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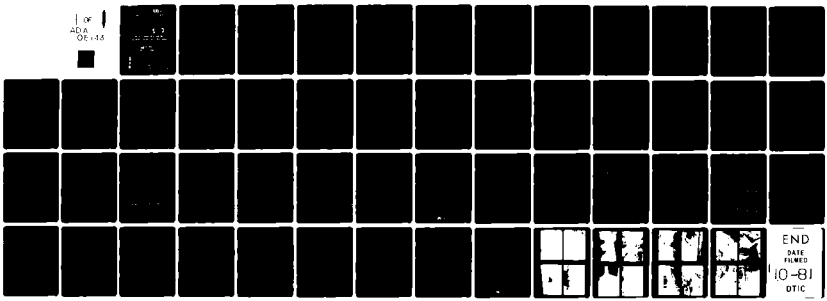

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KEMP LAKE DAM

CRAWFORD COUNTY, MISSOURI

MO 30035

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PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM.

Kemp Lake Dam (MO 30035),
Mississippi - Kaskaskia - St. Louis Basin,
Crawford County, Missouri. Phase I Inspection
Report.

United States Army
Corps of Engineers
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St. Louis District

9 Final rept.,

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11 Sep 79

10 Steve /Brady Nelson /Morales
Tom /Beckley Dave/Daniels

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

FOR: STATE OF MISSOURI

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

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

IN REPLY REFER TO

SUBJECT: Kemp Lake Dam Phase I Inspection Report

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

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

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

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED — 18 SEP 1979
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 18 SEP 1979
Colonel, CE, District Engineer — Date

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KEMP LAKE DAM

CRAWFORD COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30035

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

September 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Kemp Lake Dam
State Located:	Missouri
County Located:	Crawford
Stream:	Unnamed Tributary of Bourbeuse River
Date of Inspection:	27 June 1979

Kemp 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 if the dam fails. The estimated damage zone extends approximately 1 mile downstream of the dam. Located within this zone are four dwellings, two buildings and an interstate highway. The dam is in the small size classification, since the maximum storage capacity is greater than 50 ac-ft but less than 1000 ac-ft.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 17 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 small size with a high downstream hazard potential pass 50 to 100 percent of the PMF. Considering the small volume of water impounded, the small size of the dam and the large floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood. 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 or equaled in any given year.

Although the abundance of tree and brush growth made it very difficult to thoroughly inspect the downstream face of the embankment, the dam appears to be in generally good condition. Deficiencies visually observed by the inspection team were: (1) dense brush and tree growth over the entire embankment; (2) numerous animal burrows on downstream face of dam; (3) small slough on downstream face; and (4) brush and tree growth in approach channel of the spillway. Another deficiency was the lack of seepage and stability analysis records.

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)

Nelson Morales, P.E. (HEI)

Tom Beckley, P.E. (AEI)

Dave Daniels, P.E. (HEI)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
KEMP LAKE DAM - ID No. 30035

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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 St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Kemp Lake Dam in Crawford 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:

Kemp Lake Dam is an earth fill structure approximately 22.1 ft high and 386 ft long at the crest. The appurtenant works consist of a rock cut spillway located at the north end of the dam, a concrete box culvert bridge over the spillway and a hand-laid flagstone well located near the center of the dam just downstream of the crest. Sheet 3 of Appendix A shows a plan, profile and typical section of the embankment.

B. Location:

The dam is located in the north central part of Crawford County, Missouri on a tributary of Bourbeuse River. The dam and lake are within the Leasburg, Missouri 7.5 minute

quadrangle sheet (Section 6, T39N, R3W - latitude 38° 07.12'; longitude 91° 17.65'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 22.1 ft and a maximum storage capacity of approximately 212 acre-ft, the dam is in the small 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 1.2 miles downstream of the dam. Located within this zone are four dwellings, two buildings and an interstate highway.

E. Ownership:

The dam is owned by Mrs. Fred Kemp. The owner's address is Leasburg, Missouri 65535.

F. Purpose of Dam:

The dam was constructed primarily for recreation, although some flood protection is also provided.

G. Design and Construction History:

No plans or design information are available. The dam was constructed under the supervision of the Works Progress Administration in 1937. The only modification was in 1963 when a wood bridge over the spillway was replaced by a concrete structure.

H. Normal Operating Procedures:

All flows are passed by an uncontrolled rock cut spillway located at the north end of the dam. Mr. Frank Simmerly, a local resident and an employee of the owner, reported that the dam has never been overtopped since constructed. Mr. Simmerly's address is Bourbon, Missouri 65441.

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 519 acres.

B. Discharge at Dam Site:

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

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 939.8): 320 cfs

(3) Estimated Capacity of Primary Spillway: 320 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: 230 cfs (Elev. 939.0)

(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 936.0 for the normal pool level as shown on U.S.G.S. quad sheet.

(1) Top of Dam: 939.8 (Low Point); 940.6 (High Point)

(2) Principal Spillway Crest: 936.0

(3) Emergency Spillway Crest: Not Applicable

(4) Principal Outlet Pipe Invert: Not Applicable

(5) Streambed at Centerline of Dam: 918.5

(6) Pool on Date of Inspection: 935.1

(7) Apparent High Water Mark: 939.0

(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 Top of Dam: 2900 ft

(2) At Principal Spillway Crest: 1850 ft

E. Storage Capacities:

(1) At Principal Spillway Crest: 105 acre-ft

(2) At Top of Dam: 212 acre-ft

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 18 acres

(2) At Top of Dam: 40 acres

G. Dam:

(1) Type: Earth

(2) Length at Crest: 386 ft

(3) Height: 22.1 ft (Maximum)

(4) Top Width: 15 ft

(5) Side Slopes: Upstream 3.3:1.0; Downstream 2.1:1.0 (See Sheet 3, Appendix A)

(6) Zoning: Apparently homogeneous

(7) Impervious Core: Unknown

(8) Cutoff: Unknown

(9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(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: North abutment

(2) Type: Rock cut with box culvert control section

I.2 Emergency Spillway:

(1) Location: Not Applicable

(2) Type: Not Applicable

J. Regulating Outlets:

There are no regulating or dewatering facilities associated with this dam.

SECTION 2 - ENGINEERING DATA

No design computations or reports for Kemp Lake Dam are available. No documentations of construction inspection records have been obtained. To our knowledge, there are no documented maintenance data.

2.1 DESIGN:

A. Surveys:

No information regarding pre-construction surveys could be obtained. Sheet 3 of Appendix A presents a plan, profile and cross section of the dam from survey data obtained during the site inspection. An elevation of 936.0 was assumed for the normal pool (crest of spillway) as shown on the U.S.G.S. quad sheet.

B. Geology and Subsurface Materials:

The site is located in the northeastern portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common rock types are dolomite, sandstone and chert. The lake area is underlain by the Roubidoux formation of the Canadian Series in the Ordovician System. The Roubidoux formation consists of sandstone, dolomitic sandstone and cherty dolomite. The publication "Caves of Missouri" lists a total of seven caves known to exist in Crawford County. All but one of these caves are clustered in a nine square mile area about 7 miles southeast of the site.

The "Geologic Map of Missouri" indicates a normal fault passing near the site in a northwest-southeast direction. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years (rock associated with the Ordovician Period - 500 million years old).

Soils in the area of the dam site appear to be primarily thin deposits of residual silty clays with rock fragments. The soils are of the Clarksville-Fullerton-Talbott Soil Association and have developed from thin loessial soils deposited over weathered material from cherty dolomites. These soils are not generally considered to be very erodible. The loessial thickness map indicates that upland areas may have between 2.5 and 5.0 ft of loess cover.

C. Foundation and Embankment Design:

No foundation and design information was available. Seepage and stability analyses apparently were not performed as required in the guidelines. There is apparently no particular zoning of the embankment, and no internal drainage features are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations for Kemp Lake Dam are available. Based on a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C, Sheets 1 to 7. It was concluded that the structure will pass 17 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

The appurtenant structures associated with this dam include a flagstone well (see photos 15 and 16) which is located near the center of the dam immediately downstream of the crest. The opening of the well is about 2 ft square. No records are available to indicate the purpose of the well (observation, water supply, etc.). At the time of inspection, water in the well was at an elevation of 920.2, about 15 ft below the lake surface. In addition, a concrete box culvert bridge is constructed over the spillway.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION AND MAINTENANCE:

Normal flows are passed by an uncontrolled rock cut spillway located at the north end of the dam. There are no regulating facilities associated with this dam, and therefore, no operating records are known to exist. An abundant overgrowth of trees and brush on the embankment indicates that the dam has not been maintained. However, the spillway channel--for a distance of 75 ft downstream of the control section--has recently been cleared.

2.4 EVALUATION:

A. Availability:

The engineering data available are as listed in Section 2.1. 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 June 27, 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)
Nelson Morales - Hanson Engineers, Inc. (Hydraulic Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

B. Dam:

The dam appears to be in good condition. No obvious seepage through the embankment was observed, although the abundance of tree and brush growth made it very difficult to thoroughly inspect the downstream face of the dam. A small slough on the downstream face of the dam was noted, although it appeared to be quite old and not active. Rocks had been piled at the base of the slough, apparently to resist further movement. The vertical and horizontal alignment of the crest appeared good, and no surface cracking or unusual movement was obvious. Shallow auger probes into the embankment indicated the dam to be constructed of a reddish brown silty clay with rock fragments. Frank Simmerly indicated that the borrow material for construction of the embankment was obtained from the lake area.

The embankment surface is covered by thick brush and tree growth (some trees as large as 3 ft in diameter), which made it difficult to conduct a thorough investigation of the downstream face (see Photo No. 7). Numerous small animal burrows were observed on the downstream face of the embankment. Hand laid flagstone riprap on the upstream face was in good condition. Except for the possible observation well, no instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Primary Spillway:

Trees, brush and debris were observed in the approach channel to the spillway (see Photo No. 13). The spillway

outlet channel is well separated from the embankment, and its base is cut into bedrock. Hand-laid flagstone forms the sides of the spillway.

