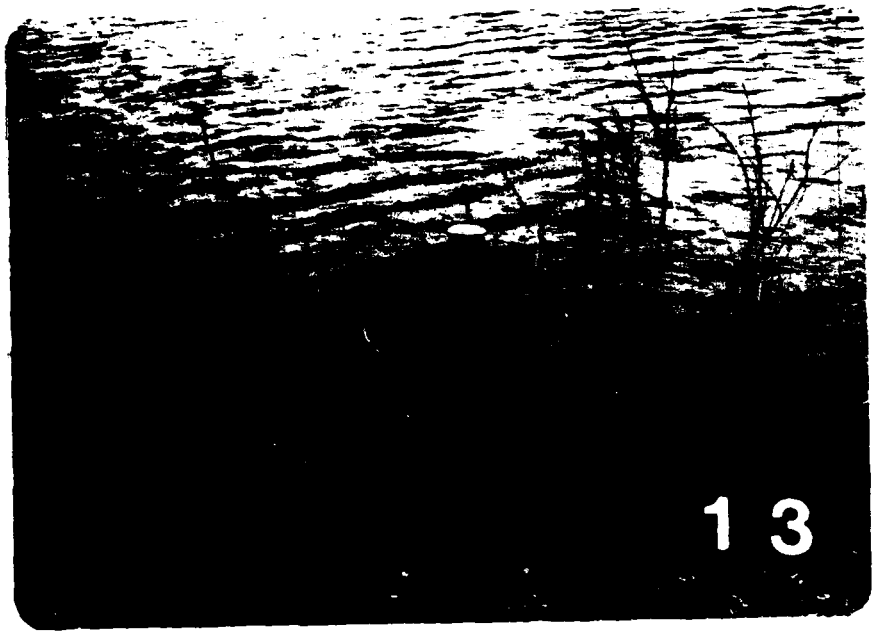
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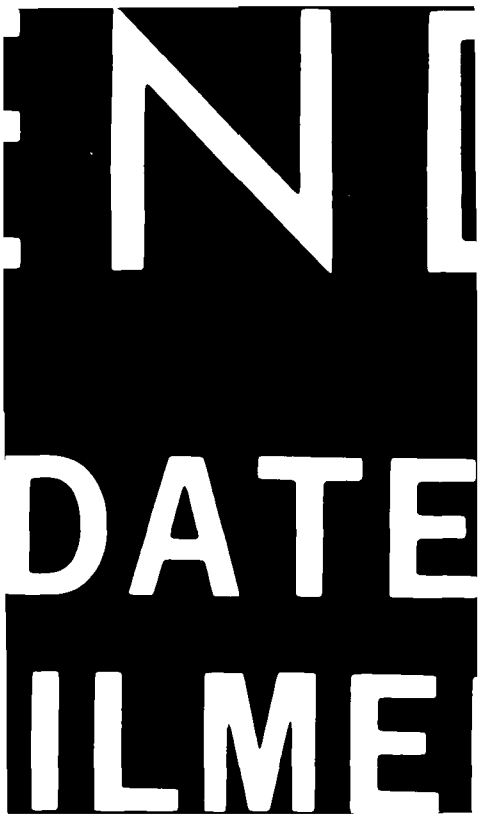
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