C.2 Emergency Spillway:

There is no emergency spillway associated with Kemp Lake Dam.

D. Reservoir:

The watershed is generally wooded and grassy, with no agricultural activity. The slopes adjacent to the lake are moderate and rolling, and no sloughing or serious erosion was noted.

E. Downstream Channel:

Although a portion of the outlet channel has been cleared, some trees and brush exist in the lower reaches of the spillway (see Photo No. 14).

3.2 EVALUATION:

The extremely dense vegetative cover made a thorough inspection impractical. Trees and brush on the dam present a potential seepage hazard and encourage animal burrowing. Brush and debris in the approach channel to the spillway can restrict flood flows. The animal holes on the embankment face can increase the possibility for seepage to develop. The small slough on the downstream face could be indicative of slope instability.

All of the above are deficiencies which should be corrected; however, vegetative growth is of such size and extent that removal should be attempted only under the direction of and with observation by, an engineer experienced in the design and construction of dams. Indiscriminate clearing could create an unsafe condition.

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 spillway is uncontrolled, so that the pool is normally controlled by rainfall, runoff and evaporation.

4.2 MAINTENANCE OF DAM:

The dense tree and brush growth indicates that the dam has not been maintained in recent years. The spillway channel has been cleared for a distance of approximately 75 ft downstream of the control section.

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:

Vegetation on the dam, the animal burrows and the slide area previously described are serious deficiencies which should be corrected. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earthen embankments. Indiscriminate clearing could jeopardize the safety of the dam.

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. Mr. Simmerly indicated that the dam had never been overtopped. A recent, apparent high water mark was visible at elevation 939.0 (3.0 ft above normal pool). Our hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

Trees and brush in the approach channel to the spillway can seriously restrict flood flows. The spillway channel is well separated from the embankment, and spillway releases would not be expected to endanger the dam. Brush and tree growth in the outlet channel can restrict flood flows.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 17 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 (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the small size of the dam, the low volume of water impounded and the large downstream floodplain, 50 percent of the PMF has been determined to be the appropriate spillway design flood. The structure will pass a 100-year frequency flood without overtopping.

The routing of 50 percent of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.72 ft at elevation 941.52. The duration of the overtopping will be 5.42 hours, and the maximum outflow will be 3146 cfs. The maximum discharge capacity of the spillway is 320 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features 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. 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 embankment was constructed in 1937. The only apparent post-construction change was in 1963 when a wood bridge over the spillway was replaced by a concrete structure.

E. Seismic Stability:

The structure is located in seismic zone 1. 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) abundant tree and brush growth on embankment surface; (2) numerous small animal burrows along downstream face of dam; (3) small slough on downstream face; (4) brush and tree growth in approach and outlet channels of spillway; and (5) lack of seepage and stability analyses comparable to the requirements of the recommended guidelines.

The dam will be overtopped by flows in excess of 17 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by the owner and her employee 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 deteriorate and possibly could become serious in the future. Priority should be given to removing the brush and tree growth and increasing the size of the spillway. Removal of large trees should be under the guidance of an engineer

experienced in the design and construction of earthen dams. Indiscriminate clearing could jeopardize the safety of the dam.

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 1. 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 50 percent of the PMF.

(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 dense brush and tree growth should be removed from the embankment. This 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.

(4) The animal burrows should be repaired and maintained.

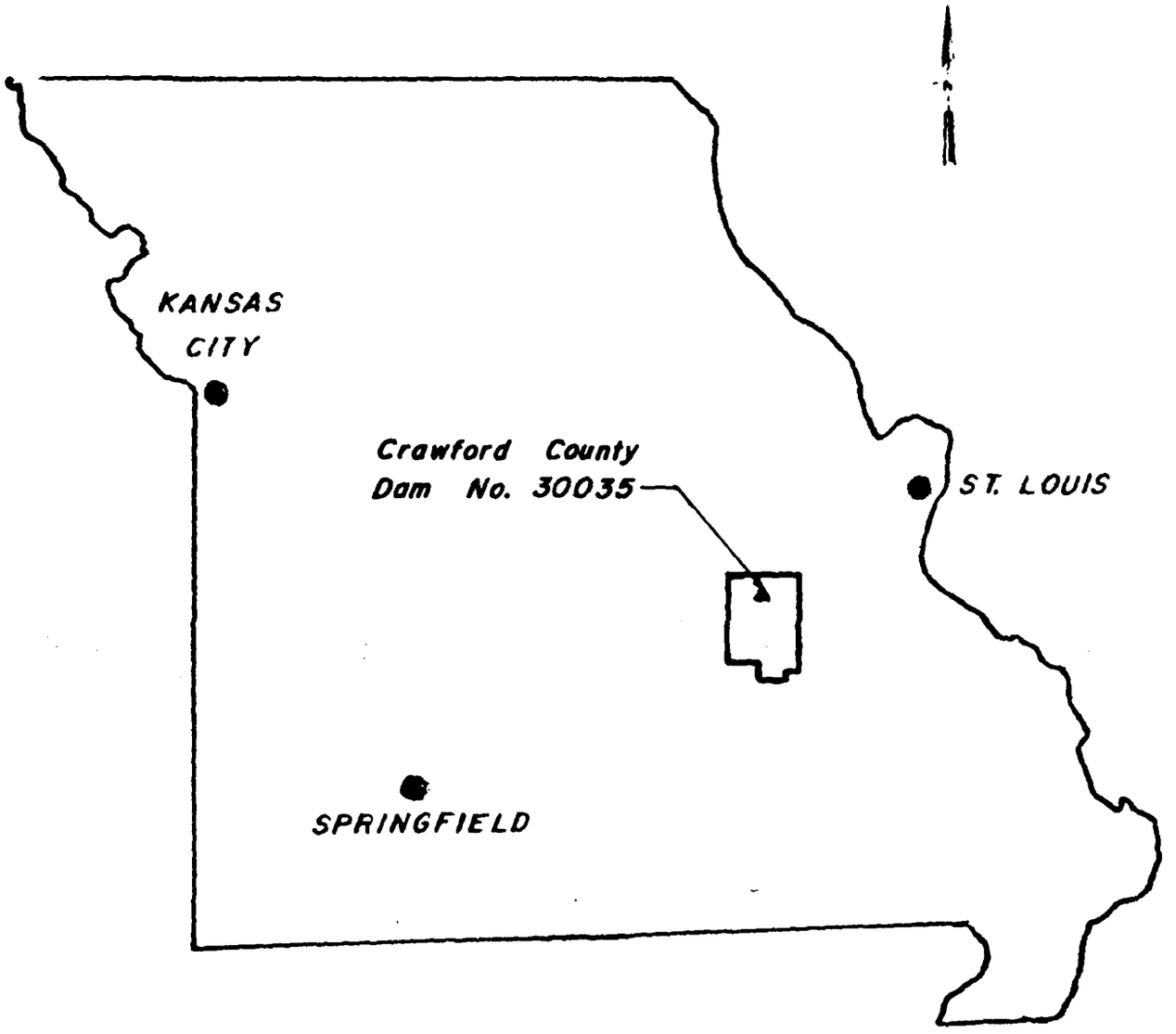
(5) The small slough should be corrected and monitored to detect further movement.

(6) The brush and trees in the spillway approach and outlet channels should be removed.

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

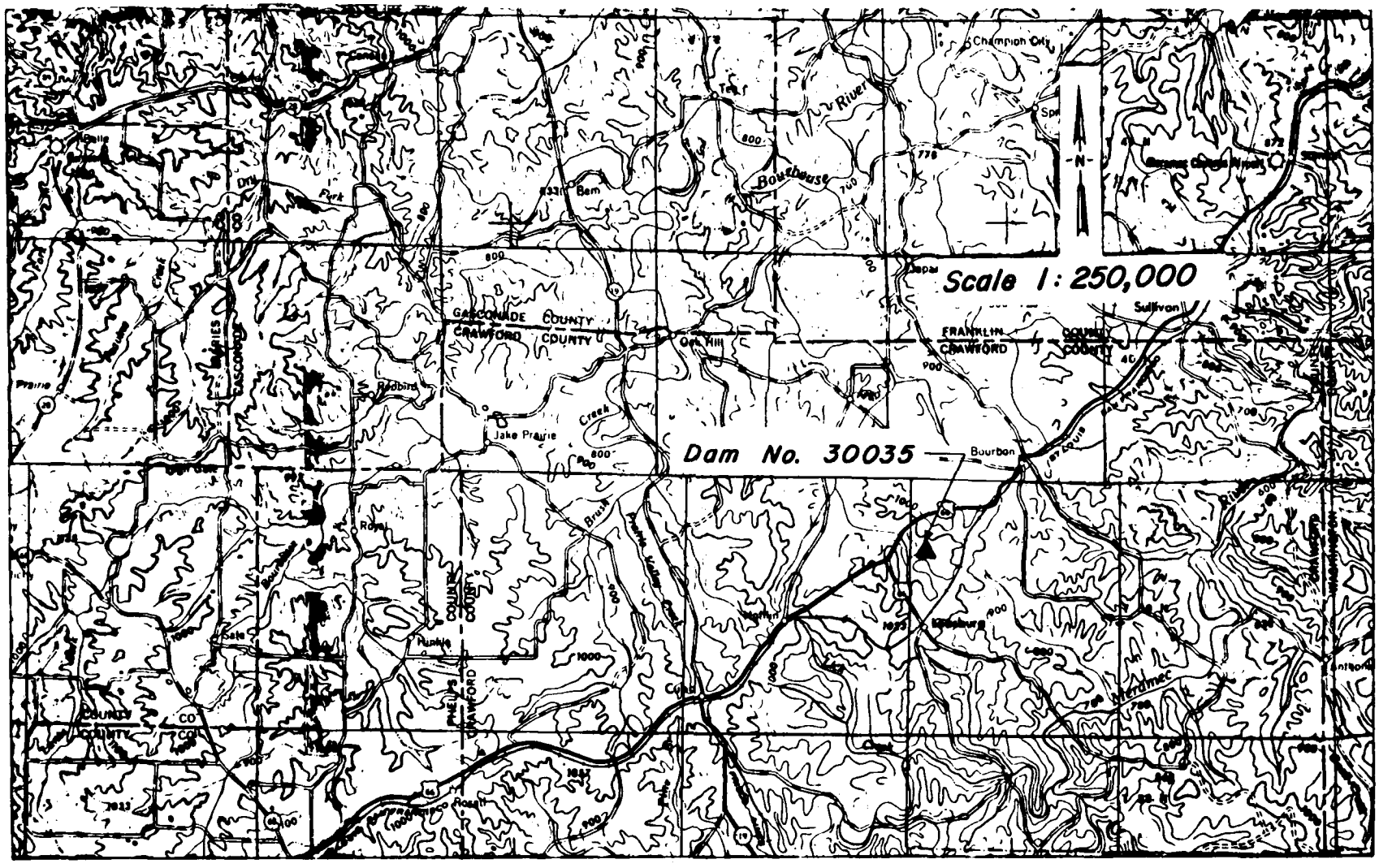
(8) The flagstone well previously described should be investigated further to determine its purpose and operation.

APPENDIX A

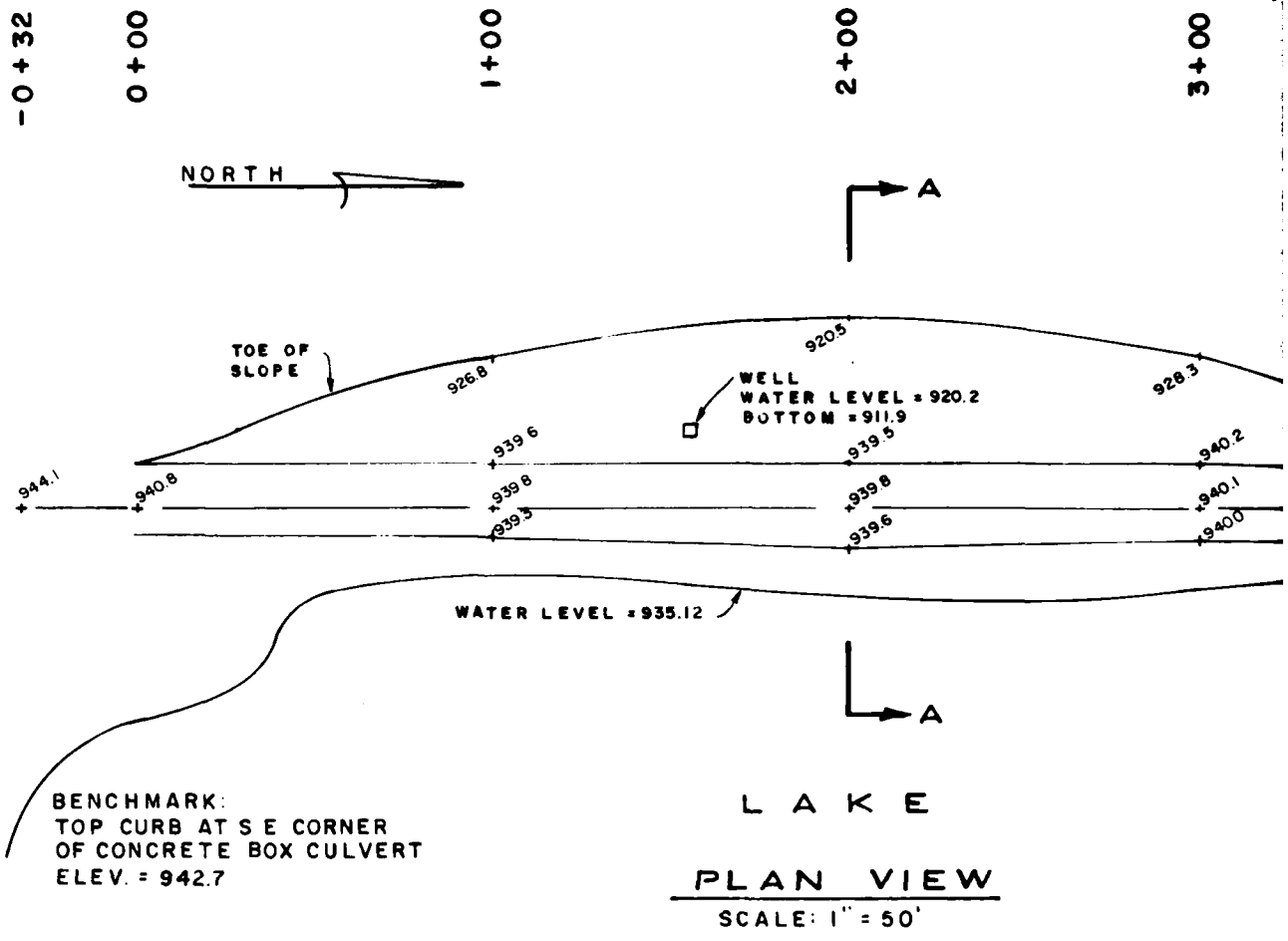


LOCATION MAP

SHEET 1 OF APPENDIX A

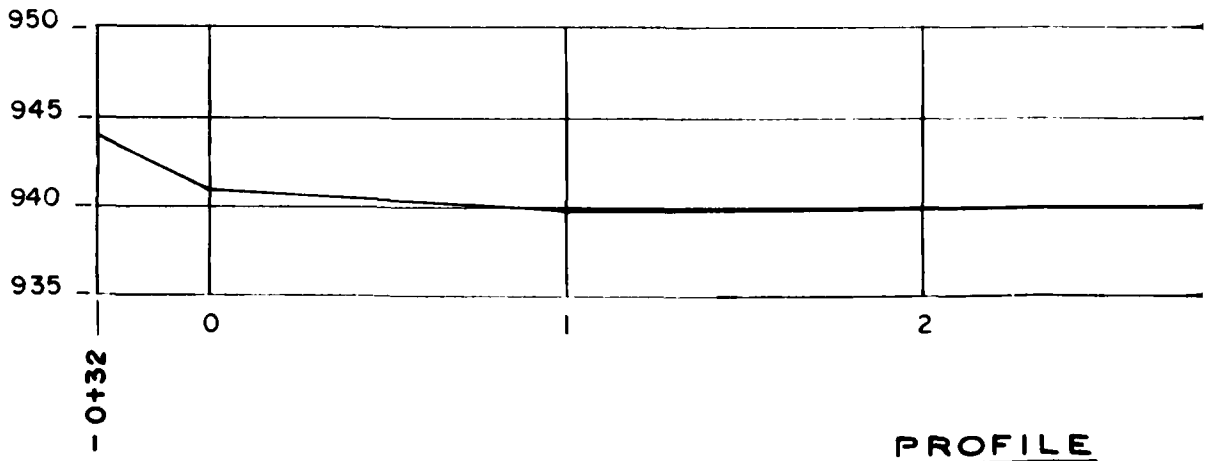


SITE VICINITY MAP

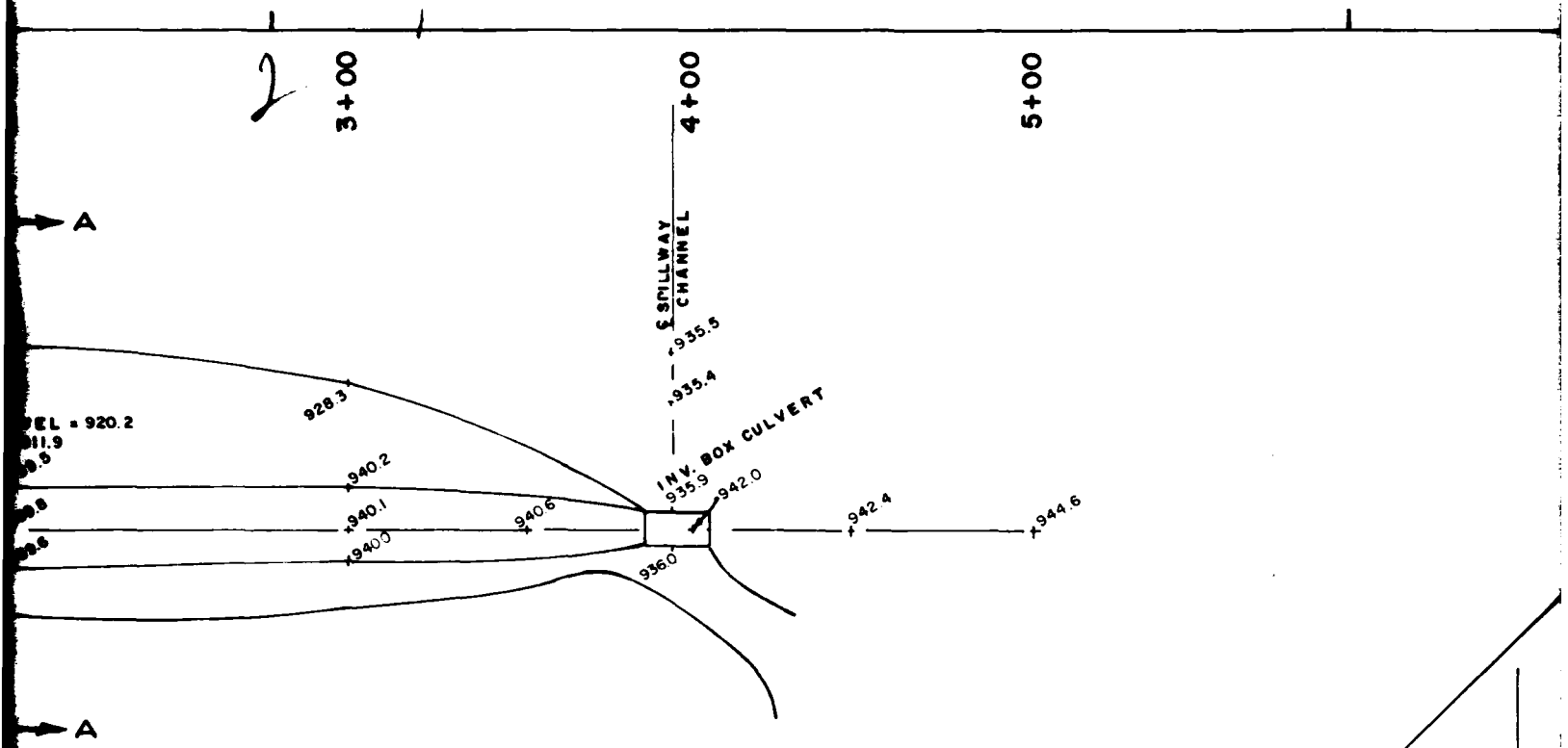


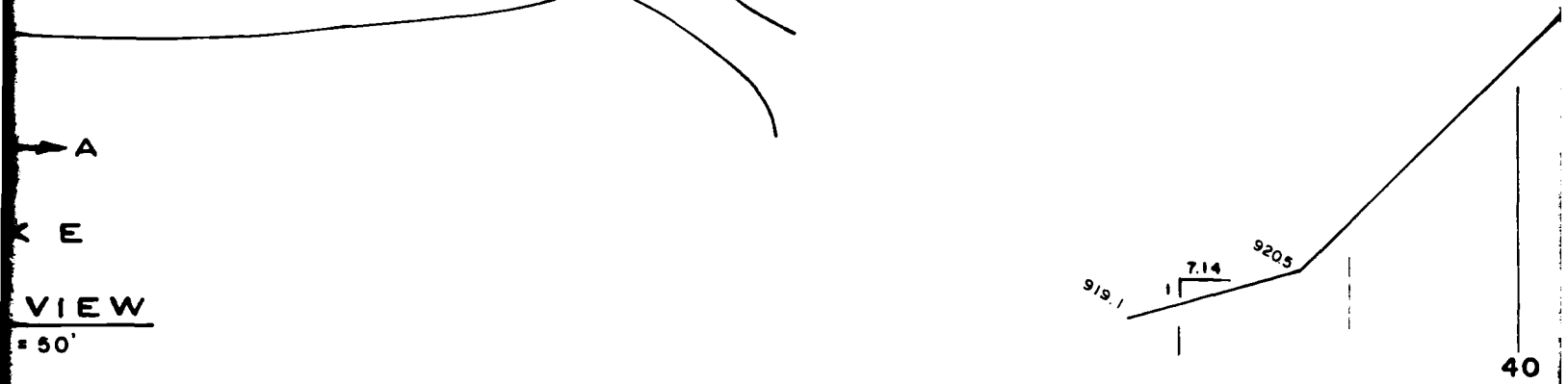
PLAN VIEW

SCALE: 1" = 50'

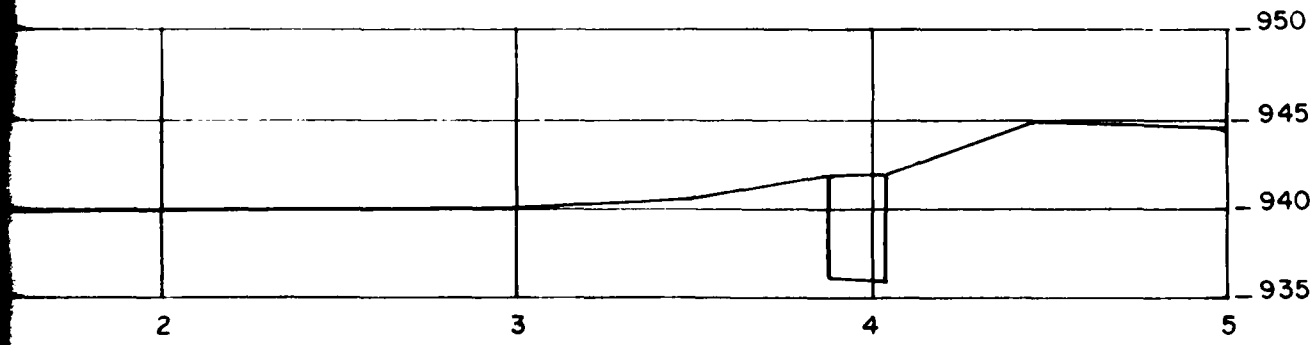


PROFILE





VIEW
= 50'



PROFILE

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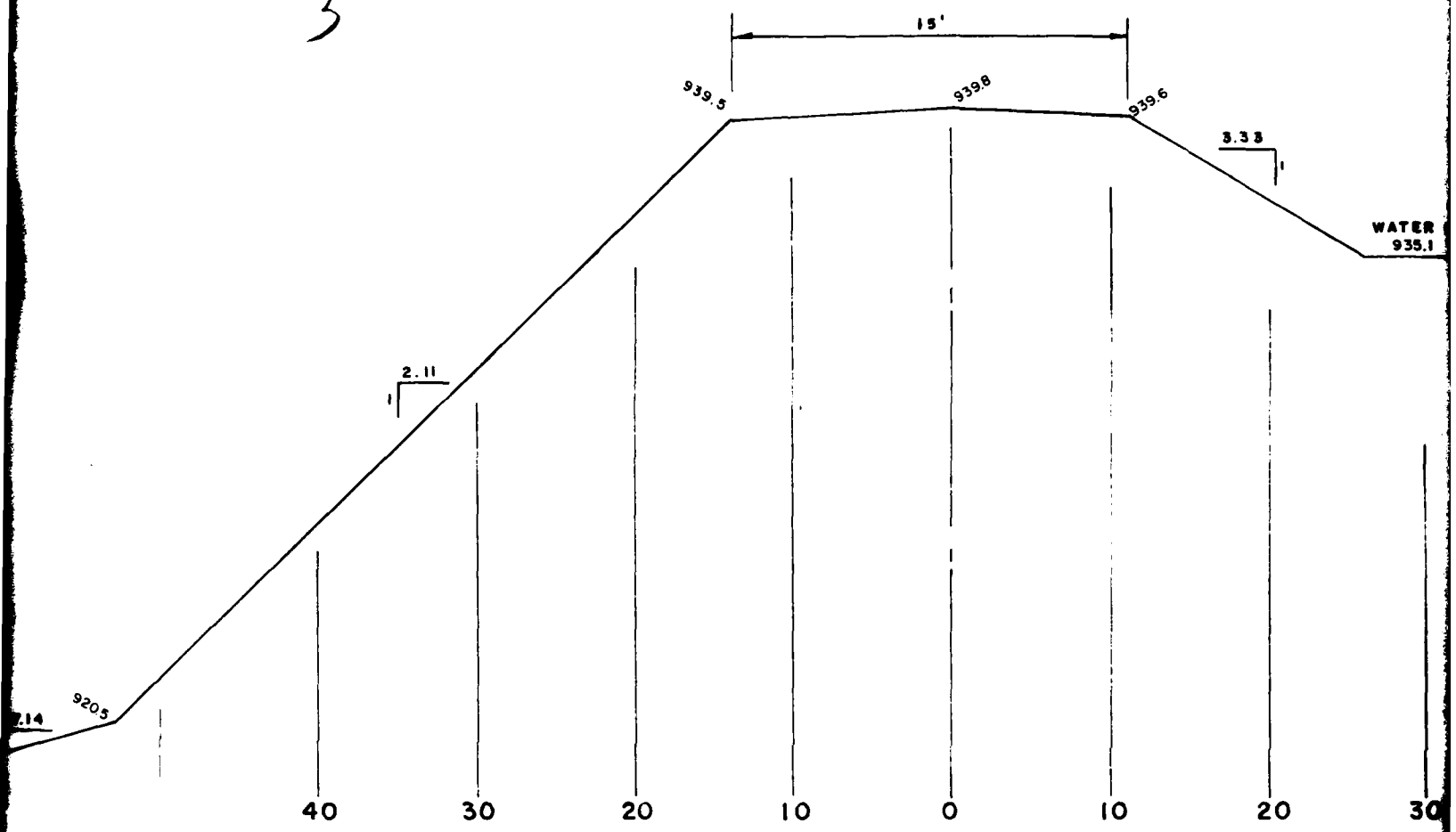

SECTION A-A STA 2+00

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945

940

935

ANDERSON ENGINEE
730 NORTH BENTON
SPRINGFIELD, MIS

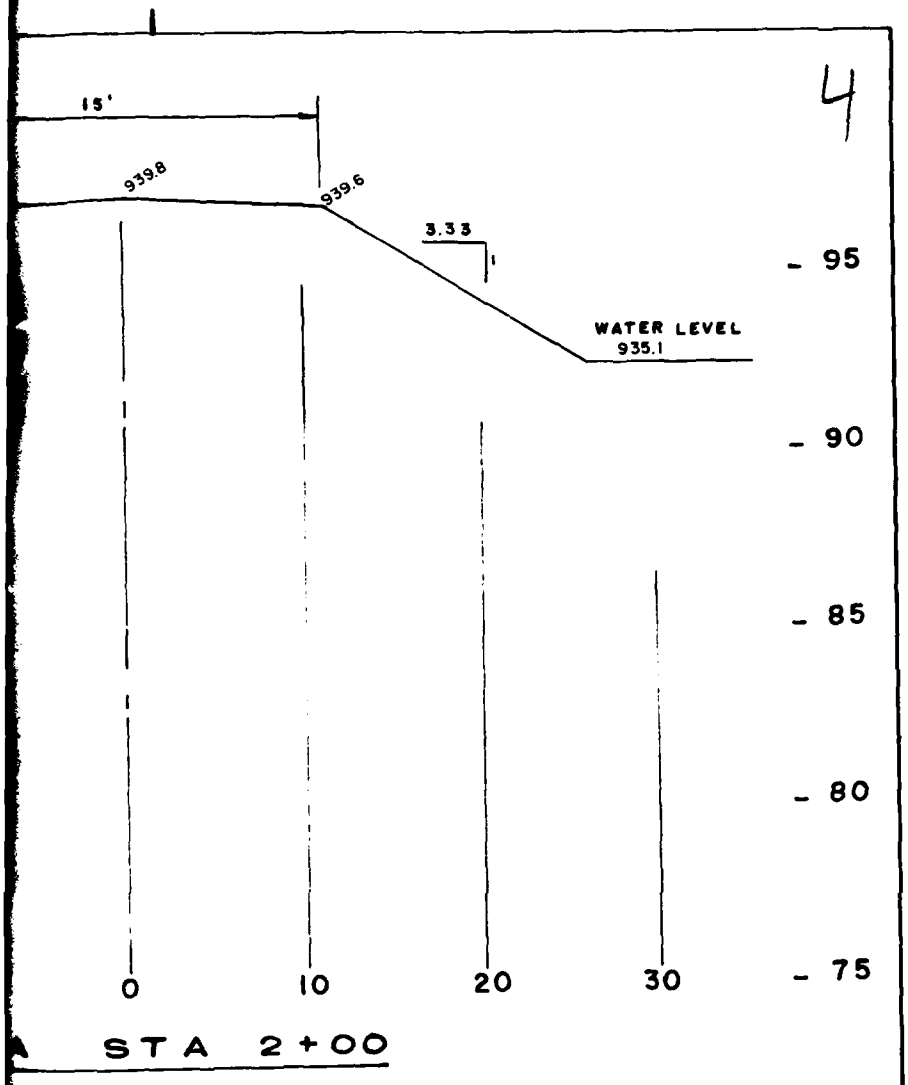
KEMP L

MO. No. 30

PLAN & PR

CRAWFORD COU

Sheet 3 of Appendix A



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

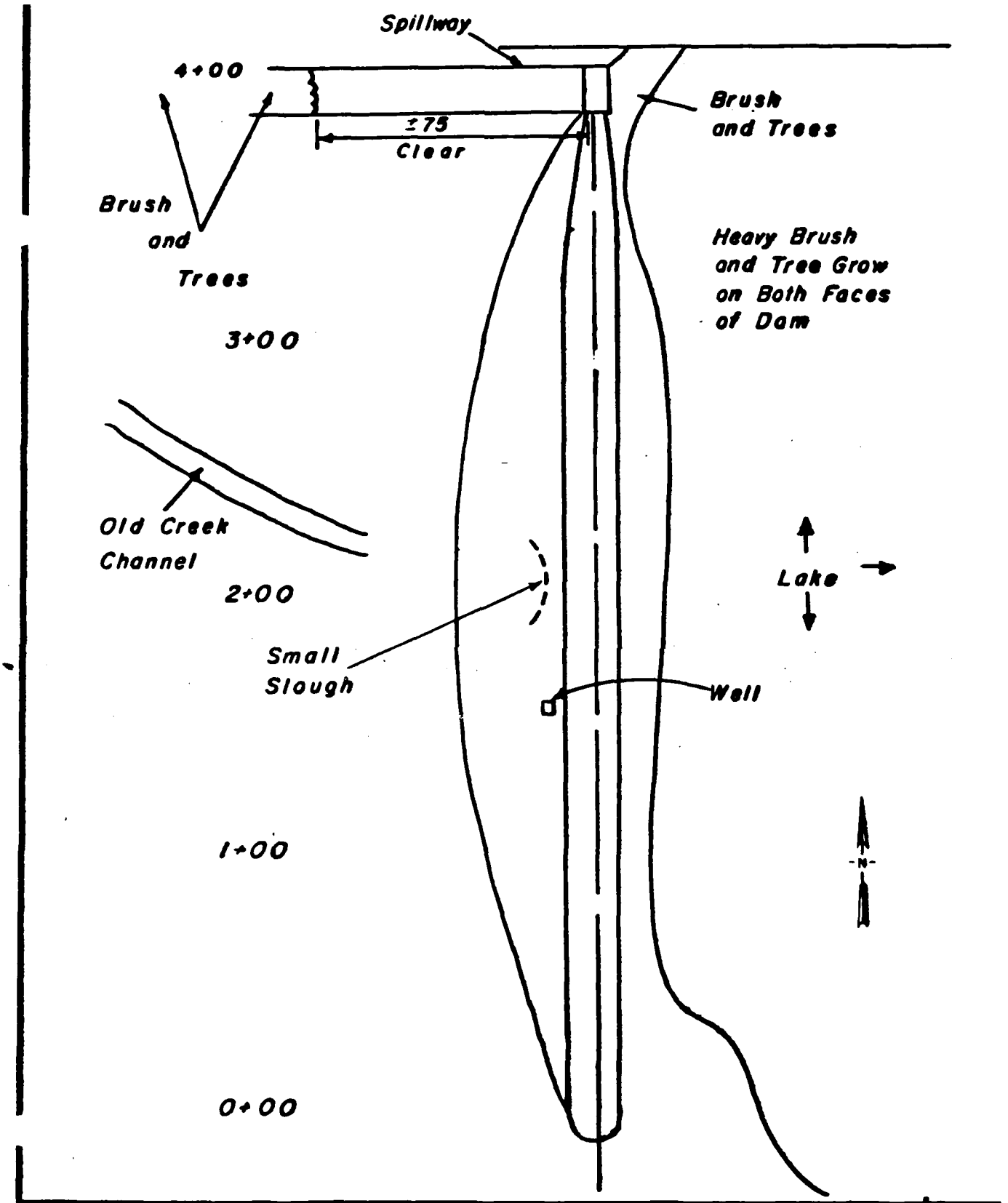
KEMP LAKE

MO. No. 30035

PLAN & PROFILE

CRAWFORD COUNTY, MO.

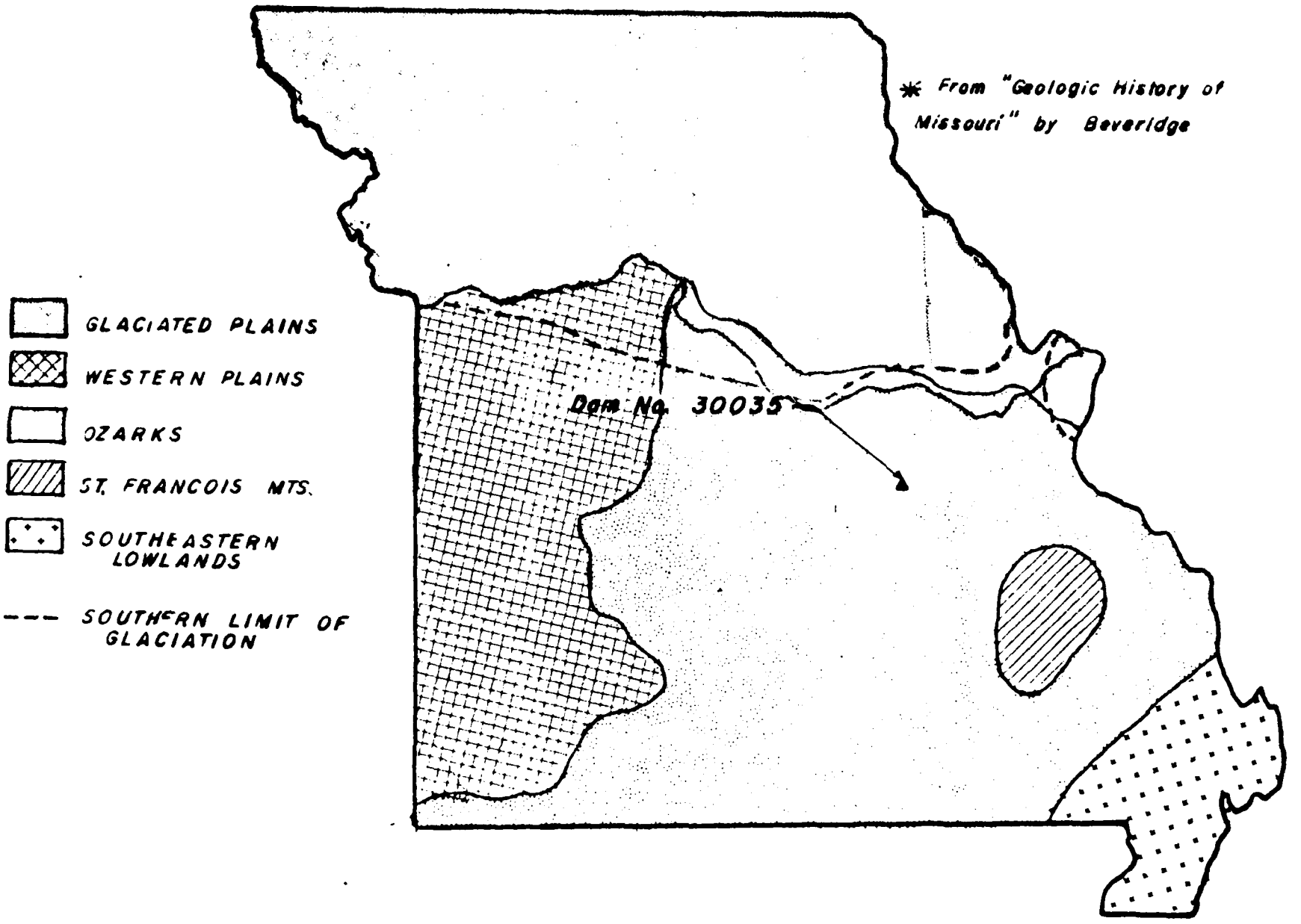
t 3 of Appendix A



DRAWN TRC CHECKED DED DATE 7-19-79 JOB NO. 79511	HANSON ENGINEERS SPRINGFIELD ILL. PEORIA ILL.	Plan Sketch Inspection Observation Sheet 4 Appendix A

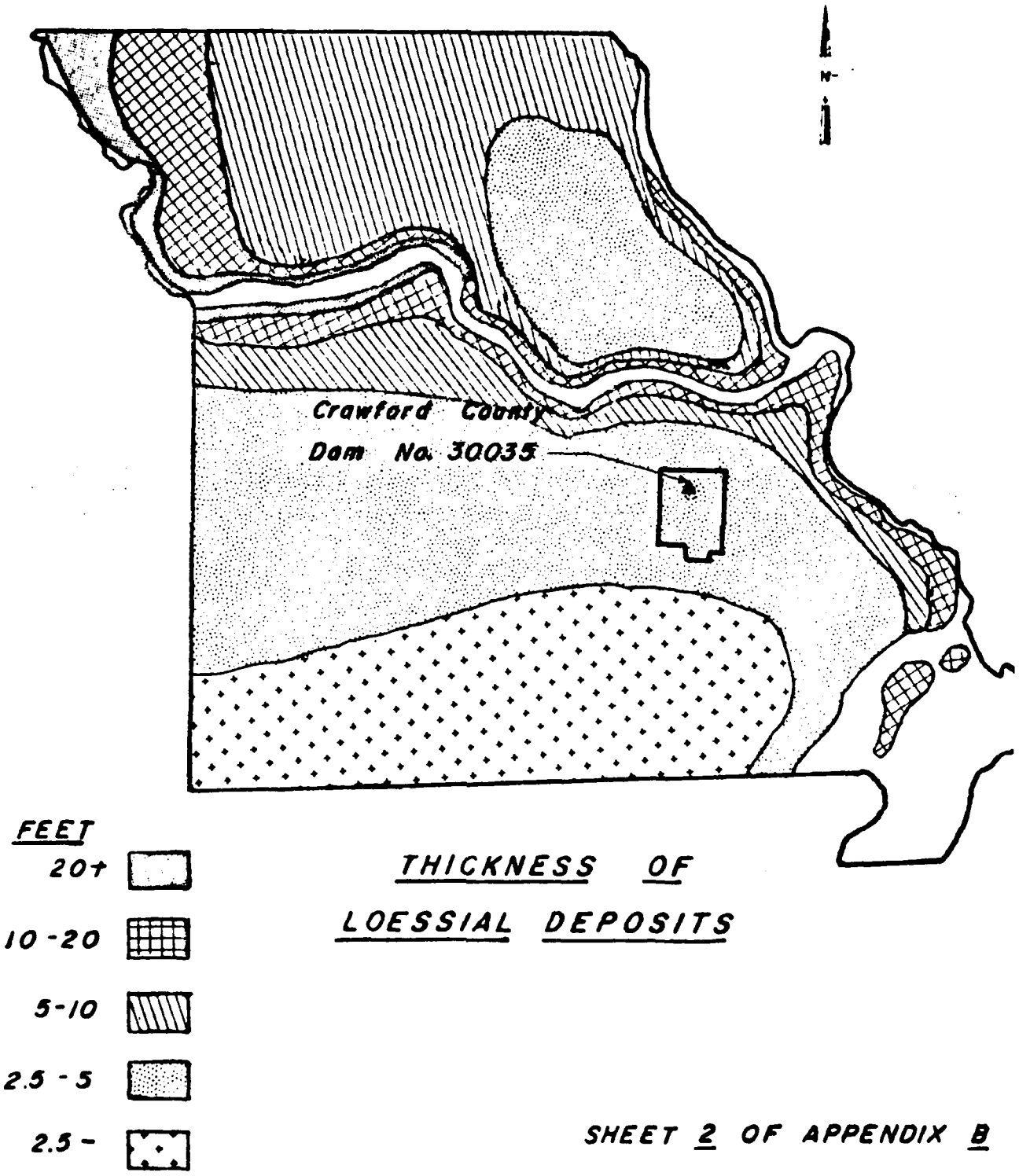
APPENDIX B

MAJOR GEOLOGIC REGIONS OF MISSOURI



SHEET 1 OF APPENDIX B

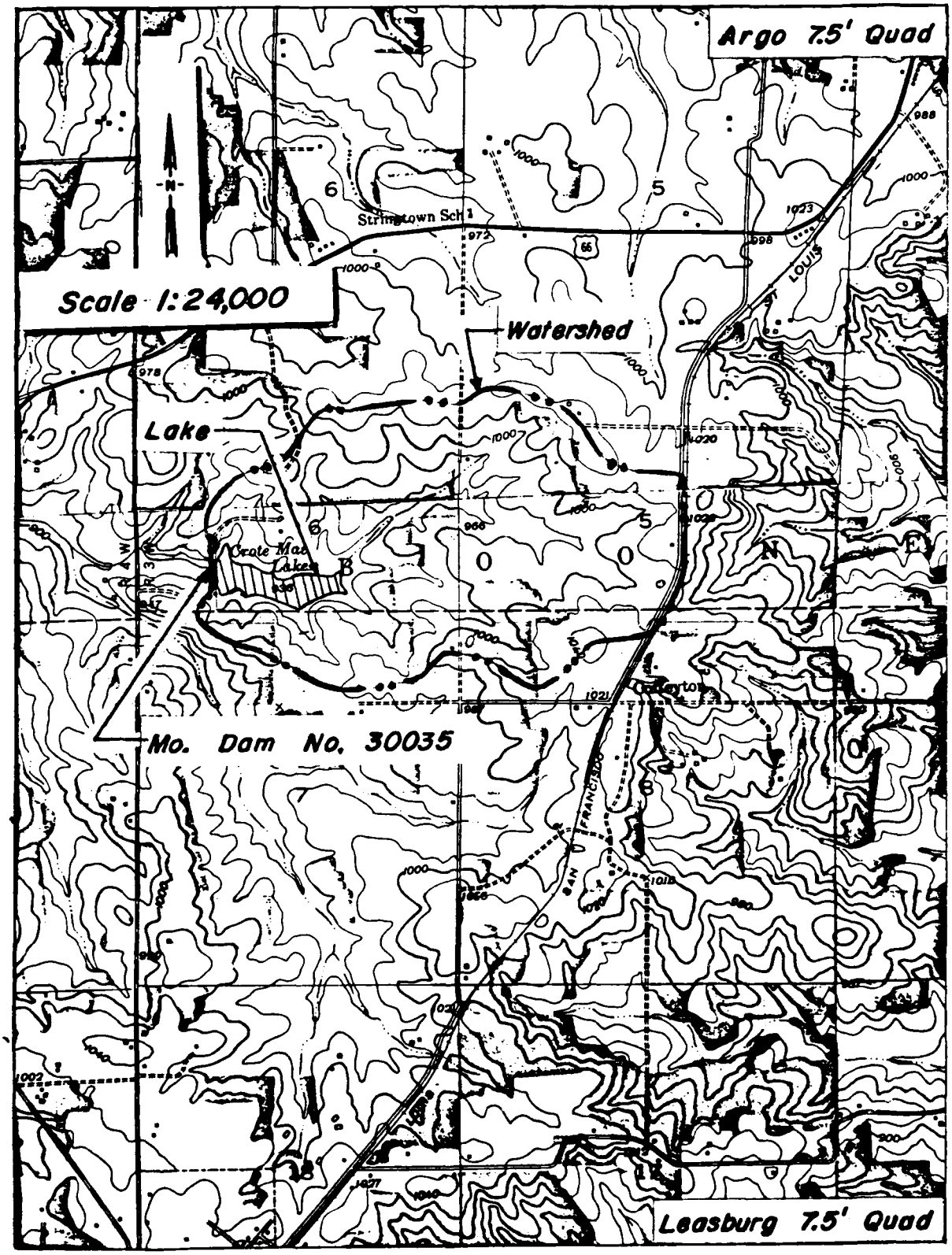
* From "Soils of Missouri"



THICKNESS OF LOESSIAL DEPOSITS

SHEET 2 OF APPENDIX B

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. The owner, Mrs. Kemp, indicates that the dam has never been overtopped and that the highest elevation of the lake has been about 1 ft below the crest of the dam. The high water marks found the day of the inspection were at elevation 939.0 (0.8 ft from the crest of the dam). No indication of overtopping was found.

Visual Inspection: At the time of the inspection, the pool level was approximately 0.88 ft 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. Leasburg and Argo, Missouri 7.5 minute quadrangle maps. 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 1308 c.f.s. and a time to peak of 18 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 8156 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the spillway will pass 17 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 (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering the small volume of water impounded, the small height of the dam and the large floodplain downstream, 50 percent of the PMF has been determined to be the appropriate spillway design flood.

The routing of 50 percent of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.72 ft at elevation 941.52. The duration of the overtopping will be 5.42 hours, and the maximum outflow will be 3146 c.f.s. The maximum discharge capacity of the spillway is 320 c.f.s.

The 100 year frequency flood was also routed through the spillway. The result indicates that the dam will not be overtopped by such an event. The computer input, output and hydrographs for 50 percent of the PMF are presented at the end of this Appendix.

OVERTOPPING ANALYSIS FOR KEMP 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 25.8 Inches For 200 Square Miles - All Season Envelope

b. Drainage Area = 519 Acres; = 0.81 Sq. Miles

c. Travel Time of Runoff 0.44 Hrs.; Lag Time 0.26 Hrs.

d. Soil Conservation Service Soil Group B

e. Soil Conservation Service Runoff Curve No. 78 (AMC III)
(No. 60 AMC II for the 100 Yr. Flood)

f. Proportion of Drainage Basin Impervious 0.04

2. Spillways

a. Primary Spillway: Rectangular Concrete Box Culvert (4.25 ft x 14 ft), Crest El. 936.0

b. Emergency Spillway: None

Length - Ft.; Side Slopes - ; C = -

c. Dam Overflow

Length 400 Ft.; Crest El. 939.8 ; C = 3.0

3. Spillway and Dam Rating:

Curve Prepared by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards. (Sheet 5 Appendix C) Box Culvert with entrance control was assumed for the spillway and $Q=CLH^{1.5}$ for the dam.

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.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph

   a. Peak - 1308 c.f.s.

   b. Time to Peak 18 Min.

2. Flood Routings Were Computed by the Modified Puls Method

   a. Peak Inflow

      50% PMF 4078 c.f.s.; 100% PMF 8156 c.f.s.

   b. Peak Elevation

      50% PMF 941.52 100% PMF 942.73

   c. Portion of PMF That Will Reach Top of Dam

      17 %; Top of Dam Elev. 939.8 Ft.

3. Computer Input and Output Data are shown on Sheets 5 and 6 of this Appendix.

```
A       OVERTOPPING ANALYSIS FOR KEMP LAKE ( DAM N18 )
A       STATE ID NO. 30035  CO. NO. 055  CO. NAME CRAWFORD
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 79511
B     300               5
B1      5
J       1       7       1
J1    .15     .20     .30     .40     .50     .75     1.0
K       0       1                               3       1
K1      INFLOW HYDROGRAPH COMPUTATION
M       1       2    0.81            0.81       1                       1
P       0    25.8     102     120     130
T                                                   -1     -78            0.04
U2   0.44    0.26
X       0     -.1       2
K       1       2                               4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE
Y                               1       1
Y1      1                                      105      -1
Y4    936   936.7   937.7   938.7   939.8   940.7   941.7   942.7   944.7   946.7
Y5      0      25      96     192     320     357     462     546     672     798
$A      0      18      40      63
$E  918.5     936   939.8   946.7
$$    936
$D  939.8     3.0     1.5     400
K      99
```

P.M.F. INPUT DATA

SHEET 5 APPENDIX C

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

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 0.15	RATIO 2 0.20	RATIO 3 0.30	RATIO 4 0.40	RATIO 5 0.50	RATIO 6 0.75	RATIO 7 1.00
HYDROGRAPH AT	1	0.81	1	1223.	1631.	2447.	3262.	4078.	6117.	8156.
	(	2.10)	(	34.64)(	46.19)(	69.28)(	92.38)(	115.47)(	173.21)(	230.95)(
ROUTED TO	2	0.81	1	292.	594.	1605.	2446.	3146.	4859.	6576.
	(	2.10)	(	8.27)(	16.83)(	45.44)(	69.25)(	89.09)(	137.60)(	186.21)(

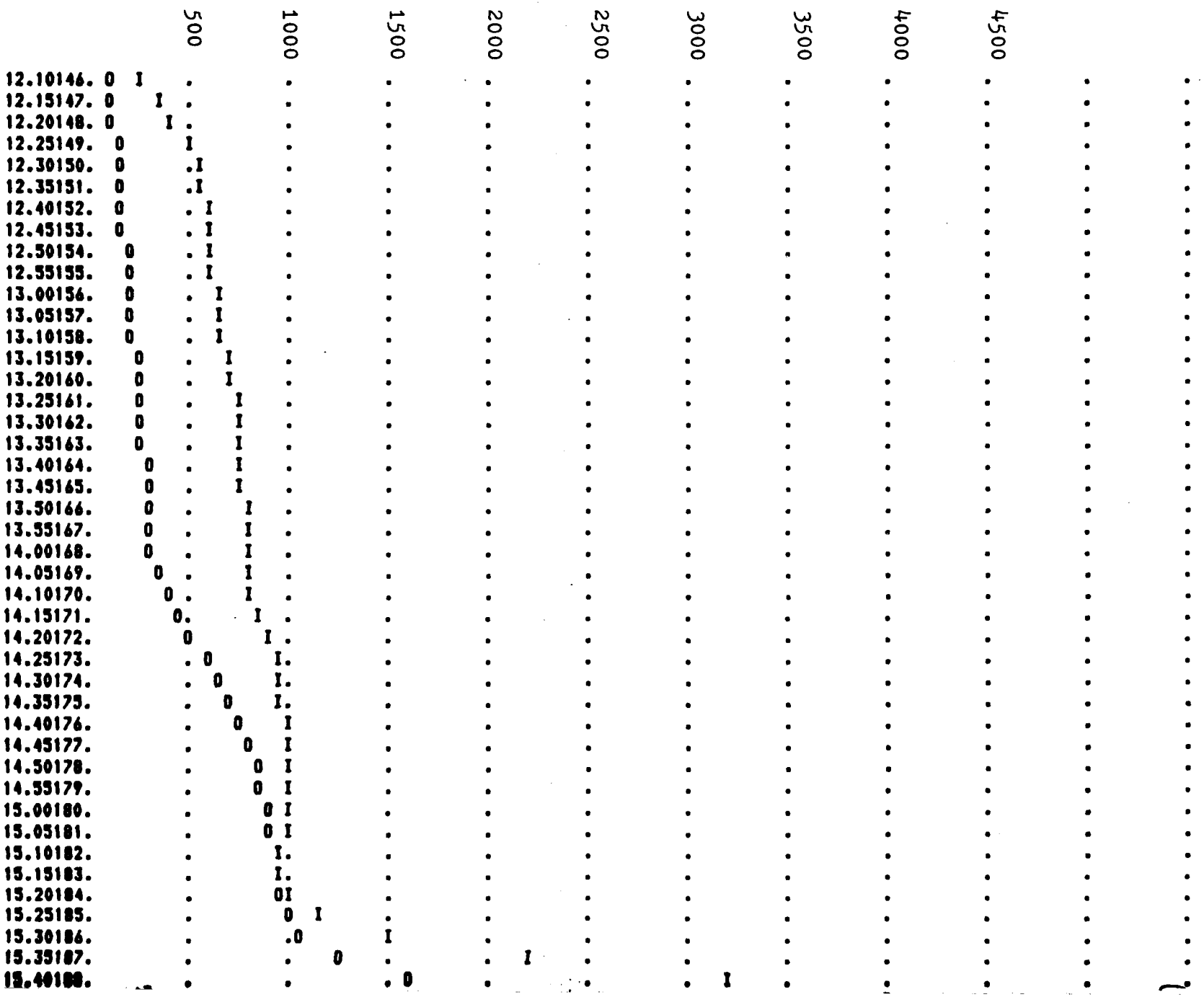
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	936.00	936.00	939.80
STORAGE	105.	105.	212.
OUTFLOW	0.	0.	320.

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
0.15	939.56	0.00	203.	292.	0.00	16.92	0.00
0.20	940.16	0.36	227.	594.	2.50	16.33	0.00
0.30	940.82	1.02	255.	1605.	3.33	16.08	0.00
0.40	941.22	1.42	272.	2446.	4.58	16.00	0.00
0.50	941.52	1.72	286.	3146.	5.42	16.00	0.00
0.75	942.16	2.36	315.	4859.	6.83	16.00	0.00
1.00	942.73	2.93	343.	6576.	7.67	16.00	0.00

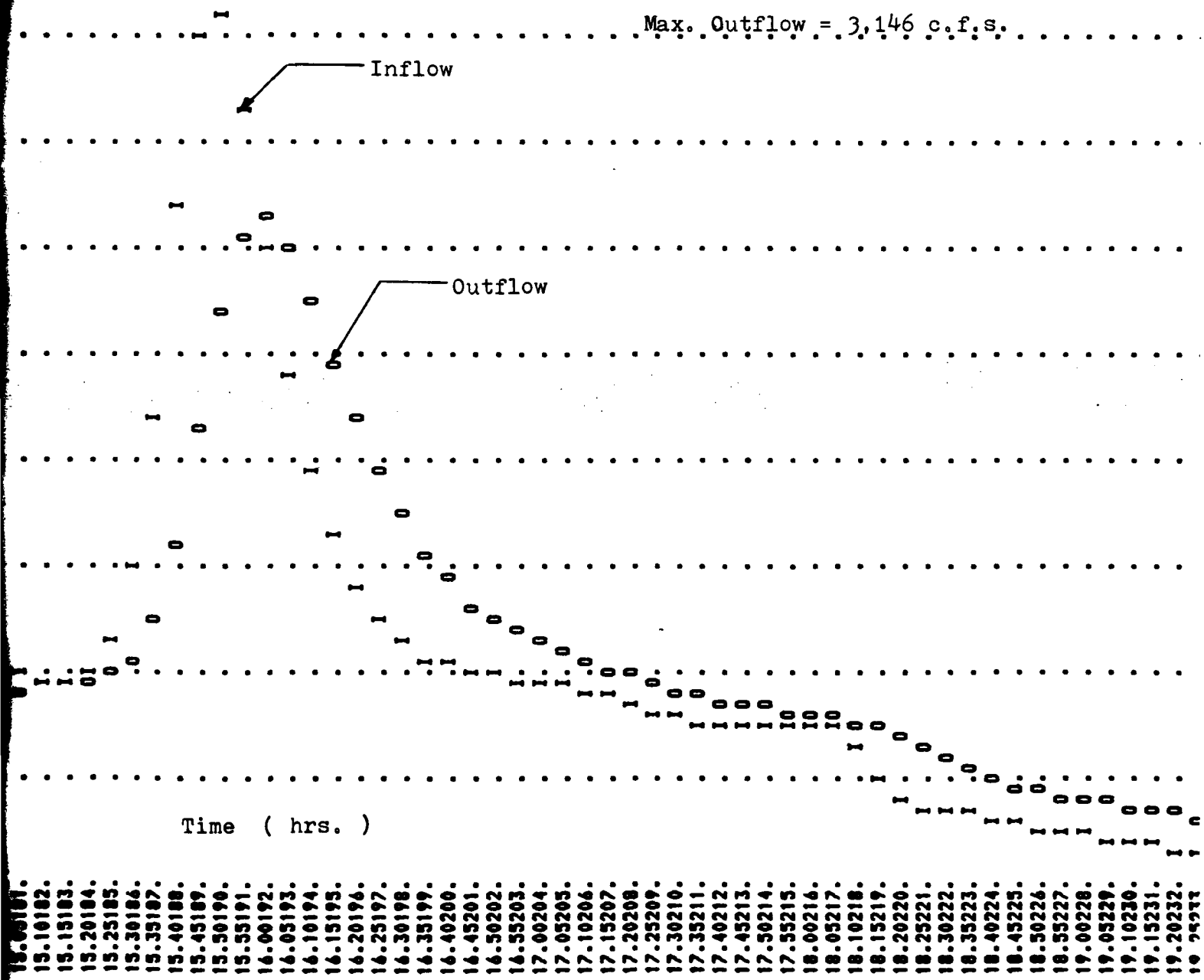
Discharge (c.f.s.)



INFLOW - OUTFLOW
HYDROGRAPH
FOR 50% P. M. F.

Max. Inflow = 4,078 c.f.s.

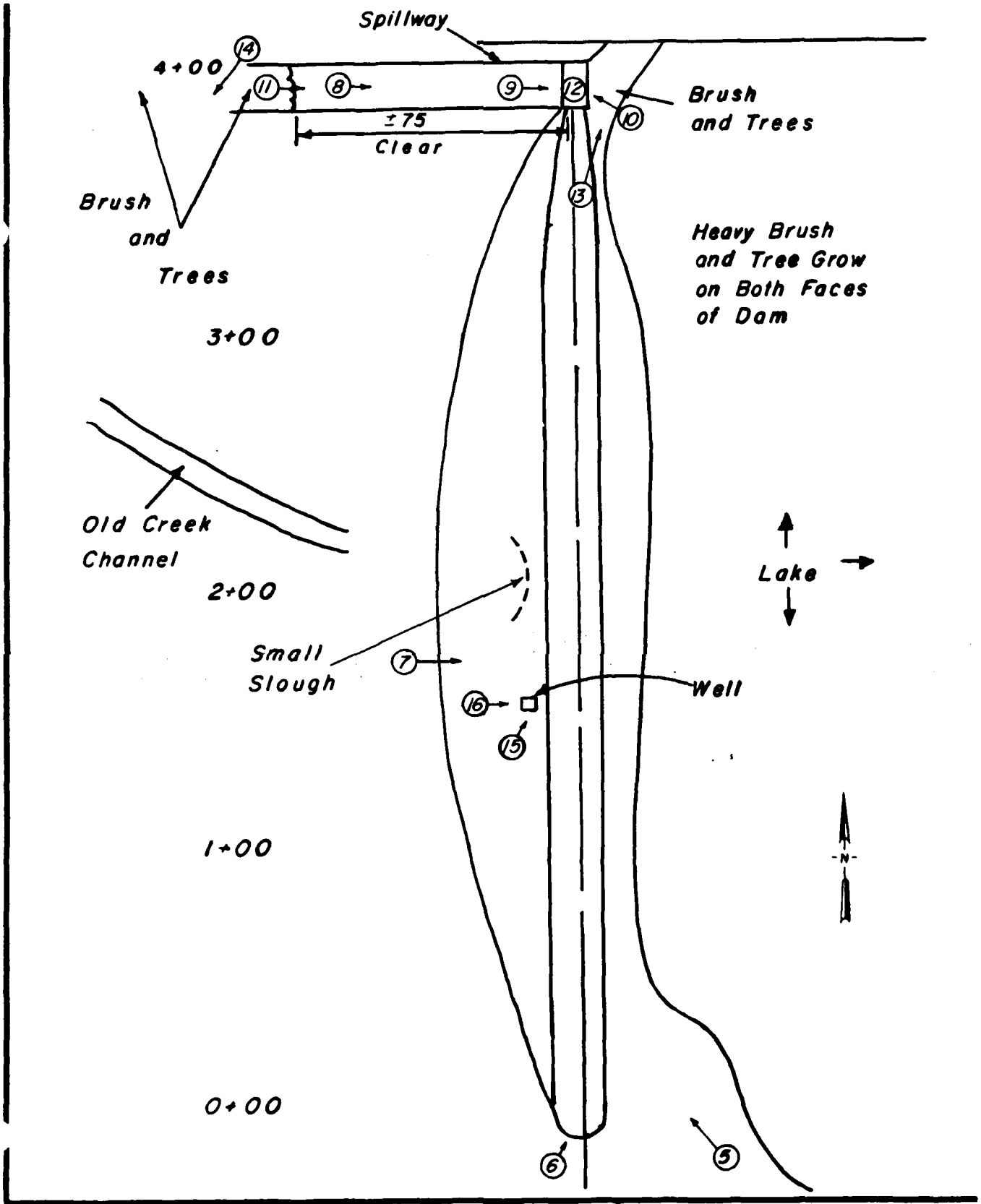
Max. Outflow = 3,146 c.f.s.



APPENDIX D

INDEX TO PHOTOGRAPHS

Photo No.	Description
1	Aerial - Looking upstream (east) at lake and watershed
2	Aerial - Looking north at dam
3	Aerial - Looking at downstream face of dam
4	Aerial - Looking southwest at upstream face of dam
5	Upstream face of dam - Looking northwest
6	Crest of Dam - Looking north
7	Downstream face of dam
8	Spillway channel - Looking upstream at control section
9	Box culvert control section - Looking upstream
10	Box culvert control section - Looking downstream
11	Spillway channel - Looking upstream
12	Spillway channel - Looking downstream from bridge
13	Approach area of spillway
14	Spillway channel, ± 75 ft downstream of control section
15	Flagstone "well"
16	Closeup of flagstone "well" - Looking down into well



DRAWN TRC CHECKED DED DATE 7-19-79 JOB NO 79511	HANSON ENGINEERS SPRINGFIELD ILL. PEORIA ILL.	Plan Sketch Key to Photographs Sheet 2 Appendix D

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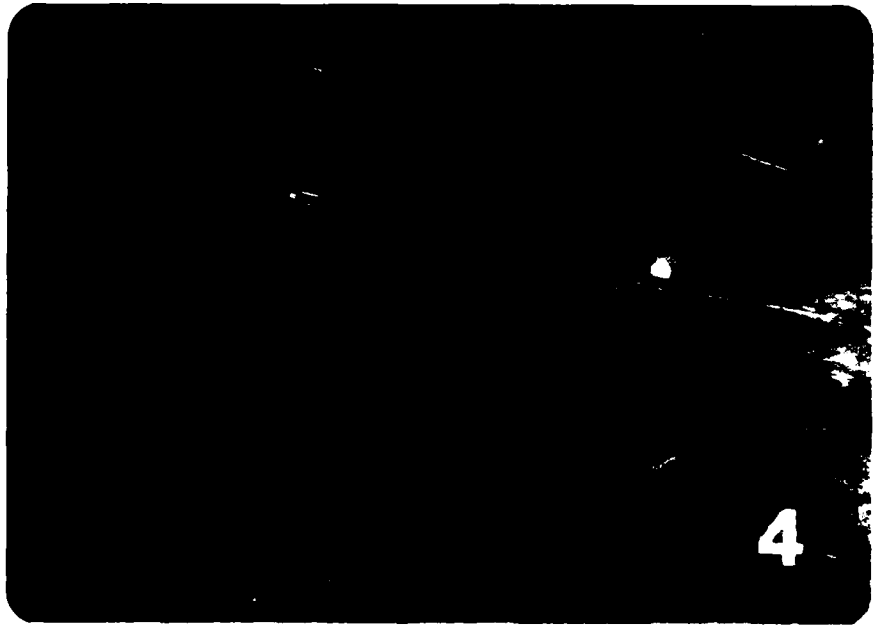
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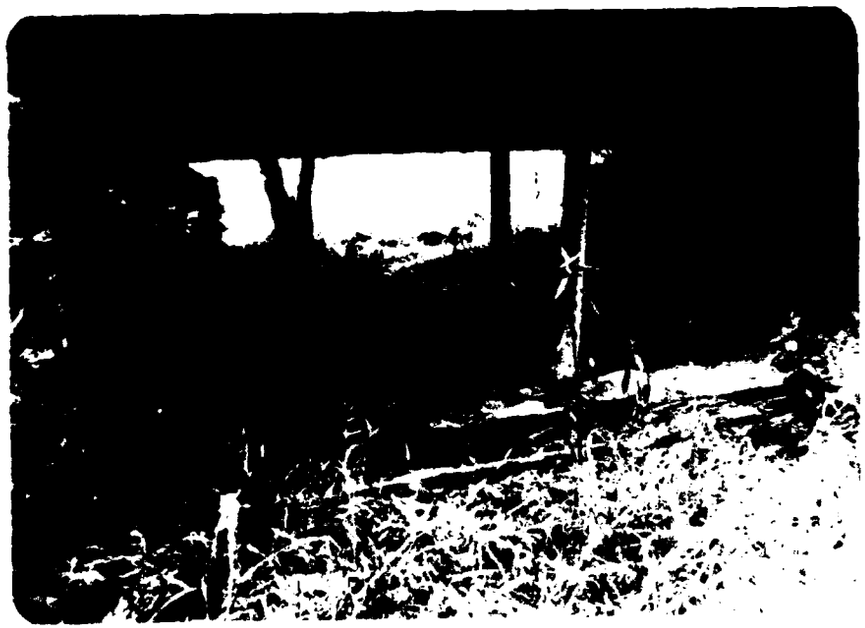

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